Key Factors in Site Selection

INTRODUCTION: Selecting a Site

When selecting a site for planting of natives, including for the option of establishing a productive native forest, several factors must be considered. These include topographical features of the site, soil type, climatic conditions, pre-plant vegetation cover, and various other miscellaneous factors. These site factors are set out in Figure 1 where they are grouped according to their importance and ease of modification.

The failure of many planted native stands in the past is often attributed to the poor siting of stands where species were not matched to appropriate sites. There are many site specific reasons that can contribute to the failure of planted natives such as severe exposure, highly competitive exotic vegetation and extremely poor soil conditions. Any one of these site specific factors can be sufficient to cause poor performance and high mortality of planted seedlings. Often natives are planted on the worst sites at the back of a property with poor access where they receive little after-planting care. The best sites are invariably allocated to pasture and pines.

Specific aspects of each of the factors (topography, soil, climate, vegetation) are discussed in greater detail in relation to establishing planted stands of native trees where there is a long-term option of timber production. Figure 2 provides a summary of these factors to be considered when selecting a site for planting natives. Many of these environmental factors discussed here complement physiological factors of trees and environment covered in Technical Article No. 4.1 in this Handbook.

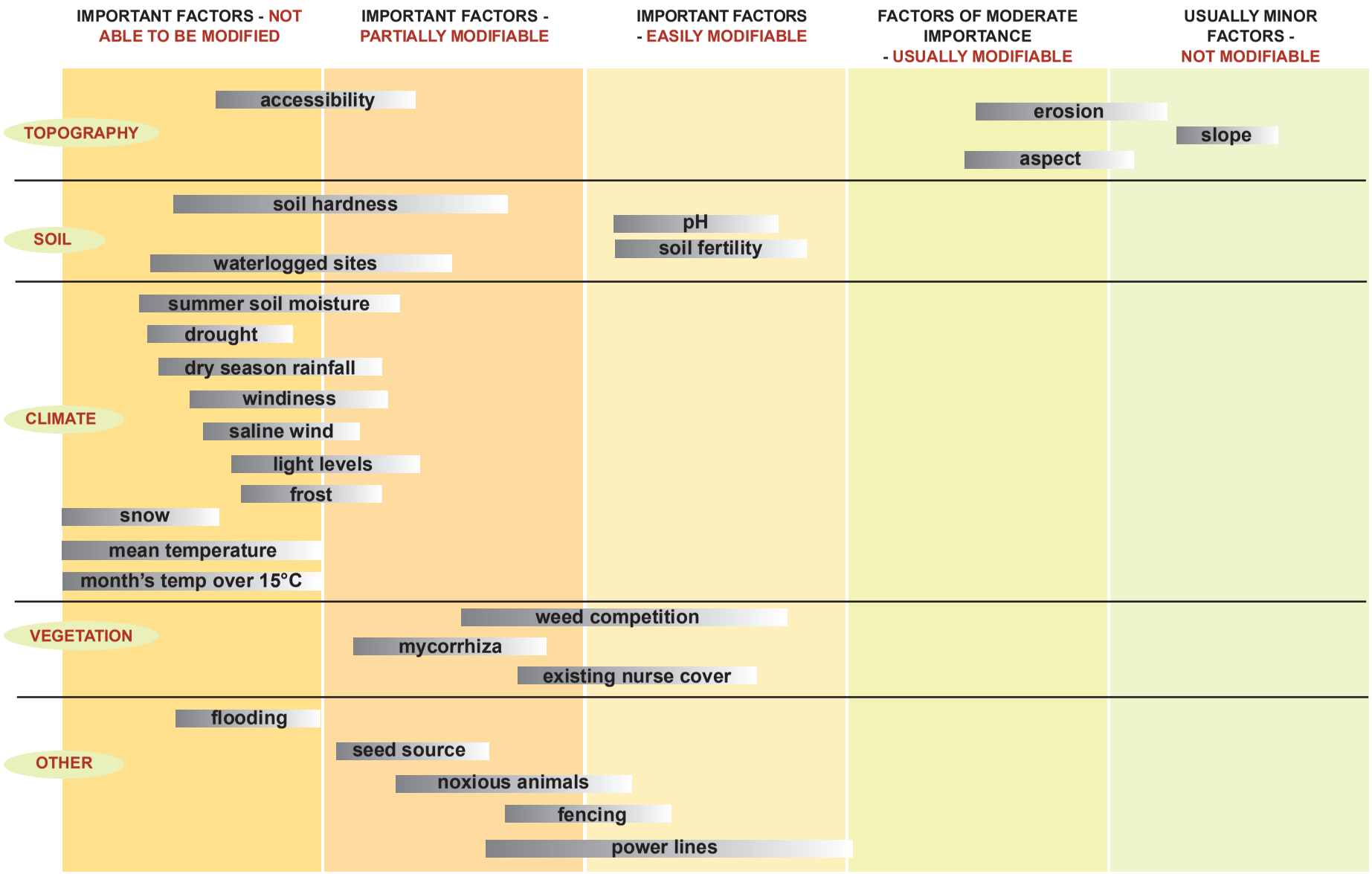

Figure 1: Key site factors to be considered when planting natives and the degree to which components of each site factor can be modified.

