Assessment of biodiversity values and threat management options – Te Kauae o Maui

Red Admiral Ecology

RED ADMIRAL ECOLOGY CONTRACT REPORT 2011/26
JULY 2011

Cover photo: Old growth tarairi-kohekohe forest in lower gully

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Contents

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Summary

This plan identifies ecological values and threats at the Te Kauae o Maui (TKOM) and describes ecological restoration inputs that are both in place and recommended over the next five years. It also outlines continued inputs to enable the recovery of ecological systems and species over the medium term 50 – 100 yr period, both in the Te Kauae project area and in nearby natural areas.

A field survey confirmed that under represented primary semi coastal/lowland[1] forest is present (< 8% lowland forest remaining in the Colville Ecological District (Leithwick et al, 1995)) and that the nationally at risk *Pittosporum virgatum* still persists. The area is floristically diverse with five distinct vegetation types observed. Western and northern dividing ridges represent the landward margin of direct coastal influence and several coastal tree species were detected throughout the area[2]. In addition a distinct secondary pohutukawa/kauri vegetation type is present (see Figure 4).

Threatened kiwi, kaka, Hochstetter's frog, brown and green geckos are present. A large land snail shell was also reported by residents, but the provenance of this shell is unknown. The area provides important linkage and stepping stone functions for wildlife between nationally under represented coastal forest remnants to the northwest and the Coromandel Range to the east. It also buffers several privately covenanted properties which on their own are insufficient to protect large fauna species.

The proposition to restore under represented habitat is conservative and relatively low cost, but the proposal to promote fauna recovery with a trapping system that has yet to be proven does constitute some risk. There are some novel recommendations including the establishment of an electric fence to effect the exclusion of pigs and associated threats.

In total there are 32 prioritised action points that recommend new/revised inputs for habitat/flora restoration, fauna protection and threat management which are summarised in Appendix 1.

[1] The semi-coastal bioclimatic zone has not been delineated in the Colville ED (Stanway et al, 1990)

[2] There is likely some degree of hybridization for these species in the semi-coastal bioclimatic zone.

1. Introduction

1.1 Objectives

This report details the results of a field/desktop assessment of ecological values/threats at the Te Kauae o Maui (TKOM) Intensive Pest Management Project as prescribed by Schedule 1 of the agreement with the Biodiversity Advice Fund (ADV- 436). Objectives:

1. Assess biodiversity values.
2. Investigate context of TKOM initiative in terms of project scale and linkages to other management programmes.
3. Design an appropriate pest management programme.

1.2 Background

Te Kauae o Maui was established in 1980 by a private group of people who purchased the valley for lifestyle purposes and several house sites were established about the

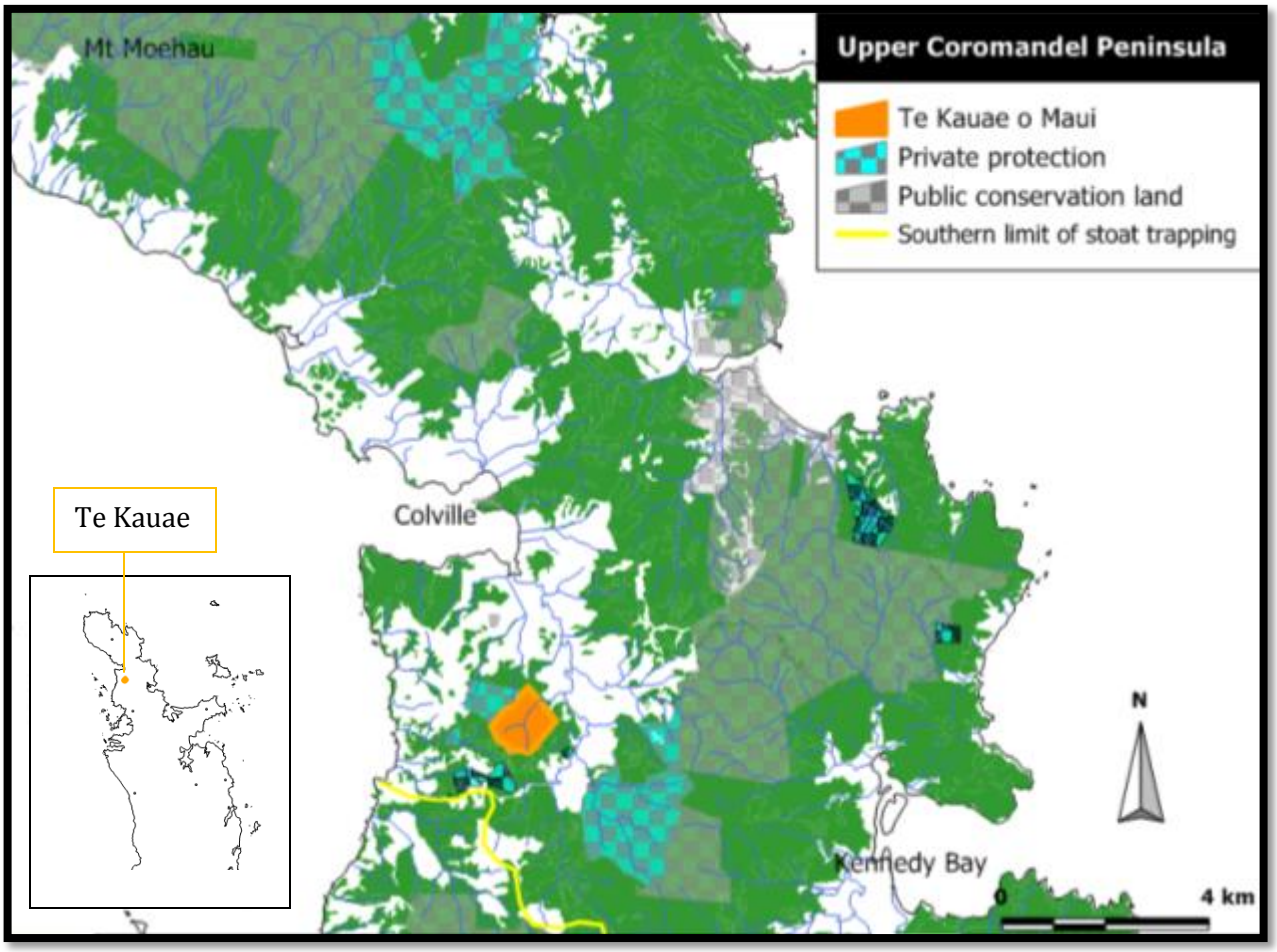

FIGURE 1: TE KAUAE O MAUI NATURE RESERVE LOCATION

eastern margins of the area (see weed location A in Figure 12). Prior to purchase all remnant merchantable kauri and podocarp species had been logged, but it appears much of the valley escaped enveloping fire events.

Te Kauae is located on the true left of the Colville Valley in north-west of the Colville Ecological District (ED) and predominately lies in the lowland/semi coastal bio-climatic zone. The area encompasses a forested unnamed tributary to the Umangawha Stream which drains into Colville Bay. Terrain grades from low angle slopes about the lower reaches of the stream to high angle slopes in headwaters. Elevation range is from 20 to 285 m above sea level.

