Now into its second year, the joint AGCSA-University of Melbourne study looking at the biodiversity and carbon benefit of urban golf courses continues to gather some interesting data. As part of the project, University of Melbourne team member Lee Wilson examined the quality of remnant vegetation on nine of the project's participating golf courses and how it compared to that found in nearby nature reserves.

Remnant refuges

Golf courses can make a substantial contribution to maintaining biodiversity in our cities as they often contain important patches of remnant vegetation. However, despite the fact that golf courses are some one of the largest patches of green space in urban areas, there is very little information about the types of remnant vegetation golf courses contain as compared to nearby patches of protected remnant vegetation in the surrounding urban landscape.

In 2012, I joined a research team at The University of Melbourne investigating the biodiversity and carbon benefits of urban golf courses and other green spaces throughout the south east of Melbourne. My role in this research group was to undertake a project that compared remnant vegetation on golf courses to remnant vegetation in nearby nature reserves.

This study is helping to improve our knowledge of how golf courses can, and do, provide habitat for indigenous plants and vegetation communities and the potential for restoration of remnant vegetation to improve vegetation quality and extent.

Within this study, vegetation surveys were conducted in patches of remnant vegetation on nine golf courses and in nine nearby nature reserves that contained similar remnant vegetation communities. The study area was restricted to within the 'Gippsland Plains' bioregion and the vegetation communities studied were classified as either 'grassy woodland', 'plains grassy woodland', 'heathy woodland' or 'sandy heathland'. Surveying areas of the same vegetation community on the nearby nature reserves provided insight into how golf courses could potentially restore or protect the remnant vegetation on their property.

For each survey, small plots (20m x 30m) were established and the name and abundance of every plant species present was recorded, and whether they were indigenous to that ecological vegetation community or non-indigenous. The nine golf courses surveyed were Victoria GC, Kingswood GC, Spring Valley GC, Peninsula Country GC, Frankston GC, Woodlands GC, Sandhurst Club, Settler's Run G&CC and Ranfurlie GC.

The diversity and abundance of the remnant vegetation communities located in golf courses was then compared to those in nature reserves and following the study three key findings can be presented. These are:

- Remnant vegetation on golf courses has a distinctly different composition to that in nature reserves;
- Site management history and size greatly influenced remnant vegetation quality; and
- The remnant vegetation on golf courses has high restoration potential.

COMPOSITION

Patches of remnant vegetation on golf courses and in nature reserves contained a similar total number of plant species. Among the golf courses, Victoria GC had the highest number of indigenous species (44) and Frankston GC had the highest percentage of indigenous species (60 per cent). Golf courses were found to have different vegetation community structure as compared to the nearby nature reserves.

In general, golf courses contained a lower diversity of indigenous species and a greater diversity of exotic (i.e.: non-indigenous) species. Of all the recorded species on golf courses, 44 per cent were indigenous and 56 per cent were exotic. In contrast, of the recorded species in reserves, 61 per cent were indigenous and 39 per cent were exotic (Figure 1). In addition, 33 per cent of the indigenous species recorded in the reserves were absent on golf courses and 44 per cent of the exotic species recorded on the golf courses were absent in the reserves.

SITE SIZE AND MANAGEMENT HISTORY

The plant species present and the quality of the remnant vegetation at each golf course were strongly influenced by site land-use history, the area of the remnant vegetation patch and management practices.

Site history: Most golf courses are located on land that was used for other purposes prior to becoming a golf course, such as cattle grazing, agriculture and horticulture. Most of the nature reserves, however, had not been used intensively for other purposes prior to becoming a site for conservation.

A strong link was identified between the quality and composition of vegetation with site history. Not surprisingly, the reserves and golf courses that contained areas of high quality indigenous vegetation, such as Frankston GC, were located on sites that had not been used intensively prior to their establishment. These sites contained more indigenous plant species and populations of indigenous orchids such as Donkey orchids (*Diuris* sp.), Sun orchids (*Thelymitra* sp.) and Greenhood orchids (*Pterostylis* sp.).

The golf courses and reserves that had been used for other purposes contained more degraded vegetation (i.e.: they contained fewer indigenous species, more exotic species and few or no orchid species). It is likely that the impacts of grazing and agriculture led to the degradation of original indigenous vegetation. Although the vegetation is in poorer condition today, restoration activities such as revegetation with indigenous species will improve the quality of the vegetation over time.

Area of vegetation: A strong link was identified between the area of remnant vegetation and the composition of vegetation. Most remnant vegetation on golf courses is located in small, fragmented sections such as the areas between the fairways. In contrast, the vegetation in reserves is generally found in larger patches (lower perimeter:area ratio). Small, linear strips of vegetation are more susceptible to weed invasion and the loss of sensitive indigenous plant species due to changed environmental conditions and disturbance.

