

It has often been suggested that golf courses have potential value as an urban refuge for native wildlife. Recent studies conducted in the United States (1,4,5,6,7) and Australia (2,3) have confirmed that golf courses can support high densities of regionally threatened birds, reptiles, mammals and frogs and therefore play a role in urban wildlife conservation.

However, while recent studies have confirmed that golf courses do have conservation potential, they have also revealed great variation in the extent to which that conservation potential is realised (Figure 1, page 39). Many golf courses support only common urban-adapted wildlife and therefore hold no conservation value.

The conservation opportunities offered by

Assessing the conservation value of Australian golf courses



Above: Australian superintendents and architects are making enormous concessions to accommodate the needs of native wildlife in their designs and daily maintenance regimes

the golf industry are potentially very important in the context of degraded urban environments, where rates of wildlife extinction are high and opportunities to protect wildlife habitat are limited.

Given their ubiquity and capacity to retain pockets of native vegetation, golf courses present many potentially valuable opportunities for small-scale off-reserve wildlife conservation. It is therefore important to understand the cause of variation in golf course conservation value; to determine why some golf courses can provide refuge to threatened species, while others simply support a range of common urban-adapted wildlife and therefore have no conservation value.

It has generally been assumed that golf course design and management actions play a critical role in determining wildlife diversity on golf courses. In recent decades, the golf industry has taken a proactive approach to environmental management, initiating education programs that outline practical ways to enhance the habitat value of golf courses by increasing the size, connectivity and structural complexity of vegetation in rough and out-of-play areas.

These strategies have, however, been adapted from landscape ecology studies conducted at much larger spatial scales than

Griffith University PhD student Simon Hodgkison recently completed a thesis assessing the conservation value of golf courses in south-east Queensland and the role that course design and management actions have on local threatened species diversity. As he writes here, the results show the positive role golf courses do have in local ecosystems.

those found on golf courses. As a result, there was never any guarantee that such small-scale on-site management actions would significantly increase the conservation value of suburban golf courses.

Biodiversity is rarely a simple reflection of local habitat size or quality and is instead often determined by regional or historical influences. Some ecologists also suggest there are spatial limits to wildlife conservation, below which efforts to increase habitat size and complexity will have little more than a cosmetic effect.

A recent study conducted in the United States (6) lent weight to this argument when it found that golf course design and management practices had little influence on local bird diversity and that instead the conservation

value of golf courses was determined by environmental factors. The findings of that study are however by no means universal to golf courses in other parts of the United States (4,5) let alone other parts of the world. It is therefore important to determine the factors influencing the conservation value of golf courses in Australia.

THE STUDY

Australian golf course superintendents and architects are making enormous concessions to accommodate the needs of native wildlife in their designs and daily maintenance regimes.

While there are peripheral benefits to these activities (i.e. promoting environmental awareness, broadening the golf experience,

improving the industry's environmental reputation, reducing maintenance costs and creating uniquely Australian courses that could boost Australian golf tourism) it is essential to determine whether natural design and management actions can achieve their principle goal of improving the conservation value of golf courses.

A recent study conducted at Griffith University's Centre for Innovative Conservation Strategies has investigated the role that course design and management practices play in determining the vertebrate conservation value of golf courses in south-east Queensland.

During the study, birds, reptiles, mammals and frogs were surveyed on 20 suburban golf courses in Brisbane and the Gold Coast between June 2001 and March 2004. On each course, wildlife were surveyed on multiple occasions at 10 randomly selected terrestrial survey points (in rough and out-of-play areas) and at 10 randomly selected aquatic survey points (in or adjacent to on-site waterbodies).

Birds and frogs were surveyed from calls and sightings along standardised transects. Reptiles were surveyed using standardised active-search techniques (i.e. overturning

PARTICIPATING COURSES

- California Creek Golf Course
- Gailes Golf Club
- Gainsborough Greens Golf Course
- Gold Coast Country Club
- Gold Coast-Burleigh Golf Club
- Helensvale Golf Club
- Keperra Country Club
- McLeod Golf Club
- Oxley Golf Club
- Parkwood International Golf Club
- Redland Bay Golf Club
- Robina Woods Golf Club
- Southport Golf Club
- St Lucia Golf Links
- Surfers Paradise Golf Club
- The Grand Golf Club
- The Pacific Golf Club
- Tweed Heads-Coolangatta Golf Club
- Virginia Golf Club
- Wynnum Golf Club

rocks, logs and leaf litter). Mammals were surveyed using a combination of spotlighting transects, Elliott trapping surveys (90 trap nights/course) and opportunistic encounters recorded within standardised search periods. ▶

For each wildlife group, local measurements of abundance and species richness were obtained for each course (pooling survey results across sampling points and survey periods). The site abundance and species richness of threatened species (i.e. those generally incapable of persisting in suburban areas of south-east Queensland) was also determined, by omitting data collected at each site for urban-adapted and urban-tolerant species.

