Copyright Statement

The digital copy of this dissertation is protected by the Copyright Act 1994 (New Zealand).

This dissertation may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- you will use the copy only for the purposes of research or private study
- you will recognise the author's right to be identified as the author of the dissertation and due acknowledgement will be made to the author where appropriate
- you will obtain the author's permission before publishing any material from the dissertation.
URBAN FORESTRY

THE INTEGRAL USE OF TREES IN URBAN DESIGN

A landscape study submitted for
the Diploma of Landscape Architecture
in the
University of Canterbury

by

J.L. Goodwin

Lincoln College
1981
ACKNOWLEDGEMENTS:

I would like to thank the following people who assisted me in the preparation of this major study: my tutor, Charlie Challenger for reviewing my work; Allan Rackham, Peter Rough, Jan Woodhouse, Bruce MacKay and Clive Ansty for their help on specific problems; Di Menzies, Mary Buckland, Nick Morgan, Mick Field and Don Barnhem for supplying information from the various local bodies; Michelle Day for her speed and care in typing; my parents for their financial and moral support; and my two flatmates Chris and Pup for their encouragement and friendship throughout the year.
BACKGROUND

Although urban forestry is a relatively new concept certain practices and disciplines associated with it have been long established. The use of trees to enhance the environment and many of the principles relating to their care are extremely old and date back to early Egyptian times.¹

However, the Germans are probably the first people to adopt urban forestry principles in the full management of their urban and peri-urban forests. The planning and management of trees and green space to provide multiple and sustained benefits to urban people has been a conscious policy since the early 1920's.²

In German cities such as Stuttgart, the urban forest is now viewed as a composite of three distinct components whose spatial and functional relationship is co-ordinated
by the overall planning process. This urban forest concept, which includes the forest belt surrounding the city, radial green arms reaching into the central city and numerous other green spaces has not reached the implementation phase.

Stuttgart occupies two valleys lying at right angles to each other, with the main part of the city in the basin-like Nesbenbach valley. The city centre is sited on flat land on the basin floor, but even here the domination of the peripheral forested hillslopes is apparent. Forests, gardens, fields and vineyards cover two thirds of the metropolitan area.

Within the central city the parks do not function as adjuncts to this area but as integral parts of their complex structure. Although Stuttgart has notably more open space than many other cities, none of it is under-used. No one lives much more than a third of a mile from a small neighbourhood park, or three-quarters of a mile from a large forested one.\(^3\)

The overall plan in Stuttgart is to link these existing parks to the river, forests, sports centres and each other; thus forming a continuous network of open space. Pedestrian links are preserved by footbridges where roads cut across the open space. Just as we often tear down houses to make way for new motorways, in Stuttgart residential streets usually have to be forfeited when creating new links between parks.

The circulation system, the heart of any well organised city, is carefully planned in Stuttgart. Care is taken that routes are of the right materials and scale, in relation to the anticipated use and type of landscape. The main arterial routes are enveloped in low maintenance trees and shrubs that screen carriageways and act as psychological noise barriers. Where possible noise is baffled with dense planting and earth mounding and the use of water in parks to disguise traffic sounds.

The recreational use of the open spaces is high, providing linear walkways while still
being wide enough to incorporate a wide range of facilities and a feeling of isolation from the city bustle. These open space areas are also managed for production purposes. Vineyards sited within the parks assist in cold air drainage thus ameliorating temperature conditions.

In addition to parks, cemetaries and wasteland are treed and used as functional resources in climate control, soil conservation and links in the open space network.

Although timber production remains a major objective in the peripheral urban forests, these green belts are also managed for recreational and environmental functions. These multi-purpose functions are identified by detailed maps which translate into corresponding management procedures. In contrast to the inner urban green spaces the peripheral forest is also managed for wildlife purposes. Remote areas of the forests remain deliberately underdeveloped yet accessible to accommodate those people who wish to observe nature and seek tranquility.

Stuttgart's forested green spaces are truly multi-purpose and through constant management have succeeded in radically changing the city character. "This contemporary urban forest should be understood however, as the end result of historic trends and events; generally crowded living conditions; the active demands and involvement of a socially, and environmentally aware, affluent urban population; and above all the integration of urban forestry into comprehensive urban renewal planning, and development." 4

Although the principles of urban forestry have been carried out in Germany and other European countries for many years, the concept was first introduced at the University of Toronto in 1965. 5 The concept combined the application of forestry and aboriculture to encompass an intensive management program for all vegetation in the urban landscape. It "does not deal with city trees or with single tree management, but rather with tree management in the entire area influenced by and utilised by the urban population." 6
Although urban forestry is still in its infancy, it has developed rapidly in response to the needs of the urban populace. In the United States and Canada it is now emerging as a fully-fledged profession, continuing to grow as urban needs become more acute.

In the Morgan Aboretum on Montreal Is. in Canada, the urban forest is managed for the urban people as a nature centre. This 6,000 acre forest began as a simple demonstration woodlot where pulpwood, firewood and maple syrup were produced. An area was also set aside to grow examples of Canada's native trees. Today production still continues but it is now a haven for city folk who come to hike, ski cross-country, birdwatch, observe wildlife and enjoy the woods. Of prime importance now is the preservation of native vegetation for people who otherwise may not have opportunities of contact with the realm of nature. Here the forest is not merely a plantation, but a place where trees, birds, mammals, insects, soil and water are integral parts of a delicately balanced environment. The educational aspects of learning the intricacies of nature's ecosystem, and forest management techniques has led to more public concern about the wise use and conservation of natural forested areas.

Although not as yet under the wing of the urban forestry campaign, the tree planting programs in South Africa provide an interesting example of purposeful and integrated use of trees in an urban environment. Here the physical structure, the biological status and the cultural needs within the urban environment have been recognised and used as a basis for an approach to tree planting.

South Africans are an intensively tree-conscious society, but live in a very harsh climate. This plus the largely industrial nature of much of their urban landscape presents a continuous challenge in displaying a tree dominated cityscape.

Although much of the impetus to plant trees arose from the desire to make their cities
inviting to overseas travellers, and to instill civic pride in the permanent residents, the large scale tree planting programs are now recognised as serving many more functions.

The use of trees in the South African urban environment are recognised as:
aesthetic; climatic amelioration; pollution control; noise and blast abatement; and timber production.

Areas of the city are seen as distinct and requiring totally different approaches to tree planting. The areas defined are streets, city squares, car parks, public parks, botanical gardens, sports and play grounds, industrial areas, sea frontage, and private gardens. The variety of tree uses outlined are then applied to the different areas of the city as part of an overall plan for the management of the urban landscape.

Traditionally forest operations have been carried out in New Zealand on a large scale, with economic returns being of prime importance. There has in recent years however been an awareness of the need to balance economic considerations with social and environmental. This awareness has been brought about by such factors as, increased urbanisation, and greater stress placed on fragile ecosystems associated with this development; greater leisure time experienced by a larger percentage of the population; and the need to use our resources to their potential. The development of multipurpose forests has thus emerged, particularly within and nearby large population centres.

Stemming from the above developments 'urban forestry' has just recently become a new concept within New Zealand. It is becoming an integral part of the Auckland Regional Authorities planning within the greater Auckland region.
In a recent booklet entitled "Opportunities for Urban Forestry in Auckland" the multiple-use of urban trees is expounded based on the need for a more energy efficient, safer, more functional and attractive city. An integral part of this concept is the development of "green-ways", including the planting of forest-scale trees and the utilisation of vacant land. The impetus for this program is based on local needs for employment, and a deficiency in timber supplies in the Auckland region. In particular specialised woods are critically deficient which will produce future difficulties for Auckland's local industries.

The Authority recognises the many functions of the urban forest as environmental protection, environmental enhancement, physical and mental health of urban dwellers, commercial exploitation, improving resource use and education and scientific interpretation.

In the booklet the case for urban forestry in Auckland is argued based on the planning, forestry and park management resources available to the Auckland Regional Authority, and the "political desire to influence for the better, the economy and landscape of Auckland and the quality of life offered to its people".

FOOTNOTES:
1. Grey and Deneke P.2
2. Schabel P.281
3. Cox P.11
4. Schabel P.286
5. Grey and Deneke P.6
6. Ibid P.6
7. Baird P.64
8. Poynton P.137
9. Ibid P.138
10. Auckland Regional Authority P.9
11. Ibid P.34
PREAMBLE

To many people in New Zealand the term 'urban forestry' has appeared ambiguous and even contradictory. A variety of meanings have been applied to this concept by different interested parties. To foresters, urban forestry is a specialised branch of traditional forestry, to horticulturalists and aboriculturalists a systematic tree planting and care program.

Although landscape architects have presently had little input in urban forestry programs their role is a key one in this emerging field of urban planning. Skilled in planning and design methods, using ecological, social and visual resources as a base, the landscape architect is best able to provide overall direction for urban forestry.

The concept of urban forestry must therefore be seen to embrace all the many professional
and public bodies interested in planning the total urban environment for the benefit of the populace. This concept removes the focus from a single tree or woodlot to the systematic planning and management of all trees and forests within and surrounding the urban environment.

It is in response to the recent developments and interest shown in the field of urban forestry in New Zealand that this major study has been undertaken.
OBJECTIVES:
The objectives of this major study are:-

(i) To determine the potential use of trees and their suitability to the urban environment;

(ii) to examine the tree use inter-relationships in order to develop a methodological approach to 'urban forestry';

(iii) to investigate a range of tree species to determine their suitability for use in the urban landscape.
USE OF TREES IN THE URBAN ENVIRONMENT
1.0 INTRODUCTION

Few people would doubt the need for trees in an urban environment. They provide welcome shade on hot summer days and an important link with nature. However the use of trees goes beyond providing an aesthetic element in our building dominated urban landscapes.

In this increasingly quantified world, it is now appropriate to portray the many uses of trees in a more objective manner. That is not to say trees should be viewed in purely mechanical or economic terms, but that the function they perform be recognised so trees are seen as an inseparable part of the urban structure.

This chapter investigates the major tree uses in the urban environment and discusses them in relation to the character of the urban landscape and their value to the
urban populace. The tree uses have been grouped within the following broad categories: Engineering, Climatic, Productive Architectural, Recreation and Ecological.

Individual tree uses do not fit solely within one of these categories, as they naturally relate to other categories. Each specific tree use has thus been placed into the most convenient category for discussion purposes.
1.1 ENGINEERING

The urban environment is biologically varied and complex, and as such there are a variety of stresses imposed upon plant life. Such factors as soil conditions, water budget, light intensity, chemical stress, air conditions and mechanical obstructions all relate directly to the vigour of plant life.

Urban environments are generally characterised by compacted soils caused by heavy and repeated use. Added to this compaction is the often frequent flooding in low-lying areas causing anaerobic soil conditions. Soils are also dependent upon local variations in climate such as rainfall, humidity, temperature and wind frequency. These factors combine to produce highly fluctuating soil conditions throughout the urban landscape.
As large portions of the ground surface area in most urban landscapes are covered with impervious materials that prohibit adequate water infiltration, moisture stress is a common problem for city trees.

Plant growth is influenced by light intensity, wavelength and photoperiod, that is, day light hours. Variations in wavelength and the critical photoperiodic effect occur through the incidence of artificial security and vision lighting sources. These variables in turn affect vegetative growth, diameter growth, dormancy, frost resistance and flowering.¹

The increasing use of chemicals for pest and weed control, fertilization, and growth regulation, makes this an important stress factor for urban plants. The detailed long-term effect on plants and soil make-up are not yet fully understood. Toxic concentrations of heavy metals such as mercury, lead and zinc may significantly alter soil PH and inhibit tree growth.²
The stresses associated with air pollution are largely chemical in nature. This phenomena, only rarely a natural hazard for plants in the past, has increased tremendously in most urban areas over the last 20 years. Air pollution is often associated with the physiological decline of vegetation within and surrounding large metropolitan areas. This decline is dependent on the nature of the pollutant, its concentration, the duration of exposure, and the species of plant involved.\(^3\)

Great damage may also be done to urban trees through construction work, overfilling of root areas with rubble and earth, and the placement of overhead and underground supply lines near trees. Under electricity wires tree crowns are often severely pruned, while leaky underground gas lines may restrict root growth and eventually kill trees. Additional damage may be caused by traffic, to the roots, bark and lower branches of urban trees.

1.1.1 Soil and Water Conservation
Trees and other vegetation play an important role in reducing soil erosion which occurs through exposure to wind and water. Trees also aid in the percolation and infiltration of surface water in urban areas.

Soil erosion occurs in most urban landscapes - it is not only a rural problem. It has been estimated that up to 100 times more soil is lost in cities and suburban areas, than from farms in the United States. Whereas one square mile of suburban land under construction may deposit 2,500 tons of silt per year into its waterways, forested watersheds contribute less than 100 tons of sediment per square mile per year.\(^4\) As a result, siltation and an annual rise in the river bed are common in most urban waterways. Consequently rivers have less water holding capacity, and lowland flooding becomes an increasing problem.

19
Vegetation protects soils in their natural state by reducing wind velocity, intercepting rainfall, holding soil with roots and increasing water absorption with organic matter.

"The roots, shoots, and tendrils, together with decaying leaves, twigs and branches, form a tightly interlaced mat that absorbs and holds water, allowing its percolation into the earth".  

When trees and absorptive ground covers are removed, the accelerating process of erosion is initiated. This results in a chain reaction where new storm-water run-off courses are formed, soil structure is altered and land stability reduced. The degree of this erosion process is directly dependent on the topography and soil characteristics. When so much harm can result so quickly from a break in vegetation, exposing bare soil, there is a need to keep slopes in particular, covered when new urban areas are developed.
Large areas of impervious roof tops, roads, paths and concrete water courses speed water to discharge points at increased velocities. Increased peak-flows result in greater volumes of water emerging at discharge points thus increasing the likelihood of flooding and soil erosion down stream. This increased peak-flow may be reduced by routing stormwater into forested areas of cities or their surrounds, taking advantage of the high infiltration capacity of these soils. In the Woodlands project near Houston, U.S.A. a natural drainage system was employed at 22% of the cost of a conventional system using trees and forested areas, porous pavements, soakage pits and grassed open swales to reduce peak flow run-off and avoid flooding.6

The combination of trees, shrubs and groundcovers in as near natural association as possible is the best for soil and water conservation. Where the natural plant association is altered trees and/or shrubs and groundcovers will be of some benefit
in preventing wind and splash erosion, and aid in the percolation and infiltration of water. Trees tolerant of periodical water deficits in their natural habitats, should be chosen for urban areas where drought conditions are common. Usually these are species with deep extensive roots and firm, glossy or hairy leaves to reflect radiation and reduce transpiration.\(^7\)

With the continuing evolution and matur-

ation of urban areas empty spaces occur, both as residues of former land uses, and gaps in urban expansion. Much of this land is often left as waste or derelict where lack of topsoil, compacted subsoils, and toxic additions from chemicals or spoil are common. Other factors such as rubble and structural remains, quarrying, slope instability, and excessive water may reduce suitability for natural plant growth.
Some tree, shrub and grass species are especially suitable in restoring such wastelands to a viable state, where other plant species and organisms can be introduced to continue restoration and conservation of soil and water regimes. If the nutrient status is particularly low or imbalanced, corrective measures may initially need to be undertaken - soil structure amelioration, chemical treatment, fertilizer application.

An example of restoration planting in an urban area occurs in South Africa, where vegetating old mine dumps is common. On the Witwatersrand, the skyline is dominated by some 95 sand dumps and 247 slime dams thrown up by 80 years of gold mining. These barren hills would cover an area of 800 ha and be 1000m high if put into one mound. After attempts to cover the dumps in plastics, resin, bitumen, rock, soil and ash failed, a wide variety of plants were tested to vegetate the dumps and dams. The main inhibiting factors were low PH levels (1.5 - 4.0), fineness and compaction of milled material, lack of plant nutrients, slope instability, and strong winds.

The PH levels are corrected by fertilizer application, the heaps remounded, and screens and barriers erected to protect against initial wind erosion. A standard seed mix using 15 different species of grass, clover, lucerne and saltbrush; plus *Acacia melanoxylon* and *Acacia baileyana* is used. The species chosen become established rapidly, further breaking the force of the wind, and encouraging seeds of various indigenous plants to be deposited by birds. This is the beginning of establishing an ecologically sound habitat where soil and water are conserved and wildlife niches renewed.

It must be remembered that the creation or restoration of soil fertility is a long process. However the soil-forming function of trees can be put to good use on waste land, whether it be natural waste,
such as stabilizing sand dunes, or man-made waste, as discussed above.

Thus the stability and protection given by trees to soil and water quality is of the utmost importance within and surrounding urban areas. Through the wise management of trees and forested areas for soil and water improvement and conservation, catastrophic events such as land slides, polluted water supplies and severe flooding, may all be minimised.
1.1.2 Atmospheric Purification

Air pollution is the phenomenon of an atypical increase in the trace contaminant levels of the atmosphere. This may result from man's activities, or extraordinary natural events, such as volcanic eruptions, large fires and dust storms.

Water, soil and vegetation are the primary sinks for air pollutants. Trees are the dominant terrestrial sinks in the temperate regions of the world. They are effective because of their size, the high surface-to-volume ratio of foliage, and the frequently hairy or rough surfaces of leaves, twigs and bark.9

It is apparent from a careful review of available literature that vegetation and particularly woody plants, do have the potential to remove both particulate (smoke, grit and dust), and gaseous (sulphur dioxide, nitrogen oxides, and hydrocarbons) pollutants from the atmosphere. (These pollutants are common in New Zealand's large cities). The question still remains however, about reducing the level of air pollution below a meaningful or medically significant level. This relates to the fact that most available information comes from controlled experimental conditions which cannot be applied conclusively to any urban area.

Basically, particles are deposited on vegetative surfaces by three processes: sedimentation due to gravity, impaction due to eddy currents, and deposition due to precipitation.10

After the particles are collected by trees, they may be absorbed or washed to the ground by rainfall. In time, the vegetative surfaces again renew their capabilities for trapping additional particulate matter.

The primary way that trees remove gaseous compounds from the atmosphere is by foliar absorption through the stomates.11 Other means may include uptake by plant surface microflora and bark pores, and absorption of gases onto leaf surfaces. However, the extent to which trees may remove gaseous pollutants is widely debated.
Trees selected for the function of cleansing the air must be able to withstand the adverse influences of air pollution. If a tree is severely injured by atmospheric pollutants its ability to function as a sink is curtailed.

Tree plantings cannot completely solve the problem of air pollution, but they may contribute substantially.

