REPORT TO THE UNITED STATES GOLF ASSOCIATION
October, 1999

Conservation of Native Pollinators on Golf Courses

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Executive Summary

Native pollinators are in decline. Without them most flowering plants would not reproduce, eliminating roughly one-third annual agricultural production in the US, and compromising the regeneration of natural plant communities. Golf courses, with their countrywide distribution and extensive out-of-play areas have great potential to contribute significantly to healthy populations of native pollinators. Native bees are the single most important group of pollinator insects, and it was needs of these that the project addressed. Understanding pollinators on golf courses and identifying the most appropriate techniques for conserving them where the goals of this project

The Xerces Society is an active member of the Pollinator Conservation Consortium, and proposed this project as part of the nationwide Forgotten Pollinators Campaign. The Society, in partnership with the USDA Bee Biology and Systematics Lab in Logan, Utah, began the project in July, 1997, working on three golf courses in NE Oregon and SE Washington to enrich the habitat in out-of-play areas and create nesting sites for native pollinator insects. For each golf course there is a local reference site that has natural vegetation to provide a comparison.

Project activities focused on four areas: insect and plant surveys, habitat enrichment, creation of nesting sites and public education. The surveys covered plant communities, soils and pollinator species. In addition, research was done to identify the likely historical plant communities for each site. Species surveys using a passive technique of water filled bowls identified a wide range of species, but for most species very few individuals were trapped (see attached chart). Due to the low numbers, USDA scientists decided not to sample in the third field season to avoid depopulating.

The habitat enhancement plan was to enrich the plant communities by adding native plants, and to create nesting sites. A list of native, pollinator-attracting plants was prepared. Obtaining native plant materials from this list proved to be a difficult task, and delayed progress of the project. Planting was done in spring, 1999, on two courses. Nesting blocks were erected on all three golf courses and the three reference sites, and were surveyed monthly to record nesting use and activity by pollinators.

Educational materials from this project include interpretive leaflets on pollinators on golf courses, information about creating bee nesting sites, and brief guidelines for course superintendents on pollinator conservation. The project was also featured on *Living on Earth*, broadcast on National Public Radio in 1998 and again in 1999. David Schwartz, special writer for the *Smithsonian Magazine*, wrote an article (tentatively entitled *Birds do it, bees do it, even nectar-feeding bats do it...*) that included this project, expected to be published in the spring 2000 issue of that magazine.

