

## 4. Strategies for poorly-known *Powelliphanta*

A surprisingly large number of *Powelliphanta* were not discovered until the 1970s, 1980s and even the 1990s. All these 'overlooked' snails live in densely vegetated alpine tussockland or subalpine scrub on remote mountains and they are naturally confined to very small areas. Given the amount of likely habitat still unexplored, there are certainly more *Powelliphanta* populations, subspecies and possibly even species that have not yet been found.

Because of their late discovery and the difficulty of finding shells in dense vegetation, the conservation status of most of the snails in this section is still unclear. There are indications that the high, cold nature of their remote habitat may have protected some taxa from the land-use changes and exotic predators currently devastating lower-altitude species. Rats are mostly absent above 800 m a.s.l., possums, thrushes and hedgehogs are in low numbers and pigs are only patchily present above the bush line (although all this may change if global warming continues to increase the altitude of the bush line). Against these alpine and subalpine snails is their size; many are small snails by *Powelliphanta* standards, so that even breeding adults are vulnerable to predation by thrushes.

In the absence of population trend data, most poorly-known *Powelliphanta* are presumed to be 'range-restricted' rather than 'threatened' (Hitchmough 2002). They are included here for the sake of completeness and because, unfortunately, decline is a more likely scenario for many than stability judging from information gathered to date.

During the preparation of these strategies, density data from the late 1960s for five Westland alpine taxa became available. The careful notes of John Marston and Ian Payton allowed comparisons with timed searches of similar quality in the same locations in the late 1980-90s. In all taxa the density had dropped in the 15-20 years between counts by an average of 67% (range 35%-89%). While the samples are too small to be definitive, the consistency in trends across the species gives cause for concern.

#### 4.1 *POWELLIPHANTA* “EGMONT”

##### **Description**

*Powelliphanta* “Egmont” is an impressively large snail (maximum diameter 68 mm; height 30 mm) with a handsome old-gold coloured shell. A few purple-brown, narrow lines spiral round the circumference of the shell, and the off-white coloured parietal callus is smooth.

This snail has never been formally described, as it was found relatively late (1962) and, in the absence of adequate samples, presumed to be the upland snail of the Ruahine Ranges, *P. marchanti* (Parkinson 1979; Powell 1979).

While the shell colour of the Egmont snails resembles that of Ruahine Ranges’ *P. marchanti*, it lacks the greenish tinge of the latter and the Egmont snail is much larger and is flatter in profile. In an examination of the genetic make-up of the *Powelliphanta* genus in 1988, the Egmont snails were clearly distinguishable from other *Powelliphanta* and should probably be described as a new species (K.J. Walker, unpubl. data; Appendix 2).

##### **Habitat**

Found under litter and the fronds of *Gabnia* and leaves of *Astelia* in subalpine scrub and shrubland of leatherwood, mountain fivefinger, haumakaroa, and inaka on volcanic soils at altitudes of 1160–1300 m a.s.l.

##### **Distribution**

*Powelliphanta* “Egmont” is known from one small area on the northwestern flanks of Mt Taranaki (formerly Mt Egmont) in Egmont National Park. It occurs rather patchily and sparsely over about 30 ha around the junction of the Kokowai and the Round-the-Mountain Tracks.

Biogeographically, the Egmont snail is intriguing: its only known habitat is a relatively young, dormant volcano—not normally the place to expect an endemic animal of ancient lineage. The cold, scrubland habitat of *Powelliphanta* “Egmont” was widespread in Taranaki during the peak of the Otiran Glaciation about 20 000 years ago (McGlone 1980) and presumably during this period the species was more widespread. When the climate eventually warmed, forests returned and covered almost all the landscape. Now the snails are found only in the remnants of such vegetation in the cool subalpine zone of Mt Taranaki.

The present distribution of the snails on the mountain seems to reflect the recent history of volcanic activity; the Kokowai Ridge area was missed by the most significant recent eruptions and debris flows over the last 5000 years, the Newall and Burell formations (McGlone et al. 1988).

The northeastern flanks of Pouakai were also untouched during these latest eruptions and it is possible that they provide another refuge for *Powelliphanta* “Egmont”. Two shells, reported to be from ‘the upper waters of the Mangorei Stream, and in the German Hill area between Kaimiro and Kent Road’, were found about 1962 by the Radford family (Parkinson 1974), though Parkinson himself believed they had come from the Waiwhakaio River (ibid.).

It is also possible that another population exists in the headwaters of the Waitotara River, at 450 m a.s.l., above the junction of the Waitotara River and the Makakaho Stream. Two old and worn shells were found here in the 1960s (Dell 1955) and, though they were discoloured, their large size (64.7 mm) makes it more likely that they are related to *Powelliphanta* “Egmont” than to *P. traversi* or *P. marchanti*, which reach a maximum diameter of only 54 mm.

However, even if the Waitotara shells had been washed a long way downstream from a **live** colony, the altitude they live at must be much lower than that of *Powelliphanta* “Egmont”. The two shells were found at about 400 m a.s.l. and there is no land higher than about 600 m a.s.l. in the Matamateonga Ranges (the headwaters of the Waitotara River). The Waitotara specimens may be subfossil shells from an extinct species that was intermediate in appearance and habitat between *P. traversi* and *Powelliphanta* “Egmont”.

### ***Population***

Based on sampling a limited area in 2001 (Clarkson 2001), the density of *Powelliphanta* “Egmont” is apparently very low, with an average of 0.3 snails/ 100 m<sup>2</sup>. This agrees with the results from more comprehensive timed searches of specific habitat over three seasons which found 0.9 snails/person hour. As reliable survey data found the range of the snail to be about 30 ha, a density of 30 snails/ha means that there are about only 900 *Powelliphanta* “Egmont”.

The snail’s distribution appears very patchy with no snails at all found in a 120 m<sup>2</sup> plot in apparently suitable habitat (Clarkson 1999). Other than this plot, almost all snail searches so far have been made under the skirts of *Gabnia* which is presumed to be the favoured habitat of *Powelliphanta* “Egmont”. This concentration of search effort is likely to have led to an overestimate of the size of the snail population.

A transect survey carried out in 1996 and repeated in 2000 yielded little change in snail numbers (Clarkson 2000). *Powelliphanta* “Egmont” is classified as ‘range restricted’ by Hitchmough (2002).

### ***Threats***

The biggest threat to the species lies in its vulnerability as a single, small very localised colony to natural events such as renewed volcanic activity on Mt Taranaki, erosion and landslides or human-induced fires.

Predation by exotic pests is apparently at low levels within the colony of *Powelliphanta* “Egmont”, as only one of 23 shells found between 1996 and 2000 was damaged, possibly by a possum. Thrushes and possums are apparently the only snail predators present on the mountain.

From evidence elsewhere, predation by possums on snails can start years after the spread of possums to an area, perhaps in response to declining alternative food resources. For these reasons possums remain a significant threat to *Powelliphanta* “Egmont”.

Numbers of goats and possums are currently controlled: if left unchecked the habitat changes that their browsing and trampling cause could increase the snails’ risk of desiccation and increase their visibility to predators.

### ***Past Conservation Effort***

Between 1996 and 2000, 4-day surveys of *Powelliphanta* “Egmont” were carried out annually by staff of the Stratford Area Office (DOC) to define the extent of the known colony (Caskey 1996, 1997; Clarkson 1999, 2000). In 2001, three 100 m transects were established and all *Gabnia* shrubs within 5 m of the strips were searched to provide baseline data on snail density (Clarkson 2001).

### ***Future Survey and Monitoring Needs***

**High 1:** Snail surveys are needed away from the known colony, in scrubland above 1100 m a.s.l. in the headwaters of the Mangorei Stream on Pouakai; and at 450 m a.s.l. above the junction of the Waitotara River and Makakaho Stream in the Matamateonga Ranges.

Before such surveys are undertaken, the people who previously found shells in these sites should be sought out to obtain more detailed site descriptions if possible.

**High 2:** Because of the very low snail densities, the survey and monitoring done to date have focused on searching under *Gabnia* shrubs, which appear to be the preferred habitat. However, the population density estimates produced in this manner are probably not representative of the wider area, and are difficult to compare with data from other similar species of *Powelliphanta*. Given the small size of the total population, and its vulnerability in one very localised site to habitat or predation changes, it will be important to monitor *Powelliphanta* “Egmont” regularly for the foreseeable future. About sixty 25 m<sup>2</sup> or fifteen 100 m<sup>2</sup> snail-monitoring plots should be measured throughout the snail’s habitat. If good records of plot vegetation are made, these monitoring plots should also provide useful information on habitat preferences. Once the relationship between the 25 m<sup>2</sup> plots, the *Gabnia*-based strip searches and the transects is known, a decision can be made about the most appropriate monitoring technique to use long term.

### ***Future Management Actions Needed***

**Medium 1:** Keep possum and goat numbers very low in the snail colony, to prevent snail predation by possums and to keep the vegetation dense and the litter layer deep and moist.

### ***Research Priorities***

**High 1:** Formally describe and name the Egmont *Powelliphanta*.

**Low 1:** Facilitate mtDNA studies to examine in more detail the relationship between *Powelliphanta* “Egmont” and other North Island and North West Nelson *Powelliphanta*.

## 4.2 *POWELLIPHANTA* “UREWERA”

### **Description**

*Powelliphanta* “Urewera” is a medium- to small-sized snail (maximum diameter 48 mm; height 22 mm) with a smooth, dark brown parietal callus. The shell is richly coloured, having a golden background with numerous narrow, dark purplish brown spiral stripes on both the top and bottom of the shell. Overlain on this is a secondary pattern of irregular, wavy axial streaks that are dark purplish brown and gold in colour.

Surprisingly, given their large size, the Urewera snails were not discovered until 1962. The curator of the Wanganui Museum sent the Auckland Museum’s snail taxonomist, A.W.B. Powell, newly discovered *Powelliphanta* shells from both Egmont and Urewera National Parks in a letter dated 30/7/62. He wrote, ‘A number [of shells] were found at the same time in subalpine scrub on a high peak north of Lake Waikaremoana by a Mr J. Sopp. He indicated the peak on map ... NZMS 19, Sheet 3, as the unnamed peak of 4663’ ...’ (Parkinson 1979). This peak, despite some incongruities in the grid reference, can only be Manuoha, still the only site where this snail has been found.

Despite differences in shell morphology, Powell put both the Urewera and Egmont snails into *P. marchanti* without further field collections. *Powelliphanta marchanti* was widespread at high altitudes in the northern Ruahine Ranges and, as such, was the closest upland colony of large land snails to both Urewera and Egmont known at the time.

However, examination of more recently obtained specimens revealed the obvious morphological differences between the Ruahine and Urewera snails, and genetic studies confirmed *Powelliphanta* “Urewera” to be a distinctive entity, more closely aligned to lowland *P. traversi* snails from the Horowhenua plains than to *P. marchanti* (K.J. Walker, unpubl. data; Appendix 2). The Urewera snails are still not formally described.

### **Habitat**

Found under litter and under *Gabnia* skirts in cool cloud forest of silver beech at high altitude (900–1350 m a.s.l.). The forests lie on slightly calcareous Miocene sandstones. Most snails have been found near the edge of large, old, stable slips where the understorey vegetation is particularly dense in the increased light levels, and where soil fertility is probably slightly enhanced.

### **Distribution**

*Powelliphanta* “Urewera” is known only from the upper slopes of Manuoha, the highest peak in Urewera National Park. Even within this limited area, snail distribution is apparently very patchy, with snails so far found in only about a dozen separate sites, often on the edge of large stable slips or in damp gullies.

There was a reliable report of a large land snail from ‘near the East Cape Lighthouse [but] unfortunately the vegetation has since been cleared from the location, and it is possible that there are now no specimens of it in existence’ (Powell 1936). The large difference in altitude between Manuoha and the East Cape Lighthouse area perhaps makes it unlikely that the latter snails were *Powelliphanta* “Urewera”.

## **Population**

In 1988, seven live snails and nine shells were found in 1 hour of searching (7 snails/person hour) under *Gabnia* (K.J. Walker, unpubl. data). In 1989, in the same general area, 43 live snails and 23 shells were found in about 8 hours of searching (5.4 snails/person hour), with 15 of the live snails found evenly spread over an area of 5 m<sup>2</sup> (Daniel 1992). In 1997 in a 500 m<sup>2</sup> plot on Manuoha, 19 live snails and 18 shells were found (3.8 snails/100 m<sup>2</sup>).

Based on these data, the only assessments of population density, it seems that the population of *Powelliphanta* “Urewera” is in relatively high numbers in small areas of favoured habitat. The distribution of the snail is apparently very patchy, and a further 7 hours of searching in 1988, 23 hours searching in 1989 (Daniel 1992) and 8 hours of searching in 1997 (DOC) close to the best known snail colony failed to find any snails or empty shells.

*Powelliphanta* “Urewera” is ranked in ‘serious decline’ by Hitchmough (2002).

