BEFORE THE ENVIRONMENT COURT
AT CHRISTCHURCH

ENV-2010-CHC-115, 123, 124 AND 135

IN THE MATTER	**of Appeals pursuant to Section 120 of the Resource Management Act 1991**
BETWEEN	**WEST COAST ENT INC** **Appellant**
AND	**ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INC** **Appellant**
AND	**WHITE WATER NEW ZEALAND INC** **Appellant**
AND	**DIRECTOR GENERAL OF CONSERVATION** **Appellant**
AND	**WEST COAST REGIONAL COUNCIL AND BULLER DISTRICT COUNCIL** **Respondents**

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STATEMENT OF EVIDENCE OF
KATHLEEN JOY WALKER
FOR DIRECTOR-GENERAL OF CONSERVATION
Dated: 17 May 2012

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AND	**MERIDIAN ENERGY LIMITED** **Applicant**
AND	**FRIDA INTA** **Section 274 Party**
AND	**WHANAU PIHAWAI WEST – RICHARD WAYNE BARBER AND IRI MAY BARBER MILNER** **Section 274 Party**
AND	**J MacTAGGART** **Section 274 Party**
AND	**ORION ENERGY NZ LTD, ALPINE ENERGY LTD, MAIN POWER NZ LTD AND ELECTRICITY ASHBURTON LTD** **Section 274 Party**
AND	**NZ RAFTING INC** **Section 274 Party**
AND	**ANN SHERIDAN** **Section 274 Party**
AND	**BULLER ELECTRICITY** **Section 274 Party**

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1. QUALIFICATIONS AND EXPERIENCE

1.1. My full name is Kathleen Joy Walker

1.2. I am employed as Science Advisor with the Ecosystems and Species Unit of the Department of Conservation (hereafter termed DOC), currently based in Nelson.

1.3. I have a Bachelor of Science degree from the University of Canterbury (1976) and am currently undertaking doctoral research at Massey University.

1.4. I have considerable experience relevant to assessing this resource consent application, including working on *Powelliphanta* for over 32 years.

1.5. I was employed by Ecology Division of the Department of Scientific and Industrial Research between 1976 and 1980 working on, amongst other things, the interrelationships between beech forest seeding, pest densities and bird numbers, and *Powelliphanta* distribution and density. I worked for the Research Section of the New Zealand Wildlife Service between 1981 and 1987, identifying sites of national significance for wildlife including a major survey of wildlife of the Nelson Region (Walker 1987). I have been employed by the Department of Conservation since its creation in 1987.

1.6. The focus of my job with the Department of Conservation is research into the causes of, and solutions to, threatened species decline in New Zealand. Since 1994 I have been leading DoC's research programmes into large-scale possum, rat and pig control techniques to protect *Powelliphanta*, including the impact of such programmes on other threatened wildlife. I am the national co-ordinator of programmes to monitor the health of *Powelliphanta* populations. Much of my work has been on *Powelliphanta* in the Buller region.

1.7. I am an author of >30 peer-reviewed scientific papers and monographs, and have presented the results of my research at international conferences.

1.8. My work on *Powelliphanta* started in 1980 with a national survey of their conservation status (Meads et al 1984). I published a comprehensive guide to all members of the genus and recovery plans for those species which were declining (Walker 2003), and am currently *Powelliphanta* Recovery leader. I recently named and described the new *Powelliphanta* species found on Mt Augustus on the Stockton Plateau (Walker et al 2008, Trewick et al 2008), and am currently preparing a taxonomic revision of the genus *Powelliphanta* using genetics and morphometrics, which will form the basis of my PhD thesis.

1.9. I am familiar with the Mokihinui Hydro Proposal to which these proceedings relate.

1.10. I have visited the site on many occasions. I have been involved for over 2 decades in research and conservation of *Powelliphanta* in the Mokihinui catchment and on the Stockton and Denniston Plateaux. This included providing evidence for the Wildlife Service at the then Planning Tribunal in 1982, and to the Protected Areas Scientific Co-ordinating Committee (PASAC) regarding reserve recommendations for Ngakawau and Mokihinui forests. Since 1994 I have been involved in the design of possum control programmes in the Mokihinui River catchment and monitoring of their impact on *P. lignaria* recovery, and from 2003 till the present in survey, research and conservation efforts for *P. patrickensis* and *P. augusta* on the Stockton-Denniston Plateaux.

1.11. I made 4 week-long trips into the Mokihinui valley in December 1979, March 1985, May 2008 and March 2011, traversing the Mokihinui Gorge each time but also walking in the headwaters of

Rough and Tumble Creek, Maori Creek, Maori Gully, Johnson River, the South Branch river flats, Goat Creek, Mountain Creek, Hennessey Creek and Glasgow Range, surveying the distribution and density of *Powelliphanta*. I inspected the forest on the true left side of the Mokihinui River, immediately downstream of the proposed dam on 22 July 2008, and on the right side just above the proposed dam on 21 March 2011. I rafted down the Gorge in April 2011, stopping on the north bank every 500 m and searching for *Powelliphanta*. In November 2011 and March 2012 with the assistance of other DoC staff I counted snails in density plots near the mouth of Specimen Creek. I flew over the transmission line route on 12 and 13 November, landed and investigated key sites.

1.12. In 1982 I spent a month in what was then the Mokihinui State Forest between the Ngakawau River and Seddonville, surveying the distribution and density of *P. lignaria johnstoni* and *P. l. rotella* (Walker 1982), with further substantial field trips in 1985, 1986 and 2005. In New Zealand's longest running demographic study of *Powelliphanta*, I have been undertaking annual trips for 28 years to a colony of *P. l. johnstoni* along the Charming Creek walkway to study population demographics in the face of changing predator numbers.

1.13. I have made at least a dozen trips to the site of the substation and the transmission line across Stockton Plateau since 2004, whilst studying *P. patrickensis*.

1.14. I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are within my area of expertise.

1.15. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I have specified where my opinion is based on limited or partial information and identified any assumptions I have made in forming my opinions.

1.16. My opinions rely in part on the evidence presented by:

- Dr Kelvin Lloyd (vegetation and invertebrates)
- Dr Colin O'Donnell (birds)
- Dr Paul Williams (geomorphology)
- Mr Terry Farrell (pest control)
- Mr Rhys Buckingham (snails)
- Mr Robert Watts (project overview)
- Mr Fred Overmars (terrestrial ecology management plan)
- Mr Raymond Brown (transmission line)
- Mr Andrew Carr (roading)
- Dr Murray Hicks (sedimentation)
- Dr John Parkes (pest control and Biodiversity Enhancement Strategy)
- Dr David Norton (ecological processes)
- Dr Graham Ussher (biodiversity offsets model)

2. SCOPE OF EVIDENCE

2.1. My evidence will deal with the following:

- A description of the large *Powelliphanta* land snails in the Mokihinui Gorge and along the proposed transmission corridor
- The importance of the Mokihinui River to speciation processes in *Powelliphanta*

- An assessment of the influence of geology, ecology and introduced pests in determining *Powelliphanta* distribution and density
- The significance in relation to the Buller District Plan of large land snail values which would be affected by the proposed hydro-electric scheme and transmission line construction
- Anticipated adverse effects of the proposed hydro-electric scheme and transmission line construction on ecological processes and patterns, and on indigenous large land snail fauna
- The adequacy of mitigation proposed for *Powelliphanta* by the applicant.

3. KEY FACTS AND OPINIONS

3.1. The applicant's assessment of potential effects on *Powelliphanta* populations and influential ecological processes is deficient. I have provided further description of potentially affected *Powelliphanta* populations and the ecological processes associated with them.

3.2. Complex patterns of speciation in *Powelliphanta lignaria* result from the formation of the Mokihinui Gorge. The Mokihinui River is still shaping evolution within *P. lignaria* in a process that is of both scientific and general interest due to its high visibility and to the beautiful and diverse nature of the giant land snail fauna the river has helped create.

3.3. *Powelliphanta* distribution and density are strongly influenced by differences in the underlying geology and by historical geography and site-scale microclimate. Regular flooding of the Mokihinui River, earthquake-triggered landslides, and warm, wet climate provide fertile productive *Powelliphanta* habitat in the Gorge, giving

the land snail populations there greater resilience to introduced pests than other *Powelliphanta* populations have in less productive environments.

3.4. The affected part of the Mokihinui Gorge contains significant and substantial communities of *Powelliphanta* land snails that are of national importance. The Gorge contains large numbers of snails including a significant proportion (8.4%: CI95%; 6.42-10.81) of the population of *P. l. unicolorata*, and smaller proportions of the populations of *P. l lignaria*, *P. l. lusca* and *P. l. ruforadiata*. An important feature of these populations is the narrow zone of contact between them, just above the river; it is nationally rare for so many subspecies to occur in such close proximity over such a small area

3.5. The transmission line will traverse coal measure vegetation which supports specialized *Powelliphanta* taxa adapted to and only found in these particular vegetation communities. The transmission line will also traverse land set aside in two Ecological Areas for the protection of *P. l. johnstoni* and *P. l. lusca*, and nationally significant sandstone pavement communities supporting the best remaining habitat of the nationally endangered *P. patrickensis*.

3.6. The potential adverse effects of the hydro-electric project on *Powelliphanta* land snail populations and their natural evolutionary processes are major, and to a large degree, irreversible. Flooding of the Mokihinui Gorge will cause the death of very large numbers of individuals, drown a significant proportion of the total population of one subspecies, fragment its remaining populations, and remove about 90% of the contact zone between the 4 subspecies occupying the Gorge. The mitigation proposed by the applicant (ie partial rehabilitation of disturbed sites and pest control) will not offset these adverse effects. The overall result will be an irreversible loss of biodiversity at a nationally renowned hotspot of large land snail biodiversity.

4. POWELLIPHANTA

Powelliphanta - general

4.1. *Powelliphanta* is a genus of giant land snails found only in New Zealand.

4.2. They are of ancient lineage, descendants of land snail stock from Gondwanaland which, like the ancestors of kiwi and tuatara, probably survived on Zelandia through the Oligocene drowning or arrived in proto-New Zealand when it emerged from the sea approximately 23 million years ago.

4.3. There are about 13 species of *Powelliphanta,* and most are naturally confined to small areas through a combination of bio-geographical history, restricted mobility, and habitat specific adaptation.

4.4. *Powelliphanta* are characterized by glossy shells, delicately marked with numerous bands, in a myriad of shades of red, brown, yellow and black (Figure 1). Some species are impressively large, like the fist-sized, golden shelled *P. superba prouseorum*, which measures 9.2 cm and weighs as much as a tui (Figure 2), whilst others are the size of a small hens's egg.

4.5. *Powelliphanta*, like other notable New Zealand pre-historic species, are slow-growing, long-lived (averaging about 12-15 years) and have low productivity. They don't reach breeding age until their 5th or 6th year, and annually lay only 4-10 hard limey eggs, superficially similar to bird's eggs, with the survival of hatchlings likely to be low. They are nocturnal and carnivorous, eating mostly large, burrow-dwelling earthworms.

Figure 1: Some of the diversity within *Powelliphanta*

4.6. *Powelliphanta*, like other notable New Zealand pre-historic species, are slow-growing, long-lived (averaging about 12-15 years) and have low productivity. They don't reach breeding age until their 5th or 6th year, and annually lay only 4-10 hard limey eggs, superficially similar to bird's eggs, with the survival of hatchlings likely to be low. They are nocturnal and carnivorous, eating mostly large, burrow-dwelling earthworms.

4.7. The distribution of *Powelliphanta* across the New Zealand landscape is a curious one, with small concentrations separated by large areas where no snails are present. In a general sense this is related to moisture: there are no *Powelliphanta* in the drier eastern areas of the country. However, within the wetter west, distribution is still very limited and patchy, for various reasons including ecological, bio-geographical and historical. This small, patchy and localized distribution has been a major cause of their demise, as it makes them very vulnerable to habitat loss.

Figure 2: *P. superba prouseorum*, the largest species in the genus (Photo Rod Morris)

4.8. *Powelliphanta* have a significant natural predator in weka, and their numbers have been reduced in recent times by the arrival of exotic pests such as possums, rats, pigs, song-thrushes and hedgehogs.

4.9. Many *Powelliphanta* species are now classified as threatened due to the combined effects of habitat loss, habitat degradation and increased predation.

***Powelliphanta* in the area affected by the MHP**

4.10. The area affected by the MHP coincides with an area of unparalleled *Powelliphanta* diversity. The Mokihinui River is the centre of the distribution of *P. lignaria*, a large (5-6 cm), beautifully patterned species (Figure 3). Powell described *Powelliphanta lignaria* (originally as ***Paryphanta*** *lignaria*) in 1930 as 'undoubtedly our most handsome land snail. Typical shells are exquisitely radially banded with alternating yellowish and dark reddish brown stripes".

Figure 3: *P. lignaria lusca*, with shells about 5.8 cm across (Photo: Rod Morris)

4.11. The Mokihinui marks the southern-most limit of the giant forms of *Powelliphanta* in New Zealand. All the snails further south are

comparatively small-bodied and predominantly alpine. This is probably temperature –related, with very large-bodied land snails requiring both high humidity and warmth to flourish.

4.12. *Powelliphanta lignaria* has 7 distinct subspecies, of which 6 are affected by the MHP: 3 subspecies on the northern bank of the Mokihinui River (*P. l. lignaria,* P. *l. lusca* and *P. l. ruforadiata*) and a fourth on the southern bank (*P. l. unicolorata*), and 2 subspecies under the transmission line (*P. l. rotella* and *P. l. johnstoni*) (Figure 4). A mixed hybrid colony of these subspecies will also be affected by proposed road-widening at Chasm Creek.

4.13. Another species, the alpine snail *P. patrickensis* which occurs only on the Stockton-Denniston Plateau, will be affected by the transmission line, and by the placement of the substation.

4.14. All of these taxa have the status of absolutely protected wildlife under the Wildlife Act 1953, and are nationally threatened due to habitat loss, disturbance and predation by introduced mammals (Walker 2003). Their current status, using the Department's threatened species national rankings, is given below.

Table 1 Conservation status of snails within the MHP (based on Hitchmough 2007)

Species	**Conservation status**
Powelliphanta patrickensis	"Nationally endangered"
Powelliphanta lignaria johnstoni	"Nationally endangered"
Powelliphanta lignaria rotella	"Nationally endangered"
Powelliphanta lignaria ruforadiata	"Nationally endangered"
Powelliphanta lignaria unicolorata	"Nationally vulnerable"
Powelliphanta lignaria lignaria	"Nationally vulnerable"
Powelliphanta lignaria lusca	"Nationally vulnerable

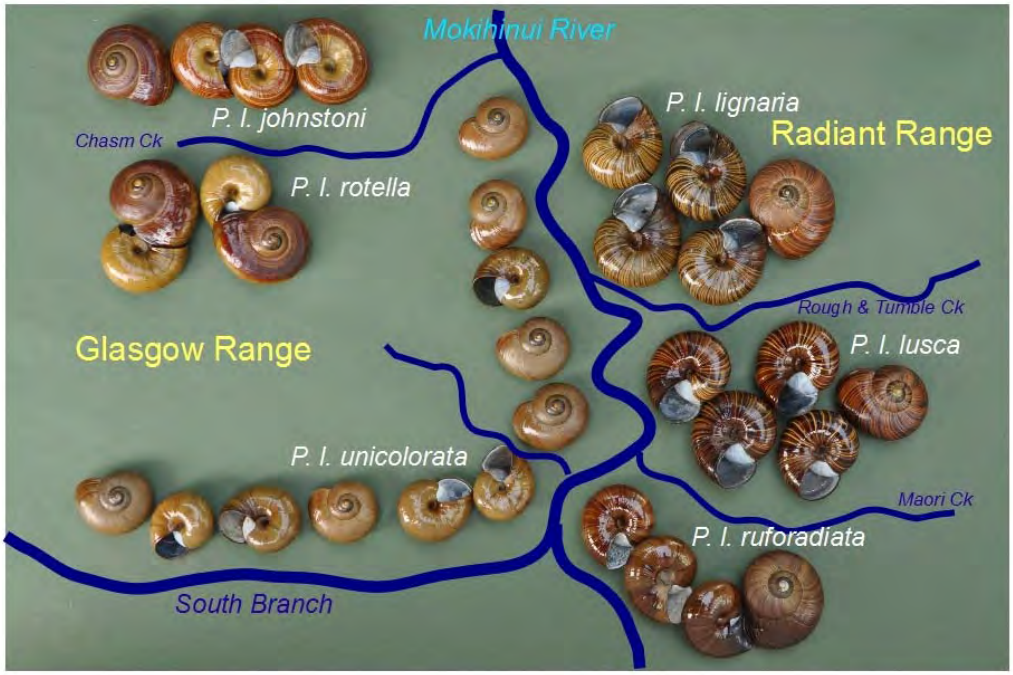


Figure 4: *Powelliphanta lignaria* subspecies affected by the MHP

5. SPECIATION ISSUES

Value of the Mokihinui for speciation studies

5.1. The giant *Powelliphanta* land snails of North Westland and North-West Nelson are distinctive, not just nationally but also internationally. Most of the world's land snails are small, vegetarian, fast-growing and widespread, whereas *Powelliphanta* are large, carnivorous, slow-growing and long-lived, and have evolved into a remarkable array of species over a small area of land.

5.2. The Mokihinui River is the most famous of all sites for *Powelliphanta*, because of the light it sheds on the processes of speciation. It features prominently in a landmark book written in 1937 and reprinted 5 times since then, 1946, 1958, 1962, 1967, 1976, titled "Shells of New Zealand" by Dr AWB Powell, after whom

Powelliphanta are named. An illustration from that book is shown in Figure 5.

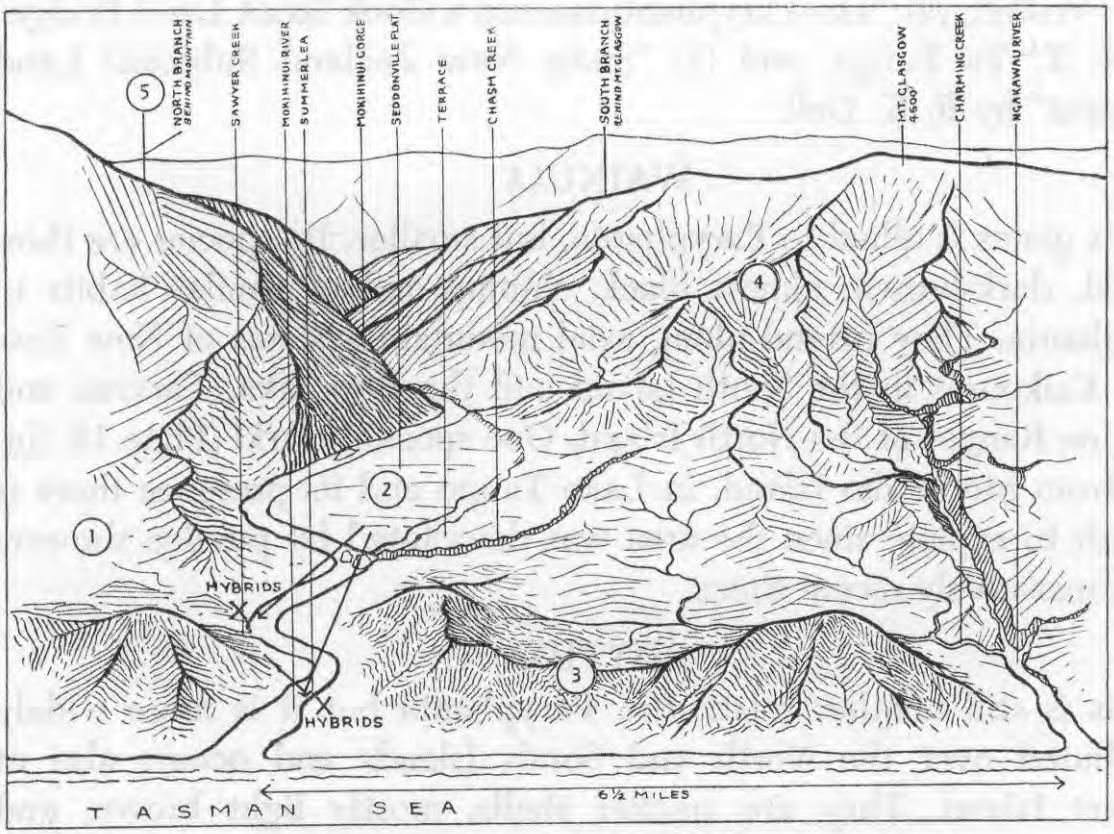


DIAGRAM OF MOKIHINUI, WEST COAST, SOUTH ISLAND.