Establishing a plantation of native trees on steepland will add significantly to cost and management difficulties, as it does for exotic production forestry on steep hill country.

TOPOGRAPHICAL FACTORS

The major issues faced by potential forest growers relate to the steepness of the land. Steeper land is more prone to erosion and the construction of access routes can provide difficulties and add cost, both for the establishment and later logging of commercially harvestable species. Sites which are distant from all-weather roads and where the construction of good access will be difficult and costly, are best not planted with commercial forest unless the timber value is guaranteed to be high enough to permit aerial lifting of logs or sawn timber. Aspect has an effect on tree growth with north facing slopes being drier than south facing. This can be a problem where summer rainfall is low. In such circumstances, trees will grow better on south facing slopes. On the other hand south facing slopes are colder, resulting in slower tree growth.

Because most topographical factors cannot be modified, the best forest sites are those which are accessible in all weather, are not prone to severe erosion and with most slopes less than 20° (35%).

Site Factor	Specific Aspect	Condition / Problem / Comment	Reason
TOPOGRAPHY	Accessibility	Roading, preferably all weather, at least to edge of site	Good access reduces time needed to get on to block
	Erosion	Minimal slip/slump erosion	Lack of erosion indicates reasonable stability
	Slope	Preferably < 20° over bulk of area. Easy - rolling country best	Flatter country is easier and less costly to work than steep
EDAPHIC	Soil hardness	Soil is difficult to dig and for roots to penetrate	Hard soils result in slower growth for most species
	pH	Range 5.5 to 7 for most trees	Conifers will usually grow at lower pH levels than broadleaves
	Soil fertility	Correct levels of elements essential for good growth	Good growth requires adequate nitrogen (N), phosphorous (P), and potassium (K) levels plus necessary trace elements. Many species grow adequately on poor soils but levels not certain for many species
CLIMATIC	Waterlogged sites	Very few trees grow well on excessively wet sites	Continually wet soils are anaerobic
	Summer soil moisture	Either summer rain or the ability of the soil to hold moisture	Trees need moisture to grow when it is warm
	Drought	Lack of moisture reduces growth rates and can cause death	Trees need water to grow
	Dry season rainfall	Some ground moisture available through dry seasons	Trees will grow through summer and autumn when there is adequate moisture
	Windiness	Excessive windiness causes uneven growth inducing stresses in the timber. Tree height reduced and trees toppled on poor or excessively wet soils.	Affects tree stability and direction of growth
	Saline wind	Saline wind burns the foliage and buds of most trees	Only some species, e.g. pohutukawa *(Metrosideres excelsa)* are salt resistant
	Light levels	Light is required for photosynthesis	Many species require high light levels to grow
	Frost	Different species have different degrees of cold resistance	Seedlings killed from 0 -15°C depending upon species
	Snow	Snow can cause death from coldness and/or damage from breakage	Weight of snow and freezing following snow fall
	Mean temperature	Plants require certain minimum temperatures to begin growth	For many species threshold temperature is about 15°C
	Month's mean temperature over 15°C	15°C is a threshold temperature for many tree species	The longer temperatures are over 15°C the more time a tree has to grow
	Weed competition	Reduces tree growth	Weeds compete with trees for available soil moisture
	Mycorrhiza	Absence of mycorrhiza specific to a tree species means tree growth is reduced or not possible	Most trees have a symbiotic relationship with one or more fungal species; the latter assisting the former to obtain and process essential elements
VEGETATIVE	Existing nurse cover	Improves tree growth and survival	Provides shelter from wind, frost and hot sun. Care must be taken to ensure that the nurse does not unduly deprive the tree of light and moisture.
OTHER	Flooding	Kills or damages trees	Damage/death from water impact or creation of anaerobic conditions. Many species can only survive in saturated soils for a few days
	Seed sources	Bird and wind spread seed essential for health of forest	Seed dispersal is essential for regeneration
	Noxious Animals	Destruction of seedlings and damage to larger trees and consumption of seed	Animal populations need to be kept low, especially when seedlings are present
	Fencing	Requirement to prevent animal (both noxious & domestic) from accessing forest blocks	Domestic animals are very destructive as they are usually more numerous than wild animals

Figure 2: Specific site factors to be considered when selecting a site for the planting of native trees.

