Guidelines for Maximizing Biodiversity on Golf Courses

By

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ASEAN Regional Centre for Biodiversity Conservation (ARCBC)
A joint cooperation project between ASEAN and the European Union
GUIDELINES FOR MAXIMIZING BIODIVERSITY ON GOLF COURSES

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Preface

As human population expands, natural vegetation retreats and biodiversity across the globe is reduced. But as the world becomes more urbanized and crowded, there is a growing demand for access to outdoor leisure opportunities. Outdoor sports such as eco-tourism, backpacking, horse-riding, and fishing are major growth industries worldwide and golf spearheads the list of these expanding outdoor activities. New golf courses are springing up in China, ASEAN countries, and other parts of the world at a tremendous pace.

Golf is sometimes accused of being environmentally unfriendly, taking up valuable space and land, competing with natural vegetation or poor rural communities, using scarce water resources and polluting the land and waterways with dangerous chemicals.

But it does not have to be this way. Golf and environment can easily develop side by side and golf courses can serve as miniature nature reserves, harbouring local resident populations of otherwise endangered species, stepping stones for species dispersal and migration. Golf courses provide green breathing spaces in a concrete landscape and the well-managed turf has many valuable service values – soil protection, water filtering, pollution fixation, and biodiversity conservation. A well-managed golf course can provide more environmental benefits than a poorly managed nature reserve; and because they are run on an economic basis they are in a stronger position to offer good management and a high level of habitat protection.

This book provides the guidelines for achieving this, whether a new golf course is being designed or an existing course is being improved. Moreover, governments have a responsibility to the wider public and should ensure that the development of new courses meet certain environmental requirements. These guidelines can form a basis for such regulations and set the environmental standards that are expected before development approval is granted.

John R. MacKinnon
Los Banos, Philippines
June 2004
Objectives and Principles

1.1 Introduction

Harmony with nature has always been part of golf's rich heritage. It is important to ensure that this is sustained and that the impacts of golf remain positive and benign. Respect for the environment goes hand in hand with human health and sporting excellence. If we lose that ideal, golf will not remain sustainable and our environment will become degraded.

The aim of this booklet is to provide guidelines to golf course managers to ensure that the pressures of land-use, resource-use, and pollution are minimized and the contribution to the landscape, biodiversity, and environmental services of golf courses are maximized whilst satisfying the members' expectations on playability and aesthetics.

This booklet is based on experience in both temperate and tropical regions and most of the guidelines are equally applicable to both regions.

1.2 Why is it important to increase biodiversity on golf courses?

- Improved public image
- Greater social responsibility
- Enhanced member and player enjoyment
- Reduced management costs

In a period of human development when issues of poverty alleviation and fair allocation of global resources are major concerns, the role of golf courses is often seen in a negative light, especially in developing countries. Golf courses are viewed as the exclusive playgrounds of the richer sectors of society, taking up valuable land and water resources and often contributing toxic wastes into local water systems.

There is a need for improving the image of golf in society and demonstrating a more social responsibility to the local community. Traditionally, courses attempt to do this by hosting charity events and making contributions to local welfare projects.

This set of guidelines offers another way to show golf course management in a more positive light by transforming golf courses into environmentally positive and contributive areas, providing a combination of benefits such as watershed conservation, biodiversity conservation, education facilities, water purification functions, carbon-fixing role and pollution abatement.

Moreover, most of the recommendations in this booklet will reduce the labor and costs of course management rather than add to the costs by allowing natural succession and natural processes to flourish rather than counter the natural state in maintaining artificial species communities.

Creating a more natural and diverse flora and fauna on the golf course will make it more attractive and also more interesting to players. As golf becomes more popular, courses become more crowded and the length of a game becomes longer. What better way could fill the moments of waiting for the group ahead to hole out than to provide a nature reserve of interesting plants and animals to admire along the way. Interest is not only in the visual senses. The scent of fragrant flowers and the sounds of birdsong and insects can also be very relaxing and pleasurable.

Whilst new golf courses sprout and grow worldwide, the area of natural habitat and reserves is ever shrinking. Golf courses are large enough to constitute valuable local nature reserves for indigenous and endangered species.
1.3 General principles

The three guiding principles of this booklet are:

- To reduce activities that are negative to the environment
- To increase biological richness and ecosystem complexity to create greater stability and natural control
- To use indigenous rather than exotic species whenever possible

The following activities are proposed:

- Minimize water needs and recycle water
- Minimize the use of toxic control agents
- Develop a waste management programme suitable to the site
- Allow natural flora and fauna to colonize water hazards and water courses
- Minimize the use of burning as a management tool
- Encourage diverse natural vegetation on off-course areas
- Declare course a wildlife sanctuary
- Seek advice from local wildlife experts
- Prepare a biodiversity management plan for the course
- Control and minimize introduction of invasive Alien Species
- Develop special habitat conditions to encourage rare local species
- Document biological data and trends or changes
- Involve membership and local community in environmental projects
- Develop educational program
- Become part of national or regional conservation programmes

1.4 Planning for biodiversity enhancement.

It is very sound to develop a detailed management plan specifically for the course biodiversity programme. A special planning team should be established to undertake this. The plan should be reviewed and revised periodically.

As with all types of planning, you should consider the three basic questions:

- What are we starting out with?
- What do we hope to end up with?
- How are we going to get to that point?

In answering these questions we can establish the objectives of the plan and the main activity components in a logical sequence.

Each activity has a timeframe for completion. Some of these may take several years (e.g., for a tree to grow). Some of these are seasonal or opportunistic and some activities can only take place after other activities or other preconditions have been achieved.

Consider these dependencies before laying out the planned activities as a time chart (Gantt Chart). In addition, each activity has a location or area of action. These should be identified and as a golf course is a large area, much of this will be related to maps at different scales.

Group the activities of the plan together with related activities under suitable headings such as water management, planting programme, wildlife enhancement, integrated pest control, waste disposal, use of chemicals on course, protection of wildlife, fire control, education programme, extension service, among other site improvement and bioaugmentation activities the golf development planners and managers may find useful in their courses.

Once your activities are planned over time you can go ahead with identifying the inputs in terms of materials, time, manpower, and equipment and also estimating the costs of these inputs. These need to be summed over time periods for budgeting and approval by relevant managers or committees.

It is useful to identify a series of intermediate targets so that you can monitor progress and achievement through the life of the plan. For this, it is useful to define certain verifiable indicators that will confirm that you are reaching the identified objectives.

All plans must be flexible. The future is fraught with uncertainty. We cannot predict flash floods, bush fires, strong storms, droughts, climate change, neighbouring land use changes, pest outbreaks or diseases of plants and animals. Our plan must have the capacity to meet unexpected challenges, meet unpredicted disasters and take advantage of opportunistic chances that might arise.

Present the plan in an attractive and clear manner so that it can be approved, followed, monitored, and eventually revised, even if there are changes in personnel responsible.
The following outline plan may be used as a model and adapted to the specific needs of a given course:

- Define management objectives to include environmental targets for the course.
- Define and map management zones around the golf course.
- Identify best management practices for each zone, including measures to reduce any harmful environmental effects noted in environmental review and potential enhancement measures and a suitable program for their implementation. A hole-by-hole mapwise plan is useful.
- Define performance standards with given timetable.
- Identify persons responsible for each activity and operation, ensuring that they have the necessary capacity to perform these tasks.
- Devise a regular monitoring program for both the physical and living environmental conditions, with defined baseline parameters on which to determine progress and effectiveness of management operations.
- Establish efficient record-keeping system so that like-to-like measurements can be taken in subsequent years to record long-term progress.
- Budget expected costs of operations.
- List unit costings on which budget is based so that revisions can be made if unit costs change.

Far too often, it is only once a course is up and running that management and membership start to think about the wildlife and conservation aspects of their lands. Options have already been lost or limited in the initial design and construction of the course. The most important message of this booklet is 'Plan for biodiversity conservation from the outset.' Golf course architects, please heed!
2.1 Water conservation

Conserving water is one of the greatest concerns of golf courses nowadays. Pressures from the communities surrounding the golf courses and the media make the superintendents wish for an extension of the rainy season.