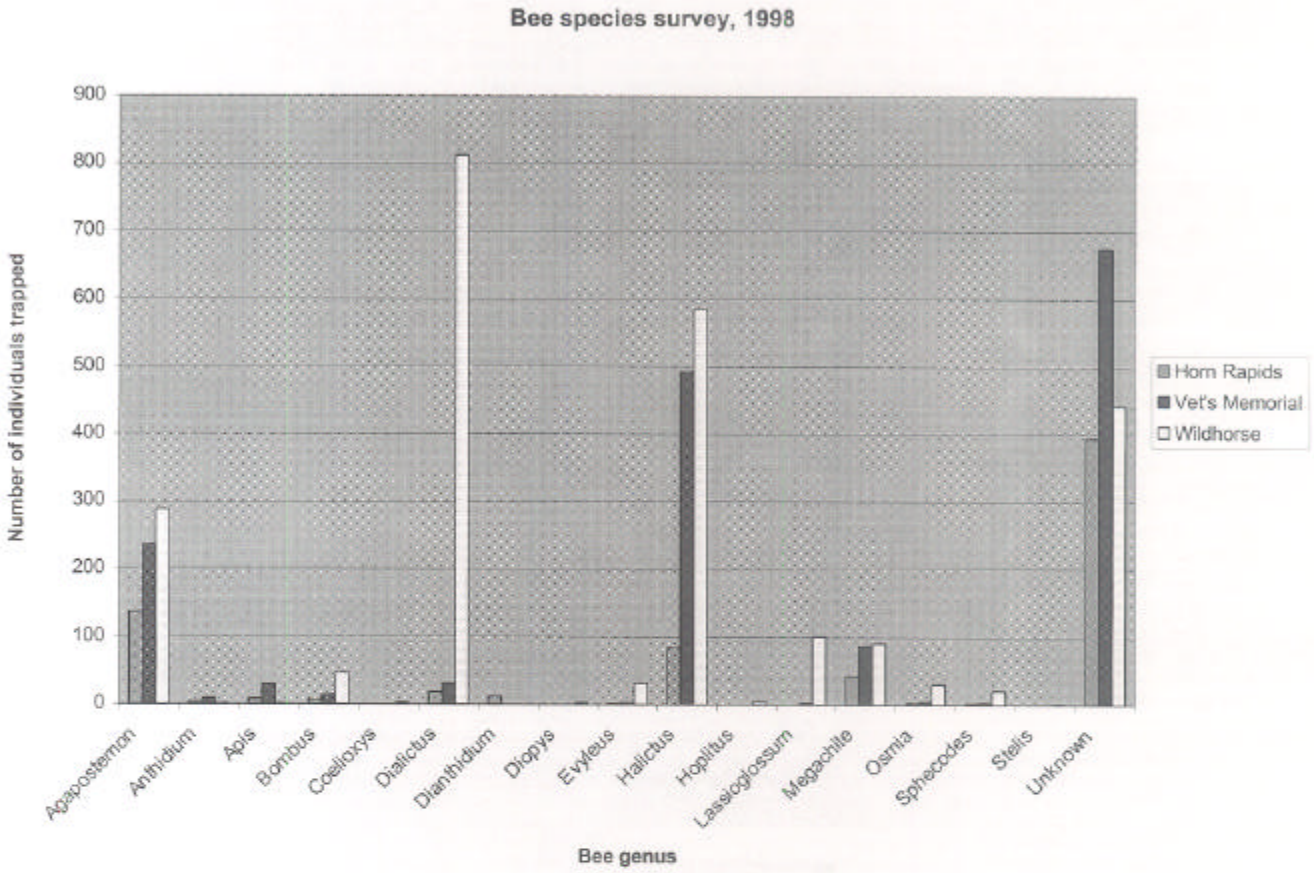

Chart 1. The species survey data for 1998 have been grouped by genera recorded on each of the three golf courses, and the abundance of specimens. For most of the genera there are few specimens, showing how impoverished the pollinator populations have become. The specialist bees that rely on a narrower range of native plants, and which in turn provide pollination for those plants, hardly show in the survey.

Three genera – "generalists" -- had a high count of individuals. Agapostemon and Halictus are both sweat bees (Halictids), members of the most ubiquitous group of bees in the US. They are also the bees most able to cope with degraded habitat as they are generalist feeders and can adapt to changed conditions. Dialictus is a genus that flies all summer, and so is likely to be trapped most regularly.

The presence of these bees on the golf courses does not necessarily indicate effective pollination. For exampale, the Halictid bees have short tongues, thus they can get nectar without reaching the pollen. Dialictus bees are small enough to get inside the corolla tube of the flower, reaching the nectar without touching the pollen.

Annual report to the USGA/NFWF Wildlife Links Program
October, 1999

Conservation of Native Pollinators on Golf Courses

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Overview

In the summer of 1997, The Xerces Society initiated an applied research project to identify how to enrich insect pollinator populations and their habitat in out-of-play areas of golf courses. The project is part of the Forgotten Pollinators Campaign, an international conservation effort focused on native pollinators created by Dr. Gary Paul Nabhan of the Arizona Desert Museum. In partnership with researchers from the USDA Bee Biology and Systematics Lab in Logan, Utah, Xerces Society staff worked on Wildhorse Golf Course in Mission, OR, Veterans Memorial Golf Course in Walla Walla, WA, and Horn Rapids Golf Course in Richland, WA. For each golf course, a reference site was also established in a local area of natural vegetation.

The project has four main components:

- Surveys of insects and plants
- Enrichment of habitat areas
- Creation of pollinator nesting sites
- Education about pollinators and their management

The first funding did not arrive until late May, 1997, thus project implementation could not begin until July. Because of this late start, only half of that first field season remained.

Surveys of insects and plants

The Xerces Society conducted surveys of pollinator insects during late summer and fall, 1997, and during the full field season from spring to fall, 1998. Once each week, a trapping survey was done using a passive technique of colored cereal bowls filled with a dilute solution of detergent that attracts insects. Each survey transect contained 45 bowls (15 each of blue, yellow and white) placed 10 to 15 feet apart in an alternating pattern of colors. Transects were laid out in the early morning and collected in the early evening. The contents of the bowls were then drained through a sieve, the insects rinsed in water and stored in labeled vials of 95% alcohol. In a local laboratory, the insects were air-dried, pinned and labeled. At the end of the field season they were transported to the USDA Bee Biology and Systematics Lab in Logan, Utah, for identification.

Identification of specimens from 1997 has been completed and the data presented in a previous report (79 bee species and 51 wasp species). Identification of the specimens from 1998 is also complete, and will be analyzed in the next few weeks. Because so few qualified taxonomic experts for bees exist in North America, identification of specimens is a serious bottleneck in the surveying process.

In addition to these surveys, bee nesting blocks were erected on the three golf courses and corresponding reference sites during the summer of 1998, and bees established nests in these. The

blocks were removed and taken to the USDA lab in the fall. There they were opened and the contents dissected to record nesting usage. The nesting cells were stored at 3-5 degrees centigrade for the winter and returned to the sites in spring of 1999 to allow the bees to emerge.

Twenty nesting blocks were erected on each site (a total of 120 nesting blocks) in spring of 1999, and have been surveyed on a monthly basis to record occupancy and activity. Data from this survey are being compiled and will be presented after the end of the field season. The nesting blocks will be collected and taken to the USDA lab for dissection in the fall, and again, data will be presented after the end of the field season.