Forests, and even small park and expressway tree plantings, may be vital as air-purifying agents. However, the larger the area of treed open space the greater is the effect in reducing atmospheric pollutants, and supplying large volumes of clean air throughout the urban environment.
There are three fundamental design principles associated with using open space in an air resource management program - separation, alteration and removal. 12

Separation refers to using open space passively to increase the distance between the source of the pollutant and the receptors, that is, as a buffer strip between incompatible uses. Recommended width varies from 8m for a street buffer to 30m for a highway 'sink', and 5 km for a buffer zone between heavy industry and residential areas. 13

Alteration is based on using open space to change the air medium through which pollution moves. In general, this is done by - altering surrounding temperatures, physically placing barriers in the wind path, and changing humidity and microclimate; all of which affect windflow and subsequently pollution deposition.

Removal refers to removing surrounding air pollution by absorption through gaseous uptake, and particulate deposition and impaction. Here vegetation, soil, and water act as a sink for pollutants, to limit and control pollution levels.

![Levels of Lead Concentration on Moss Samples](image-url)
Some principles of using open space to remove air pollution follow:

(i) Plant Characteristics - For particulate removal plants that have rough leaf surfaces and a high ratio of leaf surface area to volume should be favoured. For gaseous pollutant removal, tree species with a high tolerance to urban conditions are best, especially resistance to drought.

(ii) Forest Characteristics - A multilayered (multi-species) forest is a more effective pollutant sink than a single layered one. However, the edge strata should be less dense to allow gaseous pollutants to filter into the forested area. Increasing the edge surface area of the forest, with openings and sinous planting, improves the collection efficiency for gaseous and particulate pollutants.

Within New Zealand, native plant associations provide an ideal mixture of species and stratification for year-round 'stylized' air pollution control. However, their susceptibility to urban environmental stresses and large doses of particulate and gaseous pollutants is unknown. The enthusiasm for relying on vegetation to clean the air must thus be tempered by the realization that atmospheric filtration by plants has not been conclusively quantified for any urban area.

1.1.3 Noise Abatement

All cities are faced with the ever-present problem of noise pollution. The level of noise generated by sources such as motor vehicles, construction equipment, and industrial activities, are often of sufficient intensity to be physically and psychologically damaging to urban dwellers.
Of the many scales devised for measuring noise levels, the A weighted decibel (dBA) is the most commonly used. This dBA measurement of noise accurately correlates with the tonal composition of the human ear. The dBA scale is logarithmic, and an increase of 10dB corresponds to the approximate doubling of the loudness of a sound.14

Although the ultimate solution in eliminating excessive noise lies in removing the source, trees can play a role by spreading the wave front of the acoustic energy. Additional reductions result from air and surface absorption, reflection, refraction, diffraction and scattering of sound waves. Most of this excess attenuation is due to ground surface absorption.

Under normal daytime temperatures with low wind speeds tree belts 30 metres wide and 15 metres tall in a dense plantation may yield traffic noise reductions as high as 10 dBA's. Similarly tall, 10 metre wide belts are capable of reducing traffic noise 3 to 5 dBA's. This often reduces the noise from an 'objectionable' to a 'satisfactory' level.15

The most limiting factor in the use of trees to reduce noise levels in the urban environment is the large amount of ground needed to effectively attenuate excess sound.
The time required for trees to reach forest size and density will also limit their immediate effectiveness in noise reduction. Attenuation is also reduced at night as noise is more easily refracted over barriers when surface air is cool.\textsuperscript{16} 

The most promising use of trees and shrubs in noise reduction is in combination with solid barriers such as walls and landforms. Plant material appears to compensate for the deficiencies of a solid barrier and vice versa, resulting in a complementary effect. Results show a reduction during daytime temperatures with land form/plant material mixes of up to 15 dBA (one third as loud) immediately behind the barrier.\textsuperscript{17} 

Contrary to popular belief, noise is not absorbed by trees, it is scattered and the ground beneath absorbs the sound. However, the psychological effectiveness of trees in noise reduction must not be underestimated. If a noise source cannot be seen, then it is usually not considered as noisy as one in full view of the receptor.
Some general guidelines in using trees and solid barriers for noise reduction follow:

(i) To reduce speed from high speed and truck traffic, as on a motorway, a solid barrier (preferably earth) with several rows of trees and shrubs adjacent to and on the barrier give best results. Without the solid barrier sound levels cannot be reduced to a reasonable amount unless there is 100 metres separating the source and receptor.

(ii) To reduce noise from moderate speed traffic, as in suburban areas, plant rows of heavy shrubs with taller trees above and adjacent to the road. Where space is not sufficient a solid wall and a row of trees and shrubs will still reduce noise levels.

(iii) Noise buffers should be placed as close to the source as possible.

(iv) For year round noise reduction evergreens with thick fleshy leaves are recommended.
1.1.4 Wastewater Disposal

Because of the high cost of current sewerage treatment plants, and their debatable effectiveness in returning pure water back into streams, other solutions for effluent disposal may be appropriate. Both sewerage effluent and sludge are valuable resources in that they contain considerable amounts of essential plant nutrients which can be utilized. Application to the land may reduce stream water pollution, conserve and recharge ground water, and allow valuable nutrients to be recycled for further use.

Forests appear to be ideal for this purpose as there is some doubt over introducing potentially toxic amounts of trace metals into the animal and human food chain when waste-water is spread over agricultural lands. The vegetated soils in a forest provide a living filter of wastes, taking up valuable nutrients whilst purifying water before it reaches underground aquifers.
Application to forested areas is most efficient after secondary and before the costly tertiary effluent treatment. After secondary treatment large objects, 90% of the biochemical oxygen and suspended solids are removed. The effluent still contains 58% of the nitrogen compounds and 30% of the phosphorous compounds, which are the elements most responsible for stream eutrophication.\textsuperscript{18}

In forested areas of Pennsylvania mixed hardwoods, and conifer plantations were irrigated with treated waste water from 1963-1978. The waste water was mainly from domestic sources and applied onto different areas at rates from 2.5 cm to 7.5 cm/week either over the growing season, or the entire year.

One entire growing season application equalled 2,240 kg/ha of a 10-10-11, nitrogen, phosphate, potash fertilizer.\textsuperscript{19}

It was found that waste water spray irrigation significantly increased tree growth and wood fibre production. This increased growth decreased the structural value of the wood but enhanced its use as wood chips or a raw material for pulp and paper. No contamination of the soil was found. Wildlife populations and body weights of rabbits, mice and birds increased with no increase in toxicity or disease.

Based on the Pennsylvania study some general site guidelines for wastewater disposal have been formulated.

(i) Soil permeability must be high enough to permit drainage of the effluent and to maintain aerobic soil conditions.

(ii) Soil must have sufficient chemical absorptive capacity, water retentive capacity and depth to groundwater table to hold dissolved minerals for use by plants and micro-organisms, to prevent groundwater contamination.
(iii) Land must have low relief, a good vegetative cover, and accumulated surface organic matter, to minimize surface run-off.

(iv) The groundwater aquifer must have a fairly deep water table to accommodate subsequent changes in groundwater storage.

The above system of wastewater disposal is best adapted to smaller cities or suburbs where 520 ha of forested land could dispose of 405 million litres per day for a population of approximately 100,000.20

There appears to be great opportunity to partially solve the problem of urban wastewater and sludge disposal by recycling these products on forest lands. With increasing demands on energy and escalating costs of chemical fertilisers, there is also an opportunity to use urban wastewater to maximise woody biomass production in energy plantations for use as a fuel.

1.1.5 Traffic Control
The safety of motorists, cyclists and pedestrians is dependent upon many factors which include such imponderables as the mechanical condition of a vehicle, or the physical condition of the traveller. Beyond this area of individual variation, safety depends to a large extent upon the ease and accuracy with which people can interpret the visual evidence of their surroundings. In other words, many traffic accidents occur in the urban environment as a result of confusion or misinterpretation. Therefore our ability to use our traffic routes efficiently and safely is largely dependent upon our ability to see, and interpret what we see, quickly and correctly.

Trees may act as optical guides along a roadway. The effect of trees following the line of a road facilitates early recognition and estimation of the traffic picture.
Trees have also been found to be useful in alerting drivers to the diminution of their visual field with increasing speed. Variation in the colour, feature and form of trees at intersections and speed zone boundaries, may act as a cue or reference point aiding in the accurate interpretation of the road experience.

For motor vehicle traffic control trees and shrubs can be used in:-

(i) Repetition of highway alignment by linear planting beyond crests, around curves and at any other location where the drivers view of the road pavement itself is obscured.

(ii) Screening against headlight glare and low-angle sunlight.

(iii) Screening against distractive elements adjacent to the highway.

(iv) Provision of sufficient visual interest to prevent driver boredom.
(v) Provision of crash barriers in medians, traffic islands and other critical locations. (Dense planting of *Rosa multiflora* stopped a fully laden car travelling at 80 k.p.h. in seven metres without injury to the passengers, and only minor dents and scratches to the vehicle.)

Trees and shrubs in design may be used as hints of the correct route to follow for pedestrians and cyclists. They may also act as a barrier to prevent entry to an area. The safety of the pedestrian and cyclist may be increased by providing segregated traffic lanes along existing wide streets.

All three modes of transport commonly used in the urban environment travel at different speeds, require different surface materials, turning circles and signals or cues. Trees and shrubs are useful in guiding or deterring the predictable movement of pedestrians, cyclists and motor vehicles.

FOOTNOTES

1. Roberts P.75
2. Ibid P.76
3. Ibid P.78
4. Simonds P.15
5. Ibid P.15
6. McHarg & Sutton P.78
7. Bernatzky 1978 P.100
8. Poynton P.145
10. Ibid P.26
11. McCurdy P.310
12. Ibid P.307
13. Ibid P.308
15. Cook P.332
16. Herrington P.26
17. Cook P.334
18. Grey & Deneke P.66
19. Sopper & Kerr P.392
20. Grey & Deneke P.67
22. Robinette P.59
The climate of a city differs from that of the rural areas surrounding it in all aspects. The characteristics of the city environment affect wind speed, solar radiation, precipitation, temperature and humidity. Its compact mass of buildings and pavement constitute a profound alteration of the natural landscape, and the activities of its inhabitants act as a considerable heat source.

In contrast to the macro-climate which is defined by climatic variables over tens of years and several hundred square miles, the urban environment is defined by smaller scales. Climate on the scale found in a city is usually considered at the mesoscale, while the microscale is that of the neighbourhood, or individual site. Trees significantly affect the mesoscale climate of cities, and may provide a dramatic alteration of climatic conditions at the micro-scale; as wind, temperature and balances of solar radiation are more easily affected by changes in the physical structure of the surface.
1.2.1 Wind Shelter

Although urban environments generally have a slightly lower mean annual wind speed than rural areas, they do produce greater turbulence and wind gusts. The greatest increase in this turbulence and gusting occurs on summer nights and throughout winter.\(^2\) Increased wind speed at the micro-scale increases human discomfort and in winter can add significantly to the 'winter chill index'.

The value of trees as shelterbelts in rural areas has long been appreciated by animals and humans alike. Trees act as semi-permeable barriers - they slow the velocity of the wind by reducing the energy flow. Trees can be situated to reduce wind gusts and turbulence around corners and at the entrance to buildings. On pedestrian and cycle routes shelterbelts may be designed to reduce extreme wind velocity therefore increasing human comfort and safety.
Designed along major traffic routes where large cuttings and elevated overbridges are common, forest-scale trees can increase driver safety by preventing abrupt changes in wind speed.

An ideally planned wind control system at the meso-scale would reduce wind funnelling and gusting, while deflecting cold air away from major roads, residential areas and market gardens. The system should however enable winds to blow into the urban environment during summer from cleaner, cooler, country and green space areas. (This use is discussed further as part of Temperature Reduction). In terms of landscape planning the principles are sound, in terms of detailed planning and of its application to the site the system may pose many problems.

For example in Islamabad, Pakistan this type of system was designed to ameliorate the climate. Here the city fits neatly into a wedge-shaped space between two ranges to the north, and a river valley
to the south. These natural physical barriers, with the addition of a large area of farmland (60,000 acres) designated as a National Park, were proposed as green filters. The wide river valley when forested would filter the hot summer winds, increasing the humidity, and penetrating into the heart of the city. Conversely, planting in the narrow valleys between the hills, and on the slopes themselves would act as a filter against cold winter winds. However the rather abstract planning of superimposing 1 $\frac{1}{4}$ mile square grid roads upon the undulating terrain, has destroyed by its rigidity the unity intended in the linked system of green belts.\footnote{3}

Apart from difficulties in establishing a year round wind control system on the meso-scale, trees and forests may be designed to increase year round comfort at the micro-scale by sheltering small neighbourhoods, parks and transport routes from cold winter winds. The extent of wind reduction at the micro-scale is dependant upon the height, density, profile and width of plantings. Up to a distance of 30 times the height of a shelter-belt there is a significant improvement in leeward shelter. Although dense shelter may be required against severe gales, 35 - 45% permeability is desirable to reduce turbulence and maximise wind reduction. Where increased width decreases permeability below 35-45% the shelter effectiveness is reduced. Generally the most effective shelterbelt is that with both a windward and leeward vertical profile.\footnote{4}
1.2.2 Sun and Shade Control

The use of trees in the control of year-round sun and shade relates to the micro-climate of the urban environment. (The discussion of the sun's effects in solar radiation and the 'urban heat island' effect are discussed as part of Temperature Reduction).

Apart from direct rays from the sun there are many natural and man-made reflective agents in the urban landscape. Common natural reflection sources are water, sand, gravel and rock surfaces. The many man-made surfaces, such as glass, metal and concrete add to the reflection.

Directly associated with reflection is the problem of glare. In summer months the many man-made surfaces may reflect up to 50% of the radiation they receive. This increase in heat and glare may produce conditions that are physically and psychologically damaging to the urban dweller. Urban trees assist in reducing this glare by intercepting direct and reflected radiation. The amount of light
penetration through the canopy structure is controlled by the position of the tree to the sun or its reflection, and by the selection of tree species. Heavy dark leaf trees with dense canopies are most effective in reducing sunlight and surface reflection.

The control of summer sun and reflection is important along road-ways where early morning rays and glare from buildings may impair a drivers vision drastically. Along roadside and small urban parks large shade trees may provide a welcome relief to the weary traveller. In the suburban areas, shade trees reduce extreme summer temperatures at the micro-scale, thereby providing a more comfortable living environment.

In the winter months the sun is usually a welcome sight. The heat generated by the sun's rays during this period is reduced, so reflective surfaces are an important generator to ameliorate cold winter temperatures.
Hence, deciduous shade trees are most desirable for year-round sun and shade control in temperate climates. During the summer they will intercept as much as 90% of the direct sunlight, while their winter leafless condition will allow between 40 and 70% of the sunlight to reach the surface, depending on the species used. The implications in site design for using this method of year-round sun and shade control should be exploited within the urban environment to ameliorate microclimatic conditions.

1.2.3 Temperature Reduction

The climatic variable most affected by the city landscape is temperature and this is manifest in the 'urban heat island' effect. All cities are warmer than the surrounding countryside although the highest temperatures are associated with the densely built inner-city area. The degree of warming diminishes slowly out from the city centre, through the suburbs and then decreases markedly at the urban periphery.

There are two primary processes involved in the formation of an urban heat island, both of which are seasonally dependant. In summer the tall buildings, pavement and concrete surfaces of the inner city absorb and store larger amounts of solar radiation than do vegetation and soil in rural areas. As this warmer air rises above the city it is replaced by air flowing from the outer regions of the city, and gradually a slow circulation is established. At night, while both the city and country cool by radiative losses, the urban structures give off additional heat...
accumulated during the day, keeping urban air warmer than that of the outlying areas.

In winter a different process dominates. Since the sun angle at mid-latitudes is low and lesser amounts of solar radiation reach the ground, man-made energy becomes a significant addition to the solar energy naturally received. Artificial heat results from: combustion for home heating, power generation, industry, transportation and human metabolism.\(^8\)

Throughout the year the fast removal of rainfall through the use of gutters, drains and sewers reduces the amount of water available for evaporation, thus the heat energy normally used in this process further increases air temperatures. Although the large amount of particle pollutants generally found in urban areas reflect sunlight, they also retard the outflow of heat thus increasing urban temperatures. These processes are most effective when light winds and poor dispersion prevail. 

Apart from the use of trees and other plant material to reduce micro-climatic temperature extremes through solar absorption, the meso-scale temperature can also be ameliorated through the careful design of green spaces. Corridors of forest trees are the most effective method of ameliorating urban climatic extremes at the meso-scale. In Frankfurt, Germany, green belts only 50-100 metres wide have the effect of reducing the temperature in summer by not less than 3.5°C compared with the centre of the city.\(^9\) (In Stuggart, Germany the temperature of green spaces have measured 8°C cooler than surrounding built-up areas.\(^{10}\)
As measurements were taken the cool air from the green spaces was continually flowing to the built-up areas. With the reduction in temperature humidity showed an increase of 5% in comparison with the town centre.

In summer months under anti-cyclonic conditions with little wind, when the heat-island is most prominent, air currents charged with pollutants move toward the city centre and hang above in the form of a dome. In this case green belts laid-out concentrically around the city centre are most efficient in filtering air and reducing temperatures. Other parks, spread irregularly over the town area, are certainly not useless in meso-scale climatic control, but they will not produce the same good results as green belts systematically planned according to prevailing winds. The wider and more numerous these green belts encompassing the city are, the more effective are the air currents resulting between the greens and the built up areas.
Grasped fields are not without some effect in lowering temperature, but they will not produce results as good as parks and open spaces linked with large forest trees. Improvement of the city climate at the meso-scale can only be achieved by green spaces that are carefully planned. All other measures that may help at the micro-scale should not be neglected, but they should naturally afford second place. Although the concentric layout of green spaces interrupts the inward flow of polluted air, the exact location and layout of the green web must depend on local variations in topography, city structure, and climate.

1.2.4 Energy Conservation

Energy conservation can be seen as part of wind, shade and temperature control; in the amelioration of indoor human thermal comfort, and the reduction of energy consumption (for heating and air-conditioning) of buildings.

Tree windbreaks reduce energy loss by reducing heat convection from the exterior surfaces of buildings, that is, windbreaks reduce wind velocity and thus retard the replacement of warm air by cold. The infiltration of cold, outside air accounted for roughly one-third of the heat loss from New Jersey homes. Here a single row of conifer trees was found to have the potential to reduce air infiltration by as much as 40%. This reduced infiltration resulted in a 12 to 13% reduction in winter fuel use. An optimum distance between a windbreak and a house is approximately twice the tree height. A conifer windbreak that
This cooling effect may result in considerable energy savings for air conditioning. In California during hot climatic conditions of 38°C, dense shade trees reduced maximum temperatures in a house by 11°C, resulting in a 50% reduction in energy costs. Although air-conditioning is not common in New Zealand residential areas, shade trees reduce extreme indoor summer temperatures to a more comfortable level.