2.1.1 Ways to save water:
- Invest in a modern irrigation system and check the system regularly. Computers and weather stations play an important role in providing information on the golf course’s irrigation needs to maximize efficiency.
- Improve water distribution by regularly checking the coverage of the sprinkler heads and the performance of the pump station.
- Repair leaks promptly.
- Record water consumption to set conservation goals and monitor success. Achieving results can keep one motivated.
- Water only when needed. Evaluate soil moisture condition with a soil probe before watering to ensure that watering is needed.
- Practice deep watering. This method could result in a deep, health root system of turf grass when done regularly but not frequently.
- Avoid watering with sprinkler heads during windy days and when evaporation rate is high.
- Plant out-of-play areas with native vegetation to lessen watering needs.
- Incorporate cultural practices like aeration, slicing, use of wetting agents in the golf course program to improve water absorption of the turf areas.

Saving the precious water means saving life forms on earth. Conserving water on a golf course does not mean brown patches of turf everywhere. A well-managed golf course can save millions of gallons of water per year and still look lush and green all the time—proper allocation of the precious resource is the key.

2.2 Water quality

Protecting the quality of water on golf courses is as important as saving it. Clean water supply for plants, birds, and wildlife at the golf course also means protecting water bodies of oceans, rivers, lakes, streams, wetlands, and ponds around the golf course. Golf operations have the greatest impact on the quality of water on and around the site. Water quality has several parameters: temperature, oxygen content at 6–13 mg/l, pH level at 6.5–8.5, sediment load (measure turbidity with secchi disc), metal content, salinity (coastal or high evaporation areas), nitrate/nitrates at <0.5 mg/l, ammonia (low) and total phosphorus content at <0.02 mg/l, and presence of organic toxins (e.g., oil).

2.2.1 Ways to protect water quality:
- Keep the areas around the bodies of water vegetated. This could prevent soil erosion and could reduce potential pollution from runoff. Tall vegetation like grasses, shrubs, and trees could also provide shade to the water bodies to prevent rise in temperature.
- Avoid spraying herbicides to control plants on the water bodies. Manual removal of invasive species could help a lot in protecting the water quality of these bodies of water.
- Reduce chemical applications on turf areas. Improper fertilizer and pesticide handling could cause a decline in water quality.
From mixing to storage and disposal of these chemicals, proper handling should be practiced to reduce run-off or leaching to the water bodies.

- Reduce chemical application on turf by planting new pest- and disease-tolerant turf varieties.
- Identify sources of soil erosion i.e., open land, erosion gullies, land scars; and make necessary engineering or planting (e.g., turf over) to reduce or prevent soil erosion.
- Develop and implement an integrated pest management (IPM) program.
- Test surface water and ground water for nutrient and metal content, physical characteristics and bacteria at least once a year to monitor the quality of water on site and to check and evaluate the effectiveness of the water management strategies employed.
- Use slow-release fertilizers to lessen eutrophication (water pollution caused by excessive use of plant nutrient).
- Make regular visual inspection and chemical testing to identify problems early and take remedial action.
- Ensure high standards of chemical storage, container disposal, and limit oil spillage.

Superintendents of well-managed golf courses plan ways to protect the water quality so it stays the same or has improved as the water moves off the property.

---

### Field checking water quality

<table>
<thead>
<tr>
<th>If the water is</th>
<th>It could be...</th>
<th>You should...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue or blue-green</td>
<td>Nutrients released into the water causing an algal bloom</td>
<td>Check for possible fertilizer or manure run-off, sewage discharge or septic failure. May be too much application on course.</td>
</tr>
<tr>
<td>Orange-red</td>
<td>Acid drainage or the presence of synthetic dyes</td>
<td>Check for industrial waste or for landfill seepage draining into water.</td>
</tr>
<tr>
<td>Grey/black</td>
<td>Sewage or livestock waste</td>
<td>Check for sewage discharge or animal populations.</td>
</tr>
<tr>
<td>Light brown (muddy or cloudy)</td>
<td>Sediment deposition caused by erosion</td>
<td>Look for disturbed ground left open to rainfall (e.g., construction).</td>
</tr>
<tr>
<td>Yellow-brown – dark brown</td>
<td>Acids released from decaying plants. Also common in streams draining from marsh</td>
<td>If it's not autumn, search upstream for some foreign item in the water.</td>
</tr>
</tbody>
</table>

**If you can smell...**

<table>
<thead>
<tr>
<th>If you can smell...</th>
<th>It could be...</th>
<th>You should...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotten egg odour</td>
<td>A natural occurrence in swamps or sewage pollution</td>
<td>Look for sewage or septic inputs.</td>
</tr>
<tr>
<td>Musky odour</td>
<td>Untreated sewage, livestock waste, algae or other conditions</td>
<td>Check your watershed for sewage/septic inputs and animal populations.</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Over-chlorination of sewage input water or swimming pool discharge</td>
<td>Look for sewage input or recently drained swimming pool.</td>
</tr>
<tr>
<td>Fishy odour</td>
<td>Excess algal growth or presence of dead fish</td>
<td>Search for dead fish or look for cause of excess algae.</td>
</tr>
</tbody>
</table>

**If you notice...**

<table>
<thead>
<tr>
<th>If you notice...</th>
<th>It could be...</th>
<th>You should...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead fish</td>
<td>Naturally occurring, accompanies annual spawning or toxic dumping/nutrient overload</td>
<td>Check upstream for discharge or seepage; check fish life cycle in your area.</td>
</tr>
<tr>
<td>Increase or decrease in wildlife</td>
<td>Many reasons: habitat changes, water quality changes, natural population increases during breeding season or decrease after migration</td>
<td>Have any changes, such as construction or development, occurred since you last monitored? Note the time of year. Can this be correlated with breeding or migration?</td>
</tr>
</tbody>
</table>
2.3 Use of chemicals

Fertilizers and pesticides (insecticides, herbicides, nematicides, fungicides) are the main types of chemical treatment used on golf courses. All are hazardous to the environment. These chemicals could pose threats to humans, birds, other wildlife, and plants. Water quality on the golf course could also decline due to contamination. Minimizing the need for such treatment is both good for nature and budget.

Fertilizers are used to stimulate grass growth and bring out a strong, vigorous color to greens, tees, and fairways. They are particularly used to speed up the establishment of newly set areas of turf, seeds or plantings.

Fertilizers are expensive; they add to the grass cutting costs and they can cause algal bloom in waterways or eutrophication of ponds and lakes. Sudden death of fish is commonly associated with a new application of fertilizer. This is especially the case where water is recycled in a closed system and high concentrations of chemicals can build up.

2.3.1 Ways to reduce the need to use fertilizers:

- Select local grass species
- Plant during natural growth periods of the year
- Leave grass cuttings on the ground
- Use natural fertilizers (peat, compost, green manure) rather than chemicals

2.3.2 Ways to limit use or impact of herbicides:

- Implement manual weeding programme (may be assisted by local volunteers)
- Use biodegradable chemicals only
- Use pest and disease resistant turf varieties
- Use target-specific agents
- Avoid use of chemicals close to waterways or during rainy weather
- Use of local grass species that can naturally dominate on fairways, greens, etc.
- Use of mulch on landscape beds
- Use biological controls
- Ensure rich biota including natural enemies of target pest species
- Erect suitable fences
- Ensure adequate aeration of fungus prone areas
- Keep records of pest infestation and treatment to help in early detection of problems and problem areas
- Set threshold levels for pests to treat area only when necessary
- Train employees on health hazards, pest identification, and proper handling of chemicals
- Develop and implement an IPM programme suitable to the site
- Only apply chemicals in amounts that the turf can hold. This can be gauged by testing. Clay soils can hold more chemicals without leaching than can sandy soils.

2.3.3 Ways to reduce chemical waste:

- Storage facilities should be clean, dry, and well ventilated
- Containers should be clearly labeled
- Keep containers off the ground and well clear of floods
- Avoid spillage
- Avoid keeping more chemicals than needed and keeping chemicals for long periods
- Rinse equipment only when necessary
2.3.4 Integrated Pest Management (IPM) programme

Relying too heavily on chemicals costs a lot of money, allows pests to become resistant to those chemicals and destroys together with the pests many natural pest control agents such as arthropods, mites, amphibia and birds.

