# The 2001 Banks Memorial Lecture

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***The place of kauri (Agathis australis) in the Six-Stage Sequential Order of Forest Succession/Progression***

***The Banks Memorial Lecture was given by Graeme Platt at a meeting of the RNZIH held at the Rutherford Hotel, Nelson in November 2001.***

At first glance a mixed-species, closed-canopy rainforest gives the impression of being a totally disorganised scramble of plants and trees. The word "jungle" evolved to communicate the apparent confusion that exists when describing these magnificent forests. Closed-canopy rainforests are not lawless jungles where trees, shrubs, ferns, herbs and grasses grow wherever a seed chances to fall. A strong set of rules firmly dictates the place of each species. All species are sequentially relegated by the changing circumstances created by each separate stage of the six, clearly defined stages that dictate exactly when and where any particular species will be offered an opportunity to establish and grow to maturity. The hold any species has on its preferred location is both temporary and tenuous, before it is ultimately relegated to a location of adversity by species from subsequent stages in the Six-Stage Sequential Order of Forest Succession/Progression.

The location of kauri (*Agathis australis*) - or the specific ecology of any particular plant or tree species in the New Zealand bush - is dictated by the total dynamics of the entire ecology of the bush, that is best seen as a single living organism. The location of any particular species in the bush at any particular time is dictated by the combined influence of all the other constituent species. It is not possible for a simple grass to establish randomly in the bush, any more than it is possible for, say, a mighty kauri tree to establish and grow out in a grassy field and reach its potential as a forest giant. The pathway to fully understanding how the New Zealand bush works, and the location of the kauri (or any herb, shrub, tree or fern) becomes apparent when the rules are fully understood.

The circumstances that dictate the place of any particular plant in the bush are firmly held by the environmental tolerances that any particular plant or tree species has to the collective and ever-changing environmental conditions. The changes in the ecology are created by the constant relegation of species in the Six-Stage Sequential Order of Forest Succession/Progression. The very existence of a tree species modifies its own preferred habitat to such an extent that its own offspring cannot establish and grow at the same location. For example, a dry seeded woody colonising tree species, requiring an open sunny location to establish and grow at its preferred location, will, by its own existence, create a dense shady place where its own offspring don't stand a chance. The shady space under the tree will then be occupied by a wet-seeded, shade-tolerant species from subsequent stages that are dependent on damp shade to establish and grow to maturity. As the light-demanding Stage Three woody coloniser trees succumb naturally to old age, they are replaced with shade-tolerant species from the subsequent Stage Four in the sequence.

It is all but impossible for a wet-seeded Stage Five softwood kauri tree to germinate and establish out in an open Stage Two dry grassy field, just as it's equally impossible for a light demanding Stage Three kanuka (*Kunzea ericoides*) woody colonising species to establish in the midst of a damp shady Stage Six climax broad-leaved forest. Both of these tree species are constituents of the same forest. The Six-Stage Sequential Order of Forest Succession/Progression is a response to the fact that each separate stage of forest development changes the environment by its own existence, creating a different set of environmental conditions. With the exception of Stage Six, the juvenile seedlings from any particular stage in the sequence cannot establish and survive in the conditions that their respective mother trees created.

New Zealand is one of the most remarkable, if not the most remarkable, place on earth to observe and study sequential forest ecology. Although the surviving floral inheritance that is New Zealand's natural bush today is a highly modified and hugely depleted Ice Age relict of a once rich Gondwana-base, it is a unique microcosm of the global floristic picture. The latitudinal position of New Zealand, located half-way between the Equator and the Pole, has allowed remnants from both the ancient Paleozoic and Mesozoic and their modifications to survive regardless of the deprivations of the Cainozoic Ice Ages. The New Zealand flora constitutes a uniquely balanced ecology that is very rare elsewhere.

