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Turfgrass and Environmental Research Online

...Using Science to Benefit Golf

Photo credit: Isidor Jeklin

Researchers from the U.S. Fish and Wildlife Service and Clemson University used several golf courses located in the South Atlantic Coastal Plain to assess the value of golf courses to breeding bird species by evaluating how birds occupy golf courses with different designs and habitat configurations. Of particular importance was the value of golf course habitat on neotropical migrants such as the great-crested flycatcher (shown above) that commonly occur on golf courses with forested habitats.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 215 projects at a cost of $21 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf.***

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Golf Courses and Bird Communities in the South Atlantic Coastal Plain

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SUMMARY

Although golf course construction significantly alters the natural wildlife habitat matrix, in many cases the post-construction complex of remnant, disturbance, and introduced habitat patches can provide valuable habitat for avian species including neotropical migrant land birds. Researchers at the U.S. Fish and Wildlife Service and Clemson University sampled 24 golf courses that ranged in habitat alteration (e.g. disturbance of native vegetation) during the summer months of 2000 and 2001 to assess the value of golf courses to the breeding bird community of coastal South Carolina. Their findings include:

- The majority of birds (46.5%) associated with less developed landscapes (i.e. golf courses with less habitat disturbance) were woodland breeding species, while urban breeding species were found primarily on golf courses in which the majority of native vegetation had either been removed or replaced with ornamental vegetation, or contained a high level of human disturbance including residential and non-residential structures.
- Breeding bird species richness and neotropical bird richness were negatively related to landscape alteration and were greatly influenced by the amount of forested area within golf courses.
- Habitat improvements within golf courses for breeding bird species are possible by increasing the amount of forested area, particularly forested wetland, pine forests, and pine-hardwood mixed forests, and creating scrub-shrub patches in the place of non-essential turf areas.

The new millennium is an exciting and challenging time for bird conservation efforts throughout North America. Bird conservation is receiving more attention than ever before due to concerns about declining bird populations in the face of accelerating human alterations to our natural world (19). Of particular concern have been the downward trends in the populations of many neotropical migratory birds, birds that breed in North America and winter primarily in Central and South America.

Biologists, using advanced scientific knowledge gained mostly in the latter half of the past century, have looked closely at a combination of indicators of the health of species populations including breeding and wintering distribution, abundance, long-term population trends, and present and future threats to establish conservation priorities for species of concern (2). Coordinated international, national, regional, state and local initiatives involving a broad array of public and private partners have developed to establish meaningful bird conservation goals and strategies that are being implemented as local on-the-ground habitat conservation projects. Examples of these include the North American Bird Conservation Initiative (20), North American Waterfowl Management Plan (13), and North American Waterbird Management Plan (8).

Considering bird conservation priorities at larger geographic scales has required a different scientific approach to understanding what makes a bird friendly landscape and how these landscapes can be maintained, enhanced, and restored. Fortunately, in the past decade, avian ecologists

Photo credit: Frederick Truslow

Maintaining forested wetland habitat on golf courses in the South Atlantic Coastal Plain can provide breeding habitat for the prothonotary warbler.

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shifted their focus from bird-habitat relationships at the micro-habitat scale to landscape scale studies designed to understand how habitat patches as elements of the larger landscape habitat mosaic influence bird communities. As a significant landscape element in many regions of the country, well designed golf course habitat patches have a unique role to play in bird conservation at the landscape scale.

Golf courses are a frequently occurring landscape unit within the South Atlantic Coastal Plain. As a form of landscape alteration, golf course construction (9) produces physical and biological modifications within a landscape unit (4) resulting in altered spatial configurations that influence avian habitat selection (11). Though limited construction and environmental alteration were involved in the establishment of the first courses of the 15th century, current popularity of the sport requires building a greater number of courses within areas that involve extensive land disturbance (9).