The optimum vegetation arrangement for year-round energy conservation is in the use of windbreaks for reduction of cold prevailing winter winds; accompanied by deciduous trees that provide shade in the summer but allow relatively unobstructed penetration of winter sun. Exact plant locations will however depend on local wind conditions, aspect, access, and other design features.

The dollar savings of year-round energy conservation on a national scale could be substantial. A conservative year-round 10% reduction in energy required for home...
heating and cooling combined would reduce total United States consumption by nearly 1% or 400,000 barrels of oil per day.\textsuperscript{15}

**FOOTNOTES**

1. Van Haverbeke \textit{P.184}
2. Peterson \textit{P.28}
3. Lovejoy \textit{P.17}
4. MacKay \textit{P.26}
5. Laurie \textit{P.215}
6. Ibid \textit{P.215}
7. Peterson \textit{P.7}
8. Ibid \textit{P.16}
9. Bernatzky 1966 \textit{P.32}
10. Cox \textit{P.11}
11. Bernatzky 1966 \textit{P.32}
12. Ibid \textit{P.32}
13. Heisler \textit{P.16}
14. Van Haverbeke \textit{P.185}
15. De Walle \textit{P.268}
1.3 PRODUCTIVE

The term 'Urban Forestry' may suggest conventional forestry practices transposed to the urban scene. Pictures of pine trees being planted, or park and street trees being milled are brought to mind. Although large scale forestry practices are unsuitable, the urban landscape does possess a potentially productive resource that is at present underutilised in most urban centres.

1.3.1 Wood Products

Urban trees and forests are a functional resource for the benefit of the urban dweller. This notion must be carefully considered when the potential value of timber products from streets, parks and open spaces are assessed. Obviously the widespread harvesting in a clear-fell method could have disastrous effects on visual, recreational, and ameliorative benefits of trees in the urban landscape. Therefore to accommodate the needs of the urban dweller and retain the character of
the urban landscape, tree and forest production has to be part of an overall management system. In urban centres, streets and parks, trees can be managed for other functions until nearing the end of their natural life. A tree or forest stand may be replaced a few years before removal to minimise the initial loss, and enable the replacements to become well established. In this situation highly specialised felling equipment and even helicopters may be used to avoid damage to nearby trees, services and buildings.

In the green-belts and peripheral urban forests of Germany, two methods of felling have been developed to assure compatibility with environmental needs, visual quality and recreational objectives. In the 'selection system' mixed forests are grown in a multi-age structure where individual trees are extracted leaving natural regeneration to fill the gaps. While there are some problems removing large trees through regenerating saplings, the advantage is
that this method is an adaptation of the natural process and destruction of the forest ecosystem is minimal. Management procedures involve supplementing regeneration, and controlled thinning to maintain the best quality timber trees. The selection system maintains visual unity throughout the whole forest belt.¹

With the "shelterwood system" the forest is conceived as a number of units of different ages, but within each unit the ages of the trees is more or less uniform. When trees are felled only small clearings are created based on the unit size. Selected trees are left to initiate natural regeneration and replanting is necessary in some cases. The shelterwood system creates considerable visual, recreational and habitat diversity through the 'ecotones' and different aged tree units. At Bottle Lake Plantation, Burwood, just out of Christchurch, regeneration is one of the key ingredients in the management system.
Here regenerating pine seedlings have proved a successful method of establishing a forest. This greater reliance on regeneration and less on planting means a greater diversity in forest structure which aids in management of the forest for amenity and protection functions.

Many urban tree species are suitable for specialised timber uses such as furniture making and veneer. High quality timber trees are presently found in most urban areas in private and publicly owned land, and further plantings of such valuable trees should be encouraged.

Where trees are unsuitable for timber production, firewood may be a viable alternative to provide home heating fuel for urban communities. Once again the scale of operation should relate to the area of the urban environment and be dependent on available resources, demand and alternative fuels. At Bottle Lake second thinnings that are not harvested for posts, poles and strainers are cut.
up, split and sold as firewood. This use of prunings and wastewood from urban trees and forests is a method of effectively utilizing a resource that is often burnt at the dump.

In street tree maintenance, prunings and wind blown trees present another wood utilization opportunity. Wood chippers have been devised to be towed behind a truck or tractor to break-up prunings from city trees. These mobile chippers can be operated off a 'power take-off' and depending on the size of the unit can chip branches up to 50 cm in diameter. The ultimate size of prunings entering the chipper would depend on other possible uses, such as firewood. The portable chippers reduce branches and small boles to chips, which are blown into a truck following behind. The chips may then be used as a mulch, to protect exposed soils from erosion, or to discourage weed growth.

Wood chip and leaf mould or sewerage sludge compost is a viable alternative to buying and carting peat and top soil to replenish urban soils. Coarse wood chips mixed with either leaves or sludge provides better aeration during composting and eliminates the strong odours associated with anaerobic decomposition. These solutions provide a better alternative to landfill burial, or burning - alternatives that are often restricted by environmental regulations.

Wood chippers are currently being used by the Dunedin City Council and private contractors in various urban centres. The Christchurch City Council are at present negotiating to buy a chipper to be used in the manner outlined above.

A further use of wood chips is as an alternative fuel. It is estimated that one ton of greenwood chips (one medium sized shade tree) is equivalent in heat value to two barrels of commercial fuel oil.
In the United States the cost of wood chips delivered as a fuel was $1.00 per million BTV's (British Thermal Units) compared with $2 - $3 for coal and oil. As the production of wood chips may not be annually reliable (dependant on seasonal pruning), many coal and oil-fired boilers can be adapted to accept wood chips as a supplementary fuel.

The utility of wood chips has been proven a viable operation and its uses are directly applicable to the New Zealand urban scene. So far in this country the use of pine chips to produce steam and power by the Mid-Northland Dairy Co., has been followed by a more extensive use of a similar plant in Reperoa.

As the cost of conventional fossil fuels continues to rise, burning tree and other organic waste produced by households and industry will become an increasingly attractive option. Woodchips clean burning potential using modern gasification processes, its low recyclable ash content and perhaps most importantly, being a renewable resource, add to its potential as an alternative to existing fossil fuels.

1.3.2 Food Products
Traditionally the urban dweller has been dependent upon his rural cousin for a large proportion of his food requirements. Apart from a vegetable garden and the odd fruit tree most city folk buy their weekly food supply from the supermarket, butcher and greengrocer who in turn generally obtain their stocks from regional or national outlets. The potential is as yet untapped in providing a large proportion of fruit, nut, herb and honey supplies from the urban based forest network.

In some urban areas local community groups are developing a methodology to plan what they see as a survival option for their area. Part of the aim to provide a self-sufficient urban community involves many of the principles outlined in the development of urban forestry and in particular the growing of trees as food sources.
As well as more extensive use of private sections for fruit and nut trees, public land could be managed for production of yearly food crops. In South Melbourne fruit bearing street trees are to be planted by the local community for their own use.  

Forest environments also provide a micro-climatic environment for many herb, fern, weed and mushroom species to exist. In an age when many culinary delights are disguised in super-hygenic, multi-coloured wrappers the chance to pick wild plants from river banks and forests may be greeted with cries of alarm. However, though some wild plants may be dangerous to eat, the vast majority of edible ones are of high nutritional value and tastier than many of our over-refined, over-cultivated common vegetables.

Urban tree and forest plantations could yield not only nuts, fruits and wild plants, but honey, pollen and bees-wax. Along with nuts, honey is probably one of the first food forms known to man.
In addition to being a food it is also highly effective as an antiseptic - internally and externally. Honey from plants with specific medicinal characteristics will possess these same properties, but the dose will be of precise therapeutic proportions.

In recent years there have been heavy losses of bees to toxic spray programmes in orchards. The accommodation of beehives in private sections and urban forests could supply a large quantity of honey, aid in fertilization of tree and shrub species, and provide the bee with a home away from toxic sprays.

There are many other potential productive uses of urban trees and forests (for example dying and thatching) - this is by no means an exhaustive discussion. In todays economic climate these valuable urban resources could be better managed for the direct benefit of the city dweller.

FOOTNOTES:

1. Tregay P.290
2. The Press P.17
3. Ibid P.17
4. Ratcliff P.79
5. Ibid P.79
6. Loggins P.198
7. French & McKenzie P.15
8. Gouldstone P.20
Many of our fine cities and urban centres owe much of their character to the widespread use of vegetation. As such, trees are an important part of the townscape and one of the most interesting and effective visual elements within it. There are visual pleasures to be derived from individual trees but it is often the visual play of a mass of foliage contrasted with built forms which adds up to a sum that is greater than that of the parts.

Trees are therefore important elements at both the 'micro' and 'macro' scales in the design of the urban landscape. At both scales trees may provide contrasts of line, form, mass, colour and texture within the built environment.

Line is derived from the trunk and main branches, overall shape, and internal and external shadow patterns. Form is essentially an expression of line and is derived from the volume and shape of a tree or forest, expressed in a three dimensional manner.
Mass is derived from the size and density of leaves and branches at the 'micro' scale; or from spacing of trees and presence or absence of foliage at the 'macro' scale. Colour may be derived from the bark, branches, twigs, foliage and flowers. Texture is derived from surface shadow and is dependant upon the size and spacing of leaves and twigs at the 'micro' level; or mass and foliage at the 'macro'.

It is the architectural use of these visual elements of trees in urban landscape design that can shape and create a functional and aesthetic living environment. Trees in the city are living building materials used to establish spatial boundaries. They make the walls and ceilings of outdoor rooms, but with more subtlety than most built forms. Unlike the solid enclosure of a building, horizontal enclosure with trees depends on visual suggestion and illusion. A translucent canopy of leaves and branches as vertical enclosure may allow for a simultaneous experience of a smaller space
with a larger volume. Thus trees are a
dynamic architectural element in the city-
scape. Their use in space modulation is
affected by the changing seasons and their
ever-changing form over time.

In addition to actually creating discrete
spaces, trees can be used to connect and
extend the geometry, rhythms and scale
of buildings into the landscape. Used
as extensions of architectural and city
form rather than as decorative or softening
elements, trees greatly expand the scope
and potential of urban design. Much of the
characteristic visual disorganisation in
urban landscapes, may be unified by physi-
cally linking the disparate parts through
the establishment of an ordered continuity
of large scale trees. Trees are the most
prominent design element capable of link-
ing together an entire city.¹

Trees can be used to resolve the conflicting
scales found within the inner-city landscape.
Here tall buildings, narrow streets and
small squares dominate the visual scene.
There is generally a strong and often intimidating sense of vertical enclosure. Large trees establish a lower space that is more comfortable for human use. Tree branches and canopies create a partially transparent 'tent' that allows awareness of the space beyond, but confers a psychological sense of containment by reducing the apparent scale. Within this urban area forest-scale trees in straight lines, circles and rectangles are appropriate because they echo the cityscape and fit comfortably within the man-made geometry of circulation and structure. Thus where it is logical to do so, the 'forest design' should grow out of the established pattern in the surroundings.

A tree's function as a design element in the urban landscape must relate to the activities of the people. In the city people travel to work, shop and meet others, by bus, car, bicycle and foot. These modes of transport must be accommodated within the density of this build up area.
Here avenues and arcades of trees can form the natural transition zones from street to car-park, car-park to footpath, and footpath to building entrance. By creating a physical transition element trees become the connectors between spaces whilst also acting as a unifying element and orientation indicator.

Within the suburbs of the urban environment trees may also provide the connection between spaces. Here the transition is from private to public space - from garden to street or park system. Trees within the private section of a residential home may perform all the functions capable at the larger scale. They define and articulate outdoor space, screen undesirable views, and co-ordinate and link structural elements, providing that important connection between indoor and outdoor space.

In many suburban areas where the grid-iron pattern exists it is difficult to modulate and define useful space. Often with the little room that is left, trees
may increase the linearity of the existing pattern and add to the visual clutter. Where trees are set back in deference to utility lines, the comfortable sense of street enclosure is weakened, or lost. If the trees are spaced too far apart, each tree develops a more dense lower-branched crown. The effect of this wider spacing is to produce an interrupted pattern of contrasting light and shade that emphasises each individual tree. Only where trees are large enough to dominate other street elements does a more satisfying scale relationship and a reduction in linearity occur. Where large trees are grown close to each other and the curb, greater visual unity and enclosure for the pedestrian results, while the branch canopy over the street reduces the immensity of the roadway.

For this avenue principle to be useful in the urban landscape, planting must read as strong walls not as rows of separate trees.

Thus trees must be part of the 'streetscape' design, and not just perceived as street trees.

From planting in the suburban streetscape, trees may provide a linkage to larger transport corridors and areas of open space. The larger arterial routes, often provide an opportunity to establish wide belts of large scale forest trees which finger into the city centre. In addition to the ecological, climatic and engineering functions of such corridors, a progressive physical and psychological transition from home to highway to work-place can be developed. Similarly the transport system can ideally be used as part of the open space network linking parks, reserves, rivers and schools to the work and home environment.

The architectural use of trees in open space may be, to provide visual relief in contrasting cityscape and landscape, to create a sense of local identity within the urban fabric, and to contain and shape the overall urban development.
Where 'green' open space can be designed as an integral part of a new urban development it no longer becomes 'left-over' space remaining after structures have been built and roading patterns developed. It is then part of the visual amenity of the area and gives a sense of identity to the community by shaping the new development.

Forested open space may also provide an important function in segregating zones of incompatible urban use, for example, industrial and residential. Planning is essential to ensure that the function of open space is a complementary and interdependent fragment of the urban landscape, not just a self-sufficient entity.

Within existing urban development, open space such as lakes, rivers, hills, wilderness areas, cemeteries, schools, parks and derelict land may be interconnected to form a rational open space network.
Existing transport corridors may be re-organised to provide the essential link to accommodate the needs of both the pedestrian and the motor-vehicle. Open space can be physically created by blocking, narrowing, and redeveloping existing streets. Cul de sac, vacant lots and varying building set-backs, provide an opportunity to create a neighbourhood open space within the existing rigid confines of buildings and roads.

An open space network or green web within the city can be developed from the 'micro' scale - house, street edge, school yard, - to the 'macro' scale where large fingers of forest-scale trees are interspersed throughout the urban landscape connecting it to the rural fringe beyond.

The widespread use of tree and forest plantations in the urban fringe area can provide a definite containing element reducing the incidence of urban sprawl. By halting the spread of the city into the rural land beyond, the forest belt may also provide an important transition zone for the traveller. The urban area will be more compact and the countryside free from urban clutter. If expansion of the city becomes necessary beyond this urban fence, the forest then becomes part of the internal open space system. Large scale forest plantings in this zone may also screen undesirable industrial sites while providing an overall unifying element in an area that is often marked with spoil heaps, wasteland and disparate structural elements.

The use of forest-scale trees throughout the urban landscape may provide an overall architectural framework through suburban street, highway and open space planting. An interconnecting 'green web' defining and linking the various urban zones to each other and the rural landscape can then be obtained. Cities with all of their unrelated little pieces cry out for order. There is often a desperate need for coherence based on continuity, rhythm, repetition and linkage. Trees alone satisfy this need, and establish a unifying order.\(^2\)
The architectural use of trees in the urban landscape can thus be seen at both the micro and macro scales. The functions at both these scales can be summarised and broadly categorised as:

(i) Space modulation - defining and articulating both pedestrian scale space and the overall pattern of the landscape.

(ii) Structural co-ordination - co-ordinating buildings and disparate forms through the provision of a unifying linkage.

(iii) Visual control - screening and privacy control and the use of enframing elements to enhance vistas.

FOOTNOTES:

1.4 ARCHITECTURAL

1. Arnold P.43
2. Ibid P.148
The recreational value of urban forests has gained importance with the concentration of population and the increase of leisure time. The advantages of forest and tree areas over open fields for recreation are many. Forested areas can absorb crowds and give an illusion of solitude even in a bustling metropolis. There are more opportunities for a variety of walks providing a greater range of experiences. Seasonal changes can become more vivid and the richness of wildlife apparent while climatic extremes are modified for the comfort of the recreational user.

Within the urban environment recreational forests can be incorporated into reserve land, large parks, green belts and in the urban/rural fringe area. In large sites a forest setting may be ideally suited for a variety of other recreational activities apart from partaking in the forest experience. As well as walking, relaxing, birdwatching, picnicing and
educational activities directly associated with the forested landscape; orienteering and jogging activities, swimming pools, restaurants, museums, sports fields, campsites and other facilities may be accommodated and absorbed in forest clearings, with appropriate zoning to minimise conflict and protect the forest character.

Pedestrian, cycle and even horse routes can be accommodated in a large forested area, providing intrinsic variation and spatial characteristics based on the speed and requirements of the user. It is important to have a hierarchy of paths for these users; from open, wide primary paths capable of carrying maintenance machinery, offering a fairly direct well sign-posted route; to the more enclosed, shady, unsealed path which winds narrowly through the interior of the forest. Such a hierarchy is important in giving directional structure as well as visual and psychological variety. It is important to be able to find ones way around the main route without
becoming lost, yet also have the opportunity to wander deep into the forest in the hope of doing the opposite.

Where forested areas are managed for wildlife and/or soil and water conservation dense undergrowth is necessary to keep people to the paths and prevent random access to the sanctuary zones. Management techniques are therefore of the utmost importance in ensuring that intensive use does not destroy what the people actually came to experience and enjoy.

Within the built areas of the urban environment, trees and shrubs as part of the overall 'urban forest' can provide a diverse landscape important for relaxation and relief away from the hustle and bustle of city life. Tree groups may be arranged to provide suitable areas for informal play, lunch-time eating, and social meeting places. Larger areas of open space are important for more active pursuits and if these can become part of an 'open space' network, walking, jogging and cycle paths may be incorporated.
throughout the city for the enjoyment of the recreational user.

Trees, individually or in groups, may also be objects of direct recreational use. One tree can engage a child for days at a time, or periodically over a span of years. Any kind of bush or tree allows children to exercise great creativity in the construction of houses, forts, tents and imaginative laboratories. A mature tree with its many branches, notches and cracks is excellent for climbing in or swinging a rope from. Children can satisfy their desire for challenge in the play activity of a tree. Children also need to be alone at times and a few trees or a small forest harbouring insects and birds make an absorbing place for them to develop their identity and emotional security. Manufacturers of playground equipment have found it impossible to recreate such richness.

Within New Zealand the amount of leisure time offered to people has increased steadily, from the establishment of a
forty hour working week in the 1870's to the advent of 'flexi-time' and staggered shifts today. With the imminence of a four day or 35 hour working week urban people are going to have even greater leisure time. Add the present high number of unemployed in all urban centres and the result is an increasing number of people with greater amounts of time to recreate.

