

7. KEY FINDINGS AND CONCLUSIONS

7.1 Geology and landforms

The Kaimai-Mamaku encompasses a distinctive suite of landforms mainly of volcanic origins. The Kaimai Range, in particular, is particularly prominent from the Waikato and the Bay of Plenty, and is highly valued by the people of both regions. With the exception of the plains and downlands on the western and eastern sides of the range and plateaus, these landforms are largely of volcanic origins. The northern sector of the project area, mainly in the Waihi catchment, but also in the Waiiau and Tuapiro catchments, includes a tract of sedimentary greywacke and argillite. The main range is andesite and dacite, while the Whakamarama and Mamaku Plateaus are ignimbrite flows of different ages. Fault uplift has resulted in the large western scarp rising above the Waikato basin.

7.2 Catchments

The project area encompasses more than 240,000 ha, in 15 sub-catchments that drain into the Waihou River and Tauranga Harbour. Five of these sub-catchments - Waihi, Paeroa, Te Aroha, Middle Waihou, Upper Waihou - flow into the Waihou River and drain the northern Kaimai, steep western flanks of the range, and the northern Mamaku Plateau. The other ten - Waiiau, Tuapiro, Uretara, Rereatukahia, Aongatete, Te Puna, Wairoa, Omanawa, Waimapu, Ottawa - drain from the northern hill country near Waihi Beach, the eastern flanks of the Kaimai Range, the Whakamarama Plateau, the northern Mamaku Plateau, and the Ottawa-Otanewainuku hills to the Tauranga Harbour.

7.3 Land cover

The total area of indigenous vegetation is nearly 89,000 ha, of which *c.*70% is formally protected (the primary aim is to protect indigenous vegetation, habitats, and species, i.e. indigenous biodiversity). Much of the forested part of the project area is managed by the Department of Conservation but there are also large areas of indigenous vegetation (more than 26,000 ha) in private and Māori ownership. Most indigenous vegetation is located in the upper catchments, on steeper country, and on the extensive plateaus in the south. However, large parts of the Mamaku Plateau have been converted to exotic plantation forest.

In the middle reaches of the catchments there are many smaller remnants of indigenous vegetation, including many that extend along streams to the east. Relatively little indigenous vegetation remains in the lower altitude parts of most of the 15 sub-catchments. Large swathes of landscape are now classed as acutely threatened (<10% indigenous cover remaining) or chronically threatened (<20% remaining), with the limited remnants often degraded by grazing or weed invasion. Pest animals are also present and often have pervasive effects. There are, however, increasing numbers of remnants legally protected, with covenants on the indigenous vegetation in the middle reaches of the catchment.



7.4 Human influences

The current situation reflects the impacts of more than a century of intense human land use pressure. Significant areas of indigenous forest within the main tract have been logged (now recovering, albeit slowly) but clearance has devastated indigenous ecosystems on easier terrain and current land uses in some areas continue to cause deterioration of the state of waterways and estuaries, causing nutrient enrichment and sediment losses to streams and estuaries. Nevertheless, there are still extensive areas relatively untouched by direct human modification, and previously modified areas with a cover of indigenous vegetation are continuing to develop and improve.

7.5 Soil and water conservation

The steep uplifted nature of the Kaimai Range and the steeply-incised character of streams draining the Range and plateaus means that the forested headwaters have very high values for water and soil conservation. Access to high quality water resources is particularly important as many streams provide water for settlements, rural dwellers, and domestic stock. Sediment losses into streams and estuaries is an ongoing concern, and steep gradient streams in pasture are a recognised sediment source on the eastern side of the range. There is a high level of community concern in the lower catchments in particular, about erosion; sedimentation of receiving streams, rivers, and the Tauranga Harbour; and water quality in general, as shown by the proliferation of care groups, particularly in the lower catchments, reflecting decreasing water quality moving downstream. The regional councils have well-developed water quality monitoring networks on both sides of the range, and it is clear that there are ongoing problems with water quality.

