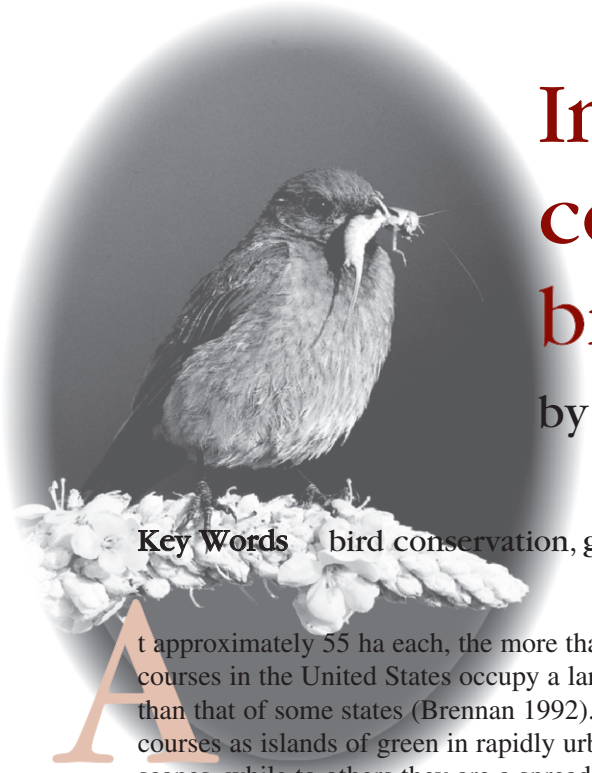

Introduction: Can golf courses play a role in bird conservation?

by Daniel A. Cristol and Amanda D. Rodewald

Key Words bird conservation, golf courses, golf industry, nongame wildlife

At approximately 55 ha each, the more than 17,000 golf courses in the United States occupy a land area larger than that of some states (Brennan 1992). Some view golf courses as islands of green in rapidly urbanizing landscapes, while to others they are a spreading blight of habitat conversion. Although native vegetation may be abundant on some golf courses, these natural habitats usually occur in small, isolated patches dominated by edge and subject to high levels of disturbance by humans (Terman 1997). The idea that golf courses could provide quality wildlife habitat elicits a decidedly mixed response among the public (Gange 2003). Unfortunately, evaluating the potential conservation value of golf courses is difficult because surprisingly little research has focused directly on the influence of golf-course design and management on wildlife and their habitats. Even for birds, which often have served as the bellwether taxa for assessing environmental impacts, there is only a small handful of peer-reviewed studies on the suitability of golf courses (Green and Marshall 1987, Blair 1996, Terman 1997). In this special section we attempt to answer the central question: can golf courses play a meaningful role in bird conservation? Some of the specific conclusions from this focused coverage are described here.

Golf courses can support birds that are of conservation concern and sometimes provide surrogate habitats for species of high management priority.

Overall, researchers found surprisingly high species richness, diversity, and abundance on many golf courses. For example, >10,000 individuals of 42 species of waterbirds were observed using 183 golf-course ponds in Florida (White and Main 2005), and 82 species of birds were detected on 24 South Carolina courses (Jones et al. 2005). Even when compared to native landscapes (e.g., Sonoran desert, Arizona), golf courses supported greater abundances and diversity of birds, largely due to the riparian vegetation community sustained by irrigation on the courses (Zwartjes-Merola et al. 2005). This raises the possibility that, at least in arid regions, golf courses might serve as surrogates for riparian vegetation communities, which are vanishing fast in regions such as the southwestern United States (Ohmart 1994). This role as a "habitat-surrogate" also was suggested by studies finding that certain sensitive species associated with oak (*Quercas* sp.) savannas (i.e., red-headed woodpecker [*Melanerpes erythrocephalus*], Rodewald et al. 2005) or sage scrub (*Artemesia* spp.) communities (i.e., burrowing owl [*Athene cunicularia*], Smith et al. 2005) readily occupy golf courses. This is not to suggest that golf courses can fill the ecological roles of natural landscapes or support the biodiversity present in native ecosystems, but they may provide specific habitat components to some declining habitat specialists.

However, such findings must be regarded cautiously. Diversity and abundance indices do not reflect important changes in species composition, and richness often increases with habitat and landscape alteration (Marzluff 2001). In the Arizona study mentioned above, 7 species of specialized desert birds found on the reference landscapes, including 3 of regional management concern, were absent

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from the golf courses. The ability of golf courses to support sensitive species may vary regionally as well. In the forested mid-Atlantic United States, 87 Virginia golf courses had lower densities of species of regional conservation concern than forested reference sites (LeClerc and Cristol 2005). In fact, the golf courses supported no more of these birds than farmland or residential reference landscapes. Ultimately, the extent to which golf courses add to or detract from the regional conservation picture will depend on the habitats they are replacing.