With the current and ever-increasing price of liquid fuels, urban dwellers are becoming increasingly discouraged from making long journeys to enjoy recreational pursuits. People are in fact making more internal short trips within the city as opposed to travelling longer distances. Although personal mobility has increased, accessibility to services and recreational facilities has decreased. These trends of increased leisure time and reduced accessibility, will undoubtedly place a higher demand on urban open space and fringe areas to provide a wider range of recreational activities.
From a study done in Christchurch in 1973 on outdoor recreation preferences it appears organised sport is no longer the most popular recreational activity. The top five recreational activities preferred by the Christchurch sample were (in order) 1. Picnics 2. Driving for Pleasure 3. Visiting Beach 4. Organised Sport (Spectator) 5. Walking. Of these five, Picnics, Driving and Walking can be suitably accommodated and enhanced by an urban forestry scheme. Other urban centres show similar preferences, with later studies in the United States indicating that driving for pleasure has decreased in importance with walking and swimming becoming more popular. Two of the more recent popular recreation pursuits, cycling and jogging, are not incorporated into these comparative studies.

Steps to provide areas for walking have been undertaken by the New Zealand Walkway Commission culminating in the N.Z. Walkway Act, which has -

CYCLE-WAY DEFINED BY TREES
"the aim of establishing walking tracks over private and public land so that the people of New Zealand shall have safe, unimpeded foot access to the countryside for the benefit of physical recreation, as well as for the enjoyment of the outdoor environment, the natural and pastoral beauty, and the historical and cultural qualities of the areas they pass through".\(^5\)

Initially the concept was for a series of connecting walkways from Cape Reinga to Bluff. However it has now become apparent that it is more important to concentrate on shorter walkways adjacent to large urban centres. Clearly the use of trees and indigenous forests could enhance elements of the walkway scheme in providing a functional and aesthetic walking environment whilst adding to the landscape quality of the area.

Both exotic and indigenous forests can accommodate a variety of recreational pursuits. The exotic forest is best able
to provide for activities that are more dependent upon supportive facilities, such as paths and tracks for jogging and motor cycling, than on the forest itself. The exotic forest can be used as a backdrop for these 'user-oriented' activities. Pursuits which are dependent upon forest character, such as walking, natural history, education, wildlife observation, are better served by a forest with a diverse range of species using our indigenous species as a base.

In the light of current trends in health awareness, nature conservation and the economic climate, urban trees and forests can provide an important recreational resource within and immediately beyond the urban environment. The role of urban corridors linking periphery forests with city zones could be invaluable in providing a 'day-trip' forest experience without the need to travel long distances. Trees and forests are invaluable in providing opportunities for both active recreation (jogging, orienteering, cycling, motorcross) and passive recreation (sitting, picnicking, walking, nature watching).

FOOTNOTES:

1. Canterbury United Council P.E6
2. Environmental Council P.30
3. Neighbour P.39
4. Christchurch City Council P.9
5. Hunt P.45
In cities and urban areas, man's activities have vastly altered the physical and biological environment, so that a totally new ecosystem exists. Of great significance in the influence urbanization has had on the ecosystem are the following: the removal of plant cover and replacement by impervious materials; increased rates of water run-off; lowering of ground water reserves; and release of heat energy as a result of combustion processes. More direct human effects are mutilated trees, eroded open space, manicured gardens and a general lack of mature forests, and wetlands. The end result is a low species diversity and a simplification of the ecosystem. The more diversified an ecosystem is, the more stable it becomes, reducing its susceptibility to external forces.\(^1\)

Up until the 1940's, many organisms could adapt to the changing urban scene and maintain viable populations, but the rapid growth and extensiveness of new technical
developments in the last 30 years has been too great for many plant and animal species. As all animals are ultimately dependent upon plants for food, and most require vegetation for cover and reproductive areas, any change modifying the structure or abundance of plant species will have an effect further up the food chain.

When assessing an area's potential for plant and animal life, consideration must be given to a whole complex set of environmental factors, ranging from soil and water regimes to climatic influences. A particular site may be unhospitable to a wide spectrum of plant and animal species. Therefore an exhaustive site survey is imperative for establishing flora and fauna habitats in city environments. This however should not be a deterrent as establishing wildlife habitats in the city provides many benefits, such as biological pest control, environmental indicators, educational rewards, and enhancement of the general quality of life.

Wildlife corridors are essential if mammals and cursorial species are to be retained as components of stable urban ecosystems. Where development within the urban environment can be formed in clusters to enable greenspace to be linked by corridors, the total usefulness of the land is greatly enhanced. Such green space should be based around existing natural landscape features, such as river valleys, indigenous flora, marshlands and coastal belts. Such features are essential contributors to the ecological stability of any region. To conserve and encourage diverse wildlife resources it is essential to maintain the physical continuity between these open space units within and beyond the urban landscape.

To encourage the most successful establishment of urban wildlife habitats urban forests and greenbelts should be based on the natural vegetation of the area as much as practicable.
Although the urban environment is certainly very man-modified in terms of physical characteristics a structurally diverse forest with a wide variety of indigenous plants is potentially richest in fauna. Dependent life-forms range from organisms on the roots, to birds roosting in the tree tops. Other native habitats such as scrub and grassland areas are equally as important for insects, butterflies, small mammals and seed-eating birds.

Forest clearings potentially support an interesting flora and fauna, and are important for certain animals which move out of the forest to feed. Much of the value created by these clearings results from the nature of the transition to the forest, a zone known as the ecotone. The value of an ecotone for wildlife in terms of number and density of species, is in its considerable richness compared with areas deep within the forest. This is particularly so when it is a broad zone encompassing a wide range of habitats from grassland through shrubs and regenerating
trees to the mature forest behind. The form and character of the forest ecotone, therefore has an essential bearing on the quality of the urban forest for wildlife habitats. However the more mature an ecosystem is, the larger the area it requires to be stable.

"It is possible to create a small grassland habitat but not an equally small forest, since the 'edge' effect - the tendency for increased variety and density where different natural communities join each other - will essentially preclude the establishment of true forest conditions." 3

Urban forest management for wildlife is essential, as enhancement of diversity and protection of existing habitats require that all phases of succession are represented in a region. In essence to manage wildlife populations it is necessary to manage habitat. Management may be needed to protect and maintain an existing habitat or to shape the development of a new one.
Many different land uses should be encouraged so as to present a mosaic of habitat and to encourage the diversity of species in the ecotones.

Variety within the urban forest may be encouraged by seeding and planting vegetation (small seedlings to semi-mature trees), and allowing dead and dying organic materials to remain on the forest floor. The variety of species will ensure that animal cover and food will be available earlier than if a single late developing species is planted. In New Zealand our native species of shrubs and trees are extremely suitable for establishing wildlife areas for animals and insects. Exotic species may also supply food and habitat requirements especially in winter when some native sources may be scarce.

The principles of using purely natural plant associations must not be blindly transposed to all areas of the urban environment. In densely built areas such as the city centre other functional requirements such as shade and shelter may take precedence. In such areas it is often more appropriate to relate planting to the architectural forms to obtain a good scale relationship and unifying element. However where natural corridors extend into the heart of the city a forested habitat can provide ecological wealth and a recreational resource.

Heavy use by the urban population can be detrimentally effective upon plant and animal ecosystems. The human actions principally responsible for ecological change are trampling of flora by pedestrians, horses, bikes and motor vehicles; erection of on-site structures; killing of animals; specimen collecting; pollution; fire; or even human presence. Sanctuary areas are therefore indispensable in the urban ecosystem as the adaptive ability of many plant and animal species to tolerate human activities is poor. As the areas most favoured by recreationists are the habitat boundaries, waterside and forest edge,
'people management' is imperative to safeguard the needs of both the people and the ecosystem.

This management policy can be aided by educating the users. Creating positive attitudes towards natural resource conservation and careful attention to sensitive zones can best be accomplished through integrating educational programs and interpretive centres, to provide information and establish an understanding of the use of such areas. Educative processes and a well designed circulation system may avoid needless destruction of ecologically sensitive areas.

To achieve an ecologically balanced urban environment it is not necessary to remove all civic order from our cities and plant native tree and shrub species, but to make some adjustments to obtain a more favourable balance with nature. There is a need to modify the natural landscape to accommodate the requirements of an urban society, however this can be accomplished with less ecosystem destruction.
Some principles of design for both ecological diversity and the needs of urban man follow as a summary:

(i) Exploit the full natural potential of the site based on the interaction of site features.

(ii) Conserve or develop diversity of habitat by protection or manipulation of the above site features.

(iii) Encourage a full range of organic life, that is, an extensive range of compatible species.

(iv) Encourage the full cycle of growth from birth to decay to develop a 'mosaic' of habitat elements.

(v) Develop balanced self-sustaining communities with a minimum of outside interference.

(vi) Control the system by management aimed at the lowest level of maintenance consistent with human uses.

(vii) Create maximum variety of opportunity for man and nature to co-exist even on the smallest area of land.

(viii) Create a coherent landscape structure derived from site potentials, habitat diversity, and the separation of conflicting interest.

(ix) Design in four dimensions, that is, accept the need for continuous design flexibility in the future.

FOOTNOTES:

1. Gill & Bonnet P.3
2. Ibid P.85
3. Ibid P.121
4. Manning P.30
The influence that the urban environment has on the health of its inhabitants is extremely complex. It involves such factors as housing standards, population density, air and noise pollution, climatic extremes, educational and recreational opportunities, and the visual character of the landscape.

Each of the tree uses outlined relates to the benefit of the urban dweller. Some uses such as engineering, climatic and productive, can be measured in quantitative and economic terms. Others such as ecological conservation and visual enhancement, are not so easy to quantify, but are equally important. In addition related green areas provide a variety of subjectively evaluated psychological benefits, such as, mental relaxation, social interaction, personal reflection, spiritual growth, creative development and stimulation.

These may all contribute to a general sense of personal well-being.
URBAN LANDSCAPE ZONES
In the discussion of the various tree uses outlined in Chapter one, numerous areas and zones of the urban environment have been referred to. Some tree uses are more applicable to particular areas of the urban environment. For example, the use of trees for wastewater disposal is not an applicable use within the densely built city centre, but may be appropriate in the urban fringe. It has thus become apparent that one uniformly rigid approach to tree use throughout the whole urban landscape is neither applicable nor desirable. It therefore becomes necessary to divide the urban environment into 'zones', to thus enable the identification of the major tree uses within each zone.

Although the urban environment has an existing zone structure established through the application of a district scheme, it is of limited value for the purposes of this
study. Traditionally the zonation is based on 'cultural use', that is, the human activities that occur within that area. For example, goods are made in an 'industrial zone', and sold in a 'commercial zone', while people live in a 'residential zone'. However, this approach ignores the structural and ecological factors which are vital in the establishment of trees in the urban landscape.

The zoning I intend to use is based on the physical, ecological and cultural structure inherent in the urban landscape. Based on these factors the urban environment is divided into the following zones:

(i) Inner-city - the compact business and trading centre of the urban environment where large, often multi-storey buildings and associated hard surfacing dominate the landscape.

(ii) Suburban - the living environment or home for most urbanites generally defined by sprawling low density housing and associated roading patterns.

(iii) Industrial - defined by its activities, and the large uniform, compact, single-storey warehouse or factory type buildings.

(iv) Arterial-routes - the urban roads that accommodate large volumes of traffic by providing a link from one urban area to another.

(v) Open-space - the non-built areas of land that are interspersed and sometimes linked throughout the city.

(vi) Peri-urban - the belts of land around cities which are neither wholly town or country.

A discussion follows on the inherent characteristics of each urban zone, the current tree practices and possibilities for future use.
2.1 URBAN ZONES

2.1.1 The Inner-city Zone

The inner-city zone is the 'heart' of the city and generally the most man altered area of the urban landscape. It is characterised by multi-storey buildings, narrow streets, and large areas of impervious surfacing. Buildings are a dominant feature through their heightened vertical scale. Being the oldest part of the city, early building styles and materials co-exist with the modern examples of city architecture. Thus forms and materials are often widely divergent creating an odd array of shapes and left-over spaces. Street and parking space is at a premium and consequently large areas of hard surfacing dominate these left-over spaces. Some of the original residential areas still survive in this urban core although these are often under threat from large building developments and the provision of arterial routes. In recent years however, urban renewal schemes have provided a new impetus in restoring these areas to a suitable inner-
city living environment.

The central city hosts a wide range of human activities from living environment, to work place, to recreational opportunities and business activities. It is also the hub of the city's cultural activities providing a wide range of entertainment for the urban populace. Thus people are also a dominant element in this zone and their needs must be catered for in this vastly altered landscape.

The inner-city zone is the initiator of the 'heat island' effect and in areas where inversion layers are common, pollution levels are high. The urban centre provides a hostile environment for many tree species who cannot survive the effects of pollution, soil compaction, lack of water, and infertility.

Viewing our cities from the air reveals that the central areas are usually deficient in large trees. Lack of trees in these areas does not correlate directly with
building height, but does reflect the intensity of use. Exceptions to this are where rivers or existing areas of native vegetation penetrate into the core of our cities. For example both Christchurch and Hamilton have extensively treed rivers in their city centres, while Wellington has an area of native vegetation penetrating to within close proximity of the city core. Most of our city-centres have parks characterised by large trees set out in a formal manner. Hagley Park, in Christchurch and Albert Park in Auckland were both formed last century and have since become extremely valuable city assets.

Why then do our inner-city zones appear to be deficient in large trees? Apart from these initially planted areas there is little evidence that tree planting is a deliberate design consideration in the overall planning of our urban centres. Hence large trees are regulated to parks and river banks, but do not form part of the overall cityscape. It is apparent that trees are used to fill in
left over spaces that remain after building, circulation and off street parking demands.

New opportunities have been developed for the introduction of trees into the cityscape by the closure of streets and creation of malls. A common practice within these malls is to plant trees in containers to provide a good soil medium, and for easy maintenance. However container grown trees will never grow to the size of similar 'open ground' species, thus their function within the cityscape is reduced.

Small scale planting does not provide immediate shade or shelter and does little to act as a unifying element within this building dominated landscape. Large size trees however fulfil the function of connecting the human psyche to the immensity of the city by providing a transitional element between human scale and spaces larger than human perception can comprehend.
TREES OCCUPY LEFT OVER SPACE.

LITTLE FUNCTIONAL VALUE.
There are of course examples where large trees have been purposefully used within the inner city zone around buildings and streets. However this generally appears to be the exception rather than the rule, as changing land use patterns have meant the exclusion of the tree as a primary element in the design of our inner-city zones.

2.1.2. The Suburban Zone

The suburban zones within our cities are dominated by low density residential housing. In New Zealand cities average population densities are less than 10 persons per hectare.\(^3\) Urban sprawl is therefore common and a high level of mobility necessary. Because of this pattern of housing the modern street, based on the grid-iron pattern, dominates our suburban landscapes. A car becomes a necessity for day to day life where public transport systems are neither in high demand nor highly efficient. However the rapidly increasing cost of cars, and more particularly energy, is making car ownership more difficult. The impact on mobility
from these rising costs will be particularly severe for families in these suburban zones.

Traditionally suburban streets are designed to provide access to adjoining properties. General standards of construction associated with highways and arterial-routes have been applied to residential streets in a monotonous fashion to provide for the motor-car at the expense of other forms of transport.

This serves to get people and services to and from individual properties as quickly as possible, but denies many opportunities for social interaction in the nearest neighbourhood space, by confining people to their own properties when at home.

Many of our suburban zones are built on Class I soils as the city has expanded to engulf the countryside. Such areas, especially in older suburbs, are often rich in flora and provide a wide range of habitats for wildlife species. However in many other areas this fertile growing medium has been stripped or compacted by heavy machinery
and vegetation is more difficult to establish.

In recent years the move towards smaller section sizes has led to an accompanying use of smaller plant material. Large trees are seen as an obstruction within many private properties as a stereotyped image of a cold, damp and untidy living environment is envisaged. Climatic, architectural and recreation benefits are thus negated, to the overall detriment of our suburban living environment.

A further look at our suburban streets reinforces the fact that the opportunity to enrich public spaces with trees has seldom been addressed. Today most street layout proposals still relegate the necessity of tree planting to a lowly position to be considered after the construction and services are present. As a consequence, small (if any) street trees are planted. Despite the council's good intentions these trees will make an insufficient impact on the scale of the street even when mature.
The only function of such trees is to provide an individual aesthetic street element.

Where large street trees do exist a common management practice is to pollard or top them every few years, to prevent entanglement with overhead wires. However this practice usually covers all trees in a street, even those on the side without wires, because symmetry is considered desirable. Regular spacing is also strictly observed, one tree is planted outside each property, even when a large tree lies adjacent inside that property. These regimented planting schemes do not allow for flexibility in streetscape design.

In recent years there has been a move towards the use of more native species. The change, however, has only been in the choice of plant material, not in the way it is used. The functional aspects of shade, shelter and spatial modulation have been neglected independent of the type of species used.
Admittedly the street often imposes many restrictions to the introduction of trees. Such things as overhead wires, underground services, narrow burms and wide carriageways, may all impede the establishment of trees in suburban streets. Other design elements such as regular housing alignment and use of street furniture, add to a general standard suburban streetscape, thus denying many opportunities to provide unity and lessen the dominance of the road-way.

Therefore the potential to incorporate trees in a functional manner in our suburban streets and properties must lie in the allied development of streets as living spaces within a neighbourhood. Design alternatives involve street layout (providing cul de sac, and narrow carriageways); introducing various service, paving and drainage methods; and creating a new design speed based on the volume of traffic. The use of trees to control traffic and create spatial boundaries has been outlined (Chapter 1), and the application of such uses
relates directly to the redevelopment of our suburban environment.

Reduced mobility of suburban families through the increase of transport costs will reinforce the need to create alternative routes to nearby community facilities. The cyclist and pedestrian can be catered for in both new and existing developments as alternative forms of transport. The adoption of a linked green-way system for all modes of transport using forest-scale trees is a natural adjunct to this development.

2.1.3 The Industrial Zones

The industrial zones are the urban areas where large factory-type buildings dominate the landscape. Here buildings take on a uniform character, through their size, design, materials used, and general site layout. The emphasis is on maximising site space so structures, industrial products and their wastes are all accommodated within as small an area as possible. Hence industrial areas have a certain 'sameness' about them,
and this is reinforced by the roading pattern which is generally based on the 'gridiron'.

'Wasteland' that may have served as an old dumping ground for industrial by-products, and areas that have yet to be developed are also common in this zone. Air, soil and water pollution are common, providing an often hostile environment for both flora and fauna.