SOIL FACTORS

Unlike topographical features, many soil factors can be modified. Probably the most important of these is soil hardness or compactness. Hard soils are difficult for tree roots to penetrate and this will greatly reduce growth rates. Deep ripping such sites before planting confers a major advantage, but if this is not possible the digging of large planting holes will at least give seedlings a good start.

Likewise the chemical condition of the soil can be modified by the addition of lime to correct very low pH, or the application of nutrients which are deficient. Soil moisture levels are a little more difficult to correct but where summer drought is a problem it may be possible to irrigate and excessively wet sites can usually be drained.

The best sites are those where the soil:

- *is friable (but not too soft as this can facilitate wind toppling);*
- *has a pH in the range 5.5 to 7.0 (for most species);*
- *has reasonable nutrient levels, especially nitrogen and phosphate; and*
- *is not excessively wet and does not dry out in summer.*

CLIMATE FACTORS

Climatic factors have a major impact on the ability of trees to grow successfully. Careful consideration must therefore be given to selecting species which are suited to the climate of individual sites. Climate factors fall into four groups: moisture, temperature, wind and light.

Moisture

An adequate and well distributed rainfall during the growing season - preferably with mean monthly rainfall close to 100 mm - will be ideal for good growth of natives. Dry periods of more than two or three weeks without rain will cause slowing of growth for most species and extended droughts will mean cessation of growth.

Wind

Wind affects the ability of a species to grow straight and to resist salt burn, if the site is near the coast. Wind records are not available for most areas so the best indicators are to look for the shaping of trees by wind and observation of areas during strong wind events. Pay particular attention to gullies and gaps in ridge lines which act as wind funnels.

New Zealand has a relatively windy climate in many regions. Trees on exposed sites such as along the west coast of the North Island are subject to prevailing westerly winds with isolated windshorn trees often a good indicator of site exposure.

Temperature

Many species have a frost tolerance limit which restricts their growth in colder places. If seedlings can be protected by nurse plants when they are small, some species will grow very well once they reach sapling size – kauri *(Agathis australis)* is an example of this. Some species, while they will grow in areas subject to snow, have relatively brittle branches that can be smashed from the weight of snow, or even worse, snow which has turned to ice.

Other temperature parameters likely to be important are the average temperatures above which growth occurs. The first of these affects growth initiation. In the north of New Zealand species begin to grow in the spring when mean temperatures rise above 11°C. Growth is then slow until temperatures reach about 15°C when it becomes faster. Consequently the number of months when the mean monthly temperature is above 15°C can be a useful predictor of performance for species like kauri. In colder parts of the country species may begin to grow at lower temperatures. For example, beech *(Nothofagus* spp.*)* growth begins in spring (Sept-Oct) when mean temperatures are probably close to 10°C and begins earlier on lowland sites than in the high country.

Light

Light levels relate to the amount of light being received by plants, particularly in their juvenile phase. The light levels must be high enough to allow photosynthesis to occur. This appears to vary between species, but little empirical information is available for New Zealand trees.

Kauri seedlings grow best at 50% of full light, but will grow at much lower levels. While many natives are probably similar in their light requirements, totara *(Podocarpus totara)* probably requires higher light levels than kauri while hardwoods like tawa *(Beilschmiedia tawa)* and pukatea *(Laurelia novae-zelandiae)* will be lower. Most species, when older, need to have their canopies in full light to achieve maximum growth. A shade tolerant species like tawa will, even when mature, grow best with some shade. This aspect of climate can be manipulated by releasing and thinning.

Rapid growth will not occur unless all or most of the factors above are favourable. Key issues are sufficient moisture, high temperatures and shelter from strong wind. Factors which prevent growth are drought, frosts at seedling stage, excessive snow, strong wind and heavy shade.

BIOLOGICAL FACTORS

Competition

Weed competition is an important issue when plants are small because the weeds compete with young trees for water, light and nutrients. If a site is badly weed infested, pre-planting removal or control is essential so that newly planted trees get a good start. Planting into pasture is not difficult but does require pre-plant spot spraying and at least one follow up releasing. Seedlings which are slow to establish may require several release sprayings. Weeds which grow in the shade like blackberry *(Robus fruticosus* agg.*)* and woolly nightshade *(Solanum mauritianum)*, or those which form dense swards like pampas grass *(Cortaderra selloana, C. jubata)*, are the most difficult to control.

Gorse (above) and blackberry (below) are major competitors for young planted native trees and shrubs.

