



Turfgrass and Environmental Research Online

...Using Science to Benefit Golf



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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 400 projects at a cost of \$30 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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International Golf Course Wildlife Research: Focus on the Future

Allyson K. Jackson and Daniel A. Cristol

SUMMARY

Golf is a growing industry around the world and courses are now being built at a rapid rate in countries such as China, South Africa, and Australia. Although there has been considerable research on the effect of golf courses on wildlife within the United States, international studies are a newer phenomenon. Here we summarize emerging research about impacts on golf course wildlife outside of the United States. Major findings include:

- Golf courses typically had higher value to wildlife when they were built in more developed areas, regardless of continent.
- Because most researchers compared golf courses to predetermined “reference” sites, the choice of reference site strongly impacted the conclusions.
- Instead of fixating on the dichotomy between golf and reference sites, we recommend focusing research around the world on how golf courses can be designed to benefit the most wildlife. Which courses have more wildlife and which portions of courses support healthier populations? In many cases, this requires little more than knowledge of the local biota and willingness to preserve native communities within the course. For example, wildlife corridors and large stands of trees are relatively simple solutions to maintaining diversity at home and abroad.

Whether it is an obnoxious goose or a majestic elk, golf courses around the world are home to many species of wildlife. Conservationists, however, worry that the high levels of human disturbance, pesticide use, and habitat alteration on golf courses could hinder local wildlife populations. Despite this, golf courses are prominent additions to the landscapes of many countries; there are over 30,000 courses worldwide, approximately half of which occur outside of the United States (21).

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With the help of research funding organizations such as the United States Golf Association Wildlife Links program, we are starting to understand the role that golf courses play as wildlife habitat in the United States. Research on golf course wildlife is not as prominent internationally, perhaps due to lack of a dedicated funding source. The purpose of this article is to summarize the state of wildlife research on golf courses outside of the United States and to offer recommendations for future work.

Importance of International Research

Though research completed in the United States can sometimes be applied to areas outside of the country, oftentimes the foreign landscape is



Researchers often compare golf courses to the habitats that would be available for wildlife had the course not been built.



Environmental stewardship of golf courses includes using best management practices to protect populations of aquatic animals such as this largemouth bass.

so different that comparisons are not possible. For example, the plants and animals of South Africa have been isolated from other wildlife populations for thousands of years and subsequently have become biologically unique. These endemic organisms, not found anywhere else in the world, are distributed over small ranges where they now face the threat of habitat loss due to golf course development (6).

Because these rare species do not occur anywhere else, planners have no basis for predicting how they will respond to construction of a golf course. The story is the same in other parts of the world, where biologists are working to understand local wildlife before various forms of development, including golf courses, alter the landscape. In one study of 200 clubs in the United Kingdom, golf course managers overwhelmingly considered their courses to be valuable wildlife habitat, but—as in the United States—few had the resources, planning, or information needed to ensure that this was a reality (10).

The State of International Research

International studies have been performed on wildlife ranging from earthworms in England to the eastern grey kangaroo in Australia (1, 12). The majority of golf course research has historically focused on birds, as they are easy to observe and sensitive to habitat alteration (5, 6, 12, 13, 17, 19, 21, 23). While the majority of international studies have focused on birds, there have also been studies of mammals (12, 18), amphibians (4, 12) and reptiles (12). Additionally, studies of non-vertebrates have answered questions about communities of earthworms, arthropods, and bumblebees on golf courses (1, 21, 23, 24). Overall, researchers worldwide generally agree on one point – that the conservation value of a golf course increases as the area surrounding the golf course becomes more urbanized (3). This point becomes important as we outline studies concluding that golf courses are either “better” or “worse” for wildlife.



Populations of fox squirrels on golf courses are being studied South Carolina.