The industrial zone is the work-place for many urban residents. However, there is little encouragement to develop these areas for them, or as part of the urban living environment, and consequently any off-site development is generally neglected. Although tree plantings do seem to have increased in recent years, unfortunately their use is in additional beautification rather than functionality. There are recent exceptions to this as some industrial sites do contain large park like grounds for recreational use by employees, and to create an impressive entry for prospective clients.
Although once again restricted by lack of space there is potential to reduce the harsh environment of many industrial zones by the widespread use of trees. Screening, co-ordinating uniformly bland structures and general micro-climatic benefits can result from a tree planting program on both private and public land. Care must be taken however in the choice of species to resist any possible air, soil and water pollution.
2.1.4. The Arterial-route Zones

Arterial-route zones are those first class roads that provide a link between different areas of the urban environment. They contrast with the internal street networks of the inner-city, suburban and industrial zones, in the volume of traffic and greater design speeds provided for. These routes may be two, four or six lane highways with either one or two way traffic.

As many of our arterial routes are widened existing streets, there is little room available for anything other than service facilities. However where new or existing arterial routes have meant the demolition of urban buildings, or where they have been created through undeveloped areas, there exists a far greater potential to incorporate flexibility into road-way design. During this process many pockets and tracts of land are left idle; these provide an opportunity to ameliorate any negative effects of new or increased traffic flow to both residents and drivers alike.

However arterial routes do provide a harsh environment for trees, as large amounts of vehicle pollution, densely compacted soil, wayward vehicles, and lack of space all contribute to reduce the viability of establishment.

The arterial route network provides the broad circulation system for the city. It acts as the 'arteries' and the efficient functioning of the urban environment may
Median strips, common along larger streets and arterial routes, are often lined with majestic large-scale trees that serve as a result of the foresight of our city forefathers who laid out the circulation system and the accompanying tree planting. Today on removal, such trees are replaced to maintain the existing character of these streets. Unfortunately the perceptions and concern for maintaining these existing streetscapes does not extend to the creation of new ones. Today many median strips are planted with a hodge podge of plants and inert materials that serve little function and easily go unnoticed in the scale of our broad street spaces.

Arterial routes are designed to effectively control the high speed flow of traffic.
Large scale trees have not as yet been seen as a functional adjunct to the efficiency and safety of city motorists, cyclists and pedestrians.

Apart from the specific use of trees in the control of traffic outlined in Chapter 1, there is the potential for the main traffic routes to become the linkage system for the city in both transport and vegetation. Forest scale tree planting along our major arterial routes would form an interconnecting green web throughout the urban landscape extending right into the city centre. The general effect of such planting would be to create easily identifiable areas within the urban environment. The 'green' transport routes then become the boundaries of the different urban zones aiding in the large scale spatial definition of the urban landscape. The arterial routes provide a circulation system from suburb to city centre, and from both to the countryside.

With the uncertain future of our transport modes, the opportunity to develop a rapid speed transport network will never go unused. With possible developments in rapid rail or mini-bus services these existing tree lined routes could easily be converted to more appropriate modes of travel. At the other extreme mo-peds and electric space-age cars may equally be accommodated within such a scheme.

It is popular to liken the city to the human anatomy with the transport routes as the arteries or veins. It is only by keeping these veins free from congestion and functioning properly that the health of the city is ensured. Forest trees may play an important part in the functioning of such arterial routes.

2.1.5. Open Space Zones

Open space includes harbours, rivers and their banks, parks, reserves, orchards, market gardens, forest areas, wetlands, beaches, lakes, golf courses, cemeteries and any other undeveloped land that is
within the city boundary. They may serve a multitude of functions which have been discussed in Chapter 1.

Spread throughout our cities are many managed open spaces ranging from small neighbourhood parks, to large scenic reserves. Trees are an inherent feature of our parks and reserves, ranging from a single row of trees surrounding a playing field to a native forest reserve. Open space areas that contain native forest are now generally managed for their ecological, educational and scientific uses. Such areas as Dunedin's town belt are seen to be an important part of the city landscape and policies now set out management guidelines to retain their character and functions.

However as yet there is little recognition in management terms as to the function trees can play in the more typical urban park. Apart from providing a setting for passive and active recreation, these areas are seen in terms of their aesthetic use, while a multitude of other functions could be incorporated into their design.
The expanding city places a heavy demand on open space for development purposes. However these areas often serve a more useful purpose in conserving areas rich in flora and fauna, recreational potential, visual resources and climatic control. They can and should be used more as a means to direct development to more appropriate areas within the urban environment.

In the past decade, planners and urban designers have shown increasing concern for urban improvement, human scale and bringing life back to our cities. The recognition of the importance linked open space can play in this improvement is now common. Although there is no lack of professional design interest, few open space areas have been designed to adequately exploit the many functions of trees. Unfortunately many people still regard open space purely as maintained grassed recreation areas open to the sky. Now with the identification of integrated open space patterns positive tree planting has to be a natural part of this open space planning.
2.1.6. The Peri-urban Zone

The peri-urban zone is that indefinite area where town or city shades into country, but which is recognisably neither. Fingers clusters and pockets of urban development intervene into the countryside. This fringe area may extend for miles before it becomes either fully urban or rural.

The peri-urban zone is directly affected in economic, social and environmental terms by the presence of the urban environment. The spatial extent, characteristics and functions of this area vary markedly over time, and generally differ from either the pure urban or rural area. Thus the area which is essentially the city's 'visiting card' is often neglected and disorganised.
As a result of deteriorating rural uses and the time lag before urban uses become predominant, urban edges have many areas of 'wasteland'. There is great potential in the redevelopment of these areas of empty land as an alternative to urban sprawl. This then determines the feasibility of maintaining the present rural edge. The relatively natural soils and viable though not often natural vegetation systems, offer a potentially viable resource for the urban community.

The main types of landuse activity found in the peri-urban zone include: agricultural producers of various types, ranging from part-time farmers, through to small intensive horticultural establishments; pockets of recently built suburban development; various industrial concerns; protection and production forests; large institutions such as airports, prisons, and defence establishments; recreational facilities; and increasingly, the establishment of rural-residential dwellings for farm workers, urban commuters, and retired folk.

Management policies for the peri-urban area now exist in many New Zealand cities. In the last decade with increasing pressure being placed upon the rural fringe from urban activities, management has become necessary to reduce urban sprawl and retain the existing character of such areas.

In Auckland, the Hunua and Waitakere ranges have been retained and managed as important adjuncts to the city. Here the regional importance of such areas for soil and water conservation, recreation, ecological habitats and timber production have been recognised.

In Wellington's Inner and Outer Town Belts, similar functions have also been recognised while the architectural use of these forested slopes has assumed notable recognition. "The dark green tree covered slopes appear to enclose and define the central city area, emphasising the topography of the city, acting as a foil and backdrop to the high-rise development and enhancing the city's location between hills and the harbour."
Now that the growth of the city has gone well beyond the original area contained by Inner Town Belt, an Outer Town Belt has been established within the peri-urban area to serve similar functions and act as a distinct boundary between urban and rural activities.

The recognition and suitable management of forested open space around Auckland, Wellington and Dunedin is now part of city and regional schemes. Christchurch is not endowed with large areas of native forest either within or surrounding its urban environment. However, the need to contain urban sprawl and recognise the importance of rural agricultural land in the peri-urban area has resulted in the formation of a 'green belt'. Although this green belt prevents further urban encroachment it lacks any real physical features to define and reinforce the containment of the urban area. The exception to this is the Port Hills area where topo-

THE PORT HILLS - A CONTAINING ELEMENT FOR CHRISTCHURCH IN AN OTHERWISE FLAT LANDSCAPE.
Graphical relief acts as a backdrop and enclosing element for the city. The use of forest scale trees in providing a similar verticle element within other areas of the green belt would improve visual containment of existing sporadic urban development.

FOOTNOTES:

1. Arnold P. 6
2. Ibid P. 8
3. Nature Conservation Council P. 16
4. Thomas P. 41
5. Environmental Council P. 32
6. Joint Centre Environmental Sciences P. 3
7. Ibid P. 17
8. Wellington City Council P. 1
2.2 SUMMARY

Trees occur on all kinds of suburban, commercial and industrial lands. The largest areas are in residential districts, in naturally forested areas, and where collectively property owners have created large areas of forest-scale trees. Large trees have traditionally been part of the appeal to property owners to provide a physically and aesthetically pleasing environment. More recently however, there has been a tendency in both private and public land to plant smaller, more colourful tree species. Although these appeal to peoples sense of beauty they provide little real use when compared with large forest-scale trees.

Although precise figures on the total 'urban forest' do not exist, it appears that approximately 20 to 30 percent of our urban trees occur in suburban areas. Therefore these areas provide an opportunity to manage such trees to satisfy many of the functions outlined.
Commercial and industrial areas make up less of the total 'urban forest', largely because of their utilitarian nature and a lesser proportion of the total urban land devoted to these activities.

Most councils now recognise the importance of making information available to the public on the functional use of trees. Some like the Christchurch City Councils 'Landscaping requirements' give a scant review of design elements and their possible use in site development. A list of trees suitable for Christchurch conditions is also included with eventual height and a brief description of form, foliage and known tolerances.1

Others like the Palmerston North City Corporation's booklet titled 'Trees, their use, selection and preservation,' outline many of the functional uses of trees. Trees may, screen off unsightly views, provide shelter from dust and wind, give shade, direct pedestrian boundaries, reduce noise, add natural beauty and improve property values. Other important factors such as soil zones have also been given in map form and a general planting guide is enclosed.2

Clearly the functions of trees in the urban landscape are known by the public agencies. The current trends in application appear to be a result of a lack of awareness by the public accentuated by a failure on the part of the public agencies to implement fully the design potential of trees on a city wide basis.

Common misconceptions regarding the use of trees in urban design has meant a general reduction in their functional value within the urban landscape. Misconceptions include:

(i) Density - that trees should be widely spaced when planted so that they develop a symmetrical spreading crown form. When planted close together it is believed they are less healthy than when grown as single trees grown alone.

(ii) Order - that trees always grow naturally in random arrangements of many different species. When
planted in straight rows or geometric patterns, the visual effect is believed to be less interesting than 'unordered' natural arrangements.

(iii) Diversity - planting a large variety of different tree species throughout the whole urban landscape is the best method of obtaining a sound ecologically based vegetation pattern.

(iv) Scale - it is better to use small trees with limited growth on narrow streets, than larger types of trees.

(v) Form and Detail - the typical crown shape of an open grown tree and seasonal colour are the most important determinants in selecting a tree for city planting. It is also believed that trees are better planted back away from curbs and structures where they will have more room to grow.

Each of the foregoing statements contradicts experienced observations and is unsupported or easily contradicted by scientific data. Although it is appropriate to consider the above factors in some instances, the wholesale implementation of tree practices based on these misconceptions reduces the potential to use trees as an inherent part of urban design.

Admittedly the urban landscape does provide many constraints to the wholesale use of trees in a well designed functional manner. However, the opportunity does exist to establish and manage a true multi-purpose 'urban forest' within our urban landscapes, and avoid using trees as a cosmetic afterthought. Only by a change in approach and management will trees be seen as objects of prime importance and accorded the due respect that our civic buildings are given.
FOOTNOTES:

1. Christchurch City Council  P.20
2. Palmerston North City Corporation  P.2
3. Arnold  P.11
2.3 IDENTIFICATION OF PRIME TREE USES

Now that the structure of the urban environment and current tree uses and trends within the different zones are apparent, it is now applicable to identify the prime tree uses. The following chart outlines the various tree uses noted and shows their interaction with each of the urban zones, thus depicting their relative importance within each zone.

It should be noted that the ultimate level of importance of a tree use within a particular zone is directly dependent on the choice of species, the soil, climate and other inherent site design features.

- Little or no importance
- Some importance
- Important
- Very important
# Prime Tree Uses

<table>
<thead>
<tr>
<th>Soil/Water Conservation</th>
<th>Atmospheric Purification</th>
<th>Energy Conservation</th>
<th>Wood Production</th>
<th>Recreation</th>
<th>NULL</th>
<th>NULL</th>
<th>NULL</th>
<th>NULL</th>
<th>NULL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner City</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suburban</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial-Route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Space</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peri-Urban</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
INTEGRATED APPROACH TO URBAN FORESTRY
To manage the urban forest on a multiple use basis the interaction between the various tree uses must be assessed. Once a prime use has been established it is necessary to determine what other tree uses can be performed without detracting from the prime objective. It is also important to be aware of potential conflicts in uses to enable the best all-round benefit to occur.

The following matrix shows the interaction between the specific prime objectives and the general categories. It should be noted here that as with most efforts to categorise dynamic elements in the landscape, these general categories of tree use are arbitrary, overlapping and often interchangeable. But, they are convenient and the specific uses are real and their interactions are important. They indicate areas of concern where careful design and
management procedures are necessary to avoid undue conflicts. Thus despite imperfections due to overlapping, this matrix offers a useful, if not exhaustive, framework for discussion and broad application.

The matrix is based on the following broad tree use categories.

<table>
<thead>
<tr>
<th>1 ENGINEERING</th>
<th>2 CLIMATIC</th>
<th>3 PRODUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 ARCHITECTURAL</td>
<td>5 RECREATION</td>
<td>6 ECOLOGICAL</td>
</tr>
</tbody>
</table>

The relationship between the prime objective (taken from the list of tree uses in 2.a) and the broad catagories are shown as follows:

- Compatible
- Incompatible
- No direct relationship

Sometimes a prime objective may be shown to be both compatible and incompatible to a broad catagory. This may result from variations in the interaction between the prime objective and the specific uses within each broad catagory, or may revolve around particular 'qualifying factors'. For example the prime objective of soil and water conservation can be either compatible or incompatible with Recreation due to the specific recreational use, that is active versus passive. Again atmospheric purification can be compatible or incompatible with ecological conservation - the removal of air pollutants may conserve downwind ecological habitats, but may destroy flora and fauna closer to the source. Therefore distance becomes a 'qualifying factor'.

Design, management and maintenance proce­dures are all assumed to be of a high standard in considering the interactions. For example wastewater disposal is compatible with soil and water conservation as it is assumed that sewerage levels are
carefully monitored to ensure no toxicity. (Efficient wastewater disposal recharges groundwater supplies and may reduce stream pollution).

Therefore the matrix cannot be used as a definitive statement on exact use interactions. It is presented to point out glaring inconsistencies in use and possible multiple use functions.
3.1 USE INTERACTION MATRICES

3.1.1 Soil and Water Conservation

Compatible: 1. atmospheric purification, noise abatement, wastewater disposal.
2. wind shelter, temperature reduction.
4. visual control
5. passive recreation
6. ecological conservation

Incompatible: 3. wood production
5. active recreation

3.1.1 Atmospheric Purification

Compatible: 1. soil and water conservation, noise abatement, wastewater disposal.
2. wind shelter, temperature reduction
4. visual control
5. passive and active recreation
6. ecological conservation

Incompatible: 6. ecological conservation
3. wood and food production
3.1.3. Noise Abatement

Compatible: 1. soil and water conservation
2. wind shelter, energy conservation
4. visual control
5. passive recreation

Incompatible: 3. wood production

3.1.4. Wastewater Disposal

Compatible: 1. soil and water conservation,
   atmospheric purification
2. wind shelter
3. wood production

Incompatible 3. food production
5. active and passive recreation
6. ecological conservation
3.1.5. Traffic Control

Compatible: 1. atmospheric purification, noise abatement.
2. wind shelter, sun and shade control
4. spatial modulation, visual control, structural co-ordination
5. passive and active recreation
6. ecological conservation

Incompatible: 3. wood and food production

3.1.6. Wind Shelter

Compatible: 1. soil and water conservation
2. energy conservation
3. food production
4. visual control
5. passive and active recreation
6. ecological conservation

Incompatible: 2. shade control
3. wood production
4. spatial definition
3.1.7. Sun and Shade Control

Compatible: 1. soil and water conservation, traffic control
2. energy conservation
3. food production
4. spatial modulation, structural co-ordination, visual control
5. passive and active recreation

Incompatible: 2. wind shelter
3. wood production

3.1.8. Temperature Reduction

Compatible 1. soil and water conservation, atmospheric purification.
2. shade control, energy conservation
3. wood and food production
4. spatial modulation
5. passive and active recreation
6. ecological conservation
3.1.9. Energy Conservation

Compatible: 2. wind shelter, sun and shade control, temperature reduction
4. spatial modulation, structural co-ordination, visual control
5. passive recreation

Incompatible: 3. wood production

3.1.10. Wood Production

Compatible: 1. wastewater disposal
4. spatial modulation
5. active recreation

Incompatible: 1. soil and water conservation
3. food production
4. visual control
5. passive recreation
6. ecological habitats
3.1.11 Food Production

Compatible: 2. wind shelter, sun and shade control
5. passive recreation
6. ecological conservation

Incompatible: 1. atmospheric purification, wastewater disposal, traffic control
3. wood production

3.1.12 Space Modulation

Compatible: 1. traffic control
2. sun and shade control, temperature reduction
4. structural co-ordination, visual control
5. passive and active recreation
6. ecological habitats

Incompatible: 1. wind shelter
### 3.1.13 Structural Co-ordination

Compatible: 2. wind shelter, shade control, energy conservation

4. spatial modulation, visual control

Incompatible: 3. wood production

### 3.1.14 Visual control

Compatible: 1. soil and water conservation, atmospheric purification, noise abatement, traffic control

2. wind shelter, sun and shade control

3. food production

4. spatial modulation, structural co-ordination

5. passive and active recreation

6. ecological conservation

Incompatible: 3. wood production
3.1.15 Passive Recreation

Compatible: 1. soil and water conservation, atmospheric purification, noise abatement, traffic control
2. wind shelter, shade control, temperature reduction, energy conservation
3. food production
4. spatial modulation, visual control
6. ecological conservation

Incompatible: 1. wastewater disposal
3. wood production
5. active recreation

3.1.16 Active Recreation

Compatible: 1. noise abatement, traffic control
2. wind shelter, shade control
3. food and wood production
4. spatial modulation, visual control

Incompatible: 1. soil and water conservation, waste water disposal
5. passive recreation
6. ecological habitats
3.1.17 Ecological Conservation

Compatible:
1. soil and water conservation, atmospheric purification, traffic control
2. wind shelter
4. spatial modulation, visual control
5. passive recreation

Incompatible:
1. wastewater disposal
3. food and wood production
5. active recreation
3.2 USE INTEGRATION GUIDELINES

To integrate the functional uses of trees into the whole urban landscape the prime uses for each zone may now be applied to the 'use interactions'. That is, the prime objectives for each zone are now studied to reveal their level of compatibility with each other. Once again this can only be considered within a general framework as the application of tree uses may apply to particular sub-zones of the urban landscape, that is, a particular site. Even so it is relevant to consider the important tree uses in each zone in terms of the interaction matrices. This will then aid in the development of a management plan, based on the inherent landscape features and the needs of the community.

The trees uses applied to the matrices are the ones identified as:

- Important
- Very Important
As the ultimate application depends directly on the site factors, such as climate, soils, available space etc, these zone/use guidelines must only be seen as showing a general pattern of integrated use, and the development of a methodological approach to urban forestry.