7.6 Climatic influences

The effects of climate on vegetation and habitats across the project area results from a complex set of interactions with altitude, vegetation and land use, distance from the coast, and landforms and soils. At lower levels, closer to the coast, coastal ecosystems are prevalent, with pohutukawa prominent. Semi-coastal forest, with species such as kohekohe and puriri, occurs along the eastern flanks of the range, with a similar influence evident on the western side of the range. Lowland tawa-dominant forest occurs across much of the flanks of the range and across the plateaus.

An obvious climatic influence is evident on the highest parts of the range where a cloud or fog cap is a characteristic feature for nearly two-thirds of the year. This feature, combined with sporadic extreme droughts, means that these higher altitude forests, which have developed to suit wet climatic conditions, are vulnerable to drought-induced dieback. Drought events in the early and middle parts of the 20th Century triggered widespread dieback of indigenous vegetation in 'cloud forest', and these effects are still very evident along the highest ridges today. This has resulted in the "scruffy" vegetation that is present in these areas.

7.7 Diversity of ecosystem types

The degree of ecological diversity within the project area is a reflection of the considerable diversity of basal geology, landforms, and altitude, combined with

distributional limits for various key species. Geologically, the northern Kaimai is distinctly different from the central Kaimai and the southern plateau. Ecologically, the northern Kaimai Range, has strong affinities with Coromandel, while the Mamaku plateau is distinctly central North Island. The transition zone, in the central part of the Range, is a distinctive area that has affinities to both, including various northern and southern limits. The degree of diversity, on a wider landscape scale, is illustrated by subdivision of the project area into eight ecological districts, within four ecological regions.

7.8 Vegetation and floral diversity

As noted above, podocarp/tawa and tawa-dominant forest is predominant on lower and mid-slopes and on the plateaus. In the north, however, there are complex mixtures of tawa, beeches, and kauri, with local kauri stands on both sides of the range (many of which have been logged). Red beech-silver beech and silver beech forest occurs on some of the higher ridges, with upland bog forest on flatter terrain at higher altitude. Extensive volcanic rock outcrops (e.g. Wahine Rock, Kakarahi) on the main Kaimai Range provide significant habitats for a diverse range of plants of open sites.

The range of ecosystem types present across a wide altitudinal range from coastal to montane means that there is a great diversity of vascular plants, with 500-600 indigenous taxa present, including at least 30 threatened or 'at risk' species, and another six taxa considered to be uncommon on a regional basis. There is also a large number of naturalised species, reflecting the long history of occupation and land development.

7.9 Ecological values of vegetation

The Kaimai Range and plateau environments, in spite of the presence of pest animals, still have very important biodiversity values. The forest tract is, in ecological terms, very significant, with large areas of the tract ranked as having 'Exceptional' botanical conservation values. Key forest classes and other features represented in each of the 15 sub-catchments are summarised in Table 21, showing recorded occurrences of key threatened species.

The Range is a key connection, and gradation, between the forests of the central North Island and the Coromandel. This ecological transition zone includes northern limits for silver beech, kamahi, and pink pine, and southern limits for *Coprosma dodonaefolia* and towai. Kauri forest reaches its southern limit on the eastern side of the North Island within the project area. The 'transition zone' on the Kaimai Range can be considered to be ecologically unique, due to the unusual combinations of landforms, altitude, and vegetation. This is reflected in the recognition of seven separate gazetted Ecological Areas and a Forest Sanctuary across the north-south extent of the project area. (North-south, the project area spans almost 90 km, and c.40 km west-east at its widest point.)

Table 21: Examples of ecologically-significant features in the Kaimai-Mamaku project area.