Also, the New Zealand bush has a reasonably balanced number of effective species in each of the separate stages, therefore the ecology is not dominated by any single stage. Furthermore, the diverse geophysical

features of New Zealand's "fussy" landscape create many small microclimates where all six stages can often be observed at a single location, without having to travel thousands of kilometres to see each stage in its pure form. The purity of each stage is often very clearly defined, to such an extent that at times it may be seen with clear demarcation lines drawn across the countryside between the separate stages.

Every tree, shrub, fern, and herb in the New Zealand flora can be allocated a proper place into one of the separate stages. To qualify for a place in a particular stage, all species have certain physiological and climatic tolerances in common, e.g. the grasses and herbs of Stage Two are all highly light-dependent plants of the Cainozoic era, which are tolerant to extremes of heat, wind and sunlight, and have dry seeds. The physiological tolerances of all plants to the parameters of climatic adversities are a direct correlation to the climatic conditions that existed on earth at the time of their basic evolution. Trees and plants of any particular stage are only able to germinate and establish when the conditions collectively created by the total mass of plants in that particular stage are equal to the conditions that existed on earth at the time of the plants basic evolutionary development.

The exact stage of development any particular patch of bush has attained is ascertained by the numerical dominance of the listed indicator species representative for that stage. As the process is a sequential transition, where plants and trees from one stage are relegated by the plants from a subsequent stage, species from two separate stages will be mixed during the transitional period from one stage to another.

Stage Three woody colonising species in the Sequence move over the top of the preceding Stage Two grasses and herbs. All subsequent stages move in under the shady canopy of the preceding Stages

*The majestic kauri*

eventually succeeding it. When any genus has more than one variation, each variation is a separate adaptation to a different set of ecological circumstances. No two variations within a genus are equal, and each variation occupies a separate location in the environment. For example, *Phormium tenax* is a light-demanding variation of *Phormium* growing out in open sunny locations, while *Phormium cookianum* is more shade-tolerant, with a habitat in shady locations along streamsides and shady cliffs etc.

The New Zealand bush sequences through six separate Stages before terminating as Stage Six broad-leaved climax forest. However, each separate Stage may terminate and become climax at locations of adversity. For example, where conditions are so adverse, Stage One will remain permanently free of plants, creating a desert. While New Zealand doesn't have any great deserts, there are many small locations of adversity where plants are denied a change, such as

in the high mountain nival zone, where permanent ice and snow create conditions so hostile plants cannot survive. Mobile sand dunes, solid rock, vertical cliff faces and the littoral salt sea spray zone are all locations of adversity, often devoid of plants. Mineral toxicity, as a result of volcanic action, creates some of the larger permanent Stage One sites of bare ground where plant life cannot establish and grow to maturity.

Stage Two Herbaceous Colonisers terminate as climax tussock grassland, where and when conditions are so adverse that Stage Three woody colonisers cannot establish and grow. The magnificent Stage Two tussock grasslands on the eastern side of the Southern Alps are dominant because the environment is so adverse that Stage Three woody colonisers are denied a chance to move in and sequentially replace them. This situation is the reality with all separate stages of the sequence. Stage Three woody coloniser species will terminate as climax forest where conditions are so adverse that they cannot be superseded by Stage Four primary broad-leaved forest, and so on through the sequence.

The superb Southern Beech (*Nothofagus*) forests in the cooler mountains and the wet areas of the Southern Alps are significant examples of climax Stage Three woody coloniser forests. Another example is the Southern rata forest (*Metrosideros umbellata*) on Campbell Island in the Sub-Antarctic Island group. These forests are protected from progression by the adversity of their location, as are terminal woody coloniser forests. *Nothofagus* are wet-seeded Mesozoic species that occupy a place as Stage Three woody colonisers. New Zealand's highly modified Cainozoic variations of the wet-seeded Mesozoic southern beeches survive today as great Stage Three forests because they have wet seeds, and are capable of surviving in cold wet locations where there is no effective competition. Where the site is drier, the dry-seeded Cainozoic tea trees kanuka and manuka dominate as the Stage Three woody colonisers. The magnificent Stage Three woody coloniser forest of pohutukawa (*Metrosideros excelsa*) on Auckland's Rangitoto Island is not a climax forest. The pohutukawa trees are being sequentially replaced with other species in the correct order, due to Rangitoto Island being a site of luxuriation. In a few hundred years from now, pohutukawa trees on Rangitoto Island will only occupy the coastal fringe, as they do elsewhere.