Integrated pest management involves tackling pest and turf problems at the most effective time in the soundest manner available. Your turfgrass will be protected by a combination of chemical, cultural, and biological activities. This will save money on chemicals, prevent pests building up resistance to chemicals and meet many environmental concerns about residual chemicals and secondary effects.

Some features of good IPM include:

- Selecting turf suited to local conditions
- Proper site preparation, especially to allow aeration of turf roots, before planting
- Trying different irrigation patterns to minimize fungus and disease. Morning watering recommended.
- Adjusting pH to suit turf
- Physically removing weeds early
- Applying fertilizer only on basis of soil tests
- Mowing only when grass is dry
- Identifying pests accurately and applying specific treatment
- Use of insecticidal soaps, sulfur-based fungicides, petroleum oil and if necessary pyrethrin/rotenone combinations for environmentally sound pest control
- Encourage natural predators of those pests causing a problems (spiders, hunter wasps, reptiles, birds).

In addition a variety of traps and attractants have been commercially developed to control some common turf pests such as armyworms, webworms, and cutworms.
2.4 Controlling special problem creatures

2.4.1 Worms, rabbits, moles, monkeys

Moles provide excellent service in aerating the ground under turf but are hated by most greenkeepers and superintendents because they make piles of loose soil and also can cause subsidence that requires a lot of maintenance time to repair. The best solution is control rather than eradication. We also suggest trapping as opposed to poisoning, and only on fairways, greens and tees. The rules of golf provide adequate relief of a free drop from fresh animal scrapes.

Rabbits and similar burrowing animals, prairie dogs, pikas, voles can become pests of golf course turf areas because they dig burrows, make scrapes and leave droppings. Squirrels may do damage on both ground and to trees. This is a case where encouragement of wildlife and needs for golf become incompatible and some form of control will be needed. Certainly levels of damage will be greatly reduced if these species are controlled by healthy populations of natural predators such as raptors, snakes and foxes but if these natural controls are inadequate, other means of pest management will have to be applied.

As a general rule trapping or shooting are preferable to poisoning but biological controls may be better still. Rabbits for instance are no longer the scourge they used to be thanks to the spread of the Mixamotosis disease.

Deer, cattle, sheep, kangaroos, porcupines, rabbits and hares, among other plant-eating mammals can do a lot of damage to young trees. A variety of protective methods can be employed ranging from electric fences, PVC piping around sapling trunks, plastic or link fences, fenced off plantation areas and various other designs of tree guard using stakes with metal mesh cylinder, car tyres or other materials.

Flots of birds may become unwelcome visitors. Geese, ducks, and gulls can make a great mess of slimy droppings and feathers that are difficult to clean up. Crows on some golf courses become regular ball thieves.

2.4.2 Snail scourge

Slugs and snails may become a pest in some conditions. In temperate regions snail-eating birds such as thrushes best control excessive snail numbers. Slugs may be best controlled by encouraging slow worms (legless lizards) or hedgehogs. In tropical regions however, some snails have become quite a scourge. The golden apple snail (Pomacea canaliculata) lives in waterways but has become a serious invasive pest in many places eating large quantities of streamside plants and leaving unsightly pink masses of eggs all over the place. The African giant snail (Achatina fulica) may become a land-based pest in wooded and shrubby areas. The zebra mussel (Dreissena polymorpha) may invade coastal waterways blocking vital drainage pipes and canals. Invasion of a golf course by such species may warrant a special eradication programme involving manual or mechanical cleaning operations or introduction of biological enemies of these species. Use of poisons should be a last resort since such poisons will certainly get into the foodchain of non-target species.

2.4.3 Alien invasive control

A variety of bird scaring devices can be employed but clearly those that are noisy would not be welcome as one settles down to a four-foot putt! The real cause to such problems is that birds have found the course to be a safe place to hang out. Safety from human persecution is indeed part of the biodiversity management objective. However, we also do not want an unnatural sense of safety either and it is best to maintain natural wariness by encouraging natural carnivores such as foxes, stoats, martens and avian raptors.
new species into local environments. That is why we place emphasis on the use of indigenous species as one of the key policies of these guidelines.

Golf courses often need to introduce special grass species to ensure quality surfaces of fairways and greens to play on, but they do not need to add more exotics species in the rough areas, ornamentals or selection of planted trees. There are always plenty of local species that can be used in those parts of the course. Yet most often they do. Because the nursery catalogues are full of such species and they do not point out which are indigenous and which are exotic.

Why does it matter? It matters a great deal. It matters because local species are pre-adapted to the local soil and weather conditions. They are pre-adapted to the local ecology. They provide food for local wildlife and can co-evolved with local pollinating species. When we plant extensive patches of exotic species, many ecological problems can arise. At best, these may be rather sterile areas under-used by local wildlife; at worst, they can interfere with local ecological processes by changing water tables, inhibiting undergrowth, cross-breeding and thereby genetically polluting local species, out-competing local species or spreading aggressively through the local countryside. In all cases they create an ecological imbalance.

From an aesthetic point of view, it is also good to let each golf course maintain its own local flavour rather than predominantly using cosmopolitan tree species sourced from all over the world and end with a humdrum landscape.

Some examples of alien invasive weeds that have become pests on many golf courses, often as a result of deliberate introduction as attractive ornamentals include trees Leucaena, Acacia auriculiformis, some Populus spp the Lantana camara bushes, climbers such as Morning Glory (Ipomoea spp) and Thunbergia grandiflora, water plants such as water hyacinth, alligator weed and water lettuce.

Most countries already have lists of undesirable alien species known to be dangerous and put a ban on further imports and encourage eradication. Datasheets on some of the worst examples of IAS can be found on the website of the GISP (Global Invasive Species Programme) http://www.issg.org
3.1 Save as much original natural vegetation as possible

If a golf course is being made in a natural or seminatural setting, it is prudent to try retaining as much of the original nature, land form, and vegetation as possible. This makes a far richer starting point than trying to recreate an entire balanced ecosystem. Certainly, some of the loveliest golf courses in the world have been able to blend the holes around natural features. The less disturbance to the land and drainage patterns, the less problems of erosion or waterlogging will be experienced later on. From a conservation point of view, there will be far more species already established on the course.

Issues of connectivity should be taken into account at the design stage. If natural woodland can be retained and still connect to larger native woods or forests, these will be far richer than if only small patches of woodland remain are planted.
Wooded areas add to the scenic beauty of golf courses, provide appreciated shade and wind shelter, reduce management costs, improve soil and water holding conditions (reducing the need for watering) and encourage local wildlife.

Even the tightest golf course has small patches of land behind tee boxes, between parallel fairways, along perimeter fences and around unsightly work areas that can be beneficially developed into wooded areas.

Avoid planting too much of the same species as monocultures are scenically less interesting, biologically less valuable, less attractive to wildlife, less efficient in providing environmental services and more prone to attack by pests, diseases and open fire.

Also avoid planting a stand of equal age trees. This results in a dense crown, which shades out the under-storey which becomes bare, unsightly and difficult to maintain. Aim to establish a compatible species mix of local species with good age distribution so that the plot can be self-sustaining without further management inputs. This will involve planting suitable under-story shrubs, young saplings, and young trees.
In areas where broadleaf trees are deciduous for part of the year such as temperate woodlands or monsoon tropical forests, mix in a few local evergreen species such as conifers and hollies in the temperate zone or conifers and laures in the tropical zone.

Woodplots can be given greater wildlife appeal by ensuring that they provide shelter in the form of hollow trunks and branches or nest boxes, attractive flowering trees that attract both nectar feeding birds and insects (such as *Erythrina* and *Cassia* in tropical regions or Lilacs and Lime in temperate regions); and especially fruit species (figs in tropical regions and hawthorns and acorns in temperate regions).

It maybe necessary to develop a small nursery area for rearing your own trees and bushes based on seeds or seedlings taken from local natural habitat. Special permission may need to be obtained to collect such seed from public parks, woods or nature reserves. You can appeal to your members, some of whom may own private woodlands.