During the summer of 1999, trapping surveys were not conducted because of concern over depleting pollinator populations. Scientists at the USDA lab felt that the existing data was sufficient and did not want to adversely impact the existing pollinator populations for information that may not offer additional value.

Plant surveys in 1997 identified species growing on site and analyzed the golf course soils. A literature search identified the likely plant communities that existed before human encroachment. A list of native plants that are attractive to pollinator insects and which could be used as the basis for habitat enrichment was compiled and annotated for easier use by golf course superintendents.

Enrichment of habitat areas

Pot-grown native plant species were planted on two courses in April of 1999. At Wildhorse, the planted area was irrigated and the plants have thrived. At Veterans Memorial, lack of water during the crucial early weeks resulted in failure of most of the planting. Obtaining native plant materials for habitat enrichment has been the most difficult aspect of this project. Native trees and shrubs are quite widely available from native plant nurseries, but herbs and forbs are much less widely grown. The project has been focused on a further subset of herbs and forbs—pollinator attracting species—and these are even less frequently grown by commercial native plant operations.

Initial plans sought to enrich two out-of-play areas on each course, one of which would also have artificial nesting sites installed. After discussions with the course supervisors and consideration of the realities of a golf course (for example, the playability of the course, not wanting to increase playing time, travel routes of players between holes, and areas most frequently disturbed when looking for lost balls), it became apparent that this part of the plan was not practical for the golf course environment. Establishing plots of sufficient uniformity to provide experimental replication and isolating the plots from outside influence (honey bees, neighboring agricultural land uses) to provide reliable data was never possible. The planting and habitat enrichment was modified to recognize the constraints of operating on a golf course and refocused to provide information on pollinator conservation that would be of practical use to golf course supervisors.

The original project proposal called for using the Forest Service native plant propagation project at Washington State University for supplying plants. However, between submitting the proposal and receiving proposal funding, the Forest Service changed policy and began subcontracting its plant propagation to private plant nurseries located throughout the country. The head of the USDA Forest Service Cooperative Programs, Tom Landis, encouraged Xerces to work with the Umatilla Tribal Native Plant Nursery. However, the summer of 1998 was a drought year and the plants planted at Wildhorse did not survive.

Native plants are a key component of restoring and enriching habitat areas. They can also be more difficult to manage. While a number of garden or introduced plant species are superficially

good for pollinators (such as varieties of aster and goldenrod, or even culinary herbs), these often benefit only a small number of pollinator species, including the European honey bee, now established across most of the United States. This creates a problem because honey bees easily dominate an area's pollinator fauna. (A hive of 40,000 honey bees will more rapidly harvest pollen and nectar than a solitary leafcutter bee or a colony of 300 bumblebees.) Honey bees may also favor introduced plant species, particularly European species, as these are the plants to which they are best adapted and from which they can most effectively collect pollen and nectar. As a result populations of introduced, often weedy, plants can get better pollination services than the native plants. The introduced plants spread and native plants suffer due to competition from invasive plants for nutrients and water, and from less pollination. (For some rare plant species, the lack of native pollinators is a critical aspect of their decline or survival.) Native pollinators don't get as much pollen as a direct result of competition from honey bees, and they end up with fewer native plants for foraging as an indirect, long-term result.

Clearly, native plants are critical for pollinators. (They can also help other wildlife, providing benefits such as larval food plants for butterflies.) The other consideration with native plants is the provenance of seed or plant cuttings. Some plant species have wide geographical ranges, but will have localized genetic variation to cope with differing growing conditions. Introducing plant materials from a different region can lead to a lessening of the genetic variation. A local species is preferred over one from another region, and, ideally, plant materials from a location with a similar environment and as close to the planting site as possible should be used. These will be best suited to local climate, growing season and conditions. Optimum adaptability to growing conditions is one of the advantages of native plants, especially local species, as it can reduce cost and time commitment for maintenance when they are established.

Finding high quality and reliable local sources of plant materials has been difficult. Identifying plants and sources that will be easily accessible to golf course supervisors and managers has been a high priority for project staff. Contract growing or collecting of small quantities of plants and seed is not a cost effective option (although in ecological terms it may be the best). Commercial nurseries offering the pollinator plants are rare. After research with regional native plant nurseries, Xerces staff has sourced seed for many of the pollinator preferred plant species from a nursery in Idaho. Three nurseries also offer a range of the pollinator plants, one in Washington, one in Montana and one in New Mexico. (With nurseries far away, the question of plant provenance arises.) Some of the pollinator species on the list are not available from any commercial nurseries.

Seed for more than half of the pollinator plants on the list can most likely be obtained this fall. These can be used in two ways, either sown directly into the habitat areas or grown in pots to produce planting stock for next spring. Sowing directly into out-of-play areas in small patches (one yard square maximum) will create floral-rich patches that can form a seed bank and colonize the habitat without creating an unsightly mud bath where golf balls get stuck or weed species thrive. Pot-grown plants can be established in the existing turf relatively easily.