The flood waters following a huge temporary damming of the Mokihinui River occasioned by the Murchison Earthquake of 1929 caused a mixing of **Paryphanta** subspecies at two locations near the mouth of the river. Thriving colonies of hybrids (**lignaria x unicolorata**) now occur at both sites. 1. **lignaria lignaria;** 2. **lignaria unicolorata;** 3. **lignaria johnstoni;** 4. **lignaria rotella;** and 5. **lignaria ruforadiata.**

Figure 5: Interest in speciation in Mokihinui *Powelliphanta* dates from at least Powell (1949)

5.3. For Dr Powell, one of New Zealand's foremost molluscan experts, the Mokihinui River was crucial in shaping his views on "the species problem" in New Zealand land snails. These were that "river systems play an important role in the segregation of low country subspecies, as instanced in Buller County with …the *lignaria* series…." (Powell 1947). In the same way as the finches of the Galapagos Islands helped crystallize Darwin's theory of evolution, *Powelliphanta*

lignaria in the Mokihinui formed Powell's ideas on speciation in the New Zealand land snail fauna.

5.4. The sheer variety in shell form over a small area, the puzzles over the biogeographic patterns of *Powelliphanta*, and the determination required to visit some of the subspecies meant that the Mokihinui River became of enduring interest to land snail enthusiasts. The Mokihinui area became a mecca for the many shell collectors in New Zealand in the 1960's-1980's, until the shells became protected by law. These quotes from the New Zealand molluscan newsletter *Poieria* are typical:

> "*After crossing Cook Strait, and driving down to Westport, we finally arrived at Seddonville and the swift Mokihinui…..That evening [5 January 1962], maps were brought out and plans discussed, for we were at last in the heart of the Paraphanta country."* (Laurie Price 1962, on a 2 week snailing holiday with Aucklander Norm Gardener & his son.).
>
> According to P.R. Jamieson, 1985, over Easter/Anzac holiday 1985, a 5 person party from Wellington: "*raced down to North Westland in search of Powelliphanta……With the easy ones out of the way we still had plenty of time to make some attempt on that mystical subspecies rotella. I say mystical, because this has always been a difficult one to collect, even though close to Seddonville*".

5.5. There are a number of reasons why the Mokihinui is so valuable in the study of speciation.

5.6. **Firstly**, with the exception of the flats around Seddonville, the area is largely intact; the native forest cover is still widespread, so snail populations remain connected.

5.7. **Secondly**, the area is geologically diverse, with a wide range of substrates, from the very alkaline limestones/siltstones/mudstones highly favoured by many land snails, to very acidic sandstones and coal measures for which land snails require specialized adaptations. These very different environments occur immediately adjacent to each other over a small geographic area.

5.8. **Thirdly**, the warm moist climate is perfect for giant land snails, providing refuges of favourable microclimates even through the glacial cycles of the Pleistocene.

5.9. **Fourthly,** the size and strength of flow in the Mokihinui River, separates snail populations on either side sufficiently for them to follow different evolutionary paths, but occasionally throws them back together in random ways, re-setting the speciation direction.

5.10. **Fifthly**, the speciation process is highly visible. It occurs in an animal which carries it's genealogy in its shell. Recent molecular and morphological research on *Powelliphanta* found shell type reflects complex inheritable genetic diversity (Walker et al 2008, Trewick et al 2008). In the case of *Powelliphanta*, appearances do matter; they wear their ancestral history on their back (Figure 6).

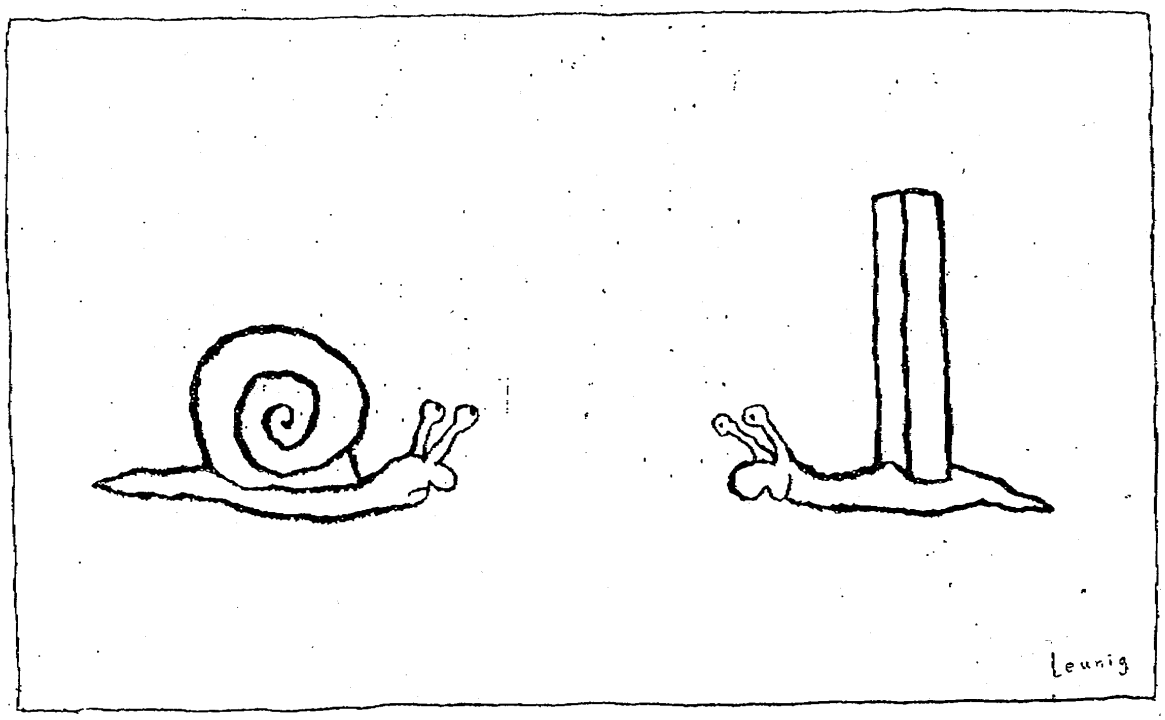


Figure 6: Shell shape and pattern can be a taxonomically useful diagnostic character in some molluscs, including *Powelliphanta* (cartoon by Michael Leunig).

Speciation processes in *Powelliphanta lignaria*

5.11. Ancestral *P. lignaria* were probably uni-coloured and comparatively small. As the Mokihinui Gorge cut down through the rapidly rising Glasgow and Radiant Ranges over the last few million years (evidence of Dr Paul Williams), the landsnail populations gradually became isolated and through genetic drift, evolved differing shell shape, colour, pattern, size and ecological niche.

5.12. While *P. lignaria* snails in the headwaters and north bank of the Mokihinui River (*P. l lignaria, P. l. lusca. P.l ruforadiata* and *P. l unicolorata)* occupy warm lowland, fertile, calcium-rich limestones, mudstones and siltstones, those on the south bank at the farthest extremities of the species range *(P. l. johnstoni* and *P. l. rotella),* specialize in the opposite type of habitat; acidic, infertile yellow silver pine and rimu forest on leached coal measures on boggy pakihi and in cold frost hollows.

5.13. The subspecies of *P. lignaria* can be seen as a cline, stretched in a horseshoe fashion around the Mokihinui River, with each subspecies most similar to its neighbour on the same side of the river (Figure 4). Those at either end of the cline near the mouth of the Mokihinui River but on opposite banks, *P. l. lignaria* and *P. l. johnstoni*, may be geographically close but are very different from each other in shell pattern and ecological niche. Indeed, so different did they appear that the taxonomist AWB Powell originally described them as two different species, with *unicolorata, johnstoni* and *rotella* on the south bank considered one species and the north bank *lignaria*, *lusca* and *ruforadiata* another. It took two decades (Powell 1930, 1938, 1946, 1949) to sort this out, through discovery of intermediate colonies in the headwaters of the Mokihinui and hybridization where they were washed against each other down the Mokihinui River.

5.14. The significance of the Mokihinui River for snail biologists today, arises from its nature as a semi-permeable barrier to land snails. *Powelliphanta* snails drown if they fall into water, but not immediately, so snails cannot normally cross the river but they very occasionally survive being washed down and across it.

5.15. Although the different subspecies of *P. lignaria* are very distinctive, there is still some gene flow between them and the process of speciation is not yet complete (and never will be if key natural processes are maintained). As the Mokihinui River continues to cut its gorge through the adjacent rising Glasgow and Radiant mountain ranges, there has been occasional mixing of populations from the north and south banks.

5.16. One such event was the Murchison earthquake in 1929 when a landslide blocked the Mokihinui River near the Forks and a lake formed in the north and south branches. When the dam eventually burst, large numbers of *P. l. unicolorata* and smaller numbers of *P. l. ruforadiata* were swept downstream and some were washed ashore

in the lower reaches of the river. Those washed ashore hybridized with existing inhabitants, forming strange new shell sizes and shapes.

5.17. The hybrid colonies originating from the 1929 earthquake were investigated, named, and became of considerable interest to biologists soon after they formed. One hybrid colony was at the mouth of Sawyers Creek, on the north bank just below the Mokihinui Bridge, where small numbers of *P. l. unicolorata* and *P. l. ruforadiata* snails washed up against an existing *P. l. lignaria* colony, and another was at Summerlea on the south bank where stranded *P. l. unicolorata* and *P. l. ruforadiata* landed on ground previously unoccupied by *Powelliphanta* and formed a new hybrid colony.

5.18. The most complex colony of all was formed at the junction of Chasm Stream and the Mokihinui River, when *P. l. ruforadiata* snails washed up against existing *P. l. unicolorata*, *P. l. johnstoni* and *P. l. rotella* snails, whose distributions overlapped at this one small site.

5.19. There was considerable professional interest as to whether the new mixtures of genes would persist in the population, and if they did, how quickly new distinctive populations would emerge; speciation visibly in action.

5.20. In order to protect the hybrid population near the Seddonville road bridge across Chasm Creek, the site was protected within a specially designated Radcliffe Ecological Area in 1986, while the Summerlea Bush colony is a Recommended Area for Protection (RAP) (Overmars et al 1998).

5.21. In addition to large scale events such as the Murchison Earthquake flood, there is also ongoing but much smaller-scale exchange of genes across the Mokihinui Gorge during regular floods. *P. l. unicolorat*a, as the most abundant snail of the upper reaches of the

Mokihinui River, has arrived regularly enough on the north bank to influence the shell morphology and gene pool of *Powelliphanta* already there, but this influence does not extend far from the river. There is much less sign of genetic exchange from the north bank to the south bank.

5.22. Above the Forks in the Hemphill Flats area of the North Branch, all *Powelliphanta* consistently have a redder & larger shell than do classic *P. l. unicolorata*, and a plainer less striped shell than do classic *P. l. ruforadiata*. While the consensus amongst specialists is that this population is still closest to *P. l. ruforadiata*, it probably represents an intermediate form that could alternatively be described as a separate subspecies. Individuals in the population are not hybrids but rather a stable intermediate form.

5.23. The Mokihinui River channel with its regular flooding events and landslides is a semi-permeable barrier to land snail distribution, playing a critical role in the natural evolutionary processes of *Powelliphanta*.

5.24. The secondary contact between well developed subspecies is maintaining gene flow and throwing up new combinations of genes, depending on the relative proportions of each subspecies at any contact point along the river. This is speciation in action, and because of the particular characteristics of *Powelliphanta*, it is extraordinary because it is readily observable.

6. DISTRIBUTION OF *POWELLIPHANTA* IN THE MOKIHINUI VALLEY

6.1. There are 4 *Powelliphanta* taxa occupying the Mokihinui valley upstream of the proposed dam site (Figure 4).

6.2. On the north bank of the Mokihinui River from the proposed dam site to just below the river's junction with Rough and Tumble Stream is *P. l. lignaria*, the largest-shelled of the *P. lignaria* subspecies, with a maximum diameter of about 6.5 cm (Figure 7). Approximately 14.2 ha of its habitat is within the MHP.

Figure 7: *P. l. lignaria*, with good snail habitat in the background, inside the proposed inundation area on the north bank, Mokihinui Gorge, opposite Johnny Cake Creek mouth

6.3. At Rough and Tumble Stream *P. l. lignaria* is replaced by *P. l. lusca*, which occupies both banks of Rough and Tumble Stream, and also inhabits the hills on the north bank of the Gorge from the Rough and

Tumble Stream to Maori Creek. Approximately 21.4 ha of its habitat in within the MHP. *P. l. lusca* (Figure 3) has a strongly spirally striped dark red and black shell (in contrast to *P. l. lignaria's* yellow and black shell) and is a little smaller (maximum diameter 5.8 cm).

6.4. From Maori Creek to the Forks the hills on the north bank are occupied by *P. l. ruforadiata,* a large snail (also 5.8 cm maximum diameter) with irregular dark spiral stripes on a pale background (Figure 8). Approximately 10 ha of its habitat is within the MHP, mostly near the mouth of Maori Creek and Pakihi Creek.

6.5. On the south bank of the Gorge and on both banks of the South Branch is *P. l. unicolorata*, a smaller snail (maximum diameter 5 cm), which as the name suggests, usually has a plain old-gold coloured shell (Figure 9). *P. l. unicolorata* also occurs just above the river on the north bank of the Gorge along-side (Figure 10), and at times hybridizing with, the other larger *P. lignaria* subspecies also present there. Approximately 275 ha of its habitat is affected by the MHP.

Figure 8: *P. l. ruforadiata* habitat at the mouth of Pakihi Creek at the top end of the proposed reservoir. The young kahikatea forest on the flats here will be inundated during floods; live *P. l. ruforadiata* displaying *P. l. unicolorata* influence on shell morphology at Pakihi Creek mouth; and a *P. l ruforadiata* with more typical shell colouration in the mid reaches of Maori Gully

Figure 9: *P. l. unicolorata*, and favourable habitat on mudstone beside the Mokihinui River just above its junction with Specimen Creek which will be inundated by the proposed reservoir.

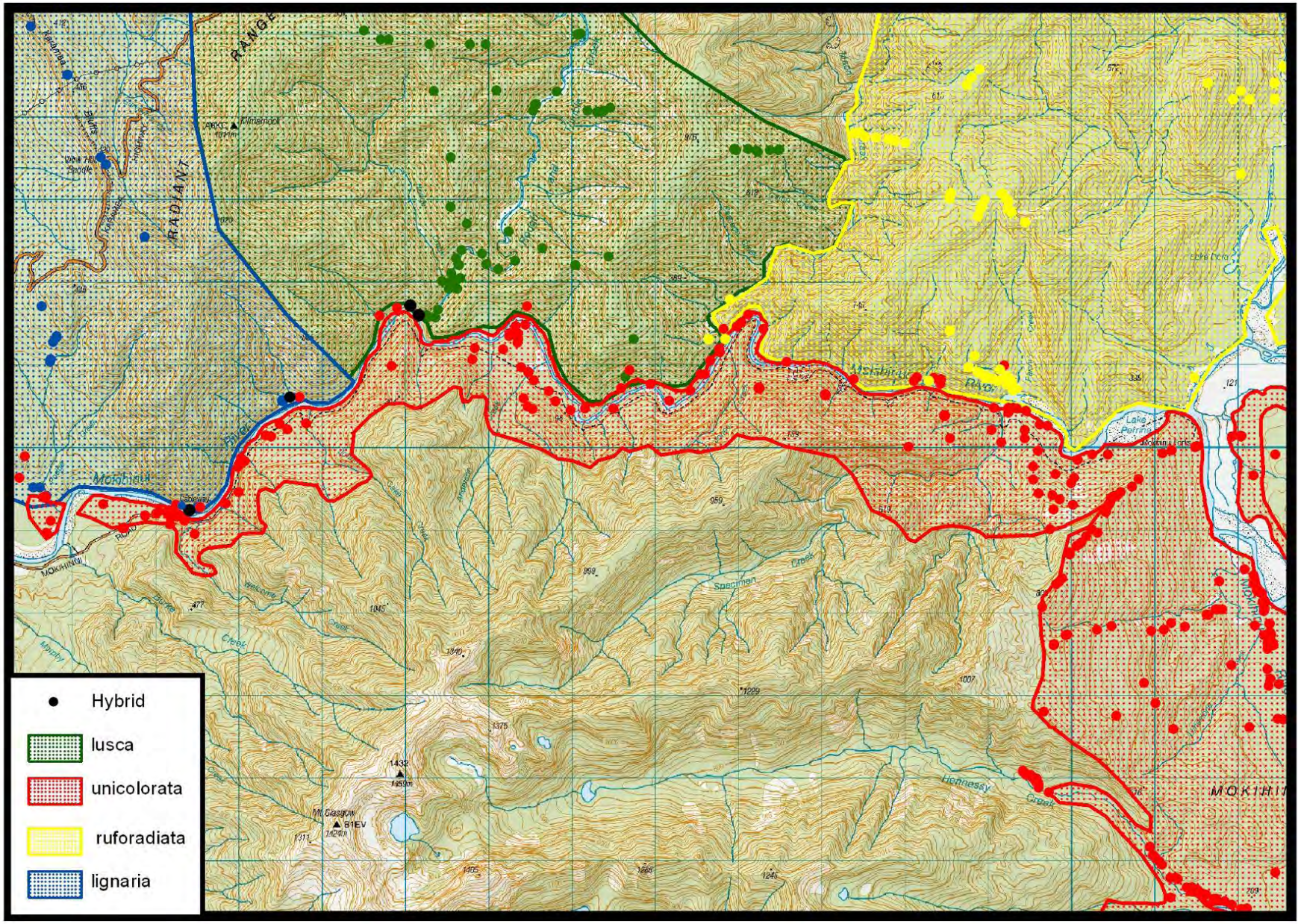


Figure 10**:** Distribution of *Powelliphanta lignaria* subspecies in the Mokihinui Gorge. Solid dots represent locations where shells were collected, and stippling represents estimated distribution (gauged from areas where shells were seen but not collected and surveyed areas where snail shells are definitely absent).

Conservation status of *Powelliphanta* populations in the Mokihinui Gorge

6.6. *P. l. unicolorata*, *P. l. lignaria* and *P. l. lusca* (ie those taxa found in the lower Mokihinui Gorge and most affected by the dam proposal), are listed threatened species classed "vulnerable", the lowest level of the "threatened" categories (Hitchmough 2007). Their placement into this category was last assessed in 2006, before the dam proposal and its potential impacts on these taxa were known. Justification for the "vulnerable" ranking is given in the Recovery Plan (Walker 2003) and summarized below.

6.7. The habitat of *P. l. unicolorata*, *P. l. lignaria* and *P. l. lusca* is substantially intact, and the environment they inhabit is, for large land snails, very favourable. The integrity, connectivity and size of the forest still available for these taxa is a key factor in their comparatively low threat ranking (Walker 2003).

6.8. They largely inhabit public land, held and managed for conservation purposes, so were regarded as much less threatened than they would be if their habitat was not conservation land.

6.9. The average level of predation observed on *P. l. unicolorata*, *P. l. lusca* and *P. l. lignaria*, at about 30- 40% of all shells found, contrasts favourably with levels observed in *Powelliphanta* elsewhere (eg 90% in most *P. superba* populations). Species such as *P. superba* are in a far poorer state because they are montane and predominantly live in colder less fertile environments where snail productivity is lower and possums rather than rats are their main predator.

6.10. By contrast, the Mokihinui River *P. lignaria* live on richer soils in warmer more productive lowland forest so snail productivity is higher, and being located in the Gorge beside the river, these snails are not and probably never will be, subject to possum predation.

6.11. The complete absence of possum predation on *Powelliphanta* in the bottom of Gorge is probably a consequence of the rich and diverse vegetation there. Although it seems counter-intuitive, my research has shown that where the vegetation is rich and possum palatable plants common, even if possum numbers are high, possums don't prey on *Powelliphanta* land snails (Walker 2003) in these sites.

6.12. There are a number of plausible mechanisms for this observation. One is that the energetic cost for possums in (1) finding a sparsely distributed animal such as *Powelliphanta* then (2) opening it's hard shell, is much higher than are the costs of eating abundant fruit and leaves. But in cooler more montane sites where the vegetation is less diverse and fruiting trees and palatable broadleaved plants much less common, it makes more energetic sense for possums to seek out protein-filled *Powelliphanta*, even if it takes a long time and a lot of energy.

6.13. Possums prey on *Powelliphanta* in all the tributaries of the Mokihinui River including the Rough and Tumble Creek, Maori Creek, Maori Gully and most of the South Branch. The absence of possum predation on *Powelliphanta* in the Gorge itself gives the snail populations there a big advantage over the populations elsewhere.

6.14. However, the situation is reversed with rat predation. Rats are uncommon in montane, cold or infertile environments, both because the invertebrates and seeds they eat are rare, and because at low temperatures rat breeding and survival is impaired. Consequently, rats are usually more abundant year-round in the Gorge with its comparatively warm temperatures and abundance of fruiting and flowering palatable plants, than they are in the colder and less diverse beech-dominated tributary valleys of the Mokihinui.

