Experience from The Eden Project

Production Nurseries
The Eden Project located in Cornwall, England, is the biggest conservatory in the world. In order to obtain and acclimatize the huge number of plants required, the Project owns the 5ha Watering Lane Nursery; This is in an isolated position (limiting the spread of potential pests and diseases) and not too far from the Eden site. The Nursery grows plants from seeds, cuttings and young plants and is used to acclimatize and quarantine larger imported plants.

In order to accommodate some of the specimen plants a new 5000m2 glasshouse was added to provide roof heights of 4.5 and 6.5m. Ian Martin, Curator of the dryt tropics biome (DTB) with particular responsibility for the Nursery, explains the enormous task of growing and bringing in so many plants to fill the humid tropics biome (HTB) and warm the temperate biome (WTB). Not forgetting many species native to countries such as Chile, the Indian foothills, parts of Russia and the USA that grow naturally in the wet temperate climate typical of Cornwall. Together with native Cornish species the outdoor landscape at Eden constitutes the outdoor wet temperate 'biome'. Eden has always had more outdoor than indoor plants but the outdoor 'biome' will take longer to develop into a more clearly defined area as the plants grow into the available space.

Sourcing plants for Eden
Sourcing of plants has to deal with various requirements. Landscape designers need a range of sizes, shapes and habits (upright, creeping, cascading) including large specimen plants to provide instant spectacle. Botanists require a large assortment of species to represent the given climatic zone and certain special features. Horticulturalists need a regular supply of domesticated and crop plants for displays. Defra (Department of Food and Rural Affairs, formerly Ministry of Agriculture) requires that no 'notifiable' pests and diseases are brought into Great Britain while Eden must limit to an absolute minimum the entry of other pests and diseases into the Biomes. This difficult juggling act never stops: new plants are inserted into the biomes, sometimes rare and endangered species, while others are substituted.

Importing specimen plants
The biggest problems stem from importing large specimen plants. Often they have been cultivated in 'extreme' soils (poor salty clay, for example). When they arrive, they are usually stressed from the journey. When they are then transplanted into better substrate, the abrupt change often represents another shock to the system. As a result some plants die, but the vast majority need to be acclimatized and recovered over a period of time. Most notably, the bark, root systems and leaf axils of specimen plants can harbour a great variety of pests and diseases. Finally, older trees might be difficult to transplant, hold upright and establish in the biomes; they might even be senile representing a batch of plants that the supplier would ordinarily have thrown away. Using specimen plants also conflicts with a horticulturist's desire for superior stock of more modern disease resistant varieties.

Some serious problems were encountered with imported specimens from one Mediterranean Country that has earnt itself a bad name in the process. The sugar-cane stem-boorer (larvae of the species of
moth, *Opogona saccharalis*) was imported with a batch of plants. This insect has the ability to infect a wide range of plants and to eradicate the problem cost the Watering Lane Nursery a great deal of money. The root systems of a batch of specimen Olive trees (*Olea europaea*) and 80 year old date palms (*Phoenix dactylifera*) were found teeming with nematode worms and so the root systems had to be thoroughly washed and the plants re-established. Nematode worms must be kept down to manageable levels except in the case of 'notifiable' species where the tolerance is zero. A batch of inexpensive Yew trees (*Taxus* spp.) were later found susceptible to the fungal disease *Phytophthora*. Importing from Holland is not necessarily much better because some exporters are of the opinion that Eden is making an unnecessary fuss over the pest and disease problem and anyway palms and certain other species that might be offered in Holland will have originated from the same Mediterranean areas in question.

**Learning from experience**

Past experience now guides production and sourcing of plants for the new Dry Tropic Biome, scheduled for opening at Easter 2005 and controls will be more severe than in the past. The fact that the new Biome will be physically separated from the other two also provides an opportunity for a clean start. With regard to specimen plants, attempts are being made to have them quarantined in the country of origin. Enquiries are being made with regard to date palms in Southern Spain. The problem is that some of the pests and diseases that need to be controlled at source are endemic in the area of production. It is therefore difficult to physically isolate the plants so that they do not become re-infected prior to delivery. Israel, California and the Gulf States are other possible sources but the extra costs are considerable: staff need to inspect the plants on site, transport costs are more onerous and phytosanitary restrictions are greater when importing from outside the EU.