Although golf course construction significantly alters natural wildlife habitat, with proper design and management, the post-construction complex of remnant, disturbed, and introduced habitat patches could provide valuable habitat for avian species and community establishment (9). Developing golf courses as an integral part of the natural landscape is becoming more popular due to concerns about the effects extensive landscape disturbance may have on ecological functions and values.

Golf courses in the coastal region of South Carolina are typically planned and constructed either as an integral component of private residential developments or as stand-alone landscape units. With hundreds of golf courses being built every year in the United States (18), land consumption, habitat alteration, and subsequent effects on breeding bird communities are of immediate concern. To achieve the goal of providing an enjoyable recreational facility that is environmentally sound and operated successfully, courses must be carefully designed, properly constructed and responsibly managed (9).

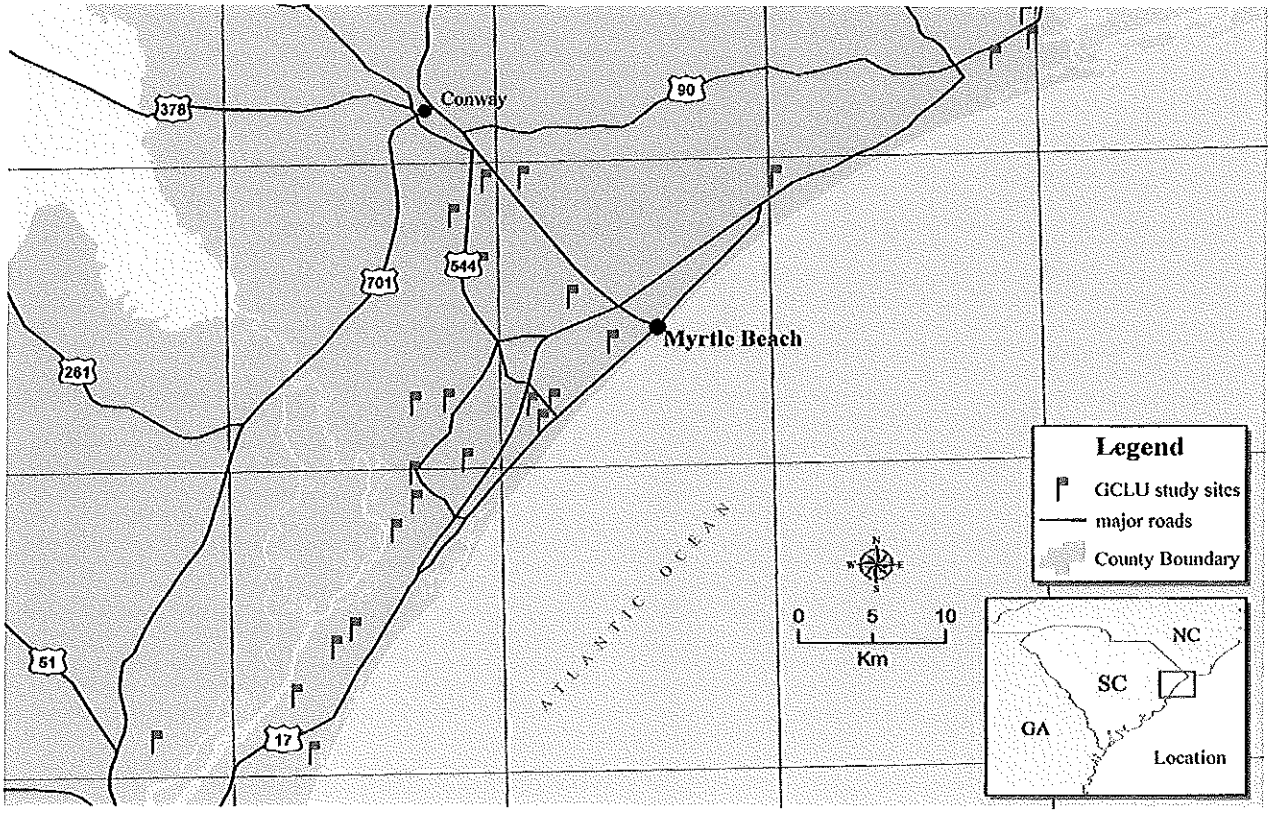

Figure 1. Study site location along northern coast of South Carolina

Figure 2. Point count grid sample design

Management of the landscape unit can be influenced by independent and joint actions of course operators and property owner associations. Both parties have a vested interest in maintaining an aesthetically pleasing tract of "green space" often with a coincidental interest in wildlife values.