6.15. The exceptions to this pattern are the years when the beech forests seed heavily (termed “mast”). Masting usually occurs every 3-5 years. When masting happens in the simple monoculture forests of beech, there’s so much seed that rat numbers irrupt in the year it falls. Rats can do a lot of damage to wildlife in the short period from when the seed eventually runs out (ie germinates) to when the expanded rat populations inevitably collapse.

6.16. So because the vegetation of the Gorge is different in key respects to that of the South Branch and other tributaries (evidence of Dr Kelvin Lloyd), rats are probably present in the Gorge in moderate numbers more of the time than they are in the tributaries of the Mokihinui, except in beech-mast years when numbers in the upper valleys probably exceed those in the bottom of the Gorge.

6.17. With one notable exception, in most vegetation types rats - unlike possums - eat snails if they are present. My observations indicate that the impact of rats on snails is usually in direct proportion to the abundance of rats. Because the Gorge probably has moderate rat numbers much of the time, in most years more snails are eaten by rats there than they are in the Mokihinui tributaries. However, in beech mast years the situation reverses. Many more snails are eaten by rats in the upper tributaries than in the Gorge.

6.18. Thus the Gorge *Powelliphanta* colonies have 3 major advantages over those in the Mokihinui tributaries; rat populations are less subject to “plague”; possums don’t prey on snails there; and the environment favours higher snail productivity.

6.19. From this it can be seen that *Powelliphanta* habitat in the Gorge and South Branch have different strengths and the snail populations have different pressures on them. This diversity confers resilience on the *Powelliphanta* populations in the Mokihinui, and this resilience is acknowledged by the “vulnerable “threat status classification.

However, *P. l. unicolorata*, *P. l. lignaria* and *P. l. lusca* were placed on the threatened species watch-lists because of concerns about introduced predator impacts. These impacts have increasingly been addressed by a programme of predator control and snail outcome monitoring started in 1994. The programme continues to evolve as better predator control techniques become available and our understanding of *Powelliphanta* ecology improves. This control programme is described later in my evidence.

Effect of geology, geography & ecology on *Powelliphanta* distribution and density

6.20. The distribution & density of *P. lignaria* apparent today reflects a complex interrelationship between geological, historical, ecological and geographical factors, and I will describe that interrelationship in the paragraphs below.

6.21. The geology of the Mokihinui catchment is described in the evidence of Dr Williams and is associated with very strong effects on ecological processes and patterns (evidence of Dr K. Lloyd). The importance of geology to snail distribution is illustrated in Figure 11, in which all shell location records from the Department's *Powelliphanta* database, plus "estimated" distribution records (gauged from areas where shells were seen but not collected and surveyed areas where snail shells are definitely absent) are mapped onto the geological maps of Rattenbury et al. (1998) and Nathan et al (2002). While the density of dots can reflect survey effort more than real snail density, some general patterns can be seen.

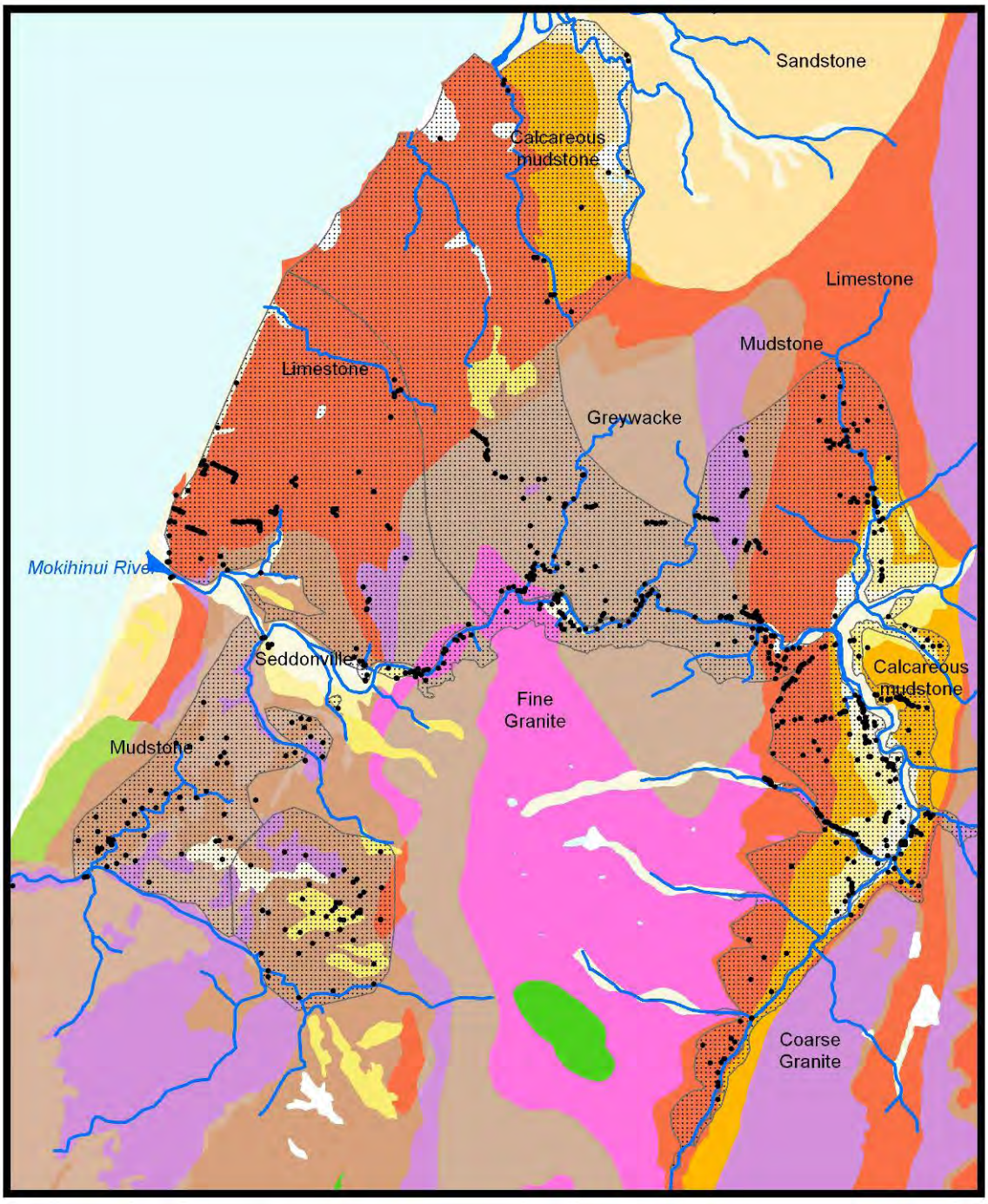


Figure 11: Geology of the Mokihinui area (modified from Rattenbury et al 1998 and Nathan et al 2002), overlain with the distribution of *P. lignaria*. Black dots show where shells have been collected and black stippling shows estimated *P. lignaria* occupation.

6.22. Substrates most preferred by *P. lignaria* are mudstones, limestones, sandstones (greywacke) and fine grained granites, and the least preferred are coarse granites. This preference is because moisture, calcium and fertility is critical to *Powelliphanta.* Mudstones readily

break down to fine silts which retain moisture well. At the other extreme coarse granites break down to very free-draining grainy and infertile soils.

6.23. Calcium content of the substrate is also important as the inner layer of the shell is built from calcium carbonate, they lay hard calcium-shelled eggs, and their main food, earthworms, are more abundant in alkaline soils. However, soil acidity and calcium play a complex role in *Powelliphanta* density, with some taxa adapted to coal measures (ie *P. l. rotella*, *P. l. johnstoni* and *P. patrickensis*) limited in their tolerance for calcium and high pH.

6.24. The effect of geology can be seen most clearly east of the South Branch flats where the range of *P. l. unicolorata* terminates abruptly along the White Creek Fault as the substrate changes from calcareous marine sediments to coarse granites (Figure 11). Snail densities plummet from ~20/100 m^2 to ~2/100 m^2 to complete absence over a few hundred metres. All the granite in the MHP in the Gorge is fine-grained and able to support snails.

6.25. Historical and ecological factors add another layer of complexity to *Powelliphanta* distribution in the Mokihinui area. There are no *Powelliphanta* on land covered by ice during the last ice age although they are sometimes present on ridges between glaciers. Thus, regardless of geology, *P. lignaria* snails are not present in the glacial cirque basins high on the eastern slopes of the Glasgow Range.

6.26. Micro-habitat preferences of *P. lignaria* include consistently moist ground where water doesn't pond. Ponding drowns eggs, juveniles and adult snails and their earthworm prey. Consequently some leached swampy terraces on the South Branch Flats only support snails where there are enough small interconnected rises above ponding areas to support a viable population.

6.27. Snails may reach high numbers on steep sunny slopes where litter is drier only where rainfall is regular enough for humidity to remain high, and other environmental factors are particularly favourable (eg the high calcium content above Lake Perrine).

6.28. Soil fertility is important, because higher fertility supports larger earthworm populations.

6.29. For all *Powelliphanta* species affected by the MHP, my conclusion is that their overall distribution patterns are shaped by the big picture things - past and present climate and geology, while the patterns of distribution and density within the range relate also to microhabitat differences in moisture and fertility. Current density is a reflection primarily of these features, overlain with recent events such as droughts, floods, and fluctuations in predator numbers.

6.30. Mr Buckingham is of the view that it's possible to mitigate habitat loss in *P. lignaria* and *P. patrickensis* by increasing snail numbers in the remaining habitat through predator control (paragraphs 11.4-11.6 of his EIC). This assumes that snail numbers are unnaturally low everywhere simply because of the impact of exotic predators. While this is partly true, in my experience the matter is more complex. Land varies greatly in its suitability as *Powelliphanta* habitat, and in most places the presence or absence of particular environmental attributes is more important than predator numbers in determining snail population size.

6.31. Much of the prime *P. lignaria and P. patrickensis* habitat **outside** the footprint of the MHP is already within long-term predator control programmes. Some of the land not currently under predator control is less conducive for snails, and predator control here will have a more limited impact on snail numbers. In my opinion predator control cannot convert unsuitable habitat into suitable habitat and so compensate for the loss of prime habitat.

7. TRANSMISSION LINE

7.1. The proposed transmission line crosses land supporting four *Powelliphanta* taxa; *P. l. unicolorata* near the dam site, *P. l. rotella* and *P. l. johnstoni* (Figure 12) in the Mokihinui Forest and *P. patrickensis* (Figure 13) on the Stockton plateau.

7.2. The taxa affected are endemic to the immediate vicinity. *P. l. rotella*, *P. l. johnstoni* and *P. patrickensis* are all now ranked as "nationally endangered" (Hitchmough 2007) primarily because of high rates of habitat loss. Large parts of the forest habitat of *P. l. rotella* and *P. l. johnstoni* were logged, burnt and converted to pine plantation between 1980 and 1985. An extensive area of *P. patrickensis* habitat has been lost over the last 10 years to open-cast coal mining, and the rate of loss is increasing.

7.3. Habitat loss remains a major cause of *Powelliphanta* decline, primarily because the snails have such small natural ranges. While Mr Buckingham and Dr Norton correctly identify exotic predators as the main conservation issue facing New Zealand's bird species, this is not true for *Powelliphanta* in Buller.

7.4. The proposed transmission line will cross the Radcliffe and Ngakawau Ecological Areas (Figure 12). These Ecological Areas were gazetted to protect significant flora and fauna values, particularly *P. l. rotella* and *P. l. johnstoni* (Appendix 1).

7.5. The proposed route across the Stockton Plateau (Figures 13 & 14) will cut through the southern Stockton Plateau. This includes the Upper Waimangaroa Recommended Area for Protection (RAP) which contains some of the best remaining relatively unmodified *P. patrickensis* habitat still in existence. In addition to being part of the RAP, this habitat was also set aside and protected as part of an Environment Court-endorsed protection package (Appendix 2) for *P. patrickensis* when the Cypress Mine proposal was consented. This in my opinion makes the site of particular value.

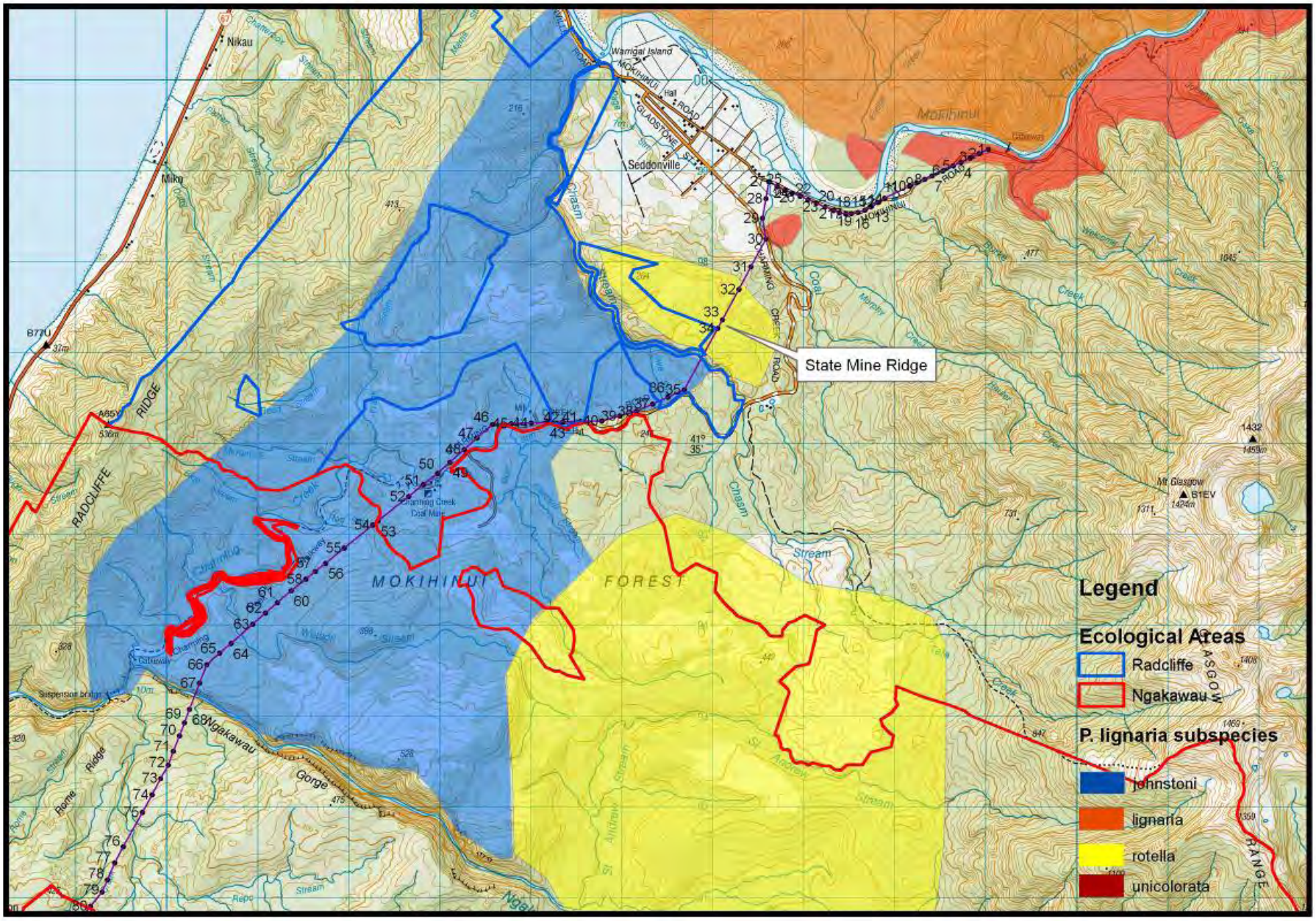


Figure 12: The overlap between the proposed transmission line, 2 Ecological Area's, and the distributions of *P. l. lusca*, *P. l. johnstoni and P. l. unicolorata*

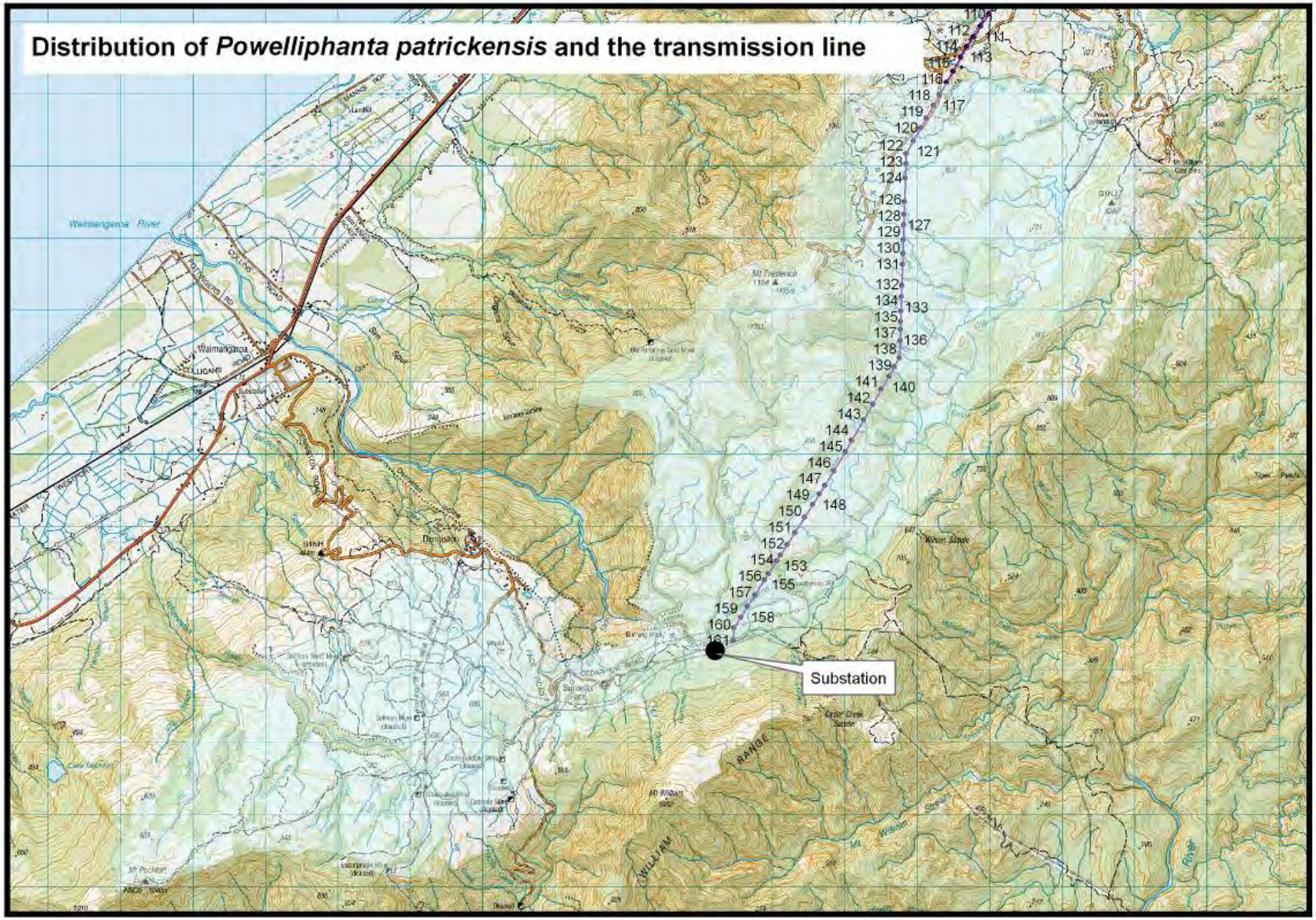


Figure 13: The overlap between the proposed transmission line and the distribution of *P. patrickensis*

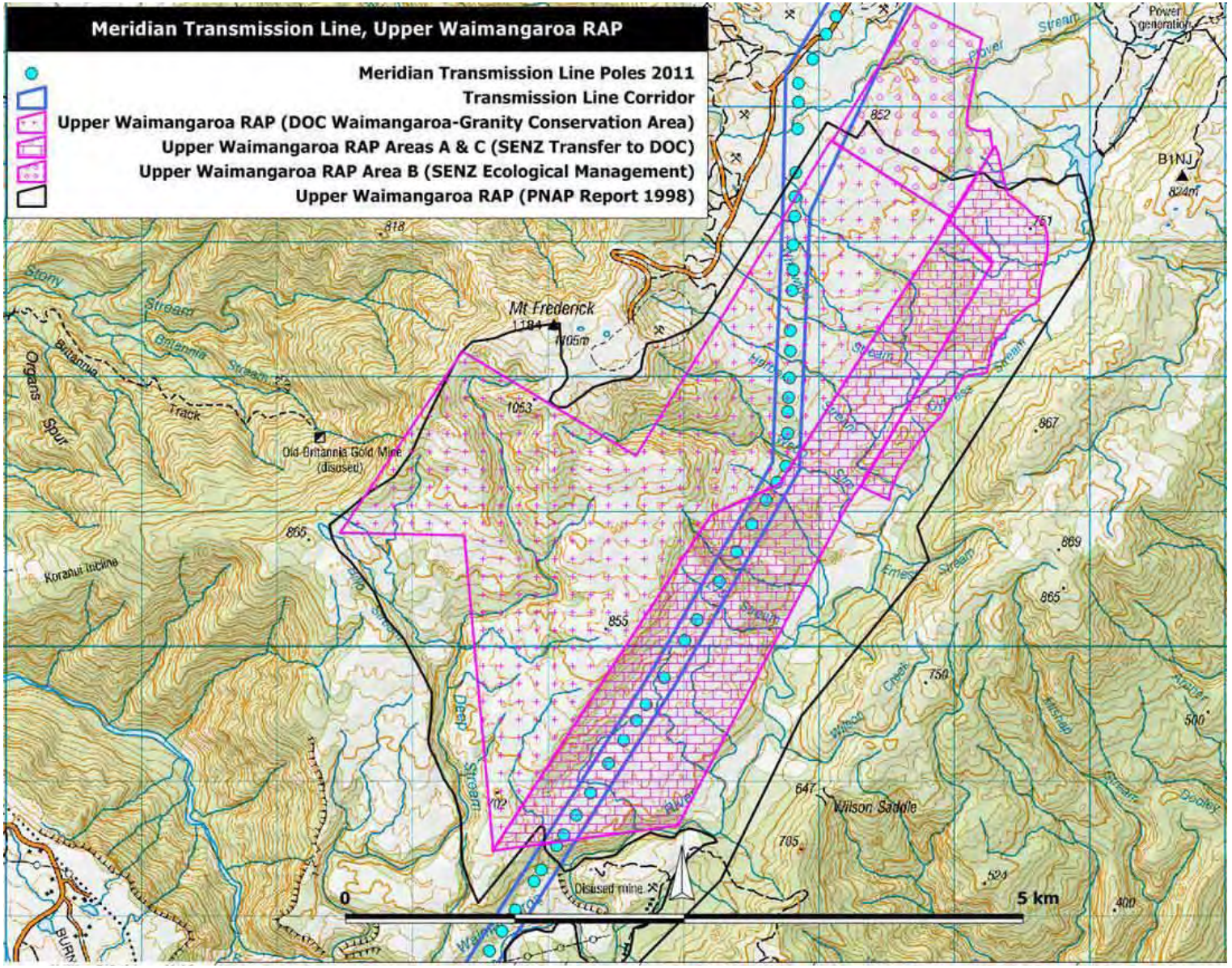


Figure 14: Transmission line route through the upper Waimangaroa RAP and through the area subject to a Deed of Agreement between DOC and Solid Energy (figure courtesy of Meridian).

Powelliphanta habitat values of the land affected by the transmission line

<u>*P. l. unicolorata* habitat</u>

7.6. The proposed transmission line will cross native forest that is habitat for *P. l. unicolorata* at the eastern end of the Seddonville Flat. This forest has been logged and snail presence is patchy, but is one of the few remnants of the lowland forest that formerly covered the Seddonville Flat and supported a large population of *P. l. unicolorata* (Powell 1946).

7.7. The transmission line re-enters forest at the bottom of the Charming Creek Road hill. This spot (about pylon 30) is near the "type" locality for *P. l. unicolorata* described by Powell (1938) as "the Seddonville Flats …around flax (*Phormium*) bushes near the State Mine" (the State Mine was on the ridgeline just west of this pylon). This snail population is important because it is the location where the "type" specimen was collected. It is scientifically important to preserve the population at this site because it is the benchmark for future re-classifications of *Powelliphanta*.

<u>*P. l. rotella* habitat</u>

7.8. The proposed transmission line then crosses the ridge to the south-west, passes over the headwaters of Chasm Creek before rejoining Charming Creek Road. A dense colony of *P. l. rotella* lives on this ridge, called in earlier records State Mine Ridge. This colony has long been of ecological interest because (1) the State Mine Ridge marks the northern-most and lowest-altitude habitat of *P. l. rotella* (2) the colony of snails is isolated from the main population of *P. l. rotella* and (3) its range here abuts that of both *P. l. johnstoni* to the west and *P. l. unicolorata* to the east (Figure 12). The snail habitat on State Mine Ridge is valuable because it enables 3 subspecies of *Powelliphanta* to maintain contact and occasionally interbreed, thus naturally slowing the process of speciation.

7.9. The original forest on this ridge was among the last of the primary forest to be logged and converted to pine plantation by the New Zealand Forest Service in the mid 1980s. Most of the pine trees subsequently blew down in a gale on 28 July 2008, when they were nearly mature. This allowed regeneration of native vegetation without the disruption to the soil that plantation logging would have caused. Despite the battering this area has taken over the last 30 years, its current and potential value as habitat for snails remains. The many small streams and gullies which remained in native vegetation (Figure 15) provided a refuge for snails from which the population should recover well.

7.10. *P. l. rotella* has a naturally restricted global range of only about 1100 ha, and is ranked as "Acutely Threatened - Nationally Endangered" (Hitchmough 2007). About 75% of this small global range has already been damaged by logging and plantation forestry. Surviving colonies are of significant conservation value because they provide the only opportunity to recover the species from threat of extinction. The Department of Conservation therefore, has had an ongoing programme of land acquisition and protection for this subspecies, and parts of State Mine Ridge which were still in native forest were added to the Radcliffe Ecological Area in 2002.

7.11. Some of the remaining *P. l. rotella* colonies are also affected by predation by possums. Consequently, since 1995 the Department (in collaboration with the AHB) has been carrying out regular possum-control over the whole range of the subspecies.

Figure 15: *P. l. rotella* and a remnant of its forest habitat in the Radcliffe Ecological Area along the proposed transmission line route (between pylons 32 & 33) on State Mine Ridge.

7.12. Unlike most of the *P. l. rotella* population, the colony on State Mine Ridge suffered little predation by either possums or rats and so was of a healthy size prior to the exotic forest blow-down, so is anticipated to recover well.

P. l. johnstoni habitat

7.13. On the western-side of State Mine Ridge the transmission line crosses Chasm Creek into the range of a second subspecies of giant landsnail endemic to the Mokihinui Forest, *P. l. johnstoni* (Figure 16). There is a locally dense colony of *P. l. johnstoni* near Lowe Stream in close proximity to the *P. l. rotella* population on State Mine Ridge; some slight *rotella* influence is visible in the Lowe Stream colony. This proximity is of evolutionary importance because it allows gene flow between otherwise diverging subspecies.

7.14. *P. l. johnstoni* occurs from the headwaters of Chasm and Charming Creeks, down the Charming Creek valley on either side of the Walkway to the Charming Creek junction with the Ngakawau River. The proposed transmission line would bisect this range (Figure 12 & 16).

7.15. P. *l. johnstoni* has a similar history of habitat loss and predation by possums to *P. l. rotella*. It is also ranked as 'Acutely Threatened – Nationally Endangered" (Hitchmough 2007), and regular possum-control in all the colonies of *P. l. johnstoni* is undertaken.

Figure 16: *P. l. johnstoni*; and their habitat in the Ngakawau Ecological Area, looking north-west from the mid Ngakawau Gorge towards Watson Stream and Radcliffe Ridge. The proposed transmission line between pylons 63 and 64 would cross in the middle distance.

P. patrickensis habitat

7.16. *P. patrickensis* is a much smaller (maximum shell diameter about 3.5 cm), glossier and lighter-shelled snail that is endemic to the southern part of Stockton and the Denniston Plateau (Figure 13 & 17), where it occurs patchily and generally in low numbers. It is present on rock pavement areas with almost no soils, but prefers deeper soils in the

ecotone between wire rush / tussockland and low manuka/southern rata forest and scrub.

7.17. The proposed transmission line bisects the distribution of *P. patrickensis*, with snails present (sparsely and patchily) from about pylon 115, to the substation at the end of the line at Pylon 161, where snails are much more plentiful.

7.18. *P. patrickensis* is ranked as "Acutely-Threatened, Nationally Endangered" (Hitchmough 2007), primarily due to on-going habitat loss due to coal mining. It suffers comparatively little from predation by exotic pests, probably because both rats and possums are rare on the Stockton and Denniston Plateaux. The harshness of the climate and the acidity, infertility and saturated nature of the soils on the plateau mean pest numbers are naturally low.

7.19. Until the 1970's disturbance to the snail colonies was confined to localized habitat loss near settlements and mine portals, though there may have been a few extensive fires. In the 1970's opencast coal mining began at Stockton with the complete loss of habitat on mined land. Habitat loss due to open-cast mining has accelerated over the last decade.

7.20. Between 2004 and 2010, prior to opencast mining about 1500 of the resident *P. patrickensis* on Mt Frederick were collected and placed in habitat below the mountain that was already occupied by the same species. Those left on Mt Frederick mostly died when the land surface ("overburden") was stripped to allow mining. In 2009/10 several hundred *P. patrickensis* in the headwaters of Whirlwind Stream were collected and placed within already-occupied Plover Stream headwaters (ie taken from near proposed pylons 122-128 and placed below pylon 121) to make way for settling-pond expansion. In 2010 - 2012 hundreds more *P. patrickensis* were killed when eastern parts of the ridgeline between the (former) Mounts Frederick and Augustus on the western scarp of the Stockton plateau were removed for expanded coal mining. There was no monitoring of the transferred snails so their survival rate is unknown.

Figure 17: *P. patrickensis* and its habitat of stunted yellow silver pine and prostrate manuka, sheltered by sandstone pavement on the Stockton Plateau coal measures, east of pylon 133 on the proposed transmission line.

7.21. In 2011, recognition of the futility of translocating large numbers of *Powelliphanta* into an ever-shrinking area of already-occupied snail habitat has led to a move away from this practice, and a growing acknowledgement of the need for habitat protection for the remaining

undisturbed *P. patrickensis* populations. This experience of large scale translocations on the plateau also apparently led Meridian to reassess its original proposals for translocations of *Powelliphanta* from the inundation area.

7.22. Consent for the infrastructure for large scale open cast coal mining which would eventually destroy much of the remaining *P. patrickensis* populations across the Denniston Plateau was granted in late 2011 to Buller Coal Ltd by the Buller District Council. About the same time Solid Energy began the process to strip away over 300 ha of *P. patrickensis* habitat in the headwaters of the Waimangaroa River to make way for the new Cypress opencast coal mine.

7.23. Much of the best remaining comparatively unmodified *P. patrickensis* habitat left lies between Cedar Creek and Cypress Stream in, and to the west of, the Waimangaroa Valley. Most of this land lies within the Upper Waimangaroa Recommended Area for Protection (RAP) and part is land held by Solid Energy but agreed for transfer to public conservation land as mitigation for the adverse impacts of the Cypress Mine. This particularly high value conservation land is where Meridian proposes to place its transmission line (Figure 14).

7.24. In my opinion there could be few routes chosen for the transmission line that would have greater impact on threatened *Powelliphanta* species. For example a transmission line following the cleared farmland beside the state highway about 5 km **west** of the proposed route, or passing through the native forests in the upper catchments of the Ngakawau and Orikaka Rivers about 10 km **east** of the proposed route, would avoid all these subspecies.

8. ASSESSMENT OF SIGNIFICANCE

8.1. In the following paragraphs I assess the value of the large land snail fauna within the affected areas according to the significance criteria and definitions of the Buller District Plan (BDP). I note the MHP overlaps three different Ecological Districts, whose attributes need to be considered for significance to be assessed. The lower Mokihinui River below the dam site largely falls in the Karamea Ecological District. Most of the river within the Gorge which will be inundated by the proposed dam falls in the Wangapeka Ecological District, and most of the transmission line route falls within the Ngakawau Ecological District.

Representativeness – BDP criteria: "*The area is one of the best examples of an association of species which is typical of the Ecological District"*.

8.2. *Powelliphanta* are typical of all three ecological districts the MHP affects, but because they are spot endemics, the ability to compare across districts is to some extent hindered.

8.3. The association of *P. lignaria* subspecies in the MHP footprint in the Gorge is large and of high quality, with all expected taxa present, and populations of good size and density. The Wangapeka ED largely comprises inland mountain and valley topography with a montane character, and much of it has been recently glaciated, leading to local extinctions of the *Powelliphanta* taxa there. Large suites of different *Powelliphanta* subspecies are not common in the Wangapeka ED because of this glaciation. The only comparable association is on Parapara Peak in the far north-east corner of the ED where a different set of species occurs. The MHP footprint in the Gorge comprise an excellent example of an association of species typical of the southern part of the Wangapeka ED.

8.4. Four of the 5 *Powelliphanta* taxa expected in the Ngakawau ED are present in the transmission line footprint; *P. l. rotella* and *P. l.*

johnstoni in the northern sector of the Ngakawau ED, and *P. patrickensis* in the southern sector. Together they provide a good example of the association of high-acidity adapted species typical of the Ngakawau ED. The transmission line passes through some of their best remaining habitat, supporting the highest population densities of all four taxa.

8.5. When considered together, in terms of representativeness, the MHP footprintranks highly.

Distinctiveness – BDP criteria: "*The area has indigenous species or an association of indigenous species which is unusual or rare in the ecological district, or endemic, or reaches its distribution limit*".

8.6. The Mokihinui Gorge is the engine room of the diversity within *P. lignaria*, and the MHP footprint contains an association of species which is both distinctive and rare in the Wangapeka ED. The predominantly lowland, lush and diverse vegetation and complex geology in the MHP footprint support a large land snail fauna unusual in the glaciated Wangapeka ED.

8.7. *P. l. unicolorata* and *P. l. ruforadiata* are confined to the Wangapeka ED, *P. l. lusca* and *P. l. lignaria* are nearly endemic to the Karamea ED, and *P. l. rotella*, *P. l. johnstoni* and *P. patrickensis* are only found in the Ngakawau ED.

8.8. The species *P. lignaria* reaches its southern limit in the Ngakawau ED, and indeed, the *P. l. johnstoni* population living at the Ngakawau River Gorge, at the point where the transmission line crosses it, form the southern limit of very large land snails in New Zealand. Beyond this point all *Powelliphanta* species are much smaller-bodied and predominantly alpine.

8.9. The *Powelliphanta* populations in the MHP footprint are outstanding in terms of distinctiveness, on both a local (Ecological District) and

national scale in that the taxa affected do not occur beyond the Little Wanganui to Waimangaroa catchments.

Intactness –BDP criteria: *"The area has a cover of predominantly indigenous vegetation, is little modified by human activity, and is not affected in a major way by weed or pest species"*

8.10. I agree with the assessments of Dr K Lloyd on the intactness of the vegetation in the project area, so have restricted my assessment to the impacts of exotic pest species.

8.11. Exotic predators of *Powelliphanta* are comparatively rare on both the plateau and in the northern Mokihinui coal-measure forests, principally because the land is cold, infertile and inhospitable to pests. Charming Creek forms a frost hollow which means rats are almost absent from this part of the transmission line, even though the valley is only a 100 m asl. In addition, pest control for *Powelliphanta* protection across most of the transmission line footprint has been occurring for many years so possum numbers too are mostly low.

8.12. In the MHP footprint in the Gorge ship rats are common but from a comparison of rat tracking data, no more so than in any other coastal lowland forest valley in New Zealand. Rats, stoats and possums are all controlled at the proposed staging area by residents, and wider possum control there is carried out by the AHB.

8.13. Overall, the project area has a high value for intactness.

Size – BDP criteria: **"***The area of indigenous vegetation or habitat is 5 ha or more in size or together with adjacent indigenous habitat is larger than 5 ha; or in the case of natural wetlands is larger than 1 ha in size*"

8.14. In totality the affected area is over 500 ha in size (Table 3 in the evidence of Dr Ussher) and clearly meets this criterion.

Protected status – BDP criteria: "*The area has been set aside by statute or covenant for protection or preservation*".

8.15. Much of the project area is located on land that is held for the protection of natural and historic resources. The northern Mokihinui Forests which the transmission line would traverse are Ecological Areas, gazetted specifically for the protection of the large *Powelliphanta* endemic to these forests.

Connectivity – BDP criteria: "*The area is connected to one or more other significant areas in a way (through ecological processes) which make a major contribution to the overall functioning of those areas*".

8.16. The intact sequence of snail habitat across the MHP provides excellent connection to valuable habitat outside the area in both the Gorge and along the transmission line. This wider habitat extends almost uninterrupted from the sea to the mountain tops, both to the north and south of the Mokihinui River.

8.17. The MHP footprint in the Gorge is playing a vital role in dispersal of *Powelliphanta*. The north bank snail populations are genetically connected to those on the south bank because of the Mokihinui River. The river is responsible for creating small populations on both banks with different gene frequencies, which are still altering depending on the number of snails transported across the river at any one time, and the density of the resident snail populations the transported snails land in. The river is creating diversity by re-connecting gradually differentiating populations in the large and significant areas of snail habitat beyond the MHP area.

8.18. In assisting the dispersal of landsnails from one bank to the other, the river in the project area in the Gorge is making a major contribution to evolutionary processes. The MHP has outstanding value for connectivity.

Threat – BDP criteria: "*The area supports an indigenous species or community of species which is threatened within the ecological district or ecological region or threatened nationally*".

8.19. All 7 taxa of *Powelliphanta* affected by the MHP are currently classified in the Department of Conservation's national listings as "threatened", with four being "Nationally endangered" and three "Nationally Vulnerable' (see Table 1). The MHP area has a high value for this criterion in terms of *Powelliphanta*.

Migratory Species – Does not apply to *Powelliphanta*

Scientific or cultural value – BDP criteria: "*The area is a scientific reference area, is listed as a geopreservation site, or has significant amenity value*"

8.20. "Scientific reference areas" include sites where a species is first described (ie the "type" locality), and such areas are important to retain as they provide the benchmark against which later taxonomic discoveries can be compared. Unsurprisingly, given that they are endemic to the immediate Mokihinui area, there are a number of *Powelliphanta* type localities which would be threatened by the MHP.

8.21. The type locality of *P. l. unicolorata*, the species most affected by the MHP, is near what would be pylon 30 on the proposed Transmission Line. This pylon is situated just before the Charming Creek Road starts climbing away from the Seddonville Flat.

8.22. The type locality for *P. l. johnstoni* is near Chasm Creek where the Seddonville Road will need to be widened. The type locality is described as "West side of Chasm Creek, towards junction with the Mokihinui River, 100-500 feet" (Powell 1946).

8.23. The type locality for *P. patrickensis* is just east of the transmission line where it crosses the Stockton Plateau ie "the eastern side of the Millerton Plateau, headwaters of St Patrick Stream" (Powell 1949)".

A grid reference given places the exact locality about 1.8 km from the transmission line.

8.24. The area is an important one for the scientific study of speciation amongst its large land snail fauna. The Mokihinui River was crucial to understanding of "the species problem" in New Zealand landsnails (Powell 1947), and subsequently became a famous site amongst those studying molluscs (see first section of my evidence). On scientific or cultural value the project area scores highly.

8.25. In summary, the habitat of *Powelliphanta* in the Mokihinui Gorge, along the transmission line route, and even in the area for proposed road widening near the mouth of Chasm Creek is clearly highly significant in terms of Section 6(c) of the RMA. It scores very highly on BDC criteria for distinctiveness and connectivity, and highly in terms of representativeness and scientific value.

Comment on the significance assessment of other witnesses

8.26. I agree with Mr Buckingham that the MHP footprint contains "significant habitat for seven endemic *Powelliphanta* taxa, all of which have restricted distributions regionally and are nationally threatened" (paragraphs 4.1 and 11.1 of Mr Buckingham's evidence in chief).

8.27. Mr Buckingham does not provide a summary of the statutory significance of the *Powelliphanta* fauna in the footprint of the Mokihinui hydro project in the context of Section 6 of the RMA.

8.28. In the absence of formal assessment of significance, Mr Buckingham describes the size and health of the snail populations in the Gorge which would be most affected by the MHP. He suggests the *P. l. unicolorata* population on the south bank is "moribund" with "low densities" "poor recruitment of mature individuals" and "high levels of predator damage", and that the populations of *P. l. lignaria, P. l. lusca and P. l ruforadiata* on the north bank "are so minor as to not

be ecologically significant" (paragraph 11.3 of his EIC). He considers that the Gorge *P. l. unicolorata* populations "are collapsing" (paragraph 9.3 EIC), along with all the *P. lignaria* populations between Waimangaroa and Karamea Bluffs" (paragraph 8.59 EIC), and "are likely to become locally extinct (paragraph 10.13 EIC) He described the area of affected *Powelliphanta* habitat on the proposed transmission line as "negligible" (Table 1 of his EIC).

8.29. I don't believe this is an accurate or reliable assessment. In my view Mr Buckingham has underestimated the significance of the Gorge populations of *Powelliphanta*. This is important because his subsequent estimate of the proportion of the snail population affected by the MHP, the predicted losses the MHP will cause, as well as the gains anticipated from the mitigation proposed, are all founded on his estimate of the size and health of the Gorge population. His underestimation is a consequence of basic problems with his snail sampling programme, which I outline below.

8.30. ***No decline trend data.*** Mr Buckingham suggests that the population of *Powelliphanta* in the Gorge is declining rapidly (paragraphs 8.46 – 8.5 & 8.59 EIC), at about 5% / annum according to Dr Usher's analysis of Mr Buckingham's statistics (Attachment E, page 84 of his evidence in chief). At that rate they would be extinct in the Gorge in about 25 years. However, he provides ***no*** data on changes in population numbers over time that might support this claim. There is no time-series information available which gives any clue as to whether this might be the case; it simply doesn't exist.

8.31. Mr Buckingham found many more young than old snails in his Gorge plots, and suggested this provided support for the theory of a "moribund", rapidly declining population in the MHP. I disagree with his conclusion. "Moribund" populations are normally characterized by small numbers of large old animals and an absence of new breeding stock. The situation in the Gorge is quite the opposite.

8.32. ***Inadequate number and spread of plots.*** In my opinion the most serious deficiency in Mr Buckingham's assessment of size and health of affected snail populations in the Gorge is that he paid inadequate attention to the problems associated with the patchiness of snails. *Powelliphanta* are notorious in their patchiness, with high densities often found immediately adjacent to areas with few or no snails. In addition snail densities in all except a very few colonies are comparatively low. These characteristics mean that large numbers of plots are required to gather a big enough sample of live snails to overcome the inherent variability in snail plot results.

8.33. There were too few snail plots in the area of the Gorge affected by the dam, and these plots did not have sufficient geographic spread to overcome the problems of snail patchiness No plots were placed in those parts of the Gorge which initial investigations (Buckingham 2006 & 2007, Meridian 2006/07 drill site surveys) showed had particularly high numbers of snails. These areas are the immediate vicinity of the proposed dam and the upper third of the inundation zone.

8.34. Mr Buckingham used data from too few plots inside the MHP footprint in the Gorge and missed areas of known high density, for his results to be reliable. To remedy this I added the equivalent of 18 plots (nearly doubling plot number) to the areas inadequately sampled by Mr Buckingham. These comprised 5 new 100 m^2 plots measured by DoC in 2012 near Specimen Creek at the top end of the proposed reservoir, and the 6 x 225 m^2 drill hole searches carried out at the proposed dam site by contractors for Meridian in 2006/07.

8.35. With this improved sampling I found the density of *P. l. unicolorata* snails in the MHP footprint to be indistinguishable from that outside it. In the high density parts of the Gorge snails are just as common as they are in the high density areas in the South Branch. This data strongly indicates the *Powelliphanta* in the MHP are not the impoverished populations Mr Buckingham thought they might be.

8.36. ***Unsuitable methodology for calculating the proportion of snails affected by the MHP***. Through an extrapolation error Mr Buckingham overestimated the proportion of the snail population unaffected by the MHP. He appears to have applied an **average** snail density figure derived **primarily** from **medium/high** density colonies, to the very large area of **low** density habitat outside the MHP (see my Appendix 3 for a statistical analysis by Dr Graeme Elliott of Mr Buckingham's snail plot data). This had the effect of exaggerating the number of *P. l. unicolorata* unaffected by the MHP.

8.37. In my opinion, by first underestimating *P. l. unicolorata* density inside the MHP footprint in the Gorge through too few plots and limited geographic spread, then compounding the error by overestimating the size of the population outside the MHP footprint, Mr Buckingham has drawn an inaccurate conclusion as to the significance of the affected *P. l. unicolorata* population. This has serious consequences as this data was later used in the biodiversity offsetting model, compromising the reliability of the offsets accounting.

9. ADVERSE EFFECTS

Impact of the MHP on *Powelliphanta* in the Mokihinui Gorge

<u>Loss of connectivity in the Gorge</u>

9.1. The construction of a dam at the mouth of the Mokihinui Gorge will have a profound impact on the large land snails there, far beyond what could be anticipated by the amount of land lost. This is because the river forms a semi-permeable boundary between 4 different subspecies of *Powelliphanta*. The evolution of these subspecies arose in part **because** of the Mokihinui Gorge; the river incised while the

land rose, forming a part-time barrier, restricting most gene flow but occasionally allowing secondary contact in chaotic ways.

9.2. Below the Gorge the connection between populations was largely lost when the Seddonville Flats were cleared of forest and the *Powelliphanta* populations there destroyed. Within the Gorge this connection remains intact and important. The dam would result in the loss of about 90% of the secondary contact zone between 3 northern and 1 southern subspecies of *P. lignaria* (Figure 18).

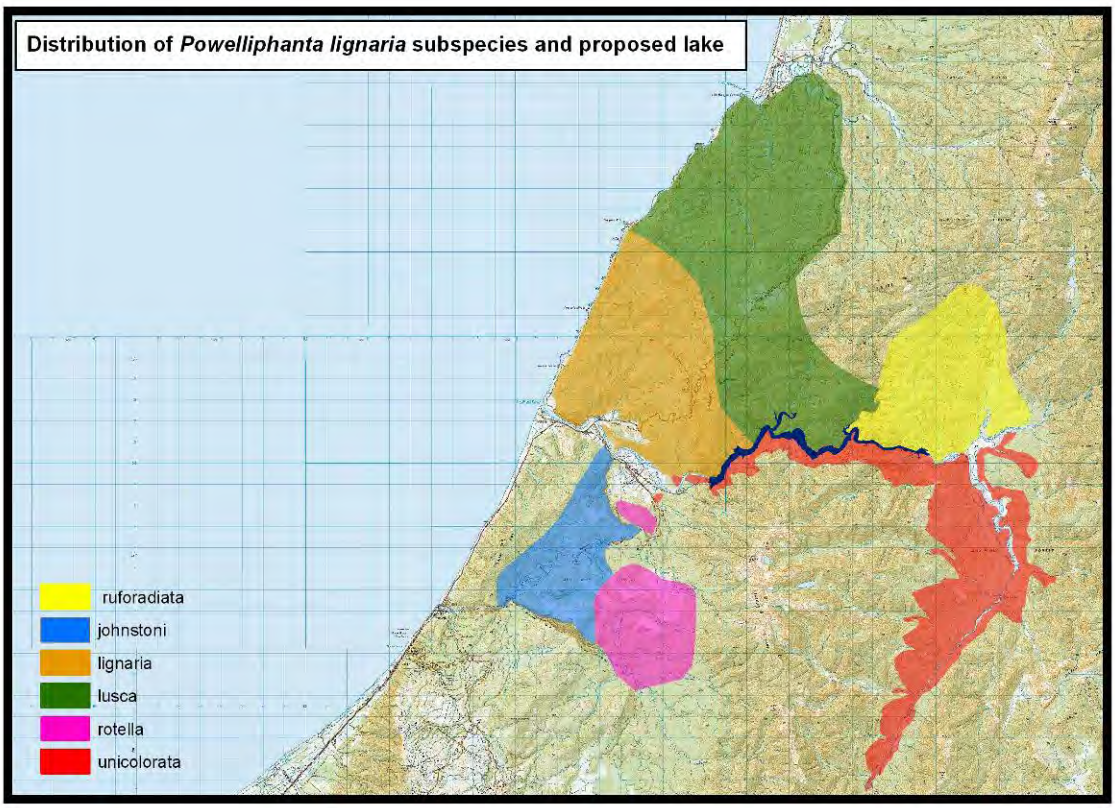


Figure 18: The dark blue line indicates the area to be inundated. A reservoir in the Gorge would destroy much of the contact zone between *P. l. unicolorata* (coloured red) and the north bank subspecies of *P. lignaria* (ie those coloured yellow, green and orange)

9.3. Creation of a lake would drown much of the population of *P. l. unicolorata* which has managed to establish a beachhead on the north bank. The replacement of a rushing river, able to occasionally cast live snails ashore, with a still reservoir in which live snails drown before they can be washed ashore, will curtail gene flow across the

Gorge. This loss of connectivity will significantly change the evolutionary pathway of this species.

Loss of habitat in the Gorge

9.4. *P. l. unicolorata* prefers fertile, alkaline and free-draining but moist soils, and a mild but humid climate. The best *P. l. unicolorata* habitat is patchily distributed, but mostly close to the river in both the South Branch and on both sides of the Gorge. *P. l. lignaria*, *P. l. lusca* and *P. l ruforadiata* on the north bank of the Gorge have similar habitat preferences to *P. l. unicolorata*. The proposed dam would permanently destroy 295 ha of *Powelliphanta* habitat in the Gorge, including some sites on both sides of the river which support particularly high numbers of snails (eg both sides of the dam site, and mudstone river terraces near Specimen and Pakihi Creeks).

9.5. This figure is conservative in that it:

(a) Presumes a stable reservoir level of 100 m asl, whereas an additional 33.5 ha of forest will be lost through routine flooding to 105 m asl (paragraph 7.11 Mr Watts EIC)

(b) Does not take into account LINZ land presumed from tenure status to be riverbed but in reality forested: 4 of the 5 new plots which I found had high snail numbers were mapped as LINZ “riverbed”.

(c) Does not take allow for any “new edge” effects, estimated to be a further 50 m of forest degradation around the reservoir (paragraph 6.4 Dr Usher EIC).

9.6. An estimated 5% of the total habitat of *P. l. unicolorata* would be lost (ie 274 ha of a total 5,591 ha range), with smaller proportional losses in *P. l. lignaria*, *P. l. lusca* and *P. l. ruforadiata*, which share the north bank with *P. l. unicolorata*.

Loss of individuals and populations in the Gorge

9.7. Given the *P. l. unicolorata* densities recorded in the MHP footprint, an estimated 66,716 (CI95%: 47,112-87,588) of these large land snails will drown when the dam is filled. This is a significant loss of individuals. In addition, an unquantified but not insignificant number of *P. l. lignaria*, *P. l. lusca* and *P. l. ruforadiata* living alongside *P. l. unicolorata* on the north bank will also drown.

9.8. An estimated 8.4 % (CI95%: 6.42%-10.81%) of the total population of *P. l. unicolorata* will be lost if the dam is built. This is higher than would be expected on the basis of habitat loss alone (~5%) because the Gorge supports some particularly high density colonies.

9.9. If the Gorge is flooded, the remaining habitat left above the reservoir may support fewer *Powelliphanta* than it did before.

9.10. This is because the zone to be inundated is likely to be acting as a "source", populating the "sink" of the land above. In the mid-lower Gorge snail numbers rapidly dwindle with elevation, particularly on the south bank. On the north bank snail numbers increase again at high altitudes where humidity is high, but on the south bank they are absent altogether above about 200 m asl. As the better quality habitat and highest numbers of snails are on the toe slopes near the river, these areas are probably acting as a "source" of snails, with some animals dispersing (and failing to thrive) in less suitable habitat above. For this reason I expect there will be fewer *Powelliphanta* living **above** the inundation zone if a dam is built, than are there now.

Impact of the transmission line on *Powelliphanta*

9.11. The impact of the proposed transmission line on *Powelliphanta* will be substantial, not just because it will cause the loss of 18.6 ha of snail habitat but because a long transmission line in an essentially

natural environment reduces the perceived naturalness of a much larger area than it directly disturbs.

9.12. It will also further fragment *Powelliphanta* populations along the key contact zones between *P. l. johnstoni*, *P. l. rotella*, and *P. l. unicolorata* around State Mine Ridge in the northern Mokihinui forest.

Permanent habitat loss the proposed transmission line would cause

9.13. Mr Buckingham described the scale of impact of the proposed transmission line on *Powelliphanta* as "negligible" (Table 1 of his EIC), but appears to have reached this conclusion from only a cursory examination.

9.14. I used a snail distribution map to improve Mr Buckingham's estimate of the amount of *Powelliphanta* habitat to be destroyed or degraded by construction of the proposed transmission line. I drew a distribution map of *Powelliphanta* across the Mokihinui and Stockton areas (Figures 12 & 13) using shell data I have collected over the past 30 years. I superimposed each pylon on this map, noting the differing characteristics of each and using the grid references provided in Appendix 2 of the Linetech 2011 report to position it. I used the GIS mapping software and recent aerial photographs to measure the distance from the road to each pylon and the length of transmission line between each pylon.

9.15. I found that in total 18.6 ha of snail habitat would be permanently lost.

9.16. A break down of the way each *Powelliphanta* taxa would be affected is provided in Table 2 and in the subsequent paragraphs.

Table 2: *Powelliphanta* habitat which would be destroyed destroyed by transmission line

	Pylon clearing (m^2)	**Trimming under line (m^2)**	**Access road clearing (m^2)**	**Substation clearing**	**Hectares cleared or trimmed**
P. l. unicolorata	2,375	9,420	-	-	**1.2**
P. l. rotella	2,725	51,415	1,772	-	**5.6**
P. l. johnstoni	10,000	89,695	1,832	-	**10.2**
P. patrickensis	6,258	-	-	10,000	**1.6**
Total area (ha)	**2.1** ha	**15.1** ha	**0.4** ha	**1** ha	**18.6 ha**

9.17. Snails are present at just over half (54%) of the 159 sites where poles would be erected. Disturbance of between 6 m^2 and 625 m^2, depending on substrate type, at each of 85 snail-occupied pole sites would permanently destroy about 2.1 ha of snail habitat (Table 2).

9.18. Further snail habitat would be permanently lost through the formation of about 720 m (0.4 ha) of new access-tracks, mostly in the *P. l. rotella* and *P. l. johnstoni* habitat in the State Mine Ridge to Charming Creek mine area (Table 2).

9.19. A smaller figure of 420 m of new access road is described in Mr Brown's evidence. The difference between my figure and Mr Brown's may lie in how access to poles 31 and 32 is obtained; it is unclear whether there will be extended and upgraded road access to these pylons or whether they will be reached by helicopter, as he suggests both options. I have assumed road access.

9.20. Vegetation cutting in perpetuity under the line will cause the permanent modification of a further 15.1 ha, once again mostly in *P. l. rotella* and *P. l. johnstoni* habitat in the State Mine Ridge to Charming Creek mine area (Table 2). The forest floor and litter layer under vegetation cut on a regular basis will inevitably become drier and more open (Figure 19). This makes the ground much less suitable for snails; survival of eggs and young snails in particular can be expected to decrease significantly.

Figure 19 The impact of power lines on *Powelliphanta patrickensis* habitat on Denniston Plateau in 2011, where vegetation trimming under the lines has allowed sunlight to reach the litter layer and dry it out, and soil has been eroded from under the poles once the hard sandstone capping layer has been broken. Note arrival of weedy gorse. Top photos illustrate the visual intrusion transmission lines can cause in the open landscape of the Plateau, reducing the likelihood of protection of the snail habitat under it. The proposed Meridian transmission

poles would be single or double guyed poles rather than the wider lattice structures shown here. They would extend disturbance onto the last large area of intact coal measures, and require similar permanent vegetation trimming at the northern end and near the substation at the southern end of the line, detrimentally affecting *P. l. rotella*, *P. l. johnstoni* and *P. patrickensis* habitat.

9.21. A Communications Tower and associated helicopter landing platform which would be placed on the top of State Mine Ridge in former "core" *P. l. rotella* habitat, will permanently remove the potential for re-occupation by snails of this site as the vegetation recovers from past logging.

9.22. At least one hectare of *P. patrickensis* habitat will be permanently lost at the Cedar Creek substation site (Figure 20): this comprises a 5250 m^2 switchyard area enclosed by a security fence, and outside the switchyard a 600 m^2 area for a substation building and a car park; an unspecified area of land for a termination gantry for the Inangahua to Westport B line, a drainage channel, a small settling pond, and substantial rock dump for the material dug from a 7m cut when the site is levelled, plus the losses to snail habitat when ~2.5 km of road is upgraded between Burnett's Face and the substation site (paragraphs 6.2-6.7 of Mr Brown's evidence in chief) to construct and service the substation.

9.23. I estimate that about 18.6 ha of snail habitat will be permanently lost due to displacement by the transmission line and associated infrastructure. This area is six times larger than the 2.8 ha estimated footprint of the transmission line suggested by Mr Watts and Mr Overmars.

Figure 20: *P. patrickensis* habitat at the proposed substation site at Cedar Ck.

9.24. Mr Buckingham estimates 10.8 ha of *Powelliphanta* habitat would be affected, which is 40% less than my estimate. This is because Mr Buckingham did not consider additional losses around the substation caused by (1) construction of a settling pond (2) overburden distribution and road widening (3) double poles in *Powelliphanta* habitat (4) loss of habitat west of Charming Creek road or (5) loss of habitat over State Mine Ridge.

Degradation of the transmission line environment

9.25. I agree with Mr Overmars and Dr Norton that the overall impact on *Powelliphanta* of the transmission line goes much further than the direct losses of the line footprint. As Mr Overmars points out (paragraph 7.11 EIC), "*the line* ***will create 159 localized disturbances****, each of which has the potential to damage vulnerable habitat, affect threatened species, and allow weeds into what in many cases are intact indigenous communities*". Similarly Dr Norton notes (paragraph 6.21 EIC) "*there are sound ecological reasons to seek to avoid these impacts. These relate to the existing integrity of the ecosystem, the incremental impact on this ecosystem, which is*

already impacted, and ***especially the potential for the poles to act as a precedent for future encroachment into this area****"* (bold emphasis my own).

9.26. I have provided expert evidence to a number of Council and Environment Court hearings regarding the effects on *Powelliphanta* of various mining development proposals on the Stockton and Denniston Plateaux, and I am aware of the important role previous and existing land modification plays in assessing the value of various parts of the plateau. I also have almost 30 years experience providing scientific advice on numerous proposals throughout New Zealand to create reserves or other specially protected status to protect ecological values (Figure 21).

9.27. Despite the plateau's widely acknowledged exceptional ecological values, there are still no gazetted ecological reserves there; instead only areas long-recommended for protection. If the transmission line runs through the heart of the last big stretch of relatively unmodified land on the Plateau, then in my opinion, based on my involvement in many previous legal protection applications, the likelihood of this area ever receiving reserve status will be greatly diminished. This in turn increases the risk of further more ecologically destructive land uses there than the current proposed transmission line.

9.28. Likewise, in the Mokihinui coal-measure forests which have high value for large land snails but which are currently outside the established Ecological Areas, construction of the transmission line will reduce the likelihood they might in future receive Ecological Area status. In my opinion the current ecological values of these areas are sufficiently high to warrant such status.

Figure 21: Providing advice (whilst employed by the NZ Wildlife Service) to the Protected Areas Scientific Advisory Committee (PASAC) in 1986 as it evaluated reserve proposals to protect *P. l. johnstoni* habitat in the Mokihinui Forest, soon after logging and burning of some of the area. (Photo Colin Ogle)

9.29. The land in the proposed transmission line corridor in the northern Mokihinui Forest which is just outside the existing Ecological Area boundaries is treated in this application as if it has low ecological value. Cheaper concrete pylons which have a bigger footprint will be used for this section, short pylons requiring vegetation clearance in perpetuity underneath the lines are proposed, and access will be by road rather than helicopter (Linetech 2011). This will lower the ecological value of the land outside the Ecological Area.

9.30. In my opinion it is not appropriate to use technologies that are more damaging to *Powelliphanta* habitat currently outside the Ecological Area boundaries than within it. This is because the habitat's value for *Powelliphanta* is equally high.

Adverse effects of road widening

9.31. The proposed widening of the main road into Seddonville at Chasm Creek will adversely affect the mixed colony of *P. l. johnstoni, P. l.*

rotella, *P. l. unicolorata* and *P. l. ruforadiata* present at that location (Figure 22).

9.32. The snail colony near the Chasm Creek bridge is unique in that four subspecies of *P. lignaria* occur within a tiny area and hybridize extensively there. The area north-west of the bridge is also the type locality for *P. l. johnstoni*.

9.33. In 1986 this area was included in the Radcliffe Ecological Area. This Ecological Area was created with the specific intention of protecting this colony and maintaining its links with the larger snail populations in the Charming Creek catchment to the south (Appendix1).

9.34. The snail colony near the Chasm Creek bridge occurs on both sides of the road, and on both sides of the bridge. Because of its small size, any road-widening is very likely to have a substantial negative effect on the colony.

9.35. The detail provided by Meridian on this road widening is insufficient for a full assessment of the likely affects on the snail colony. Dr Michael Steven noted (para 73 of his review of MHP landscape and visual effects for the Buller and West Coast Regional Councils) that the drawings of the road changes proposed in Meridian's application show a high wall (~15 m) would be required on the uphill side of the road as well as a substantial wall on the downhill side. This indicates that considerable removal of material from the Ecological Area at this point is expected. Given the very small size of the snail colony present here, this habitat loss is of considerable concern.

Figure 22: The wooden railroad bridge (with the white railing of the Seddonville Highway bridge just visible above it) over Chasm Creek just above its junction with the Mokihinui River, within the forests of the Radcliffe Ecological Area. Dam-related road widening around this bridge would destroy part of the hybrid snail colony there. (Photo Kath Walker)

Summery of adverse effects of the proposed development

9.36. In summary the MHP will cause serious adverse impacts on *Powelliphanta* populations. These impacts are

In the Gorge:

9.37. Loss of connectivity – between either side of the Gorge; an estimated 90% of the secondary contact zone between 4 subspecies will be affected.

9.38. Loss of valuable habitat – about 5% of the total habitat of *P. l. unicolorata* will be lost, along with a proportion of the habitats of *P. l. lignaria*, *P. l. lusca* and *P.l. ruforadiata*. The best *P. l. unicolorata* habitat is near the river; if this habitat is drowned then lower quality habitat at higher elevations may not support a population of land snails. Thus the impact may exceed the 5% of habitat inundated.

9.39. Loss of individuals and populations: - an estimated 66,716 (CI95%: 47,112-87,588) individual *P. l. unicolorata* large land snails, and an unquantified number of *P. l. lignaria, P. l. lusca* and *P. l. ruforadiata* large land snails will drown when the dam is filled. An estimated 8.4% (CI95%: 6.42%-10.81%) of the total population of *P. l. unicolorata* would be permanently lost, along with an unquantified proportion of the *P. l. lignaria*, *P. l. lusca* and *P. l. ruforadiata* populations.

On the transmission line:

9.40. Loss of habitat - About 18.6 ha of snail habitat would be lost to pylons, access roads, vegetation cutting in perpetuity under the pylons, and a substation plus associated car park, settling pond, rock dump, drainage channel and road widening.

9.41. Compromised future protection – the likelihood of formal protection for threatened coal measure snail communities on the Stockton plateau and in the northern Mokihinui Forest will be diminished by the presence of a transmission line through these habitats.

At Chasm Creek:

9.42. road widening would destroy most of the small hybrid *Powelliphanta* colony and part of the Ecological Area formed to protect it.

Comments on the adverse effects assessments of Meridian's witnesses

9.43. Mr Buckingham notes that the loss of approximately 3% of the *P. l. unicolorata* habitat" is significant for the current population" (paragraph 9.3, EIC). However, he suggests all other adverse effects of the MHP on *Powelliphanta* are "minor or negligible in ecological impact" (eg Tables 1 & 7 his EIC).

9.44. Mr Buckingham's evidence provides little in support of his conclusion that the impacts on *P. l. lignaria*, *P. l. lusca*, *P. l.*

ruforadiata, *P. l rotella*, and *P. l. johnstoni* will be minor or negligible (section 9 of his EIC). To determine that very low to extremely low proportions of the population of each of these taxa will be affected (as he asserts), the size of each population must be reasonably accurately known. There is no reliable information on the size of the population of *P. l. lignaria*, *P. l. lusca*, *P. l. ruforadiata*, *P. l rotella*, and *P. l. johnstoni*. Mr Buckingham reports that his assessment was based on "a broad assessment of their relative densities and distribution range only" (table 7 of his EIC), but I have no confidence in this assessment.

9.45. Mr Buckingham notes (paragraph 11. 3 EIC) that the areas of habitat of *P. l. lusca*, *P. l. lignaria* and *P. l. ruforadiata* habitat affected by the MHP "are small (c 20 ha, 3 ha and 1 ha respectively)". I disagree with this assessment as my data show that *P. l. lignaria* occurs in about 14 ha of the inundation zone in the lower Gorge, *P. l. lusca* in 21.4 ha at Rough and Tumble Creek and *P. l. ruforadiata* in 10 ha in the upper Gorge.

9.46. Mr Buckingham's Appendix 3 is a report written by Dr B Lloyd. It states "Because the total range and density distributions of other *Powelliphanta* taxa [besides *P. l. unicolorata*] found in the MHP are unknown, the proportions of their total populations affected by the MHP **cannot be estimated".** In the caucusing agreement (also Appendix 3), all parties including Mr Buckingham agreed that "without other information, the proposed survey [by Meridian] is **insufficient** to predict the proportion of each *Powelliphanta* taxon that will be affected by the MHP". Dr Ussher notes in his evidence (Attachment J), that Mr Buckingham's estimates are "probably **hypothetical** rather than approximate for populations other than *P. l. unicolorata*".

9.47. Given the general agreement amongst Meridian witnesses that it's not possible given the current state of knowledge to estimate the extent of the adverse impact of the MHP on *P. l. lusca*, *P. l. lignaria*

and *P. l. ruforadiata*, Mr Buckingham's certainty that the impacts are "minor" or "negligible" (Table 1 of his EIC) is unsupportable.

9.48. Mr Buckingham (paragraph 11.5 EIC) concludes that "predators are the only threat which could cause local extinctions of *Powelliphanta* populations within the MHP". I disagree with this conclusion. I am confident that should the MHP proceed habitat loss will cause the local extinction of *Powelliphanta* populations within the MHP footprint. This habitat loss will occur when the forests at the staging area and dam site are destroyed and the reservoir is filled.

9.49. Mr Buckingham further concludes in the same paragraph that "habitat loss …will not affect the survival of any of the *Powelliphanta* taxa within the MHP footprint". My analysis indicates that an estimated 8.4% (CI95%: 6.42%-10.81%) of an already depleted population will be lost; much greater than the proportion Mr Buckingham estimated. I expect that a loss of this magnitude will affect *P. l. unicolorata's* probability of persistence.

9.50. Mr Buckingham makes the case that predators are on the verge of causing the extinction of *Powelliphanta* from all the coastal populations between the Buller and Karamea Rivers, including the Gorge populations (paragraphs 8.49-8.59 of his EIC). However, some of the examples he quotes in support of this proposition arise from data I know well because it was collected by myself and my team. Mr Buckingham's lack of familiarity with these data has led to mistaken propositions.

9.51. He describes the various changes in fortunes of a population of *P. l johnstoni* in the north Mokihinui coal forests (paragraph 8.54 of his EIC). I have been measuring this population annually for 27 years. Mr Buckingham attributes the latest decline in snail numbers there to changing numbers of rats. My data show the site has extremely low rat densities almost all the time and negligible predation on snails by rats has occurred there. Mr Buckingham's firmly held beliefs about

predation obscure alternative scenarios that are more consistent with the data.

Significance of adverse effects

9.52. A major adverse effect is the disruption to the natural processes of evolution in *Powelliphanta* within the Gorge. The Mokihinui Gorge is the only site in the Wangapeka ED, and one of the few sites in New Zealand where so many distinctive subspecies lie adjacent to each other, such that they can interact in complex ways. The only other place where the vegetation cover is still complete enough, and snail diversity complex enough for this to occur is the Heaphy Valley in the Heaphy ED, but here the characteristics of the river, the land beside it and the natures of the species of snail involved are such that the resultant land snail diversity is less than at the Mokihinui.

9.53. The large land snails affected by the proposed hydro scheme are all endemic to the Ecological Districts they lie within, so any impacts on them are impacts on the total global population of each species or subspecies. A significant proportion of the global population and habitat of *P. l. unicolorata* will be permanently lost if the Gorge is flooded. A smaller but still significant proportion of the global population and habitat of *P. l lignaria*, *P. l. lusca*, and *P. l. ruforadiata* on the north bank of the Gorge would also be lost to the reservoir; habitat of *P. patrickensis* would be lost to the substation and switchyard and associated drainage channels, settling ponds, spoil heaps and road widening; and habitat of *P. patrickensis*, *P. l. rotella* and *P. l. johnstoni* to the placement of power pylons and associated access roads and line clearance.

9.54. The type localities of *P. l. unicolorata* ("the Seddonville Flats…around flax (*Phormium*) bushes near the State Mine" Powell 1938) and *P. l. johnstoni* ("west side of Chasm Creek, towards junction with the Mokihinui River, 100-500 feet" Powell 1949), may both be affected by vegetation clearance associated with construction of the transmission line at the former and road-widening at the latter

site. In my opinion adverse effects on type locality populations should be avoided.

9.55. At the southern end of the Stockton Plateau the proposed transmission line passes through much of the best remaining, least modified *P. patrickensis* habitat. This will reduce the likelihood of the formal protection of this habitat necessary to protect it from coal mining.

9.56. In my opinion the MHP will have a major adverse effect on the large land snail populations of the Mokihinui. This is because the many impacts of the hydro scheme extend in a linear way over such a large part of the area, with a narrow but very long reservoir penetrating the core of *P. l. unicolorata* distribution, an even longer transmission line cutting through *P. l. rotella*, *P. l. johnstoni* and *P. patrickensis* habitat, and impacts even reaching the notable hybrid snail colony at the junction of the Seddonville main road and Chasm Creek with dam-related road widening there.

9.57. Overall, I assess the likely adverse effects of the proposed Mokihinui hydro-electric development project on *Powelliphanta* snails to be of major significance.

10. POTENTIAL GAINS FROM MITIGATION ACTIVITIES

***Powelliphanta* specific mitigation**

10.1. The applicant's mitigation proposals centre on the small scale transfer of snails from the dam site and staging area, small scale temporary movement of snails away from poles during construction of the transmission line, and pest control over a large area, primarily in the South Branch of the Mokihinui River.

10.2. Mr Overmars describes restoration of snails to the staging area in paragraph 6.25-6.27 of his evidence in chief. This would involve transfer of a small number of *P. l. unicolorata* from an adjacent colony to the staging area once it had been revegetated. If examination before the dam was built found the adjacent colonies too sparse to be able to provide sufficient donor snails, he describes a retrieval effort at the dam and staging area equivalent to 4 people spending about 3 days @ 8 hours/day searching for snails before dam construction begins. Any snails found would be placed in the adjacent colonies, then years later once the staging area was considered sufficiently restored, the snails would be returned to the staging area.

10.3. While this is a rather elaborate plan for a small return (for reasons which I explain below), it is probably worth doing in order to retain some of the genetic stock from the south bank *P. l. unicolorata* colony at the dam site. Once the dam is filled, snails would be unlikely to get back to the staging area in any other way. As it would be a small and isolated population, at risk of genetic bottlenecks, a substantial number of individuals would need to be transferred to the site. However, this is likely to be difficult as colonies above the proposed reservoir are already small and, due to the source and sink effect described earlier, are likely to become even smaller should the MHP proceed.

10.4. I note this plan fails to conserve equally important genetic diversity at the dam site on the north bank and populations further up the Gorge. However, I agree with Mr Buckingham and Mr Overmars that the original proposal for large scale translocations of snails is impractical and, I would add, undesirable.

10.5. In my opinion the plan for the staging area is not likely to be very successful as the best snail habitat is beside the river where the proposed dam will be built, and there is no intention to rehabilitate this site as it will be permanently built over. The staging area away

from the dam site –where this proposed snail restoration would occur - is mostly rather poor snail habitat now, probably because of ground surface effects of past logging on a leached and poorly drained river terrace.

10.6. I support the proposal by Mr Carr (paragraphs 3 9.13 & 9.14 EIC) to manage 2-way traffic near the narrow bridge north of Seddonville through the use of traffic lights in preference to road widening. This should avoid further impacts on the snail colony around the Chasm Creek bridge.

10.7. I generally endorse the provisions in paragraph 7.20a of Mr Overmars evidence in chief relating to avoidance and remediation of the proposed transmission line facilities. However, I am not optimistic that measures to keep disturbed sites weed free and restored to natural native vegetation will be successful in the long term, given the issues regarding weeds on the transmission line raised in Dr K Lloyd's evidence.

10.8. The sites will all need to be visited regularly for line maintenance over many years, and I'm not confident that this level of commitment can be sustained over time. Lapses would facilitate weed incursion which will increase the area of snail habitat degraded or lost.

10.9. Much emphasis is put by Meridian's witnesses on avoidance of high density *Powelliphanta* populations through "micro-siting" of poles. However, to avoid the worst impacts on snails the transmission line corridor would need to be much wider. A significant improvement at the northern end of the Charming Creek Road would be to move the line outside the corridor to the eastern side of the road and follow the road instead of going directly over State Mine Ridge.

10.10. The proposal to move snails 50 m from each of the 159 pole sites and access roads before they are disturbed will probably be unworkable in practice. It was used by Meridian at the dam site with partial success because the areas involved were small, readily accessible and

in close proximity to each other. However, removal has been less successful at widely separated coal prospecting drill sites across the Stockton and Denniston Plateaux and this practise is now no longer used there.

10.11. The sites can't be searched in advance as snails from adjacent habitat outside the search area will enter it subsequently. Sites must be searched afresh each day before disturbance happens as snails will often move onto the site overnight.

10.12. The proposal to search each 225 m^2 site for 2 person-hours would not allow even a cursory check of an area this size. This level of effort will recover only a tiny proportion of the snails present. From the time taken in thousands of snail plots monitored by the Department of Conservation we know it takes about 5 person hours to search 225 m^2 adequately, but not comprehensively.

10.13. Mr Overmars describes (paragraph 7.22 EIC) predator control for *P. patrickensis* protection already being carried out on Stockton Plateau by Solid Energy in the area of the proposed transmission line. He notes snail numbers are anticipated to increase there as a result, implying any losses the transmission line causes will be made up for by increased snail survival there as a result of this pest control. However, this predator control is **already** intended to be making up for the certain loss of a significant proportion of the population and habitat of *P. patrickensis* caused by opencast coal mining. It is unclear to me how the same single action can mitigate two separate additional losses.

10.14. The measures described by Mr Overmars and Mr Buckingham are all about trying to reduce the scale of the snail losses which are the inevitable consequences of a transmission line route through such important snail habitat. In my view the evidence presented by witnesses for Meridian has not adequately demonstrated why a substantial area of prime snail habitat needs to be lost, or why the

intactness and integrity of 2 Ecological Areas must be compromised by the choice of such an inappropriate route.

Biodiversity Enhancement Strategy

10.15. Meridian has proposed a "biodiversity enhancement strategy" (BES) as mitigation/compensation for the losses to biodiversity caused by the MHP. This is in essence an aerial 1080 pest control programme over the catchment of the South Branch of the Mokihinui River (32,466 ha), the lower Mokihinui Gorge (1,690 ha) and upper Mokihinui Gorge at Pakihi Creek (1,142 ha).

10.16. The premise behind this seems to be that (**a**) browsing ungulates are degrading the flora and exotic predators reducing the numbers of native fauna in the Mokihinui valley; (**b**) that the required control of these pests in the Mokihinui isn't occurring and won't in the foreseeable future; and (**c**) that by Meridian applying pest control in the upper Mokihinui valley, all biodiversity losses from the MHP would be fully offset.

10.17. While this seems appealing, closer inspection shows that it falls far short of offsetting the MHP's impacts. The appeal is based upon (1) negative portrayal of existing pest control in the area (2) overstatement of gains (3) unjustified optimism for the effectiveness of pest control (4) the unjustified assumption that the gains are additional to conservation business as usual and (5) underestimated biodiversity losses caused by the MHP.

10.18. Meridian's witnesses portray DoC's existing pest control programme as irrelevant; Dr B Lloyd, (page 5 Appendix 3 of Mr Buckingham's EIC) asserts the latest operation was unsuccessful in protecting *Powelliphanta* and actually led to an increase in rat numbers, and Dr Norton (paragraph 6.37) asserts that DoC's pest control is not "*true integrated conservation management within priority sites*" and has no certainty of funding. I disagree with these opinions, for the reasons outlined below.

10.19. Firstly, rather than being a failure due to poor timing as Mr Parkes and Dr B. Lloyd suggest, the mid summer timing of the 2010 DoC 1080 operation is now considered to be optimal if rat numbers are to be kept low for as long as possible after the operation.

10.20. Secondly, although the DoC operations in the Mokihinui are targeted at *Powelliphanta* protection, it is likely they are also effective in conserving wider aspects of biodiversity. This is because (1) the methods used control not just those pests which prey on *Powelliphanta* - possums and rats – but also stoats: the 3 species which are the main predators of all New Zealand wildlife, and (2) although the treated areas are comparatively small, pest control is applied so frequently (biennially) that pest reinvasion is minimized.

10.21. Thirdly, DoC's pest control programme for *Powelliphanta* protection has been expanding in scope and scale as new methods more effective against rats become available. The major extension to DoC's South Branch predator control for *P. l. unicolorata* from 300 ha to around 2000 ha in the last few years is evidence of this. These extensions and improvements are on-going.

10.22. Fourthly, the DoC pest control programme for *P. lignaria* subspecies in the wider Mokihinui area is both long-term (began in 1994) and comprehensive. Almost all the habitat of *P. l. rotella* and *P. l. johnstoni* is protected under this programme and nearly 50% of the habitat of *P. l. unicolorata* and *P. l. ruforadiata*. Other agencies (Animal Health Board and Solid Energy) are carrying out pest control in collaboration with DoC over almost all the habitat of *P. l lignaria*, *P. l. lusca* and *P. patrickensis* (Figure 23).

10.23. With substantial proportions of the habitat of all the *Powelliphanta* species and subspecies affected by the MHP already in long-term pest control programmes, gains that might accrue to *Powelliphanta* from Meridian's proposed additional pest control are limited.

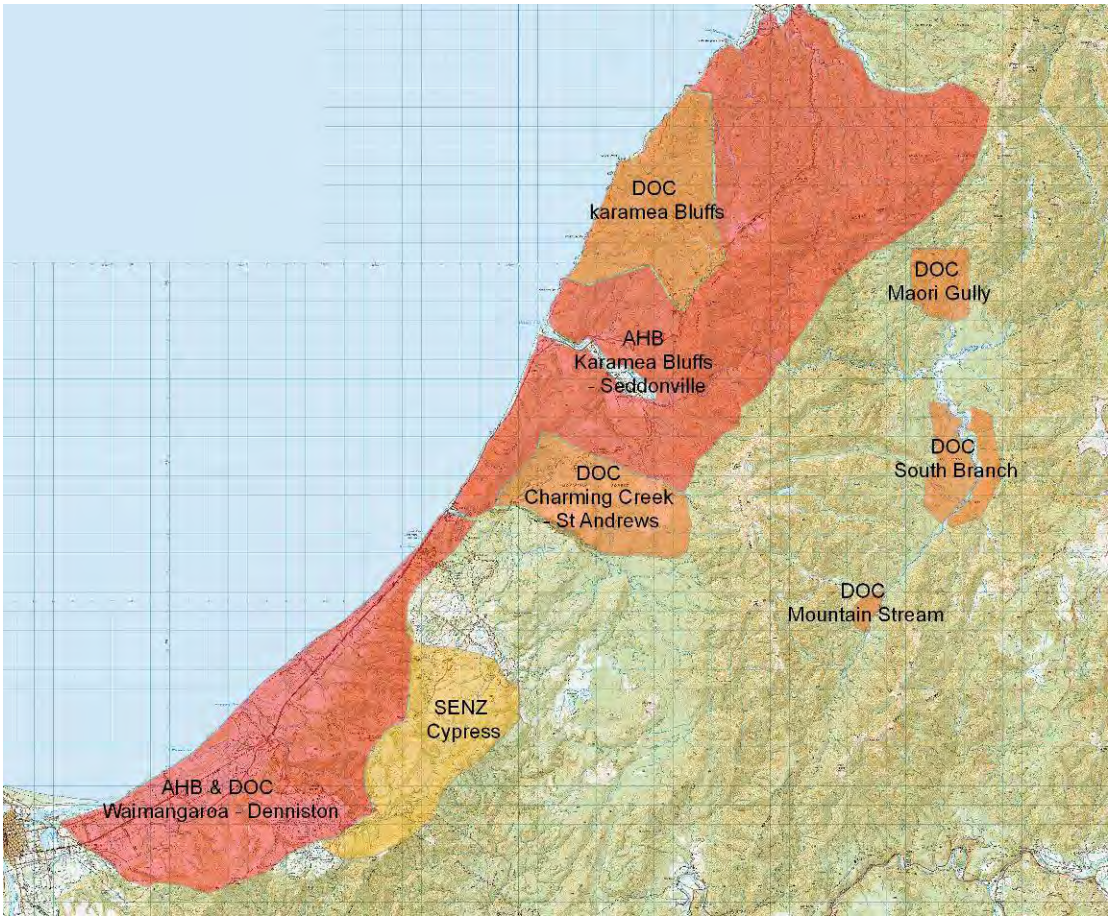


Figure 23: Areas where possum control is currently being carried out for protection of *Powelliphanta* (DoC and Solid Energy) and TB control (AHB).

Proposed pest control

10.24. The pest control proposed by Meridian in the South Branch and in Pakihi Creek would use methods DoC is currently using and, **if** done well, should work as well as conventional DoC pest control programmes. However, as outlined in the evidence of Dr O'Donnell, there are still many uncertainties with pest control, and the desired outcomes are far from guaranteed in my opinion.

10.25. Many of the benefits for *Powelliphanta* from Meridian's BEA would depend on successful pest control in the remnants of the Gorge after inundation. However the specific methodology by which this control might be achieved has not been identified.

10.26. As currently designed, Meridian's proposed 1,690 ha pest control area in the Gorge appears unworkable. This is primarily because of

its poor shape. It comprises a very narrow band, about 200 m wide, on very steep land just above the proposed reservoir. It has so many convolutions that pests from untreated adjacent land would quickly reinvade the treated area.

10.27. No techniques have yet been developed to control rats on this scale in these conditions, to my knowledge.

Biodiversity Offset

10.28. Mr Buckingham (paragraph 11.7 EIC) concludes that *Powelliphanta* will be a major beneficiary of the BES. I disagree. I do not believe the proposed biodiversity offsetting outcome would represent a substantial net-gain of biodiversity values for the threatened *Powelliphanta* land snails lost to the proposed hydro-electric development. I describe why I come to this view in the following paragraphs.

Non-offsettable values

10.29. The offsetting approach used ignores impacted aspects of *Powelliphanta* biodiversity that are not offsettable (eg. loss of natural speciation processes in *Powelliphanta* in the Gorge; loss of intact coal measures habitat of *P. patrickensis*); or are difficult to offset (eg. the permanent loss of a significant proportion of the habitat of *P. lignaria* snails in the Gorge). These are “costs” which don’t appear in the offsetting equation. Dr Ussher describes (paragraph 4.6 EIC) “no net loss” and “equivalence of exchange” as fundamental to a valid offsetting approach, yet his model would result in major net loss of significant components of *Powelliphanta* biodiversity.

10.30. In my view the non-offsettable losses to speciation processes in *Powelliphanta* in the Gorge, and degradation of intact coal measures habitat should be avoided altogether. Loss of *P. l. unicolorata* and *P. l. lusca* habitat could potentially be partially compensated by returning the dairy land on the Seddonville and Cobyvale flats back

into forest, but because of extensive land drainage this is not really a practical option, and the offsetting activities proposed do not achieve this.

10.31. By excluding the non-offsettable and not easily offsettable elements from the balance sheet, the offset accounting model severely underestimates the true loss of *Powelliphanta* biodiversity in the impact sites and overestimates the potential gains by inflating the area and density of *Powelliphanta* occupation in the BEA and potential rates at which populations are assumed to increase.

10.32. Neither Dr Ussher nor Dr Norton mentions the value of the Gorge to speciation processes within *Powelliphanta*.

10.33. Dr Norton expresses the view (paragraph 6.12-6.14) EIC) that to be "non-offsettable" something must be irreplaceable (ie not found elsewhere) and highly vulnerable. I agree that irreplaceable or highly vulnerable biodiversity is not offsettable. However I do not agree with his conclusion that no elements in the areas affected by the MHP definitely met this criteria (Paragraph 6.13 EIC). This is because; (1) the natural speciation processes within *Powelliphanta lignaria* subspecies in the Gorge cannot occur elsewhere (2) these subspecies are nationally rare (3) the Gorge holds a unique combination of them.

10.34. There is general agreement (including by Dr Norton) that the coal measures ecosystem is highly threatened and nationally rare. *P. patrickensis*, a species specifically adapted to and only found in this ecosystem, is highly threatened and nationally rare. Neither the ecological processes within *P. lignaria* subspecies in the Gorge, nor the coal measures ecosystem are replaceable. In my opinion they are therefore not offsettable and it would be appropriate to avoid them.

No net loss

10.35. As a result of the hydro-electric project, even with complete success of the proposed pest control, there will be an **overall reduction of diversity** within *P. lignaria* through the drowning of hybrid populations on both banks of the Gorge, a reduction in the **population size, area occupied and natural range** of *P. l. unicolorata, P. l. lignaria, P. l. lusca* and *P. l. ruforadiata*, and a **decrease in the ecological health and functioning** of this suite of taxa. In my opinion residual impacts of the proposed dam on *Powelliphanta* are significant.

Additionality

10.36. Most of the best snail habitat above the Forks in the upper Mokihinui, falls within DoC's existing pest control areas in Maori Gully and the South Branch (including the Mountain Creek block, which received pest control regularly from 1994-2008 but is currently "switched off") (Figure 23). Much of the snail monitoring done by Meridian contractors beyond the MHP was done **inside** DoC's existing predator control areas.

10.37. Snail data from inside DoC's control areas seems to have been put into the offset model as if it also applied to the untreated proposed BEA. This is inappropriate in my opinion, as the snail populations have already responded to some degree to the pest control DoC has already carried out. Their populations are already elevated compared to those outside, in the BEA. This would result in overestimated baseline values for *P. l. unicolorata* in the BEA, which are thereby artificially inflated relative to anticipated losses in the MHP footprint in the Gorge.

10.38. I am not aware that there is an intention to halt DoC's existing 2,165 ha pest control programme in the South Branch, yet I note that this area is included within the 35,300 ha area stated to be the size of the proposed BEA (e.g. Dr Norton EIC paragraphs 3.3, 3.4, 6.26, 6.28c,

6.37; Mr Overmars EIC paragraphs 4.5; Mr Parkes EIC paragraph 2.3 and 4.25). Furthermore I am not aware of information to support an assumption that there would be no future increase in the scale and scope of DOC's current pest control in the Mokihinui for the protection of *Powelliphanta* and other biodiversity. Thus it is not clear that the additionality principle is met, if this is taken to mean "*securing positive outcomes* ***where such outcomes would not otherwise occur***" (Dr Norton paragraph 6.5 EIC, bold emphasis my own).

Underestimation of biodiversity in the MHP footprint

10.39. In my opinion Mr Buckingham underestimated most elements of *Powelliphanta* biodiversity in the MHP footprint that are used in the calculations in Dr Ussher's model (Table 3).

10.40. Furthermore, anticipated improvements to *Powelliphanta* as a result of the proposed pest control have in my opinion been overstated. For example, most high density *P. l. unicolorata* colonies outside the Gorge are already under pest control by DoC (Figure 24) so the BEA would be protecting largely low density colonies. However, as described in my Appendix 3, Mr Buckingham overestimated numbers of snails in the low density populations in the South Branch and these numbers were subsequently used in the offset model, overestimating the number of snails that would benefit from the proposed pest control.

Table 3: Aspects of *Powelliphanta* biodiversity which, in my opinion, have been underestimated in Dr Ussher's biodiversity offset model

Aspects of biodiversity in MHP underestimated	**My value estimates**	**Value used in Ussher's biodiversity offset model**
Role of Gorge in *Powelliphanta* speciation processes	Irreplaceable - very high value	Not valued – no estimate
Proportion of population of *P. l. unicolorata* affected	8.4%	< 2%
Proportion of *P. l. unicolorata* habitat affected	5%	c 3%
Minimum* area of *P. l. unicolorata* habitat affected	275.4 ha	230 ha
Minimum* area of *P. l. lignaria* affected	14.2 ha	3 ha
Minimum* area of *P. l. lusca* affected	21.4 ha	20 ha
Minimum* area of *P. ruforadiata* affected	10	1 ha
P. patrickensis, P. l. rotella, P. l. johnstoni habitat lost	18.6 ha significant	Not valued
Intact coal measure ecosystem modified	Irreplaceable	Not valued

* 100 m asl reservoir level

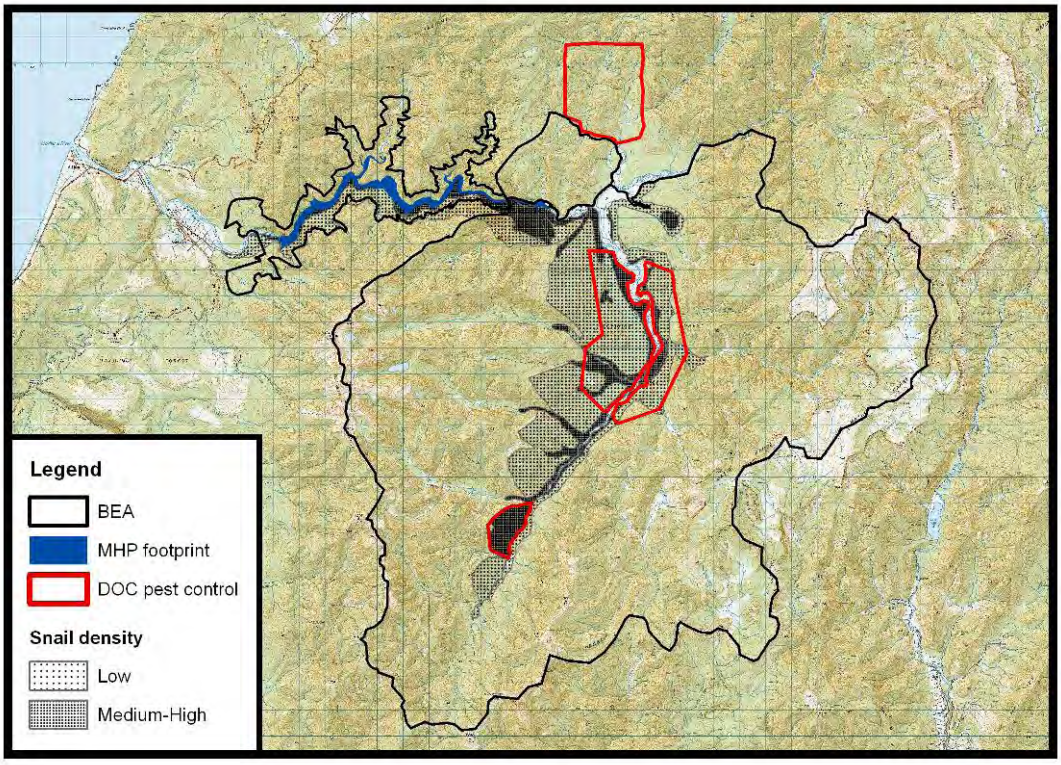


Figure 24: The extent of low and high density *P. l. unicolorata* habitat inside and outside DoC's existing pest control programme and within the proposed Biodiversity Enhancement Area

<u>No assessment of uncertainty /reliability of values used</u>

10.41. In my view, Dr Ussher has made insufficient allowance for the fact that estimates in the model may be unreliable.

10.42. For example, the model reproduces Mr Buckingham's "hypothetical" (Dr Ussher Attachment J) estimates of the size of each taxon's range.

10.43. Rates of snail decline and increase are greatly affected by sample size and the time spans over which they are calculated. As far as I can ascertain, decline estimates used in Dr Ussher's model are not based on trend counts over time, nor are estimates of rates of increase.

10.44. I think it highly unlikely that the sustained exponential increases in snail numbers projected by the model would occur, based on my experience with monitoring snail populations under pest control over

the last 18 years. This further contributes to my overall view that the outcomes of the BEA projected by Dr Ussher's model are unlikely to be realised.

11. CONCLUSIONS

11.1. The proposed hydro-electric scheme will irreversibly alter the evolutionary processes which have created a nationally significant centre of biodiversity of large *Powelliphanta* landsnails in the Mokihinui Gorge.

11.2. It will cause a minimum 60,000 individual *Powelliphanta* from 4 different subspecies to drown when the reservoir is filled. It will cause the irreversible loss of an estimated 5% of the habitat of *P. l. unicolorata,* and the loss of an estimated 8.4% of its population. It will cause the loss of a smaller but unquantified proportion of the population and habitat of *P. l. lignaria*, *P. l. lusca* and *P. l. ruforadiata* land snails.

11.3. It will degrade the habitat of *P. l. rotella,* and *P. l. johnstoni,* despite the specific protection of their small remaining habitat within two Ecological Areas, and it will decrease the likelihood that some of the last remaining intact coal measure habitat of *P. patrickensis* is protected from mining.

11.4. The applicant proposes large scale pest control over the upper Mokihinui valley adjacent to the proposed reservoir as mitigation. However *P. l. unicolorata*, the land snail most affected by the proposed scheme, and *P. l. ruforadiata* are both already well protected in the upper Mokihinui valley by an ongoing DoC pest control programme. Pest control offered in the lower Gorge for 2 other subspecies is of insufficient scale to be achievable, and no mitigation is offered for the significant losses to *P. patrickensis*, *P. l.*

rotella and *P. l. johnstoni* which the hydro-electric scheme will cause.

11.5. Overall, the proposed dam will result in a major adverse impact on the renowned *Powelliphanta* land snails of the Mokihinui which will not be mitigated or compensated.

REFERENCES

Buckingham R. 2006. A survey for bats, birds and *Powelliphanta* landsnails in the lower and mid Mokihinui River valley, February 2006. Contract report prepared for Mitchell Partnerships. 13 pp plus maps and appendices.

Buckingham R P 2007. A survey for *Powelliphanta* land snails, birds and bats in the Mokihinui River gorge and tributaries, March 2007. Draft contract report prepared for Mitchell Partnerships. 42 pp plus maps.

Davison A 2002. Land snails as a model to understand the role of history and selection in the origins of biodiversity. *Population Ecology, 44*: 129-136

Hitchmough R, Bull L, Cromarty P (compilers) 2007 *New Zealand threat classification system lists 2005*. New Zealand Department of Conservation, Wellington.

Holdaway RJ, Wiser SK,Williams PA, Clarkson BR, Smale MC. 2011. A threat assessment of New Zealand's naturally uncommon ecosystems. Paper presented at New Zealand Ecological Society Conference, Rotorua, 28August1September2011.(http://www.nzecologyconference2011.com/pix/Ecology_in_the_Heartland_2011_Proceedings web.pdf). 49 pp.

LineTech 2011. Mokihinui 110KV line: Tee line from IGH-WPT to Mokihinui Hydro. Conceptual design and constructability report. Unpublished contract report for Meridian Energy Ltd (revision 3).

Meads MJ, Walker KJ, Elliott GP 1984. Status, conservation, and management of the land snails of the genus *Powelliphanta* (Mollusca : Pulmonata). *New Zealand Journal of Zoology 11*:227-306.

Nathan S, Rattenbury MS, Suggate RP (compilers) 2002. Geology of the Greymouth Area. *Institute of Geological and Nuclear Sciences*

1:250,000 geological map 12. Institute of Geological and Nuclear Sciences, Lower Hutt. 58 pp + ma

Overmars FB, Kilvington MJ, Gibson RS (1998) Ngakawau Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme Series No. 11. Department of Conservation, Hokitika, New Zealand.

Powell, AWB 1976. *Shells of New Zealand*. Whitcoulls Publishers, Christchurch.154p

Powell AWB 1930. The Paryphantidae of New Zealand; their hypothetical ancestry, with descriptions of new species and a new genus. *Records of the Auckland Institute and Museum 1*: 17–55.

Powell AWB 1938. The Paryphantidae of New Zealand, no. 4. and the genus Placostylus in New Zealand. *Records of the Auckland Institute and Museum 2*: 133–150.

Powell AWB 1946. The Paryphantidae of New Zealand, no. 5. Further new species of Paryphanta,Wainiua and Rhytida. *Records of the Auckland Institute and Museum 3:* 99–136.

Powell AWB 1947. The species problem in New Zealand land snails. In Henderson, J.(Ed.): Report of the sixth science congress, May20-23, 1947. *Transactions of the Royal Society of New Zealand 77* (5): 202-208.

Powell AWB 1949. The Paryphantidae of New Zealand, no. 6. Distribution, hybrids and new species of Paryphantidae, Rhytida and Schizoglossa. *Records of the Auckland Institute and Museum 3*: 347–372.

Rattenbury MS, Cooper RA, Johnston MR (compilers) 1998. *Geology of the Nelson area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 9.* Institute of Geological and Nuclear Sciences, Lower Hutt. 67 pp + map.

Trewick SA, Walker KJ, Jordan C 2008. Taxonomic and conservation status of a newly discovered giant landsnail from Mount Augustus, New

Zealand. *Conservation Genetics 9(6).* doi:10.1007/s10592-007-9495-8.

Walker KJ 1982. Distribution and status of *Powelliphanta* land snails in the Mokihinui State Forest, and recommendations for conservation reserves. Fauna Survey Unit Report No.34. NZ Wildlife Service. 7 pages.

Walker KJ 1987. Wildlife in the Nelson Region. *Fauna Survey Unit Report No. 42*. NZ Wildlife Service. 240 pages plus maps.

Walker KJ 2003. Recovery plans for *Powelliphanta* land snails 2003-2013. *Threatened Species Recovery Plan 49*. Wellington, New Zealand Department of Conservation. X + 208p. + 64 plates.

Walker KJ, Trewick SA, Barker GM 2008. *Powelliphanta augusta*, a new species of land snail, with a description of its former habitat, Stockton coal plateau, *New Zealand. J Roy Soc NZ* 38 (3): 163-186.

Williams PA, Wiser S, Clarkson B, Stanley MC 2007: New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology 31*: 119-128.

APPENDIX 1

Gazettal notices for Radcliffe and Ngakawau Ecological Areas

Declaring Land to be Held for Conservation Purposes as Ecological Areas

Under section 8 (1) (a) of the Forests (West Coast Accord) Act 2000, the Minister of Finance and the Minister for State-Owned Enterprises jointly declare that the land described in the Schedule is held under the Conservation Act 1987, for conservation purposes and as ecological areas, subject to that Act and to be known as the ecological areas named in the Schedule to be managed to protect the scientific values specified in this notice.

Schedule

Nelson Land District—Buller District

Berlins Bluff Ecological Area—

To protect forest ecosystems on the most extensive inland area of limestone in the North Westland Ecological Region. 1358.5300 hectares, being Area "A" shown on S.O. Plan 302283 (formerly part Section 3, S.O. 15024).

Ngakawau Ecological Area—

To protect the range of forest types and wildlife habitat within the Ngakawau catchment including the southern range of land snails *Powelliphanta lignaria johnstoni* and *Powelliphanta lignaria rotella*.

Dated at Wellington this 28th day of February 2002.

DR MICHAEL CULLEN, Minister of Finance.

MARK BURTON, Minister for State-Owned Enterprises.

Explanatory Note:

Ecological areas are held for conservation purposes to protect indigenous intrinsic natural values and resources, ecological and evolutionary systems and in particular to protect values of scientific interest.

(File: DOC HK LMT 0045)

hn1483

Declaring Specially Protected Area

Under the Conservation Act 1987, the Minister of Conservation declares that the land described in the Schedule is held for the purposes of an ecological area, shall be managed as part of the Ngakawau Ecological Area and shall be known as the Ngakawau Ecological Area Extension.

Schedule

Nelson Land District – Buller District

13,255.0000 hectares, being area "A" on S.O. Plan 307286.

Dated at Wellington this 29th day of July 2003.

CHRIS CARTER, Minister of Conservation.

Explanatory Note

Ecological areas are held for conservation purposes to protect indigenous intrinsic natural values and resources, ecological and evolutionary systems, and in particular to protect values of scientific interest.

Protected area status for this land will protect a large, compact altitudinal sequence of coastal, plateau and mountain land forms and little modified vegetation associations from near sea-level to the tops of the Glasgow Range, a key site for two species of large native land snails ***Powelliphanta lignaria johnstoni*** *and* ***P.l. rotella****, the stronghold of a locally endemic daisy* ***Celmisia morganii*** *and good populations of forest birds.*

(File: DOC HK PAP 11-02-03-32)

ls4969

Declaring Land to be Held as Ecological Areas—West Coast

Pursuant to section 63 of the Conservation Act 1987, the Minister of Conservation, declares that the areas of land described in the Schedule hereto, are hereby held as ecological areas under section 21 of the Conservation Act 1987.

Schedule

Nelson Land District—Buller District

Glasseye Creek Ecological Area

2770.9798 hectares, more or less, being all the land shown on S.O. Plan 14745, situated in Blocks III, V, VI and VII, Kongahu Survey District.

Karamea Bluff Ecological Area

4503.9313 hectares, more or less, being areas "A", "B", "C", "D", "E", "F", "G", "H", "I", "J", "K", "L", "M" and "N", S.O. Plan 14746, situated in Block V, Kongahu Survey District and Blocks VII, VIII, XI and XII, Mokihinui Survey District.

Mokihinui Forks Ecological Area

23 200 hectares, more or less, being all the land shown on S.O. Plan 15367, situated in Block XVI, Otumahana Survey District, Blocks II, III, IV, VI, VII, VIII, X, XI, XII, XIV, XV, XVI, XVIII and XIX, Marina Survey District, Blocks I, II, III and IV, Taupo Survey District, and Blocks IV, VIII, XI and XII, Lyell Survey District.

Radcliffe Ecological Area original.

360 hectares, more or less, being Sections 1 and 2, S.O. Plan 15376, situated in Blocks XI and XV, Mokihinui Survey District.

Explanatory Notes

The ecological areas are all held for conservation purposes to protect indigenous intrinsic natural values and resources, and ecological and evolutionary systems, and in particular to protect the values specified in these explanatory notes.

The Glasseye Ecological Area protects a representative forest habitat for *Powelliphanta lignaria lusca*, and protects lowland and coastal forests and other ecosystems with high wildlife and botanical values.

The Karamea Bluff Ecological Area protects the forests, rivers and wildlife of the southern steeplands of the Karamea Ecological District.

The Mokihinui Forks Ecological Area protects characteristic land forms, geological formations, soils, plant communities and wildlife of the Wangapeka and Matiri Ecological Districts.

The Radcliffe Ecological Area protects populations and habitats of *Powelliphanta lignaria johnstoni* and *Powelliphanta lignaria unicolorata* around their type localities on northern Radcliffe Ridge.

Declaring Land to be Held for Conservation Purposes as Ecological Areas and to be Part of Existing Ecological Areas

Under section 8 (1) (a) of the Forests (West Coast Accord) Act 2000, the Minister of Finance and the Minister for State-Owned Enterprises jointly declare that the land described in the Schedule is held under the Conservation Act 1987, for conservation purposes and as ecological areas, subject to that Act and to be part of the ecological areas named in the schedule, to be managed to protect the scientific values specified in this notice.

Schedule Addition

Nelson Land District—Buller District

Addition to Radcliffe Ecological Area—

To protect the northern and western ranges of the land snail *Powelliphanta lignaria johnstoni* and the northern range of the land snail *Powelliphanta lignaria rotella*.

1151.6030 hectares, being Sections 1 and 3, S.O. 15021.

Dated at Wellington this 28th day of February 2002.

DR MICHAEL CULLEN, Minister of Finance.

MARK BURTON, Minister for State-Owned Enterprises.

Explanatory Note:

Ecological areas are held for conservation purposes to protect indigenous intrinsic natural values and resources, ecological and evolutionary systems and in particular to protect values of scientific interest.

(File: DOC HK LMT 0045)

APPENDIX 2

Deed of agreement between Solid Energy and the Department of Conservation regarding protection of part of Stockton Plateau

DEED OF AGREEMENT

DATED 18 February February 2005

PARTIES:

SOLID ENERGY NEW ZEALAND LIMITED at Christchurch ("Solid Energy")

and

THE DIRECTOR-GENERAL, DEPARTMENT OF CONSERVATION ("DOC")

BACKGROUND

A. Solid Energy is a State Owned Enterprise, carrying out business as a coal miner, the share holders of which are Ministers of the Crown. Solid Energy recognises that the mining of coal can adversely impact on the environment but desires that its activities have a net positive environmental effect, and is committed to achieving continuous and demonstrable improvement of environmental performance across all its mine sites in a transparent manner.

B. DOC is a department of State (established pursuant to the Conservation Act 1987), the functions of which include advocating the conservation of natural resources, advising the Minister of Conservation on matters relating to conservation generally, and administering the Wildlife Act 1957.

C. In March 1998, Solid Energy was granted Mining Permit 41-515 ("the Mining Permit") over the land described in that permit, known as Upper Waimangaroa ("the Mining Permit Area").

D. The land within the Mining Permit Area is partly unallocated Crown land administered by Land Information New Zealand ("LINZ") (2,125 ha), and partly State Coal Reserve administered by the Ministry of Economic Development ("MED") (788 ha).

E. Solid Energy and DOC acknowledge that the Mining Permit Area contains significant natural ecosystems and provides significant habitat to indigenous species which are absolutely protected under the Wildlife Act 1957 (subject to the powers of the Director-General under section 53 of the Act).

F. Solid Energy and DOC acknowledge that the Mining Permit Area contains significant coal resources.

G. Solid Energy has access arrangements with LINZ and MED pursuant to the Crown Minerals Act 1991 which allows access to and mining of part of the Mining Permit Area. Conditions of the access arrangements require Solid Energy to ensure that environmental disturbance is minimised and that all flora and fauna is protected, except for disturbance authorised under the access arrangements.

H. On 18 June 2004 the West Coast Regional Council and the Buller District Council granted Solid Energy a suite of resource consents that enable the company to undertake mining activities within that part of the Mining Permit Area known as Cypress Mine ("the Resource Consents").

I. On 9 July 2004 the Director-General lodged an appeal against certain conditions of the Resource Consents.

J. As part of the settlement of the Director-General's appeal, the parties have agreed that certain parts of the land within the Mining Permit Area should form part of a recommended area for protection, or be otherwise managed in accordance with this Deed.

K. Solid Energy also holds Coal Mining Licence 37-150 over the land described in that licence ("the Mining Licence Area"), being land at Stockton which is adjacent to the Mining Permit Area. This Deed also records the agreement reached in respect of the management of a specified part of the Mining Licence Area.

L. The parties now wish to record their agreement as set out below.

NOW THE PARTIES AGREE AS FOLLOWS:

1. The Director General's appeal is settled on the basis of the agreed terms and conditions for the Resource Consents referred to in paragraph 7(a) of the attached Consent Memorandum. Solid Energy agrees not to seek conditions from the Environment Court in settling the outstanding appeals for the Resource Consents which differ from those set out in the conditions referred to in paragraph 7(a) of the attached Consent Memorandum, except with the agreement of the Director General, such consent not to be unreasonably withheld.

2. Solid Energy agree not to oppose, and to use reasonable endeavours to support, the inclusion of the area generally bounded in red on the plan attached to this Deed (ie Areas A and C) in a recommended area for protection to be administered by the Department of Conservation under either the Conservation Act 1987, or the Reserves Act 1977.

3. Solid Energy shall, pursuant to section 40 of the Crown Minerals Act 1991, surrender that part of the Mining Permit which relate to the land marked "A" and "C" on the plan attached to this Deed ("the Surrendered Area"), subject to the boundaries of Area A and C between those points marked 1 to 7 being surveyed or otherwise defined to reflect appropriate topographical and ecological features, and reasonable operational requirements, the costs of which survey or other definition are to be met equally by DOC and Solid Energy. Any dispute as to the appropriate survey boundaries is to be determined, failing agreement between the Parties, by arbitration by a single arbitrator in accordance with the Arbitration Act 1996.

4. Solid Energy will surrender the Surrendered Area when requested to do so by DOC, and will not oppose the transfer of the administration of the Surrendered Area to DOC. DOC will provide to Solid Energy reasonable access to Area C for purposes connected with the performance of conditions of the Resource Consents.

5. Until the Surrendered Area is surrendered by Solid Energy in accordance with paragraph 3, Solid Energy shall use its best endeavours to not use the Surrendered Area in a manner which is inconsistent with the protection of the landforms and ecosystems which exist within it or so as to have an adverse effect on those landforms and ecosystem values.

6. Solid Energy shall use its best endeavours not to use that part of the Stockton Coal Mining Licence marked "B" on the plan attached to this Deed in a manner which is

inconsistent with the protection of the landforms and ecosystems which exist within it or so as to have an adverse effect on those landform and ecosystem values.

7. Subject to any resource consents Solid Energy might obtain subsequent to the date of this Deed, Solid Energy will use reasonable endeavours, having regard to its operational requirements in carrying out mining and mining operations in the Mining Permit Area, to ensure that those mining or mining operations do not compromise the protection of indigenous flora and fauna within the Mining Permit Area, or have an effect which is inconsistent with the protection of the landforms and ecosystems values present on that land, or have an adverse effect on those values.

8. Solid Energy will consult with DOC over any future mining or mining operations within the Mining Permit Area which might adversely affect absolutely protected wildlife (as defined in the Wildlife Act 1957), significant indigenous vegetation, significant habitat of indigenous fauna or outstanding landscape values. DOC may make recommendations to Solid Energy about such matters.

9. For the avoidance of doubt, this Deed does not restrict the right of DoC to advocate its position on any resource consents which may be applied for in the future by Solid Energy within MP 41-515, or to advocate for a RAP which is larger than the area bounded in red on the attached plan.

10. Solid Energy and DOC agree that any statements to the media or other publicity concerning this agreement shall be conducted jointly.

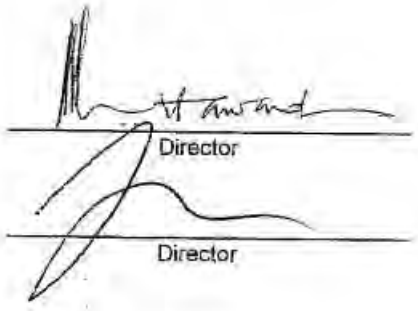
11. Except as provided in paragraph 1 of this Agreement, this Deed is conditional upon:

    a. the Resource Consents being finally granted on terms substantially in accordance with the conditions referred to in paragraph 7(a) of the attached Consent Memorandum or otherwise acceptable to Solid Energy; and

    b. the grant by the Director-General of such permits as may be required under the Wildlife Act 1957 for a period of 3 years from the date of commencement of the Resource Consents to authorise the activities permitted by the Resource Consents.

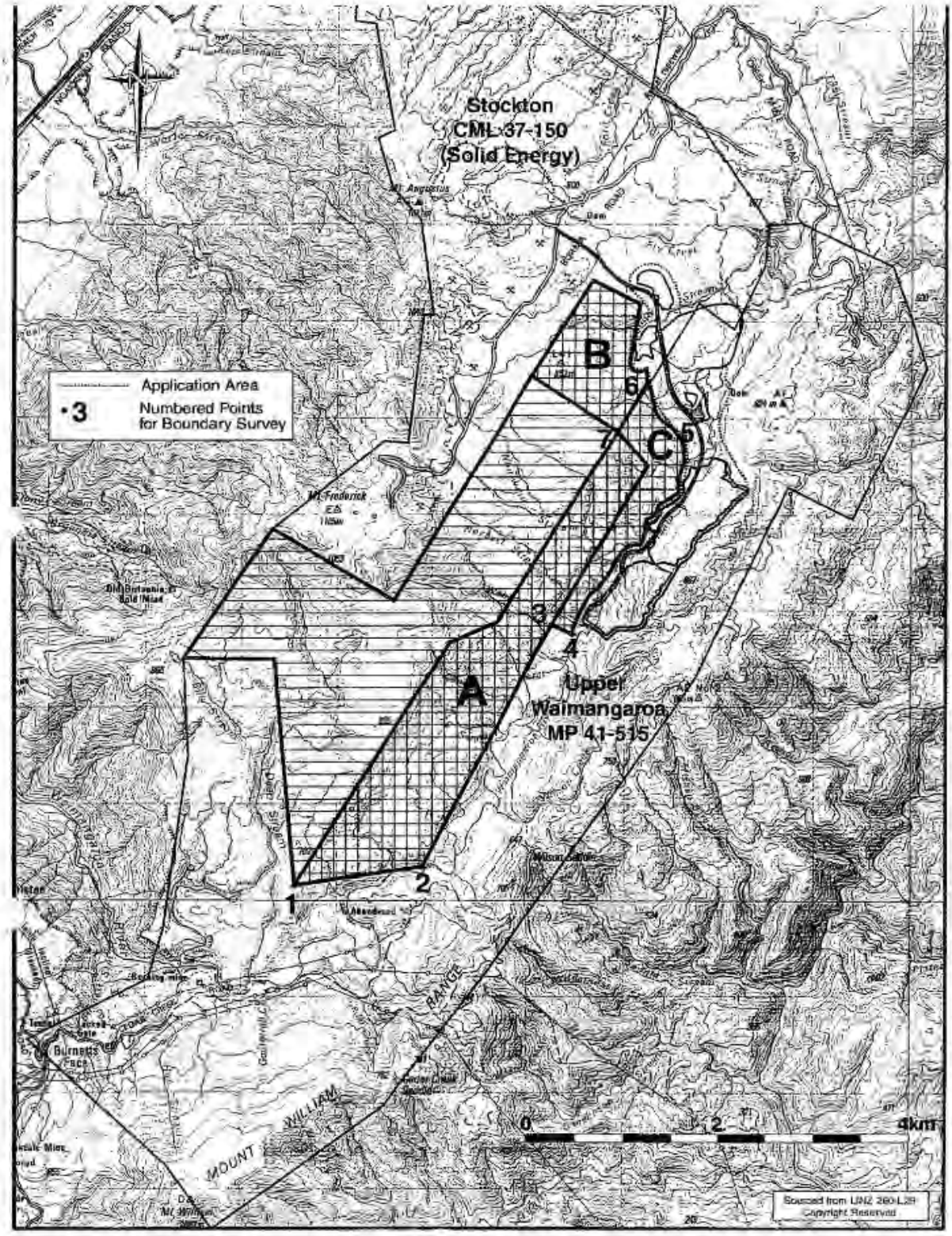
EXECUTED as a Deed

SIGNED for and on behalf of)
SOLID ENERGY NEW ZEALAND LIMITED)
by:)



SIGNED by the **DIRECTOR-GENERAL OF**)
CONSERVATION pursuant to delegated:)
Authority by Mike Slater, Conservator)
West Coast

Mike Slater)



Plan 1: Surrendered Areas and Areas for Ecological Management

SOLID ENERGY
Coals of New Zealand

APPENDIX 3

Statistical analysis of *Powelliphanta* snail data from the Mokihinui

Dr Graeme Elliott
Department of Conservation
May 2012

Introduction

I have been asked to critique the statistical analysis of *Powelliphanta* snail data undertaken by Brian Lloyd. In particular to look at the appropriateness of his analysis and his estimates of the proportion of the *Powelliphanta lignaria unicolorata* population that is within the area to be inundated if the dam is built.

Modelling relationships between snail density and other factors

Lloyd used generalised linear models with Poisson or negative binomial errors to analyse the data. In my view these are the appropriate models to use and I have no issues with the conclusions he made from the modelling. It is of note that he found that snail densities were significantly lower in Walker's low density snail zone, than in the high and medium density zones, but there was no difference between the medium and high density zones. In light of this I have combined Walker's medium and high density zones in all subsequent analysis.

Proportion of the snail population killed

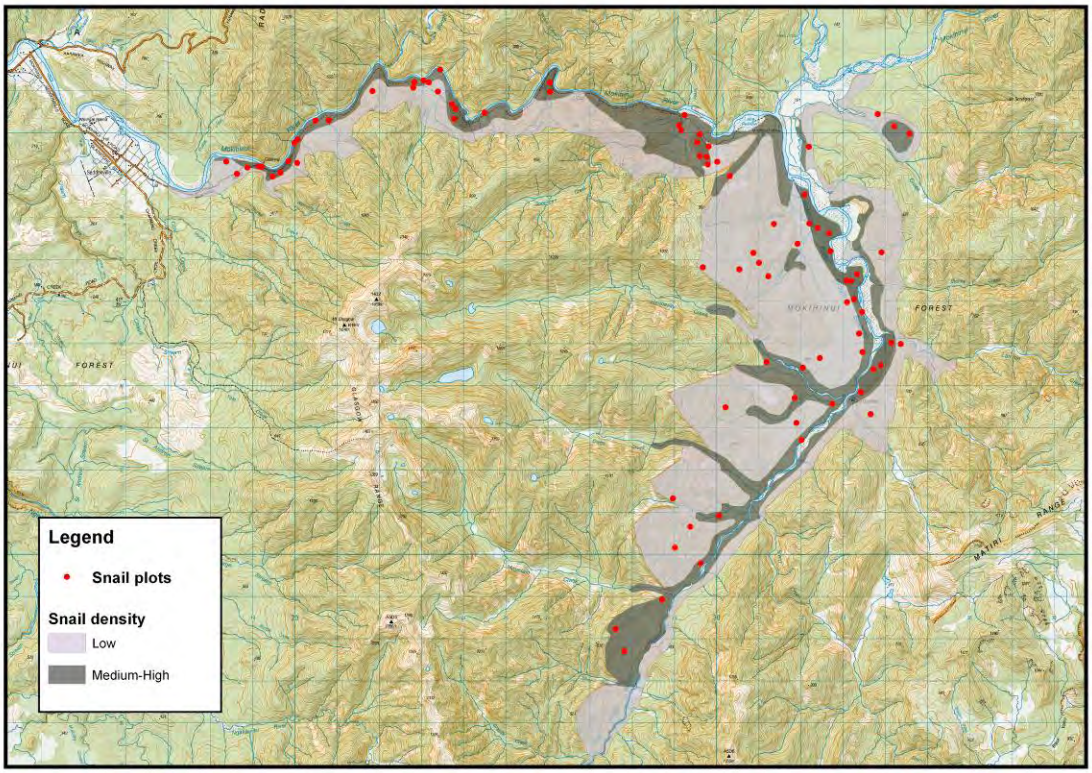
To produce estimates of the snail density and the proportion of snails in the inundation area, Lloyd stated that he weighted the densities of snails in the plots by the inverse of the sampling intensity in each strata, but it is not clear

which strata he used in his analysis. Did he use geographic strata comprising lower Gorge, Lake Perrine, and the South Branch, or did the strata comprise Walker's low, medium and high snail density zones, or did they comprise just the inundation and the non-inundation areas?

To understand what Lloyd did I re-estimated the density and proportion of the snail population in the inundation area with several different weightings to find the one that most closely matched his estimate. For the purposes of this part of the analysis I have assumed that *Powelliphanta lignaria unicolorata* is confined to the south of the Mokihinui River and I have only used plots from within this area.

Lloyd seems to have used only the inundation and non-inundation areas as strata in his analysis and my calculation using the data Lloyd presented gives an estimate of 0.80% of the snails being drowned by the proposed dam. This is very close to Lloyd's estimate of 0.81%. This analysis effectively assumes that the snail plots were located randomly within both the inundation area, and the rest of the snail's range, and that the plots were thus representative of the density of snails within these two areas.

This assumption is inappropriate. A visual inspection of a map of the location of the plots shows that they were not located randomly or representatively within the inundation and non-inundation areas – they are clustered in the high density parts. 69% of the plots were in the medium to high density zone, yet this comprised only 28% of the snail's range. Lloyd explicitly says that while 34 plots surveyed during 2008 were randomly located within the two areas, a further 60 plots surveyed in 2011 were randomly located in Walker's three snail density zones. In essence Lloyds method is inappropriate because it under-represents the low density parts of the snail's range.



Walker's low and medium to high density *P. l. unicolorata* zones, and the snail plots on the south bank of the Gorge and in the South Branch.

The closest we can get to reasonable estimates of the proportion of the snails that would be killed, is to assume that plots were randomly distributed within Walker's density zones, estimate the density in each of these zones from the plots that were within them, then multiply these estimates up by the area of each zone that occurs inside or outside the inundation area. This suggests that 4.83% (95% bootstrap confidence interval 3.51%-6.62%) of the snails would be drowned by the proposed dam.

Since Lloyd undertook his analysis, data from the equivalent of 18 additional snail plots on the south side of the Mokihinui River were provided to me. With these plots in the calculations the estimate of the proportion of snails killed on the south side of the Mokihinui rises to 5.25% (95% bootstrap confidence interval 3.99%-6.85%).

If we include the *Powelliphanta lignaria unicolorata* that occur on the north bank of the Mokihinui Gorge, and if we assume they are confined to the inundation zone and that the patterns of their density and distribution on the

north bank are the same as that on the south bank, then the estimate of the proportion of the population that would be killed rises to 8.40% (95% bootstrap confidence interval 6.42%-10.81%).

These estimates can also be expressed in numbers of "findable" snails, that is an estimate of the number of snails that would be found if the snail's range were to be searched in the same manner as the plots were. This is clearly an underestimate of the actual number of snails because many snails, particularly small ones, are not found when plots are searched. I estimate there are 66,716 (95% bootstrap confidence interval 47,112-87,588) "findable" snails in the inundation area, out of a total population of 794,352 "findable" snails (95% bootstrap confidence interval 544,834-1,073,205).

Conclusion

The best estimate of the number of "findable" *Powelliphanta lignaria unicolorata* that will be killed through the construction of the dam is 66,716, and these comprise 8.4% of the population.

My estimate of the proportion of snails that would be killed differs from Lloyd's because I have more plots on which to base my estimates and apparently because he erroneously assumed that the snail plots were representative of the density of snails when in fact the snail plots over-represented areas of high snail density.

There are some small differences between Lloyd's and my estimates of snail density that are caused by plots being assigned incorrectly to Walker's high, medium and low density areas, and small differences in interpretation of the range of *Powelliphanta lignaria unicolorata* and its sister subspecies. These do not substantially affect the estimate of the proportion of the snails that would be killed should the river be dammed.