*manuka*

Each stage in the sequence of Forest Succession/Progression has two separate states: a state of luxuriation and a state of adversity. As with the Chinese academic concept of Yin-Yang, the continuum joining the two states is a graduated scale of ever-increasing divergence. At one end of the scale a specific plant will grow to perfection, but as it nears the other end there is a point where its survival becomes impossible. Species from all stages (except Stage Six) are confronted with severe competition in locations of luxuriation. Consequently, they are relegated into locations of adversity near the very brink of survival.

The more luxuriant a particular location is, the quicker the species contained within it are relegated out into locations of adversity by the subsequent stages. The Stage Six broad-leaved climax forest trees are the only species that are able grow on in perpetuity at locations of luxuriation, while all of the other tree and plant species in the preceding stages are relegated to sites of adversity. The reality is that all plants growing to maturity in New Zealand native bush have been relegated into hostile sites of adversity by the Stage Six climax broad-leaved hardwood forest species, which are honoured with the privilege of a permanent habitat in a location of luxuriation. (The early settler farmers of Northland understood this with the saying, "Never purchase land unless it is covered with puriri, (*Vitex lucens*), karaka (*Corynocarpus laevigatus*) and taraire (*Beilschmiedia taraire*) trees". These trees are Stage Six climax broad-leaved species. The farmers observed that Stage Six tree species only occupy the good land. All other species have only one chance to occupy their preferred location of luxuriation, before they are relegated out into a location of adversity by the species from subsequent stages in the sequence.

The Stage Four primary broad-leaved tree species may be observed in their purest state under the canopy of exotic plantations of radiata pine and eucalypts. When these exotic plantations are nearing maturity at about fifty years and are correctly spaced, it is extremely difficult for any other species to grow under them except the wet-seeded Mesozoic species from Stage Four of the sequence. Not only is shade essential for the survival of the Mesozoic species of Stage Four, the moist organic litter on the forest floor is essential to create the conditions for their wet seeds to remain viable and germinate.

The shade-dependent Paleozoic ferns, especially the tree ferns, colonise and establish in the shady conditions within Stage Four Primary broad-leaved forest. While tree ferns remain a highly visual feature within the latter Stage Five and Stage Six

forest types, they decline significantly, numerically as the forest progresses through to Stages Five and Six.

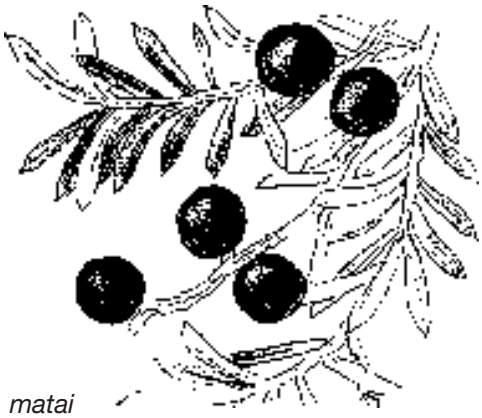
The epiphytes that perch high amongst the branches of mature Stage Five softwoods and the Stage Six broad-leaved climax forest trees, are, in reality, mostly species from Stages Three and Four taking advantage of the appropriate space created on the old trees. The mature Stages Five and Six trees have, in fact, created the correct "terrestrial" sites for the species from the earlier stages high amongst their branches. Northern rata (*Metrosideros robusta*) is a Stage Three woody coloniser. Puka (*Griselinia lucida*) is a Stage Four primary broad-leaved species, as is *Pittosporum cornifolium*. The blade-leaved monocotyledons, such as *Collospermum hastatum* and *Astelia solandri*, which festoon the mature Stages Five and Six trees as epiphytes, are wet-seeded, shade-dependent Mesozoic plants fighting for their correct place in Stage Four. Prior to the evolutionary development of the sun-tolerant plants of the Cainozoic, these shade-dependent plants of the Mesozoic would have occupied open locations in much the same way as primary herbaceous colonisers do today.

