Black Maire (*Nestegis cunninghamii*) decline in the Haurangi Forest Park

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Introduction

In early 1995 the DOC officer responsible for the Haurangi Forest Park, Joe Hansen, drew attention to the extensive and recent decline of black maire, a dominant canopy species in the Washpool, Putangirua and Hurupi catchments and important in many other catchments in the park. In June, following a visit to the site by Philip Simpson (DOC Science and Research), foliage samples from debilitated trees were forwarded to FRI. These samples, while showing evidence of damage caused by a number of insects and disease, revealed no evidence of any primary agent of decline. It was suggested the insect and disease damage was more typical of trees under stress where ongoing attrition of the foliage occurs.

As a result of further discussions with Philip Simpson a field evaluation was requested, the results of which are presented in this report. Although this report is produced under the name of the contracted party, it includes valuable contributions by Philip Simpson, in particular with regard to vegetation structure (Simpson, 1995).

Background

The health of New Zealand's indigenous forests is causing increasing concern to NZ FRI's forest health specialists. Damage can generally be grouped into three broad types:

- IMPACT OF POSSUMS

As seen occurring in northern rata (*Metrosideros robusta*) (Hosking, 1994a), pohutukawa (*Metrosideros excelsa*) (Hosking and Hutcheson, 1993), montane totara (*Podocarpus cunninghamii*), and many other species. Damage by possums can generally be readily identified.

- NATURAL ECOLOGICAL PROCESSES

As seen in mountain beech (*Nothofagus solandri* var. *cliffortioides*) (Hosking and Hutcheson, 1988), red beech (*Nothofagus fusca*) (Hosking and Kershaw, 1985) and hard beech (*Nothofagus truncata*) (Hosking and Hutcheson, 1986). Declines associated with the natural dynamics of forest stands, including those driven by catastrophic events such as drought, often involve considerable research effort to identify and document the processes involved.

• UNEXPLAINED DECLINE

Over the past five years unexplained decline of a number of tree species has been brought to the attention of the forest health group. While such events may conform to natural processes, the coincidence of decline in several unrelated species seems to suggest a wider influence such as that which might result from major environmental change. Such unexplained declines include cabbage tree (*Cordyline australis*) (Hosking and Hutcheson, 1991), kanuka *(Kunxea ericotdes)* (Hosking,1994b), mangeo *(Litsea calicaris)* and rewarewa (*Knightia excelsa*). The symptoms expressed by these species are variable and may involve very rapid death as in cabbage tree, or more usually a slow contraction of the crown associated with a wide range of secondary pathogens and insects.

The line between the latter two categories is not always clear, since older stands or individual trees become more susceptible to dieback simply as a function of their age. The combination of the impact of possums and unexplained decline gives forest health researchers at NZ FRI considerable concern for the future of large areas of New Zealand's indigenous forests and shrublands.

Field investigation

A field visit to the Haurangi Forest Park was carried out between November 21 and 23 by the author in the company of Joe Hansen (DOC Officer, Te Kopu Field Centre), Philip Simpson (DOC Science and Research, Wellington) and Colin Miskelly (DOC Conservancy Advisory Scientist, Wellington).

The field evaluation involved three components:

- viewing of the forest from ground vantage points to examine the pattern of canopy decline and forest species associations (Appendix I).
- inspection of individual trees including a traverse across a typical area of decline (Appendix I).
- aerial inspection of major catchments with particular reference to the southern part of the park.

FOREST STRUCTURE

Large parts of the park have suffered severe human disturbance in the past, in particular from pastoral farming. The area most affected by maire dieback is immediately to the south of the farmed catchments of the Tauranganui river which is now regenerating hardwood shrubland containing extensive open grassland. Past burning has affected the forest structure in the Hurupi and Whangaimoana catchments where residual black maire, beech and totara are

scattered across an advanced, and largely continuous, hardwood shrubland. High forest begins in the upper Hurupi catchment and is typified by the Washpool catchment. A central core of original forest is flanked by various types of secondary shrubland and forest. Coastal forest, including ngaio (*Myoporum laetum*), kanuka, cabbage tree, akiraho (*Olearia paniculata*) and kowhai (*Sophora tetraptera*) occur on the steep slopes leading up to the elevated marine terraces along the western edge. Kanuka forest, with some manuka (*Leptospermum scoparium*), is widespread often with broadleaved understorey (kawakawa (*Macropiper excelsum*)) and riparian kahikatea (*Dacrycarpus dacrydioides*). Tauhinu shrubland is a dominant feature on shady slopes. Species such as mahoe (*Melicytus ramiflorus*), *Coprosma grandifolia*, and tree ferns regenerate within the forest.