When Golf Courses are Better for Wildlife

Golf courses become progressively better for biodiversity with increasing scarcity of suitable habitat in the area. In the United Kingdom, golf courses supported greater diversity of birds than adjacent farmland (21) and can even conserve historic landscape types, such as heathland (9). In a before-and-after study, Swiss researchers surveyed many different species in agricultural fields, and later on the golf course built on those fields. The number of species and their diversity



Italian researchers found that the avian species richness on golf courses was positively correlated with the amount of forest cover, a finding that American researchers have corroborated

increased when the golf course was built (8). Golf courses in urbanized areas of Japan offer forest and other natural habitat that cannot be found in surrounding areas, making them a refuge for many displaced species (23). Colding and colleagues found that some species of amphibians are more common on golf course water hazards than in ponds in the surrounding urban areas of Stockholm, Sweden (4).



Data on 12 important aquatic and terrestrial habitat characteristics, including chemical contaminants, were quantified in order to better understand the influence of golf course management techniques on the stream salamander communities in North Carolina.

When Golf Courses are Worse for Wildlife

There are numerous international studies that detail the negative impacts of golf courses. Bird diversity and abundance were lower on golf courses in South Africa than in the surrounding natural area (6). Golf courses had more homogeneous bird communities than reference parks in Montreal, Canada (13). Similarly, in southeast Queensland, Australia, golf courses supported primarily common urban-adaptable species instead of the diversity found in nearby natural areas (12).

Better or Worse than What?

In each of the previous studies, it is important to have a suitable point of reference for com-

parison to a golf course. Researchers often compare golf courses to the habitats that would be available for wildlife had the course not been built. This is, however, extremely variable on a site-by-site basis, making it hard to produce generalized conclusions. For example, golf courses developed on reclaimed-mine sites, landfills, and eroded lands offer a more positive change in biodiversity than those carved out of old growth forest (22). In the United States, golf courses have typically been compared to the habitats surrounding them (e.g., hayfields, old fields, and pastures), structurally similar habitats (e.g., parks and campuses), or the types of land replaced by golf courses (e.g. undeveloped desert) (20, 14, 16).

To evaluate the value of golf courses globally, we must consider what was present in the area before the construction of the course. In highly developed areas, such as the United Kingdom and continental Europe, golf courses have been compared to the farmland that they usually replace (8, 21). In Japan, golf courses can offer the only green space around urban centers and so have been compared to highly urbanized areas (23). Both of these studies showed the benefit of golf course habitat over what it replaced. Conversely, golf estates in South Africa have reduced species diversity compared to the natural



University of Arizona scientists have been radio tracking Gila monsters to gain a better understanding of how they are responding to the golf course and its surroundings.



In British Columbia, researchers looked within one golf course and found that bird density was greatest in and around the water features.

areas that they replaced. Because the golf course is compared to a nature preserve, full of endemic plant and animal species, we see a dramatic decrease in diversity (6).

It is apparent that if any of these researchers had chosen a different reference site, their conclusions about “better” or “worse” would have been very different. A recent review determined that 64% of all comparative golf course studies found that golf courses had higher ecological value than their reference sites (3). This information is not relevant unless one understands the context that researchers used in comparing their golf course to another data set. For example, your local golf course may offer greater ecological value than an urban shopping center, but it is not likely to have greater ecological value than the nearest forest reserve.

Focus on How to Make Each Course Better

Though most golf course research focuses on this comparison between a golf course and some sort of “reference site,” the variability inherent in this comparison makes it no longer particu-



Researchers in Florida established important nectar sources for the Schaus Swallowtail butterfly in an effort to help save this endangered species.

larly useful as we seek to understand the impact of golf course development around the globe. Because each region of the world and each golf course is unique, we suggest that it is more pertinent to study how different course designs can most benefit wildlife within the landscape of each ecological region. For example, Italian researchers found that the avian species richness on golf courses was positively correlated with the amount of forest cover (19), a finding that American researchers have corroborated (15).