There may appear to be exceptions to the rules: parataniwha (*Elatostema rugosum*) is a herb that occupies very shady wet, places in Stage Six broad-leaved climax forests. However, this herb is very shade-tolerant and follows all the rules. Parataniwha is a Mesozoic herb with wet seeds, and cannot occupy a place alongside the modern Cainozoic sun-tolerant, dry seeded herbs and grasses of Stage Two. Orchids are wet seeded Mesozoic herbs that probably occupy just about every shady ecology known. A number of wet-seeded, blade-leaved herbaceous monocotyledons of the Mesozoic are also included in this group: *Xeronema, Collospermum* and *Astelia*. While these ancient herbs may appear to be violating all of the Sequential Order of Succession/Progression rules, they are wet seeded Mesozoic herbs relegated into shady locations in the Cainozoic.

The major exception to the rules are the many tangled, wiry, divaricating variations of shrubs that exist within the New Zealand flora. This phenomenon of tangled growth is one of the most interesting evolutionary adaptations known in botanical science. Sadly, it has been pathetically trivialised for many years by claims that the giant - and now extinct - flightless Moa created these variations by constantly picking leaves off them. All of the tangled, divaricating plants are modern adaptations of ancient Mesozoic Stage Four wet seeded genera, trying to move forward and adapt into the modern dry seeded Cainozoic Stage Three ecology. Furthermore, a number of tree genera have variations that also have a tangled, wiry, juvenile stage, allowing them to temporarily occupy a place in the modern adverse Cainozoic Stage Three ecology. However, when the forest has progressed to Stage Four, the foliage of these trees revert back into their true and proper adult form, to occupy their correct place within the sequence. This phenomenon is an evolutionary issue of the greatest interest. These modern Cainozoic adaptations are actually jumping back and forth across the Mesozoic-Cretaceous/Tertiary-Cainozoic evolutionary boundary line. They commence life out in the open as small leaved Stage Three Woody Colonisers and revert to their correct large leaved Stage Four Primary Broad-leaved form when the bush collectively reaches Stage Four.

The juvenile leaves on New Zealand Stage Six trees are larger than the mature adult leaves, in accordance with the global norm. However, the juvenile leaves on many of New Zealand's wet seeded Stage Four are smaller than the mature adult leaves, due to the Cainozoic enforced adaptations of these Mesozoic species.

Kowhai (*Sophora microphylla*) is a dry seeded tree species that correctly establishes out as a dry seeded woody coloniser with a very tangled



*matai*

divaricating juvenile form with small leaves, that reverts to its larger adult foliage after the tree has attained a height of about two metres, allowing it a move forward into Stage Four. On the other hand, *Sophora prostrata* is a dry seeded Stage Three woody colonising shrub, rarely reaching three metres in height, that remains a permanent constituent of Stage Three.

Each tree genus that has a variation with a tangled divaricating juvenile growth and small foliage also has a non-divaricating opposite: matai (*Prumnopitys taxifolia*) and miro (*Prumnopitys ferruginea*); pokaka (*Elaeocarpus hookerianus*) and hinau (*Elaeocarpus dentatus*); *Plagianthus divaricatus* and *Plagianthus regius*; *Streblus heterophyllus* and *Streblus banksii*; *Pennantia corymbosa* and *Pennantia baylisiana*, etc. The large-leaved variants of every genus are the Mesozoic evolutionary base, while the tangled, wire-like divaricating variations with small leaves are the modern Cainozoic adaptations. With the shrubs *Corokia buddleioides* is the Mesozoic variation occupying its correct place within Stage Four, and *Corokia cotoneaster* is the Cainozoic adaptation struggling to occupy a place in Stage Three. *Coprosma grandifolia* is the shade-dependent Mesozoic variation, and *Coprosma acerosa* is one of the many modern sun and cold wind-tolerant Cainozoic adaptations of coprosma.