## **Threats**

Predation by possums is probably the biggest threat to *Powelliphanta* “Urewera”, as 63% of 19 shells found in 1989 (Daniel 1992), and 52% of 29 shells collected in the late 1990s, indicated that the snails had been killed by possums.

None of the shells found in 1989 showed signs of rat damage, but 35% of shells collected in 2000 were from snails killed by rats. Ship rats are usually absent or very rare above 900 m a.s.l. in New Zealand (Innes 1990), as cold winter temperatures apparently inhibit breeding (R.H. Taylor, pers. comm.). However periodically, warm winters and heavy beech seedfall coincide and result in abnormally high rat numbers at higher altitudes. This occurred on Manuoha in 1999/2000, and led to an unusually high incidence of rat predation on *Powelliphanta* “Urewera”.

In the medium term, rats are probably not a significant problem and rodent-control programmes are not necessary. However, in the long term, higher rat numbers at high altitudes are likely to be a significant threat to *Powelliphanta* “Urewera” as global warming continues.

Thrushes (and possibly hedgehogs) are likely to be lowering snail recruitment levels, but their impact is not quantified. The number of hedgehogs is probably low on the cool, wet, densely vegetated tops of Manuoha.

Both red deer and possums are a threat to the snail population as their browsing of the forest understorey opens up and dries out the snail’s micro-habitat and makes the snails more accessible to predators such as thrushes. Desiccation is probably the main cause of egg and hatchling failure, and even adult survival is very dependent on moist forest floor conditions.

The Manuoha area seems prone to slips, but even though the snail populations are quite localised, it is unlikely that all of their habitat would be destroyed in another major slipping event. The existing slips seem to have almost improved conditions for the snails—the vegetation at ground level on the slip edges is very dense and lush in response to increased light levels and enhanced fertility.

### ***Past Conservation Effort***

1. L. Daniel surveyed the snails around the slips on the western face of Manuoha on 21-27/03/89 and prepared a useful report summarising the known distribution of the snails and giving guidelines for their management (Daniel 1992).
2. T. Herbert, D. King and a Conservation Corp group surveyed the upper northern, eastern and western ridges of Manuoha and the headwaters of Waiotukupuna Stream between 30/01/93 and 5/02/93 (Herbert 1993).
3. B. Bancroft, D. King and two volunteers spent 10 person hours in December 1997 searching for sites with sufficient live snails to justify placement of two monitoring plots. Snails were located in only one site and one 500 m<sup>2</sup> plot was established.
4. Between 20/06/2000 and 23/06/2000, J. Wheeler made observations of shell density on the northwestern and southeastern slopes of Manuoha while monitoring possum density on three traplines in the area (Wheeler 2000).

### ***Future Survey and Monitoring Needs***

- High 1:** Before investing too heavily in protection of the snails near the summit of Manuoha, all shell reports from the wider areas should be properly checked on the ground. Such a survey should include the lower Ngatapa Stream and the ridge between Taparawera and Otiau Streams near their junction with Hopuruahine Stream.
- High 2:** A survey both within the known snail areas and extending outwards from them should be made, similar to and building on that one made by Herbert in 1993. The position of live snails and shells should be carefully pinpointed using GPS and recorded, brief habitat descriptions made and the extent of the search area recorded and mapped. The maximum diameter of all live snails should be recorded, all empty shells collected and cause of death determined.
- High 3:** Using the information gained from the systematic snail survey, establish at least ten 100 m<sup>2</sup> monitoring plots or forty 25 m<sup>2</sup> plots randomly within the known snail habitat. Carefully mark and record the route to the plots so that they can be re-measured. Count the number of live snails and empty shells in the plots. Remove the shells, determine the cause of death and use the data to track the rate at which empty, predator-damaged shells subsequently accrue. Releaser annually for the first 3-5 years until trends become apparent, and thereafter less frequently.

### ***Future Management Actions Needed***

- High 1:** Keep possum numbers steadily below at least 3% RTC throughout the snail colonies. If the data from the monitoring plot show continuing significant predation by rats, use methods of possum control which also target rodents (1080 or choliciferol poisoning). Use of brodifacoum baits in bait stations is not advisable because pest control will need to be on-going and recreational hunting is common. Trapping rats would be very expensive at this site, and at present is not warranted.

**High 2:** Keep deer to barely detectable levels in the Manuoha area. Ensuring that understorey and slip vegetation is dense and lush is probably the easiest way to limit predation by thrushes on *Powelliphanta* “Urewera”. Maintaining a humid forest floor environment will also increase snail recruitment and survival.

***Research Priorities***

**High 1:** Formally describe and name the Urewera *Powelliphanta*.

**Low 1:** Facilitate mtDNA studies to examine in more detail the relationship between *Powelliphanta* “Urewera” and other North Island *Powelliphanta*.

### 4.3 *POWELLIPHANTA SUPERBA* “GOULAND RANGE”

#### **Description**

*Powelliphanta* shells were first discovered on the southern Goulard Range by Frank Soper in the late 1960s (I. Payton, pers. comm.). Though the shells bore an obvious resemblance to *P. superba*, their relatively small size and axial stripes led to the view that they were a hybrid between *P. superba mouatae* and *P. rossiana* (Climo 1978).

With the collection of more material in the early 1980s (K.J. Walker & G.P. Elliott, pers. obs.) it became clear that the snails originated solely from *P. superba* stock. Allozyme studies confirmed a significant genetic distance between the Goulard Range snails and others in the *P. superba* series and, indeed, a closer relationship to *P. annectens* than to *P. superba* (K.J. Walker, unpubl. data; Appendix 2). However, on morphological and ecological grounds they are best considered as a new, still undescribed subspecies of *P. superba*, tag-named for now as *P. s.* “Goulard Range”.

*Powelliphanta superba* “Goulard Range” is a medium-sized snail (maximum diameter 54 mm; height 23 mm), with a widely umbilicated, subglobose shell and a more prominent spire than other *P. superba*. The parietal callus is smooth and dark purplish brown. The shell is a rich tan-brown colour with subtle old gold, mid-brown, dark brown and black axial bands, particularly visible on the base of the shell.

#### **Habitat**

A high-altitude snail, found at 1000–1200 m a.s.l. on mountains which are usually covered in mist, cloud or rain. Found under small logs, litter and moss in silver beech forest near the bush line, and in subalpine shrubland of leatherwood, inaka, mountain flax and red tussock just above the bush line.

#### **Distribution**

Known from only a few spot localities between Flanagan and Mt Goulard on the southern Goulard Range, south of the Heaphy Track in Kahurangi National Park. A small shell found in 1985 on the neighbouring Domett Range is also likely to belong to this subspecies.

Based on fruitless snail searches in suitable habitat just west of Muriel and off southeastern Goulard Downs, it seems that the distribution of this snail must be naturally small, at best perhaps 500 ha.

#### **Population**

Only two limited assessments of population density have been made. In 1968, snails were found at a rate of 5.4 snails/person hour (19 snails, 5 intact shells, 3.5 hours search; I. Payton, pers. comm.). In 1985 they were found at 1.3 snails/person hour (4 snails, 10 shells, 3 person hours search; K.J. Walker & G.P. Elliott, pers. obs.). All the populations of *Powelliphanta superba* on nearby Goulard Downs declined drastically between 1980 and 2000 because of predation by possums, so it is likely that the density of *P. s.* “Goulard Range” has also since declined. Given the apparently limited distribution of this snail, total population size is now likely to be very small.

*Powelliphanta superba* “Goulard Range” is classified as ‘nationally endangered’ (Hitchmough 2002).

### ***Threats***

The main threat to *Powelliphanta superba* “Gouland Range” is predation by possums. In 1985 the population at Mt Gouland was already affected by possums—77% of 53 shells found were from snails that had been killed by possums. However, at the same time there was no sign of possum damage on the 10 shells found in the small, isolated Flanagan snail population.

### ***Past Conservation Effort***

No effort towards conservation of this land snail has been made, though the Mt Gouland population is likely to have benefited from a possum-control operation carried out in 1995 just north of the population.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colonies, to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail’s survival.

### ***Research Priorities***

**High 1:** Formally describe and name the Gouland Range *Powelliphanta*.

#### 4.4 POWELLIPHANTA “ANATOKI RANGE”

##### **Description**

*Powelliphanta* “Anatoki Range” is a small snail (maximum diameter 41.2 mm; height 17.6 mm). It can be distinguished from other striped alpine snails of west and south Nelson by its higher spire and only very slightly flared body whorl. The shell is covered alternately with old gold to olive-green and reddish brown to black axial stripes. The surface of the upper shell is tinged with red, and due to very fine striae, appears slightly matt.

*Powelliphanta* “Anatoki Range” is not formally described as it was discovered only recently.

Small alpine ‘rossiana’-type shells were first reported (Peter Jamieson, pers. comm.) about 1970 from Parapara Peak, just north of Anatoki Range, but subsequent searches failed to find any there. On 27/01/87, Shannel Courtney found a single shell on the Anatoki Range during a New Zealand Forest Service ecological survey of the Anatoki – Waingaro area. Live snails were subsequently found on 26/6/91 during a search of the same locality (K.J. Walker & G.P. Elliott, pers. obs.).

Rather than grouping *Powelliphanta* “Anatoki Range” with other small striped alpine *Powelliphanta* from the south Nelson ranges, allozyme data showed these snails to be most closely related to *Powelliphanta* “Parapara”, a cryptic taxon within *P. gilliesi fallax* (K.J. Walker, unpubl. data; Appendix 2). Judging from shell characteristics, *Powelliphanta* “Parapara”, which is widespread in montane forests between Walker Ridge and Parapara Peak, arose from hybridization in the distant past between *P. g. fallax* and *Powelliphanta* “Anatoki Range”.

The complexity of its origins aside, *Powelliphanta* “Anatoki Range” is morphologically and genetically a distinctive taxon, best considered as a new, still undescribed species.

##### **Habitat**

*Powelliphanta* “Anatoki Range” is an alpine species, found at 1500 m a.s.l. on fertile soils on a narrow lens of limestone amidst otherwise non-calcareous infertile substrates.

The snails live under the skirts of *Astelia nervosa*, *Chionochloa flavescens*, mountain flax and red tussock in a low shrubland of inaka, leatherwood and snow totara, with *Hebe glaucophylla* and *Helichrysum intermedium* on intervening rocky bluffs.

##### **Distribution**

The snails have been confirmed from only one small site on the eastern end of the Anatoki Range. Several general surveys of other parts of the Anatoki and Devil Ranges failed to locate further colonies, or indeed any other apparently suitable calcareous habitat.

Shell collectors found several “Anatoki Range” type shells on Parapara Peak, and one river-carried specimen was found on the banks of the lower Parapara River. While this seems to indicate a colony on Parapara Peak, it must be very small since several intensive searches of the summit area have failed to find shells or signs of live snails. While there must always have been a small area of natural tussock grassland on Parapara Peak, its extent was increased through burning of the subalpine forest and scrub last century, probably for mineral prospecting. Burning and prospecting activities

have made the tussock sparse and the litter layer thin and degraded, and it is possible that suitable alpine snail habitat no longer exists on Parapara Peak.

### ***Population***

In the only known colony on Anatoki Range, snails were found at the rate of 3 snails/person hour in 1991 (6 snails, 6 intact and 2 broken shells, 2 person hours search; K.J. Walker & G.P. Elliott, pers. obs.). The area of suitable habitat at the site appears to be less than 1 ha, so the total population is unlikely to be large. Because only a very small population is known at present, *Powelliphanta* “Anatoki Range” is classified as ‘nationally critical’ (Hitchmough 2002).

### ***Threats***

The main threat to *Powelliphanta* “Anatoki Range” is probably habitat degradation by hares, goats and deer all feeding on the small area of fertile soils and lush vegetation where the snails occur. Habitat degradation probably also increases the risk of snail desiccation and of predation by thrushes.

Long-term issues include: habitat loss through fires, mineral prospecting activity and erection of telecommunication towers; and global warming which may allow ship rats—serious predators of lowland *Powelliphanta*—to live at higher altitudes.

### ***Past Conservation Effort***

No effort towards conservation of this snail has been made so far.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colony and to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail’s survival.

### ***Research Priorities***

**High 1:** Formally describe and name the Anatoki Range *Powelliphanta*.

**Low 1:** Facilitate mtDNA studies to examine the phylogeny of *Powelliphanta* “Anatoki Range” and its relationship to *Powelliphanta gilliesi*.

## 4.5 *POWELLIPHANTA* “LODESTONE”

### **Description**

A small snail (maximum diameter 41 mm; height 18 mm) with a very low spire and rather flattened appearance. The dorsal surface is sculptured with minute spirals, giving it a matt appearance, while the ventral surface is smooth and glossy. The background colour of the shell is a khaki-yellow, but this is overlain with numerous dark purplish brown axial stripes. The parietal callus is smooth and dark brown.