The purpose of the project was to assess the value of golf courses to breeding bird species by evaluating how birds occupy golf courses with different designs and habitat configurations. An understanding of bird-habitat relationships will provide golf course superintendents and developers a means to establish design, construction, and management procedures for maintaining golf courses with suitable habitat for breeding bird communities.

Methodology

Site Classification

Twenty-four golf course landscape units along the north coast of South Carolina representing a landscape alteration gradient of sites ranging from high to low habitat alteration were selected for study (Fig. 1). Highly altered sites were golf courses in which the majority of native vegetation had either been removed or replaced with ornamental vegetation or contained a high level of human disturbance including residential and non-residential structures. Less altered sites were considered to be those golf courses in which the majority of native vegetation was left intact with a substantial amount of forested area interspersed throughout the landscape and minimal human dis-

turbance. Using color infrared aerial photography and ground-truthing visits each golf course was assigned to one of three alteration gradient groups: 1) LOW (n=6), 2) MEDIUM (n=11) or 3) HIGH (n=7).

Bird Counts

Breeding bird species composition and species richness (number of species) were determined using fixed-radius (50-meter) point counts following recommended methodology for monitoring bird populations and avian habitat associations in the southeastern United States (6). A point count is a tally of all birds detected visually or by sound by an observer from a fixed station during a five- minute time period. Point counts were conducted during the breeding season (May-June) by observers between sunrise and 10:00 a.m. A grid of possible point locations 250 meters apart was generated using a computer-based geographic information system to determine the locations of point counts within each golf course. These points were then layered over 1994/1999 color infrared aerial photography of each golf course to help observers navigate to each point in the field (Fig. 2).

Habitat Patch Mapping

Habitat patches were determined through a combination of on-site visits and aerial photography interpretation. Patch perimeters were digitized to provide measurements of area and perimeter length per patch. Habitat patches within each golf course were characterized by shape, size, type, number, heterogeneity and boundary characteristics (10).

Parameter Estimation

Species richness, species diversity, total relative abundances, neotropical migratory bird (NTMB) species richness were calculated for each golf course and subsequently applied to each alteration group.

Breeding Habitat Guilds

To examine breeding bird species composition across the golf course alteration gradient groups, all species recorded within each point count were categorized according to breeding habitat association (i.e. wetland-open water, successional scrub-shrub, woodland or urban habitat). Total relative abundances per breeding habitat association were calculated for each alteration group and tested to examine if there was a relationship between the alteration groups and the type of species found within each group. A community similarity index (14) was calculated to measure the degree of similarity in the breeding bird community among the three alteration groups.

Statistical Analysis

Landscape Alteration

Mathematical models were constructed to determine if species richness, species diversity, and NTMB richness were statistically different among groups. Golf courses within each respective group served as experimental unit replicates. Comparisons were then made to determine which group had the highest mean.

Landscape Structure

To determine the influence of landscape structure (i.e. habitat composition and spatial configuration) on bird parameter estimations within golf courses, quantifiable landscape metrics generated for each landscape unit per patch type included in a regression model. Percentage values of area were used to account for the variation in total land area between golf courses in order to conform to species-area empirical data.