Creating pollinator nesting sites

Nesting boxes have been erected on all six golf courses and reference sites. Each box has 44 holes of four different sizes, and is fixed to a wooden stake. Not all the boxes have survived: one of the reference sites has public access and several boxes have disappeared; on another, a couple of boxes have been damaged by grazing cattle. Monthly surveying of these boxes indicates that they have been swiftly occupied by various genera of bees. Full results will be compiled after the end of the field season.

A sand pit and a sand pile were constructed in the habitat area at Wildhorse, but not at either of the other sites (Horn Rapids would not benefit from either of these as it is a sandy site).

Education about pollinators and their management

Xerces Society project staff realized early in the three-year grant cycle that educational information was important to the golf course superintendents and golfers. Accordingly, resources and time have been invested in producing educational materials and developing guidelines for course superintendents and managers.

Gathering the information into a useful format is a significant part of this project. During the site visits, project staff realized that golf course staff and players were very interested in the program. While surveying much time was spent explaining to passing players and clubhouse staff what was happening and why. Course supervisors were interested in having interpretive materials for their members and players.

Several documents have been prepared in draft form and are being refined:

- Native Pollinators on Your Golf Course—a leaflet outlining the project and its activities
- Nesting Boxes/Native Plants for Bees—an information sheet on simple ways you can help bees
- Guidelines for Creating Habitat for Native Pollinator Insects on Golf Courses—guidance for golf course professionals

Draft copies are attached.

Where opportunity has allowed, the project work has been promoted through the media. This has included a feature about the project on *Living on Earth* broadcast on National Public Radio in 1998 and 1999, and an article written by David Schwartz (tentatively entitled *Birds do it, bees do it, even nectar-feeding bats do it...*), expected to be published in *Smithsonian Magazine* in spring, 2000.

Separate from this project, but related to it, is the production of the Pocket Guide to Pollinator Insects. Written in an accessible style, it will provide gardeners, naturalists and land managers with a handy reference on pollinator insects. It will include an overview of the natural history of the various groups of bees and pollinator insects seen in the wild, in backyards and on golf courses, and enable identification of many of them to the genus level. Draft manuscripts for several chapters have been received from well-known scientific contributors. Many slides and illustrations have been submitted for consideration. Houghton Mifflin, publisher of the Peterson guides, has expressed a keen interest in it.

Project products

- Species surveys were completed during the late summer of 1997 and the spring and summer of 1998. Specimens from these have been identified and data compiled.
- Nesting boxes were placed on the golf courses during the spring of 1998. These were collected and taken to the USDA lab in Logan, Utah, for dissection and analysis. The natal cells were carefully stored and returned to the golf courses for emergence in spring of 1999.
- Nesting boxes were erected on each of the three golf courses and the three reference sites in spring of 1999, and regular monitoring of these has been done. Analysis of field recording will be done after the end of the current field season. These boxes will be taken to the USDA lab for analysis.

- A source of native plant material has been located and seed for many of the desired plants are expected to be sown on the golf courses in fall of 1999, or grown into plants to be planted in spring of 2000.
- Interpretive materials have been prepared for golfers, including
  - Native Pollinators on Your Golf Course
  - Nesting Boxes/Native Plants for Bees
- Guidelines for Creating Habitat for Native Pollinator Insects on Golf Courses were prepared in draft form.

Future work

The current program is expected to run until May, 2000 (three years from receipt of first grant check). By that date:

- Surveys from the 1999 field season will be completed and data compiled.
- Seeds will be obtained and sown in habitat patches or will be grown in pots for transplanting next spring.
- The three draft documents listed above will be completed.