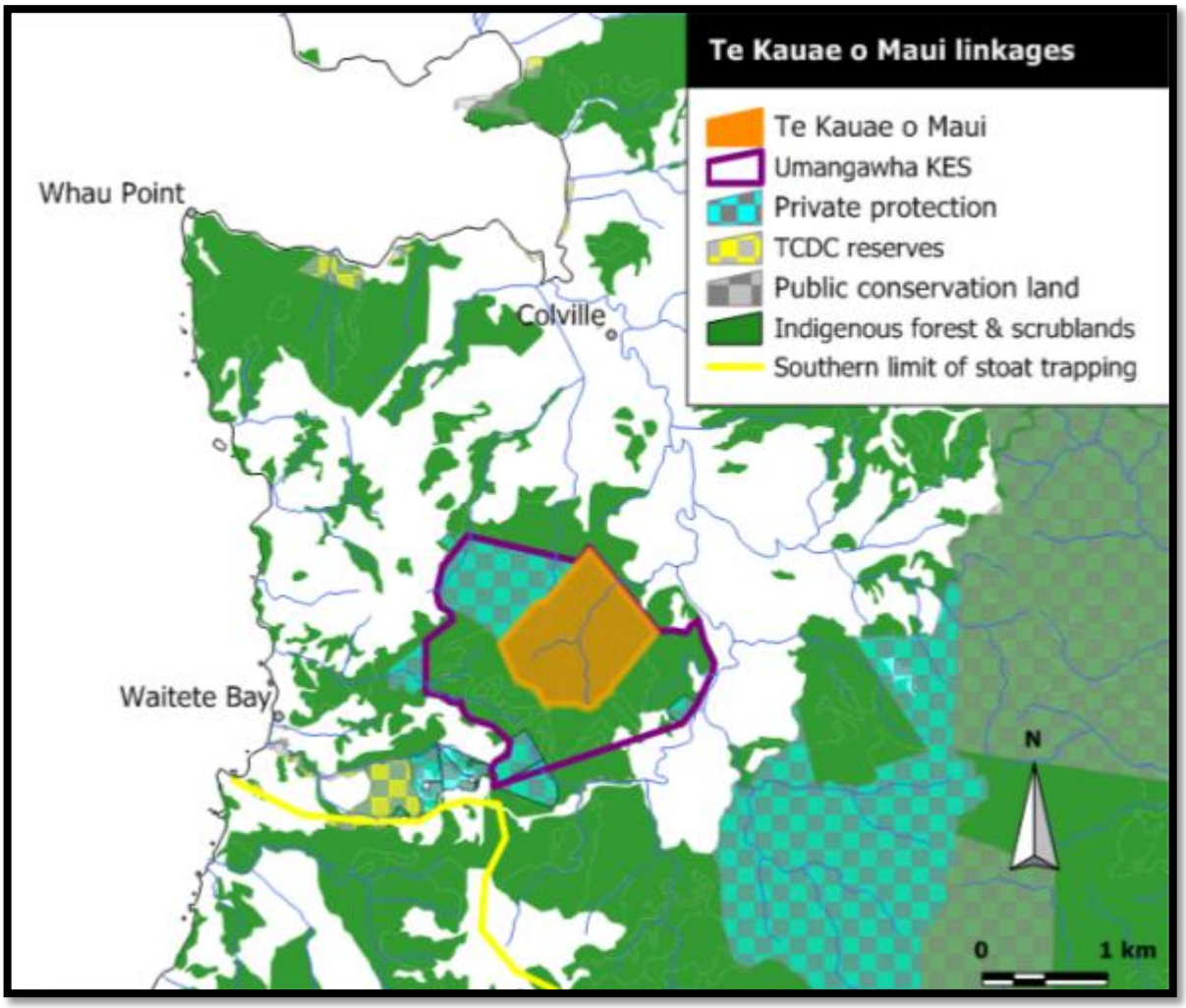

FIGURE 2: TE KAUAE O MAUI NATURE RESERVE LOCATION & LINKAGES

Parent rock is of volcanic origin (GNS, 2011), and the brown clay soils are considered to

be of relatively low fertility and poor drainage (McLeod and Briggs, 2009).

The site is not formally protected and forms a key linkage function between outlying public and private protected lands and to the Coromandel Range (sees Figures 1 & 2). It also directly buffers a total of 339.45 hectares (ha) of surrounding forest/scrublands, 105.99 ha being protected either by Thames Coromandel District Council or QE 11 covenant, the remaining 233.46 ha being unprotected. There have been three publicly funded ecological assessments of this area over the last 20 years:

1. Coromandel brown kiwi (*Apteryx mantelli*) survey: in 1992/93 a low density grid square survey of the Coromandel Ecological Region (ER) north of the Karangahake Gorge was completed (Marsh, 1993). During that survey the birds distribution was found to be unevenly distributed/fragmented across the region, but good numbers of kiwi were detected at the Umangawha site.

2. Key Ecological Site (KES): an assessment of ecological values and threats with the purpose of prioritising funding for a limited number of ecological sites on the Coromandel Peninsula was completed in 1999 (Stanway *et al*. 2000). The designation of the Umangawha KES (T10/9/TC) was primarily due to the remant kiwi population and it can be seen in Figure 2 that most of this area is not formally protected.

3. An assessment of significant natural areas (SNA) was completed in 2008/09 for the Waikato Regional and Thames/Coromandel District Councils (Kessels *et al*. 2010). This desktop project covered all natural areas > 0.5 ha above MHWS in the TCDC territorial area with the aim to prioritise areas for biodiversity management based on different ecosystems. TKOM is a component (97 ha) of the 330.46 ha Te Kauae O Maui SNA (TC090) and under present Waikato Regional Council criteria would be considered to be nationally significant due to the presence of resident nationally threatened wildlife (*ibid*).

No previous comprehensive investigation of terrestrial biodiversity has been completed. A review of available literature suggests flora to be a mosaic of secondary forest/ scrub-land supporting Nationally Vulnerable fauna. Nationally At Risk flora is present.

1.3 Te Kauae vision

The Te Kauae project aims to "Restore natural processes/species through a holistic kaitiakitanga or guardianship", and these are in alignment with the New Zealand Biodiversity Strategy (DOC & MfE, 2000) which seeks to reverse biodiversity decline in key natural areas.

"To restore natural processes/species through a holistic kaitiakitanga or guardianship."

The initiative aims to showcase how local key ecological processes and threatened species recovery can be attained in a rural and natural lifestyle community. It also seeks to contribute to recovery of meta populations such as kiwi and kaka across the Upper Coromandel landscape.

1.4 Te Kauae goals

A. To restore all known floristic associations at TKOM and improve pollination and seed dispersal

- Threatened and uncommon flora in the reserve are restored so that they contribute to the biodiversity of the reserve.
- Plant pest control efforts within the area result in the effective control of these species resulting in the restoration of forest systems.

B. Protection of resident and visiting meta population species

- To provide safe linkages for the dispersal of native species between the Coromandel Range and coastal communities from Waitete Bay to Whau Point.
- Continue to protect and advocate for the protection of kiwi at TKOM and in the wider community.
- Provide safe refuge for large hole nesting species (such as kaka) that are prone to predation by stoats.

C. Restoration of relict fauna clusters whose home range is predominately confined to TKOM

- To create self sustaining herpetofauna and mollusc populations within the TKOM operational area.

D. To provide natural aesthetic and medicinal resources to the Te Kauae o Maui and nearby communities

- Restore forest bird population for the appreciation and enjoyment of the wider community.
- Provide for the propagation and sustainable harvest of medicinal plants (Rongo).

1.5 Actions

- Threatened and uncommon flora species will be propagated and re-established in appropriate ecological niches.
- Animal and plant pests will be controlled to low densities (except mice) and ongoing control strategies initiated.
- Intensive control of all rodents will be implemented about any known small fauna population clusters.
- A flexible 2 wire solar electric fence will be established about the perimeter to protect fauna species from known and potential feral pig threats/effects[3].
- Supplementary habitat will be provided for lizards.
- Possums will be consistently controlled to low densities and rats to < 5% tracking rates. Mice will not be targeted except about known small fauna population clusters.
- Result and outcome monitoring will be established to measure the efficacy of protection measures.

1.6 Result and outcome monitoring – measuring performance

Monitoring is important to assess progress towards achieving these actions/goals. Progress will be assessed by:

[3] Action requires feasibility test

I. Annual reporting of pest control and monitoring results.

II. Annual reporting of floristic restoration and outcome monitoring (weta, lizards and forest canopy[4]).

1.7 Ecosystem restoration – realistic medium term goals and long term vision

Much of the coastal/lowland forest about Colville has been converted for pastoral/forestry purposes post European settlement. This has resulted in habitat loss/fragmentation, the introduction of mammalian browsers/predators and associated degradation of forest processes (pollination, seed dispersal and soil generation). Restoration efforts need to be both realistic in terms of the present situation but also look to the future in terms of what type of habitat will provide opportunity for future generations.

Restoration of locally relict habitat and species is explored in Section 3. It appears that there are substantive gains to be made over the medium term (next 20yrs) with regard to flora species richness and potentially also for invertebrates and lizards through intensive rat control. It is acknowledged that fauna diversity/densities are unlikely to reach that of offshore islands where nutrient inputs are substantively higher.

Te Kauae also forms an important anchor role for local biodiversity restoration as it is surrounded by remnant habitat clusters which singularly are unlikely to substantively contribute to improved biodiversity due to issues of scale and fragmentation. E.g. there are a number of linked privately and publicly protected natural areas to the west in the Waitete Valley (see Figure 2). Limestone which is naturally uncommon in the Coromandel ER is a present in this valley, and the potential for natural value restoration which includes pohutukawa (*Metrosideros excelsa*) associations on spurs is high.

2. Biodiversity values - Flora

Vegetation is continuous from the Colville Valley floor to the crest of the low coastal dividing ridge. Remnant vegetation patterns suggest that broadleaved tarairi-kohekohe associations originally dominated gullies and these graded to kauri-podocarp/broadleaved

[4] Bird counts are not recommended due to the relatively small management area

associations on spurs and slopes. There is also evidence that pohutukawa was an associate on upper spurs and ridges throughout the area.

The area falls within the semi coastal bioclimatic zone. Diagnostic features to support this classification include tawapou (*Planchonella costata*) and houpara (*Pseudopanax lessonii*) (one instance of each species only), whau (*Entelia arborescens*) in the old growth gully and coastal influence to *Metrosideros spp*. throughout the area (Figure 3).