In British Columbia, researchers looked within one golf course and found that bird density was greatest in and around the water features and the most species were found in hedgerows and wooded areas with ground cover left intact (17). Arthropod diversity is higher on Japanese golf courses with taller turfgrass (24), and vertebrate abundance and species richness increases with increased native vegetation in Australia (11). Each of these studies help show not just whether a golf course is good or bad for birds or better or worse than a reference site, but rather what types or areas of golf course features provide more valuable wildlife habitat.

There is no reason that a properly designed golf course cannot fit seamlessly into its surroundings. Max Terman, a founding father of golf course wildlife studies, touts the benefits of these “naturalistic” golf courses, as golfers enjoy them for the challenge, managers prefer them for the

lower water and pesticide consumption, and the public gains because wildlife benefit from the habitat availability (22). Gange and colleagues recommend that golf courses attempt to blend in with their environment rather than stand out, with vegetation that takes into account the natural soil chemistry of the area, leading to less upkeep (7).

To build a course that fits in its environment, designers must understand the natural area where they are building, along with the needs of the prominent wildlife. In Canada, for example, wolves are an important keystone predator, keeping grazing mammal populations (e.g. elk, deer) in check. These grazing mammals have started to congregate near human activity, where their predators are scarce, creating problems for human residents such as overgrazing and automobile accidents. In response to elk problems on a golf course, researchers redesigned fences to create a habitat corridor, meant to encourage wolves to move through the golf course. As wolves started using this corridor to pass through the mountains, the elk that were previously a problem dispersed away from the golf course (18). That study demonstrates how understanding the dynamics of the ecosystem can greatly help managers come up with innovative and cost-effective solutions.



Research conducted on golf courses in New York state found that golf courses supported populations of turtles comparable to protected areas.



Research in Florida indicated that small man-made ponds on golf courses provide food resources capable of attracting many species of waterbirds, especially diving, fish-eating birds. These same food resources also attract other waterbirds such as wading birds.

Conclusions

More international research is needed to discover exactly how wildlife respond to golf course development. It will be most beneficial to focus on how golf courses can be made more wildlife friendly, rather than on whether or not they replicate, improve upon, or fail to live up to former habitat quality. As golf course development is expected to continue, it would be useful to be able to make sound recommendations for course design to benefit wildlife.

One possible way to better understand how different aspects of the golf course affect wildlife is to monitor reproductive success, instead of merely diversity. At least one study has found that male birds (in this case the endangered ortolan bunting in Norway) are less likely to suc-

cessfully mate at the interior of a golf course than at its periphery (5). A Swiss review shows that many breeding birds would benefit from ecologically enhanced golf course designs (2). Future studies should abandon the “reference site” paradigm and instead carefully record variation between courses in wildlife use and the features within each course that make it better or worse than other designs.