### 3.3 Nursery establishment

It is important to determine the type of nursery (centralized, decentralized) required. Since golf courses usually cover huge areas of land, a number of decentralized nurseries may be more appropriate than one centralized one. Also, you may need different nurseries for different groups of plants. Some species need plenty of sunshine and grow quickly. Climax forest trees often need a lot of shade and may require protective netting. There are, however, both advantages and disadvantages in the choice of either type of the nurseries; these relate mainly to production economics and administrative and transport costs.

Identify a pocket or pockets of the golf course where the nursery could be established. This should be accessible but out-of-play. Water availability is important. Following the choice of the type of nursery would be the procurement of materials for nursery construction, nursery tools and equipment and finally nursery construction.

Identify plants that are native to the area. Choose from these plants which are to be propagated in the nursery. Some plants can be transplanted directly from source to a landscape bed and do not need nursery care.
It often pays to raise seedlings in the safe and easily managed confines of the nursery until they are large enough to compete and survive in the wild habitat.

Seedlings or cuttings, when propagated/produced require maintenance e.g., watering, weeding, and care daily or weekly inspection to detect and control diseases and pests outbreaks. You must budget these requirements into your work plans.

### 3.4 Collecting wild seeds, cuttings and wildlings

Obtaining the plant resources to develop such wooded areas may require a bit more work than opening the local nursery catalogue. Nurseries tend to stock garden ornamentals and a high proportion of exotic species that are less hardy and less suitable to local wildlife than the local native species.

Some research is needed to identify and select the varieties of plant species (shrubs, herbs, and trees in particular) whose propagation and introduction would contribute to enhancement of biodiversity as well as sources for such germplasm. A large number of plant species for a diversity of functions are needed for planting purposes. For example, shrubs and trees with flowers that could attract birds, insects, butterflies and bats should be selected, developed and planted. Fruit bearing tree species are also important as certain species of birds and mammals may depend on them for food. These varieties of plants and the landscapes (old growth forests, plantations, secondary forests, grasslands, etc.) where they thrive have to be identified and seeds and other forms of germplasm collected for propagation in a nursery and eventual planting.

In several projects where indigenous species are involved, wildlings are the most common form of germplasm used. This in effect means that natural forests continue to be robbed of their future generation since natural seedlings are collected and planted elsewhere. To make matters worse is that fact that even when planted, as experience shows and again, the survival rate of wildlings falls below 30%.

Whilst wildlings are generally the quickest way to generate colonizer species, we strongly encourage collection of seed in the case of the most tropical climax trees unless the species are very common and high mortality of wildlings is not important.

In tropical humid forests, a good way to reduce mortality in collecting wildlings is to cut around the wildlings a couple of weeks before lifting the plants as this gives the roots a chance to reform in the cylinder of soil that will be lifted, causing far less stress than otherwise when the plants are transported.

Many colonizer species can be propagated by planting cut stakes of up to 2m length into the ground prior to the wet season. This allows the first ‘crop’ of trees to get away very fast and shade out grass and other ground plants so that a second ‘crop’ of slower growing trees and seedlings can be grown in the shade of the colonizers. This is a particularly useful technique for getting forests established on fire-prone grasslands.

### 3.5 Establishing new woodlands and forests

Restoration of tree cover is often a major part of biodiversity conservation on a golf course. Woods and forest may be regenerated for a variety of important functions:

- Look attractive and give profile to the golf course horizon
- Repair degraded sites
- Maintain and support valuable biodiversity
- Protect the ecosystem and ecological communities
- Lower maintenance costs of the landscape
- Improve water quality
- Minimize soil erosion
- Help promote positive attitude towards the environment

Establishing woods and forest is a long-term programme. They cannot be created instantly; indeed as the mix of trees grows together, it forms a complex ecosystem that will continue to adapt and change for many decades.

Although increasing species diversity may be one objective of the planting programme, we should not aim at merely planting as many different species as possible. The aim is to provide a variety of habitats valuable to a variety of creatures. Habitats should be composed of ecological communities of local species that can coexist harmoniously and that are well matched to the local conditions of soil and climate. We emphasize the word local for very basic reasons. The local creatures from invertebrates to mammals and birds have developed alongside the plant, soil and water conditions that occur locally. These are the species that will most benefit from habitat restoration and the species that will suffer most from any landscape that departs markedly from the original.

We can adopt one or several specific objectives such as improving wildlife habitat, creating more aesthetically pleasing surroundings, restoring natural communities, protecting local rare species, preserving the local gene pool of a single rare species or natural community.

3.5.1 Site preparation

Proper site preparation is essential for success in establishing woods and forest. Where patches of original forest remain, the task is much easier as we can recruit natural colonization from parent trees to do much of the reforestation work for us. Where there are no original trees present the task is much harder. Land which has been previously deforested, burned, mowed or grazed will need deep ripping (200-300 mm) along the land contours. This helps water penetration and encourages deep healthy root growth of planted trees. Steep land, abandoned pastures or river flats may need only slashing and mulching.

Mulching with wood chips, hay, bagasse, agricultural waste or mowings will reduce the need for spraying weeds. However, it may be necessary to apply a quickly decomposing non-residual herbicide such as the glyphosate ‘Roundup’ to eliminate ephemeral weeds prior to planting with seedlings or young trees. This reduces competition for minerals and water and adds to the mulch.

3.5.2 Planting out

Various tools have been developed to reduce labour and improve survival when collecting wildlings and in planting out young saplings. Special tree planting shovels, manual tree spades or planting spears are designed for making holes of different bore and depth or making driving holes in hard or rocky terrain. One especially useful implement is the Hamilton Treepplanter which cleanly cuts cut the earth to a given shape and depth. This tool can greatly reduce the time taken to handle plant seedlings or tube-grown plants and can also be used to rescue small wildlings for replanting elsewhere. The size of the planter gouge can be adjusted to match the size of bagged seedlings (square or round, different bore and taper).
A massive shortcut can be taken if the source superintendent has access to a mechanical tree spade which can lift, transport and plant large trees, salvaged from development clearing or taken from nurseries or plantations.

After planting out, care must be given to ensure that young trees thrive and survive. For the first three or more years, they will require weeding or continued mulching to protect them from overshadowing shrubs, grasses or climbers. In addition they may need protection from browsing animals (Section 2.4 above).

Young trees may also need protection against wind-snap by staking them or fixing them with guy ropes until their roots are well developed and they can cope with the local weather conditions.

Liberally surrounding the base of young trees with grass cuttings or wood chippings helps to protect them from weed encroachment and maintains humidity.

Once the trees are taller than surrounding vegetation and fully established, protective tree guards can be removed and they can become fully integrated into the local environment.
3.5.3 Getting the right species mix

Selection of trees should match the local conditions of the planting areas. Try to acquire a natural mixture of local species for woodland or forest of that region. It is also wise to establish an age staggered plantation such that as old trees die there are younger trees in the understory able to fill the gap without further planting.

The table below gives an example of 12 plant groups suitable for planting on different land types in Queensland, Australia. For each group lists of suitable species are available. This is only an example. You will need to acquire similar lists for your own part of the world.

Suitability graphs of plants for respective Australian conditions

<table>
<thead>
<tr>
<th>Altitude</th>
<th>Isohyet</th>
<th>Geology</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowlands</td>
<td>Moist</td>
<td>Alluvial/colluvial</td>
<td>1</td>
</tr>
<tr>
<td>Lowlands</td>
<td>Most/wet/very</td>
<td>Beach sands</td>
<td>11</td>
</tr>
<tr>
<td>Lowlands/footills</td>
<td>Wet/very wet</td>
<td>Metamorphic/Basal plutonic/</td>
<td>4</td>
</tr>
<tr>
<td>Lowlands/footills</td>
<td>Wet/very wet</td>
<td>Acid volcanic/granite complex</td>
<td>5</td>
</tr>
<tr>
<td>Lowlands/footills</td>
<td>Wet/very wet</td>
<td>Alluvial/colluvial</td>
<td>3</td>
</tr>
<tr>
<td>Foothills/uplands</td>
<td>Moist</td>
<td>Metamorphic, basic plutonic,</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>acid volcanic, alluvial/colluvial,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Basic volcanic</td>
<td>2</td>
</tr>
<tr>
<td>Uplands</td>
<td>Wet</td>
<td>Basic volcanic</td>
<td>9</td>
</tr>
<tr>
<td>Uplands</td>
<td>Wet</td>
<td>Metamorphic, basic plutonic,</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>acid volcanic, alluvial/colluvial,</td>
<td></td>
</tr>
<tr>
<td>Uplands</td>
<td>Very wet</td>
<td>Basic volcanic</td>
<td>7</td>
</tr>
<tr>
<td>Uplands/highlands</td>
<td>Very wet</td>
<td>Metamorphic, basic plutonic,</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>acid volcanic, alluvial/colluvial,</td>
<td></td>
</tr>
<tr>
<td>Highlands</td>
<td>Moist/wet/very</td>
<td>Basic volcanic</td>
<td>10</td>
</tr>
<tr>
<td>Highlands</td>
<td>Moist/wet</td>
<td>Metamorphic, basic plutonic,</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>acid volcanic, alluvial/colluvial,</td>
<td></td>
</tr>
</tbody>
</table>

In selecting your species, pay special attention to prevailing local conditions. You will need to select fire tolerant species if the course is subject to periodic bush fires, salt tolerant species if the course is flooded by sea water, wind resistant species (e.g. palms and bamboos) if you have regular cyclones, and deciduous species if you have a long dry season.