The Lodestone snails were discovered well after the main period of *Powelliphanta* classification; only in the 1960s did they become known to shell collectors and they were not mentioned in the literature until the mid-1980s (Hayward 1985). As a result, the taxonomy of the Lodestone snail was not critically assessed until 1990, and they are still not formally described.

In their flattened profile and strong axial striping, the shells are similar to alpine *Powelliphanta* on Mt Owen, Mt Murchison and the mountains around St Arnaud. However, they are substantially larger than the Owen snails and lack the latter's red dorsal colouring. And they are more flattened with a lower spire than the St Arnaud snails and lack the latter's dark colour on the ventral surface.

Allozyme data (K.J. Walker, unpubl. data; Appendix 2) showed the closest relatives of the Lodestone snails to be the other, newly discovered, striped alpine snails on the Owen and St Arnaud Ranges, but there was a large genetic distance between these groups, and at least a species-level difference between all these small striped snails and other *Powelliphanta*. A conservative approach would be to consider the Lodestone snails as a new subspecies of a new, still undescribed species that also incorporates the Owen, St Arnaud and Mt Murchison snails.

### **Habitat**

*Powelliphanta* “Lodestone” is an alpine snail, found at 1100–1400 m a.s.l just below, at, and just above the bush line. It lives under litter and under the skirts of *Astelia nervosa*, prickly shield fern and red tussock just above the bush line, and under litter and bush tussock in silver and mountain beech forest. These snails are apparently confined to calcium-rich soils on a marble substrate.

### **Distribution**

The range of *Powelliphanta* “Lodestone” seems naturally confined to a small part of the Arthur Range in Kahurangi National Park. All records so far have come from narrow lenses of marble southwest and northeast of Flora Saddle, and less reliably, from Hoary Head, a marble dome northeast of Mt Lodestone. They are apparently entirely absent from the intervening non-calcareous substrates.

### **Population**

During a 45-minute search of about 30 m<sup>2</sup> on Mt Lodestone in 1990, snails were found at a rate of 16 snails/person hour (12 snails, 4 shells; K.J. Walker, pers. obs.), indicating a dense population.

No other measurements of the population density have been made, but from the small number of shells which have been found and its highly restricted range, the total population is likely to be small. *Powelliphanta* “Lodestone” is classified as ‘range restricted’ by Hitchmough (2002).

### ***Threats***

Because of their small size, all ages of *Powelliphanta* “Lodestone” are vulnerable to predation by thrushes and hedgehogs. Both are likely to be in relatively low numbers in this wet, cold environment, but nevertheless may have a significant impact on the snail population.

Possums in the area already prey on the large montane snail *P. hochstetteri hochstetteri*, but too few *Powelliphanta* “Lodestone” shells have been found to know if they also are affected. The dense grassland habitat of the Lodestone snails may make them more difficult for possums to find. Moderate or high numbers of any of the pest species present (possum, red and fallow deer, goats, pigs and hare) pose a threat to the snail’s habitat, particularly the moist, deep litter layer which protects the snails from desiccation and predation.

### ***Past Conservation Efforts***

No effort towards assessment or conservation of this land snail has been made.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colonies, to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail’s survival.

### ***Research Priorities***

**High 1:** Formally describe and name the Lodestone *Powelliphanta*.

## 4.6 *POWELLIPHANTA* “OWEN”

### **Description**

A small, compact snail (maximum diameter 38 mm; height 17 mm) with a reddish hue to the upper surface of the shell and, particularly on the base, dark reddish brown axial stripes that are uneven and infrequent.

The Owen snails were discovered in the 1960s, long after the main period of *Powelliphanta* classification, and because of their small, fragile shells and alpine habitat in North West Nelson, they were assumed to be *P. rossiana patrickensis*.

It was not until 1988, when live snails and a large enough sample of shells was available, that the taxonomy of the Owen snails was critically assessed. Allozyme data (K.J. Walker, unpubl. data; Appendix 2) confirmed that the Owen snails were not related to the glossy, unicoloured alpine snails on the Denniston Plateau, but rather to other strongly striped *Powelliphanta* snails newly discovered on Mt Lodestone and the St Arnaud Ranges.

### **Habitat**

*Powelliphanta* “Owen” is an alpine snail, found at 1250–1500 m a.s.l. just at, below and above the bush line. Snails live under prickly shield fern, *Astelia nervosa*, bush tussock and under litter in stunted silver beech forest; under mountain flax, turpentine scrub, *A. nervosa* and tussock in subalpine shrublands, and under tussock above the shrub line.

The largest snail populations are found on calcium-rich soils on marble substrates, but they also occur on calcareous mudstones and sandstones, and very sparsely on leached soils on infertile granite substrates.

### **Distribution**

The largest colonies of *Powelliphanta* “Owen” are found below Billies Knob on the northern flanks of the Mt Owen marble massif in Kahurangi National Park. They also occur sparsely on the Lookout Range, and on Turks Cap, a small range just west of the Mt Owen massif. They are apparently absent from the highest parts of the Mt Owen block. They abut but do not overlap the range of *Powelliphanta* “Matiri”, an entirely unrelated alpine snail on the south-western slopes of Mt Owen.

### **Population**

In a small area of forest at the top of The Staircase, snails were found at the rate of 5 snails/person hour in 1990 (5 snails, 20 shells, 1 person hour search; K.J. Walker & G.P. Elliott, pers. obs.).

No other measurements of population density have been made. *Powelliphanta* “Owen” is classified as ‘nationally endangered’ by Hitchmough (2002).

### **Threats**

The biggest threat to the colony of *Powelliphanta* “Owen” near Billies Knob is predation and habitat destruction by feral pigs. When a search for snails was made in 1990, pigs were found to have rooted under all the fern, tussock and deep litter snail habitat in the forest at this site. All 20 of the shells found in the search were damaged by pigs. Pigs are probably able to eat the snail and shell of even adult *Powelliphanta* “Owen”, in addition to eggs and juvenile snails, so their impact at Billies Knob was

probably underestimated, particularly as pigs also reduce snail breeding success and compete with snails for food.

The Owen *Powelliphanta* are also vulnerable to predation by thrushes, and possibly also to hedgehogs and possums. In 1985, all 13 shells found near Billies Knob, were damaged by thrushes; and of 10 shells found in the same area in 1997, six were damaged by thrushes and four by pigs.

Some forested snail habitat on the northern margins of Mt Owen was burnt, possibly as early as 1871 when a gold field was established at Blue Creek, and the tussock tops were used for summer stock grazing in the late 1800s and early 1900s. Hares are now very common in the tussock grasslands of Mt Owen, and they have replaced fire and stock as a threat to the snail's habitat.

### ***Past Conservation Effort***

The locality of *Powelliphanta* snails and other fauna and flora of the Matiri - Owen area were recorded during a systematic survey by the Forest Research Institute in 1982/83 (Spurr 1985). No other significant effort towards assessment and conservation of the Owen snails has been made.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colonies, and to locate other populations if they exist.

**High 2:** Using the information gained from the distribution surveys, establish about ten 100 m<sup>2</sup> permanent monitoring plots within the snail's range. Census of the number of live snails and empty shells within the plots will provide information on population density and trends, and on the levels of exotic predator-induced snail mortality. Searching tussock plots will be difficult to do without significant damage to the habitat, so after two annual counts (to assess mortality levels) the plots are probably best measured at five-yearly intervals.

### ***Future Management Actions Needed***

**High 1:** Keep pig numbers low around the snail colonies of Billies Knob forest.

**Medium 2:** Wait until the snail survey and plot data become available and the impact of exotic pests on the Owen snails is better known before deciding whether targeted control of possums is required. However, encourage as much hunting of deer, goats, pigs, possums and hares as possible, to maintain a moist and dense vegetative cover in the snail colonies, and thereby some protection from thrushes.

### ***Research Priorities***

**High 1:** Formally describe and name the Owen *Powelliphanta*.

#### 4.7 *POWELLIPHANTA* “NELSON LAKES”

##### **Description**

There are three, morphologically and geographically distinct populations of strongly striped, small (maximum diameter 43 mm; height 20 mm), alpine *Powelliphanta* in the Nelson Lakes area, which with more knowledge, may be found to be good taxonomic units in their own right. However, for this plan they are considered collectively as *Powelliphanta* “Nelson Lakes”.

Snails above the Speargrass Valley were discovered by Roger Frost in 1983. Allozyme data indicated that these Speargrass snails were most closely related to *Powelliphanta* on Mt Owen and, much more distantly, to *Powelliphanta* on Mt Lodestone (K.J. Walker, unpubl. data; Appendix 2).

A second population of snails was discovered by Frost on the northwestern slopes of the St Arnaud Range about 1987, and a third population discovered by Norm Marsh on Mt Murchison in 1996, but the genetic make-up of these latter two populations have not been examined. A conservative grouping would see all the Nelson Lakes snails as one subspecies and the Owen and Lodestone snails two other subspecies of a new still undescribed species.

The shells of snails in the Speargrass Valley are a gold-tan colour, streaked with many irregular axial bands of deep reddish brown. Warm reddish brown axial bands dominate the upper shell surface of the St Arnaud Range snails, with dark brown to black bands of variable width on the lower surface. A few, very narrow khaki axial bands occasionally occur. The Mt Murchison snail shells are similar, though the upper surface colour is purplish brown. In all three populations the parietal callus is smooth and dark brown, and the shells have a very glossy base, but a finely striated and matt upper surface.

##### **Habitat**

*Powelliphanta* “Nelson Lakes” is an alpine snail, found at 1200–1600 m a.s.l., just below, just above, and at the bush line. So far, snails on Mt Murchison have only been found above the bush line.

Snails mainly live under the skirts of red tussock, mid-ribbed snow tussock and mountain flax, just above the mountain beech treeline on substrates of indurated sandstones-mudstones. Snails seem most abundant in patches of taller tussock in gentler gullies where soils are slightly deeper and the litter is cool and moist.

##### **Distribution**

Snails from the Speargrass Valley are only known from a total area of about 5 ha in the upper reaches of Speargrass Creek on the western slopes of Robert Ridge in Nelson Lakes National Park. The distribution of the St Arnaud snails is equally restricted with several very small colonies on the northwestern corner of the St Arnaud Range, which is also within the National Park. Both these populations occur just east of the main Alpine Fault, on the outer edge of the highly glaciated Nelson Lakes mountains.

So far snails have been recorded from only two small areas on Mt Murchison. Mt Murchison lies at the northern end of the Braeburn Range, west of Lake Rotoroa. It is the only part of the Braeburn Range above the treeline, and as *Powelliphanta* "Matakitaki" snails occupy the remaining high forested points of the Braeburn Range, the distribution of the Mt Murchison snail is probably naturally very small.

### ***Population***

At the core of the Mt Murchison and St Arnaud colonies, snail densities appear to be moderate: snails were found at the rate of 3.2 snails/person hour in 1997 in the former area (10 snails, 3.1 person hours search; K.J. Walker & G.P. Elliott, pers. obs.), and 7.7 snails/100 m<sup>2</sup> in 1997-99 in a 300 m<sup>2</sup> plot in the latter area. However, no live snails were found in a search of 3 person hours of the Speargrass colony in 1998.

*Powelliphanta* "Nelson Lakes" is classified as 'range restricted' by Hitchmough (2002).

### ***Threats***

For all three populations the major threat has been habitat loss and degradation. From the late 1880s until the early 1900s sheep were grazed during summer months on the tops, and many sheep and cattle remained (after going wild) until they were finally shot out (Potton 1984).

The headwaters of Speargrass Creek, the northern face of Mt Robert, and the northeastern slopes of Mt Murchison were burnt to increase the area of open grazing land. In the first decades after their release in the area, very high numbers of deer, goats, and hares and, less commonly, pigs and chamois, sought shelter and food in the taller, more fertile tussocks at the bush line. Overgrazing led to slips and running screes on the steep slopes of the western St Arnaud Range and Mt Robert, and to invasion of some of the more degraded areas by shorter exotic grasses.

Grazing by ungulates is less now than it was last century, particularly on St Arnaud Range, but hares still graze all snail habitat despite the reduction of the more succulent herbs many years ago.

A road and telecommunications tower reduced the area of habitat for the Mt Murchison snails. The shells of *Powelliphanta* "Nelson Lakes" are thin and fragile, and empty shells often disintegrate, particularly in open areas, making cause of death hard to determine. It seems thrushes, and less frequently mice or rats, are responsible for most predation on this snail, but pigs are also killing some snails on Mt Murchison.

### ***Past Conservation Effort***

On St Arnaud Range six 5 m<sup>2</sup> permanent plots were established in 1997 and a further six in 1999 (300 m<sup>2</sup> in total) to measure population trends. This site lies on the edge of the Rotoiti Mainland Island, and since 1995 the snail habitat should have benefited from the reduction in deer, possum and rodent numbers within the mainland island.