	Coastal Forest	Semi-Coastal Forest	Lowland Forest	Upland Forest	Ecological Areas	Forest Sanctuary	Threatened Plants	Long-tailed Bats	Short-tailed Bats	Kiwi	Indigenous Fish	Kākā	Falcon	Kokako	Hochstetter's Frog
Waihou Kaimai Sub-Catchments															
Waihi			✓	✓	✓	✓	✓	✓		✓	✓				✓
Paeroa			✓								✓				✓
Te Aroha			✓	✓			✓	✓			✓	I			✓
Middle Waihou			✓	✓	✓		✓	✓			✓				✓
Upper Waihou			✓	✓	✓		✓	✓	✓	✓	✓	B	✓	B	✓
Tauranga Harbour Sub-Catchments															
Waiau	✓	✓	✓				✓	✓		✓	✓				
Tuapiro		✓	✓		✓		✓	✓		✓	✓				✓
Uretara		✓	✓	✓	✓		✓	✓			✓	I	I		✓
Rereatukahia		✓	✓	✓	✓		✓	✓		✓	✓		I		✓
Aongatete		✓	✓	✓	✓		✓	✓		✓	✓	I	I		✓
Te Puna			✓				✓	✓			✓	✓			
Wairoa			✓	✓	✓		✓	✓	✓	✓	✓	B	✓	B	
Omanawa			✓				✓	✓		✓	✓				
Waimapu			✓				✓	✓		✓	✓	I			
Otawa	✓	✓	✓				✓	✓		✓	✓	I		✓	✓

Key: ✓ = present; B = breeding; I = itinerant.

7.10 Indigenous avifauna

The fauna complement is also very significant, with a diverse range of threatened avifauna, including kokako, kiwi, kākā, falcon, and long-tailed cuckoo (see examples in Table 22). A now typical suite of common forest birds is present throughout. Falcon occur throughout but kākā are only itinerant visitors over much of the tract other than the northern Mamaku Plateau. It is clear, from the data available, that there is a concentration of remnant threatened species in the south. It also appears that there is a more diverse complement of common species in the northern Kaimai than there is in the central part of the Range. This may be related to the relative extent and diversity of habitats available in different parts of the project area. It is also evident, however, that introduced predators have taken a heavy toll on terrestrial indigenous fauna, especially birds, lizards, and invertebrates. Limited monitoring data is available (see Table 23), and pest control to protect indigenous avifauna is undertaken at a limited number of sites (discussed further below).

Table 22: Monitoring data available for various fauna groups within sub-catchments in the Kaimai-Mamaku project area.

Key: D = DOC; A = Aongatete Forest Trust; O = Otanewainuku Kiwi Trust; F&B = Forest & Bird; C = Care Group; ✓ = Other organisation.

	F&B - 5MBC Oct 2009	F&B - Everybirdy Nov 2009	OSNZ Bird Atlas 09-79: 99-04	5-MBC (other)	Kokako Census	Kiwi Survey/ Monitoring	Lizard Survey	Indigenous Frog Survey	Long-Tailed Bat Survey	Short-Tailed Bat Survey	Walk-through Ecological Survey
Waihou Kaimai Sub-Catchments											
Waihi	✓	✓	✓					D			
Paeroa	✓	✓	✓								
Te Aroha	✓	✓	✓					D			
Middle Waihou	✓	✓	✓					D			
Upper Waihou	✓	✓	✓		D				✓/D	✓/D	D
Tauranga Harbour Sub-Catchments											
Waiau	✓	✓	✓								
Tuapiro	✓	✓	✓								
Uretara	✓	✓	✓								
Rereatukahia	✓	✓	✓								
Aongatete	✓	✓	✓	A				D			
Te Puna	✓	✓	✓								
Wairoa	✓	✓	✓	D	D	D/✓	D	D	✓	D	
Omanawa	✓	✓	✓								
Waimapu	✓	✓	✓					D			
Otawa	✓	✓	✓					D			

7.11 Bats, lizards, and fish

Long-tailed bats are probably present throughout indigenous forest associated with the main forest tract, but short-tailed bats are only known from Opuiaki and Mokaihaha. Records of common lizards are present throughout. Hochstetter's frog occurs at Otawa (just outside of the project area) and in the northern Kaimai Range.