Some weed species, particularly those which are light demanders (eg, gorse *(Ulex europeaus)* and broom *(Cytisus scoparius)* can be utilised as nurse plants for tree species which will tolerate some shade. This does require some skill but when done well enables the establishment of a tree crop at relatively low cost. As soon as the trees gain control of the site they will begin to suppress and kill the light-demanding nurse plants.

Blackberry (left) and woolly nightshade, or those which form dense swards like pampas grass (right), are the most difficult to control.

To summarise: weeds must be controlled to allow successful tree establishment although some weeds can aid the process, being used as nurse plants. It will be much more expensive to establish a forest on very weedy sites.

Mycorrhiza

Mycorrhizas are symbiotic associations of plant roots with fungi that are probably universal in natural vegetation in New Zealand (Wardle 1991). Generally, these are endomycorrhizas. Only beech is purely ectomycorrhizal among native species. Manuka (*Leptospermum scoparium*) can be either ecto-or endomycorrhizal (refer to box on ecto-and endomycorrhiza).

Mycorrhizas increase nutrient uptake, especially of phosphorus and most plants in most soils depend on them for survival, i.e. they are mycotrophic. However, mycotrophy ceases when plant-available P exceeds a certain level, which varies primarily according to the ability of a species to produce root hairs. Where root hairs are highly developed such as with some dicotyledon families, grasses, rushes and sedges, mycorhiza may be infecting the root but are likely to have little effect. Conversely, plants with thick rootlets and few or no root hairs such as broadleaf (*Griselinia* spp.) and the nodular rootlets of the podocarps and kauri are strongly mycotrophic (Wardle 1991).

A small number of species, like the beeches, require the presence of specific mycorrhiza to ensure reasonable performance of seedlings to be raised in a nursery. The rooting and potting medium of nursery-raised seedlings can be inoculated from the inclusion of duff collected from the vicinity of beech forest. Active inoculation of mycorrhiza for the other major native trees and for commonly raised shrubs in nurseries is generally not required, as the fungal species are widely distributed.

SPECIES AND SITES

Inspecting local areas that have already been planted in natives or are naturally regenerating will give an indication of appropriate species to establish on new sites, management requirements and expected performance.

A useful guide to determining the most appropriate species for a site is to observe what already may be growing well (or poorly) in an area nearby that has similar site characteristics such as aspect, shelter and soil type. However, some care is required in interpreting such nearby areas of native vegetation cover as a guide for planting degraded or open sites. On most sites, native forest regeneration generally follows a successional pathway and a key requirement is to determine the successional stage that the nearby forest cover may be at. Hardy pioneer or seral species will dominate open exposed sites before these are gradually replaced by later successional species.

Investigating the local history of the site through discussion with current and previous landowners or locating early aerial photography may be practical options. Finding out as much as possible about any previous establishment programmes of native forest species on similar sites to determine key species and management methods within the catchment before planting is also prudent.

Growth of weeds, particularly woody brush weed species, are one of the major factors in poor performance and high mortality of planted native trees and shrubs.

OTHER FACTORS

Planting of riparian zones with floodplains and wetlands require planning to ensure appropriate species are planted on the best sites.

There are a few other aspects which must be taken into consideration when selecting tree planting sites. The most important of these is to control animals which eat trees, especially newly planted seedlings. In the domestic situation, adequate fencing of all new planting is mandatory and must be done before trees are planted. Fencing is also an important control measure for many noxious animals although is rarely the complete answer. With noxious animals, a range of control measures are necessary - fencing, shooting, poisoning, the use of animal repellents and protective sleeving can all be used, depending upon the scale of the planting programme, species being planted, site type and resources. (Refer to Technical Article No. 7.2).

On low-lying sites flooding can sometimes be a problem. Sites which flood frequently are perhaps best left unplanted with dense trees and shrubs, although species like kahikatea *(Dacrycarpus dacrydioides)* will do well on such areas. A wide range of sedges and rushes are often best suited to these flood-prone sites.

When establishing an indigenous forest area, having good seed sources nearby is a distinct advantage. Once trees are well established on originally bare areas, birds will begin to visit and will bring seed from adjacent forest stands.

Sites crossed by power lines, especially high tension lines, are best avoided for, unless the strip of unplanted land under the lines can be grazed or otherwise used, the land will be completely non productive.

As with exotic plantation forest, care is required in the planting of native production forestry to accommodate powerlines.

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Author: Ian Barton, Tãne's Tree Trust

Contact: Tane's Tree Trust
Website: www.tanestrees.org.nz

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Tãne's Tree Trust promotes the successful planting and sustainable management of New Zealand native trees and shrubs for multiple uses.

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