3.2.1 The Inner-City Zone

The important tree uses in this zone are:
to reduce the scale and co-ordinate dominant buildings; segregate and direct traffic flows through spatial modulation; and provide a more comfortable environment for pedestrians through amelioration of climatic extremes.

Generally these objectives can be incorporated in the central city with a minimum of conflict. Design conflicts to be aware of however, result from detailed considerations, not of principle. They generally involve the choice and placement of tree species for wind shelter. Shelter-belts are often inappropriate here as their low branch structure and straight rows reduce spatial modulation and serve to divide and further
compartmentalise this zone. Evergreen species also provide problems in winter with frosting and large shadow areas, conflicting with the need for sun. Shelter trees must therefore be used strategically to reduce extreme gusting near building corners, and alleyways. The seasonal micro-climatic variations must be carefully studied before choice of species and exact placement are decided.

The relationship of trees to the site, surrounding buildings and people is very much at a micro-scale. Trees will never become a dominant element in this landscape but must be seen to enhance and reinforce the existing man-made character, while acting as a human scale element in ameliorating and actively defining areas within this zone.

3.2.2. The Suburban Zone

The important tree uses identified in this zone are micro-climatic amelioration - shade, shelter and energy conservation; visual and physical control of traffic and its associ-
ated noise; conservation of soil and water regimes, particularly on hill slopes; the production of alternative food supplies; and providing a treed environment to co-ordinate existing built forms and create comfortable and safe areas for recreation.

Specific design conflicts to avoid involve the use of fleshy fruit producing trees along traffic routes and in parking areas, where damage may occur to cars and inconvenience to pedestrians and cyclists. This choice of species for the particular location is once again important.

The climatic functions of trees need careful consideration with respect to local site conditions to best incorporate shelter and sun in the winter, and shade and cool breezes in the hot summer months. This ideal situation provides reductions in the energy requirements for winter home heating and summer cooling. Careful detail to screening and views will also influence ultimate tree species and placement for climate control.
The emphasis here is to provide a safe and enjoyable people oriented living environment. As well as the uses of trees outlined at the micro-scale, large trees throughout a suburban zone provide a useful backdrop and unifying element within the individual identity displays of each property owner.

3.2.3 The Industrial Zone

Major tree uses reflect the need to reduce the physical and ecological harshness of the industrial zone. Atmospheric purification and noise abatement assume prime importance particularly on the large scale where tree belts can be used as noise barriers and pollution filters between industrial and suburban zones. Careful attention to prevailing winds and their velocity must be taken into account to ensure maximum filtration of pollutants.

Other tree uses relate directly to the visual elements within this zone. Screening unsightly spoil heaps and providing large trees to reduce the dominance of the large and generally bland industrial buildings. The extension of these tree functions to include places for workers to recreate would add to the general usefulness of factory sites.

There are no direct conflicts shown in incorporating these priority uses within the
industrial zones. Care must however be taken in selecting suitable hardy tree species to endure any difficult site features.

As in the inner-city zone trees will not dominate this zone. Their usefulness revolves around the need to ameliorate this zone to make it part of the urban 'living' environment.

3.2.4 The Arterial-route Zones

The use of trees within this zone naturally relates to the physical and visual control of traffic and its associated noise and pollution discharges; the amelioration of climatic extremes, especially glare and reflection for the safety of all travellers; and at the larger scale the provision of a spatial boundary to aid in identifying urban areas.

Once again the climatic factors need careful consideration, to provide shade and reduce glare in early mornings and late evenings, yet allow sun to penetrate in winter to avoid icing of roads. Strategic placement of trees to reduce wind gusts through cuttings and on overbridges will increase safety in fast speed multi-laned highways. The wind shelter/spatial modulation conflict is less of a problem here as the use of trees in spatial definition relates more to the macro-scale. Noise abatement and atmospheric purification can be directly accommodated in the same tree planting layout, as dense plantings of trees and understorey shrubs filter carbon monoxide and provide large reductions in noise levels when associated with mounding. The general aim of using trees along arterial routes is to provide the means for a safe, quick and efficient travel experience while
reducing interference with activities outside the route.

3.2.5 The Open Space Zone

A large number of important tree uses have been identified within the open-space zones which relate in particular to the macro-scale. Although tree uses within the open space itself are important, it is in providing an open space network throughout the city that trees can perform many more functions. The reduction of temperature extremes, soil and water conservation, ecological conservation, atmospheric purification, recreation and spatial definition all relate to tree uses at this larger scale.

Within the open space zone conflicts arise with the production of food, and wood in particular. Care must be taken to ensure that selective methods of felling are used to avoid disturbance to ecological habitats, soil conservation areas, and recreational areas. In instances where other functions are of prime importance wood production
must only be considered as part of a long term management strategy. Thus the production versus amelioration, recreation and conservation conflicts must be seen in relation to each site and the functions required of that site in relation to its surrounds. That is, as large open space zones may occur within other zones of the urban environment, the prime tree functions must be considered in relation to the uses outlined within that zone.

Other areas of concern within this zone relate to the conflicts between recreation activities. Careful design and control is necessary to avoid conflicts between active, noise generating recreation and the provision of areas for quieter more relaxing, nature related recreation.

Within the open-space zone major tree functions fall into two broad categories of compatibility. Passive recreation, soil and water conservation, ecological conservation, and food production, such as honey, may all be accommodated in a similar area.

On the other hand more active recreation and timber production are more naturally compatible. Trees for noise reduction and atmospheric purification could then provide the boundaries between the two broad use categories.

Depending on the size and other site features of our open space zones trees may provide a wide range of benefits to the urban dweller within that space; that is partaking in the open space environment, while also providing general community benefits on a larger scale through conservation and amelioration functions.

3.2.6. The Peri-urban Zone

A large number of potentially important tree uses have been identified in the urban fringe. This is in direct relationship to large areas of unused land available, due to the many and often conflicting land uses found here. The use of trees may relate, to the rural activities of the area - provision of shelter, food, wood products, and soil conservation, or to the suburban
activities - water catchment conservation, wastewater disposal, passive and active recreation. Uses which apply to the whole zone are spatial definition, structural co-ordination and ecological conservation.

Clearly all these uses cannot be accommodated within one area of this zone, as there are many incompatible functions. As in the open space zone dominant site features and relationships to outside activities are important. General conflicts occur within the same uses as discussed in the open space zone. However the emphasis and importance of many of these uses is heightened. Thus the degree of conflict will also increase.

Wood and food production take on far more importance in the peri-urban zone where large scale forests, orchards and tree crop farms become feasible and often desirable. However the necessity to conserve soil and water regimes, especially in urban water catchment areas becomes equally important.

SOIL CONSERVATION AND TIMBER POTENTIAL - CARE NEEDED TO AVOID CONFLICTS.
The potential to conserve and manage naturally forested areas for ecological conservation also becomes an important consideration. Lastly the pressures felt through increased urbanisation and the need for large outdoor recreation areas heighten the initial conflicts outlined.

Specific conflicts arise in soil and water conservation which is sensitive to more active uses; wastewater disposal which requires careful monitoring to avoid ecological and people conflicts; and large scale production activities which need more careful management close to urban centres to maintain other viable tree uses.

The peri-urban zone is often vast and may extend for many miles beyond the city boundary. The potential to accommodate the many tree functions outlined will depend on a careful appraisal of existing elements and the identification of related priority uses. Incorporation into a detailed 'green-belt' framework will aid in serving as many of the tree functions as possible, while retaining the existing important rural and urban based land uses.
3.3 URBAN FORESTRY PLANNING

3.3.1 A Procedural Method

The pitfall in any type of planning scheme is the failure to relate planning issues and activities discussed to practical and productive solutions. To enable the principles of urban forestry to easily slot into other planning schemes a complete survey of the urban landscape must be available in two main parts.

Firstly, a tree inventory is essential - we must know what we have got before we can plan for what we need. Ideally tree inventories should be in three sections.

(i) A record of the tree species, it's location, age, size, condition, present management, future needs, replacement date. Unlike buildings, trees need no only recognition and preservation, but renewal to maintain the continuity of use.

(ii) The environmental or site conditions where the tree is growing - soil conditions, land use, obstructions,
wind damage, flooding etc. The object of this part of the inventory is to determine what species match which local conditions.

(iii) The environmental functions or uses the tree(s) perform at the 'micro' and 'macro' scales is essential. A hierarchy of functions is necessary here to determine the most important uses. Only by identifying such functions can future management proposals be sure to maintain the 'multi-benefit' concept of the urban forest.

In the second part, possible areas for tree planting need to be assessed in terms of their functional potential/limitations, and site features/constraints. In terms of functional requirements land could be assessed in terms of its low fertility, erosion susceptibility, flooding problems, wind exposure etc. On the more positive side, areas suitable for ecological enhancement, recreational pursuits, and production purposes may also be identified. Site features need to be recorded also, particularly:

(i) Micro-climatic conditions – as these vary a great deal from urban area to area. Such things as sunlight/shade, forest pockets, rain shadows, temperature variation, salt and wind exposure should all be recorded here.

(ii) Public utilities and obstructions – overhead wires, underground sewers, buildings, footpaths and fences should be recorded to avoid future maintenance problems.

(iii) Street hierarchy to determine a streets potential in forming a possible urban 'green web'. Traffic routes can be identified as arterial routes, minor streets, pedestrian ways, cycle ways etc. Bus routes and stops are important items in this survey too.

(iv) Soil survey in detail to determine the type of soil, depth of topsoil, nature of sub-soil, fertility level, toxicity etc. Local soil conditions can vary a great deal and too often tree planting fails because of insufficient data and regard for soil conditions.
(v) Land use (present and proposed) and relationship to surrounding land, that is the urban zone.

Other site features and tree particulars may also be recorded, however this provides a minimum necessary to implement a 'multi-benefit' urban forestry program.

The information bases listed must be flexible to allow continual updating as the urban landscape evolves, site conditions change and new information becomes available on tree species and their functional suitability in the urban environment. There are many methods of recording such information with the aid of computers. For detailed information refer to Myers and McCurdy. From this recorded information, recommendations as to implementation and management procedures on publicly owned land can be determined by local authorities.

3.3.2. Communications

Urban forestry is a relatively new field, and good communications are essential to further its objectives. Good communications assist the flow of information from scientist to practitioner, practitioner to professional, and from professional to laymen.

Communication in urban forestry can be considered in two phases: communications among workers actively involved in urban forestry and related fields and communication between the professionals and the general public.

(i) Communications between professionals are often difficult to establish because of diverse training, interest and backgrounds associated with urban forestry. People directly involved include arborists, foresters, landscape architects, horticulturists, planners, soil scientists, hydrologists, entomologists, pathologists and nurserymen. Each can make an important contribution to the overall
knowledge and experience that must be shared. Those in one profession must have an appreciation of the work of those in others, to enable the integration of the entire field of knowledge.

(ii) The general public who often generate interest and support for many tree preservation orders and arbor day activities include some well-informed and motivated people who are concerned with the role of vegetation in their communities. They may however have little contact with the professional working in an urban forestry program and therefore not appreciate the many functional benefits that a tree planting program may offer.
As a large percentage of the potential urban forest is on private property there is a need to inform the public of these benefits. By encouraging interest in functional tree planting in private property the strain on local councils to maintain trees will be lessened. There is a great reservoir of interest in trees by the general public that remains untapped by the professionals involved in tree implementation. Such individual interest is important in turning good will into strong public support.

3.3.3. Research

Nearly all the potential tree uses outlined in Chapter 1 need further practical research. Much of the existing information is based on experiments carried out under laboratory conditions. In New Zealand we have our own pattern of urban ecology and environmental stresses. As yet many of these have not yet been identified or related to tree growth.

Areas of further research necessary to undertake a comprehensive urban forestry program are:

(i) The ecology of the urban landscape - identification of interrelationships and dominant species.

(ii) Detailed urban soil conditions and tolerances.

(iii) The type of pollution prevalent in New Zealand's cities and its effect on our native tree species.

(iv) The potential for forested areas to act as discharge sites for primary treated sewerage effluent.

(v) A study of the urban heat island and the potential of green ways to reduce excessive urban temperatures.

(vi) Investigation into the potential reduction in energy costs from effective tree placement in residential areas.

(vii) The design of alternative silvicultural techniques to effectively manage urban trees for timber and other related products.

(viii) Investigation into the potential economic returns from a functional tree management program.
3.3.4. Urban Forestry Management

Management really is the key to a successful urban forestry program. Unless trees are planted, maintained and removed according to an adopted plan the benefits that come from purposeful tree planting will not follow.

The urban forest requires three fundamental management operations: planting, maintenance and removal.

(i) Planting – for the urban forest to be immediately perceived and its benefits quickly felt, trees must be large and numerous enough to transform the character of our cities. In fact in urban situations trees are more healthy if grown close enough together to intermingle and create a continuous network of branches as they do in a forest.¹ (Open grown specimens are not common in nature and are likely to be more susceptible to injury and disease, since genetic evolution favours trees in close groups). Trees also adapt to the space limitations of cities much as they do in the forest by fitting their branch and root structure into available space.

Thus trees at the desired long term spacing with a 10 - 15 cm diameter trunk and five to seven metres tall
are ideal for immediate effects. Since we are limited by availability, and cost of such large specimens, alternative planting involves many more trees at closer spacing which are later thinned. Advantages of this method are a strong immediate visual impact, increased rates of vertical growth, more upright tree trunks with a higher branch structure, protection by mutual shading, and a viable wood product from early thinnings.

A more experimental planting technique available under a tree management program is the addition of new trees beneath an existing canopy of older trees. This method aids the transition from older unhealthy trees to young trees. This method could involve the use of a tree type that, in forest communities, would replace the older trees on the site by natural plant succession. The dominant, more shade tolerant species would grow up under the existing trees.

(ii) Maintenance - the kind of maintenance that a tree should receive depends on the location, species, age and function. The location is related to stress. Park trees growing in open grass will need less care than a tree growing in a paved traffic island. Similarly a tree species tolerant of pollution and drought will better survive conditions of severe stress in a traffic island. A city with mostly mature or long established trees may need more pruning and less watering than a city where the majority of trees are recently planted. Trees for shade will need a higher branch structure than ones for shelter so maintenance also relates directly to functional requirements.

In general basic tree care includes the following six maintenance categories listed for average city conditions in temperate climates:

(a) Watering - in some urban areas trees need to be watered during the first two years under dry
summer conditions up to twice a week. Watering is one of the most critical operations for urban tree health and survival especially in paved areas where most of the rain does not reach tree roots. Here watering can be better accomplished by incorporating watering holes in the pavement when planting the tree.

(b) Protection from encroachment - a significant number of trees could be saved by regular surveillance and alteration of harmful conditions. Common encroachments are - vehicles driving or parking above the tree root zone; wheel stops without enough clearance to protect tree trunks from bumpers; polluted water runoff; and vehicle access routes that damage and break off overhead branches.

(c) Damage repairs - if not properly trimmed and dressed, broken limbs and damaged trunks are common tree injuries that will allow noxious organisms to invade the heartwood.
(d) Feeding - although trees adapt in nature to a wide range of soil types, urban trees often need fertilizing to compensate for very low nutrients available to restricted roots, limited rain water infiltration, and lack of forest litter. The immediate need for fertilizing can be offset to a degree by including a large volume of good soil mixture around roots when trees are planted. Overfertilizing can be damaging to trees and once well established large trees are better off with little fertilizer.

(e) Pruning - trees should be pruned to preserve their health and appearance, to prevent damage from falling limbs and in the production of fruit and timber products. Presently pruning is done by removing the tops of crowns to keep the foliage in balance with a restricted root system. The reasons for
this improper pruning is based largely on the fear that tall trees have more chance of falling over onto houses and other property. This hypothesis is dubious, since a taller more open grown crown and a flexible trunk of a naturally adapted tree is better able to withstand strong winds. The conflict between trees and overhead utility lines is also a common reason for topping and pollarding. With the exception of trees with strong terminal branches (for example, *Quercus palustris*, Pin Oak) there are few circumstances where careful pruning will not resolve any conflict between branches and wires. Trees and utility lines can co-exist in harmony where there is a sympathetic handling of the pruning.

(f) Insect and disease control - the need to control insects and diseases may vary from treating trees once every three or four years, to making several applications in one
season. There are no totally pest free trees. Many insect and disease situation can be tolerated as a natural part of the urban forest environment. In unusual cases where severe defoliation or other serious damage is done to a tree, chemical controls are necessary in urban areas. However restraint is an essential requirement in countering the excessive use of environmental toxins as the side effects may be more harmful than the original disease.

(iii) Removal - includes utilization and disposal of materials from the urban forest. Materials to be removed are dead trees, hazardous trees, pruning and storm debris, stumps, leaves and fruits. However now the trend should be towards removal before a tree becomes dead or hazardous because of the insects it harbours and incidence of rotten wood. A further method of benefit to cities from tree management involves the exploitation of over-planting and later thinning to take advantage of the natural regeneration process. Based on traditional forestry methods, trees are grown in dense groves until they reach an age when they will benefit by a 'release cutting' or selective thinning. Removal of tree thinnings would then become a natural part of urban tree management.

FOOTNOTE:
1. Arnold P.12
URBAN TREE SELECTION
3.4 SUMMARY

Clearly the introduction of an urban forestry program requires close investigation into both societies needs and the ecological requirements of desirable tree species. City climate and other physical attributes of urban life may be controlled or ameliorated through this management. Or perhaps management will be dictated by the need to provide high-quality water for municipal supplies, or to dispose of wastewater and sludge in ways that groundwater supplies are not contaminated. One fact of urban forest management is clear - it must be 'multiple-use' or rather 'multiple-benefit' management.

However the application of urban forestry into the urban landscape must not be seen in grand isolation. Urban forestry is one aspect of urban planning and must therefore be seen as part of other planning and management proposals. Thus urban forestry should be incorporated into urban renewal schemes, motorway planning and park design.
The importance in selecting the most appropriate tree species to best fulfill the functions outlined in Chapter 1 cannot be over-emphasised. This choice will ultimately determine the success or otherwise of an urban forestry scheme. A compromise will ultimately have to be made as no tree species can perform all the possible functions equally well. Thus the identification and relationship between the various tree functions is once again important when selecting suitable tree species.

Understanding the physical constraints of the site is also important in the selection of suitable tree species. This is particularly relevant in harsh urban environments where abiotic stresses will reduce a tree's health, vigour and ultimate effectiveness as a functional design element.
In evaluating the cultural constraints of tree growth there are both regional and local conditions to be taken into account.