During the late 1990s, several days were spent by DOC staff surveying for snails just beyond the known Speargrass and St Arnaud Range colonies and in 2002 1 day was spent surveying the summit of Mt Murchison. No other conservation work has been undertaken for *Powelliphanta* “Nelson Lakes”.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known populations and to locate other colonies if they exist.

**High 2:** Using the information gained from the distribution surveys, establish about ten 25 m<sup>2</sup> permanent monitoring plots in both the Speargrass and Mt Murchison populations and re-lease the existing plots on the St Arnaud Range. Census of the number of live snails and empty shells within the plots will provide information on population density and trends, and on the levels of exotic predator-induced snail mortality. Searching tussock plots will be difficult to do without significant damage to the habitat, so after two annual counts (to assess mortality levels) the plots are probably best measured at five-yearly intervals.

### ***Future Management Actions Needed***

**High 1:** Keep fires out of, and the numbers of ungulates and hares very low around, the snail colonies. Tall, healthy, dense tussockland vegetation creates not only a moist micro-climate for snails and abundant food for their prey (worms), but also protection from predators. Restoration of the quality of the snail’s alpine grassland habitat is probably the single most useful recovery action which can be taken for the Speargrass and St Arnaud populations. Controlling pigs is important for the Mt Murchison snail population.

### ***Research Priorities***

**High 1:** Facilitate genetic studies to examine the distinctiveness of the Mt Murchison and St Arnaud Range snails, and their relationship to other *Powelliphanta*.

**High 2:** Formally describe and name the Nelson Lakes *Powelliphanta*.

## 4.8 *POWELLIPHANTA* “BATON”

### **Description**

A small snail (maximum diameter 39 mm; height 19 mm) with a rounded, bulbous appearance and a raised apex. The shell is shiny, though not particularly glossy. It is a warm mid-brown to tan colour, with a few, very sparse, narrow reddish axial streaks. The colour of the mantle and mucous is faint blue, unlike the transparent appearance in most other *Powelliphanta*.

It can be distinguished from *Powelliphanta* on the nearby Garabaldi Ridge by its lighter colour, larger size and more inflated profile.

A shell of this snail was first discovered during a botanical survey of the Baton Saddle area by Shannel Courtney on 15/02/91. On 1 April that year, live snails were found during a specific snail search of the same locality (K.J. Walker & G.P. Elliot, unpubl. data), but the Baton snails have yet to be formally described.

Morphologically and genetically the Baton snails are distinctive, with their nearest relatives being other blue-mucous *Powelliphanta* on the Garabaldi and Denniston Plateaux. They are more distantly related to other undescribed plain olive-coloured alpine *Powelliphanta* on the Matiri and Matakita River tops (K.J. Walker, unpubl. data; Appendix 2). A conservative approach would be to consider the Baton, Garabaldi and Denniston snails as three new subspecies of a new, still undescribed species.

### **Habitat**

*Powelliphanta* “Baton” is an alpine snail, found in tussock grassland just above the bush line at 1100–1200 m a.s.l. The snails live under the skirts of tussock and *Astelia nervosa* on fertile soils on a conglomerate substrate.

### **Distribution**

*Powelliphanta* “Baton” has been confirmed so far from only one small area in the headwaters of the Baton River, on the Arthur Range, Kahurangi National Park. Its small size, inconspicuous colour and densely vegetated habitat resulted in it being overlooked until now, despite its proximity to a well used walking route (in use since about 1860). The range of the snail is almost certainly larger than currently known, but its failure to be seen elsewhere indicates that the population density throughout its range is probably low.

### **Population**

In 1991, snails were found at a rate of 3.3 snails/person hour (5 juvenile snails, 3 eggs, 5 shells, 1.5 person hours search; K.J. Walker & G.P. Elliott, pers. obs.). Due to the apparently low density and very small extent of the known population, *Powelliphanta* “Baton” is classified as ‘nationally critical’ by Hitchmough (2002).

### **Threats**

Though it is located in Kahurangi National Park, the subalpine basin supporting the only confirmed population of *Powelliphanta* “Baton” is far from pristine. The lower reaches of the Baton Valley were the site of a minor goldfield between 1857 and 1900 and because of this activity, ‘Jones pack track’ was formed from the Baton River to Karamea Bend, and it passes through the snail habitat at Baton Saddle. From about 1880, the alpine tops below the Baton Saddle were used as summer pasture for herds of

sheep and occasionally cattle. Forest at the bush line was burnt to increase the area of grass. By 1924 'excellent [exotic] white clover was growing there ... [but by] about 1930 ... this had disappeared, probably on account of the heavy grazing by mobs of deer' (Newport 1978).

After stock were removed the alpine grasslands continued to be grazed by feral goats, deer and hare, though numbers of the former two are now reasonably low.

Deterioration of the grassland environment probably made the snails more vulnerable to desiccation and to predation by thrushes, but at this altitude most other predators of *Powelliphanta* are rare.

### ***Past Conservation Effort***

No effort towards assessment or conservation of this land snail has been made.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colony, and to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail's survival.

### ***Future Management Actions Needed***

**Medium 1:** Keep goat, deer and possum numbers low in the Baton Saddle Basin to protect the quality of the tussock grasslands, and allow regeneration of the subalpine forest and scrub.

### ***Research Priorities***

**High 1:** Formally describe and name the Baton *Powelliphanta*.

#### 4.9 *POWELLIPHANTA* “GARABALDI”

##### **Description**

A small snail (maximum diameter 38 mm; height 18 mm) with a compact, though rounded, appearance. The apex of the shell is low and flattened. The whole shell is a glossy, dark brown-olive green colour, with a dark brown, smooth parietal callus. The colour of the mucous and mantle is faint blue, unlike the transparent appearance in most other *Powelliphanta*.

Shells of this snail were first discovered by Ian Millar during a caving expedition to the Garabaldi Plateau in February 1985 (Hawes et al. 1986). In 1991 live snails were found during a specific snail search in the same locality, but the Garabaldi snails have yet to be formally described.

Morphologically and genetically the Garabaldi snails are distinctive, with their nearest relatives being other blue-mucous *Powelliphanta* on the Denniston Plateau, on the Baton Saddle and at Kirwans Hill (K.J. Walker, unpubl. data; Appendix 2). However, they are easily distinguishable from these by their small size and plain, dark coloured shell.

A conservative approach would be to consider the Garabaldi, Baton, Kirwans and Denniston snails as four new subspecies of a new, still undescribed species, but further studies of their genetic make-up are needed to confirm this.

##### **Habitat**

*Powelliphanta* “Garabaldi” is an alpine snail, found at 1200–1400 m a.s.l just at and just above the bushline. The snails live under the skirts of red tussock, mountain flax, *Celmisia* daisies and turpentine scrub on calcium-rich soils on an extensive limestone plateau.

##### **Distribution**

*Powelliphanta* “Garabaldi” is known only from one small part of the Garabaldi Plateau in the remote centre of Kahurangi National Park. Shells were found very patchily over about 25 ha between the northeastern end of Garabaldi Ridge to Sandy Peak.

Given their inconspicuous nature, and the remoteness of the area, it is possible that they also occur on other parts of the Herbert Range, but the likelihood of their existence elsewhere is limited if they are a true calcicol.

##### **Population**

During a search over about 8 ha of the northern Garabaldi Ridge in 1991, snails were found at the rate of 0.7 snails/person hour (5 shells, 7 person hours search; K.J. Walker, G.P. Elliott, P. Lawless, pers. obs.). Since all of the snails were found in one location in the final 2.2 hours of the search, the density is actually 2.3 snails/person hour. No other measurements of the population density have been made. *Powelliphanta* “Garabaldi” is classified as ‘range restricted’ by Hitchmough (2002).

### ***Threats***

Hedgehogs have probably not yet reached the Garabaldi Plateau, but thrushes almost certainly are reducing snail recruitment and survival rates. Hares and chamois reached the area in only the last 30 years, but they and red deer and goats can probably live in reasonably high densities on the fertile soils, and their trampling and grazing could pose a threat to the humidity of the snail micro-habitat.

### ***Past Conservation Effort***

No effort towards assessment or conservation of this land snail has been made.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colony, to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail's survival.

### ***Research Priorities***

**High 1:** Formally describe and name the Garabaldi *Powelliphanta*.

#### 4.10 *POWELLIPHANTA* “MATIRI”

##### **Description**

A small snail, with a relatively sturdy shell of rounded, bulbous shape. The shell is generally a plain, dark olive green colour. The base of the shell is glossy, but the upper surface is faintly matt due to fine striae. The mantle and mucous is blue (at least in the snails on Bald Knob Ridge), unlike the transparent colour in most other *Powelliphanta*.

There are detectable differences in shell morphology across the range of the Matiri snails. Snails from the Thousand Acres Plateau are relatively small (maximum diameter 40 mm; height 19.5 mm) and the shell colour on both the dorsal and ventral surfaces is dark green, with a few black axial streaks. Above Lake Jeanette in the upper reaches of the Matiri River the shells are relatively large (maximum diameter 42.5 mm; height 21 mm), the dorsal surface of the shell is faintly warm reddish brown and there are no axial streaks. Snails on Bald Knob Ridge are intermediate in size (maximum diameter 41.6 mm; height 19.5 mm) with a reddish brown dorsal surface and an olive green lower surface with occasional black axial bands.

The Matiri snails were discovered after the main period of *Powelliphanta* classification (1930s–40s); the first mention of their presence was in 1969. As a consequence of their late discovery, their taxonomy was not critically assessed until 1990, and the Matiri snails are still not formally described.

Based on shell morphology and allozyme data, their closest relatives are the newly discovered southern, plain olive green, rounded-shell snails in the alpine tops between Lewis Pass and Murchison (*Powelliphanta* “Matakitaki”) and they are more distantly related to the Baton, Garibaldi and Denniston snails (K.J. Walker, unpubl. data.; Appendix 2).

The Matiri snails are probably best considered one subspecies and the Matakitaki snails a second subspecies, of a new, still undescribed species.

##### **Habitat**

*Powelliphanta* “Matiri” is largely an alpine species, most commonly occurring at 1200–1500 m a.s.l., but there are several small isolated colonies at lower altitude (about 600 m a.s.l.). They live under the skirts of tall *Chionochloa* tussock, or under litter in subalpine scrub and forest in calcium-rich soils on limestone, sandstone and mudstone substrates.

##### **Distribution**

The snails occur patchily on the Matiri Range and on most of the high peaks between the Matiri River and the Fyfe River, at the southern end of Kahurangi National Park. Their distribution abuts, but apparently does not overlap, that of the small striped alpine snail, *Powelliphanta* “Owen”, on the southwest flanks of Mt Owen.

## ***Population***

The highest densities of snails are apparently on Mt Baigent and Trent Peak on Bald Knob Ridge, and on the Thousand Acre Plateau (Spurr 1985). In 1991 on Mt Baigent snails were found at a rate of 6.4 snails/person hour (8 snails, 10 shells, 1.25 person hours search; K.J. Walker & G.P. Elliott, pers. obs.). However, densities appear much lower in most other *Powelliphanta* “Matiri” populations (Spurr 1985).

Because of their relatively wide distribution and occasional high densities, the Matiri snails are apparently much more populous than other alpine *Powelliphanta* of North West Nelson. *Powelliphanta* “Matiri” is classified as ‘range restricted’ by Hitchmough (2002).

## ***Threats***

The warm climate, fertile soils and abundant earthquake slip scars with seral vegetation in the Matiri country mean relatively high numbers of feral pigs, goats, deer and hares are present. Pigs are present on the tussock tops and constitute a threat to the *Powelliphanta* populations through predation and habitat destruction. The other pests trample and browse the grasslands, drying out the snail’s micro-habitat. So far, too few shells have been collected for accurate assessment of the effect of these threats on the snail population. Only 25% of the 101 shells found during the 1983 survey were intact, but the cause of the damage to the broken shells was not determined (Spurr 1985).

## ***Past Conservation Effort***

The locality of *Powelliphanta* and other fauna and flora of the Matiri - Owen area were recorded during a systematic survey by the Forest Research Institute (FRI) in 1982/83 (Spurr 1985). Shells collected throughout the 1990s by Department of Conservation goat hunters confirmed the accuracy of the FRI survey, and found only a few new sites.

## ***Future Survey and Monitoring Needs***

**Medium 1:** Systematic searches of small plots for live snails and empty shells in representative samples of known colonies are required to determine current conservation status and threats to the taxon.

## ***Research Priorities***

**High 1:** Formally describe and name the Matiri *Powelliphanta*.

#### 4.11 *POWELLIPHANTA* “MATAKITAKI”

##### **Description**

*Powelliphanta* “Matakitaki” is consistently larger (maximum diameter 42–44.5 mm; height 20–21.5 mm) than *Powelliphanta* “Matiri”, but in colour and shape looks similar. The base of the globose shell is glossy, but the upper surface is faintly matt due to fine striae. The shell colour is olive green to tawny brown, overlain by a faint reddish hue on the dorsal surface and occasional, inconspicuous, narrow axial bands of dark brown. The parietal callus is smooth and olive-brown, and the mantle and mucous (at least in the Lewis Pass population) is a faint blue-green colour.