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Literature Cited

1. Bartlett, M., I. James, J. Harris, and K. Ritz. 2008. Earthworm community structure on five English golf courses. *Applied Soil Ecology* 39:336-341. (TGIF Record 147058)
2. Birrer, S., and R. Graf. 2004. Golf courses as a habitat for breeding birds. *Der Ornithologische Beobachter* 101:233-246. (TGIF Record 163076)
3. Colding, J., and C. Folke. 2009. The role of golf courses in biodiversity conservation and ecosystem management. *Ecosystems* 12:191-206. (TGIF Record 150928)
4. Colding, J., J. Lundberg, S. Lundberg, and E. Andersson. 2009. Golf courses and wetland fauna. *Ecological Applications* 19:1481-1491. (TGIF Record 154917)
5. Dale, S. 2004. Effects of a golf course on population dynamics of the endangered ortolan bunting. *Journal of Wildlife Management* 68:719-724. (TGIF Record 110854)
6. Fox, S. J. C., and P. A. R. Hockey. 2007. Impacts of a South African coastal golf estate on shrubland bird communities. *South African Journal of Science* 103:27-35. (TGIF Record 163033)
7. Gange, A.C., D. E. Lindsay, and J. M. Schofield. 2003. The ecology of golf courses. *Biologist* 50:63-68. (TGIF Record 163079)
8. Graf, R., H. Bolzern, and T. Roosli. 2004. Nature conservation aims on golf courses? Monitoring control on the golf course 'Holzhausen' (Canton Zug, Switzerland). *Naturschutz and Landschaftsplanung* 36:311-320. (TGIF Record 163081)
9. Green, B. H. and I. C. Marshall. 1987. An assessment of the role of golf courses in Kent, England, in protecting wildlife and landscapes. *Landscape and Urban Planning* 14:143-154. (TGIF Record 37537)
10. Hammond, R. A., and M. D. Hudson. 2007. Environmental management of UK golf courses for biodiversity-attitudes and actions. *Landscape and Urban Planning* 83:127-136. (TGIF Record 163040)
11. Hodgkison, S., J. Hero, and J. Warnken. 2007. The efficacy of small-scale conservation efforts, as assessed on Australian golf courses. *Biological Conservation* 135:576-586. (TGIF Record 163071)
12. Hodgkison, S., J. Hero, and J. Warnken. 2007. The conservation value of suburban golf courses in a rapidly urbanising region of Australia. *Landscape and Urban Planning* 79:323-337. (TGIF Record 163046)
13. Hudson, M. R., and D. M. Bird. 2009. Recommendations for design and management of golf courses and green spaces based on surveys of breeding bird communities in Montreal. *Landscape and Urban Planning* 92:335-346. (TGIF Record 163051)
14. LeClerc, J. E., J. P. K. Che, J. P. Swaddle, and D. A. Cristol. 2005. Reproductive success and developmental stability of eastern bluebirds on golf courses: evidence that golf courses can be productive. *Wildlife Society Bulletin* 33:483-493. (TGIF Record 107609)
15. LeClerc, J. E. and D. A. Cristol. 2005. Are golf courses providing habitat for birds of conservation concern in Virginia? *Wildlife Society Bulletin* 33:463-470. (TGIF Record 107603)
16. Merola-Zwartjes, M., and J. P. DeLong. 2005. Avian species assemblages on New Mexico golf courses: surrogate riparian habitat for birds? *Wildlife Society Bulletin* 33:435-447. (TGIF Record 107605)
17. Moul, I. E., and J. E. Elliot. 1994. The bird community found on golf courses in British

Columbia. *Northwestern Naturalist* 75:88-96. (TGIF Record 163084)

18. Shepherd, B., and J. Whittington. 2006. Response of wolves to corridor restoration and human use management. *Ecology and Society* 11 (online). (TGIF Record 163137)

19. Sorace, A., and M. Visentin. 2007. Avian diversity on golf courses and surrounding landscapes in Italy. *Landscape and Urban Planning* 81:81-90. (TGIF Record 163066)

20. Stanback, M. T., and M. L. Seifert. 2005. A comparison of eastern bluebird reproductive parameters in golf and rural habitats. *Wildlife Society Bulletin* 33:471-482. (TGIF Record 107602)

21. Tanner, R.A., and A. C. Gange. 2005. Effects of golf courses on local biodiversity. *Landscape and Urban Planning* 71:137-146. (TGIF Record 105089)

22. Terman, M. R. 1997. Natural links: naturalistic golf courses as wildlife habitat. *Landscape and Urban Planning* 38:183-197. (TGIF Record 94810)

23. Yasuda, M., and F. Koike. 2006. Do golf courses provide a refuge for flora and fauna in Japanese urban landscapes? *Landscape and Urban Planning* 75:58-68. (TGIF Record 105091)

24. Yasuda, M., F. Koike, and M. Terman. 2008. How management practices affect arthropod communities on Japanese golf courses. *Landscape and Ecological Engineering* 4:133-138. (TGIF Record 163139)