For instance, the following list gives examples of relatively fire-tolerant trees in Australia:

- Acacia species
- Acmena smithii
- Agonis juniper
- Ajuga australis
- Banksia species
- Carpodotus galactescens
- Casuarina species
- Eucalyptus species
- Ficus macrophylla
- Kennedia species
- Livistona species
- Melaleuca species
- Pittosporum species
- Xanthorrhoea

Wattle
Lilly Pilly
Australian Cedar
Astral Bugal
Banksia
Pigface
Casuarina
Gums
Moreton Bay Fig
Running Postman
Fan palm (once more than 3m)
Paperbark
Pittosporum
Grass tree

The required stock can be sourced from local nurseries that specialize in indigenous trees but in many countries no such nurseries exist and seeds or other propagation material e.g., wildings and cuttings may have to be collected from the wild.

It is very important that any collection of seeds or wildings from natural areas is done with the necessary permission or collecting permits from landowners concerned. Collection of some plants may contravene local protection laws. It is also important not to deplete the wild stock of species to create your own woods. The aim is to add and augment the local biota, not to deplete or damage it.

In temperate regions and seasonally dry areas, tree seed usually has a good storage life and seed can be kept in a cool storage until such time as it is needed for planting. Storage of seeds requires a cool dry place and bags of seed should be porous and well circulated by air to prevent fungus. They need to be protected from insect and rodent seed eaters. Bags of seed must be clearly labeled as to species, date of collection and locality of collection.

Seed storage is not worth attempting in the humid tropics where most seeds have no dormancy period and lose viability quickly. Seeds must be collected opportunistically when available, germi-
Habitat Management of Out-of-Play Areas

3.5.4 Layering the canopy strata

Different trees will need different regimes of planting and care. Coloniser plants grow fast and can tolerate high levels of sunshine. Climax trees tend to grow slowly and require considerable shade, moisture and protection in their earlier stages. Coloniser species should be included in the planting mix. They are important in establishing new forests for a variety of reasons:

- They grow rapidly, suppress weeds and force slower growing species to grow tall.
- They fruit and flower at an early age to produce foods for wildlife.
- They build up leaf litter and improve soil.
- They are short lived and when they die create light gaps to be filled by climax species.
- They attract the types of birds that act as good seed dispersers between forest and woodland patches.

The 'natural' areas of a golf course should be planned with a view to establishing rich, healthy, and dynamic ecosystems without the need to resort to use of chemical herbicides, pesticides or artificial fertilizers.

Forests are three-dimensional. Re-establishing forest involves not only planting the upper canopy but also the understorey and ground herds as well. Diversity is the common objective to allow naturally colonizing species, whose seeds are often distributed by birds and mammals to mix in with the planted trees and shrubs.

Climbers may also be important. The leaves of many climbers provide food for primates, squirrels and butterflies and many climbers have fruits that are attractive to wildlife.

Forested corridors increase the chances of colonization from one forest patch to another. This enables the entire forest network to support more species than a similar area of isolated patches. Try to establish suitable connectivity to the forest and woodland patches on your golf course, even if this in no more than a single line of trees.

3.6 Creating and managing water bodies and wetland areas

Lakes, ponds, marshes and streams are attractive features on golf courses, interesting and challenging hazards for the game itself but also great places for conserving some important wildlife. They protect surface and groundwaters and control pollution whilst recharging aquifers. They provide wider recreation potential.

Clean, well-oxygenated water is more aesthetic and permits the coexistence of greater numbers of living organisms. Polluted, muddy or eutrophic water kills aquatic organisms, creates nasty smells, unsightly scum and a breeding ground for mosquitoes and dangerous bacteria. It also leaks out into wider ecosystems causing wider environmental damage and health risks outside the course area.

Choking of waterways by excessive water weeds leads to large management costs in clearance activities and disposal problems, reduced oxygen levels in the water and die off of oxygen hungry species such as some fish species.

The secret of waterway and wetland management must be on ensuring good natural or artificial filtration, avoiding pollution, and good water flow for aeration. The more the number of organisms that live in the aquatic environment of the course the more stable the system will be and less prone to sudden die-off of different species, algal bloom, clogging by water weeds, among the unsightly outcome of an environmentally imbalanced golf course.
Variety of habitats is key to achieving high biodiversity. Vary the conditions as much as possible. For instance, a stream can have sections that differ in degree of shade, depth of water and flow speed, substrate type (mud, sand, gravel, rocks, concrete). Lakes and ponds can have areas of different depths, shore steepness, shoreline shading and vegetation (reeds, grass, sand) and substrate (mud, gravel, plastic sheeting, concrete).

Filtration of silt and pollutants can be achieved by passing water through gravel substrate streambeds and by encouraging filter feeding organisms such as bivalve mollusks. The latter require soft sand or mud substrate to live in. Mud substrate should only be used in areas where water turbulence is minimal and the mud does not get stirred up into the water. Mud can also be fixed by growth of appropriate water weeds.

Pollution can be minimized by observing a few basic best management practices:

- Limit fertilizer application in areas adjacent to wetlands.
- Use slow release fertilizers.
- Practice IPM.
- Prevent chemical transport to wetlands by ensuring drainage systems do not empty directly without treatment. Buffer strips may aid in preventing runoff.
- Prevent runoff and drift from irrigation systems.
- Avoid storm water runoff from impervious surfaces such as buildings and parking lots.

Some water plants that at first might appear attractive can become serious weeds such as water hyacinth (*Eichhornia crassipes*) or water lettuce (*Pistia stratiotes*). Try to eliminate these plants completely to avoid re-colonization. Use of plastic liners reduces the rooting ability of some water invasive plants.

Water temperature is critical for many organisms and warm water contains less oxygen than cool water. Having deep water as part of the water system reduces the daily temperature fluctuation and helps promote greater diversity. Shading of water bodies with overhanging trees also reduces temperature rise and algal growth.

Encouraging a healthy growth of below surface water weeds (as opposed to floating plants) increases oxygen, cover and food for aquatic organisms. Use of oxygenator can be used to increase oxygen and water movement if necessary.

Introduce local mollusk species as these are filter feeders that help maintain clean water.

Try to ensure the presence of animals that like to eat the dominant water plants to ensure a healthy balance and reduce weed clearance labor. Such biological controls are always preferable to manual costly operations or the use of herbicides. For instance, weevils and moths are available that can control water hyacinth.

Where allowing fishing, is compatible with the use of the area as a golf course, this can be developed as a secondary land-use provided that it is controlled in a sustainable manner.

In designing the drainage and water flow system of the course, it is often possible to leave some permanent or seasonally marshy areas in the off-course areas. These can be very valuable miniature nature reserves in their own right. Globally, wetlands are under tremendous threats from development and few remain in a natural condition. Such sites can be colonized by many endangered marsh plants (including wild rice, water chestnuts and other species if high germplasm value) and wildlife – amphibians, turtles, dragonflies, and birds.

Water birds and turtles may require safe perches to rest or hunt from. Turtles gather on emergent rocks or tree trunks on lakes. Egrets and cormorants congregate on tree trunks emerging from water or growing on...
small islets. These can become important night roosts or breeding colonies for many species. Other birds need dense covers of reed beds or scrub (rails, small herons and warblers).