Secondary broadleaved low forest is also widespread, especially on shaded aspects and includes lancewood (*Pseudopanax crassifolius*), rangiora (*Brachyglottis repanda*), putaputaweta (*Carpodetus serratus*), five-finger (*Pseudopanax arboreus*), pate (*Schefflera digitata*), broadleaved *Coprosma* spp., mahoe, horopito (*Pseudowintera colorata*), tree ferns, tarata (*Pittosporum eugenioides*), broadleaf (*Griselinea littoralis*) and lacebark (*Hoheria populnea*). Pockets of original forest include black (*Nothofagus solandri*) and hard beech, mamaku, kiekie, white maire (*Nestegis lanceolata*) (low elevations), narrow-leaved maire (*Nestegis montana*), (1 sapling recorded), kaikomako (*Pennantia corymbosa*) and supplejack. This mix of species is unusual and combines lowland and montane elements, with both moist and dry affinities. Podocarp broadleaved forest includes rimu (*Dacrydium cupressinum*), matai (*Prumnopitys taxifolia*), miro (*Prumnopitys ferruginea*), totara (Hall's) (*Podocarpus cunninghamii*) with interspersed understorey of black maire, rewarewa, tarata, broadleaf, hinau (*Elaeocarpus dentatus*), heketara (*Olearia rani*), pigeonwood (*Hedycarya arborea*), putaputaweta, toru (*Toronia toru*) and epiphytic astelias.

Beech forest is present at upper elevations and forms spur patches and includes black and hard beech with *Pseudopanax simplex, P. edgerleyi, Cordyline indivisa* and C. *banksii,* crown fern and *Coprosma lineariifolia.*

Some species are notably absent or rare. Fuchsia (*Fuchsia excorticata*) (1 seen), no hangehange (*Geniostoma rupestre*), nikau (*Rhopalostylis sapida*), tawa (*Beilschmiedia tawa*), kamahi (*Weinmannia racemosa*) or rata (southern block of Park). Rewarewa and maire (3 spp.) are near the southern limit of their range, especially in the East. Larger trees are drenched in epiphytes including *Astelia* (narrow leaf mostly), ferns, mosses, orchids (*Dendrobium, Earina mucronata/autumnalis*), and one *Pittosporum cornifolium*. Tree ferns are an important seral element with mamaku (lower elevation), ponga and especially *Cyathea smithii* present.

MAIRE

Black maire (*Nestegis cunninghamii*) is a canopy tree 15 to 30m in height and up to 150cm DBH. Although common in the past throughout lowland North Island forests, the Haurangi Forest Park probably has the most signifi-

cant remaining populations. The hardness of its wood and firewood properties has led to its disappearance from most areas. Narrow-leaved and white maire are scattered through the lowland area, but black maire is widespread in extensive original beech-podocarp mosaics. Some occur as emergent trees in secondary forest being left when the surrounding trees were cut for farmland. Black maire is dominant where beech and rimu are less dominant. It occurs mainly on sunny aspects from valley floor to ridges. The following age classes were evident:

1. *Large old trees:* Up to 1.5m diameter, seldom more than 15m tall. Crowns spreading or greatly reduced by contraction.

2. *Saplings:* 1-3 metres tall, all within the shrub understorey, with a patchy distribution over most habitats.

3. *Seedlings:* 1-3 years old, 5-10cm tall with a patchy distribution, most common on relatively open sites and under large podocarps (kereru roosts).

Despite the unlogged/unburnt nature of this forest, it is very open in places, especially where podocarps are infrequent. Toetoe and introduced grasses form patches throughout, obviously maintained by deer and possums. Many maire saplings about lm high occur around the edges of these open places and many of these are browsed so that they are multiple-headed, unlike the cane-like saplings in the understorey. Hinau and many small lancewood saplings are also browsed. The old broadleaved trees (maire, hinau, broadleaf) are not regenerating, but the faster growing, short-lived species are, including lancewood, lacebark, kaikomako, horopito and pigeonwood. Several species show signs of dieback: toru (rare), tarata, putaputaweta, lacebark and pigeonwood. In the case of lacebark and toru, possums seem to be the cause.