Effects of Forested Area

Because vegetation characteristics (e.g. stem density, basal area, foliage height diversity, etc.) may not be as important as simple measures

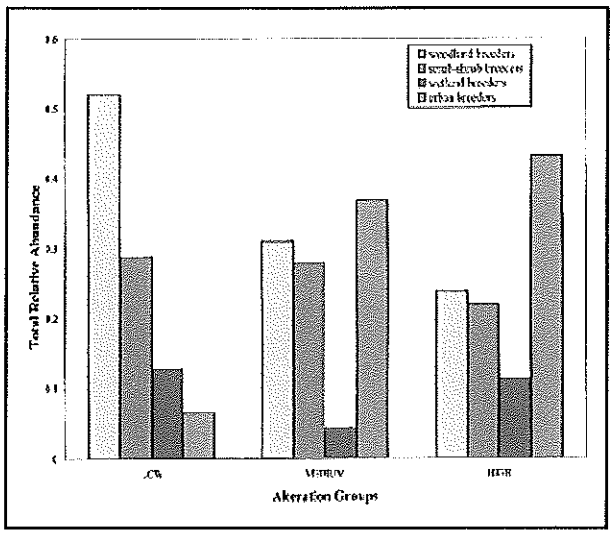

Figure 3. Relationship between total relative abundance of species associated with breeding habitats across alteration groups

of forested area in explaining variability among avian community parameters (5), regression analyses were conducted to test the effects of forested area percentages on species richness, species diversity, and NTMB richness. Specifically, we tested if parameter estimations increase as percent forested area increases. Positive parameter estimates would indicate that bird parameters benefit from more highly forested areas.

Results

Bird Counts

Across all 24 golf courses, a total of 5,362 birds, 82 species, and 30 NTMB species were recorded at 599 point count stations for years 1 (n=10) and 2 (n=14). Estimates from years 1 and 2 were pooled for each golf course per group.

Breeding Habitat Associations

Bird communities of the more altered golf courses (medium and high) were most similar as indicated by the community similarity indices and were consistent with the total relative abundance outcomes of breeding habitat associations. Also, the distribution of breeding habitat associations was influenced by the level of alteration. The majority of birds (46.5%) associated with less developed landscapes (low units) were woodland breeding species, while urban breeding species were found primarily in more altered groups (medium: 32.9%) and (high: 37.3%) (Fig. 3).

Landscape Alteration

Average species richness and NTMB richness decreased as landscape alteration increased, but a significant difference in species diversity was not detected among groups (Fig. 4).

Landscape Structure

Regression models successfully determined significant landscape metric variables for explaining the variability within species diversity, species richness and NTMB richness. Components of forested area, surface water and disturbed habitat patches, and turfgrass were most influential as significant variables throughout the models at both scales with 45% to 90% of the observed variation explained. Regression analyses revealed significant positive linear relationships exist between the percentage of forested areas within golf courses and species richness and NTMB richness (Fig. 5).

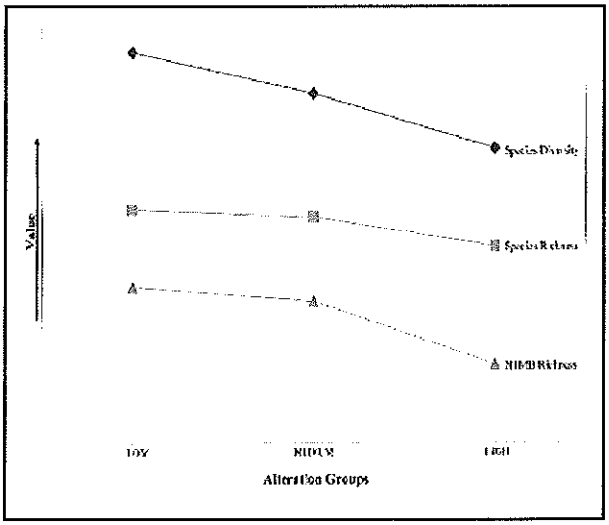

Figure 4. Diagrammatic representation of observed trends in bird community parameters across alteration group.