In some places, even the protection of crocodilians may be feasible on courses (Australia, Florida, and Africa).

3.6.1 Waterbody safety issues

When designing water hazards or wildlife ponds, ensure that safety considerations are observed. Accidental drownings have happened on golf courses and some ponds are rendered more dangerous by having a slippery plastic lined sides and bottom that make it difficult to climb out should an accident occur.

Water is a continual temptation to children. People sometimes tempt fate to rescue animals that are having trouble getting out of water hazards. Inexpert handling of golf carts sometimes causes a wet topple and ball hunters are often tempted to plumb the depths (sometimes at night) in search of golf balls.

Erect rails or net barriers where children are likely to venture to the water edge. Ensure that deep water is far from banks and that the immediate edge water is neither too deep nor the bottom to steep or slippery to climb out. Leave long poles and maybe a safety buoy close to dangerous pools for use in case anyone falls in.

3.7 Management of grasslands, heath, and desert

Many excellent golf courses have little or no natural woods but are formed instead from natural grasslands, sand dunes (links), heaths or even desert. The priority here should be to maintain as much as possible of the natural vegetation and biota, introduce as few new species as possible and try to retain habitat connectivity.

Various dangers need careful management:

- Use of deep bores to water fairways and greens may result in lowering of the original water table and this will have significant impacts on desert or dry grassland vegetation.
- Fire may be a problem to dry open habitats. Fire may even be necessary to maintain these habitats in ideal condition but such fire would cause a disturbance to the golfers and leave the course temporarily blackened.
- Heathlands have hard soil and peat. Fire can destroy the peat layer, whilst application of chemicals and irrigation can affect the soil pH and change the nature of the heath vegetation irrevocably.
- Open habitats may not be climax communities but rather a seral stage between newly colonized land and some eventual climax of scrub or woodland if natural conditions were allowed to exist.
- Some grassland systems require certain levels of grazing to maintain their condition. If this depends on large ungulates, this may be impossible to maintain under golf course conditions.

In all these cases, a very good understanding of the natural ecology should form the basis of long-term management.
4.1 Establishing a butterfly garden

Great results can be achieved with small inputs in attracting beautiful butterflies to the golf course and local rarities can be targeted for special encouragement. A butterfly garden can be created inside a netted cage or dome with the advantage of continued breeding of established species, the ability to show them to visitors and children for educational purposes and greater control on releases onto the golf course or the garden may be open and integrated with the wild populations.

The idea of the butterfly garden is to encourage attractive or rare species to breed and the secret is to grow exactly those favoured foodplants on which those species will lay their eggs and which their caterpillars will eat. As a reward and attractant, it is usually wise to also plant flowers and provide water and minerals for adult butterflies to feed so that they live longer, remain stronger and do not have to fly far away from the breeding area in search of such needs.

Growing the foodplants for locally endangered butterflies (and moths) is a cheap and easy way that a golf course can
make a significant contribution to regional conservation.

Most species are rather specific on what they lay their eggs on, but such information is generally well known. A lot of details can be downloaded from the web following a search for butterfly food plants. Otherwise contact your local butterfly expert or entomological society for advice.

The table below lists major genera of food plants and the main butterflies that eat them.

### Butterfly food plants

<table>
<thead>
<tr>
<th>Tropical Areas</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Citrus</td>
<td>several swallowtails</td>
</tr>
<tr>
<td>Aristolochia vines</td>
<td>many breeding</td>
</tr>
<tr>
<td>Cassia/Senna</td>
<td>many pierids</td>
</tr>
<tr>
<td>Passiflora Palms</td>
<td>many hesperids</td>
</tr>
<tr>
<td>Oleander family</td>
<td>several hawk moths</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperate areas:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unica</td>
<td>many nymphals</td>
</tr>
<tr>
<td>Thistles</td>
<td>some nymphals</td>
</tr>
<tr>
<td>Wild Carrots</td>
<td>Common Swallowtail</td>
</tr>
<tr>
<td>Salix</td>
<td>Apatura spp.</td>
</tr>
<tr>
<td>Vetches</td>
<td>many lycaenids</td>
</tr>
<tr>
<td>Plumus</td>
<td>many species</td>
</tr>
<tr>
<td>Oak</td>
<td>hairstreaks, many moths</td>
</tr>
<tr>
<td>Privet, lime (t/f), bedstraw</td>
<td>hawk moths</td>
</tr>
</tbody>
</table>

#### 4.2 Attracting adult butterflies to flowers and other baits

In addition to attracting and encouraging butterflies by planting their larval food plants, adult butterflies can be attracted to flowers and other baits. Certain flowers are more attractive than others to attract showy butterflies to ornamental areas and areas where people spend most time – snack shelters, tees and clubhouse.

Examples of very attractive plants are Buddleia davidii for temperate regions and Hibiscus,Ixora and Lantana for tropical regions. Lantana must be well controlled as it can become an invasive alien weed (Section 2.4.2).

In Australia, Wattle Acacia, Grevillea, Bottlebrush Callistemon, Paperbark – Melaleuca are among good plants to attract butterflies and moths.

A good tip is to visit local nurseries and see what flowers are being most visited by butterflies. Look also into local wild habitat to see what local species are most attractive and ensure that these are growing in the off-course areas.

Some spectacular butterflies can be attracted by other types of bait. Purple emperors (Apatura) and Charaxes butterflies are attracted to animal (civet) dung or decaying carrion. Other Charaxes, nymphals and swallowtails are attracted to animal urine or decaying fruits (bananas). Many tropical butterflies can be attracted to puddles or ground saturated with mineral rich water. Carpets of pierids, swordtail and Graphium swallowtails and
even the spectacular Rajah Brooke’s Birdwing (Trogonoptera) regularly visit such sites. Effective attractants can often be created that do not offend the delicate nostrils of genteel golfers.

### 4.3 Encouraging ants

There are many species of ants and usually large numbers of each species. Ants are both fascinating and may also be a nuisance but they are essential elements of the ecosystem. Ants work their way through all parts of trees and foliage undertaking roles of pollination, seed dispersal, pest control, mineral transfer, and soil aeration.

Ways to ensure that your habitats have healthy ant communities include:

- Planting nectar-rich flowers
- Leaving soil undisturbed
- Growing more trees
- Avoid using poisons
- Maintaining high diversity of plants and animals

### 4.4 Encouraging dragonflies

Dragonflies and their delicate relatives the damselflies are great controllers of insect pests including the adults and larvae of midges and mosquitoes that can spoil a game of golf on a summer evening. In addition dragonflies are colourful and graceful additions to the biota and a good indicator of the health of the course ecosystems.

Whilst dragonflies fly over all habitats, their entire life cycle revolves around or takes place within fresh water. Here the adults mate, flying in tandem over suitable breeding spots. The female lays eggs on vegetation just below the water surface. A succession of aggressive carnivorous larval stages live among the water weeds, among rocks and gravel in ponds and streams and

![Life cycle of dragonfly](image)

the final nymph stage climbs out of the water into the waterside plants where the adult emerges from the nymphal case.

Dragonflies fly widely over open country whilst damselflies keep closer to water and often remain in shady wooded areas. Different species prefer different microhabitats—the depth of water, the speed of flow, type of substrate or types of water vegetation and degree of shade.

Encourage these interesting and beneficial insects by maintaining good water quality, variety of water habitat and healthy water and fringing plants.
4.5 Encouraging spiders

Spiders are another important group of invertebrate servants acting as pest control agents and maintaining the balance of creatures in the ecosystem. Most spiders weave tacky webs that catch flies and other food, but other spiders hunt their prey on foot, making spectacular leaps onto their prey and yet others pounce out of burrows or from trapdoors or simply march about the ground at night seeking food.

In a few parts of the world, there are dangerous spiders whose bite can be poisonous to humans. In such regions it is best to admire spiders at a distance and leave them alone.

Key to maintaining healthy and diverse populations of spiders is to maintain habitat diversity, woodland connectivity, avoid use of poisons and provide habitat for a wide range of prey species.