Black maire is a very important component of the forest particularly between the Washpool Creek catchments and Hurupi Stream catchment. Over quite extensive areas it approaches 50% of the canopy and on average would contribute 20% overall.

INTRODUCED ANIMALS

The area has a history of high goat numbers which have now been largely eliminated. Possum numbers do not appear high and damage is only evident on close examination. Toru (*Myrsine salicina*) is an uncommon tree and is declining through possum browse and juvenile lacebark is locally browsed.

Deer tracks, droppings, shrub browse and grass grazing is very common. Lancewood, hinau and black maire are the most commonly affected. The ground cover is generally good (dominated by *Coprosma rhamnoides* and *Blechnum discolor*), but has probably been largely induced by deer. Pig tracking and rooting is locally common and hares are widespread. Past animal numbers are likely to be important in explaining the present forest structure.

McKelvey (1959) characterized animal impact in the area as follows:

> **Haurangi Range**
>
> Throughout the Haurangi Range there are high populations of red deer, goats, cattle, pigs, opossums, sheep and, in open country, rabbits and hares. All have acted in concert to bring about heavy and spectacular forest damage. The effect of each individual animal species is obscured in the general depredation. Also widespread indiscriminate burning in the past has predisposed the area to soil deterioration. On many steep slopes there is only rubble and dust under the forest canopy and scree is streaming around the bases of large trees. Slips abound, but instead of healing are being kept active by goats. On the high ridges, the shrub tier has gone or is represented by a few xerophytic unpalatables. Many minor hardwood species have been killed by opossums while kamahi has been virtually eliminated from the area.The shrub tier and the forest-floor cover have gone; all that remains are canopy trees, and for these there is little hope of replacement.

Black Maire health

SYMPTOMS

The typical early symptoms of black maire decline in the Park are the progressive loss of outer canopy foliage and increasing incidence of dead fine twigs in the upper canopy (Figure 3)*. Progressive crown contraction results, with the dieback of major branches and eventually tree death (Figure 4). While all stages of decline were present very few completely healthy trees and very few dead stags were evident. Most trees had extensive areas of dead fine twigs and limited foliage present. Foliage tended to be chlorotic with most trees having a distinctly yellow hue.

For the purposes of characterizing tree condition a simple 5 point scale was used where:

1 = healthy (Figure 5)

2 = near healthy with a few dead fine twigs (Figure 3).

3 = unhealthy with clear symptoms of decline and significant foliage loss and twig dieback (Figure 5)

4 = near dead with only last vestages of live crown left (Figure 4)

5 = dead

Note: All figures are included under Appendix III

This classification was used for individual trees inspected, and for groups of trees on viewed faces.

DECLINE PROGRESSION

Joe Hansen, who has over 20 years familiarity with this area, had only noted maire decline within the last year or two. This recent nature of the decline is supported by the condition of affected trees although very large trees supporting dense leafy short branches suggest the area may have been affected by past decline episodes. The great majority of affected crowns still retain the fine twig structure typical of recent foliage loss. Experience with beech and northern rata suggests fine twigs are lost within a year of death, particularly in exposed environments such as in this case. Affected trees also show strong synchrony of condition with very few healthy trees and few trees with crowns degenerated to large wood and stags (Figure 6). The distribution of dieback while present throughout the affected catchments tends to be worst within the mid and upper slope, with relatively healthy trees largely confined to valley bottoms. Typical views of declining forest are shown in Figures 7 and 8.

DAMAGING AGENTS

A range of insects and diseases were recorded both from the field examination of trees and from the foliage inspected in the laboratory. A full list is given in Table 1 (Appendix II). No individual agent is a strong contender as a primary cause of decline. The foliage insects and fungi and the root infection by *Armillaria* are all opportunists and more indicative of tree ill thrift rather than the underlying cause. The psyllid/scale damage may be caused by *Eriococcus fossor* while the leaf miner is likely to be *Coccomyza brittini*, both recorded by Spiller and Wise (1982). The very high incidence of puriri moth damage (Figure 9) is unusual but not very different from that which occurs on *Carpodetus.* It is interesting however that attack continues on very old and large trees. Puriri moth has never been associated with ill health in its host (*Alma*, 1977). Nestegis provides a new record for a large native cerambycid *Ochrocydus huttoni* which is commonly associated with manuka and kanuka but is also common in beech (Hosking, 1978). It has never been implicated in ill health of its host although in beech frass clearing holes can weep fermenting sap. One instance of this phenomenon was recorded on maire during the visit.