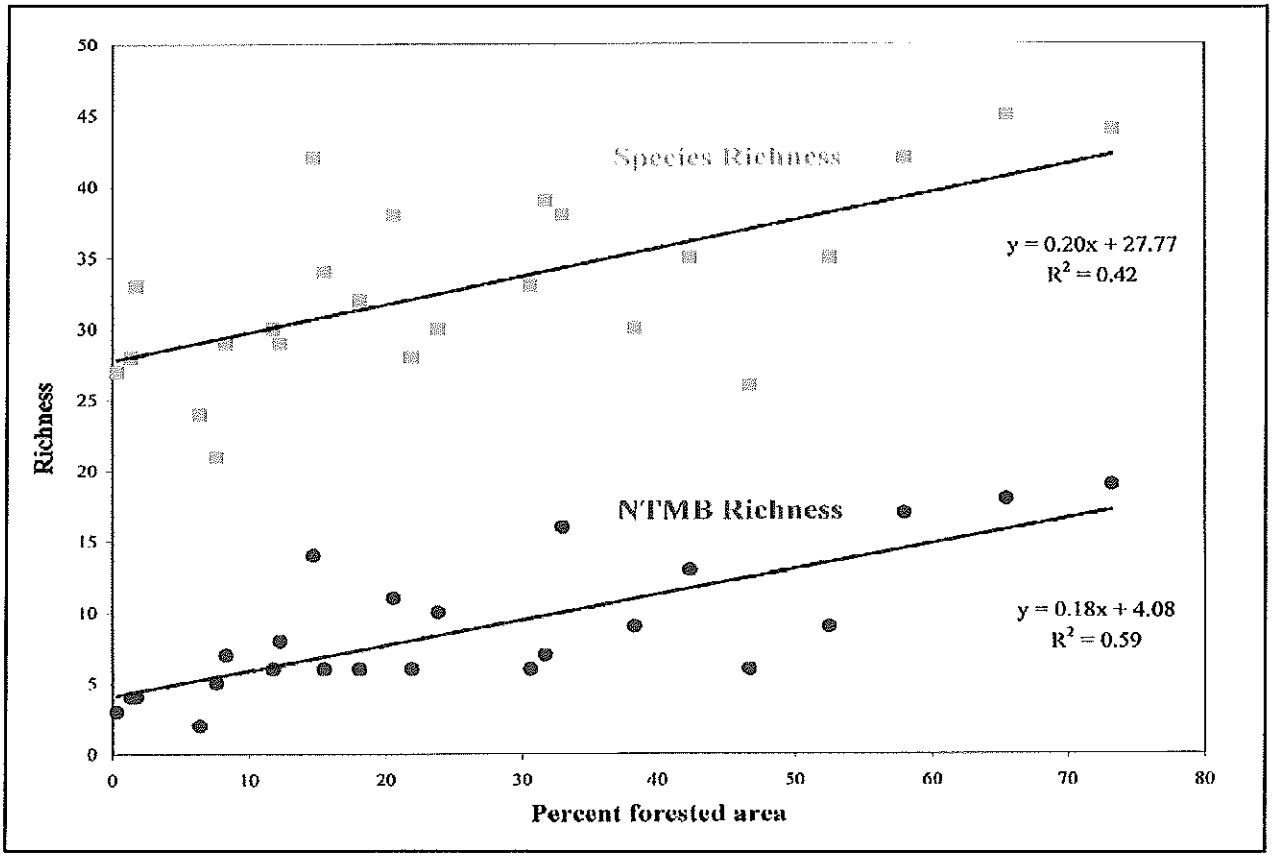

Figure 5. Distribution of bird community parameters in relation to percent forest area

Discussion

Breeding bird communities were influenced by landscape structure and the amount of landscape alteration within golf courses. The most influential landscape attribute throughout this study was the amount of forested area within a golf course.

Bird species richness increased as forested area increased within golf courses. Landscapes with higher percentages of forested area provide for a more diverse habitat mosaic (16) offering resources (e.g. nesting sites, food, shelter, etc.) to a greater number of species (15). Highly forested golf courses were typically connected to low/undeveloped areas, perhaps allowing birds unimpeded dispersal throughout the landscape (21) and providing necessary buffering against environmental disturbances many species find unsuitable (12, 17).