FIGURE 3: COASTAL INFLUENCES AT TE KAUAE - NORTHERN RATA (*METROSIDEROUS ROBUSTA*) AND POHUTUKAWA IN CLOSE PROXIMITY.

Gullies and upper slopes have retained more of their original floristic elements while the lower slopes and spurs have been most modified by logging prior to 1980.

General forest vegetation types are shown in Figure 2 using the Waikato Regional Council (BIO VEG) GIS layer. This is a slightly simplified version of the Land Cover Data Base 2 (LCDB 2) vegetation classification system that is based on characteristics

such as phenology and floristic composition. More detailed field assessment found an intact primary tarairi-kohekohe association in a side gully not identified in the BIOVEG layer (see blue area in Figure 4) and also a north facing secondary pohutukawa/kauri association (red area in Figure 4).

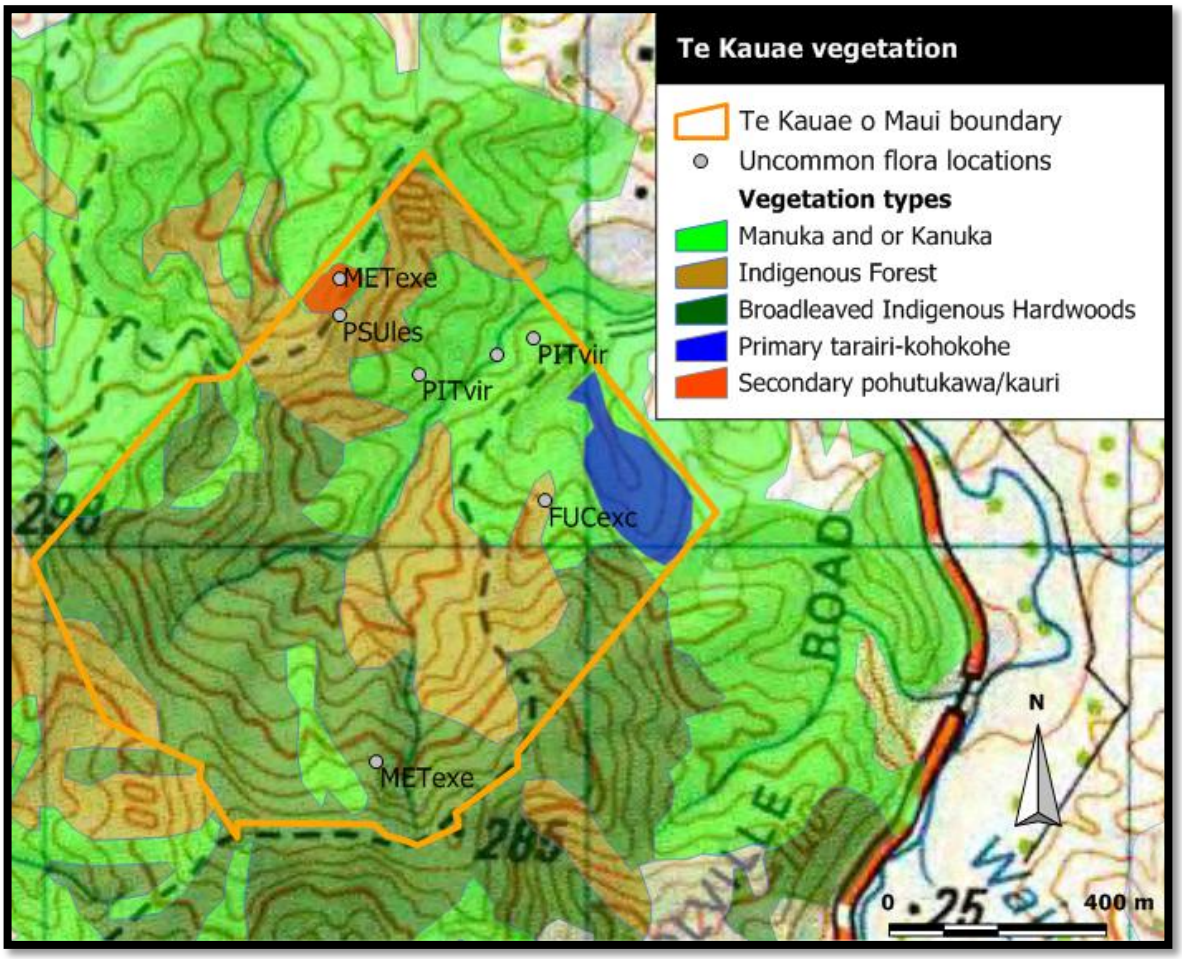

FIGURE 4: TE KAUAE O MAUI VEGETATION

In general terms the lower slopes are dominated by a regenerating kauri/kanuka association (10 - 15 m high) (see Figure 5) which grades to manuka (5 m) on steep spurs that also support some very dense stands of regenerating kauri and tanekaha (*Agathis australis* & *Phyllocladus trichomanoides*). The Nationally At Risk *Pittosporum virgatum* was also observed in two discrete areas (see Figure 4). Common hardwood species such as hangehange (*Geniostoma ligustrifolium*), heketara (*Olearia rani*) and *Coprosma spp*. are present in the kanuka understory. On manuka spurs prone to drought more hardy

species such as mingimingi (*Leucopogon fasciculatus*), divaricating *Coprosma spp*. and akepiro (*Olearia furfuracea*) were typically encountered.

FIGURE 5: LOWER CATCHMENT REGENERATING SLOPES, TE KAUAE 2011

Gully systems are less modified and support mature rata/tarairi-kohekohe (*Beilschmiedia taraire-Dysoxylum spectabile*) forest (see Figure 6), but in the upper catchment (shown as hardwood association in Figure 2), tawa (*Beilschmiedia tawa*) replaces tarairi on steep slopes. Much of the hardwood association forest has been logged and old bulldozer routes are readily identified by lines of kanuka through the broadleaved forest. Nikau is commonly observed as a canopy and also sub canopy species and puriri was observed throughout the area. As expected forest structure is more complete with a range of epiphytes, treefern associations in the sub canopy and supple jack (*Ripogonum scandens*) is present in gullies. Forest understory was relatively sparse in the tarairi dominated forest, but more dense and diverse on upper slopes where light levels are higher.

FIGURE 6: LOWER CATCHMENT TARAIRI-KOHEKOHE FOREST, TE KAUAU O MAUI

3. Restoration of uncommon species and nectar/fruit productivity

Amongst the mosaic of forest there were several species/forest associations that were uncommon at Te Kauae and these have been identified with the objective of restoration and also improving nectar/fruit productivity. Several of the uncommon species are not presently classified as Nationally Threatened/At Risk. However as there are only very few of these individuals present in the area, and also the level of input into their propagation and establishment is low, securing their contribution to forest processes at Te Kauae is considered important. The areas/species are shown in Figure 7, standard species

abbreviations are used[5], and a guide to the likely areas that would be favourable for each species is shown.