There is some morphological variation across the range of the Matakitaki snails, but too few shells have been found to document this.

Until recently, the existence of *Powelliphanta* snails east of the Buller and Maruia Rivers was not considered a possibility. In 1988, however, a shell fragment was found by K. Climo at Station Creek, northwest of Springs Junction, and in 1990 Mike North found a whole shell on the summit of Baldy, a peak drained by Station Creek.

During the mid–late 1990s, Department of Conservation goat hunters, particularly Rex Hancox, found further populations of the large green alpine snail on seven other mountain peaks flanking the Matakitaki River between Maruia and Lake Rotoroa.

As a consequence of their late discovery, only snails from the Lewis Pass colony were included in an examination of the genetic make-up of *Powelliphanta* in 1990, and the taxon is not yet formally described.

Based on shell morphology and limited allozyme data, the closest relatives of the Matakitaki snails are the undescribed small, plain green alpine snails of the Matiri area (K.J. Walker, unpubl. data; Appendix 2). There is a substantial genetic distance not only between these groups but also between them and other *Powelliphanta*, and the Matakitaki snails are probably best considered one subspecies (and the Matiri snails a second) of a new, still undescribed species.

##### **Habitat**

*Powelliphanta* “Matakitaki” is an alpine species, most commonly found at 1200–1400 m a.s.l., but snails also occur up to 1700 m a.s.l. and, at one site, down at 1000 m a.s.l. The snails live under litter in high-altitude silver and mountain beech forest; under mountain flax, *Astelia nervosa* and turpentine scrub in subalpine shrublands, and under tussock in alpine grasslands.

Two of the snail populations occur on the calcium-rich soils of a narrow band of marble or calcareous mudstone rock, while most of the other colonies occur on schists.

### ***Distribution***

The snails have so far been found in small parts of seven, widely separated mountain tops in a large area in south Nelson bordered by the Buller, Maruia and D'Urville Rivers. Their distribution abuts, but apparently does not overlap, that of small striped alpine snails - *Powelliphanta* "Nelson Lakes" - in the northeast corner of the area.

*Powelliphanta* "Matakitaki" snails have been found on small parts of the northern and southern ends of the Braeburn Range, the northern Ella Range, the Nardoo and Baldy tops between the Glenroy and Matakitaki Rivers, Mt Mantell, Mt Cann and on another Baldy just northeast of Springs Junction.

No snails have yet been found on the heavily glaciated mountain ranges of the Southern Alps; all sites are on outlying, generally lower, ranges.

### ***Population***

On the marble of Mt Baldy (the southern part of the snail's range), snails were found at a rate of 5 snails/person hour in 1991 (4 snails, 8 damaged shells, 0.8 person hours search). On the less fertile northern Braeburn Range, they were found at a rate of 0.8 snails/person hour in 1997 (2 snails, 3 shells, 2.5 person hours search; K.J. Walker & G.P Elliott, pers. obs.). No other measures of the density of live snail populations have been made.

From more general searches for shells and snails on Mt Cann, Mt Mantell and on the Nardoo tops, it seems that snail numbers are generally very low in all except a few specific small locations. If the Matakitaki snails are as genetically uniform across their relatively wide range as they appear, they are reasonably secure, despite apparently low numbers at most sites. *Powelliphanta* "Matakitaki" is classified as 'range restricted' by Hitchmough (2002).

### ***Threats***

Most of the few shells found have been damaged, principally by thrushes and rats. Rats are not generally present at such high altitudes, but in the late 1990s a series of heavy beech masts and warm winters in south Nelson caused a rat plague and apparently an upward expansion of their range. If global warming brings warmer winters more frequently, rats may become a significant threat to these alpine snails.

The fertile calcium-rich soils favoured by these snails also support a variety of grasses and herbs which attract high populations of goats, hares and deer. With such intense use of small areas by such pests, the snails are at risk of being crushed and of lowered productivity and survival through desiccation of the snails, snail eggs, and the habitat.

### ***Past Conservation Effort***

Department of Conservation staff investigated reports of shells, discovered new localities, and carried out brief snail surveys on Mt Cann, Mt Mantell, Nardoo and the Ella Range during the 1990s.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colonies and to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail's survival.

### ***Research Priorities***

**High 1:** Formally describe and name the Matakītaki *Powelliphanta*.

#### 4.12 *POWELLIPHANTA* “KIRWANS”

##### **Description**

A small snail (maximum diameter 40 mm; height 18 mm) with a low, flattened apex and less rounded appearance than nearby *Powelliphanta* “Matakitaki”.

The shell is a plain warm tan-brown colour, with a faint reddish tinge on the dorsal surface and one or two narrow black axial bands on the ventral surface. The shell is mostly glossy, but has a soft matt appearance on the dorsal surface of the inner whorls, caused by very fine sculpturing.

Kirwans Hill was the scene of early gold mining and a geologist, Mr H. Wellman, collected the first shells and sent them to A.W.B. Powell about 1937. In his 1938 description of snails from Rewanui in the Paparoa Ranges as *Paryphanta gagei*, Powell mentioned the Kirwans Hill snails: unfortunately they were only ‘Fragmentary specimens of what appears to be the same species’ (Powell 1938). Complete shells were not collected and critically examined until the late 1980s.

The Kirwans Hill snails are in fact readily distinguishable from *Powelliphanta gagei* by their shell colour; tan brown for the former, but rich red top and olive green base for the latter. Allozyme data (K.J. Walker, unpubl. data; Appendix 2) indicated a large genetic distance between Mt Ryall *P. gagei* and the Kirwans Hill snails. The Kirwans Hill snails had no close genetic relatives, but clustered loosely with *Powelliphanta* “patrickensis”, *Powelliphanta* “Garabaldi” and *Powelliphanta* “Baton”, rather than with the geographically closer *Powelliphanta* “Matakitaki”.

A conservative approach would be to consider the Kirwans, Garabaldi, Baton and Denniston snails as four new subspecies of a new, still undescribed species.

##### **Habitat**

*Powelliphanta* “Kirwans” is an alpine snail, found just at and just above the treeline at 1250–1280 m a.s.l. The snails live under the skirts of tussock and mountain flax, on greywacke parent material.

##### **Distribution**

*Powelliphanta* “Kirwans” is known only from the small area (less than 10 ha) of tall tussock on the open tops of Kirwans Hill, about 12 km northeast of Reefton. Kirwans Hill is an isolated southwestern outlier of the Brunner and Victoria Ranges. There have been a number of reports of *Powelliphanta* on the tussock tops of the Victoria Ranges, but only one shell has been collected and it did not closely resemble *Powelliphanta* “Kirwans”. A population of *Powelliphanta* was seen on the southern Brunner Range in 1976 (I. Payton pers. comm.) but the species was unknown. Until enough specimens are collected to be sure of the identity of the Brunner - Victoria snails, the distribution of *Powelliphanta* “Kirwans” must be considered to be naturally very restricted.

## ***Population***

On Kirwans Hill, snails were found at a rate of 7 snails/person hour in 1969 (14 snails, 2 person hours search; I. Payton & J. Marston, pers. comm.). In 1990, when about 1 ha of Kirwans Hill was searched, snails were found at the rate of 1.7 snails/person hour (5 snails, 35 shells, 3 person hour search; K.J. Walker & G.P. Elliott, pers. obs.). *Powelliphanta* “Kirwans” is classified as ‘range restricted’ by Hitchmough (2002), though the 76% drop in numbers between 1969 and 1990 means that the classification should perhaps be reviewed.

## ***Threats***

The main cause of mortality for *Powelliphanta* “Kirwans” a decade ago was apparently its natural enemy, the western weka. On the Kirwans Hill tops in 1990, of 41 shells found, at least 30 had probably been damaged by weka. Weka were seen pulling out tufts of carpet grass on Kirwans Hill and probing in the holes they had created (K.J. Walker, pers. obs.).

The impact of weka on the snail population may be somewhat greater now than it was in the past, as the snail’s tussock grassland is providing less cover than it used to do. The beech forest on the southern edge of Kirwans Hill Tops was burnt during the gold mining period (1897–1939) and is now a barren and rather dry scrubby tussockland. Hares and deer browse the tussock tops and there are now few succulent herbs or extensive areas of tall dense tussock to provide snails with shelter. Pigs have recently caused substantial damage to the snail’s habitat (J. McLaughlin, pers. comm.), and presumably also to the snail population.

## ***Past Conservation Effort***

No effort towards conservation of this land snail has been made.

## ***Future Survey and Monitoring Needs***

- High 1:** Systematic surveys are required to determine the extent of the known colony, to determine the identity of the Brunner and Victoria Range *Powelliphanta*, and to determine, from examination of empty shells and habitat condition, threats to the snail’s survival.
- High 2:** Establishment of at least twenty 25 m<sup>2</sup> permanent plots to measure population density. Re-measurement of plots at regular intervals to monitor population trends.

## ***Future Management Actions Needed***

- High 1:** Keep pigs out of the Kirwans Hill snail colony, and deer populations at low levels to protect the snail’s habitat.

## ***Research Priorities***

- High 1:** Formally describe and name the Kirwans Hill *Powelliphanta*.
- Medium 1:** Facilitate mtDNA studies to examine the phylogeny of *Powelliphanta* “Kirwans” and its relationship to other *Powelliphanta*.

#### 4.13 *POWELLIPHANTA GAGEI*

##### **Description**

Powell described *Powelliphanta gagei* from the southern-most end of the Paparoa Ranges in the headwaters of Seven Mile Stream above Rewanui in 1938. The shell is moderately large (maximum diameter 42.5 mm; height 24 mm) and smooth and generally glossy, but the upper third of the shell is finely sculptured. The upper surface of the shell is a warm reddish brown while the lower surface is muddy dark olive green. In 1979 Powell relegated the Rewanui snails to subspecies rank as *P. rossiana gagei*.

Snails were later found at much higher elevations on many parts of the main Paparoa Ranges, and assumed to be *P. rossiana gagei*, but this now seems less likely. All the alpine snails are much smaller and have compact rather than rounded inflated profiles. Snails found at Mt Ryall, 10 km north of the Rewanui population, have a rich red colour on the upper third of the shell and a bright olive green ventral surface, streaked with a few darker axial bands. The red upper area is densely sculptured giving a matt appearance and there are numerous narrow, very fine radial red lines which are absent on the Rewanui snails. In contrast to the Rewanui snail shells, the boundary between the reddish sculptured top and the darker base on the Mt Ryall snail shells is very sharp and clear-cut. The shell reaches a maximum diameter of 37.5 mm and height of 18.5 mm. Snails from near Mt Ramsey, 25 km north of Mt Ryall, share the characteristics of the Mt Ryall snails. However, the few shells collected from Mt McHardy to Mt Stevenson (a long range to the east of the main Paparoas) seem different again, being small but fairly uniformly brown.

Unfortunately the genetic make-up of only the Mt Ryall snails has been examined. Dissection revealed that the snails have a striking purple mantle and mucous (in most *Powelliphanta* there is no colour), and the allozyme data (K.J. Walker, unpubl. data) showed the Mt Ryall snails to be unrelated to *P. rossiana* but, instead, a separate species with no close relatives (Appendix 2).

However, in the absence of better morphological data from the northern and eastern Paparoa Ranges populations (so far only a handful of specimens have been collected) or of genetic examination of both these and the Rewanui snails, all Paparoa Ranges snails are included here as *Powelliphanta gagei*.

##### **Habitat**

*Powelliphanta gagei* is an alpine snail, found at 800–900 m a.s.l. at Rewanui and west of Mt Ramsay; and above the treeline (1100–1450 m a.s.l.) at all other sites. At Rewanui snails occur on infertile, acidic coal measures, in low subalpine shrubland dominated by manuka, pink and yellow-silver pine and inaka. Here snails shelter under *Gabnia procera*, mountain flax and *Astelia nervosa* (R. Buckingham, pers. comm.). At Mt Ryall snails live under leatherwood scrub at the treeline, and under red tussock and *Celmisia* spp. at higher altitudes, mostly on schist and conglomerate parent material. At all sites the humidity is generally high, with frequent fog, cloud and rain.

### ***Distribution***

Found in a very restricted area on a ridge in the headwaters of Seven Mile Stream, Rewanui; between Croesus Knob, Mt Ryall and Marconi Hill in the southern Paparoa Ranges; and recorded at spot localities between Mt Ramsay and Mt Fleming on the main Paparoa Ranges, and between Mt McHardy and Mt Micawber on the eastern Paparoa Ranges.