Management practices: The current management of golf courses and nature reserves strongly influence the quality and composition of remnant vegetation. On golf courses, common practices that can impact the remnant vegetation include routine clipping of trees and shrubs, mowing to the base of trees, planting non-indigenous species and leaving areas to seed and grow without intervention.

Areas of remnant vegetation that are left to grow without intervention can allow both indigenous species to re-establish, such as the coastal tea tree (*Leptospermum laevigatum*), and weed species to establish, such as sweet pittosporum (*Pittosporum undulatum*) and blackberry (*Rubus fruticosis*). These weed species can grow in very high densities and outcompete populations of indigenous vegetation. The competition between indigenous and weed species can lead to a decline in the quality of vegetation over time as indigenous species are lost.

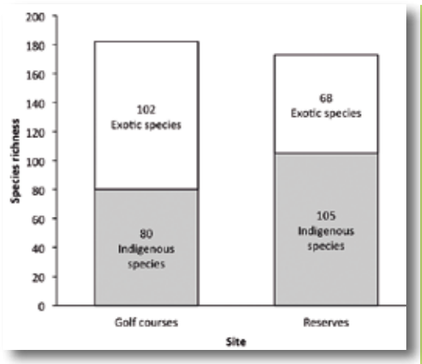

Figure 1. The number of plant species in remnant vegetation on golf courses and nature reserves within the surveyed areas

Opposite page: University of Melbourne researcher Lee Wilson compared patches of remnant vegetation on golf courses to those in nearby nature reserves as part of the biodiversity project

Golf courses and nature reserves that contained higher quality vegetation generally removed weed species, revegetated areas with indigenous species and used controlled fire to maintain vegetation health. Controlled fires are particularly important for natural heathland vegetation in areas containing sand-based soils. Fires maintain plant diversity by removing dense populations of indigenous and weed species and allowing other indigenous species to re-generate from seeds stored in the soil. I am confident that increased efforts in management practices that promote indigenous plant diversity would improve the quality of vegetation on golf courses.

RESTORATION POTENTIAL

Few patches of remnant vegetation on golf courses contained high quality or highly degraded vegetation. Most golf courses contained remnant vegetation that was moderately degraded but had a strong potential for restoration.

Most courses contained abundant populations of common indigenous species such as coastal tea tree (*Leptospermum laevigatum*) and bracken (*Pteridium esculentum*) and non-indigenous species

The study has shown that golf courses can play a significant role in the conservation of vegetation communities that are under pressure from continued urbanisation

Project team member and PhD student Alessandro Ossola measures the height of vegetation at Spring Valley Golf Club

Small 20m x 30m plots were established at nine golf clubs in Melbourne's south east and the name and abundance of every plant species present was recorded

such as panic veldt grass (*Ehrharta erecta*) and black nightshade (*Solanum nigrum*). Few species of orchids were recorded on golf courses. Frankston Golf Club was a remarkable exception and contained several populations of different indigenous orchid species. Most of the nearby reserves contained better quality remnant vegetation than golf courses.

However, the golf courses do have great potential for restoration. For example, at Victoria Golf Club some small areas of high quality vegetation were observed that appeared remnant but were actually the result of the club's re-vegetation programme (**see ATM Volume 12.5 'Victoria heads back to its roots'**) and weed removal practices.

SIGNIFICANT ROLE

From this study I am optimistic that golf courses can play a greater role in the conservation of vegetation communities that are under pressure from continued urbanisation, urban expansion and agricultural intensification around our cities. Restoration could be targeted at golf courses that before being established were not intensively managed.

All golf courses with remnant vegetation of any quality, no matter how small or large, can consider simple management interventions to maintain and improve vegetation quality, such as:

- The removal of non-indigenous plants (exotic weeds and species not locally indigenous);
- Allowing patches of ground layer vegetation to develop without mowing or chemical intervention; and
- Using periodic fire to ensure successful seed bank germination, as is practiced in nature reserves.

This study is a success if it is simply able to raise the awareness of the valuable patches of remnant vegetation within our golf courses and the simple and inexpensive management strategies that can greatly improve their quality and continued protection.

While this part of the project has come to an end, the research team at The University of Melbourne aims to further investigate the potential for remnant vegetation restoration within golf courses and, furthermore, the restoration of faunal biodiversity associated with better quality and healthy vegetation communities.

Editor's Note: See ATM Volume 14.4 (July-August 2012) for more about the AGCSA-University of Melbourne project and also some of the project's findings on insect biodiversity, written by project team member Luis Mata. Project leaders Dr Steve Livesley and Dr Caragh Threlfall will also provide an update of the project at the upcoming 29th Australian Turfgrass Conference at Twin Waters.

MELBOURNE SCHOOL OF LAND & ENVIRONMENT

Among the golf courses surveyed, Victoria GC (below) had the highest number of indigenous species (44), such as milkmaids (*Burchardia umbellata*, pictured right). In recent times the club has successfully undertaken a major revegetation programme