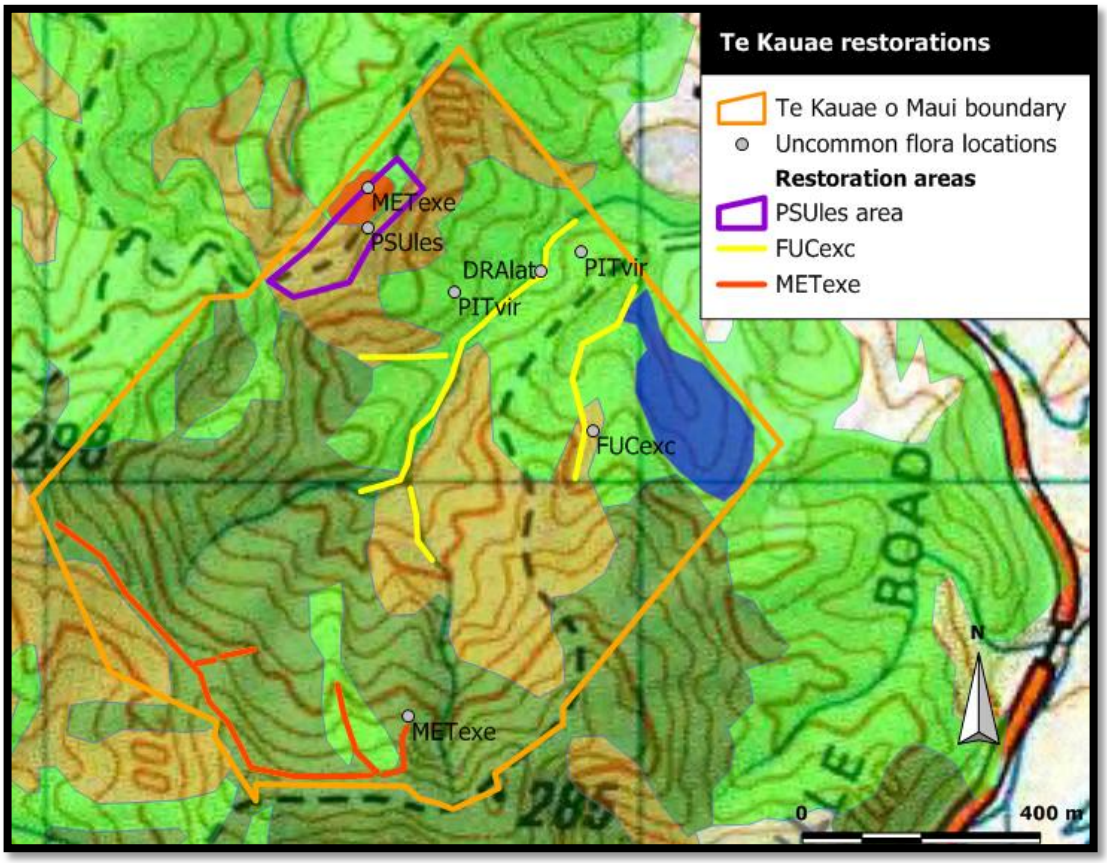

FIGURE 7: UNCOMMON SPECIES/RECCOMENDED RESTORATION AREAS, TE KAUAE

Wholesale planting of species throughout these areas is not recommended; more a considered approach that duplicates aspect, soil, drainage and light conditions where species persist is advised.

Species for restoration

Pittosporum virgatum is classified as Naturally Uncommon and on the Coromandel Peninsula is sparsely distributed (typically about groves of regenerating kauri forest). Several adults were observed about the locations shown in Figure 7. However no immature specimens were noted and one potential reason for this may be possum browse as the dry spurs are also favoured by possums (no onsite evidence was obtained to

[5] METexe - pohutukawa, FUCexe - tree fuchsia, PSUles - houpara, PITvir - Pittosporum virgatum, DRAlat - Dracophyllum latifolium

support this line of thinking). Propagation of the species in other suitable reserve habitat is appropriate to future proof it against one off events such as fire.

Restoration action points:

1. Propagate and establish *Pittosporum virgatum* at other kauri remnants.

2. Monitor kauri spur remants for regeneration of *Pittosporum virgatum*.

FIGURE 8: *PITTOSPORUM VIRGATUM*, TE KAUAE O MAUE 2011

Tree Fuchsia was noted on one occasion and as it grows on forest margins it can be confused as an adventive species and inadvertently killed by poorly targeted weed control. It is also a preferred species by possums on the Coromandel Peninsula and restoration of this species will only be successful if possums are controlled to low densities. It is commonly found on stream margins in areas of medium light and these

riparian areas have been indicated in yellow (see Figure 7). The restoration of fuchsia would shade streams during summer due to its spreading habit from stream banks.

Restoration action points:

3: Propagate and replenish fuchsia in light wells about stream margins.

Coastal species have been identified on ridges and spurs at Te Kauae. There have been substantive disturbance to these areas, which has included bulldozing prior to 1980. With the exception of some old growth remnants most of these areas are now dominated by kanuka/manuka therefore the future floristic component of these areas is unclear as the most common understory species are presently mahoe (*Melicytus ramiflorus*) and fivefinger (*Pseudopanax arboreus*).

Pohutukawa is the dominant emergent on coastal spurs in the upper Colville ED and it would appear justified from ecological and natural character perspectives to restore this forest component at Te Kauae. The associate houpara (*Pseudopanax lessonii*) was also observed (one adult specimen only) and so it has also been included as a restoration species. In addition both these species contribute profusely to nectar production and the inclusion of kowhai (*Sophora macrophylla*) as an early season nectar species would also be advantageous to nectarivores. Two mature nei nei (*Dracophyllum latifolium*)[6] specimens were observed at the toe of a steep spur (c.30m a.s.l.). This species is not nationally threatened but it would be ecologically advantageous that it is present in more than one location at TKOM. Further investigation of propagation and management techniques are recommended.

Restoration action points:

4. Propagate and establish pohutukawa, houpara, kowhai and nei nei.

Whau (*Entelea arborescens*) was observed in several riparian canopy gaps and should freely reproduce. It is vulnerable to weed competition and so weed surveillance is important.

[6] See photograph on back page

4. Biodiversity values - Fauna

The sanctuary supports several resident terrestrial threatened species. Those observed over the last ten years are summarised below in Table 1. Classification rankings are from (Miskelly et al. 2008) and (Newman *et al*. 2010).

TABLE 1: THREATENED SPECIES OBSERVED IN TE KAUAE O MAUI , 2000-2011

SPECIES	COMMON NAME	CLASSIFICATION	RESIDENT*
Apteryx mantelli	Coromandel Brown Kiwi	Nationally vulnerable	Y
Woodworthia maculatus or	Common gecko or	Not threatened	Y
Dactylocnemis pacificus	Pacific gecko	At risk	Y
Naultinus elegens	Auckland green gecko	At risk	Y
Leiopelma hochstetteri	Hochstetter's frog	At risk	Y
Nestor meridionalis septentrionalis	NI kaka	Nationally vulnerable	U/N
Paryphanta sp.?	Kauri snail (shell)	Indeterminate	U/N

*Residency status notes: Y = yes, U/N = unknown, N = no

4.1 Avifauna

Kiwi protection and monitoring

Coromandel Brown kiwi are an endemic long lived nationally threatened species considered to be in serious decline without management (Miskelly *et al.* 2008). Kiwi on the Coromandel peninsula are considered to be a genetically distinct form of brown kiwi endemic to the Coromandel Ecological Region (ER) (Burbidge *et al*. 2003) which was estimated to contain 1,000 individuals in 2008 and projected to increase to about 2,000 by 2018 (Holzapfel *et al.* 2008). Several actively managed populations are flourishing, but the fate of birds outside of the managed areas is not presently known and likely to mirror the national trend of decline. Unmanaged mainland brown kiwi populations are presently declining at an annual rate of 3%, primarily due to the predation of young kiwi by stoats (*Mustela erminea*) (*ibid*).

TKOM is a core component of the Umangawha KES which was identified an important remant kiwi population in the early 1990s (Marsh, 1993). Stoat trapping commenced in

2000 when 23 stoat traps were established about the 97 ha site. This effort was substantively bolstered in 2005 when the Moehau Environment Group established landscape scale stoat trapping throughout the local area. It can be seen in Figure 2 that Te Kauae is near the southern limit of continuous landscape protection in the Upper Coromandel peninsula and is also potentially exposed to invasion by ferrets.

A kiwi listening survey in 2010 determined that at least 6 pair were considered to be predominately inside the eastern 40ha of TKOM (T. Herbert, pers. comm.). This equates to approximately one pair per 7 ha and densities such as this are found only in discrete locations in the Coromandel ER (pers, obs). There is also some chick survivorship information as a male (Barney) was monitored for three years and hatched four chicks each year (not all were able to be monitored as some chicks were inaccessible in burrows). Of these six chicks were transmittered, with one surviving to 1500 grams when it was killed by a dog on the western bush boundary. A second chick <1000g was also killed by a dog that same weekend as stock were being moved from forest on a neighbouring property. Two others died from stoat predation and the sixth dropped its transmitter prior to reaching 1000g and so its fate is unknown. One chick was successfully released after it attained 1000g.

More recently two other adult kiwi are known to have died (trapping and dog) on land buffering TKOM and a sub adult has taken residence behind one of the houses and so although kiwi persist in the greater Umangawha area, it is presently unclear if this cluster of birds is contributing to the wider kiwi population. Educating dog owners and possum trappers is an ongoing task that is facilitated by TKOM landowners. Dog owners in the neighbouring area are encouraged to regularly put their dogs through kiwi aversion training, but not all people in the wider community are motivated to do this.

This is especially important given that the proportion of days that adult kiwi roost on the surface (c.f. in burrows and hollow logs) is about 50% in regenerating scrublands (males 46%, females 64%) and 91% for chicks (data from Moehau - Forbes, 2009). Functional dog aversion training and appropriate land development policy rules that give dog owners and kiwi a fair go are critical to minimise this threat. Even if birds are not killed, disturbance during nesting periods has been shown to be a factor in nest failures at

Moehau (T. Herbert, pers. comm.) and this also has implications for development activities in kiwi habitat during nesting periods.

Stoats and kiwi have large home ranges and so it would be unfair to recommend operational thresholds for kiwi densities at this small site as it is near the southern limit of contiguous landscape trapping in the northern Coromandel (see Figure 1). There are also several site specific risks to birds that could be mitigated by the following actions:

1. Potential for birds to fall into incomplete building foundations. A large female has been found dead within building foundations in recent times on the Coromandel peninsula. An awareness of this hazard by residents when constructing buildings would minimise the threat.