### ***Population***

On Mt Ryall in 1991, snails were found at a rate of 1.1 snails/person hour (7 snails, 17 shells, 6.5 person hours search; K.J. Walker & G.P. Elliot, pers. obs.). Live snail density is even lower at Rewanui where they were found at 0.4 snails/person hour in 1997 (2 snails, 5 person hour search; R. Buckingham, pers. comm.). This is a substantial decline from the 3.6 snails/person hour found in a search 28 years earlier in 1969 (18 snails, 5 person hour search; I. Payton, pers. comm.).

In Hitchmough (2002) the Rewanui *Powelliphanta* are classified as 'nationally critical' while the *Powelliphanta* further north on the Paparoa Ranges are ranked as 'range restricted'.

### ***Threats***

In the lower, less fertile habitat at Rewanui, possums and rats seem to be a threat to the snail population with about 75% of shells found in 2002 killed by these pests (mostly possums).

By contrast, at Mt Ryall shells showed signs of only the snail's natural predator, the weka, and the four shells collected from the eastern Paparoa Ranges were intact.

The biggest threat to *Powelliphanta gagei* is further habitat loss to fires, roading and coal mining above Rewanui. In 2001 Solid Energy built many access roads in advance of a new, large-scale coal mine in the Rewanui snail area.

### ***Past Conservation Effort***

In 2002 a 100 m<sup>2</sup> permanent plot was established at Mt Ryall to measure snail density and population trends, and shells were collected from this site, Rewanui and Mt Epping to gather information on causes of mortality.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colonies, to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail's survival.

### ***Future Management Actions Needed***

**High 1:** Urgently seek protection of the snail habitat at Rewanui from the impact of the planned new coal mine.

### ***Research Priorities***

**High 1:** Facilitate allozyme and mtDNA studies of the genetic make-up of Rewanui and northern and eastern Paparoa Ranges *Powelliphanta*.

#### 4.14 *POWELLIPHANTA FLETCHERI*

##### **Description**

A small snail (maximum diameter 36 mm; height 20.5 mm), more flattened in appearance than *Powelliphanta rossiana rossiana* and with a much lower spire and more open umbilicus. The shell colour is mostly dark greenish brown, turning to russet-brown above. There are a few, widely spaced axial stripes, showing distinctly only on the base. The shell is smooth and glossy (Powell 1938).

It was first described by A.W.B. Powell as *Powelliphanta fletcheri*, but he later relegated it to subspecific status - *P. rossiana fletcheri* (Powell 1979). In 1990, allozyme data indicated a large genetic distance between snails from the type locality at Mt Tuhua, and small alpine *Powelliphanta* further south at Fox Glacier and Haast (K.J. Walker, unpubl. data; Appendix 2). Unfortunately it was not possible to compare *P. r. fletcheri* with its nearest geographic neighbour, *P. rossiana rossiana*, as no live snails of the latter could be found.

On the basis of morphology, *P. r. fletcheri* is readily distinguishable from *P. rossiana rossiana*, *P. rossiana* "Fox" and *P. rossiana* "Haast", so resurrection of its species status is probably appropriate.

##### **Habitat**

*Powelliphanta fletcheri* is an alpine snail found at 1100–1300 m a.s.l., just at and just above the tree line. It lives under the litter of scattered leatherwood shrubs and under the skirts of tall tussock and large-leaved alpine herbs. The snails occur on soils from both granite and schist parent material. The grassland habitat in which the snails are found on Mt Tuhua is the result of fires on the upper mountain and is in various stages of regeneration to subalpine scrub (Wardle 1980).

##### **Distribution**

The type and only confirmed locality for *Powelliphanta fletcheri* is Mt Tuhua on the eastern side of Lake Kaniere about 20 km southeast of Hokitika on the West Coast. The snails live in only a small part of the tussock tops of Mt Tuhua, in an area probably less than 3 ha in extent.

However, fragments of shell which look similar to *P. fletcheri* were found at five other spot-localities east of Mt Tuhua during the 1990s. Unfortunately all the fragments found so far have been too weathered or broken to confirm their identity. Shells have been found in the western-most end of both the Newton and McArthur Ranges which are part of the main Southern Alps, as well as on Mt Turiwhate and Houhonu Ridge which, like Mt Tuhua, are outlier 'island' mountains, west of the Alpine Fault.

##### **Population**

On Mt Tuhua in 1954, snails were found at a rate of 6 snails/person hour (12 snails, 2 person hour search; Price 1955), and in 1969 they were found at 9.2 snails/person hour (46 snails, 5 person hour search; I. Payton, pers. comm.). In the same general area in 1988, snails were found at a rate of 3.8 snails/person hour (15 snails, 76 shells, 4 person hour search; K.J. Walker, pers. obs.). When a 500 m<sup>2</sup> plot was thoroughly searched on Mt Tuhua in 1995, snails were found at a rate of 0.6 snails/person hour (9 snails, 64 shells, 16 person hour search), and when the plot was re-measured in 2000 the rate had dropped even lower, to 0.06 snails/person hour (1 snail, 40 shells, 16 person hour search),

Although the first three counts are not directly comparable with the last two, from these figures it seems that the population has declined significantly during the last 30 years. From a strong population in the 1950s and 1960s, the population density is now apparently quite low. As *Powelliphanta fletcheri* is confined to the southeastern side of Mt Tuhua, the total population size is presumably small.

*Powelliphanta fletcheri* is classified as 'range restricted' by Hitchmough (2002), though this may change if further investigation confirms the apparent trend of decline.

### ***Threats***

On most of the many *Powelliphanta fletcheri* shells collected from Mt Tuhua, there is a small hole in the apex. That there is some sign of collapse at the same spot, even on the shells of live snails, suggests that the hole may be due to a weakness in the structure of the shell rather than predation, but this is unconfirmed. One or two snails showed signs of substantial thrush damage and a few of weka damage, but in most shells the hole in the apex is much too small to have been created by a weka.

The main obvious threats are probably depletion of the sheltering tussock grassland habitat through high numbers of deer and through burning. The snail habitat on Mt Tuhua was subject to fire some time near the beginning of the 1900s. That the snails persist in a very small part of the available habitat on Mt Tuhua suggests that past fires may have influenced their present distribution (Nichol 1996). It may be that the southern slopes on which the snails predominate may have been too damp to hold a fire or that the fire was less intense there than on the drier slopes. Fire remains a threat to the snails today (ibid.).

### ***Past Conservation Effort***

Population trend assessment on Mt Tuhua through establishment of a 500 m<sup>2</sup> permanent plot, in 1995, and re-measurement in 2000.

### ***Future Survey and Monitoring Needs***

- High 1:** Re-measurement of the large snail plot on Mt Tuhua in 2005, and establishment of twelve to sixteen more 25 m<sup>2</sup> plots scattered within good snail habitat on Mt Tuhua. Placement of plots over a wide area on Mt Tuhua would help determine if the apparent decline is real or a by-product of sampling different areas within a highly patchy snail colony.
- High 2:** Systematic surveys are required to collect enough samples from the snail populations away from Mt Tuhua to allow identification of species.
- High 3:** Survey and monitoring is also needed to determine the extent and density of each colony and to determine, from examination of empty shells and habitat condition, threats to the snail's survival.

### ***Future Management Actions Needed***

**High 1:** Protect the only confirmed snail habitat on Mt Tuhua from grazing by deer and from fire.

### ***Research Priorities***

**High 1:** Formal re-instatement of the name of this snail as *Powelliphanta fletcheri*.

#### 4.15 *POWELLIPHANTA ROSSIANA ROSSIANA*

##### **Description**

At its type locality on Mt Greenland, *Powelliphanta rossiana rossiana* is a fairly small snail (maximum diameter 35 mm; height 19 mm) with a thin, smooth and glossy, rounded shell with a narrow umbilicus. The shell is a dark greenish brown with irregular dark brown axial streaks (Powell 1930).

Though *P. r. rossiana* was known only from Mt Greenland and Mt Rangitoto when first described (Powell 1930), since the 1980s *Powelliphanta* have been found on a number of other mountain tops nearby. Unfortunately very few shells have been recovered from each site so it is not yet clear whether these are additional populations of *P. r. rossiana*.

Snail shells from Mt Bonar appear similar to the shells of Mt Greenland snails. The genetic make-up of *P. r. rossiana* has yet to be examined, even at the type locality, as no live snails have been found in recent years.

*Powelliphanta* shells collected from the headwaters of the Tuke River are darker and smaller (maximum diameter 32 mm; height 17 mm) than typical *P. r. rossiana*, and are more compact with a lower spire.

##### **Habitat**

*Powelliphanta rossiana rossiana* is an alpine snail, found at 950–1200 m a.s.l., just at and just above the bush line. Most snails have been found in tall tussock-land scattered with leatherwood and inaka. However, on Mt Greenland, which barely rises to bush line height, they occur in a low stunted forest of scattered pink and yellow-silver pine and manuka (D. Norton, pers. comm.), but Price (1955) found them ‘living only on the summit under a covering of wiry bog grass’.

On Mt Bonar and Mt Rangitoto they occur on gneissic granites; on Mt Greenland on quartz-bearing greywacke, and in the Tuke River headwaters on schists. Rainfall is high at all sites with conditions generally very cool and moist year-round.

##### **Distribution**

Found on the summit of all the outlier ‘island’ mountains west of the Main Divide between Ross and Harihari (Mt Greenland, Mt Rangitoto and Mt Bonar) on the West Coast. Shells have also been found east of the Alpine Fault on Karnback and in the Tuke River headwaters, and snails are likely to be present at other sites between these two peaks. The identity of the snails at these eastern sites is not yet confirmed.

Distribution within the known sites is apparently very patchy.

##### **Population**

In 1936 Harry Johnston, on his first snail search, spent 3 hours searching for live snails on the summit of Mt Greenland. He ‘found plenty of collapsed broken shells and retrieved some fair examples’, but located only one live snail (Johnston 1956). After several hours searching in the same area in 1954, experienced shell collector L. Price ‘considered [himself] lucky to have half a dozen lives in the bag’ (3 snails/person hour; Price 1955). However, the population at the type locality, Mt Greenland, is now apparently even smaller, with only a few shells and no live snails found in recent years.

Numbers seem higher on Mt Bonar with many broken shells ( $2/m^2$ ) reported in alpine scrub in 1989, but once again no live snails were seen (R. Stocker, pers. comm.). *Powelliphanta rossiana rossiana* is classified as 'nationally endangered' by Hitchmough (2002).

### ***Threats***

*Powelliphanta rossiana rossiana* is ranked as 'endangered' because the population at the type and only confirmed locality (Mt Greenland) is apparently very small and declining. In addition, the small area of high-altitude land available to snails on Mt Greenland has already been compromised by roading for mineral exploration, army maneuvers and burning. Placement of a radio repeater on Mt Bonar has destroyed some snail habitat. At both Mt Greenland and Mt Bonar most snails are killed by introduced predators, probably thrushes, but possibly also possums, and the enhanced mortality poses a considerable threat for such small populations.

### ***Past Conservation Effort***

No effort towards assessment or conservation of this land snail has been made.

### ***Future Survey and Monitoring Needs***

**High 1:** Surveys of the extent and status of the snail colonies on Mt Greenland, Mt Rangitoto and Mt Bonar are required as a first priority, followed by distribution surveys of the headwaters of the Tuke River and other similar tops nearby.

Effort should be made to collect as many empty shells as possible during these surveys to allow confirmation of snail identity and cause of death.

**Medium 2:** At least twenty  $25\text{ m}^2$  permanent plots should be established on Mt Bonar and Mt Greenland and re-measured five-yearly to determine population trends.

### ***Future Management Action Needed***

**High 1:** Protection of the snail habitat at the type locality, Mt Greenland, from further degradation by fire and roading or other human activities.

### ***Research Priorities***

**High 1:** Facilitate morphological and genetic studies of the alpine *Powelliphanta* in the Ross area to determine their identity and the relationships both between colonies and with other *Powelliphanta*.

#### 4.16 *POWELLIPHANTA ROSSIANA* “FOX”

##### **Description**

A small snail (maximum diameter 36–39 mm; height 18–21 mm) with a thin, glossy, dark olive green shell with very sparse black axial streaks. The umbilicus is much wider than in typical *Powelliphanta rossiana*.

The first records of *Powelliphanta* snails in the Fox area were made in the 1960s when John Marston and Ian Payton followed up reports from locals. During the 1980s and 1990s additional *Powelliphanta* colonies were discovered both north and south of Fox Glacier. Unfortunately only a few shell fragments have been collected from most of these sites, so their identity as *Powelliphanta rossiana* “Fox” has not yet been confirmed.

In 1990, in an examination of the genetic make-up of *Powelliphanta*, snails from Mt Fox were found to be highly distinctive (K.J. Walker, unpubl. data; Appendix 2). Unfortunately specimens of *P. r. rossiana* found north of Mt Fox were not available for examination, but there were large genetic distances between the Fox snails and their closest southern geographic neighbour. On morphological grounds the Fox area snails are probably best considered a subspecies of *P. rossiana*, but this conservative approach may need to be reviewed when better information on both *P. rossiana* and the Fox snails becomes available.