Environmental characteristics that might explain variations in wildlife diversity among golf courses were then measured at three separate (local, landscape and regional) scales. At each survey point, local environmental characteristics (eg. foliage height diversity, canopy cover, ground cover, tree density, native grass cover, number of hollows, number of logs, abundance of woody debris) were measured using standardised techniques.

Landscape scale environmental characteristics (eg. on-site vegetation connectivity, the area of vegetation, area of water, number of streams, number of temporary waterbodies, number of permanent ponds) were measured on each golf course from rectified aerial photographs using MapInfo Geographic Information System (GIS).

Similarly, regional environmental characteristics in the area surrounding golf courses (eg. area of vegetation, built land and the number of streams within a 1km, 2km and 5km radius of each course boundary) were measured from rectified aerial photographs and remnant vegetation databases using MapInfo GIS.

For each vertebrate group, separate multiple regressions were then used to identify the environmental characteristics that best explained among-site differences in local abundance and species richness. Regressions were first conducted separately within each (local, landscape and regional) scale and then with all scales combined to determine the scale at which environmental characteristics most significantly influence local wildlife diversity.

The study also examined how wildlife abundance and species richness changed with the size of individual habitat fragments on golf courses (by comparing wildlife diversity against local fragment size for the 200 randomly selected terrestrial survey points surveyed on all golf courses).

RESULTS AND DISCUSSION

The study confirmed that wildlife diversity on golf courses was not simply a reflection of local golf course design and management



practices. Local bird, reptile, mammal and amphibian diversity on golf courses was partly influenced by regional environmental factors, increasing with the area of surrounding native vegetation and decreasing with the area of adjacent built land. Local amphibian diversity also increased with the number of streams that were connected to each course.

Unlike the recent North American study (6) however, the conservation value of golf courses was not solely determined by environmental conditions in the surrounding landscape. The local diversity of threatened vertebrates increased significantly with the size and complexity of on-course habitats. Australian golf course architects and superintendents can therefore evidently play a significant role in determining the conservation value of suburban golf courses.

Principal among the environmental factors influencing vertebrate diversity on golf courses was the area of native vegetation retained on-site. The diversity of threatened birds, reptiles, mammals and even frogs increased with the area of eucalypt vegetation retained locally.

FRAGMENT SIZE

The size of individual fragments was also important, with the number of threatened birds, reptiles and mammals increasing with fragment size. Unfortunately, there was no distinct threshold in the relationship between fragment size and species richness that could serve as a spatial guideline to ecologically sound development. The number of threatened species continued to increase with fragment size beyond fragments larger than 60ha. The conservation value of golf courses will therefore always be further enhanced by increasing the area of native vegetation.

While some spatial guidelines can nevertheless be obtained from these results,

caution is needed, since the relationship is likely to change regionally and between habitat types. In addition, the results only show the fragment sizes required to be 'utilised' by threatened species. Many species will be dependent on larger fragments to perform critical breeding and nesting activities. Nevertheless, the results show that vegetation area is a critical determinant of local threatened vertebrate diversity on golf courses.

Fragment shape was also important, and had particular influence on reptile diversity. Golf courses that retained rounded fragments had significantly higher reptile conservation value than those with predominantly narrow fragments wedged between fairways. This relationship may not be a simple response to fragment shape, but reflect the fact that narrow fragments often have structurally simplified understorey (to allow golfers to play from the rough). Course designs that maximise vegetation fragment width will have increased reptile conservation value.

HABITAT STRUCTURE AND COMPLEXITY

The study also investigated whether the spatial arrangement of habitats on golf courses is important, or if high biodiversity can be maintained simply by retaining a sufficient area of habitat. Habitat configuration and connectivity is often a major determinant of local wildlife diversity in fragmented landscapes since this determines their capacity to maintain ongoing access to critical resources (i.e. food, water, mates and shelter from predators and adverse environmental conditions).

Small-scale variations in habitat connectivity (such as those induced by variations in golf course design) may however have limited influence on wildlife diversity, particularly if animals can move freely across fairways and other playing surfaces. The study found that while connectivity isn't a prime determinant of local conservation value, it does have benefits for specific threatened wildlife including small forest birds and threatened skinks and should therefore be maximised wherever possible.

Amphibian conservation value increased with the diversity of local waterbody types. Many frog species are adapted to breed in certain waterbody types having evolved specific strategies to overcome the inherent threats (i.e. predation and desiccation) that are unique to those waterbodies.