Cicada oviposition scars were plentiful on small branches. Such damage has never been associated with dieback unless breakage occurs (Kay, 1980). No such breakage was found on maire or the crowns of other species.

No evidence of possum browse was found on maire in the course of the field visit although extensive damage was recorded on *Acacia melanoxylon*, *Myrsine salicina* (toru) and juvenile lacebark both within the forest and along the access track. Deer browse of regeneration up to 2m high was evident as noted above.

POPULATION CHARACTERISTICS

Almost all trees were mature to old to senescent, all were over 40cm DBH and most over 80cm DBH (Table 2, Appendix II). Crown condition classes ranged between 1 and 4 but were concentrated in the 3-4 classes. No young trees were found in ground inspections suggesting a significant regeneration gap. However, a much more detailed survey would be needed to substantiate this observation. A count of annual wood growth rings in a felled dead stem of 40cm DBH suggested an age of between 200 and 300 years. The same stem showed a long history of puriri moth attack and *Ochrocydus* tunnels in its cut surface. Most population information was collected on a traverse of a badly affected area below Surf.

AERIAL EXAMINATION

The aerial examination was carried out with Joe Hansen and a pilot in a Cessna 172 aircraft. The flight line is shown in Figure 2 and the inspection confirmed the concentration of black maire in the southern section of the park west of the Aorangi Range. The only other notable areas were east of the Kawakawa summit and west of Ngapotiki. The aerial survey confirmed that ground observations were made in the area showing greatest decline and greatest concentration of the species.

DISCUSSION

The decline of black maire in the Haurangi Forest Park has no immediately obvious cause. It may result from the interaction of two or more factors including; cohort scenescence, environmental stress, insect and disease, and introduced animal impacts.

COHORT SCENESCENCE

The age structure of black maire in the area visited showed almost all affected trees to be large diameter, old to overmature, probably in excess of 300 years old. While regenerating saplings were present no intermediate age classes were found. Such a structure would suggest the maire date from the time of establishment of associated podocarps rimu, matai, totara and miro, possibly replacing beech forest following extensive disturbance. If this is correct it could be concluded the maire is dying of old age. However, while age may be an important factor, the synchrony of decline would suggest it alone cannot be invoked to explain the present situation.

ENVIRONMENTAL STRESS

The symptoms of decline are consistent with a plant species under stress and similar to the non-specific decline seen in a number of other indigenous spe-

cies. The potential influence of both long term (global warming, increased UV radiation) and short term (drought, wind) environmental impacts are recognized although on the basis of present knowledge their contribution to the present situation can only be speculated upon. However, forest health specialists are becoming increasingly concerned at the occurrance of decline in a number of unrelated species suggesting some wider influence may be placing significant stress on indigenous forest ecosystems. Such an influence would be first evident in susceptible species and scenescent populations.

INSECTS AND DISEASES

All insects and diseases recorded on the affected trees are saprophytic, weakly pathogenic, or common inhabitors of healthy trees. The foliage insects listed in Table 1 are typical of those found on trees under stress. They can usually be found on perfectly healthy trees, but increase in abundance on stressed individuals. The longhorn beetle *Ochrocydus*, and the puriri moth, commonly inhabit healthy trees, often in very high numbers. There is no evidence to link increased incidence of either species with debilitated trees, nor has either been implicated in tree decline. It is highly unlikely either is contributing to the present situation.

INTRODUCED ANIMALS

There is no evidence introduced animals are directly implicated in the present decline of older black maire. However, it is probable that past animal populations, in particular deer and goats, have influenced present forest structure. The clear regeneration gap, shown by the absence of young trees, may well have resulted from high animal numbers in the past. No evidence was found of possum damage to maire foliage.