The off-shore islands, particularly the northern groups of the Poor Knights, Three Kings, and Hen and Chickens, are the refuges for the oldest and least modified variations of the flora. The large-leaved Mesozoic

species from Stages Four, Five and Six that exist on the islands, with their relatively stable maritime climates, have been least affected by the adversities of the Cainozoic, such as the privations of recurring Ice Ages and periods of dryness. The variations of each genus with smallest leaves are generally located in the southern, cold, frosty, exposed wind swept Mountain valleys and hillsides.

The Six-Stage Sequential Order of Forest Succession/Progression cannot be reversed, except by destructive force - such as experienced as the result of a bush fire or a windstorm, sending trees crashing to the ground. Any holes created in the forest are reoccupied again, with plants and trees in the correct order as per the Six-Stage Sequence. While it is impossible for the Six-Stage Sequence to be reversed, stages may be, and often are, skipped over completely. Stages are only skipped over and missed out at locations of luxuriation. This often happens in Northland, where Stage One bare ground is colonised directly by Stage Three woody colonisers, such as manuka and kanuka, Stage Two herbaceous colonisers being completely bypassed. This situation only takes place at locations where conditions are perfect for direct occupation by the appropriate stage. In the mountains, snow, ice and rock avalanches crashing down the mountainsides into the bush can leave a path of destruction that is so fertile and sheltered by the trees in the bush on each side that it is occupied by Stage Four primary broad-leaved species, completely missing out both Stages Two and Three. Holes in the bush, created by senile old trees falling over or wind damage in Stage Six broad-leaved climax forest, are always replaced by plants and trees in the correct sequence. If the hole in the Stage Six climax bush is very relatively small, it may be filled with tree species from Stage Six, bypassing all the preceding Stages.

The importance of the Six Stage Sequential Order of Forest Succession/Progression in ecological studies cannot be over-emphasised. Not only is the Six-Stage Sequence the order of forest development at any specific location, it is also the altitudinal sequence from the top of a mountain to its lowland base. All six stages of the sequence may, at times, be clearly visible as separate altitudinal strata across the sides of high mountains: Stage One is the snowy, ice-capped nival zone permanently devoid of plants; Stage Two herbaceous colonisers occupy the zone between the snow-cap and the tree-line, where the shrubs and woody colonising trees of Stage Three are fighting their way up the mountainside; Stage Four primary broad-leaved species occupy the lower slopes, clearly indicated with their dense green foliage and by the presence of a multitude of tree ferns; Stage Five softwoods occupy the warmer lower ridges; and Stage Six climax broad-leaved forest tree species are dominant in the sheltered, fertile valleys at the lowland base of the mountains.

The relegation of all species into locations at the very limit of their physiological tolerances, within the development of any single patch of bush, is also repeated latitudinally. The six stages in the sequence also run in a graduated line from the South Pole to the Equator, marked with a dominance of plants from each Stage at separate latitudes. Antarctica can be seen to represent Stage One devoid of any plants. The Sub-Antarctic Islands and the drier parts of the South Island are dominated by Cainozoic Stage Two herbs and grasses. The beech forests, covering the cooler, wetter parts of the South Island and the lower North Island, represent Stage Three primary woody colonisers. The lower North Island is dominated by species from both Stage Four primary broad-leaved forest and Stage Five softwood forest trees. The upper North Island through to the equator is dominated by the Mesozoic Stage Six climax broad-leaved species. While the demarcation lines between the various stages through the length of New Zealand are rather vague and often crudely defined, the dominance of Antarctica (as representing Stage One with no plants), and the hot closed canopy rainforest at the equator (representing Stage Six climax broad-leaved hardwoods forest species of the Mesozoic), is more than clearly evident.