The regional constraints relate directly to the topography, climate and soil type. These factors determine the 'range' or natural geographical area where a particular tree species grows. Topography affects the range through altitude and the modification of climatic conditions. Climate determines the range of a particular species, principally through temperature and rainfall. Soil type is the immediate natural factor that affects a tree's distribution.

Knowledge of these regional factors and the resulting distribution of plant material within the natural landscape is thus important in tree selection. Where an indigenous species meets the functional requirements and can tolerate the urban environmental stresses, it is a logical choice.

In addition to being an established part of the ecological situation, native plant species provide a natural and distinctive 'visual flavour' to the landscape.

However, one cannot always predict how a tree will grow in an urban situation on the basis of its natural ecological occurrence. The native American Elm, Ulmus americana, planted extensively in cities has been almost completely eliminated in the northeast of the United States by disease. On the other hand, many exotic species, such as London Plane, Platanus x acerifolia and Ginkgo biloba, are extremely tolerant and thrive in city locations. Thus the local features are of great importance in determining a tree's urban suitability.

Local factors and their relationship determine the specific on site constraints that affect a tree's viability.
Local urban constraints which may influence a tree's survival are:

(i) Wind exposure - although overall wind velocity is reduced in urban environs, severe turbulence and gusting may occur. This may result in broken branches and in extreme cases wind-blown trees. The safety aspect of a tree's susceptibility to wind damage is especially important in urban areas.

(ii) Frost - local frost pockets may occur where cold air drainage is impeded. Frost tolerance may be an important factor in the choice of a suitable tree species.

(iii) Salt - seaside locations provide an unsuitable environment for many species susceptible to salt damage. Natural adaptation to such sites gives an indication of potentially suitable tree species.

(iv) Flooding - complete immersion of roots in water is damaging to many tree species. Tolerance to such conditions is important in flood plain areas.

(v) Soil Compaction - regular flooding, continual vehicle and pedestrian use compact urban soils reducing the amount of oxygen available to tree roots. This damage is often not recognizable because it leads to gradual deterioration of trees and is not distinguishable from many other stress factors.

(vi) Drought - large areas of impervious materials and increased water run-off reduces the amount of water available to tree roots. Water budget is thus an important factor in urban tree survival, especially in areas of compacted soils.

(vii) Artificial light - the incidence of security, motorway and street lighting effectively increases the photoperiodic length. These all-night light sources can weaken trees and make them more susceptible to air pollution and early frost.
(viii) Pollution - large amounts of particulate and gaseous pollutants, and ozone, are damaging to many tree species. The concentration and degree of exposure are directly related to a tree's health.

(ix) Shade - tall buildings reduce the amount of sunlight available to many areas of the city. Naturally shade tolerant species are more suited to such conditions.

(x) Toxic Wastes - chemical sprays and even dog urine are toxic in concentrated amounts. Extensive damage to small trees in particular is brought about by such wastes.

(xi) Pests and diseases - although many tree species are commonly considered to be 'hardy', they may still be attacked by pests and diseases. All plants have pests that live on them - it is only when their numbers become excessive that tree health is impaired.

In extreme cases trees may die from pests or diseases. Trees, like other living organisms, are particularly prone to attack in old age.

(xii) Physical abuse - damage to tree trunks and bark are common in urban areas. Where a tree is ring-barked it will usually not survive. Susceptibility to such physical damage is more critical in the early years of a tree's growth.

The third area of concern in selecting appropriate tree species relates to the placement of trees in the urban landscape, that is, the design. Many of the tree uses outlined in Chapter 1, such as, traffic control, noise abatement, energy conservation, architectural and visual enhancement, and recreation, all relate directly to the use of trees as a design element.

The selection criteria involved here must extend far beyond the identification of a genus and species, or familiarity with sources of supply.
The selection must revolve around a thorough knowledge of a tree's particular attributes. Such features include:

(i) Size - although divisions in size cannot be rigid, as local conditions cause differences in growth, groupings are convenient to meet spatial requirements.

(ii) Crown structure - although the form of some trees change over time, all trees have a characteristic shape under normal growing conditions. Understanding the subtleties of a tree's structure is one of the most important facets of using trees as an effective design element.

(iii) Density - variations in foliage densities result from the arrangement of the leaves on the branches and leaf size. These determine the amount of shade cast and the visual density of the tree. Contrary to common observation smaller leaved trees do not necessarily admit more light than larger leaved varieties.

(iv) Growth rate - trees generally grow more slowly in inner-city habitats compared with the rural or even suburban environment. The completion of the planting is only the beginning of the design process. Anticipating the rate of growth in a design is important in ensuring proper spacing of trees in relation to buildings and each other. Trees are living, growing objects that must be considered in time as well as space.

(v) Life expectancy - although there is merit in using fast growing species to obtain a more immediate visual effect, trees with a long life expectancy are invaluable in providing a constant element in an ever-changing urban landscape.

(vi) Nuisance factor - the tendency of many tree species to produce vigorous root growth - *Salix sp*; abnoxious fruits - *Ginkgo biloba*; or poisonous parts - *Sophora sp*; must be considered when choosing trees for urban areas.
(vii) Seasonal change - design for all seasons is important. Leaf loss in winter must be anticipated and designed for in a planting layout. In good design, seasonal changes enhance the quality and function of urban spaces.

(viii) Ecological association - it is wise to gain an understanding of the natural ecological relationships among trees. Trees associated in nature have an inexplicable rightness, and a more comfortable appearance when used together. The indiscriminant mixing of a large number of different tree species should thus be avoided in designing public open space.

While the use of exotic species is often justifiable and more appropriate in the urban landscape it necessitates a responsible approach to avoid any undesirable effects on ecology or the visual appearance of the landscape. The functional requirements, environmental tolerances, and species attributes must be carefully correlated before a choice is made. Thus the often emotive arguments between the use of native versus exotics, conifers versus broadleaf, or deciduous versus evergreen must be analysed and evaluated in terms of the most appropriate use/site/tree relationship.
In the following table tree species have been scored on the basis of their use, value, tolerance to environmental constraints, and particular attributes. The scores give an indication of a tree species general suitability for a particular use within a specific site.

The uses valued (based on Mackay 1980) are timber, energy, shelter, fruit and nuts, bee forage, soil and water conservation, and ecological conservation. The environmental tolerances considered are frost, wind, salt, poor soils (low fertility and pH extremes), compacted soils, drought, flooding, shade, artificial light and air pollution. The particular attributes identified are size, form, type (deciduous versus evergreen), and growth rate.
All scoring is related to tree species in their mature or semi-mature state. Where the relative value of a tree species for a particular use or environmental tolerance is unknown an asterix has been used to indicate this value. Where no information is available no score has been given. Size has been scored based on growth in good cultural conditions. The general form indicated is at a trees semi-mature state, as fully mature trees often lose their natural shape and become rather dishevelled. Finally only species greater than 5m (normal height) have been considered.
<table>
<thead>
<tr>
<th>Rating</th>
<th>Use Value</th>
<th>Tolerance</th>
<th>Growth</th>
<th>Size</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>-</td>
<td>-</td>
<td>D - Deciduous</td>
</tr>
<tr>
<td>0</td>
<td>No value</td>
<td>Intolerant</td>
<td>-</td>
<td>-</td>
<td>E - Evergreen</td>
</tr>
<tr>
<td>1</td>
<td>Low value</td>
<td>Slightly tolerant</td>
<td>0.5m/yr</td>
<td>5 - 15m</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Medium value</td>
<td>Moderately tolerant</td>
<td>0.5-1.5m/yr</td>
<td>15 - 25m</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>High value</td>
<td>Highly tolerant</td>
<td>1.0m/yr</td>
<td>25m</td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**

- **C** - Columnar
- **S** - Spreading
- **O** - Oval
- **R** - Rounded
- **P** - Pyramidal
<table>
<thead>
<tr>
<th>Tree</th>
<th>Species</th>
<th>Energy</th>
<th>Timber</th>
<th>Shelter</th>
<th>Nuts/Fruit</th>
<th>Forage</th>
<th>Soil Water</th>
<th>Conservation</th>
<th>Ecology</th>
<th>Frost</th>
<th>Drought</th>
<th>Wind</th>
<th>Flooding</th>
<th>Salt</th>
<th>Poor Soils</th>
<th>Compact Soils</th>
<th>Pollution</th>
<th>Shade</th>
<th>Artificial</th>
<th>Light</th>
<th>Growth</th>
<th>Size</th>
<th>Form</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies</td>
<td>alba</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td>10</td>
<td>13</td>
<td>1</td>
<td>10</td>
<td>13</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td></td>
<td>1</td>
<td>3</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>balsamea</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>*</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td></td>
<td>2</td>
<td>3</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>concolor</td>
<td>1</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td></td>
<td>31</td>
<td>*</td>
<td>*</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>**</td>
<td>*</td>
<td>0</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td></td>
<td>3</td>
<td>1</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>grandis</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
<td>21</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>**</td>
<td>*</td>
<td>0</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td></td>
<td>2</td>
<td>3</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>pinsapo</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td></td>
<td>32</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>**</td>
<td>*</td>
<td>0</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td></td>
<td>1</td>
<td>2</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td>Acacia</td>
<td>baileyana</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td>23</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>**</td>
<td></td>
<td>3</td>
<td>1</td>
<td>S</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>dealbata</td>
<td>*</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td>22</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>1</td>
<td>2</td>
<td>S</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>decurrens</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td>22</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>2</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>galpinia</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>22</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>2</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>giraffae</td>
<td>2</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td></td>
<td>23</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>2</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>karroo</td>
<td>*</td>
<td>2</td>
<td>*</td>
<td>2</td>
<td></td>
<td>13</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>longifolia</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>2</td>
<td></td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>melanoxylox</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
<td>22</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3</td>
<td>1</td>
<td>S</td>
<td>E</td>
</tr>
<tr>
<td>Acer</td>
<td>campestr</td>
<td>*</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td>*</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>3</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>*</td>
<td>*</td>
<td></td>
<td>1</td>
<td>3</td>
<td>S</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>negundo</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td>13</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
<td>O</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>pseudoplatanus</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>32</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>1</td>
<td>3</td>
<td>R</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>rubrum</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td></td>
<td>11</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>1</td>
<td>3</td>
<td>O</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>saccharinarum</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td></td>
<td>21</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>1</td>
<td>3</td>
<td>O</td>
<td>D</td>
</tr>
<tr>
<td>Species</td>
<td>Species Name</td>
<td>Timber</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nut/Fruit</td>
<td>Bee Forage</td>
<td>Ecological Conservation</td>
<td>Soil/Water Conservation</td>
<td>Frost</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compaction Soils</td>
<td>Pollution</td>
<td>Shade</td>
<td>Light</td>
<td>Artificial</td>
<td>Size</td>
<td>Form</td>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>-----------</td>
<td>------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>-----</td>
<td>------------</td>
<td>------------------</td>
<td>-----------</td>
<td>-------</td>
<td>-------</td>
<td>------------</td>
<td>-----</td>
<td>------</td>
<td>------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acer</td>
<td>A. platanoides</td>
<td>1 * 2 0 2</td>
<td></td>
<td></td>
<td>3</td>
<td>3 2 1 0 2</td>
<td>3 1 0 0 1 3</td>
<td>2 3 3 1 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. saccharum</td>
<td>3 * 1 * 1</td>
<td></td>
<td></td>
<td>3</td>
<td>3 1 0 0 3</td>
<td>1 3 3 1 3 1</td>
<td>1 1 3 0 D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aesculus</td>
<td>A. carnea</td>
<td>1 1 0 2</td>
<td></td>
<td></td>
<td>3</td>
<td>3 1 1 3</td>
<td>1 * 2</td>
<td>1 3 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. glabra</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>3 1 1 3</td>
<td>* * *</td>
<td>1 1 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. hippocastanum</td>
<td>1 1 0 2</td>
<td></td>
<td></td>
<td>3</td>
<td>3 1 1 3</td>
<td>3 1 0 3 1 3</td>
<td>3 1 0 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agathis</td>
<td>australis</td>
<td>3</td>
<td></td>
<td></td>
<td>1 2 1 0 1</td>
<td>1 2 1 0</td>
<td>1 2 1 0</td>
<td>1 3 3 0 E</td>
<td>1 3 E D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Ailanthus</td>
<td>altissima</td>
<td>2 1 1 0 3</td>
<td></td>
<td></td>
<td>3</td>
<td>2 2 3 3</td>
<td>3 2 *</td>
<td>3 2 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albizzia</td>
<td>A. julibrissin</td>
<td>1 1</td>
<td>* 1</td>
<td></td>
<td>2 2</td>
<td>2 2</td>
<td>2 2</td>
<td>2 2</td>
<td>3 3</td>
<td>3 3</td>
<td>3 2</td>
<td>P D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alectryon</td>
<td>excelsus</td>
<td>2</td>
<td></td>
<td></td>
<td>1 0 2 0 0</td>
<td>1 0 2 0</td>
<td>1 0 2 0</td>
<td>2 2 R A</td>
<td>3 2 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Alnus</td>
<td>cordata</td>
<td>* 2 2</td>
<td></td>
<td></td>
<td>1 2 2</td>
<td>* 2 2 2</td>
<td>3 * 3 2</td>
<td>4 2 B D</td>
<td>3 2 P D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. glutinosa</td>
<td>2 2 2</td>
<td></td>
<td></td>
<td>2 2 2</td>
<td>3 2 3</td>
<td>2 2 2</td>
<td>2 2 2</td>
<td>3 2 P D</td>
<td>3 2 P D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>A. incana</td>
<td>* 2 2</td>
<td></td>
<td></td>
<td>2 2 2</td>
<td>3 2 2</td>
<td>* 1</td>
<td>1 0</td>
<td>3 2</td>
<td>3 3</td>
<td>P D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. rubra</td>
<td>2 3 1</td>
<td></td>
<td></td>
<td>1 1 1</td>
<td>2 3 2</td>
<td>3 3</td>
<td>3 3</td>
<td>3 3</td>
<td>P D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

173
<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Energy</th>
<th>Shelter</th>
<th>Nuts/fruit</th>
<th>Bee Forage</th>
<th>Soil/Water Conservation</th>
<th>Ecological Conservation</th>
<th>Pest</th>
<th>Drought</th>
<th>Frost</th>
<th>Flooding</th>
<th>Salt</th>
<th>Poor Soils</th>
<th>Compact Soils</th>
<th>Pollution</th>
<th>Shade</th>
<th>Light</th>
<th>Artificial</th>
<th>Size</th>
<th>Form</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Araucaria</td>
<td>araucana</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
<td>*</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arbutus</td>
<td>unedo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td>*</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>S</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aristotelia</td>
<td>serrata</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>S</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beilschmiedia</td>
<td>tarairi</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. tawa</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Betula</td>
<td>lutea</td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>R</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. nigra</td>
<td></td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. papyrifera</td>
<td></td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. populifolia</td>
<td></td>
<td>1</td>
<td>1</td>
<td>*</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. pubescens</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>*</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>*</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. verrucosa (pendula)</td>
<td></td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>P</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caragana</td>
<td>arborescens</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>*</td>
<td>**</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>R</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpinus</td>
<td>betulus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. caroliniana</td>
<td></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>*</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>R</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>Species</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nuts/Fruit</td>
<td>Bee Forage</td>
<td>Soil/Water Conservation</td>
<td>Ecological</td>
<td>First</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compact Soils</td>
<td>Pollution</td>
<td>Shade</td>
<td>Light</td>
<td>Artificial</td>
<td>Growth</td>
<td>Size</td>
<td>Form</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>-------------------------</td>
<td>------------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td>------------</td>
<td>--------------</td>
<td>-----------</td>
<td>-------</td>
<td>-------</td>
<td>-----------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Carpodetus</td>
<td>serratus</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>22132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carya</td>
<td>illinoensis</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>21110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. ovata</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>2111022</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Castanea</td>
<td>C. sativa</td>
<td>2</td>
<td>1</td>
<td>121</td>
<td>1</td>
<td>221122</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casuarina</td>
<td>C. glauca</td>
<td>3</td>
<td>2</td>
<td>212</td>
<td>1</td>
<td>1233323</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. cunninghamii</td>
<td>1</td>
<td>2</td>
<td>3111</td>
<td>1</td>
<td>2231323</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catalpa</td>
<td>bignoniodes</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>31110</td>
<td>2</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. speciosa</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>31101</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cedrus</td>
<td>atlantica</td>
<td>2</td>
<td>1</td>
<td>212</td>
<td></td>
<td>331032300</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. deodara</td>
<td>2</td>
<td>1</td>
<td>212</td>
<td></td>
<td>33102201</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Celtis</td>
<td>occidentalis</td>
<td>2</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>321123</td>
<td>*</td>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cercis</td>
<td>siliguastum</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>Species</td>
<td>Energy 1</td>
<td>Energy 2</td>
<td>Energy 3</td>
<td>Shelter</td>
<td>Nuts/fruit</td>
<td>Bee Forage</td>
<td>Ecological Conservation</td>
<td>Fire</td>
<td>Frost</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Compact Soils</td>
<td>Pollution</td>
<td>Shade</td>
<td>Artificial Light</td>
<td>Growth</td>
<td>Size</td>
<td>Form</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>--------------------</td>
<td>------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td>----------------</td>
<td>-----------</td>
<td>-------</td>
<td>------------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Chamaecyparis</td>
<td>lawsoniana</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td>13</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td>Coprosma</td>
<td>robusta</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>E</td>
<td>21</td>
<td>S</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>C. repens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cordyline</td>
<td>australis</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>E</td>
<td>2</td>
<td>O</td>
<td>E</td>
</tr>
<tr>
<td>Cornus</td>
<td>florida</td>
<td>1</td>
<td>1</td>
<td></td>
<td>*</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. nuttallii</td>
<td>1</td>
<td>1</td>
<td></td>
<td>*</td>
<td>1</td>
<td></td>
<td></td>
<td>*</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corylus</td>
<td>columna</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>*</td>
<td>0</td>
<td>2</td>
<td></td>
<td>PD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corynocarpus</td>
<td>laevigata</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crataegus</td>
<td>monogyna</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. orientalis</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td></td>
<td>*</td>
<td>3</td>
<td></td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. oxyacantha</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptomeria</td>
<td>japonica</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Name</td>
<td>Species</td>
<td>Growth</td>
<td>Size</td>
<td>Form</td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cupressus</td>
<td>arizonica</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. lusitanica</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. macrocarpa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. sempervirens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cupressocyparis</td>
<td>leylandii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyathea</td>
<td>dealbata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>medullans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>smithii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytisus</td>
<td>palmensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dacrydium</td>
<td>cypressinum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dicksonia</td>
<td>fibrosa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diospyros</td>
<td>virginiana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dodonea</td>
<td>viscosa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Common Name</td>
<td>Timber</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nits/Fruit</td>
<td>Bee Forge</td>
<td>Broadleaved</td>
<td>Conservation</td>
<td>Soil/Water Conservation</td>
<td>Frost</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compact Soils</td>
<td>Shade</td>
<td>Artificial</td>
<td>Natural</td>
<td>Growth</td>
<td>Size</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>-----------</td>
<td>-------------</td>
<td>--------------</td>
<td>--------------------------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td>-----------</td>
<td>---------------</td>
<td>-------</td>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>Dovyalis</td>
<td>caffra</td>
<td>1*2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysoxylum</td>
<td>spectabile</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eleagnus</td>
<td>angustifolia</td>
<td>112</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eleocarpus</td>
<td>dentatus</td>
<td>121</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eucalyptus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. botryoides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. camaldulensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. cladoclyx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. delegatensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. gunnii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. obliqua</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. regnans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. sideroxylon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. saligna</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fagus</td>
<td>grandifolia</td>
<td>2111</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sylvatica</td>
<td>2111</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Timber</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nuts/ Fruit</td>
<td>Bee Forage</td>
<td>Ecological Conservation</td>
<td>Soil/Water Conservation</td>
<td>Frost</td>
<td>Frost</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compaction Soils</td>
<td>Pollution</td>
<td>Shade</td>
<td>Light</td>
<td>Artificial Growth</td>
<td>Size</td>
<td>Form</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>--------------------------</td>
<td>----------------------------</td>
<td>-------</td>
<td>-------</td>
<td>----------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td>------------</td>
<td>------------------</td>
<td>-----------</td>
<td>-------</td>
<td>-------</td>
<td>----------------------------------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Fraxinus americana</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
<td>13 R D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. excelsior</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
<td>13 R D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. ornus</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>11 S D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. pennsylvanica</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
<td>12 O D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuchsia excorticata</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
<td>11 S D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gikgo biloba</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td>12 S D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gleditsia G. triacanthos</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>12 S D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Griselinia littoralis</td>
<td>*</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>11 R E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoheria H. populnea</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>21 S E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. sexstylosa</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td>21 S E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ilex decidua</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
<td>11 S D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. aquifolium</td>
<td>**</td>
<td></td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>11 P E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juglans J. nigra</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
<td>13 R D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>J. regia</td>
<td>J. communis</td>
<td>J. virginiana</td>
<td>Knightia excelsa</td>
<td>Larix decidua</td>
<td>L. laricina</td>
<td>L. occidentalis</td>
<td>Leptospermum ericoides</td>
<td>Libocedrus bidwillii</td>
<td>L. decurrens</td>
<td>Ligusytum lucidum</td>
<td>Liquidambar styraciflua</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>----------</td>
<td>-------------</td>
<td>---------------</td>
<td>------------------</td>
<td>---------------</td>
<td>-------------</td>
<td>------------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ecological</strong></td>
<td>2</td>
<td>* 1</td>
<td>* 1</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conservation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frost</strong></td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drought</strong></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wind</strong></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Flooding</strong></td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Salt</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Poor Soils</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compact Soils</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pollution</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shade</strong></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Artificial</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Growth</strong></td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Form</strong></td>
<td>R</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