##### **Habitat**

*Powelliphanta rossiana* “Fox” is an alpine snail, found just at and just above the bush line between 850 m a.s.l. and 1300 m a.s.l. The snails live under *Astelia nervosa*, mountain flax and tall *Chionochloa* tussock in dense subalpine scrub. Humidity is high, with frequent mist, cloud and rain on the mountain tops. All colonies are just east of the Alpine Fault, and are on schist parent material.

##### **Distribution**

*Powelliphanta rossiana* “Fox” is known from three spot-localities south of the Fox Glacier on the Fox, Copland and Karangarua Ranges in South Westland. A shell recently found north of Franz Josef Glacier on Cole Spur is morphologically distinctive, and is perhaps better regarded as *P. rossiana rossiana* than *P. rossiana* “Fox”, at least until more specimens have been examined.

##### **Population**

On Mt Fox in 1969 snails were found at a rate of 2.6 snails/person hour (18 snails, 7 person hour search; I. Payton, pers. comm.), and in 1990 they were found at 1.7 snails/person hour (6 snails, 22 shells, 3.5 person hour search; K.J. Walker & G.P. Elliott, pers. obs.). These are the only guides available to the possible size of the population of *P. rossiana* “Fox”. Indications are that the snail’s distribution is very patchy within each known locality but that, where present, its numbers are low to moderate. *Powelliphanta rossiana* “Fox” is classified as ‘range restricted’ by Hitchmough (2002).

### ***Threats***

All 22 of the shells found on Mt Fox in 1990 were intact, with no sign of predator attack. Only a few decayed shells have been collected from the other known localities so no assessment of their status has been possible. On this very limited information it seems that *P. rossiana* “Fox” faces no immediate threats from the usual predators of *Powelliphanta*.

The largest potential threats are probably habitat loss or degradation caused by fires or by the installation of permanent structures such as radio communication towers. All known colonies of this snail lie within Westland National Park, and so are protected to some degree from undesirable activities and developments.

### ***Past Conservation Effort***

No effort towards assessment or conservation of this land snail has been made.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic snail surveys are required on all of the frontal mountains north and south of Fox Glacier to obtain information on the size and extent of the populations of *Powelliphanta rossiana* “Fox”. Enough samples need to be collected to allow identification of species.

**High 2:** Survey and monitoring are also needed in the known colonies to determine population trends and, from examination of empty shells and habitat condition, threats to the snail’s survival.

### ***Research Priorities***

**High 1:** Formally describe and name the Mt Fox snails.

#### 4.17 *POWELLIPHANTA* “HAAST”

##### **Description**

Plain brown *Powelliphanta* snails have been known from scattered localities on the frontal mountains behind Haast since at least the 1960s (Climo 1971), but remain undescribed and poorly known.

Snails on the Mark Range are small (maximum diameter 35 mm; height 18 mm) with a smooth, glossy, and rounded shell with very narrow umbilicus. The shell is a tan-brown colour on top with a greenish brown base. There are a few, sparse, black axial streaks, on only the lower half of the shell.

The shells of snails on Browning Ridge appear similar, but the single specimen collected from the Mataketake Ridge is much larger than the Mark and Browning Range snails. *Powelliphanta* snails are reported to be on the Thomas Range (I. Payton, pers comm.) but their morphology is undescribed. All these snails have been treated here as *Powelliphanta* “Haast”, but much more information is required before this identification can be confirmed.

Allozyme data (K.J. Walker, unpubl. data; Appendix 2) showed the closest relatives of the Mark Range snails (the only *Powelliphanta* “Haast” snails tested) to be *Powelliphanta rossiana* “Fox”, although the relationship was not close. The small striped *Powelliphanta* “vittatus”, which is almost sympatric with *Powelliphanta* “Haast” and certainly its closest geographic neighbour, was found to be a separate species.

A conservative approach would be to consider the Haast snails a subspecies of *P. rossiana*, at least until better information on the morphology and genetic make-up of both is available.

##### **Habitat**

On the Browning and Mark Ranges, *Powelliphanta* “Haast” is a snail of subalpine forest and scrub, largely found between 950 m a.s.l. and 1050 m a.s.l., though individuals are also occasionally found in much higher-altitude tussock grassland. They live under litter and the fronds of prickly shield fern in old silver beech forest, and under mountain holly and turpentine scrub at the bush line.

Snails on the Mataketake Ridge and Thomas Range north of the Haast River have so far been found only well above the bush line at about 1150 m a.s.l. under tall tussock. All the known colonies occur on schist rocks.

##### **Distribution**

*Powelliphanta* “Haast” is known from spot-localities on the northwestern end of the Browning and Mark Ranges, between the Haast and Turnbull Rivers; and from the northeastern end of the Mataketake Range and the south end of the Thomas Range on the north bank of the Haast River in South Westland. It probably also occurs at many other sites along those ranges, and possibly also on nearby ranges, though as with most *Powelliphanta*, its distribution is likely to be very patchy, for obscure reasons.

## ***Population***

Although the situation today is unknown, indications are that at least between the 1970s and 1990s, the number of live snails in most *Powelliphanta* “Haast” populations was high.

In 1968 I. Payton and J. Marston found 58 live snails when searching on the Thomas Range for 7 person hours (8.3 snails/person hour). In 1985 A. Ballance and W. Hutchison found 25 live snails on the northern end of the Mark Range, and in 1988 K.J. Walker and G.P. Elliot found 47 live snails, many of them juveniles, in a search of the same area taking 3 person hours (15.7 snails/person hour).

No more recent information on the size of populations of *Powelliphanta* “Haast” is available. It is classified as ‘range restricted’ by Hitchmough (2002).

## ***Threats***

In 1998, despite good numbers of live snails, the snail population on the Mark Range was clearly being affected by two introduced pests, thrush and deer. A high deer population had trampled and crushed a number of snails, and open areas on deer tracks were being used by thrushes as anvils to bash snails. Large numbers of snails had been killed by thrushes: of the 100 shells collected by Ballance and Hutchison in 1985, 86% were killed by thrushes and 5% crushed by deer; of 418 shells seen by Walker and Elliott in 1988, about 85% had been killed by thrushes. In 2001, 99% of 22 shells collected by P. Tisch on the Mark Range had also been killed by thrushes.

At first it was thought weka may have been responsible for some of these deaths, as many shells had a small neat hole in the apex. However, the hole was generally too small for a weka bill, weka have not been present in the area for many years and many of the shells were found clustered around anvils.

This is one of the few populations of *Powelliphanta* where thrushes are causing such devastation. Most of the other small fragile-shelled *Powelliphanta* live in subalpine scrub or alpine tussock where there is a dense protective cover of vegetation. The larger *Powelliphanta* species that inhabit lowland forest are vulnerable only as juveniles, and in fact are protected by the dense subcanopy layers usually found there. *Powelliphanta* “Haast” is the exception amongst small *Powelliphanta* in living primarily in simple open silver beech forest, where thrush numbers are higher and their opportunities for finding both snails and anvils is greater.

While it has been possible to recognise thrush and deer as threats to *Powelliphanta* “Haast” (it is not usually so clear), their impact on the snail population has not been measured, and snail population trends are unknown.

## ***Past Conservation Effort***

No effort towards conservation of this land snail has been made.

## ***Future Survey and Monitoring Needs***

**Moderate 1:** Establish at least twenty to forty 100 m<sup>2</sup> permanent plots in snail habitat on the Mark Range and monitor five-yearly to determine population trends.

**Moderate 2:** Survey snails on the Mataketake and Thomas Ranges, and collect enough shells to determine identity and threats to the snail’s survival.

**Moderate 3:** Survey and map the distribution of the snails on the Mark and Browning Ranges to estimate population size.

**Low 1:** Look for new snail colonies in other similar habitat on adjacent mountain ranges.

***Future Management Actions Needed***

Keep deer—and as a preventative measure, possum—numbers low in the snail habitat in the high-altitude silver beech forests of the Mark and Browning Ranges.

***Research Priorities***

Formally describe and name the Haast snails.

#### 4.18 *POWELLIPHANTA* “VITTATUS”

##### **Description**

*Powelliphanta* “vittatus” is a small undescribed snail first found in 1974 (Climo 1978) at Wolf River, near the mouth of Milford Sound, and so tag-named *Powelliphanta* “Wolf River” for some years. However, during the 1980s it was found on the Mackenzie Range well north of the original site and in the 1990s even further north on the Cascade Plateau and northern Haast Range. Recent correction of a mapping error has seen Wolf River renamed Professor Creek, rendering the tag name completely irrelevant. In its place a new tag name has been coined, *Powelliphanta* “vittatus”, referring to the longitudinal stripes which are the key standard feature of this snail, and one which distinguishes it from all other essentially unicoloured, southern *Powelliphanta* (*P. spedeni*, *P. fiordlandica* and *P. rossiana*).

Between populations of *Powelliphanta* “vittatus”, there are considerable differences in morphology.

The snails at Professor Creek and on the Mackenzie Range are small (maximum diameter 35 mm; height 18 mm) narrowly umbilicated, globose, and with an exerted spire. The shell colour is old gold, overlain on the dorsal surface with a faint reddish sheen, and with many dark brown to black irregular axial bands, particularly obvious on the base. It is finely sculptured from the periphery to the apex, giving the top half of the shell a dull, matt appearance.

The snails on the northern Haast Range are much larger (maximum diameter 40 mm; height 21 mm) with a rich red dorsal surface. There are numerous dark brown to black narrow axial bands conspicuous on both the top and bottom of the shell.

Snails on the Cascade Plateau are a rich red colour like those on the Haast Range, but are the same small adult size as those at Professor Creek.

Based on allozyme data from samples from Professor Creek, *Powelliphanta* “vittatus” was found to be genetically distinctive, requiring description as a new species within *Powelliphanta* (K.J. Walker, unpubl. data; Appendix 2). It grouped loosely with *P. rossiana* and *P. spedeni*, but was separated by at least one fixed difference from the former and three fixed differences from the latter (ibid.).

##### **Habitat**

*Powelliphanta* “vittatus” is predominantly a low- to mid-altitude forest-dweller, found under crown fern in rata/kamahahi forest, and under the fronds of prickly shield fern in tall silver beech forest. At Professor Creek it occurs at 100–200 m a.s.l.; on the edge of the Cascade Plateau at 350 m a.s.l.; at Duncan River at 800–900 m a.s.l., and on the Mackenzie Range at 990 m a.s.l. However, on the Haast Range it occurs from 50 m a.s.l. up to the bush line at 1100 m a.s.l., with individuals living in tussock grassland at 1450 m a.s.l., although the highest concentrations of snails occur at 50–500 m a.s.l.

All the known colonies are on soils derived from schists.

### ***Distribution***

Found in very small parts of the large area between Jackson's Bay and the mouth of Milford Sound in South Westland. At present known from only spot localities on the Mackenzie Range, the headwaters of Duncan River and on the northeastern edge of the Cascade Plateau, but somewhat more widely from the lower reaches of Professor Creek near Yates Point, and from the northwestern end of the Haast Range. *Powelliphanta* snails reported (I. Payton, pers. comm.) from the ridgetop of the southern Haast Range may also be this species.

### ***Population***

Little is known about the size of the population of *Powelliphanta* "vittatus" today. At Professor Creek snails were found at the rate of 2 snails/person hour in 1984 (2 snails, 20 shells, 1 person-hour search; R. Buckingham, pers. comm.), and in the same area in 1988 they were found at 3 snails/person hour (12 snails, 4 person hours search; K.J. Walker & G.P. Elliott, pers. obs.). Live snails have not been specifically searched for and have been seen only infrequently in the other known colonies, but judging from the number of empty shells, the populations appear to be of low to moderate density.

An estimate of population size must wait until better information is available on the extent of each of the known colonies. In the absence of population trend data *Powelliphanta* "vittatus" is classified as 'range restricted' by Hitchmough (2002).

### ***Threats***

Because of its small fragile shell and tall forest habitat, most populations of *Powelliphanta* "vittatus" seem to be suffering heavy predation by introduced thrushes, and occasionally by rats. At Professor Creek in 1984 few snails appeared to have died a natural death, with thrushes being apparently the main predator, though quite a few shells were also found crushed on deer tracks. Of 76 shells collected by C. Wickes and P. Van Klink in 2002 near Cascade Plateau, 97% were from snails that had been killed by thrushes.

### ***Past Conservation Effort***

No specific effort towards conservation of this snail has been made. However, the northern Haast Range population lies within the newly created Haast Kiwi Sanctuary and the snails there are likely to benefit from the increased vegetative cover resulting from regular possum and deer control.

### ***Future Survey and Monitoring Needs***

**High 1:** Systematic surveys are required to determine the extent of the known colonies, to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail's survival. At least ten 100 m<sup>2</sup> plots need to be established in each of the main snail colonies to determine snail density and population trends.