There are still significant populations of indigenous fish in streams, including some threatened species, although it is evident that the lower reaches of most waterways are heavily modified and are under considerable pressure from catchment land uses. It is still, nevertheless, readily apparent that all of the 15 sub-catchments in the project area still retain high value as indigenous fish habitats, in spite of the significant problems in lower catchments. Pest fish species are present at a few locations in the east. Ongoing connectivity (in terms of physical and chemical barriers) to the sea is critical for migratory indigenous species, and downstream habitat quality is important for those species that utilise lowland habitats, either at key stages of their life cycles or on an ongoing basis.

7.12 Vegetation monitoring

The Department of Conservation has vegetation monitoring in place in various parts of the wider tract, with a strong focus on the northern Kaimai (Table 23). In the north, monitoring infrastructure includes a network of rata view sites, permanent 20 × 20 m vegetation plots, foliar browse lines, and exclosures. In the central and southern zones, the main focus is on foliar browse assessments. Most catchments have some vegetation monitoring infrastructure, and those that don't often have monitoring sites in adjacent catchments in similar vegetation types. The notable exception is upland forest in the Te Hunga and Waiteariki Ecological Areas. While the monitoring data that is available is somewhat patchy, in terms of geographic spread, and there is enough information available to enable formulation of a picture of the current state of the vegetation.

Table 23: Summary of DOC vegetation monitoring within the Kaimai-Mamaku catchments

	Monitoring Type					
	Rata View Sites ¹	FBI ²	20 × 20 m Plots ³	Exclosure ⁴	LUCAS/NVS ⁵	Understorey Assessment ⁶
Waihou Kaimai Sub-Catchments						
Waihi	✓	✓	✓		✓	
Paeroa						
Te Aroha	✓		✓		✓	
Middle Waihou	✓	✓		✓	✓	
Upper Waihou	✓		✓		✓	✓
Tauranga Harbour Sub-Catchments						
Waiau						
Tuapiro	✓	✓	✓	✓	✓	
Uretara	✓	✓	✓	✓		
Rereatukahia					✓	
Aongatete		✓		✓	✓	
Te Puna						
Wairoa		✓		✓	✓	
Omanawa					✓	
Waimapu		✓			✓	
Otawa		✓				

Key

1. Ongoing monitoring of selected northern rata trees.
2. FBI = Foliar Browse Index assessments of foliar browse condition (due to possum browse or other influences).
3. 20 × 20 m permanent vegetation sample plots established by DOC to monitor vegetation condition.
4. Sites fenced to exclude deer and goats (and domestic stock), to assess effects on forest understoreys.
5. 20 × 20 m permanent plots established (by Ministry for the Environment) to monitor carbon stocks in indigenous vegetation.
6. Walk-through assessment of understorey composition and condition.

Monitoring assessments, post-2000, in various parts of the project area, have shown declines in the canopy condition of northern rata in the northern Kaimai, but that other possum-preferred species were in moderate to good condition, and that kamahi in the southern Kaimai was in poor condition, but that other species had improved in condition. This 'picture' is related to the pattern and history of possum control. A similar 'picture' is evident in relation to the effects of deer and goats, as discussed further below.

Pest Plants

The diversity of habitats, combined with the high degree of fragmentation, urban settlement and rural subdivision, has led to a great proliferation of pest plants. These problems will not diminish over time as there is a considerable lag time for further expansion of species spreading by wind, birds, and garden waste dumping. The regional councils and the Department of Conservation all have well-developed surveillance, recording, and control programmes in place, but this will require ongoing commitment.