Conclusions

The decline of black maire might best be interpreted within the framework of Manion's three factor theory of forest decline (Manion, 1981). The theory holds that for decline to occur there must be:

1. A predisposing factor, i.e. a condition which predisposes a stand to decline but which does not in itself initiate the process. The most common predisposing factor is age, i.e. old trees are more likely to decline than young ones.

2. An inciting factor, i.e. some perturbation which puts additional pressure on the predisposed tree or stand and initiates the decline process. The most common inciting factors are climatic, in particular drought.

3. Contributing factors, i.e. factors which drive the decline process to completion. These are largely insects and diseases, the opportunists always waiting to take advantage of the weak and dying. They are often the most obvious sign of decline.

With regard to black maire, the stands are apparently old and hence fulfil the requirement of predisposition. The inciting factor is unknown but it would not be too difficult to invoke either short or long term environmental stress. All the damaging insects and disease conform to contributing factors, none having the potential of a primary role. The most disturbing part of the process is the lack of a younger replacement cohort between young saplings and those in decline. It will be important to ensure a strong population of saplings survive in the long term, a concern which has implications for animal control.

Recommendations

1. The present situation should be monitored to determine the fate of affected trees, i.e. how many contract the upper crown and re-establish a vigorous lower crown, how many die and how many fully recover.

2. The role of introduced animals should be clarified in relation to the open nature of the forest and their impact on regeneration. Particular attention should be paid to black maire regeneration and the future of toru.

3. Changes in both seral and high forest should be monitored long term through both permanent vegetation transects and permanently marked photo points.

4. All monitoring records plus the records of this evaluation should be managed by a dedicated individual who might also be responsible for reporting on the resulting findings from time to time.

5. Consideration might be given to a wider forest health initiative examining decline affecting a number of indigenous species.

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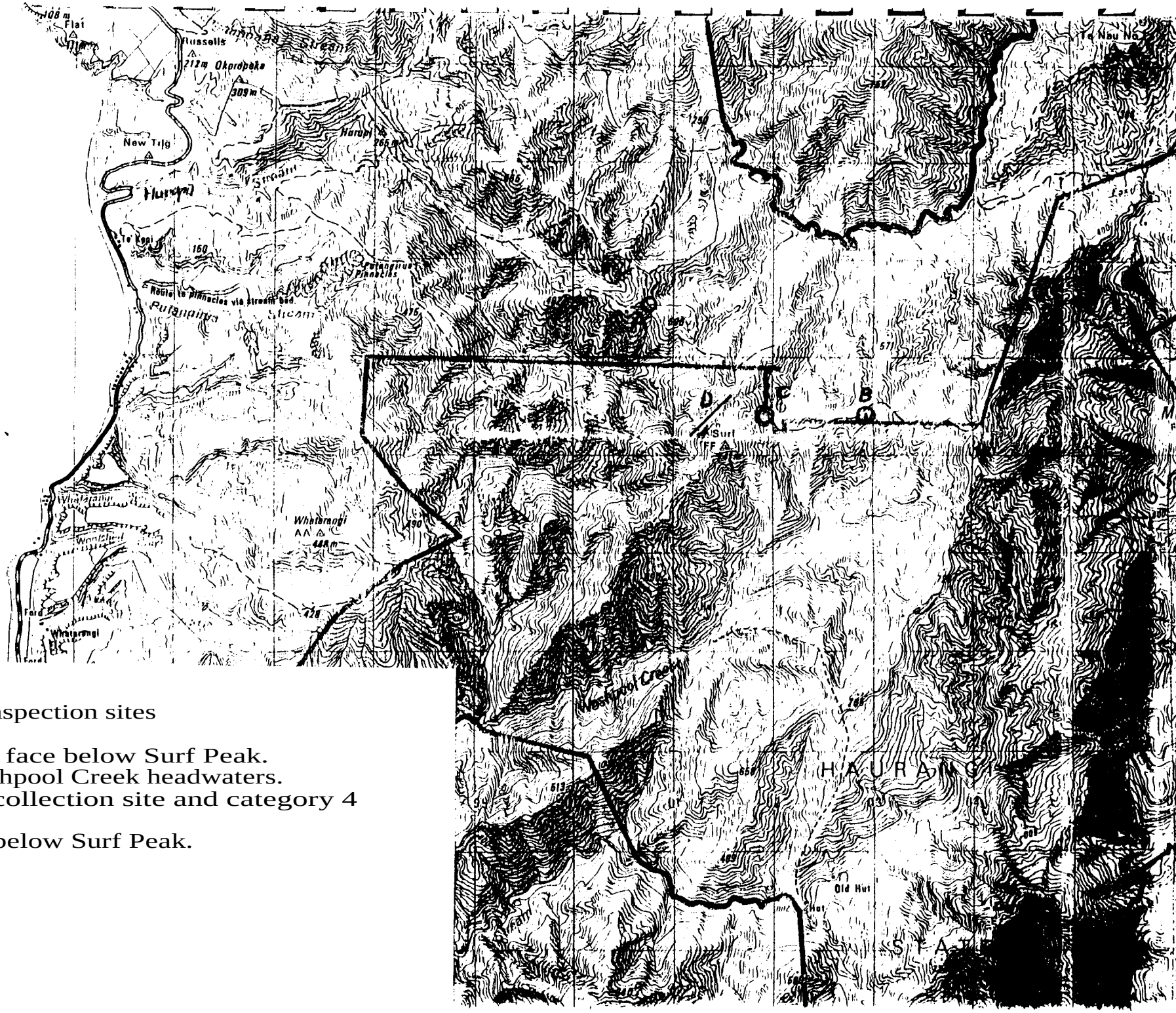