The continuous landmass of South America running from the Equator to edge of Antarctica is the prime location to observe this situation. Amazonia in equatorial Brazil is dominated by Stage Six Climax Broad-leaved tree species. Parana and Santa Catarina states located slightly south of the equatorial region is the home of the Stage Five Softwood *Araucaria angustifolia* and the podocarps with an under story of Stage Four Primary Broad-leaved species. Stage Three dry seeded woody colonising trees and shrubs dominate the open sunlit flora of Northern Argentina. Patagonia in Southern Argentina is dominated by massive Stage Two primary herbaceous grasslands and Antarctica represents Stage One land bare of vegetation.

# *The Six-Stage Sequential Order of Forest Succession/Progression*

***Each Stage is listed with the predominant indicator species representative of that Stage.***

***STAGE ONE: Bare Ground***

Bare Stage One ground is land that is free of vegetation after a destructive event, such as a bush fire, volcanic eruption, mobile sand invasion, landslip, silt inundation etc. Any location that is free of vegetation for whatever reason. While Stage One has no visible plants, land in this state is occupied with an innumerable assortment of micro-flora and fauna in the form of bacteria, yeasts, fungi and lichens.

***STAGE TWO: Primary Herbaceous Colonisation (Grassland)***

Stage Two plants are light-dependent, all are very tolerant to the extremes of sunlight, wind, dryness, and cold, and all evolved and developed in the modern Cainozoic era. All species have dry seeds, with extended periods of viability lasting at times for many years.

*Carex*
*Festuca*
*Aciphylla*
*Danthonia*
*Celmisia*
*Juncus*
*Cortaderia*
*Acaena*
*Chionochloa*
*Linum*
*Haloragis*
*Gahnia*
*Cyperus*
*Scirpus*
*Spinifex*
*Raoulia*

***STAGE THREE: Woody Colonisers***

All trees and shrubs evolved and developed in the Cainozoic era, all are light-demanding angiosperms with dry seeds that at times remain viable for many years. New Zealand's *Nothofagus* are highly modified Cainozoic variations of a wet seeded Mesozoic genus, occupying cold wet sites as a Stage Three woody coloniser.

*Leptospermum*
*Kunzea*
*Metrosideros*
*Dracophyllum*
*Epacris*
*Nothofagus*
*Hebe*
*Sophora*
*Brachyglottis*
*Cassinia*
*Dodonaea*
*Carmichaelia*
*Pomaderris*
*Pachystegia*
*Weinmannia*
*Olearia*

***STAGE FOUR: Primary Broad-leaved Forest***

All Stage Four trees, shrubs and ferns are shade tolerant. Many are extremely intolerant of bright sunlight, all the ferns have their origins in the Paleozoic and the broad-leaved species of the Mesozoic era. They all have wet seeds contained within juicy fruit, drupes and berries (or are ferns with spores). Wet seeds have a very short period of viability, lasting from between two weeks to three months, and must germinate and establish within one season. Fern spores cannot germinate in direct short-wave light, and are dependent on total shade and moisture to reproduce, establish and grow to maturity.

*Fuchsia*
*Pseudopanax*
*Pittosporum*
*Coprosma*
*Hoheria*
*Griselinia*
*Melicytus*
*Aristotelia*
*Elaeocarpus*
*Dicksonia*
*Cyathea*
*Corokia*
*Cyathodes*
*Schefflera*
*Myrsine*
*Myoporum*
*Geniostoma*
*Nestegis*

***STAGE FIVE: Softwood Forest***

Stage Five softwood trees are all Gymnosperms of the Podocarpaceae, Araucariaceae, or Cupressaceae, originating in the early Mesozoic, and producing either wet-seeded fruit, or cone-bearing softwood trees with wet seeds. While seeds of *Agathis*, *Podocarpus* and *Libocedrus* may superficially appear to produce dry seeds, they are wet, with a very short, one-season period of viability.