2. Pig hunters and their dogs have been observed to come into the area without permission. Pigs also represent a disturbance threat during nesting (and threat to other fauna) and so the exclusion of pigs would help mitigate both of these threats. A permanent electric fence system about the boundary is considered to be the most practical method of exclusion.

3. Potential for transmission of avifauna disease from domestic birds to kiwi and a plan to deal with this possibility is recommended. Options such as double fencing any chook range areas may be a practical mitigation measure against future issues.

Kiwi Action Points:

1. Reduce threats to kiwi by continuing to advocate dog aversion training in the local area.

2. Encourage local trappers to used kiwi safe trap setting methods.

3. Minimise threats to birds about dwelling sites.

4. Reduce the frequency of feral pig and dog visitation into Te Kauae.

5. Continue listening surveys to monitor the adult calling population.

Other birdlife

Some forest bird species are expected to benefit from enhanced habitat and threat management. E.g. tui (*Prosthemadera novaeseelandiae*) and kereru (*Hemiphaga novaeseelandiae*) as described in Baber et al, 2009. However monitoring the benefit of management is likely to be problematic due to the relatively small treatment area and also the mobility of forest bird species. Outcome monitoring is therefore not recommended, but perhaps more instructive would be the confirmation of species such as kaka consistently nesting in the reserve.

Other birdlife action point:

1. Observe for the occurrence of nesting bird kaka.

4.2 Herpetofauna

Frogs

Hochstetter's frog is present at Te Kauae. These frogs have meta populations on the Coromandel Ranges and, although riparian linkages between the Te Umangawha Ridge system and the main ranges have been degraded since European development, these frogs are likely closely related to the main Coromandel Range frogs and not a distinct population that deserves special attention/ management.

Preferred habitat for these frogs is restricted to 1st order streams at Te Kauae and monitoring of this species is not recommended due to the potential disturbance of refugia which are sparse. Further it is likely that that these frogs are persisting at the lower limits of their habitat range due to environmental limitations. E.g.: a 17, 000ha survey of Hochstetter's frog in 2008 (in Colville ED) found that frog densities were positively correlated with increased elevation (pers. obs) and that detection rates substantively decreased as distance increased from the main Coromandel Ranges towards the coast.

For the above reasons it is strongly recommended that these frogs not be sampled/ interfered with as there is a reasonable chance their survivorship at Te Kauae could be compromised. There is also a possibility that the Nationally Vulnerable Archey's frog may be present as they have been detected at low altitudes on the eastern seaboard of the Moehau Range (pers. obs.). The level of effort required to confidently search for this species is beyond the scope of this report.

Lizards

Brown and green gecko's have previously been detected about lower Te Kauae scrubland areas, usually under old drums and iron and while gathering firewood (N & N McCauley, pers. comm.). During the field work three brown gecko specimens of varying age classes were observed and a green gecko was found dead by residents.

Coromandel Striped Gecko (*Toropuku stephensi var. coromandel*) is potentially present (Data Deficient/formally Nationally Critical), as it has been detected within 600 m of TKOM (Chappell, 2007) (see Figure 9). The field survey was completed during winter and so an intensive search for lizards was not completed, therefore the reported lizard results should be treated with some caution. Control of mammalian predators should benefit lizards and outcome monitoring is considered appropriate.

The establishment of artificial cover objects (ACO's) (incl. ground onduline™ sheets and tree wraps) is recommended (3 x replicates of 10 ACO stations). Night time spotlighting is also feasible in some areas and in addition tracking tunnel footprint data may also assist with efforts to understand changes in populations over time.

FIGURE 9: COROMANDEL STRIPED GECKO, COROMANDEL TOWN 2007

Lizard action points:

1. Establish three replicates of 10 ACO's and tree wraps in preferred habitat.

2. Assess tracking cards for lizard prints over time.

3. Complete night transects during optimal weather conditions.

Ground skinks have also been observed by residents sunning themselves about forest margins during warm periods but these have yet to be identified.

4.3 Molluscs

A large native snail shell (approx. 55 x 20mm) (See Figure 10) was found on the ground by a resident in 2006 while excavating shed foundations on the margin of the 3ha old growth gully (blue area in Figure 4). No further evidence of large native snails was detected during a daytime search of the area on 8 September 2011. As with many endemic species they tend to be long lived and so it is possible that a relict *Paryphanta sp.* population has persisted in relatively unmodified forest, but there are doubts as to the provenance of this individual shell. Several scenarios as postulated below:

1. An empty shell has been lost/discarded from an informal collection that people living in the area may have had.
2. It could have been the result of an informal translocation effort.
3. Snails persist/ed elsewhere at Te Kauae and the shell has been moved from another discrete area at Te Kauae by a mammalian predator.
4. A relict population was not detected during the daytime search in the old growth gully.

Mollusc action points:

1. Informally survey other areas to establish if the species is present.

2. Control mammalian threats to very low densities around any identified mollusc areas.

FIGURE 10: LARGE LAND SNAIL, COLLECTED TE KAUAE O MAUI 2006

Threatened native snail species may be present in the reserve but in the absence of further evidence a watching brief only is recommended. If in the event there is a small relict population present at Te Kauae then probably the best chance of any further detections lies in informal day/night observations while intensive mammalian threat operations are completed in the immediate vicinity.

5. Recommended threat management programme

There are two general ecological restoration options in mainland New Zealand. Eradication of mammalian predators has been effected within pest exclusion areas (E.g: Zealandia), resulting in the security of biodiversity assets within these areas. Management of threats to low densities range in scale from landscape projects (e.g. Operation ARC in the South Island where aerial treatment of large scale sites has resulted

in the recovery of threatened species), to smaller ground based operations where typically a range of toxins is used within a bait station network. Due to issues of scale and a preference towards trapping techniques neither of these models are applicable at TKOM. What is required is a systematic approach that both controls threats and also prevents leakage of threat species into a relatively small protected area and this poses some challenges. Each individual threat has been identified and location specific options presented. With the exception of stoat control most strategies revolve around a scenario of low levels of threat management on adjacent lands.

Possums
Priority: High
Non target effects: Potential to trap kiwi if trap sets are not kiwi proof.

Local landowners and the Department of Conservation (DoC) began controlling possums on the Upper Coromandel Peninsula in the late 1980's when forest canopy condition was just beginning to decline due to possum impacts (Burns, 1985). The establishment of possums was relatively late on the Upper Peninsula compared to other mainland North Island areas and they have been controlled intermittently since 2000 at Te Kauae.

Field observations indicate that vulnerable forest species are in good condition in the lower (eastern) portion of the reserve, but still recovering from past effects in the upper areas. Recent Te Kauae trapping data shows that 346 possums were caught for the 8 months to August 2011 (see Table 2). All ridges and spurs were systematically trapped (see Figure 11) until capture rates declined to zero. The gender ratio was even indicating that a good proportion of residents were captured. While acknowledging the potential for some dispersal throughout the area over the period, it appears that densities were moderate prior to treatment this year (at least 3.6 possums/ha (346/97ha)).

TABLE 2: TRAPPING RESULTS TE KAUAE O MAUI, JANUARY- AUGUST 2011

Possums	Stoats	Rats	Mice	Cats	Magpies
346	2	140	60	5	2

The data also shows that possums were unevenly distributed throughout the area and this is attributed to favoured habitat such as northern elevated aspect in winter and the presence of preferred forest species. This is not surprising considering the mosaic of vegetation patterns at Te Kauae.

The control of possums to very low densities is very achievable. However maintaining this will require consistent inputs especially about the perimeter which is mostly contiguous forest/scrub and in the main untreated. While trapping the peremeter should be effective, it will continue to be labour intensive and maintaining possum densities to very low levels is considered to be important to the recovery of small fauna at Te Kauae.

Alternatively there are several re-setting traps passing through trial and approval processes and results to date indicate they are likely to have similar coverage to bait stations (D. Peters, pers comm.). An ideal scenario would be to saturate the reserve with re-setting traps at 150m intervals. This would require approximately 52 traps and a theoretical layout is shown in Figure 11. In the event that finance was initially unavailable for the full amount then half the number would ensure a buffer line was established about the perimeter. Manual control would be necessary throughout the reserve on an annual basis during periods of possum dispersal if only the buffer option was initiated.