4.6 Tolerating termites

Termites are another important group of invertebrates that perform vital ecological roles in recycling of nutrients and dead woody materials, aeration of soil, as well as constituting important elements in the local foodchain and favoured food for many other interesting animals from birds and spiders to echidnas, anteaters, and pangolins.

In nature termites are kept under control by such predators but in simplified ecosystems they can become a pest and cause damage to living trees as well as buildings and outdoors wooden structures. We recommend living with termites but treating vulnerable timber with suitable repellants and preservatives whilst also trying to ensure that there is a rich biota including enough species that feed on termites.

4.7 Encouraging amphibians

Frogs and tadpoles are an attractive addition to the golf course fauna. We were mostly fascinated by these creatures as children and the fondness persists. Again these act as valuable pest control agents killing large numbers of flies and mosquitos. In addition the bubbling and booming calls add a distinctive and mysterious mood to the tropical night chorus.

They can be easily encouraged provided that clean water in ponds and streams is available for breeding. Some tree frogs live among the foliage of forest and woods and lay their eggs over rain puddles after a storm. If suitable species are not already present, it is easy to transport the eggs (frogspawn) or tadpoles from other sites where there are plenty to spare. Make sure that you only introduce tadpoles from similar habitats that you can simulate on the golf course. It is a waste to transport species that are not suited and will not survive.

Providing safe habitat for amphibians is also important for conservation as these animals are in worldwide decline due to pollution and the fast pace of development. There may be one or two locally endangered species in your area that could be the focus of a special conservation project for the club.

One frog (toad) Bufo marinus, the Cane Toad, has become introduced into many tropical countries and has now become an immense pest displacing and even eating native amphibians. It is a large species and can also eat small mammals and birds. This species should not be encouraged and, if present, should be actively controlled. The case underlines the principle of using only local species. It is not a sound practice to try to enrich the environment by introducing extra exotic species.

4.8 Encouraging reptiles

Most people like lizards but hate snakes. Some people have quite severe phobia of snakes. Yet snakes provide an important service in regulation of small vertebrate populations, especially rats and mice.
Snakes are generally shy and reclusive and will try to keep out of humans' way. Most people who get bitten by snakes do so in clumsy attempts to kill or capture them. Leave them well alone and all will be well. It would be unwise in many countries to walk without boots at night in the bush or rough areas of a golf course but keeping to the playing area in daytime with proper footwear is pretty safe. The most likely dangers are a few sluggish members of the viper family that remain motionless and camouflaged and might bite if stepped upon (e.g. pit vipers in Asia, puff adders in Africa and rattle snakes in the Americas). It might be politic with the members to actively rescue specimens of those species and translocate them away from the golf course when encountered.

Reptile fauna can be encouraged by providing plenty of habitat diversity and suitable cover (hollow trees, holes, bark, rocks). Both snakes and lizards enjoy sunning themselves on rocks or open patches in the vegetation. Many species need water. Turtles are an attractive addition to many lakes. In some parts of the world (Africa, Florida, NE Australia) there are even crocodiles in the water hazards.

Foremost requirement for maintaining a healthy reptile population is protection of the area from poisons and carnivorous pets.

4.9 Sensitive snake issues

Your membership will undoubtedly include some people who hate or are terrified by snakes and would prefer that all snakes be eliminated.

Needless persecution of snakes is both impractical and quite contrary to the guiding principles being adopted here. What to do? Here are a few tips:

- Make it very clear to the membership why the management policy is to leave snakes alone
- Give clear advice to members about any dangerous snakes including pictures and information about their favored haunts
- Erect snake warning signposts in areas where dangerous snakes are known to be present
- Provide information about how to avoid danger – namely, leave any snakes encountered alone, wear suitable footwear in hazard areas, avoid looking for balls in most dangerous areas
- Warn members that they venture off the course area at their own risk and should carry appropriate insurance

- Provide emergency advice (and suitable anti-venom) in cases of accidents

4.10 Encouraging fish

Fish are an important component of any biodiversity golf course water system. More than any other organism it is fish that will eat mosquito and midge larvae and also clean algae off water vegetation and rocks to keep water systems healthy and clean.

In addition, fish are attractive to watch and provide a feeding base for many interesting birds, reptiles, and other fauna.

Different fish perform different functions and it is best to build up a community of species that perform these different roles. Some fish are carnivorous, others eat fruits, many eat invertebrates, some eat plants or algae and some even feed on the faeces of other fish helping to speed up the nutrient recycling and keeping the water clean.

Great care must be made in selection of suitable fish. It is easy to get the wrong balance. Carp can dominate the system and eat other species, exotic Tilapia can become serious invasive pests and spread out of your water system into the neighbouring countryside. Keep to local species as far as possible.

Some fish can live in turbid and dirty water but most require clean water with plenty of oxygen. You may need to increase the level of oxygen by use of a powered aerator or use of waterfalls. Water plants are also a major source of oxygen into water systems. Use fresh flowing water if possible. However, in courses with pumped and re-circulated water you will need to allow natural processes for refreshing the water such as water weeds, rocky streams, gravel beds and fish and mollusks.

Increase the variety of fish niches by maintaining a wide range of water habitat of different depth, substrate, water flow, shade and associated vegetation.

As with other wildlife, it is essential to protect fish from chemical pollution and poisons and this will have implications on your turf management program and types of treatment used to control pests and promote fertility of turf grass.
4.11 Encouraging mammals

Very large animals such as elephants, buffalo, tigers and wild pigs belong in nature reserves and not on the golf course. Their presence is generally incompatible with running a safe golf course and they should be excluded by suitable fences.

Smaller deer, antelopes, capybara, raccoons, prairie dogs, foxes, badgers, squirrels and the like maybe considered acceptable cohabitants and can be actively catered for in the design and management of the golf course.

Small carnivores such as small wild cats, stoats and civets are probably essential in limiting numbers of rodents and other wildlife to tolerable levels.

Such animals can be encouraged to take up residence by ensuring that their special habitat requirements are available. Deer and antelope would require woodland shelter, access to water and saltlicks and available grazing areas in the off course area. Winter (or dry season) feeding may boost populations if shortages of winter food are a limiting factor. Foxes and badgers and other small carnivores would need quiet, shaded areas where they can make dens and burrows. Artificially constructed burrows can be very effective.

Squirrels, gliders, possums and chipmunks require the availability of suitable food trees and can be further encouraged by erection of suitably sized nest boxes.

Domestic dogs and cats do not provide a natural control and should be discouraged from golf courses if natural mammals and birds are to be encouraged. Similarly, a policy of no hunting should be applied. This does not mean pest mammals – rabbits, rats, squirrels, may not be trapped for control purposes.

4.12 Encouraging birds

Birds are one of the easiest groups of animals to attract and as they are colourful, tuneful (some species) and active by day, they have big impact and add greatly to the environment. They also serve a great job in controlling insect species and thereby reducing the needs for insecticides.

The oriole is an attractive fruit-eater with a beautiful bird call.
The following table lists some of the main groups of birds that depend on different types of foods with some notes of ways to attract them.