*Ian Martin* concludes that starting with smaller plants of superior disease-free certified stock is by far the best solution but conceding to the landscapers the need for some larger specimen plants. Another advantage with younger stock is that it will establish in the biomes more quickly and grow faster. Contacts are now being made to source plants for the new Dry Tropics Biome. The four regions of most interest are: North Africa, the South West USA extending into Northern Mexico, Namibia and Botswana, the Rajasthan area of North West India. The requirement for mature specimen plants from these regions will be modest and despite their age, most species tend to compact. A large number of the required plants can be grown from seed, either because they are annuals or varieties that will flower and be attractive when relatively young. Some of the required plants or seed is already in stock plus a collection of several hundred cacti and succulents. Eden's interest in agricultural crops and ethnobotany will require sourcing from various Institutes and organizations such as the International centre for Agro-Forestry or the Desert Legume Program (the latter deals with all leguminous trees that have useful properties). Other species and varieties explains Sue Minter, Head Curator, are obtained from future harvest gene banks around the world, organized by their chief researcher Andrew Ormerod. Large numbers of plants are also grown from seed or cuttings donated from collections of Universities, Botanical Gardens and other Institutions around the world.

**Pest & Disease Control**

*Ian Martin* points out that the Watering Lane Nursery (and Eden) have placed themselves in a position where they have no choice but to be highly rigorous over the issue of plant health. Firstly because of the specifications given to their suppliers and secondly because they have a close relationship with the plant
health authorities (Defra) who are in the public eye and have to be seen playing by the rules. More seriously both Defra and Eden want to ensure that no pest and disease problems get out of hand.

In the 'bad old days' it would have been possible to eradicate most pests and diseases using systemic chemicals applied to the soil or the leaf surfaces. Today such chemicals may be banned or it is necessary to obtain clearance to use them. These chemicals may not work because of pest and disease resistance or they may be toxic to humans (this is a particular problem in the Humid Tropics Biome due to the potential dispersion of these substances into the atmosphere due to high temperature and humidity).

**Looking for pest and disease problems**
The objective at Eden has to be the eradication of every single insect pest in the Biomes; worrying about five whitefly in a biome of 330,000 cubic metres of greenhouse might seem ridiculous, but their potential to reproduce and explode into major infestations is constant threat. Management has to decide what level of control of each given pest and disease is acceptable. Eden's Chief Scientist, Alister Griffiths, and his team of experts constantly monitor the biomes also for plant growth and nutrition and soil-water factors. They work closely with the horticultural supervisors who also have experience of pest and disease control and integrated pest management systems and with the Defra's National Laboratory at York and with the Regional Plant Health Inspectorate at Truro, Cornwall. If by chance an insect or disease is 'notifiable' Defra will impose immediate action to remove the threat. Sue Minter points out that temporary plant exhibits can represent big plant health risks; the highest risk and the most severe controls regard those plants that go into the biomes. The second category risk is given to plants taken into the restaurant area that connects the two covered biomes and category 3 plants can be placed in other less sensitive areas.

**IPM (Integrated Pest Management)**
*Tom Keay,* Curator of the Warm Temperate Biome (WTB) is certain that in 5-10 years time they will have some of the most knowledgeable people in the world on using IPM (integrated pest management) that uses chemical treatment together with biological agents to obtain control, due in part to the great sizes of the Biomes and the study of population dynamics. Biological control using predator insects and other biological agents has an important role to play in suppressing populations of insect pests or outbreaks of disease, but it can never entirely eliminate them. However the application of plant chemicals can upset biological control methods for months. A mild soap is used to keep the leaves clean and usually only mild chemicals such as *pyrethroids* are applied. According to Ian Martin, Eden is trying to obtain permission to utilize a new potent and highly selective natural extract from the tree species *Melia azedarach* and *Azadiachta indica.* The active ingredient is a bioregulator that kills insects by inhibiting moulting and hence growth. The product occurs naturally in the leaves, flowers, fruit and seed of these tree species and is completely innocuous to humans. In addition, populations of Ariole lizards, geckos (that enjoy eating cockroaches) some bullfrogs and tree frogs are established in the Humid Tropics Biome along with a few birds (Malayan White Eyes) that eat mealy bugs, white fly and mosquitoes. An occasional praying mantis, might also be seen.

**Development of the plant communities**
What is so exciting in the Eden biomes is that plants will grow to maturity with a minimum of intervention to keep them healthy and shaped. The Biomes are proving good growing environments. Sue Minter points out that as the plants grow (depending on position and layout) they will start to
compete with each other in the natural development of a secondary forest. As a result some of the ground flora will be shaded out. This provides Eden with new opportunities to demonstrate the natural development of plant communities and a small area might eventually be cleared of larger trees to provide comparison.

Edward Bent August 2003  Grateful thanks to members of The Eden Project staff.