180
<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Energy</th>
<th>Shelter</th>
<th>Nuts/fruit</th>
<th>Bee Forage</th>
<th>Ecological Conservation</th>
<th>First Flowers</th>
<th>Drought</th>
<th>Wind</th>
<th>Flooding</th>
<th>Salt</th>
<th>Poor Soils</th>
<th>Compact Soils</th>
<th>Pollution</th>
<th>Shade</th>
<th>Artificial Light</th>
<th>Size</th>
<th>Form</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liriodendron tulipifera</td>
<td>2 1 2 1 1 3 1 1 0 1</td>
<td>0 1 0 0 2 3</td>
<td>P D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnolia grandiflora</td>
<td>2 1</td>
<td>0</td>
<td>3 1 3 P E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. x soulangiana</td>
<td>3 2</td>
<td>2 2 1</td>
<td>2 1 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malus sylvestris</td>
<td>2 1</td>
<td>0</td>
<td>3 3 0 2 1 R D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melicytus ramiflorus</td>
<td>1 1</td>
<td>2 2 1 2 1 3</td>
<td>S E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metasequoia glyptostroboides</td>
<td>3 0 1 2</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metrosideros excelsa</td>
<td>* 2 1 3 3 1 3 3 3 3 1 2 2 2 S E</td>
<td>1 2 S E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. umbellata</td>
<td>1 1</td>
<td>1 3 2 2 2 1 2</td>
<td>1 2 S E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morus alba</td>
<td>1 1</td>
<td>1 3 2 1 2 3 2 1 R D</td>
<td>1 2 1 S D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. nigra</td>
<td>* 2</td>
<td>1 3 2 1 2 3 2 1 S E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myoporum laetom</td>
<td>1 1</td>
<td>2 2 0 2 3</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myrsine australis</td>
<td>3 3 2 2 3</td>
<td>*</td>
<td>2 1 S E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Timber</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nuts/fruit</td>
<td>Bee forage</td>
<td>Ecological Conservation</td>
<td>Frost</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compaction</td>
<td>Pollution</td>
<td>Shade</td>
<td>Artificial Light</td>
<td>Growth</td>
<td>Size</td>
<td>Form</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>-------------------------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td>------------</td>
<td>------------</td>
<td>-----------</td>
<td>-------</td>
<td>-------------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Meryta sinclairii</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>1 0 2 3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>RE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nothofagus antarctica</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* * *</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>**</td>
<td>2</td>
<td>1 3</td>
<td>3 2 1</td>
<td>3</td>
<td>1</td>
<td>SE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. dombeyi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* * *</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>**</td>
<td>1</td>
<td>1 2</td>
<td>1 2 1</td>
<td>1</td>
<td>1</td>
<td>OE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. fusca</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>2 2 1</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1 3</td>
<td>3 2 1</td>
<td>3</td>
<td>1</td>
<td>OE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. menziesii</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>2 2 1</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1 3</td>
<td>3 2 1</td>
<td>3</td>
<td>1</td>
<td>OE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. solandri</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>3 2 1</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1 3</td>
<td>3 2 1</td>
<td>3</td>
<td>1</td>
<td>OE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. solandri var cliffortiodes</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>3 2 1</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1 3</td>
<td>3 2 1</td>
<td>3</td>
<td>1</td>
<td>OE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nyssa N. sylvatica</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>* 2 2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1 3</td>
<td>3 2 1</td>
<td>3</td>
<td>1</td>
<td>OD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ostrya virginiana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 1 3 1 1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1 1</td>
<td>2</td>
<td>1 1</td>
<td>1 1 1</td>
<td>1</td>
<td>1</td>
<td>RD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picea abies</td>
<td>2</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>0 1 0 2 1 0 1 1 1 1</td>
<td>1</td>
<td>3 1 1 1 1 0 2 2</td>
<td>2 2</td>
<td>PE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. pungens var. glauca</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1 1 0 2 1 0 2 2</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1 2</td>
<td>1</td>
<td>2 1 3</td>
<td>2 1 3 2 1 0 2</td>
<td>2 3</td>
<td>1</td>
<td>PE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. rubens</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1 1 0 2 1 0 2 2</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1 2</td>
<td>1</td>
<td>2 1 3</td>
<td>2 1 3 2 1 0 2</td>
<td>2 3</td>
<td>1</td>
<td>PE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. sitchensis</td>
<td>2</td>
<td>2</td>
<td>**</td>
<td>3</td>
<td>1 1 2 1 0 0 2</td>
<td>2</td>
<td>2 1</td>
<td>1</td>
<td>1 2</td>
<td>1</td>
<td>2 1 3</td>
<td>2 1 3 2 1 0 2</td>
<td>2 3</td>
<td>1</td>
<td>PE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinus canariensis</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>2 3 2 2 1 0</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3 3</td>
<td>3 3 3</td>
<td>3</td>
<td>3</td>
<td>RE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree Type</td>
<td>Common Name</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nuts/Fruit</td>
<td>Bee Forage</td>
<td>Soil/Water Conservation</td>
<td>Ecological Considerations</td>
<td>Proct Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compacts</td>
<td>Pollution</td>
<td>Shade</td>
<td>Artificial</td>
<td>Height</td>
<td>Size</td>
<td>Form</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>------------------------</td>
<td>--------------------------</td>
<td>---------------</td>
<td>------</td>
<td>---------</td>
<td>------</td>
<td>------------</td>
<td>--------</td>
<td>----------</td>
<td>-------</td>
<td>-----------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Pinus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. cembra</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td>1</td>
<td>2</td>
<td>P</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. cembroides</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2*</td>
<td>1</td>
<td>P</td>
<td>E</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. contorta</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
<td>S</td>
<td>E</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. monticola</td>
<td></td>
<td>2</td>
<td>1*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
<td>C</td>
<td>E</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. mugo</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3*1</td>
<td>3</td>
<td>S</td>
<td>E</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. nigra</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2*</td>
<td></td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>E</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. palustris</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3*</td>
<td></td>
<td>0</td>
<td>0</td>
<td>E</td>
<td></td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. pinaster</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td></td>
<td>1</td>
<td>1</td>
<td>E</td>
<td></td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. pinea</td>
<td></td>
<td>1</td>
<td>2*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1*</td>
<td></td>
<td>2</td>
<td>2</td>
<td>E</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. ponderosa</td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2*</td>
<td></td>
<td>1</td>
<td>1</td>
<td>E</td>
<td></td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. radiata</td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2*</td>
<td></td>
<td>2</td>
<td>0</td>
<td>E</td>
<td></td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. rigida</td>
<td></td>
<td>1*</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2*</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2*</td>
<td></td>
<td>1</td>
<td>1</td>
<td>E</td>
<td></td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. sylvestris</td>
<td></td>
<td>*</td>
<td>2</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2*</td>
<td></td>
<td>2</td>
<td>2</td>
<td>S</td>
<td>E</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittosporum</td>
<td>eugeniodes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1*</td>
<td></td>
<td>1</td>
<td>1</td>
<td>E</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. tenuifolium</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2*</td>
<td></td>
<td>1</td>
<td>1</td>
<td>E</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plagianthus</td>
<td>betulinus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platanus</td>
<td>acerifolia</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3*</td>
<td></td>
<td>3</td>
<td>0</td>
<td>S</td>
<td>D</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

183
<table>
<thead>
<tr>
<th>genus</th>
<th>species</th>
<th>energy</th>
<th>shelter</th>
<th>nuts/fruit</th>
<th>timber</th>
<th>bee forage</th>
<th>root</th>
<th>water conservation</th>
<th>soil/water conservation</th>
<th>drought</th>
<th>wind</th>
<th>flooding</th>
<th>salt</th>
<th>compact soils</th>
<th>pollution</th>
<th>shade</th>
<th>growth</th>
<th>size</th>
<th>form</th>
<th>type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platanus</td>
<td>P. occidentalis</td>
<td>2 1 1</td>
<td>2 1</td>
<td>3 2 3</td>
<td>2 1 2 1</td>
<td>3 2 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 3 2</td>
<td>1 3</td>
<td>3</td>
<td>S D</td>
</tr>
<tr>
<td></td>
<td>P. orientalis</td>
<td>1 1 1</td>
<td>2 1</td>
<td>3 2 3 *</td>
<td>2 1 3 2</td>
<td>3 2 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R D</td>
</tr>
<tr>
<td>Podocarpus</td>
<td>dacrydiodes</td>
<td>3 1 1 1</td>
<td>3 1 0 1 1</td>
<td>*</td>
<td>2</td>
<td>1 2 3 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 3 2</td>
<td>1 3</td>
<td>3</td>
<td>P E</td>
</tr>
<tr>
<td></td>
<td>P. ferrugineus</td>
<td>2 1 1 1</td>
<td>3 1 1 1</td>
<td>3 2 2 2</td>
<td>1</td>
<td>1 2 3 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R E</td>
</tr>
<tr>
<td></td>
<td>P. hallii</td>
<td>2 1 2 1</td>
<td>3 2 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1 2 3 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>S E</td>
</tr>
<tr>
<td></td>
<td>P. totara</td>
<td>3 1 2 1</td>
<td>3 2 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1 2 3 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R E</td>
</tr>
<tr>
<td>Populus</td>
<td>alba</td>
<td>* * 2</td>
<td>2 3</td>
<td>* 2 1 3 2</td>
<td>0</td>
<td>2 3 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R D</td>
</tr>
<tr>
<td></td>
<td>P. canascens</td>
<td>2 2 *</td>
<td>2 3</td>
<td>* 2 1 3 2</td>
<td>0</td>
<td>2 3 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R D</td>
</tr>
<tr>
<td></td>
<td>P. deltoides cv. virginiana</td>
<td>2 2 *</td>
<td>2 3</td>
<td>* 2 1 3 2</td>
<td>0</td>
<td>2 3 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R D</td>
</tr>
<tr>
<td></td>
<td>nigra</td>
<td>1 2 1 2</td>
<td>2 3</td>
<td>1 2 3 2</td>
<td>1</td>
<td>2 3 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>R D</td>
</tr>
<tr>
<td></td>
<td>P. nigra var. italicca</td>
<td>0 2 2 1</td>
<td>2 3</td>
<td>1 2 3 2</td>
<td>1</td>
<td>2 3 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>C D</td>
</tr>
<tr>
<td></td>
<td>P. tremula</td>
<td>* * 2</td>
<td>*</td>
<td>3 1 3</td>
<td>* 2</td>
<td>0 2 3</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>O D</td>
</tr>
<tr>
<td></td>
<td>P. tremuloides</td>
<td>1 * 2</td>
<td>*</td>
<td>3 1 3 1</td>
<td>* 2</td>
<td>0 2 3</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>O D</td>
</tr>
<tr>
<td></td>
<td>P. trichocarpa</td>
<td>* * 2</td>
<td>*</td>
<td>3 1 3 1</td>
<td>* 2</td>
<td>0 2 3</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>P D</td>
</tr>
<tr>
<td>Prunus</td>
<td>amygdalus</td>
<td>1 1 0 3</td>
<td>3 0</td>
<td>2 *</td>
<td>1</td>
<td>2 3</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>C D</td>
</tr>
<tr>
<td></td>
<td>P. avium</td>
<td>1 1 2 *</td>
<td>1 3</td>
<td>*</td>
<td>2 2 3</td>
<td>3 1 2</td>
<td>1 2</td>
<td>3 2 1 2</td>
<td>1 2 3 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 2</td>
<td>3 2</td>
<td>3 2</td>
<td>2 3</td>
<td>3</td>
<td>D P</td>
</tr>
<tr>
<td>Tree</td>
<td>Species</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nuts/Fruit</td>
<td>Bee Forage</td>
<td>Conservation</td>
<td>Ecological</td>
<td>First</td>
<td>Drought</td>
<td>Wind</td>
<td>Flooding</td>
<td>Poor Soils</td>
<td>Compact Soils</td>
<td>Pollution</td>
<td>Shade</td>
<td>Artificial</td>
<td>Growth</td>
<td>Size</td>
<td>Form</td>
<td>Type</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>--------------</td>
<td>------------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>------------</td>
<td>---------------</td>
<td>-----------</td>
<td>-------</td>
<td>------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Prunus</td>
<td>P. laurocerasus</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.5</td>
<td>S</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>P. stenoptera</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>O</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>Pseudopanax</td>
<td>arboreus (Neopanax)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P. crassifolius</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudotsuga</td>
<td>menziesii</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>P</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Pyrus</td>
<td>calleryana</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>D</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P. communis</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>D</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Quercus</td>
<td>alba</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>R</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. borealis (rubra)</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>R</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. cerris</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>R</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. ilex</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>R</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. imbricaria</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>R</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. nigra</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>R</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. palustris</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>R</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. phellos</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>R</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q. robur</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>R</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Taxon</td>
<td>timber</td>
<td>energy</td>
<td>shelter</td>
<td>nuts/fruit</td>
<td>bee forage</td>
<td>soil/water</td>
<td>conservation</td>
<td>drought</td>
<td>wind</td>
<td>flooding</td>
<td>salt</td>
<td>poor soils</td>
<td>pollution</td>
<td>compact soils</td>
<td>shade</td>
<td>artificial light</td>
<td>growth</td>
<td>size</td>
<td>form</td>
<td>type</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>--------------</td>
<td>----------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td>------------</td>
<td>-----------</td>
<td>----------------</td>
<td>-------</td>
<td>----------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Sequoiadendron giganteum</td>
<td>2</td>
<td>*</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Sophora japonica</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. microphylla</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>S</td>
<td>S</td>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. tetraperta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorbus aria</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. aucuparia</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. intermedia</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamarix T. gallica</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>0</td>
<td>*</td>
<td>3</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxodium distichum</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>*</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxus baccata</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>2</td>
<td>*</td>
<td></td>
<td>0</td>
<td>0</td>
<td>*</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thuja T. occidentalis</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>1</td>
<td></td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. plicata</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>*</td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilia americana</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Common Name</td>
<td>Timber</td>
<td>Energy</td>
<td>Shelter</td>
<td>Nuts/Fruit</td>
<td>Bee forage</td>
<td>Conservation</td>
<td>Soil/Water Conservation</td>
<td>Ecological Conservation</td>
<td>First</td>
<td>Drought</td>
<td>Mind</td>
<td>Flooding</td>
<td>Salt</td>
<td>Poor Soils</td>
<td>Compact Soils</td>
<td>Pollution</td>
<td>Shade</td>
<td>Artificial</td>
<td>Growth</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
<td>-----------</td>
<td>------------</td>
<td>-------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>----------</td>
<td>-----</td>
<td>------------</td>
<td>---------------</td>
<td>----------</td>
<td>-------</td>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>Tilia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. cordata</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>*</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>P</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. europaea</td>
<td></td>
<td>2</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. platophylllos</td>
<td></td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>*</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tsuga</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>canadensis</td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. heterophylllla</td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>*</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulmus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>alata</td>
<td></td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>RD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U. americana</td>
<td></td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>RD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U. glabra (montana)</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>*</td>
<td>23</td>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U. procera (campestre)</td>
<td></td>
<td>2</td>
<td>1</td>
<td>*</td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>23</td>
<td>RD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lucens</td>
<td></td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weinmannia</td>
<td></td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>12</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>racemosa</td>
<td></td>
<td>1</td>
<td>*</td>
<td>1</td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>12</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

188
REFERENCES
TEXT REFERENCES:


CHRISTCHURCH CITY COUNCIL Landscaping requirements. Planning information booklet No. 5. 24p.


MANNING O. 1979 Designing for nature in cities p.3-36 in Laurie I.C. op cit.


PALMERSTON NORTH CITY CORPORATION. *Trees: their use, selection and preservation,* unpublished pamphlet 2p.


RATCLIFF P. 1975. Wood disposal or wood harvesting. *International Shade Tree Conference* p. 79-80


SPECIES REFERENCES:


