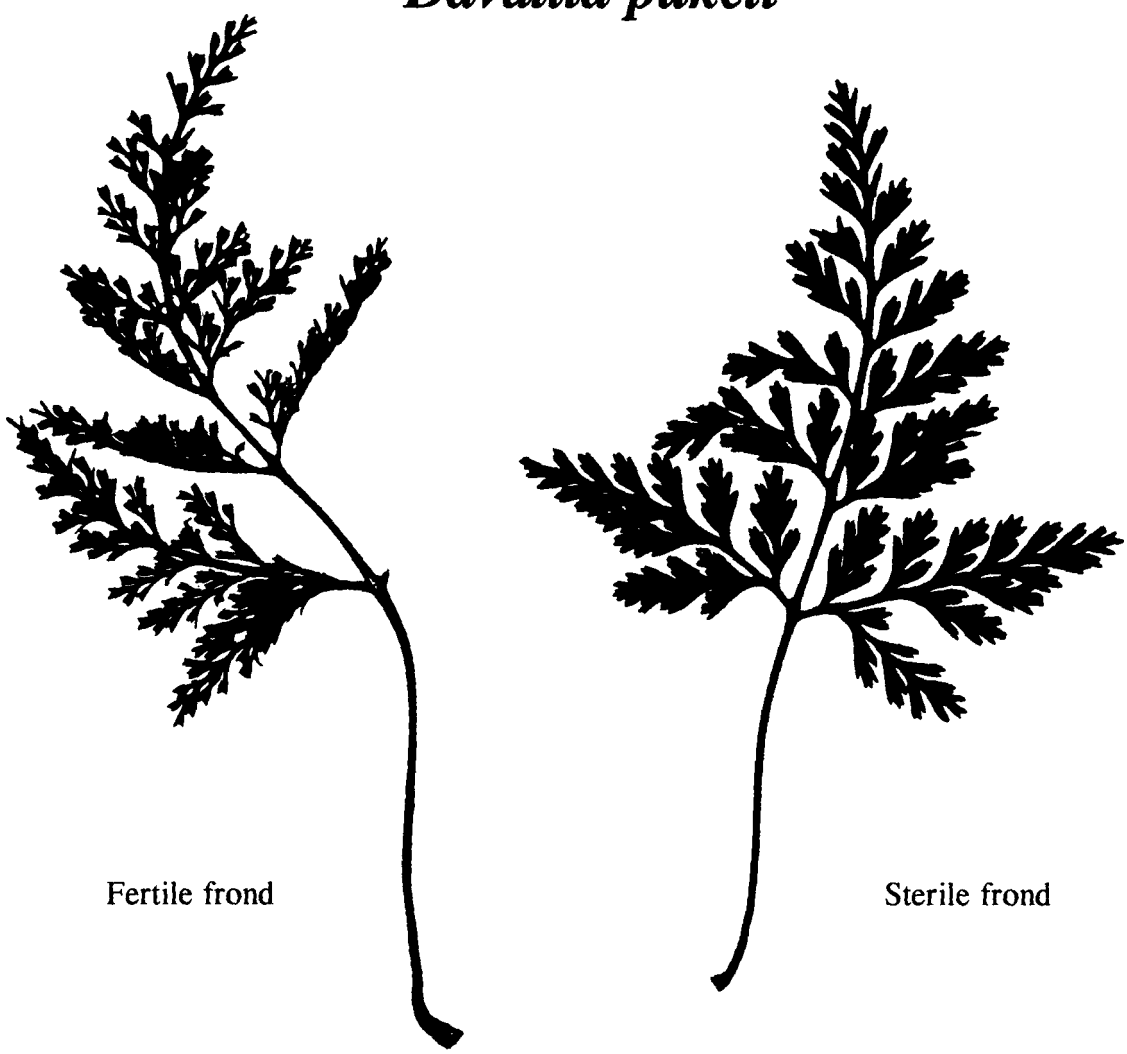
POPULATION CENSUS, HABITAT ASSESSMENT AND MANAGEMENT, OF THE ENDANGERED FERN,

Davallia puketi



Fertile frond

Sterile frond

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Executive summary

Title : Population Census, Habitat Assesment and Management of the Endangered Fern Davallia puketi

Study venue : Puketi Kauri forest, Northland.

Author : Tim Shaw (D.O.C Kerikeri, Northland).

Finish Date : 10th May 1994

Investigation overview : D. puketi is considered an endangered fern as it is known from only one small habitat that is under a variety of degradation threats including mammalian browse and weed infestation. Nothing more than anecdotal data about the fern within its sole locality were known, making effective reaction to the habitat threats difficult. This investigation sought to supply baseline distribution and abundance, habitat requirement information and management suggestions about the fern.

Objectives

1) To establish the absolute distribution and abundance of *D. puketi*.
2) To identify habitat requirements of *D. puketi* .
3) To identify and quantify threats to *D. puketi* and its habitat.
4) To establish a long term monitoring scheme for *D. puketi* .

Methods : Quadrat census, one way analysis of variance.

Results : D. puketi habitat requirements were found to be broad. The fern was not significantly correlated to any one of the ten environmental factors measured suggesting its distribution and abundance is dictated by chance. Four major clumps of Davallia were recognised and mapped. Monitoring plots were established. Goats and potential weed infestation were identified as the major threats to the habitat of *D. puketi* .

Recommendations :

1) Annual monitoring of *D. puketi* and its habitat, to detect changes in habitat quality and trends in the ferns population size and distribution.
2) Bi-annual goat hunting and / or electric fencing of the *D. puketi* site.
3) Broad rather than narrow habitat search for other wild populations of *D. puketi*
4) Transplant experiments to establish optimum natural growing conditions for *D. puketi* .
5) Establish further wild populations of *D. puketi* in Puketi forest.
6) Genetic identification of *D. puketi* .
7) Regularity of 1) & 5) to be reviewed as their effectiveness dictates.

Contents

Population Census, Habitat Assessment and Management of the Endangered Fern Davallia puketi .

The fern genus *Davallia* is generally subtropical. It is represented by a minimum of 40 species dispersed through Asia, Polynesia, Madagascar, Natal and New Zealand. Species within the genus have roughly triangular shaped leathery fronds produced at intervals along creeping rhizomes (Parsons 1993.c).

Within New Zealand there are two distinct taxa of *Davallia , D. tasmanii* and *D. puketi ,* both of which are considered endangered. The definition of this status is that the taxa are believed likely to become extinct if the factors causing their decline continue (Johnson et al 1993).

Davallia tasmanii grows only on the Three Kings Islands where it has limited distribution. The only *Davallia* species naturally occuring on the New Zealand mainland is *Davallia puketi* . This species was first discovered in 1984 and is known from a single small site within Puketi Kauri forest, Northland. *D. puketi* has has yet to be officially described and named but is thought to be at least distinct from *D. Tasmanii* (Parsons, 1993.c).

The entire habitat occupied by *D. puketi* measures approximately 1500 square metres. It consists of a narrow ridge top that falls away steeply to the north east forming an exposed rocky bluff. Vegetation on the bluff consists of rare emergent kauri (*Agathis australis*) and tanekaha (*Phyllocladus trichomanoides)* to 25metres above a localised canopy of occasional kanuka (*Kunzea ericoides*) and towaii (*Weinmannia silvicola*) to 6metres. The sub canopy (above 2metres) is densest at the top of the bluff and locally present throughout. Manuka (*Leptospermum scoparium*), mapou (*Myrsine australis*), mingimingi (*Leucopogon fasciculatus*), *Cyathodes juniperina, Phebalium nudum ,* towai and *Dracophyllum adamsii* form the bulk of the sub canopy. On much of the bluff only a shrub layer of vegetation to two metres persists. Usually epiphitic species dominate this ground cover including *Metrosideros perforata, M. albida*

and *Astelia banksii*. Also common in this layer are shrubby mingimingis' and mapou. Common ground layer species include *Trichomanes reniforme„ Earina* and *Dendrobium* orchids and climbing species of *Metrosideros*.

Some areas of the bluff have only very sparse vegetative cover and there are significant areas of exposed unvegetated rock. The light environment of the area is high due to aspect, steep slope and incomplete canopy cover.

D. puketi occurs in the ground layer in scattered clumps. Its rhizomes creep along the ground and in some cases up the trunks of trees to four metres.

The need to know more about *D. puketi* became apparent in early 1992 when signs of goat occupation of the bluff along with possum sign and early signs of weed invasion were noted (J. Beechman 1992). Shrinkage of the range of *D. puketi* within the site was also suspected (Pers. Com, S.McManus ; P. Bellingham).

Immediate informed management of *D.puketi* was prevented by the lack of baseline information regarding this species and by the absence of useful data on the taxon generally. Effective management required a detailed survey of the species in situ and monitoring of the species over time (Lisa Forester, 1992).

The survey undertaken involved a detailed measurement by quadrat of ;

1) the distribution and abundance of *D. puketi* ,

and 2) environmental conditions in *D. puketi* habitat.

These measures were hoped to respectively provide baseline data on the size of the *D. puketi* population and to reveal some environmental requirements of the plant.

A monitoring scheme was established by permanent marking of a selection of the quadrats for future re-survey.

This report describes the methods used to obtain and record the above information. Total abundance, geographic distribution and age size structure of the plant are explained. Analysis of variance between tenenvironmental factors and the distribution and abundance of *D. puketi* are presented and discussed.

Monitoring plots are outlined and suggestions are made on their application as tools in the future management of *D. puketi* .

Threats to *D. puketi* identified in the course of the survey are discussed.

Method

This survey was designed and set up over three days in late May 1992. It took a total of eleven field days to complete data collection. These eleven days were done in two groups; three days in early June 1992 and the balance of eight days over February, March 1993.

Six observers were involved in data collection. S. Mc Manus (D.O.C Kaikohe) and Tim Shaw (D.O.C Kerikeri) were involved throughout. Occasionally P. Herbert and M. Forsyth (D.O.C Kerikeri), M. Hoblink Volunteer) and M. Parsons (Auckland University) assisted. Total person days involved in data collection was 29.

Survey Design

Initially an appreciation of the absolute range of *D. puketi* within the bluff was gained. The plant grows at the southern end of a north east facing bluff . The upper altitudinal edge of its range is the northern lip of the ridge and its lower limit the base of the fifteen to 30 metre bluff.

A baseline 81metres in length running at 130 degrees magnetic was established along the ridge top. In places the baseline is stepped allowing it to remain on the ridge and give a common start point for each row of quadrats. At three metre intervals along this baseline 28 permanent wooden stakes numbering 0 to 27 were erected.

Lines perpendicular to this baseline were created by running strings at precisely 40 degrees magnetic from each stake. Each string was marked at three metre intervals along its length with a knot. As the strings descended the bluff they were kept three metres apart with a three metre long aluminium pole and in place by electric fence standards.

In this way 108 three metre square quadrats were positioned over the entire *D. puketi* population.

Quadrats are described by their position on a particular row. Rows are numbered from north to south (one to 27), and individual quadrats from the ridge top to bluff bottom, (ranging between one to six). Quadrats were set up and removed two rows at a time as the survey moved from north to south along the bluff.

Quadrat description of the bluff extended at least to the edge the fall face on each row and further down only where the presence of *D. puketi* continued.

Observers worked in pairs with one measuring for each quadrat whilst the other recorded. Abseiling by the measurer was necessary through much of the bluff.

Measurements taken for each quadrat included
a) Ten environmental factors.
b) A vegetative description.
c) Density, distribution and age size structure of *D. puketi*.
All data was recorded on prepared forms (appendix One).

The distribution and abundance of *D. puketi* was correlated to environmental factors using a one way, model one analysis of variance on the computer program "minitab". Significant results were those with a 'F value significantly greater than one, and a 'P' value less than 0.05.
A common null hypothesis for the environmental factors was employed stating that

" The abundance of *D. puketi* within a quadrat is not influenced by factor one to ten."

Of physiography the additional null hypothesis was asked, that:

" The presence of *D. puketi* in a quadrat is not influenced by physiography."

a) Environmental measurements

1) Aspect. Magnetic compass bearing used to name aspect as north, north east etc.
2) Slope. Gradient was measured using a Suunto hypsometer. (Units = 0 to 90 degrees).
3) Physiography. Five of the physiographical units described by the nine unit land surface model (Blomg et.al, 1965) were applied to the bluff . They were

Interfluve. (cc. Ridge top).
Convex creep slope. (cc. Lip of ridge).
Transportational mid slope. (cc. mid slope).
Fall face. (cc. Vertical cliff face).
Toe slope. (cc. Base of cliff).

4) Drainage. This was a subjective categorisation of drainage into one of four categories; as follows.

Excessively well drained.

Well drained.

Moderately well drained.

Poorly drained.

5) Loose rock on surface. A simple presence absence score was gained plus a percentage of total ground cover estimation.

6) Bed rock on surface. Again a simple presence absence score was noted plus a percentage of total ground cover estimation.

7) Soil depth. A graduated measuring stick was pushed into the ground to give a maximum depth of soil in centimetres.

8) Soil distribution. A percentage estimation of the amount of the quadrat covered in soil.

9) Ground cover. The percentage of the ground surface covered by five factors was measured. These factors were vascular plants, moss, leaf litter, bedrock and loose rock.

10) Canopy height and cover. Canopy was classed as any vegetation that shaded the ground surface and was given as a percentage of the total quadrat area. An average canopy height was also recorded.

b) Vegetation description

The vegetation within each quadrat was described using a matrix with species abundance categorised in columns and vegetative strata in rows (refer appendix one). The categories of abundant, frequent, occasional and rare used are those proposed in D.O.C 1991. In this way every vascular plant species contained in each quadrat , its position(s) in the strata and abundance within strata was recorded.

c) D.puketi distribution and abundance

Leaves of Davallia were used as the unit measure of the plants distribution and abundance. Leaf information was collected in a matrix where columns categorised leaf age and rows leaf size. The categories for age and size are shown below.

Age	Young	Light green in colour, soft to touch.
	Middle aged	Dark green and leathery, no blemishes.
	Old	Dark green and leathery with signs of decay such as browning off of tips.
	Dead	Frond completely browned off but still attached to rhizome.
Size	Small	cc. Less than 100mm in length (rhizome to tip).
	Medium	cc. Between 100mm and 150mm in length.
	Large	cc. Greater than 150mm in length.

The sum of the age / size classes gave the total number of fronds per quadrat.

An additional simple description of the distribution of *Davallia* in each plot was made. The categories were ; epiphytic, clumped , common throughout and rare throughout.

Quadrat maps

An ariel and a cross section sketch map of each row of quadrats was done. These maps were drawn to the same scale on the same sheet of paper to allow cross referencing from one to the other (refer appendix one). Physiography and major two dimensional features such as trees were drawn onto the cross section maps whereas the distribution of *Davallia* and one dimensional characters such as tracks were shown on the ariel sketches.

Monitoring plots

A sample of quadrats from the 46 that contained *Davallia* were permanently marked with brightly painted wooden stakes and labelled with individual numbered aluminium tags.

Monitoring quadrat selection was non random, based on seeking a representative cross section of the geographical range of *D. puketi* while also considering the threats that the plant faces and the habits which it displays. The selected quadrats needed to be easily accessed by observers to minimise the degree of disturbance by human trampling and tracking.

Threats

Notes on the type and amount of browse on *Davallia* and on other vegetation in the quadrats were taken systematically on each data sheet (appendix one).

Results

Total frond abundance and age / size classes

1170 mature fronds were counted. Of this 1170, 64 were dead. Additional to the mature fronds two koru (opening buds) were recorded, both in the June part of the survey. No fertile fronds were seen.

94.4% of fronds were middle aged or above (figure one). Almost exactly half of the fronds (including the dead fronds) fall into the mid size range of 100 to 150mm long with the remaining 49% split evenly between smaller than 100mm and larger than 150mm (figure two).

Figure one: Number of D. puketi fronds in each of four age class

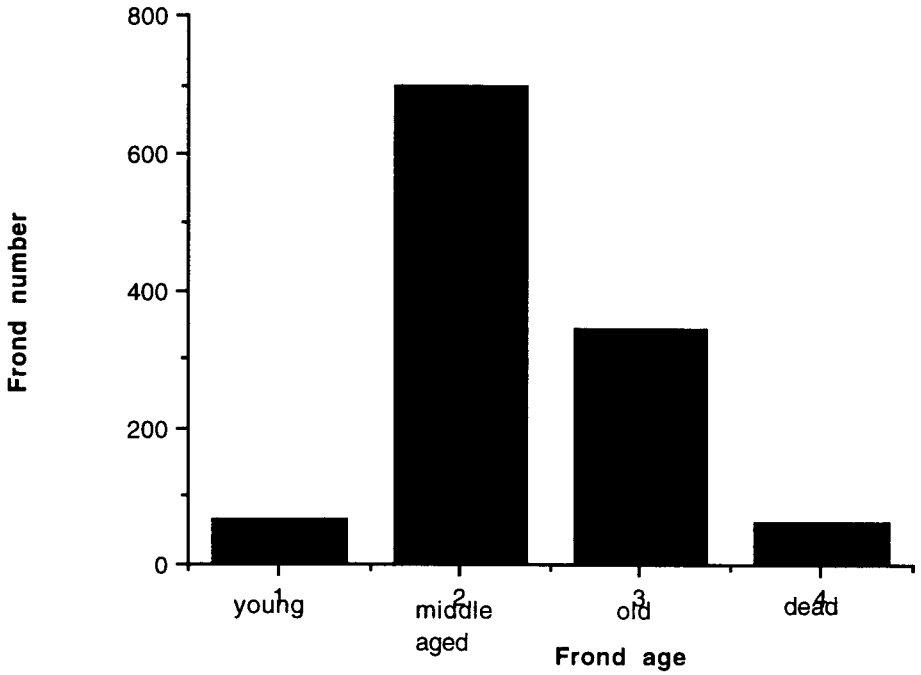
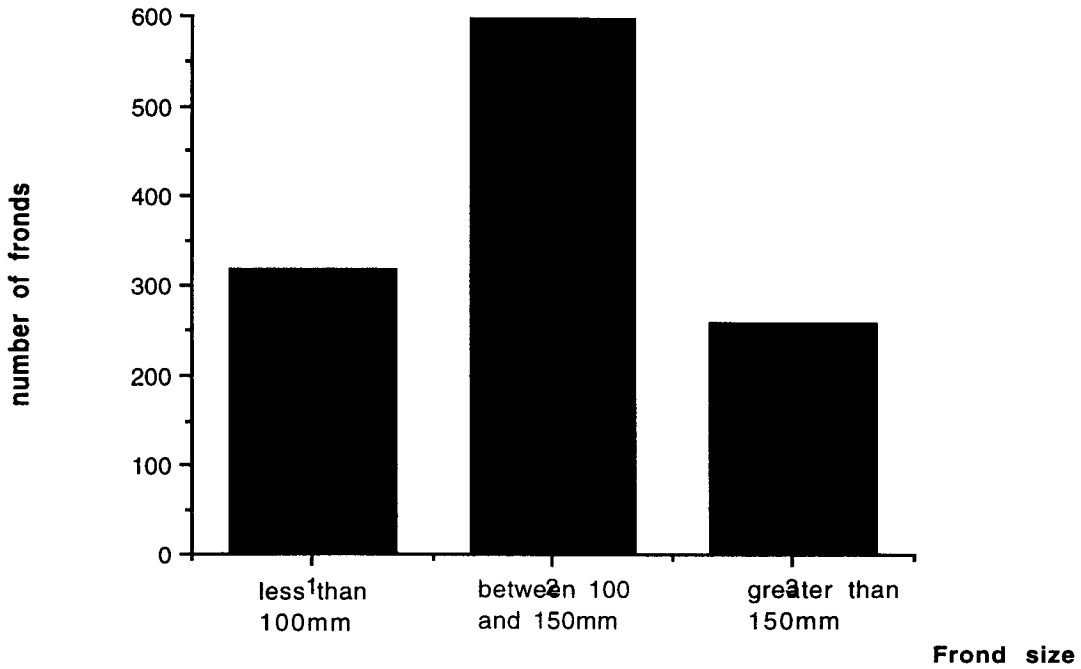


Figure two: number of D. puketi fronds in three size classes



Total distribution of D . puketi

Davallia was found in nineteen of the 27 rows and 49 of the 108 quadrats. Map one shows this distribution plus the number of fronds found per quadrat.

The eight rows of quadrats that contain no *Davallia* divide the population into four recognisable clumps. The first clump (clump one) marks the northern extent of *Davallia's* range and grows entirely epiphytically on a horizontal Totara (*Podocarpus totara*). The two largest clumps occur between lines eight and four (clump two) and lines 21 and 13 (clump three). Clumps two and three cover almost continuously 26 (78 square metres) and 13 (39 square metres) quadrats respectively. At the southern end of *Davallias* range is a small disjunct clump covering seven plots (clump four).

The number of fronds counted per quadrat that contain *Davallia* range between two and 90 with a mean of 24. The densest frond growth per quadrat was recorded in clump four.

Relationship between frond distribution / abundance and environmental factors

Analysis of variance 'P' and 'F' values at 0.05 level of confidence, for frond abundance and *Davallia* presence, against ten environmental variables, are presented in table one. The implications of these tabulated values are outlined immediately following the table.

MAP ONE : Davallia puketi distribution and abundance, Puketi forest.

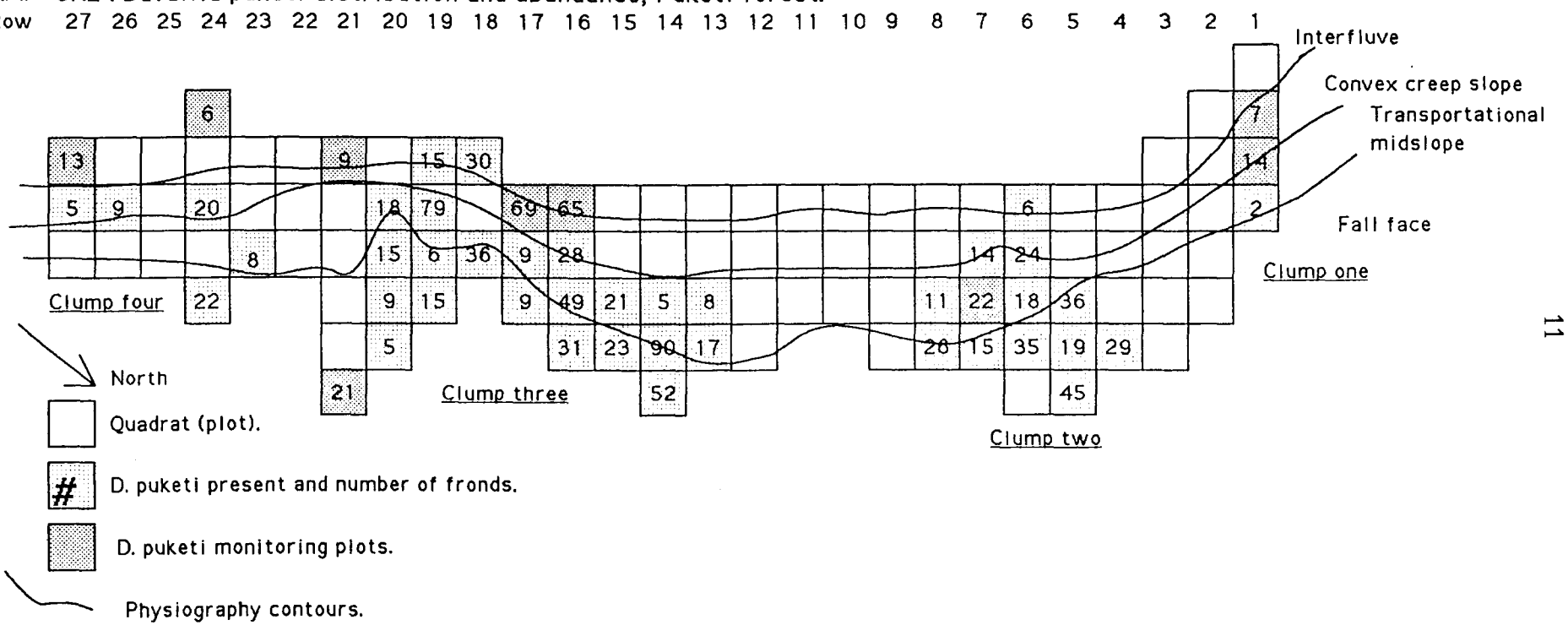


TABLE ONE. Analysis of variance "p" and "F" values at 0.05 level of confidence.

Factor	Treatment	"F" Value	"P" Value
Frond abundance	canopy height	1.44	0.206
	canopy %	2.02	0.055
	soil distribution	0.72	0.672
	soil depth	0.93	0.514
	g.c, vascular plants	1.71	0.109
	g.c, moss	0.99	0.454
	g.c, leaf litter (minus outlier)	1.72	1.22
	g.c, bedrock	0.69	0.603
	g.c, loose rock	0.95	0.470
	physiography (five units)	0.55	0.64
	physiography (eight units)	0.65	0.690
	slope (rounded up)	1.44	0.192
Davallia presence absence	physiography (five units)	2.44	0.69
	physiography (eight units)	2.48	0.22

1) Aspect. All but Four of the quadrats containing *Davallia* faced north east. The remaining four were generally flat ridge top areas with a slight south west aspect.

2) Slope. The gradient between the virtually flat ridge top and the vertical fall face varies but is always steep. *Davallia* grew throughout the slope variation measured. No significant correlation was found between slope and abundance of *Davallia* fronds.

3) Physiography. *D.puketi* grew in all the physiographical units described with its vertical boundaries the ridge top and the base of the fall face. No significant correlation was found between any particular unit and *Davallia* presence, or between relative abundance of fronds for each unit.

4) Drainage. Variation in drainage throughout the bluff was insufficient to be meaningful to *Davallia* distribution. All areas were either well or excessively well drained.

5) Loose rock on surface. The presence of loose rock within plots containing *Davallia* did not significantly influence the distribution or abundance of the plant. Loose rock occurred in 62% of the 108 plots.

6) Bed rock on surface. As with loose rock , no significant correlation between bedrock and *Davallia* was found. Bed rock occurred in 60% of the 108 plots.

7&8) Soil depth and distribution. Soil depth and distribution on the bluff was extremely variable. Maximum soil depth ranged from zero to 40 cm with a mean of 18cm. Soil type also varied from old clay through to young, highly humic soils. All quadrats had at least some soil. No significant correlation was found between the abundance of *Davallia* and soil.

9) Ground cover. The percentage of ground covered by vascular plants, moss, leaf litter, bed rock and loose rock did not significantly influence the distribution and abundance of *Davallia* . Vascular plants were the dominant ground cover overall, occurring as greater than or equal to 40% in 74% of the 108 quadrats. Comparatively leaf litter covered 21% and moss 6%.

10) Canopy height and cover. No significant correlation between the abundance of *Davallia* and the height and percentage canopy cover was found. The canopy ranged from being locally absent to tall forest to low dense shrubs. Mean canopy height for the bluff was just under four metres. Mean cover was 45% with a range of zero to 100%.

Monitoring plots

Nine of the 49 quadrats containing *D. puketi* were chosen for permanent marking for resurvey. The location of these is shown on map one. Below is a description of each monitoring plot.

Line	Plot #	Tag #	Description
1	3	A10016	Northern limit of *Davallia* , epiphytic.
1	2	A10015	Northern limit of *Davallia* , epiphytic.
7	3	A10014	Mid slope, *Davallia* terrestrial, goat tracks bisect area.
16	1	A10013	Ridge top, *Davallia* epiphytic and terrestrial, goat tracking.
17	1	A10012	Ridge top, *Davallia* epiphytic and terrestrial, goat tracking.
21	6	A10011	Toe slope, dense tall canopy, *Davallia* terrestrial.
21	1	A10010	Ridge lip, goat track through centre, *Davallia* terrestrial.
24	1	A10009	The only south west aspect *Davallia* plot. Terrestrial.
27	1	A10008	Southern limit of *Davallia* . Terrestrial rhizomes.

Observed threats to D. puketi

46 of the 1106 live fronds counted were browsed, one down to only a stipe while the other 45 were damaged by rarely severe but often low levels of insect browse. No sign of mammalian browse was detected.

Insect browse on other foliage was especially common as 'pin holing' of *Metrosideros albida* .. Taraire (*Beilschmiedia taraire*), mapou and mahoe (*Melicytus ramiflorus*) showed lesser signs of insect damage.

Possum and goat browse was generally low. At the base of the bluff kohekohe (*Dysoxzylem spectibile*), had severe possum browse whilst on the bluff only slight possum damage to totara and taraire was detected. Goat browse was limited to *Astelia banksii* clumps having the tips of their leaves browsed; some shrubs such as hangehange (*Geniostoma ligustrifolium*) and mahoe showing signs of foliage loss; and bark stripping of kanuka.

Tracks worn to bare earth and rock by especially goats but also possums occur throughout the bluff. These tracks are particularly on the mid slope areas and on ledges between fall face sections. The ridge top interfluve has a goat track down its centre. No fresh goat pellets or tracks were detected over the nine month period in which the survey was completed. Fresh possum pellets were common.

Discussion

D. puketi habitat, distribution and abundance.

D. puketi was found to be present in just under half the 1500 square metre area surveyed and in the full range of habitat offered by the bluff. It is likely that this is a conservative estimate of range within the area as quadrats recorded as having no fronds and therefore no *Davallia* could well have had dormant rhizomes.

No significant relationship was found between the distribution and abundance of *Davallia* fronds and the ten environmental factors measured. There is therefore not enough evidence to reject the null hypothesises that:

1) The abundance of *D. puketi* in each quadrat is not influenced by the environmental factors one to ten.
2) The presence of *D. puketi* in each quadrat is not influenced by physiography.

The lack of a significant relationship between environment variation on the bluff and *Davallis* frond distribution suggests that the habitat requirements of *Davallia* are broad and that its present distribution on the bluff is dictated by chance. *D. puketi* distribution on the bluff shows it is capable of growing in seasonally arid environments with little to no soil and through a wide range of light conditions.

Search for other sites at which *D. puketi* occurs should therefore not be limited to similar rocky bluffs.

Frond number per quadrat was extremely variable and measures only the amount of photosynthetic *Davallia* and not the extent of rhizomes. In disturbed sites where soil and root mats were exposed, rhizomes were observed as complex tangles and highly branched. It is thought unlikely that the number of fronds consistently reflects the mass of the rhizomes.

Defining individual *D. Puketi* plants is impossible without uprooting and following rhizomes. Thus it is not possible to say just "how many" *D. puketi* plants there are on the bluff. The most that can be concluded is that there are four apparently discontinuous clumps of *D. puketi* . Continuity within the four clumps is unlikely .

This clumped distribution suggests that either all the *Davallia* is a fragmentation of one individual or that there are at least four different individuals that are growing toward each other. *D. puketi's* apparent inability to produce viable spores and its extremely localised distribution suggest the one individual option (Braggins perrs. comm).

Genetic identification of *Davallia* material from different areas of the bluff would be useful in identifying the relationship between clumps and between this species, and other *Davallias'*. Genetic identification of this plant as unique, would confirm the species priority for management.

Frond size was normally distributed with most in the average size category of 100 to 150mm. Frond adaptation for different light environments was evident. The largest fronds occurred in the highly shaded areas at the bottom of the bluff. Those fronds exposed to direct unfiltered light tended to be smaller and often yellowy in appearance.

Little can be concluded from the age structure observed. Frond aging is probably a yearly cycle as they are believed to be replaced annually (Braggins Pers. comm). This aspect of *D. puketi's* biology is currently being investigated by Matt Parsons, Auckland University.

The two koru counted in the June section of the survey and the complete lack of koru in February / March is consistent with the late summer early autumn frond production observed in cultivation (pers. com, Braggins ; pers. obs). It is likely that the exact timing of growth varies with the climate of each season (pers. com, Braggins).

No fertile fronds were found during this survey. The only dispersal mechanism for *Davallia* observed was local vegetative growth and fragmentation. Gravity has dispersed several clumps of the plant down slope. In most cases this spreads the plant only as far as the base of the fall face. One small gravity moved clump found after this survey dispersed a considerable distance down the toe slope (McManus pers comm).

Monitoring scheme

The need to abseil or scramble through low vegetation to view much of the bluff creates a significant habitat disturbance. Broken rhizomes, removal of soil, tracking and general opening up of the habitat are all costs to *Davallia*, of this survey. Thus the choice of monitoring plots was ultimately dictated by their accessibility. No quadrats requiring abseiling were chosen.

It is suggested that the nine monitoring plots should be resurveyed annually in February . This means consecutive years can be reliably compared with this survey and each other. Additionally frond numbers are likely to be stable as it is just prior to koru growth.

A data sheet that could be used for each resurvey is presented in appendix two. Ariel quadrat maps, simple *Davallia* distribution descriptions and frond counts are retained from the original survey as they are readily comparable if collected consistently with the described method.

Photo points for each monitoring plot should be established. These are more likely to detect temporal environmental changes than the subjective measurements used in this survey.

Areas that were recorded as having no *Davallia* by this survey should be included in the annual resurvey. This needs only to be a casual observation for *Davallia* presence and abundance allowing detection of any increase in the plants range. In particular this should include the quadrat rows that separate the *Davallia* population into four clumps (rows nine to twelve, two, three, 22 and 25) and areas immediately outside the boundaries of present *Davallia* distribution. A place is reserved on the resurvey form for areas searched to be noted.

Threats

Browse was shown to be a minor cause of *Davallia* foliage loss with only four percent of live fronds showing sign of browse, all of it insect in origin. Mammalian browse of *Davallia* could involve the complete removal of the frond and therefore explain why none was detected. However if mammalian browse was significantly targeting *Davallia* it is likely that damaged and obviously frondless rhizomes would have been observed. No such sign was observed.

Browse of other species on the bluff was also mostly insect in origin. Goat and possum browse, whilst nowhere severe, was certainly present.

Tracking caused by particularly goats (but also possums), was the most obvious habitat disturbance to *Davallia*. Tracking has destabilised areas of soil on the bluff, dislodging some clumps of *Davallia* and fragmented other clumps through rhizome trampling.

Goats are in low numbers in the Puketi forest due to ongoing goat control work carried out by the Kaikohe Department of Conservation. However, goats will be an ongoing disturbance on the bluff as they are attracted to it as a safe warm loafing area.

As there is no historic data on *D. puketi*, the effect that mammalian browse and tracking is having on the plant, cannot be quantified. It could be argued that tracking that dislodges clumps of rhizome extends the range of *Davalia*; that mammalian browse reduces weed infestation and

maintains the bluff as a seral plant community, that may best suit *D. puketi ;* and that browse of competing plant species helps *Davallia* by increasing light availability. These marginal benifits are likely to be out weighed by loss to habitat quality and size and it is proposed that control of goats and possums would improve the long term health of the habitat of *D. puketi* . With the possible negative effects of mammals removal in mind, it os essential that the response of the fern and it's bluff habitat to such management is monitored.

The lack of fresh sign observed during the survey suggests goats are irregular visitors to the bluff. It is proposed that most of the goat threat to the bluff could be eliminated by at least biannual hunting of the bluff by cullers and dogs. Quarterly hunting may be necessary initially, to determine the optimum hunting regularity. Long term removal of goats could be achieved by ring fencing the bluff with either a wire or electric fence. The terrain of the bluff certainly favours the relatively easily erected electric fence and the north east aspect would allow effective solar powering. Such a fence could be made to exclude both goats and possums.

Weed infestation of the bluff habitat was restricted to a small patch of Foxgloves at the nortern end of the bluff. A significant weed threat locally present in surrounding forest but not yet on the bluff was mistflower. The dominant behaviour of this weed in high light environments suppresses slow growing ground cover and would have a negative impact on *D. puketi*.

The annual monitoring scheme is essential to keep up with and respond to these and any other threats that may develop.

Threats to the survival of *D. Puketi* are magnified by its existence as a single wild population. Although the plant is in cultivation the establishment of *D. puketi* at another site within Puketi would also be prudent. This survey suggests that a possible relocation site does not need to be exactly the same as the present locality.

Experiments involving measurement of *D. puketi* in a variety of controlled environments would identify precisely the conditions required for optimum growth. This would answer questions about the plants biology and allow more informed transplanting.

Acknowledgments

Steve McManus (D.O.C Kaikohe) was an equal contributor to the design and execution of this survey. Lisa Forester (D.O.C Northland) supervised the survey and Terry Conogon (D.O.C Northland) showed us how to abseil. Richard Trabing (Otago University) was a great help with computing this write up and Dr John Braggins (Auckland university) gave valuable technical information. Thanks to Matt Parsons (Auckland university) for the numerous references made in this report to his work on *D. puketi*. Dr Henrik Moller (Otago University) gave useful comments throughout the write up, especially on the first draft.

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