### ***Future Management Actions Needed***

**Moderate 1:** Keep deer and possums at low levels in the Professor Creek and Cascade Plateau snail colonies.

### ***Research Priorities***

**High 1:** Facilitate mtDNA studies of the genetic make-up of the morphologically distinctive populations of *Powelliphanta* "vittatus". Formally describe and name the species.

#### 4.19 *POWELLIPHANTA SPEDENI LATEUMBILICATA*

##### **Description**

*Powelliphanta spedeni lateumbilicata* is a small snail (maximum diameter 39 mm; height 25 mm) with a dark green glossy shell. It differs from its close relative *P. s. spedeni* in its less globose shape, more exerted spire, wider umbilicus, lack of dorsal striations and darker colour (Powell 1946). It also lacks any trace of the red sheen on the dorsal surface that is a feature of *P. s. spedeni* (Powell 1930).

##### **Habitat**

*Powelliphanta spedeni lateumbilicata* lives under the fronds of prickly shield fern in high-altitude silver beech forest; in alpine scrub; and also just above the bush line in tall, snow tussock. All the known colonies occur on soils formed on schist and sandstone-siltstone bedrock, at 910–1000 m a.s.l. where the humidity is high, with frequent cloud, mist and rain.

##### **Distribution**

So far known from only a few small areas on the Kaherekaou Mountains south of Lake Monowai, and from The Hump south of Lake Hauroko, on the boundaries between Fiordland National Park and Dean, Rowallan and Waitutu forests. On the basis of morphology and allozyme data, *Powelliphanta* snails on the north shore of Lake Monowai near Green Lake, formerly presumed to be *Powelliphanta spedeni lateumbilicata*, are likely to be *P. s. spedeni* but are included here until this can be confirmed.

##### **Population**

There is little information available on the size of the *Powelliphanta spedeni lateumbilicata* population. In the only known timed search for live snails, they were found at the rate of 12.7 snails/person hour near Green Lake in 1984 (19 snails, 1.5 person hour search; K.J. Walker & G.P. Elliott, pers. obs.), which indicated a dense population. However, this colony appeared to be very localised and, judging from the number of broken, empty shells visible, was suffering high levels of predation.

Only a few shells from spot-localities on The Hump and the Kaherekaou Mountains have been found, so population size there is unknown. In the absence of population trend data, *P. s. lateumbilicata* is classified as 'range restricted' by Hitchmough (2002).

##### **Threats**

Humans, deer and more particularly introduced thrushes are the main threats to *Powelliphanta spedeni lateumbilicata* at present. The Green Lake walking track cuts through a dense snail colony, and thrushes are taking advantage of the abundant exposed anvil stones to kill large numbers of snails. In 1984, 91% of 165 shells were from snails that had been killed by thrushes and 9% of the shells had been crushed, presumably trampled by people. In 2001, of 11 shells collected, eight were from thrush-killed snails and three were crushed, with hundreds of other broken shells visible in clusters on the track. Of 26 shells collected in 1992 from the Kaherekaou Mountains, 65% were from snails that had been killed by thrushes.

Better information on the size and extent of the snail population is required before the impact of predation by thrushes on the snail's long-term survival can be gauged.

### ***Past Conservation Effort***

No effort towards conservation of this land snail has been made.

### ***Future Survey and Monitoring Needs***

- High 1:** Systematic surveys are required to determine the extent of the known colonies, to locate other populations if they exist, and to determine, from examination of empty shells and habitat condition, threats to the snail's survival.
- Medium 2:** Establish about twenty 100 m<sup>2</sup> permanent plots within the snail's range and monitor annually for several years and thereafter less frequently, to determine population trends.

#### 4.20 *POWELLIPHANTA FIORDLANDICA*

##### **Description**

*Powelliphanta fiordlandica* is a small snail (maximum diameter 32 mm; height 16 mm) with a thin, fragile, weakly calcareous shell. The shell colour is olive, overlain on the top surface with rich reddish brown, fine spiral bands and axial stripes from the apex to the periphery. Over the whole shell there are occasional diffuse black axial streaks. The top half of the shell is finely sculptured and appears matt, while the base is very glossy. However, the most distinctive features of this snail are the loose shell coiling and very wide, open umbilicus, and the bright yellow slime—no other *Powelliphanta* have these characteristics.

Ever since this snail was first described in 1971, its placement in the genus *Powelliphanta* was queried (Climo 1971; Parkinson 1979), but no live material was available for proper anatomical or genetic study. This became available in 1988, and subsequent research found a very large genetic distance between the Fiordland snail and all other *Powelliphanta* (K.J. Walker, unpubl. data; Appendix 2). While placement of this snail into a new, as yet undescribed genus is indicated, it has not yet occurred.

##### **Habitat**

Found under ferns, logs and litter in low-altitude (60–80 m a.s.l.) forest of silver beech and miro, with kamahi and Hall's totara.

Also occurs from 400 m a.s.l. to just above the bush line at 640 m a.s.l. under litter in silver beech forest with occasional southern rata, Hall's totara, kamahi, *Archeria traversi* and mountain lancewood, and less commonly in mountain beech, leatherwood and turpentine scrub.

The snail habitat is on schist substrates, in an area which receives a high rainfall, year-round.

##### **Distribution**

*Powelliphanta fiordlandica* has a patchy distribution in the far southwestern corner of Fiordland. The type locality is the low, exposed southern end of Five Fingers Peninsula on Resolution Island, and snails also occur at low altitudes in at least one river valley on the main part of Resolution Island.

On the mainland between Dusky Sound and Chalky Inlet, at least four widely scattered colonies occur at mid to high altitudes.

##### **Population**

Only limited indications of possible population size are available. One live snail and more than 50 empty shells were seen during a casual search over a 3-km area on the main part of Resolution Island in 1987. An intensive search of 12 person hours yielded 19 live snails (13 of them juveniles), 11 eggs and 185 empty shells (up to 93% damaged by predators) near Chalky Inlet in 1988 (1.6 snails/person hour). In 1999, 3 live snails and 48 shells (94% of them damaged by predators) were found in an intensive search of 1.6 person hours (1.9 snails/person hour) over about 6 m<sup>2</sup> at the type locality.

The total area occupied by snails in each of the colonies is unknown, but indications are that the range is not extensive. For obscure reasons, most apparently suitable habitat between the colonies does not support snails. An accurate estimate of total population size is not yet possible.

*Powelliphanta fiordlandica* is classified as 'vulnerable' by Hitchmough (2002).

### ***Threats***

With weka absent from Resolution Island and in very low numbers or absent on the mainland, *Powelliphanta fiordlandica* has few natural predators—probably only South Island brown kiwi. The usual exotic predators of *Powelliphanta* are also either absent or rare in this species' habitat. However, despite apparently low thrush numbers, on the mainland they seem to be the main cause of snail death.

All land occupied by *P. fiordlandica* is protected within Fiordland National Park, but the snail's micro-habitat on the forest floor is degraded at all sites through high deer numbers. This decreased ground cover probably increases opportunities for thrushes to both find and kill *P. fiordlandica*.

### ***Past Conservation Effort***

Wellington deerstalker, Albie Frampton, located most of the mainland snail colonies in the early 1980s; during kiwi research, J. Jolly searched for snails on Resolution Island and B. Lloyd on the mainland in the late 1980s; K.J. and G.P. Elliott searched for snails on the mainland and examined the genetic make-up of the species in 1988; and R. Mason and B. Thomas investigated snail density at the type locality in 1999.

### ***Future Survey and Monitoring Needs***

- High 1:** Systematic surveys are required on Resolution Island and between Dusky Sound and Chalky Inlet to determine the extent of known colonies and to locate other populations if they exist.
- High 2:** Snail density-monitoring plots need to be established in several mainland colonies and on Resolution Island, and re\*measured two-yearly to determine population trends, and to more clearly identify threats.

### ***Research Priorities***

- High 1:** Seek confirmation that thrushes are the cause of the high levels of mortality apparent in most populations of *Powelliphanta fiordlandica*.
- High 2:** Review the taxonomic placement of *fiordlandica* snails within the genus *Powelliphanta*, and red scribe as appropriate. Examine the genetic basis for morphological and ecological differences observed between mainland and Resolution Island *P. fiordlandica*, and if required, split into separate taxa.

## 5. Research priorities

### 5.1 POPULATION BIOLOGY

To better predict long-term population changes of *Powelliphanta*, detailed population studies of representative lowland, upland and alpine taxa are needed. This will enable the construction of models of the relationships between snail density, predator density and levels of predator control.

The sort of information needed for each representative group includes:

- (a) Rates of recruitment, productivity and survival when exotic predators are absent.
- (b) The impact of a variety of predators on key *Powelliphanta* population parameters.
- (c) Whether there are any natural long-term fluctuations in population size, and their causes. Normal population density in the absence of exotic predators.
- (d) Food requirements and food supply within a range of *Powelliphanta* habitats.

To set realistic targets for snail abundance we need knowledge of the habitat's carrying capacity for snails, rates of population growth and natural population fluctuations. Such information can only come from detailed population studies.

### 5.2 IMPROVEMENT OF PEST CONTROL

- (a) Determine the optimum timing and intensity of possum control for *Powelliphanta* survival.

Incorporate the existing possum-control and snail-monitoring programmes into an integrated rigorous research-by-management experiment, designed to identify the appropriate frequency and intensity of possum control in a range of forest types.

The main requirements are that in a range of representative possum control operations there is maintenance of an agreed possum control regime, and regular measurement of possum and snail density and vegetation condition in the treated area and in a matching untreated area. Data needs to be collated from all these operations, and relationships between control type and frequency, possum and snail density and habitat factors assessed.

- (b) Design a rat- and hedgehog-proof fence.

A modified version of the Karori Refuge predator fence is required to keep rats and hedgehogs permanently out of small snail colonies surrounded by farmland, without the long-term use of poisons.

- (c) Design cost effective and humane pig control strategies for remote sites with relatively low pig densities.

Pigs are a major problem for many New Zealand land snails, including *Powelliphanta*, but they have large territories, are labour intensive to trap or hunt and are hard to poison without non-target bycatch and hunter opposition. A workable control strategy has yet to be devised.

- (d) Determine the impact that hedgehogs and thrushes are having on recruitment of lowland, upland and alpine species of *Powelliphanta*.
- (e) Identify the predators that cause the shell damage seen on many small species of alpine snails.

*Powelliphanta* species at and above the bush line have thin fragile shells that crush easily, and sign left by predators is difficult to interpret. Mice, possums, thrushes and hedgehogs are the only likely candidates, but the latter two species are probably rare in that environment. A number of alpine snail species are obviously suffering a high mortality from predators, but conservation remedies cannot be applied until the culprits are clearly identified.

- (f) Monitoring snail numbers is a key requirement for measuring the effectiveness of recovery efforts, but the main method of monitoring snails – plot census – has several uncertainties. Even though *Powelliphanta* snails are long-lived (12+ years) are there seasonal fluctuations in snail numbers? Do such fluctuations differ between lowland and upland snail species? Do snail monitoring plots need to be measured at the same time of year to avoid confounding results?
- (g) Assess the impact of common possum-control techniques on rodent populations. Do some possum control regimes increase the size of the rat population in the longer-term, thereby replacing one snail predator with another? What method and timing of possum control best protects snails from rats?
- (h) What are the factors that lead to high levels of snail predation by rats? In some coastal forests there are very low levels of rat predation, yet in other coastal and mid-altitude forests rat predation levels are very high. Likely factors are the rat species involved, vegetation type and availability of other food, and the densities of higher predators. Are there ways to manipulate the environment to limit the effect of rats, and are there some lowland mainland sites where snails (and other invertebrates) are secure from rats, even without pest management?

### 5.3 CONSERVATION STATUS

Carry out:

- (a) publication of the 1995 revision of *Powelliphanta* taxonomy;
- (b) more detailed genetic examination of the relationships and status of the forms, subspecies and undescribed taxa within the North Islands' *Powelliphanta traversi* - *marchanti* complex;

- (c) research into the genetic basis behind the conspicuous morphological differences in red and yellow forms of *Powelliphanta hochstetteri anatokiensis*; yellow-based and brown-based forms of *P. b. hochstetteri*; D'Urville Island and mainland populations of *P. b. obscura*, and in the three forms of *P. gilliesi jamesoni*;
- (d) formal description of the 21 newly discovered or still undescribed *Powelliphanta* taxa of Gunner River, Haidinger, Heaphy, Parapara, Maungaharuru, Buller River, Wolf River, Mt Fox, Haast, Matakītaki, Matiri, Garabaldi, Baton, Kirwans Hill, Nelson Lakes, Owen, Lodestone, Anatoki Range, Goulard Range, Egmont and Urewera.

The urgency and priority of *Powelliphanta* recovery actions depends on the distinctiveness of each taxon: the availability of a widely accepted taxonomy is crucial in ensuring that the right snails are targeted and in gaining public and Departmental acceptance of the need for conservation resources to be utilised.

## 6. Acknowledgements

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