*Agathis*
*Podocarpus*
*Halocarpus*
*Dacrydium*
*Lepidothamnus*
*Libocedrus*
*Phyllocladus*
*Dacrycarpus*
*Prumnopitys*
*Lagarostrobos*

***STAGE SIX: Climax Broad-leaved Forest***

The trees of Stage Six are all broad-leaved hardwood angiosperms with wet seeds produced in large juicy fruit, except *Laurelia* with its windborne seeds, which must fall on very wet ground and germinate within two or three weeks to survive and germinate as new seedlings. The broad-leaved Angiosperms, trees from Stage Six, evolved during the Cretaceous period of the Late Mesozoic. The Arecaceae is represented in Stage Six by *Rhopalostylis*. Tree species from Stage Six have an extremely shade-tolerant juvenile stage of growth.

*Hedycarya*
*Syzygium*
*Beilschmiedia*
*Corynocarpus*
*Dysoxylum*
*Rhopalostylis*
*Vitex*
*Alectryon*
*Litsea*
*Pouteria*
*Laurelia*

***The place of kauri***

As shown above, kauri is a Stage Five softwood forest species, with a preferred natural habitat in rich, moist, lowland valley floors where it attains a massive size. However, it is relegated to poorer soils on exposed ridges and hillsides. Kauri trees are sequentially replaced out of their preferred habitat by the more shade-tolerant juvenile plants from Stage Six climax broad-leaved forest trees. Additional evidence that New Zealand's Stage Five kauri trees are relegated into locations of adversity by Stage Six climax broad-leaved species is precisely recorded in the annual growth rings of trees growing in the two respective locations. Kauri trees growing in their preferred location of luxuriation in rich, moist, valley floors may at times have between one and five annual growth rings to the centimetre. Kauri trees forced out into locations of adversity may have as many as twenty-five or thirty-five growth rings to the centimetre. Trees growing in warm valleys with rich, moist soils can grow up to ten times faster than those on exposed ridges. Kauri often achieves numerical dominance on ridges, creating an illusion that ridges are its preferred habitat.

The three largest surviving kauri trees in New Zealand each have a theoretical timber capacity of over two hundred cubic metres. These are Tane Mahuta with 244.5 cubic metres, Te Matua Ngahere with 208.1 cubic metres, and the Phantom Tree with approximately 208 cubic metres. These giant trees, located in the Waipoua Forest, are all growing in very wet ground surrounding a great swamp. This situation is clearly visible from the air, if not from the ground. The large number of huge, deep-reaching peg roots that support these trees, penetrate to a depth of three to four metres under the tree into the water-table, maintaining moisture stability within the trees. While large kauri trees at times grow high up on hillsides, these large trees are always located in wetter locations in gullies or beside watercourses, where the natural rainfall is concentrated beyond the natural precipitation by being funnelled into the root range of trees.

The predominant location of the bulk of the twenty recognised variations of *Agathis* at the at the edge of the wet tropics, otherwise on mountainsides or high ridges within the tropics coincides perfectly with their place as a Stage Five softwood species in the Six-Stage Sequential Order of Forest Succession/Progression. The equatorial forests are occupied by the late Mesozoic Stage Six tropical broad-leaved hardwood tree species, relegating the Stage Five softwood conifers slightly south or higher up the cooler mountainsides.

Many conservation and forest management strategies are very seriously flawed, as they are all based on the false assumption that the natural habitat of a particular species is its preferred habitat. The reality is that all plants are marginalised into sites of adversity by species in the subsequent stages in the Six-Stage Sequential Order of Forest Succession/Progression. The concept of selectively logging Stage Five softwood timber tree species (including kauri) on a sustainable yield

basis is a very seriously flawed concept, as the damage caused by the felling of kauri trees reverts the bush back to Stage One, where the Six-Stage Sequence commences afresh. Any clearings created in the bush where kauri is felled will be colonised by Stage Two herbaceous colonisers and Stage Three woody colonisers, such as manuka and kanuka, and not Stage Five softwood species such as kauri.