Pest Animals

There is a ubiquitous suite of introduced pest animals present across the entire tract (Table 24) and, where not under active management, these have had, and continue to have, significant negative effects on indigenous vegetation and fauna, resulting in pests causing the steady decline and ongoing loss of key elements from remaining indigenous ecosystems. It is evident, however, that elements of the vegetation have been severely affected by introduced browsing animals such as goats and possums, with deer also present and increasing in parts of the central Kaimai Range. These animals have altered canopy composition and condition (possums), as well as understorey composition and structure and regeneration sequences (possums, goats, deer, and ship rats). However there are still parts of the Mamaku Plateau that have not been heavily impacted by introduced browsing animals and forest structure is largely intact, e.g. Opuiaki. The suite of pests present across the entire tract also includes mustelids, rats, cats, hedgehogs, mice, and pest invertebrates (e.g. wasps). Pest fish (koi carp) are present in some eastern catchments but are subject to a Department of Conservation eradication programme.



Table 24: Pest animal species distributions within catchments in the Kaimai-Mamaku project area.

	Feral Goats	Red Deer	Fallow	Pigs	Possums	Ship Rat	Norway Rat	Stoat	Ferret	Weasel	Cat	Hedgehog	Mice	Pest Fish
Waihou Kaimai Sub-Catchments														
Waihi	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Paeroa	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Te Aroha	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Middle Waihou	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Upper Waihou	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Tauranga Harbour Sub-Catchments														
Waiau	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Tuapiro	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uretara	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Rereatukahia		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aongatete		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Te Puna		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Wairoa	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Omanawa		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Waimapu		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Otawa		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Pest Animal Control

Goat control has been implemented widely for many decades. This is currently strongly focussed on the northern Kaimai, but has previously involved considerable monitoring and hunting responses in central and southern Kaimai. Goat control has also been undertaken at Orokawa Bay, along with control of feral pigs and possums. Possum control has been undertaken by the Department of Conservation in the Waiorongomai Valley, at Opuiaki (5,600 ha), and at Mokaihaha, and at Otanewainuku and Ottawa (adjacent to the project area). Control of mustelids and rats has also been undertaken by the Department of Conservation at Opuiaki. Integrated pest control is also being implemented on conservation land and Māori land at Whakamarama, as part of a pest control research project. There are now also two community-based trusts undertaking intensive pest control in forested areas, (Otanewainuku and Aongatete) and a care group doing the same (Puketoki). Refer to Table 25 for a summary of pest control activity.

Table 25: Pest control within catchments in the Kaimai-Mamaku project area.

Key: D = DOC; A = Aongatete Forest Trust; O = Otanewainuku Kiwi Trust;
 F = Friends of Puketoki; C = Care Group; R = Recreational Hunting;
 M = Māori land; * = Landcare Research project Multi-Pest Dynamics Project.

	Feral Goats	Red Deer	Fallow	Pigs	Possums	Ship Rat	Norway Rat	Stoat	Ferret	Weasel	Cat	Hedgehog	Mice	Pest Fish
Waihou Kaimai Sub-Catchments														
Waihi	D	R												
Paeroa	D	R												
Te Aroha	D	R			D									
Middle Waihou	D	R			D			M*						
Upper Waihou	D	R			M/D	M								
Tauranga Harbour Sub-Catchments														
Waiau	D	R												
Tuapiro	D	R			C	C								
Uretara	D	R			C	C								
Rereatukahia		R												
Aongatete		R			C	C		C/M						
Te Puna		R			P	P/C	C							
Wairoa	D	R			D	D		D						
Omanawa		R			C/D/O	C/O	C	C/O			C			
Waimapu		R	R											
Otawa		R	R		D/C	C								

Human Use

The Waikato and western Bay of Plenty are major population centres, with intensive land subdivision occurring in the western Bay of Plenty. The project area is also relatively close to Auckland. Levels of increased use in adjacent lowlands is being reflected by increased use (and related interest in management regimes) in the forests along the range, with c.200,000 annual visitors. As well as walking/tramping, there is significant interest in historic interpretation, hunting, mountain biking, and 4WD recreation.