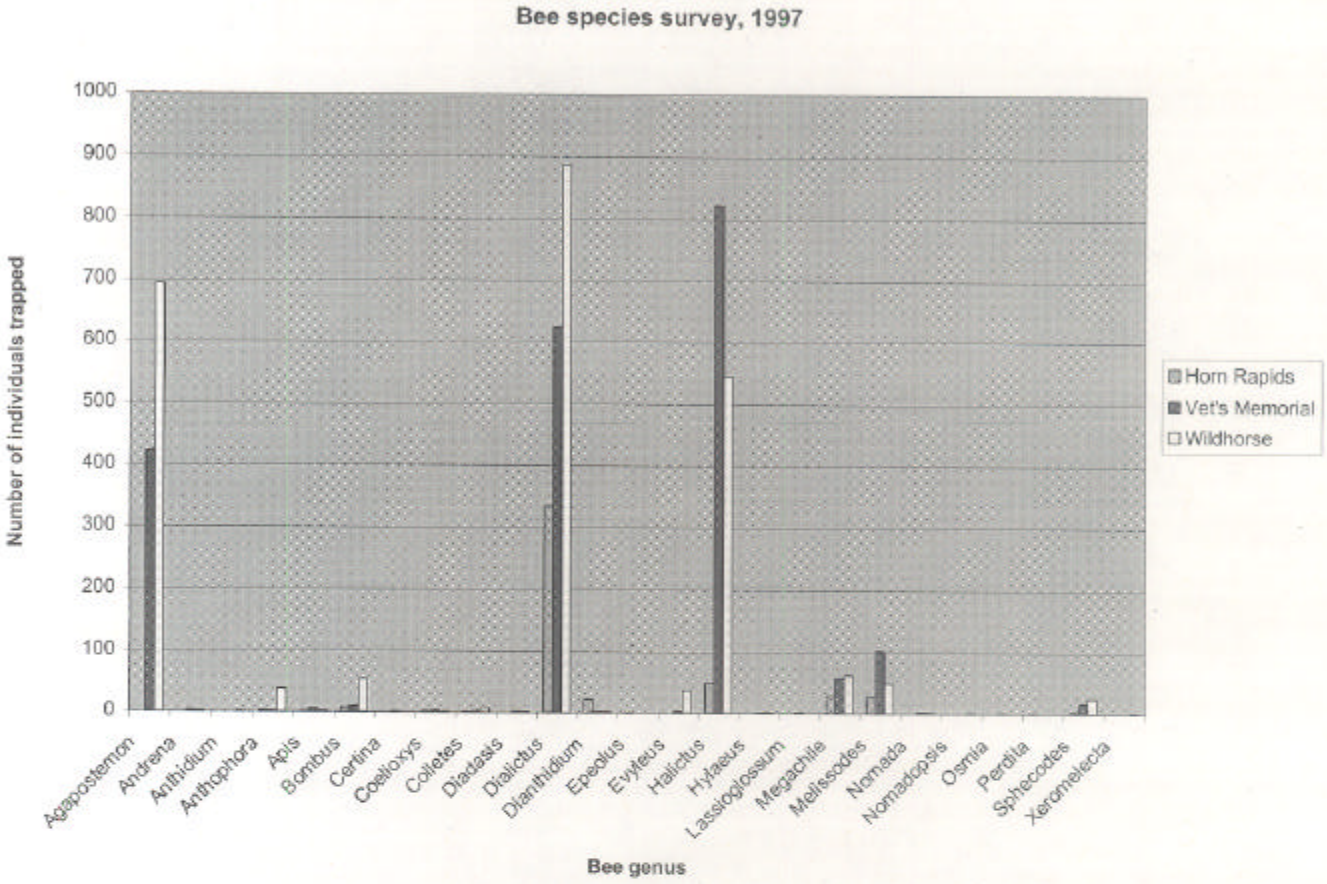

Chart 1

During the 1997 field season, 4985 bees were trapped representing 25 genera. Identification of specimens was done to the species level, but summarizing the survey data by grouping specimens into genera gives an overview of the pollinator populations on the golf courses. The pattern shown by this chart is that most genera have very few individuals, with three genera (Agapostemon, Dialictus, and Halictus) forming the bulk of the specimens trapped. The pattern causes concern as these three genera are the most generalist bees, those most able to adapt to degraded conditions. The other native bee genera appear to have low populations. This is, sadly, a situation that was predicted by USDA researchers in 1979.

Of the three dominant genera, two—Agapostemon and Halictus—are Halictid sweat bees, a family that feeds on a wide range of flowers and can survive a wide range of environments. The Halictus genus is often the last to remain in degraded conditions. Dialictus bees have a remarkably long flight season, one of the first to fly in spring and last in fall, and consequently likely to be trapped all season.

Although these bees are present on the golf courses in some quantity they will not necessarily pollinate flowers. The Halictids have short tongues, and consequently can take the nectar without touching the pollen. Dialictus bees are small enough to get inside the corolla tube of flowers without disturbing the pollen on the anthers.