Only Stage Three woody colonising trees and shrubs can be harvested in perpetuity on a sustainable yield basis, and only at locations of luxuriation (and using the correct tree-felling regimes that retain mature seed trees in adequate quantities to allow for the proper dispersal of seed). The bush clearings where Stage Three woody colonisers have been felled will be recolonised by their own kind from within Stage Three. The Stage Three species manuka and kanuka can be harvested as bakery-grade fuel-wood and source of essential oils, and several *Nothofagus* as sources of saw-wood, wood products and wood fibre.

The continuous relegation of species into locations of adversity at the extreme limits of their ability to survive in the conditions created by the natural Six-Stage Sequential Order of Forest Succession/Progression, is the prime cause of so many species being catalogued as "endangered species". Translocating "endangered species" to their preferred location of luxuriation, into the correct stage of the Six-Stage Sequential Order of Forest Succession/ Progression, is the only practical way to ensure their survival. Species are forced towards extinction because they have been relegated to a location of adversity where their survival is often difficult, if not impossible.

Kauri is a long-lived tree species maturing as a very large tree, with a natural habitat in New Zealand forests north of 37 degrees south. Kauri is a Stage Five tree species in the Six-Stage Sequential Order of Forest Succession/Progression. New Zealand kauri is relegated out of its preferred natural habitat in the warm, moist, valley floors by the Stage Six broad-leaved hardwood climax tree species.

Kauri is a shade-tolerant species during its juvenile phase. However, optimum growth potential is only realised when the correct spacing has been won by the young adolescent trees, gaining access to high light. *Agathis australis* has a tall erect apical growing shade tolerant juvenile form, a direct inheritance from having its roots in the Mesozoic and a bushier disordered crown in response to the variable conditions of the modern Cainozoic Four Season Solar ecology.

Due to its genetic inheritance forced on it during the Cainozoic Ice Ages, New Zealand kauri is capable of growing in cooler conditions than those experienced in its natural habitat of today. Kauri, under conditions of cultivation, are performing considerably better further south in Taranaki than it does in its natural habitat of northern New Zealand.

While the *Agathis australis* gene pool was decimated as a result of over one hundred years of reckless and uncontrolled logging practices from the mid 19th to the mid 20th century, quality gene stock is available over a very wide area of the original habitat in many actively regenerating, small, scattered groves. New Zealand kauri today is actively recolonising the bush in a fully functioning natural ecology, occupying its correct place in the Six-Stage Sequential Order of Forest Succession/ Progression. The future of New Zealand kauri is secure without great acts of active human intervention. However, it is vital that these areas of naturally regenerating kauri be left to grow in peace, with total protection for all time.

Future conservation policy of all naturally occurring tree species should be based on the concept that "if it wasn't planted by man, then it should not be harvested by man".

***The time-scale of the Six Stages,*** based on the warm northern kauri forest sequence, climaxing as Stage Six, with taraire, puriri, karaka, and kohekohe being the dominant broad-leaved tree species.

***Stage One***
Bare ground

***Stage Two***
After a fire, bare ground will be carpeted with herbs and grasses for1-3 years

***Stage Three***
Woody colonisers establish 1-10 years after a fire, and have generally eliminated all herbs and grasses within 15 years. The life span of average Stage Three kanuka in the Auckland and lower Northland is approximately 60-120 years

***Stage Four***
Stage Four species commence establishing 12-15 years after the Stage Three woody colonisers first establish. As the Stage Four species progress concurrently with Stages Three and into Five, they have a major influence on the length of time for forest progression

***Stage Five***
The life span of average large, 2 m diameter kauri is 450 - 750 years. At a location of luxuriation, softwoods are generally establishing well, 50-80 years after the Stage Three woody colonisers have established

***Stage Six***
Climax broad-leaved forest is the only forest type able to regenerate in perpetuity at a location of luxuriation. Stage Six forest is fully established when all of the softwoods have completed their life cycle and have been replaced by hardwoods (calculated as 810 years)