Neotropical migratory bird (NTMB) richness was negatively related to landscape alteration. Neotropical migrants tend to be more abundant in landscapes with a high proportion of forested area (3) and may be avoiding more urbanized landscapes (5). Fifty-seven percent of the species categorized as woodland breeders in our study were also NTMBs and therefore highly altered golf courses may not provide the necessary buffering and forested habitat (3) needed by many NTMB and woodland breeding species (e.g. Prothonotary warbler, Summer tanager, Swainson's warbler, Yellow-throated vireo).

Less altered golf course landscapes (i.e. low units) supported a larger number of woodland breeders than golf courses with a higher degree of alteration. Relative abundance of urban breeders (e.g. European starling, House finch, Northern mockingbird) may have been higher in medium-high units because of the species' ability to cope better with human influences (5). A higher density of avian "urban exploiters" are associated with more urbanized landscapes, causing a shift from

more native species to more invasive/exotic species as landscapes became more developed. Densities of woodland species ("urban avoiders") gradually disappear as landscapes became more developed (1).

Our results suggested less developed golf courses (low units) were of higher conservation value as indicated by a greater density of birds species of higher conservation concern as ranked by the Partners in Flight approach (2) (e.g. Hooded warbler, Painted bunting, Swainson's warbler, Northern parula, Wood thrush). Efforts to properly manage and/or conserve these landscapes are warranted and must be considered.

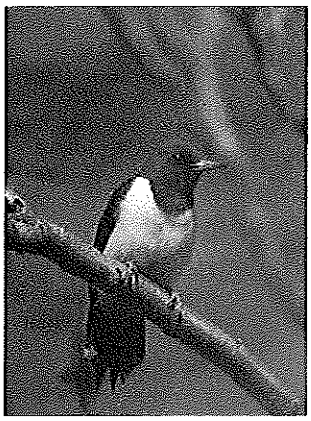

Photo credit: Jim Flynn

Golf courses that include habitat with dead trees provide suitable habitat for cavity nesting species, such as this adult male red-headed woodpecker.

The positive bird response to landscapes with a higher percentage of forested wetland, pine and mixed forest habitats underscores the importance of maintaining patches of native vegetation. Our results also suggest small discontinuous turfgrass patches, fewer manmade water areas, and increasing the area of disturbance/scrub-shrub patches may also improve bird habitat on golf courses. Disturbance areas within golf courses created open grassy and scrub-shrub areas and added woody vegetation that are important to disturbance-dependent bird species (7).

With other intense urbanization development (i.e. business parks, shopping malls, non-forested residential areas) unsuitable to many species, golf course construction and routine maintenance procedures may create vital disturbance areas providing habitat for species in decline (e.g. Brown-headed nuthatch, Yellow-breasted chat, Painted bunting, Indigo bunting, Orchard oriole, Red-headed woodpecker) that require disturbed habitats.

Conclusion

Breeding bird species richness and NTMB richness were negatively related to landscape alteration and were greatly influenced by the amount of forested area within golf courses. Landscape structure modeling demonstrated habitat improvements within golf courses are possible by increasing the amount of forested area within golf courses, particularly forested wetland, pine forests, and pine-hardwood mixed forests. More simply stated, bird communities typical of the forested South Atlantic Coastal Plain region benefited by maintaining greater amounts of native forest vegetation within a golf course.

Although we focused on golf courses as a separate landscape element, golf courses must be considered as an integral component of the larger landscape. Consequently, the composition of bird communities within golf courses is also likely a product of the bird community found in the larger surrounding landscape, although this relationship was not studied at this time.

Our study demonstrates that golf course architects and superintendents in conjunction with owners of associated residential developments can provide significant benefits to breeding bird populations by maintaining suitable habitat within a golf course. Furthermore, golf courses have great potential to play an important bird conservation role at the local and regional level by working together with adjacent landowners to form on-the-ground partnerships to develop and coordinate complementary habitat management strategies.

Acknowledgements

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