**Bird suitability niches**

<table>
<thead>
<tr>
<th>Feeding niche</th>
<th>Example families</th>
<th>Remarks and ways to encourage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nectar feeders</td>
<td>Sunbirds, hummingbirds, honey-eaters</td>
<td>Often spectacularly coloured birds. Attract by planting flowering trees and shrubs. Try to get a mix of species flowering in different months.</td>
</tr>
<tr>
<td>Small canopy insects</td>
<td>Whiteeyes, flycatchers, nuthatches, tailbirds, wrens, warblers</td>
<td>Maintain healthy, diverse woodlands and plenty of flowering trees and plants known to harbour caterpillars. Plant flowering trees that attract pollinating insects. Provide small nestboxes.</td>
</tr>
<tr>
<td>Large insects</td>
<td>Shrikes, small owls</td>
<td>Excellent for control of grasshoppers and other pests. Encourage open woodland habitat and quiet nesting areas. Leave hunting perches such as stumps or dead trees.</td>
</tr>
<tr>
<td>Small fruits, nuts</td>
<td>Barbets, doves, thrushes, starlings, tits, flowerpeckers, orioles, jays, nuthatches</td>
<td>Include many of the best songsters. Plant fruit-bearing trees and bushes with small soft fruits.</td>
</tr>
<tr>
<td>Medium-sized probers</td>
<td>Plovers, sandpipers, ibises</td>
<td>Have some shallow edges to water bodies or streams lined with sand, gravel or mud substrate. Very shallow water level to encourage crustaceans, worms, mollusks. Minimize insecticide use on course.</td>
</tr>
<tr>
<td>Fish eaters</td>
<td>Some kingfishers, herons,</td>
<td>Maintain safe roost trees (e.g. on islands), hunting perches and banks in which kingfishers can make nest holes. Water quality and good fish population is essential.</td>
</tr>
<tr>
<td>Raptors</td>
<td>Owls, hawks, falcons</td>
<td>Raptors require large trees, cliffs or buildings as perches or nest sites. They also require no persecution and a rich biodiversity on which to prey.</td>
</tr>
<tr>
<td>Aerial insectivores</td>
<td>Swallows, martins, swifts, wood swallows, nightjars, pratincoles</td>
<td>Maintain clear water bodies and healthy woodlands.</td>
</tr>
<tr>
<td>Undergrowth skulker</td>
<td>Babblers, flycatchers</td>
<td>Leave dense undergrowth in woodland plots well out of playing area. Maintain good woodlands and provide food in winter on bird feeders.</td>
</tr>
<tr>
<td>Migrant generalist songbirds</td>
<td>Robins, thrushes, flycatchers</td>
<td>Leave patches of dense ground cover for breeding and tall trees for roosting. Maintain rich woodland habitat with variety of habitat such as water bodies, substrate and vegetation cover. Provide safe roosting Islands.</td>
</tr>
<tr>
<td>Ground feeders</td>
<td>Grouse, pheasants, partridges, rails</td>
<td>Maintain diverse woodland habitat with variety of habitat such as water bodies, substrate and vegetation cover. Provide safe roosting Islands.</td>
</tr>
<tr>
<td>Wetland herbivores</td>
<td>Ducks, geese, swans, grebes, coots, storks, cranes</td>
<td>Maintain diverse woodland habitat with variety of berry species and insect attracting flowers. Provide winter food, water and nest boxes.</td>
</tr>
<tr>
<td>Resident generalist songbirds</td>
<td>Robins, thrushes, orioles</td>
<td>Maintain mixed woodlands and leave dead or dying trees in place as food for growing grubs on which birds depend. Erect nest boxes of suitable size.</td>
</tr>
<tr>
<td>Wood-boring insects</td>
<td>Woodpeckers, tree creepers</td>
<td>Maintain mixed woodlands and leave dead or dying trees in place as food for growing grubs on which birds depend. Erect nest boxes of suitable size.</td>
</tr>
</tbody>
</table>

Birds respond quickly to safety. Freedom from hunting and disturbance and reduction in the number of domestic cats will usually cause a noticeable increase in bird numbers and their tameness.

**Erythrina trees and seasonal colour**

Attract pollinating insects and birds.

Maintain suitable habitats and diverse food sources, roosts and nest sites. Augment with winter provisioning, water bath and nest boxes if necessary.
5

Promoting Conservation Ethics Among the Membership

Strengthen the whole biodiversity programme and demonstrate to the wider public and neighbouring land-users the positive environmental commitment of the club by fostering good conservation ethics.

- Enrolling local participation
- Designing an education program. This could be in the form of educational boards, news articles, signs around the golf course or an environmental brochure of the golf course.
- Promote adoption of green tips and code of ethics (see annexes).
- Host environmental tours around the golf course for the members and their guests, children of members or for students of neighbouring schools.
- Host an environmental golf tournament for members.
- Make an inventory of birds and wildlife on the property. Update the inventory periodically to monitor the success of the projects implemented.
- Encourage the membership or club to sponsor conservation activities in the neighbouring countryside.
- Encourage etiquette and practices that are compatible with environmental conservation - minimal wastage of water, safe disposal of garbage, separation of garbage for easy recycling, use of biodegradable materials wood, paper, cardboard rather than tin, glass, and plastic, safe disposal of machine sump oil.

5.1 Sanctuary programmes

Make a point of publicizing that the golf course is a nature sanctuary and that hunting, collecting or disturbing wildlife is prohibited. Security from hunting and persecution will quickly encourage local wildlife species and these will become more tame, approachable and visible for players’ enjoyment.

It may be necessary to make key breeding areas or other sensitive sites (badger set) off limits during breeding season to reduce levels of disturbance.

There will probably be some local nature lovers or naturalist club or society that will be keen to assist the course management in protecting the wildlife portions of the estate and documenting the biodiversity that occurs there. This can lead to improved wildlife management, wider use of the land and good public relations and publicity for the club. ‘Audubon Cooperative Sanctuary’ program and European ‘Committed to Green’ program are both examples of international programs to help golf courses and other private lands to be developed and managed in an environmentally beneficial way with an emphasis on providing habitat for wildlife. Details of these programs can be found on their respective websites and www.gololecology.com and www.audubon intl/programs/acss/golf.htm. Clubs can become members of these programs and work towards full recognition.

5.2 Education programme

It helps to build up good relationships and explain the positive environmental role of the golf course management if the club has an active education programme. Remember that a golf course is small in terms of wildlife habitat. It cannot be biologically very rich if managed in isolation from the neighbouring countryside. You need to extend and buffer your own environmental efforts by encouraging neighbours to share your objectives and assist improve habitat on their lands also.

Target audiences for environmental education would include:

- The members
- Members’ families and children
- Local communities, neighbouring land-owners and schools

A typical education programme would include such items as:

- Publication of a newsletter
- Notices posted on members boards
- Educational signboards placed out on the course
The objectives of the education programme should be to:

- Increase the knowledge of, appreciation for, enjoyment of and respect towards significant wild plants and animal species occurring on the course.
- Alerting members to seasonal phenomena.
- Explaining aspects of course management and pointing out the benefits of such management for the environment and local community.
- Encouraging public and member help in improving the environment.

5.3 Monitoring

Management for biodiversity is a long-term process. Expect dynamic change. Monitor these changes by an active recording programme. Such a programme would have most of the following elements:

- Keep records of trees planted; their survival and rates of growth.
- Undertake periodic inventories of birds, mammals, other vertebrates, some insect groups.
- Keep records of all reports or sightings of rare, endangered or unusual animals.
- Establish some baseline data on distribution and numbers of some key indicator species and repeat census of these at seasonal or annual intervals.
- Seek assistance from local nature lovers groups, societies or professional scientists to help document and monitor key taxa.
- Analyse data over time to identify population trends of indicator species and try to relate these changes to management prescriptions.
- Formulate new management prescriptions for further improving biodiversity and incorporate into revised management plans for approval and adoption.

Annex 1. Earth Saving Tips from Earth Share

Golf and the Environment

Next time you are out on the greens, think about whether your own actions are "green." Here are some easy suggestions on what you can do to help the environment:

- Replace all divots.
- Walk the course instead of using a golf cart.
- If you do use a golf cart, keep your cart on the designated path.
- Urge your golf course to replace its carts with electric-powered ones, which greatly reduce both air pollution and noise pollution.
- Carry your trash with you until a waste container is available.
- Recycle glass, aluminum, and plastic on the golf course.
- If your course doesn’t have its own recycling program, urge them to start one.
- Adhere to local rules that may restrict access to environmentally sensitive areas on a golf course.
- Buy recyclable products (e.g., biodegradable golf tees).
- Accept the natural limitations and variations of turfgrass plants growing in a natural environment. (e.g., brown patches, thinning, loss of color).
- Be willing to play on brown grass during periods of low rainfall.
- Patronize courses that are environmentally friendly.
- Recognize that golf courses are managed land areas that should complement the natural environment.
- Respect environmentally sensitive areas of the course.
- Support golf course management decisions that protect or enhance the environment and encourage the development of environmental conservation plans.
- Support maintenance practices that protect wildlife and natural habitat.
- Encourage maintenance practices that promote the long-range health of the turf and support environmental objectives. Such practices include aerification, reduced fertilization, limited play on sensitive turf areas, reduced watering, etc.
- Commit to long-range conservation efforts (e.g., efficient water use, integrated pest management, etc.) on the golf course and at home.