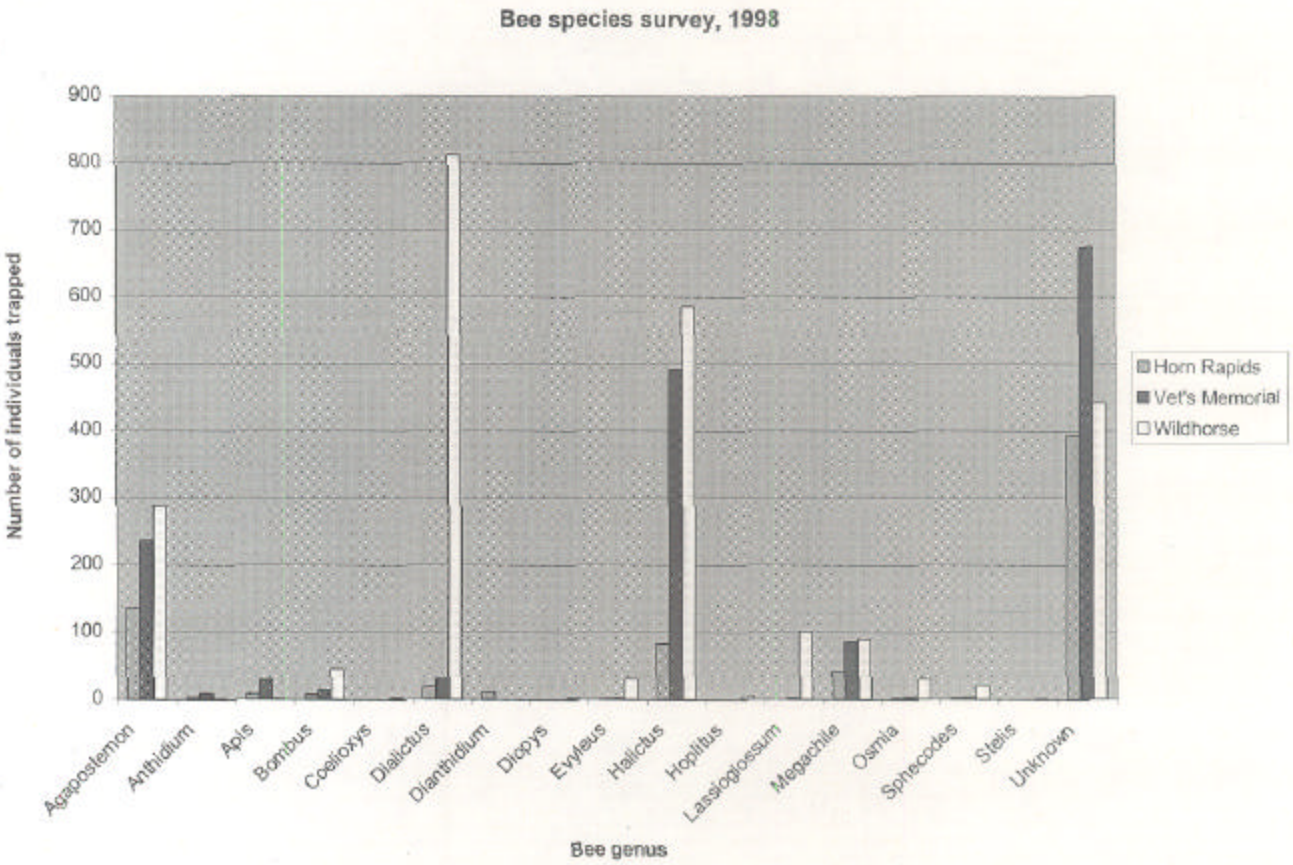

Chart 2

A summary of the 4751 specimens trapped in 1998, again presented as an abundance of each genus trapped. The significant number of unknown specimens is likely to be a result of specimens being damaged during collection or transport, and thus hard to identify to the species level. (Accurate, species-level ID of specimens may depend on a detail such as which way the hairs lie.) The shortage of experienced taxonomists has been identified as a bottleneck for pollinator conservation. The second phase of the project, for which funding has been requested, plans to develop a new methodology to enable golf course superintendents to assess pollinator populations.

The pattern of three dominant genera, with low individual counts for the other genera, is a repeat of the 1997 findings. This indicates that pollinator populations are severely depleted. This led the project, under guidance from USDA scientists, to abandon plans for another trapping survey in 1999 to avoid depopulation of pollinators.

The low population of most genera gives cause for concern. Many of these are more specialist bees, foraging from a limited range of plants, and are effective pollinators of these. Since the three dominant genera are generalists or can take nectar without touching the pollen, the plant communities will have a lower fruit and seed productivity without the pollination service provided by these missing bees.

Guidelines for creating habitat for native pollinator insects on golf courses

Prepared by the Xerces Society with funding from the US Golf Association/National Fish & Wildlife Foundation Wildlife Links Program

Introduction

There is a growing awareness of the importance of wildlife on golf courses. Wildlife of all sorts - plants, birds, animals and insects - is an additional pleasure for golfers on the course. Golf courses are being recognized as important sites for a wide range of wildlife. As many places come under increasing development pressure, golf courses provide two conservation opportunities. First, on older courses there are often areas of original vegetation and well established animal and insect communities that can survive as the surrounding area becomes increasingly suburbanized. Second, new courses provide excellent opportunities for the creation of diverse habitat that can become a refuge for wildlife.

Many golf courses are lovingly tended and manicured to create park-like conditions. This has been described as the "Augusta National Syndrome", a desire to replicate the image of horticultural perfection seen by millions on their television screens during the US Masters Tournament. Older golfers in particular admire this, but it is a highly intensive approach and beyond the resources of many golf courses. Despite the widely held perception that golf courses are treated with toxic chemicals, the reality is that course supervisors everywhere are looking for ways to reduce inputs or find alternatives that will provide a high quality playing environment and improve the courses for wildlife. There are many examples of good practice where wildlife benefits and costs are reduced.

The importance of good stewardship of golf courses has been recognized internationally. For example, the Royal and Ancient Golf Club of St. Andrews, Scotland has been at the forefront of promoting better management of golf's natural heritage in the UK. Here in the US, the US Golf Association has an active program of research investigating the environmental impacts of course management. The USGA has provided funding for the Xerces Society, based in Portland, OR, to work in partnership with the USDA Bee Biology and Systematics Laboratory, based in Logan, UT, to run a program investigating conservation of native pollinators, especially bees, on golf courses. This report has been prepared under the aegis of that program.