FIGURE 1. Ground inspection sites

A - Looking south to face below Surf Peak.
B - Looking into Washpool Creek headwaters.
C - Foliage sample collection site and category 4 tree crowns
D - Ground traverse below Surf Peak.

APPENDIX II

TABLE 1- Damaging Agents recorded on *Nestegis cunninghamii*
(from samples collected on 21.6..95 and 22.11.95)

Agent	Part attacked	Type of damage	Significance
Eriophyid mites	foliage	pit galls	probably little
Tortricid larvae	foliage	surface damage	none
Leaf miner	foliage	death of parts of leaf	probably little
Fungi/bacteria	foliage	necrotic spotting	probably little
Puriri moth	stem/branches	large 7 - shaped chambers	probably little
Ocrocydus huttoni	stem	large oval shaped tunnels	probably little
Cicada	twigs and small branches	oviposition scars	none
Psyllids/scale	leaves/stem growing tip	malformation	unknown
Galls/bacterial infection	associated with psyllid damage	tissue death or malformation	unknown
Psochids	already damaged tissue	secondary feeders on dead tissue, fungi etc.	none
Armillaria	roots/lower stem	kills root and stem tissue	may kill debilitated trees
Deer	foliage of regeneration	defoliation	inhibition of regeneration
Frost or wind	stem	splitting/malformation	none

TABLE 2 - Individual black maire tree characteristics

Tree No.	Location	DBH (cm)	Crown class	Age class	Association	Regeneration
1	Above Hurupi Stream 2 km from coast	55	2	mature	manuka/grass	3-4m saplings common
2	Above Hurupi ford S41-26.272 E175-14.898	40	3	mature	shrubland	not found
3	Above Hurupi ford S41-26.272 E175-14.898	-	4	old	shrubland	not found
4	Above track S41-27.499 E175-17.920	40	4	mature	shrubland	present
5	On traverse below Surf.	80	3	old	high forest	common 1-3m saplings
6	On traverse below Surf.	80	2	old/ contracting	high forest	common 1-3m saplings
7	On traverse below Surf.	90	2	old	high forest	present
8	On traverse below Surf.	80	3	old	high forest	present
9	On traverse below Surf.	120	3-4	old	high forest	present
10	On traverse below Surf.	60	1/3*	mature	high forest	not found
11	On traverse below Surf.	110	3-4	old	high forest	present
12	On traverse below Surf.	130	3-4	old	high forest	present
13	Ridge below Surf.	60	3	mature	grass/ shrubland	present
14	Ridge below Surf.	80	3-4	old	forest/ shrubland	not found
15	Ridge below Surf.	90	4	old	shrubland	present

* upper crown condition 3, lower regenerating regrowth condition 1 (Figure 5)

Appendix III

Figure 3: Young mature tree showing very early crown deterioration typical of condition 2.

Figure 4: Tree in the last stages of decline with single remnant branch remaining in the contracted crown typical of condition 4.

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