Possum control action points:

1. Systematically control possums with a kiwi-safe ridgeline/spur trapping network.

2. Establish 40 forest condition monitoring plots.

Monitoring the outcome of possum control is likely to be problematic in this small mixed habitat treatment area. In addition it is clear from the walkthrough surveys that the canopy condition of indicator species (e.g kohekohe) in the lower eastern portion of the area is in considerably better health than that to the west (upper). Randomised representative sampling is considered inappropriate and instead a systematic technique utilizing the standard Foliar Browse Index method (Payton *et al*., 1999) is recommended. Two indicator species would be selected within 20m radius plots at 100m intervals along the small mammal tracking lines, and possum effects to canopy, fruiting/flowering and trunk stem use assessed. This will result in data from up to 40 plots from transects 31-34, with 20 plots in the lower and upper catchment areas respectively. Parameters to be recorded are shown in Appendix 2. This sample may not be large enough for statistical analysis, but will constitute a large proportion of indicator species that is available to be

assessed in an independent manner. Insufficient indicator trees may potentially be present and the use of simple photo monitoring of indicator species is recommended as a back stop measure in this eventuality.

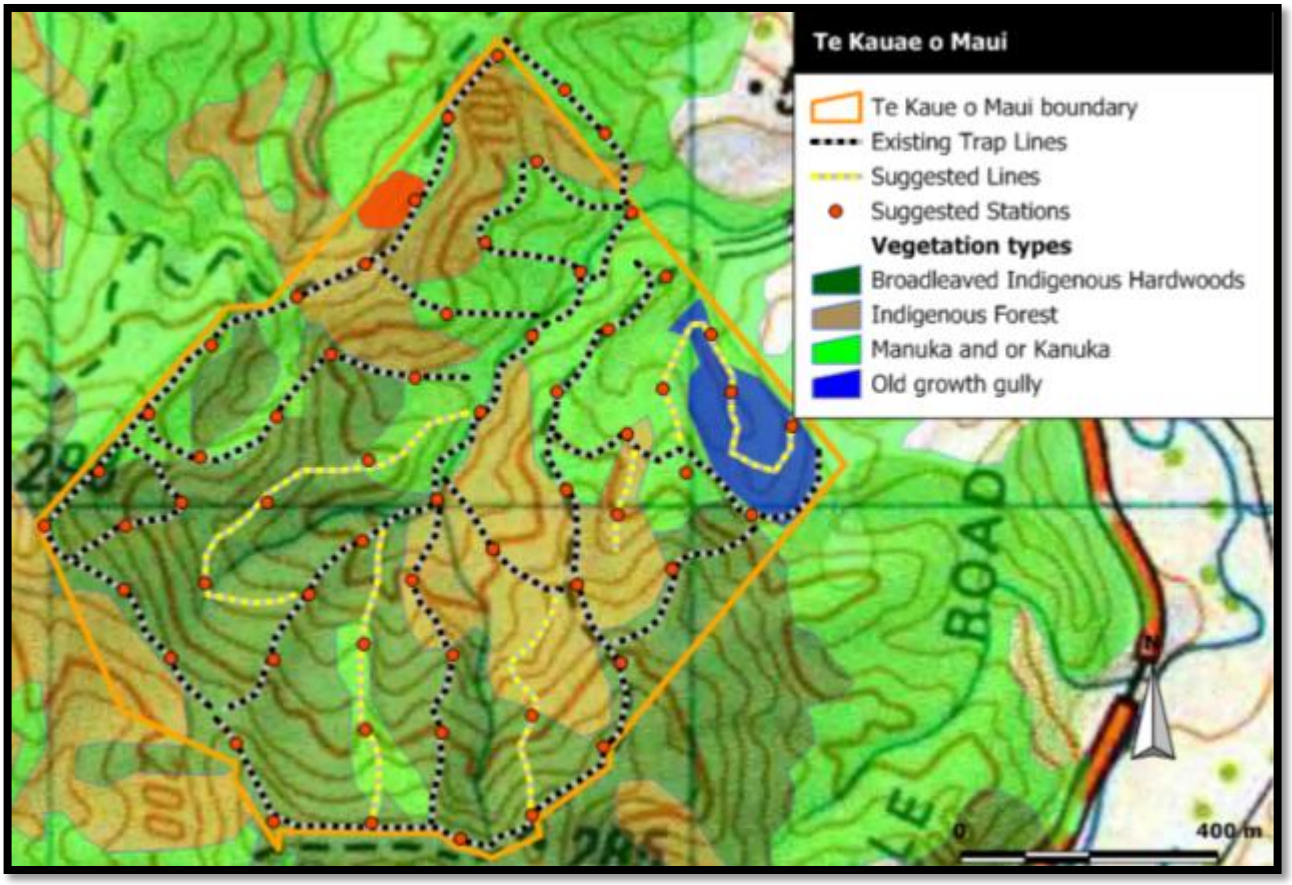

FIGURE 11: EXISTING AND RECOMENDED SUPLEMENTARY POSSUM CONTROL LINES, TE KAUE O MAUI.

Stoats

Priority: Continued maintenance and monitoring.

Non target effects: Potential to capture small forest birds in DoC 200's.

In 2000 23 stoat boxes were established in accordance with best practice (at 200m intervals). Stoat boxes are now checked in accordance with the Moehau Environment Groups management regime. In terms of trapping no further recommendations are made to this approach and annual monitoring of kiwi is recommended. Continued high quality trapping is essential as the TKOM stoat control effort is an integral component of landscape scale stoat trapping north of Waitete Bay. The overall landscape effort is important not only for kiwi in the general landscape but it also supports small scale

habitat protection for shore birds such as New Zealand dotterel (*Charadrius obscurus*) on the coastline from Waitete Bay to Whau Point. In addition the landscape trapping effort buffers the Colville Bay winter flock site which has been designated one of the four most important on the Coromandel Peninsula for NZ dotterel (Dowding, 2006).

Goats
Priority: Presently low
Non target effects: Not applicable at present

Goats established in the Upper Coromandel around the 1870s (Moore and Cranwell 1934), and reached medium to heavy infestation levels by 1950. Goats cause substantial damage to the forest understory. Large mobs were present throughout the local area and hunted for sport during the early 1970's (pers obs). Subsequently a large proportion of them were removed by members of the public and finally hunted to functional extinction in the late 2000's by DoC hunters. No goat sign was noted during the field surveys or during separate field work in the local area and they are probably not a management issue at TKOM at this time. Surveillance will be required to detect any future escapes/releases.

Cats
Priority: High
Non target effects: None - cage traps are utilised.

Cat invasion will be continuous and need to be controlled in perpetuity. Presently cats are targeted when sign is observed. No improvements are recommended to this approach due to the relatively small area of the site (in relation to cat ranges) and the frequency of informal monitoring that trappers move throughout the area. It is recommended that the number of cage traps be increased from two to five.

Feral pigs
Priority: High
Non target effects: None - cage traps are utilised and an exclusion electric fence recommended. Potential of electric shock to kiwi if bottom wire was live.

The case for excluding feral pigs is justified as they have been shown to impact on forest regeneration (C. Krull, pers comm.), predate on herpetofauna (pers obs.) and also attract pig hunters and dogs in to the area. They are also considered a vector for kauri collar rot fungus (*Phytophthora taxon Agathis*). A practical two wire solar electric fence about the ridge/spur margins of the reserve is recommended as in addition to excluding pigs, it would also mitigate the effect of wayward hunting dogs and reduce disturbance to nesting

kiwi. Fences in bush are adversely affected by factors such as windfall and the concept would need to be investigated thoroughly prior to funding applications. Conceptually one low earthing wire (non electric) close to ground and another (live) at approximately 400mm above ground that is easily re-established after storms etc. is envisioned.

Feral pig action point:

1. Design and construct a practical electric exclusion pig fence.

Rodent control
Priority: High
Non target effects: Potential to capture forest bird species in traps and for mouse population eruption if rats are controlled to very low densities.

Rats have been targeted with covered single action traps since 2000 about some discrete areas and informally captured as by catch during possum trapping. Control needs to be more intensive and systematic to control rats to low densities in order to promote recovery of vulnerable fauna species. Rat control (over the entire area) would require the establishment of 600-1800 rat traps (density range of 6-18 traps/ha) throughout the entire area, which would be a substantive sum to raise and also to check and maintain. The primary advantage of this approach is that it would soak up any re-invasion or leakage from adjacent areas.

Due to the variation in habitat it appears possible to treat areas of high carrying capacity as independent treatment areas and thus only require a smaller array of traps - somewhere between 72-216 traps (depending on trap densities) to treat discrete 12 ha areas (there would also need to be some overlap). There is risk with this approach as re-invasion from untreated areas may swamp the treated areas and so if tracking target thresholds were not met then trapping inputs would need to be reviewed. Pre-feeding prior to opening traps is considered to be of primary importance to take advantage of rodent behavioural traits and effectively reduce rat densities when using kill traps (B. Thomas, pers. comm.).

Some of the neighbouring land is privately protected (QE II) and the control of rodents on this neighbouring land near the common boundary my reduce leakage into the TKOM

treatment area. Restoration of natural process is in alignment with QE II objectives and so an approach to the neighbouring landowners should be considered.