These guidelines have been written to provide help to golf course managers and supervisors with planning and managing out-of-play and other areas on their courses. The guidelines do not attempt to give great detail about specifics of plant care. Not only are there many excellent sources of information, golf course staff are experts are growing and caring for plants since that is what they do every day! To compound the situation, every golf course has differing soils or climate, growing conditions that the staff will understand better than anyone.

Bees as pollinators

Native bees play a critical role in keeping flowering plants healthy. Without insect pollination many flowering plant species cannot reproduce. About two thirds of plants need insects or other animals to pollinate them, and bees are the most important insect pollinator. They visit hundreds or perhaps thousands of flowers on a typical foraging trip, eating energy-rich nectar from the flowers to power their flight muscles. Female bees also collect pollen for food for their offspring. While foraging, bees transfer pollen grains (male sex cells) from flower to flower, a vital reproductive service for the plants. This exchange of pollen means that female plant ovules are fertilized and seed can develop, allowing the plants to reproduce while indirectly providing food for animals and people.

The work of pollinators is of vital importance, providing an essential link in maintaining healthy plant and animal communities. Plants are the foundation of the food web, converting the sun's energy through photosynthesis into plant matter that can be utilized by animals. Healthy plant communities are the basis of natural ecosystems, providing food for herbivores or frugivores that form the foundation of food webs,

are usually the first bees active in the spring). Generally, this floral resource cannot be provided by one habitat patch or a single site.

When people think of bees they tend to picture fat bumblebees or swarms of honey bees, and regale us with tales of being stung. In reality these are the exceptions. Honey bees are not even native to the US and are one of the very few species that might sting. It is only the social bees living in colonies that are likely to sting because they have a community to defend. In the US ,the vast majority of native bee species are solitary, passive creatures with no hive to defend. When foraging away from the nest no bee is looking for conflict and will only sting as a last resort - maybe because they are being swatted or squashed, or just caught in someone's clothes by accident.

Where to plant

Despite the low risk there is still some resistance to encouraging bees close to playing areas. Fortunately conflict between players and bees is low as many places on a golf course where people usually go are unlikely to be appropriate for bee conservation. Playing areas have specific requirements to provide a good golf game, including sward height and composition, ball visibility and access, which mean they are unlikely to be suitable for habitat enhancement. A survey of the course and golf play will identify suitable sites, often in out-of-play.

There are a number of issues to consider when deciding where to create habitat areas.

- **Playing areas.** The principal playing areas (tees, greens and fairways) are obvious places that are inappropriate for active pollinator conservation. Tees and greens have special conditions that must be maintained for the course to be playable. Along fairways the golfer wants to see the ball and have it travel predictably. Colored flowers (particularly white) will not be good as they will hide the ball, and some broad-leaved plants can cause uneven bounce.
- **Layout.** Depending on the layout of the course and slope of the fairways, some roughs or out-of-play areas will be more likely to have balls land or roll into them.
- **Skill of players.** Depending on the skill of players some courses may experience a greater frequency of sliced or hooked shots resulting in more excursions off the fairways.
- **Topography.** The topography will influence the habitat. For instance, south-facing slopes will be warmer, creating better conditions for sun-loving bees. Drier, warmer ground is also preferred by soil nesting bees.
- **Existing habitat.** Look for existing areas of good habitat, as these patches may already have a pollinator population. These pollinators will benefit directly and swiftly from expanding and enhancing these existing habitat patches, and changing the management regime of adjacent areas.
- **Rare plant or wildlife colonies.** Modifying the habitat of rare species could jeopardize their survival unless the changes are carefully considered and implemented. This applies to both changing the growing conditions of a rare plant, by for example introducing plants that can out compete it for water or sunlight, or the living area of a butterfly by altering the plant communities it relies upon for food and shelter as an adult or caterpillar.
- **Size and shape of habitat area.** Bigger areas will generally be better for wildlife, providing a site that is more likely to support larger, more stable plant and animal communities. Whilst any habitat area can be beneficial, narrow or linear areas will be less good as disturbance to the margins (for example, from mowing adjacent grass or players moving between holes) will impact further into the habitat. Big and blocky is a good idea, giving the maximum habitat area for the minimum edge length.
- **Visibility of the habitat.** On some courses having a habitat area next to the club house may not be appreciated by all golfers. A flower-rich prairie is a beautiful sight, but some players will have a different idea of what a beautiful course looks like. Ensuring the habitat areas are visible to players can be of great educational or interpretive value, giving an opportunity to inform players how the course in managed.
- **Accessibility of habitat areas.** The habitat areas must be accessible for planting and maintenance. Although in the long term maintenance should be reduced, in the establishment period access will be needed for weed control and especially watering.