Habitat quality, as measured through reproductive or condition parameters, should be a key consideration for improving conservation value. Merely documenting the presence of territorial birds during the breeding season, as in some of the studies in this special section, does not reveal whether golf courses provide the resources necessary for successful reproduction. Even documentation of nesting success alone falls short of answering the real question: do golf courses support viable populations of birds? Four of the papers in the special section examine reproduction and ask whether golf courses provide more to birds than a place to feed and rest (LeClerc et al. 2005, Rodewald et al. 2005, Stanback and Seifert 2005, White and Main 2005). Collectively these papers show that generalizations are difficult and the ability of golf courses to support breeding populations may vary by taxa. For example, although golf-course ponds were heavily used by waterbirds in Florida, virtually no reproductive behavior, let alone nesting, was detected on any of the 183 ponds, despite the fact that more than half of the species detected bred in local freshwater wetlands and potentially could nest on golf-course ponds. In contrast, red-headed woodpeckers frequently nested on golf courses and appeared to have similar rates of nesting success compared to off-course habitats (Rodewald et al. 2005). Even within the same species and region, findings can be contradictory. Eastern bluebird (*Sialia sialis*) nestlings on golf courses showed greater developmental stability (Møller and Swaddle 1997) than off-course birds in Virginia, suggesting more favorable habitat conditions on courses (LeClerc and Cristol 2005). However, in North Carolina, golf-course bluebirds had later nesting dates, smaller clutch sizes, and smaller chicks than those nesting off courses (Stanback and Seifert 2005).

Authors in this special section also identify 3 pressing research and educational needs related to bird conservation on golf courses: 1) study of the effects of chemical applications (pesticides and herbicides)..., 2) generation of specific management recommendations for species of conservation importance..., and 3) development of methods to evaluate management outcomes.

Landscape context of golf courses is an important consideration, and in some cases may influence birds more than local habitat management.

Most biologists recognize that the successful conservation of wildlife requires managing at the landscape or regional scale. In particular, bird communities are well known to be strongly influenced by landscape-scale features (e.g., Robbins et al. 1989, Askins 1995, Robinson et al. 1995), so it is no surprise that the landscape surrounding golf courses also can be an important determinant of the bird communities they support. Results were surprisingly consistent and showed that retention of forest on or around golf courses (e.g., percent forest cover) improved their value to birds of conservation concern. Alternately, increased amounts of residential development surrounding courses tended to be associated with fewer species of conservation concern. For example, woodland breeding birds in South Carolina were most abundant on courses in the least-developed landscapes (i.e., most forest cover and least residential cover surrounding course), whereas urban-associated birds were most abundant on courses within the urbanizing landscapes (Jones et al. 2005). In Virginia, some golf courses had 3 times the species of conservation concern as others, and the best predictor of this difference was the proportion of forest in the landscape (a circle with 1.5-km diameter) around the course (LeClerc and Cristol 2005). Similarly, residential development within 100 m of courses was strongly associated with reduced diversity of all birds, Neotropical migrants, and declining species on courses in Ohio (Porter et al. 2005). In fact, that study showed that the amount of intact natural landscape (forest, open water) surrounding golf courses was a better predictor of bird diversity than any on-course variables. The management implication from these findings is clear—the current trend toward surrounding golf courses with densely packed homes is likely to reduce their value for bird conservation.

Managers can manipulate the structure and composition of golf courses to enhance their ability to support birds.

Although landscape context may constrain the ulti-

mate suitability of golf courses for certain sensitive species, effective habitat management can substantially improve the ability of golf courses to attract and sustain bird populations. In some cases management recommendations are relatively straightforward and predictable. For instance, managers wishing to provide habitat to red-headed woodpeckers should retain oaks, large trees, and dead limbs or snags (Rodewald et al. 2005). Many waterbirds need islands to provide nesting habitat that is protected from predators and areas of shallow (<40 cm) water around pond edges for foraging (White and Main 2005). At this point, however, the empirical support for habitat prescriptions comes from correlational studies rather than experimental manipulations, which are sorely needed.

What's next?

Though we do not view golf courses as appropriate substitutes for native ecosystems, they do provide habitat to a wide diversity of birds, including some species of conservation importance. This role may be especially important in urbanizing landscapes that lack other large open spaces or natural areas.

But whether golf courses can be important for bird conservation cannot be completely resolved at this point. There are some critical research needs that have been articulated by managers, golf-course-industry representatives, and the researchers in this issue. First, we need research that addresses the population demography of species of conservation concern. Basic demographic parameters, such as reproductive rates and survival estimates, should be compared for golf-course and non-course habitats in order to determine whether courses represent population sinks or ecological traps. Second, we need more research that spans multiple spatial and temporal scales, moving beyond the usual short-term studies of local habitat. Many important questions regarding the consequences of habitat modifications require long periods (>5 years) of study. Furthermore, explicit consideration of landscape context is essential, as the landscape may ultimately determine the success of local management efforts. Third, we need research that focuses on nonbreeding seasons, as courses may serve important conservation roles during these times. For example, en-route migratory birds may use golf courses as stopover habitats. Fourth, we need research that incorporates experimental approaches, particularly when investigating effects of habitat manipulation and residential development within the surrounding landscape.

Authors in this special section also identify 3 pressing research and educational needs related to bird conservation on golf courses: 1) study of the effects of chemical applications (pesticides and herbicides) on survival, condition, and reproduction of birds on golf courses, 2) generation of specific management recommendations for species of conservation importance that potentially reside on golf courses, and 3) development of methods to evaluate management outcomes. Golf-course managers and those who regulate them are unlikely to adopt the recommendations of wildlife professionals unless there is solid empirical evidence to support them. We hope that this special section spawns another generation of research that gets closer to determining whether there is wisdom in suggesting that golf courses can play a role in bird conservation.

Acknowledgments. The United States Golf Association (USGA), through the Wildlife Links program administered by the National Fish and Wildlife Foundation (NFWF), funded much of the research summarized here. We are grateful to J. Snow and K. Erusha of the USGA, P. Stangel of the NFWF, and others who provided support.

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