Rodent control action points:

1. Establish a functional rat trapping network throughout the TKOM area and implement mouse trapping about key sites.

2. Utilize pre-feed trapping techniques prior to opening traps.

3. Respond to increases of rat tracking rates above 10%.

4. Advocate for control of rodents on adjacent land to minimise reinvasion.

Rodent monitoring

To date there has been no monitoring of rodents at Te Kauae. Densities are likely related to forest type, with rats dominating in the old growth broadleaved gullies and mice persisting on the steep scrubland spurs. The results of rat control will be assessed by using 10 x standard rat Trakka™ tunnels at 50m intervals on 4 x 450m transects placed 200m apart for independence (see Figure 12), as described in Gillies & Williams, 2002. Present result monitoring tracking rate thresholds for rats are 5% or less and this equates to no more than two tunnels tracking rats per monitoring round at Te Kauae.

Rodent result monitoring action point:

1. Establish, sample and analyze a minimum of 4 x independent 450m tracking tunnel transects in the TKOM area. A cluster specific transect will be also be required if discrete areas are trapped.

Outcome of rodent control monitoring

The monitoring of lizards as an outcome measure of performance is recommended, but if lizards are present in low densities then it may take some time before any material change in densities/distribution is observed. One complementary option would be to utilise tracking tunnel data of invertebrate species.

Auckland tree weta (*Hemideina thoracica*) have recently been shown to respond positively to the eradication of rodents at Maungatautiri (Watts *et al*, 2011). This species is likely to be present and so is considered a potential outcome monitoring indicator species. Another reason for choosing this species is that it is readily identifiable from

other weta species during all life stages and entails considerably less effort than making overall insect community counts (Watts *et al*, 2011). Replicating the sampling method as described at Maungatautiri is recommended and this will entail deploying tracking cards in 40 Trakka™ tunnels for weekly intervals during April when weta are most active on the ground (*ibid*). There are some risks with this approach as the Maungatautiri project was of complete eradication and also mice are not targeted at Te Kauae. Typically mouse densities increase in autumn. In addition the tracking tunnel coverage will not be as intensive as at Maungatautiri where tracking tunnels were placed on a 50m grid. Therefore it is possible that the Te Kauae sampling effort lacks necessary resolution, but given the tracking tunnels are to be established I consider the investment worthwhile due to the relatively low levels of effort required.

Outcome of rodent outcome monitoring action point:

1. Complete weekly weta tracking rounds during the month of April.

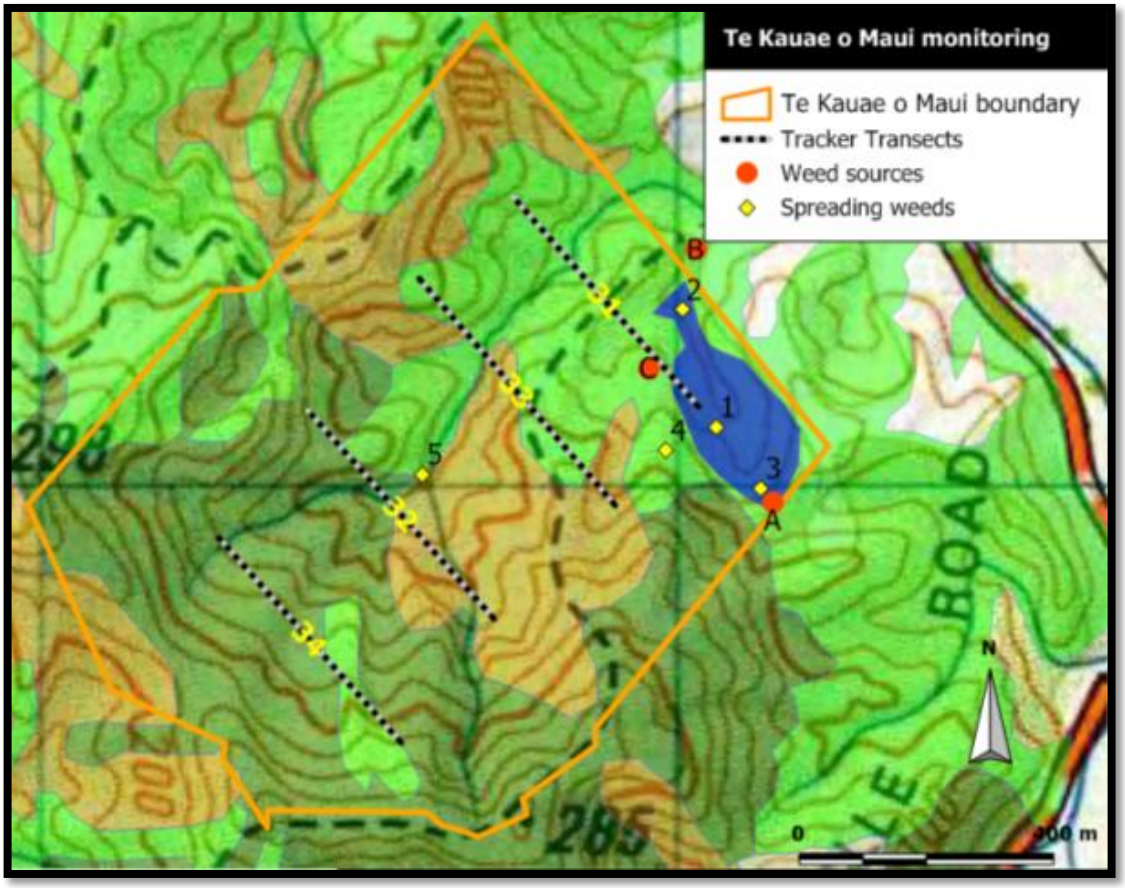

FIGURE 12: RECOMENDED TRACKING TRANSECTS, WEED SOURCES AND LOCATIONS WHERE ESCAPEES WERE DETECTED, TE KAUAE O MAUI 2011.

Summary

TKOM have opted for trapping techniques and while labour intensive, single action traps have been shown to be successful in controlling rats at other sites on the upper Coromandel in similar habitat (Stewart, in prep). However in these instances there is variance in trap densities (range 6 – 18 traps/ha for rats) and also checking frequencies. Establishing an effective balance between inputs and efficacy will entail some trial and error at Te Kauae.

There is uncertainty with regard to which approach to take. Would a blanket trapping technique be necessary or will a monitored discrete area approach will be sufficient? In addition there is also risk of operational failure as rat trapping initiatives have been found to be ineffective (e.g.: Ogden & Gilbert, 2008) and so the result/outcome monitoring methods as previously described will need to be employed to establish whether the treatment methods are benefiting flora/fauna values.

The future coordination of pest control with any neighbouring lands is also recommended as in addition to preventing leakage in to the TKOM operation area there is also potential to support threatened species across the wider landscape. With respect to possum control the main advantage of utilising resetting traps in a grid is that leakage of pests from outside the treatment area is intercepted prior them re-establishing.

Ecological plant pests

Priority: High

Non target effects: Potential for rare/uncommon flora to be cleared while plant pests are being removed.

The 2000 Biodiversity Strategy noted that "invasive pests and weeds pose the greatest single threat to biodiversity on land…that weed invasions threaten the long term viability of many of New Zealand's natural habitats"(DoC & MfE, 2000). There are two general risk areas of concern:

- they threaten the survival of native plants by smothering or out-competing them.
- they threaten the survival of native animals through providing cover for predators, reducing the availability of preferred foods and by lessening the availability of desirable habitats.

This is especially the case in northern coastal environments such as Te Kauae where the potential sustainable use of floral resources for commercial and medical advantage is also threatened (Mc Gowan, 2010). E.g.: whau which offers commercial opportunity due to its low weight to mass properties and is uncommon in the Colville ED. It occupies forest clearings/margins about the coastal bioclimatic zone and is also present at Te Kauae.

This species is vulnerable to completion/smothering by introduced species but fortunately the spread of weed species into forested habitat is at an early stage of establishment and control is presently still feasible. Established house site infestations were observed at sites A and C with the former hosting bird spread species such as jasmine, smilax and climbing passion fruit. Plectranthus and tradescantia were observed downstream on nearby neighboring property (site B) (see Table 3 for species list and priority of control).

Control of all species has been initiated (88 logged hrs since May 2011), but intensive inputs will need to be sustained over the medium term to get rid of the established infestations about abandoned residential areas. Of concern is the escape of smilax and passion fruit into the forest and immature specimens were observed in the vicinity of points 1-3 (see Figure 12). In particular smilax forms a dense mat over seedling and sapling forest tiers, suppressing forest regeneration. A contact search of this general area is required within the next year to prevent smilax establishing throughout the forest at Te Kauae. This effort will need to be repeated annually and general surveillance continued in perpetuity while seed sources remain within bird carrying distance (both in and out of TKOM).