- **Planting density.** In practice, plan for about one perennial plant 12 to 18 inches, and annuals at a slightly higher density. Whatever happens, try to establish as many plants as you can.
- **Distribution.** These plant populations do not necessarily have to be in a single habitat patch. If habitat areas are not too far apart, populations of plants can be spread between two or three patches, particularly for perennials.
- **Resources.** Cost is inevitably a factor (not just purchasing plant material, but also maintenance). If resource constraints mean that 300 plants can not be planted in one year then stagger the planting over two or three.

Planting material

There are two basic choices, seeds or transplants. Seeds have the advantages that they are cheaper than transplants so potentially you can have more plants for your money. Additionally, nurseries will probably be able to provide seed for a wider range of species than they can supply transplants. However they can be more difficult to establish especially if being introduced into existing grassland. If a clean seed bed can be achieved (when creating a new course, for example) then seeding with a mix of grasses and forbs can be a successful approach. For the majority of situations, golf course supervisors are likely to be interested in adding native plants to enrich existing grassland. Transplants are usually preferred in this situation as they can survive competition from existing plants. Successful establishment will require on-going maintenance (see next section).

Sometimes alternative sources of planting material are available. If an area of local habitat similar to the golf course environment is being lost to development, removal of natural sod or plants may be possible. Translocation of habitat has mixed success and may not succeed. The opportunity to move some native vegetation from a construction site to a golf course should not be seen as a justification for allowing destruction of good habitat areas.

Plant establishment

Growing native plants is like growing any other plants, they need to be cared for, especially controlling weeds and watering. Careful planting and tending during the first growing season will reap benefits later as the plants will be well established and require less maintenance in subsequent years.

Most planting on golf courses will probably be done with transplants, using them to enhance existing areas of vegetation.

- **When to plant.** Perennials can be planted during the fall or spring. In regions with long, cold winters, spring is better to avoid frost heave pushing plants out of the ground. Spring planting also allows development of root systems before the next winter. Species that flower early in the season are best planted in fall so they are established in time for blooming.
- **Site preparation.** Remove the worst weeds. Areas of bare soil may create a worse weed situation for the future, so avoid clearing all vegetation. The advantage of planting transplants is that they can be introduced to an existing vegetation cover, which helps to suppress weeds.
- **Planting.** When planting pot-grown plants make sure the hole is large enough to accommodate the whole root mass. The different species should be distributed in a random pattern across the habitat area, with transplants of each species clustered into groups of five or six individuals. Planting transplants on a grid pattern is not necessary, as this planting should be to create a natural area. After planting mulch with a couple of inches depth of clean straw (aerification cores could be used if they will not regrow)
- **Irrigation.** Watering during the first summer is critical. For the first six weeks, irrigate at least once a week, preferably more frequently. After that, water during particularly dry or hot periods. These guidelines are very general and will need to be adapted to local soil, topography and climate. Mulching in the first year after planting can help to retain moisture and reduce irrigation. Irrigation in subsequent years should not be necessary. (Unless a drought is going to kill the plants!) This can encourage root development near to the surface, making the plants more susceptible to damage by dry spells, and impede growth of the deep roots the plants need.

For bees that prefer a wood nesting substrate there are several techniques that can mimic the conditions of a snag.

- **Log and snags.** Get some logs or old stumps and place them in the habitat patches. As with the adobe blocks, drill holes at least 4" deep and 3/32" to 3/8" diameter into the logs.
- **Elderberry stems.** Elderberry stems are naturally used by some bee species as they has a soft central pith, and can easily be used to create nesting sites in two ways. The first is to get elderberry stems cut into lengths of 8' to 12". Drill out the central pith to form a hole 3/32" to 3/8" diameter, and then tie them in bundles of 15 to 20 stems. Finally, fix them to a stake or tree with the stems horizontal to the ground. The second method is to make stakes from elderberry stems and drive them into the ground. They should be about 18" to 24" high. Towards the top of the stake drill a hole (in the same 3/32" to 3/8" diameter range) through the bark into the pith.
- **Nesting blocks.** Bee nesting blocks can be made from blocks of lumber at least 4" by 4" and 8" long. In one side of the block, drill lots of holes 3/32" to 3/8" diameter and almost all the way through the block. Ideally, the block should have one end sloping and capped with plywood to form a roof (like a bird nesting house, the roof should extend beyond the front of the block to protect the nesting holes). This block can be fixed to a stake or tree in a sunny, preferably eastward facing spot.

Conclusions

Golf courses offer wonderful opportunities for wildlife conservation. They can contain large areas of natural vegetation that are relatively undisturbed by people, that with a little care and planning can support a wonderful diversity of wildlife. The guidelines given in this document will help with the planning and maintenance of habitat areas to provide homes and food for native pollinator insects, especially bees. A flower-rich habitat will also attract hummingbirds, butterflies, beetles and other insects. These in turn will attract other animals and birds, and some of the insects will be beneficial in themselves – several wasp species are predators of golf course pests such as cutworm. Simple changes to the environment of golf courses can have great benefits for wildlife. Often these changes can be achieved at minimal cost and involve only small alterations to current course management and maintenance routines.