Like many urban and agricultural land types, golf courses have a greater tendency to retain permanent ponds (for their irrigation, storm-water mitigation and aesthetic value)

than temporary and semi-permanent waterbodies. As a result, species that breed in temporary waterbodies are facing widespread declines and extinctions in urban areas, while permanent pond-breeders are in many cases increasing in abundance and distribution. By retaining a range of waterbody types, (including temporary and semi-permanent ponds), golf courses can support a greater diversity of native frog species and provide refuge to those that are threatened by urbanisation. The impact that habitat structure has on vertebrate diversity was also a central focus of the study. While many golf clubs may have a limited capacity to increase the size of on-course habitats, many will have greater freedom to increase the structural complexity of habitats in rough and out-of-play areas through altered management regimes.

While these may have design value, acting as an aesthetic contrast to the manicured look of mown fairways, tees and greens, it was important to assess the associated ecological benefits of such actions. The study found that efforts to enhance habitat complexity will significantly increase golf course conservation value. The diversity of all threatened vertebrates

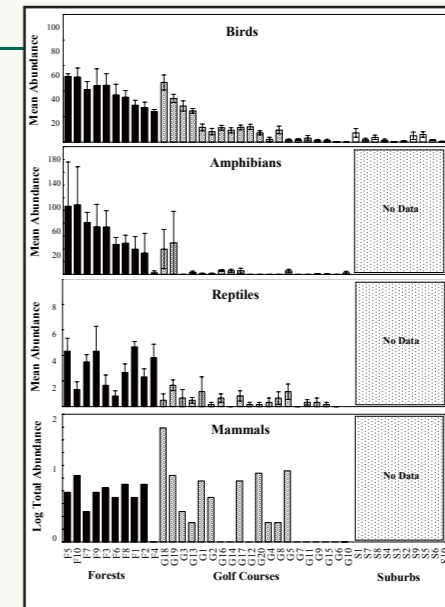


Figure 1. Variable refuge value among 20 golf courses in south-east Queensland as determined by comparing the site abundance of threatened birds, reptiles, mammals and frogs on golf courses (G1-20) with that recorded on 10 eucalypt forests (F1-10) and 10 suburban residential areas (S1-10). (No data is available for reptiles, mammals and frogs in suburban areas. Columns = means, whiskers = 95% confidence intervals).

increased with habitat complexity, with different vertebrates responding to different structural features.

The local diversity of threatened birds increased with foliage height diversity and the area of native grass cover. Threatened reptile diversity increased with the abundance of coarse woody debris and with the proportion of canopy cover. Threatened mammal diversity increased with local tree density, the area of native grass cover and the abundance of dead and hollow-bearing trees.

Threatened frog diversity increased with the complexity of aquatic (floating and emergent) and adjacent reed vegetation and was also influenced by waterbody structure. Waterbodies with steep concrete-edged banks surrounded by manicured turfgrass had significantly lower frog conservation value than those with complex bottom physiology, gently-sloping banks and adjacent reed vegetation. While different wildlife respond to different habitat structures, the ecological factors driving these responses are likely to be universal.

On golf courses with high habitat complexity, wildlife would have access to a greater diversity of food, shelter, nesting

and breeding sites, increased protection from predators and adverse environmental conditions and reduced exposure to noise and other disturbances that can suppress local rates of survival, reproduction and juvenile development.

CONCLUSION

The study validates recent efforts to 'naturalise' golf course design and management practices within the Australian golf industry. While the conservation value of suburban golf courses is partly determined and therefore to some extent restricted by environmental conditions in the surrounding landscape, efforts to increase the size, connectivity and structural complexity of on-site habitats can, nevertheless, significantly increase local wildlife diversity and ensure that golf courses play a positive conservation role in urban landscapes.

Golf course architects and superintendents therefore have a unique opportunity to design and manage public open-spaces that not only provide recreational, aesthetic and economic value, but make a much-needed contribution to urban wildlife conservation.

While golf courses clearly have

conservation potential and could grow to become an important recognised contributor in urban biodiversity strategies, this would require a sustained effort by all involved. More research is required to assess the reproductive value (productivity) of habitats retained on golf courses and the nature and intensity of threats faced by local wildlife. Greater collaboration is also required between research organisations, community environmental groups and the golf industry to ensure the conservation potential of the industry is realised to the greatest extent possible.

Realising the conservation value of suburban golf courses requires combined efforts at local (course management), landscape (course architects) and regional (urban planning) scales. While efforts are currently being made by golf course superintendents and architects, greater effort is required at an urban planning level to ensure that golf courses are built in areas where they will have strategic value (in the context of the surrounding urban landscape).

Conservation priorities are only one of many conflicting functional, aesthetic, engineering and economic constraints that influence golf

course design and management practices. Nevertheless, golf course superintendents and architects can be reassured that where they do set aside areas of wildlife habitat, their actions can produce achievable ecological outcomes that will have real conservation benefits for regionally threatened vertebrates that are increasingly facing extinction from urban areas.

REFERENCES

A full list of references can be obtained from the AGCSA.

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