The woolly nightshade infestation at location 4 has been controlled and is normally not an ongoing concern, but due to the relatively high light levels on the slope continued surveillance is recommended annually to ensure the scrubland understory association establishes.

The small streamside infestation of kahili ginger (location 5) has potential to spread throughout the Te Kauae forest. All adult plants have been controlled over the last three

years but annual ongoing surveillance is necessary to prevent regeneration and this includes any invasive species on neighbouring properties.

TABLE 3: PRIORITISATION OF PLANT PEST CONTROL, TE KAUAE

SPECIES	COMMON NAME	PRIORITY
Hedychium gardnerianum	Kahili ginger	High
Asparagus asparagoides	Smilax/climbing asparagus	High
Solanum jasminoides	Jasmine	High
Solanum mauritianum	Woolly nightshade	Medium
Phytolacca octandra	Climbing passion fruit	Meduim
Not determined	Unidentified succulent	Meduim
	Mexican daisy	Medium
Ageratina adenophora	Mexican devil weed	Low
Phytolacca octandra	Ink weed	Low
Tradescantia fluminensis	Tradescantia	Low
Plectranthus ciliatus	Plectranthus	Low

Invasive weed action points

1. Annually restrict the spread of fruit from mature adventive species into the forested area (includes those on nearby lands within bird borne range).

2. Control all species that are spreading from known infestations sites (Such as A & C).

3. Remove all known established infestations/species which includes abandoned gardens.

4. Advocate for non invasive species plantings about house sites.

5. Ensure weed control people are able to identity uncommon/threatened flora.

In summary there is a small suite of plant pest species scattered about the eastern half reserve (including neighbouring properties) and several species are spreading from existing infestations into the forest. Control of high and medium level threat species is achievable, but if not managed in as sustained manner they will establish and seriously affect forest components and systems within the medium term.

Biosecurity
Priority: High
Non target effects: Some degree of imposition on residents in terms of minimising the risk of adventive species/organisms establishing.

Weed issues have been addressed in the previous section and in general terms the risk of introducing harmful biota into the area is higher than at uninhabited sites due to building activities and general living in and around the forested areas. Strict biosecurity measures will likely be impractical so the following threats are identified and minimisation procedures recommended:

1. The introduction of microscopic biota such as *Phytophthora taxon Agathis* (PTA) which kills kauri is possible as residential areas are in close proximity to kauri. In addition feral pigs nest about the base of these trees (see Figure 13) and they have been implicated in the transference of this disease which is present in the Waitakere Ranges (Auckland), Northland and Great Barrier.

- clean/treat equipment that ahs been used in forest off the Coromandel Peninsula in areas of know PTA infestation.
- exclude pigs and dogs from the forested areas.

In the event that PTA does arrive on the Coromandel Peninsula then more stringent measures could be considered including felling small trees about house sites to prevent the establishment of PTA at Te Kauae and enacting stricter biosecurity controls when leaving residential areas to walk in the forest.

2. Avian disease that threatens kiwi could arrive in New Zealand at some point in time. Poultry are kept in the vicinity of the forest and there is potential overlap between domestic birds and wild kiwi. There would most likely be prior notice from statutory authorities and, although not urgent, contingencies such as the provision to house poultry out of the forest or maintain a quarantine on introducing more domestic stock should be considered at this point in time.

FIGURE 13: FERAL PIG NEST AT BASE OF KAURI, TE KAUAE 2011

Biosecurity action points:

1. Any field workers arriving from areas where PTA is present should follow recommended biosecurity protocol (clean and treat all field equipment).

2. Exclude dogs and feral pigs from forested areas.

3. Establish contingencies to prevent the spread of avian disease from domestic poultry to wild kiwi in the event that an avian disease harmful to kiwi arrives in NZ.

Acknowledgements

This work was primarily a desktop exercise, acknowledgement is made to the following people:

Wildlife and plant field records by Te Kauae o Maui biodiversity team (Nicole & Nathan McCauley). Thanks also to Mischa and Luke McCauley for helping with field surveys.

John Smith-Dodsworth identified the tawapou specimen which was growing in an unusual site.

Contributions by Rosemary Stewart and Hamish Kendal.

Te Kauae o Maui is grateful to the Biodiversity Advice Fund for funding this report.

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Appendix 1

Summary of all recommended action points, Te Kauae 2011 - 2016.

Floral restoration action points – non urgent but potential long term value:

1. Propagate and establish *Pittosporum virgatum* at other kauri remnants.

2. Monitor kauri spur remants for regeneration of *Pittosporum virgatum.*

3. Propagate and replenish fuchsia about stream margins.

4. Propagate and establish pohutukawa, houpara, kowhai and nei nei.

Kiwi action points – non urgent but important:

1. Reduce threats to kiwi by continuing to advocate for local dog aversion training.

2. Encourage local trappers to used kiwi safe trap setting methods.

3. Minimise threats to birds about dwelling sites.

4. Reduce the frequency of feral pig and dog visitation into Te Kauae.

5. Continue listening surveys to monitor the adult calling population.

Lizard action points – non urgent but potential high value:

1. Establish 3 replicates of 10 ACO's and tree wraps in preferred habitat.

2. Assess tracking cards for lizard prints over time.

3. Complete night transects during optimal weather conditions.

Mollusc action points - non urgent but potentially important:

1. Informally survey other areas to establish if the species is present.

2. Control mammalian threats to very low densities around any identified mollusc areas.

Possum control action points - non urgent but essential:

1. Systematically control possums with a kiwi safe ridgeline trapping network.

2. Establish forest condition monitoring plots.

Feral pig action point – non urgent but potential high value:

1. Design and construct a practical electric exclusion pig fence.

Rodent control action points – important and essential:

1. Establish a functional rat trapping network throughout the TKOM area and implement mouse trapping about key sites.
2. Utilize pre-feed trapping techniques prior to opening traps.
3. Respond to increases of rat tracking rates if they increase above 10%.
4. Advocate for control of rodents on adjacent land to minimise reinvasion.

Rodent result monitoring action point – important and essential:

1. Establish, sample and analyze a minimum of 4 x independent 450m tracking tunnel transects in the TKOM area. A cluster specific transect will be also be required if discrete areas are trapped.

Outcome of rodent outcome monitoring action point – non urgent but useful:

1. Complete weekly weta tracking rounds during the month of March.

Invasive weed action points – urgent and important:

1. Annually restrict the spread of fruit from mature adventive species into the forested area (includes those on nearby lands within bird borne range).
2. Control all species that are spreading from known infestations sites (Such as A & C).
3. Remove all known established infestations/species which includes abandoned gardens.
4. Advocate for non invasive species plantings about house sites.
5. Ensure weed control people are able to identity uncommon/threatened flora.

Biosecurity action points - non urgent but important:

1. Any field workers arriving from areas where PTA is present should follow recommended biosecurity protocol (clean and treat all field equipment).
2. Exclude dogs and feral pigs from forested areas.
3. Establish contingencies to prevent the spread of avian disease from domestic poultry to wild kiwi in the event that an avian disease harmful to kiwi arrives in NZ.

Appendix 2

Foliar browse index parameters – Te Kauae o Maui, 2011.

Parameters to be assessed during sampling of forest trees vulnerable to possum browse. Foliar Browse Index (Payton *et* al., 1999).

Species

Tag number

Distance from plot centre

Magnetic bearing from plot centre

Diameter at 1.35m height (note, "multi" or "M" indicate several stems that were not measured)

Species abundance (rare, occasional, common or abundant)

Tier (sub-canopy, canopy or emergent)

Segment assessed (whole tree or tagged stem only)

Level of possum trunk use (0 = no trunk use, 1 = light trunk use, 2 = moderate trunk use, 3 = heavy trunk use)

Foliage cover (scores given describe the percentage of the total canopy area filled with foliage from 5%; representing trees with 1 – 10% foliage cover; to 95% representing trees with 90 – 100% foliage cover, in 10% increments)

Level of possum browse (0 = no browse, 0.5 = 1-5% of leaves browsed, 1 = 6-25% of leaves browsed, 2 = 26-50% of leaves browsed, 3 = 51-75% of leaves browsed, and 4 = over 75% of leaves browsed). Both the top third, and the entire tree were assessed. The score of 0.5 was used for the first time in 1998. Prior to 1998 a score of 1 was allocated to trees with between 1 and 25% of leaves browsed.

Level of dieback (from 0 = no dieback, to 4 = over 75% of branches show dieback). Both the top third, and the entire tree were assessed

Abundance of flowers (from 0 = no flowers, to 4 = abundant flowers)

Abundance of fruit (from 0 = no fruit, to 4 = abundant fruit)

Two mature nei nei (*Dracophyllum latifolium*) specimens were observed at the toe of a steep spur (c.30m a.s.l.).