Care Groups and Wider Community

There is now considerable pressure from the wider community for increased active management in the wider forested tract, as well as throughout much of the lower sections of the 15 sub-catchments that make up the wider tract. This pressure is well demonstrated by the number of community-based care groups, more than 50, working generally in the lower to middle reaches of the catchments. Ecological restoration is a strong focus in these degraded environments, as shown by the large number of ecological care groups in operation, although these are largely (with a few exceptions) in the Tauranga catchments. These care groups are well aware of the importance of

sound ecological management and sustainable rural land use for receiving environments such as Tauranga Harbour and the Waihou River and The Firth of Thames.

With growing population pressure and changing land use (e.g. advancing urban and particularly rural interface) within the Kaimai-Tauranga catchment, particularly along the Bay of Plenty coastline within the next 20 years, conservation efforts need to strategically align with and contribute to social and economic policies. This can only realistically be achieved by proactive long-term engagement with communities within and adjacent to the project area.

7.13 Concluding statement

There is wide concern that the forests of the Range not currently under intensive management are on the verge of experiencing collapse, and that the indigenous fauna (vertebrates and invertebrates) have suffered catastrophic population collapses. It is readily evident that forests on the northern Mamaku Plateau are in relatively good condition, especially areas where possums are being managed and where more intensive integrated pest management has occurred in the recent past. It is also evident that forests of the northern Kaimai are in reasonable condition and that adequate levels of vegetation monitoring are in place to detect changes. The northern Kaimai is also under active management for goat control, and possum control has been undertaken over one block where rata condition is of concern. Tawa-dominant forest is predominant on lower and mid-slopes on the central Range, with a recognised deer population. These forests now have limited vulnerability to browse impacts, subject to pest populations not attaining high levels.

Upland forest on the range appears to be in a poor state, but this is due primarily to the effects of drought-related forest dieback. Browsing animals do, however, play an important role in regeneration at dieback sites, and possums are also a known factor in kaikawaka decline. There may be a need to increase monitoring (and management) effort in upland forests, but this needs further evaluation. Other possum control has been undertaken at Whakamarama and Otanewainuku-Otawa (adjacent to the project area), and in coastal forests at Orokawa Bay (along with goat and pig control).

Indigenous fauna, especially birds, are of particular concern, but the major declines due to predation have already occurred, as for extensive areas of mainland habitats, and it is now a matter of determining where further management effort should be directed. There is probably a need for further targeted surveys of key species, to underpin selection of further intensive management sites, although this is only one factor that should be taken into account in the evaluation of priorities for ecosystem management.

Current monitoring data for feral red deer and possums appears to be lacking. Monitoring (and management) within the Kaimai-Mamaku tract is somewhat patchy and has become focussed on particular locations. There would be merit in taking a more holistic approach to future management.

The previous delineation of key representative vegetation sequences and special features in Ecological Areas and a Forest Sanctuary needs greater recognition. These

areas are currently receiving various levels of active management in the northern Kaimai (goat control) and northern Mamaku (recent control of possums, stoats, rats), but probably need more emphasis in the central and southern Kaimai Range.

There is enough monitoring information to indicate that more active management is required, throughout the upper catchments (except for the areas already subject to intensive management, as noted above), to halt the decline of indigenous biodiversity. There is also sufficient information available to indicate the types of recovery (and recovery trajectories) that can be expected if a wider programme of active management is put in place.

What is also obvious, however, is that it is beyond the capabilities of a single agency, an agency collective, or even the combined efforts of agencies and the wider community, to achieve ecosystem recovery uniformly across the project area. It will be necessary to pick “winners”, to complement existing projects, in terms of representative swathes of indigenous forest and selected catchments, in which to implement restoration management, and these ecosystem restoration projects require clear objectives and good strategic and operational planning. It will also be necessary to expand and integrate the monitoring network, to be able to continue to evaluate condition and trend within these systems, and to report on achievements over time. If these matters are addressed, it is feasible to sustain and restore the indigenous biodiversity of the Kaimai-Mamaku into the future.

