Recovery plans for *Powelliphanta* land snails

2003–2013

THREATENED SPECIES RECOVERY PLAN 49

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Illustrations

Front cover: *Powelliphanta lignaria lignaria*. Photograph by Rod Morris.
Back cover: Variety of *Powelliphanta* species. Photograph by Gideon Climo.
Cartoon p. vii: Andrew Jeffs
Line drawing p. ix: *Powelliphanta superba mouatae* by Pauline Morse

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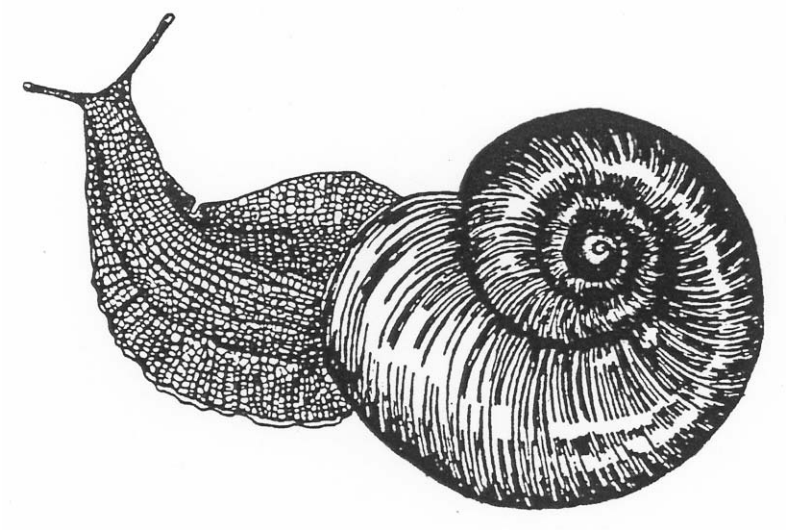
NOTES ABOUT THE ILLUSTRATIONS:

(i) Species distribution maps: solid red dots represent sites from which shells have recently been collected; red stippling represents the known or reliably presumed range of the taxon.

(ii) Shells selected for photographs represent the range of morphological characteristics within each taxon. Broken shells were used when no intact empty shells could be found. The scale indicates the size of both the profiles and the bird's-eye views of the shells in each photograph.



Abstract

This is the first edition of recovery plans for the many species and subspecies of *Powelliphanta*—a genus of threatened large land snails. The plans support a 20-year vision or goal: to maintain the diversity of *Powelliphanta* in the New Zealand landscape by restoring representative populations of each subspecies to an ecologically viable and humanly visible size by the year 2023. Each plan, however, recommends actions for the next 10 years.

Though quantitative information on the density of *Powelliphanta* before European settlement is scarce, live snails (and shells) of many lowland and upland *Powelliphanta* species are much rarer now than they were 20 years ago.

Our knowledge of the ecology of these snails is limited, but because their shells leave a record of the cause of death, it is overwhelmingly clear that the main causes of mortality in all populations today are human induced.

Powelliphanta are declining primarily because introduced brushtail possums (Appendix 1), ship rats, pigs and, less frequently, thrushes and hedgehogs prey on eggs, juveniles and adults of *Powelliphanta* year round. More catastrophically, but nowadays less frequently, *Powelliphanta* are declining as their forest and tussock grassland habitats are destroyed.

To enable the populations of *Powelliphanta* to recover, possums, ship rats and pigs need to be reduced to very low numbers in the immediate future, but it is not yet clear whether this strategy on its own would be sufficient to restore the worst-affected populations. Nor is it clear whether pulsed, rather than continuous, pest control would be sufficient.

Because many populations are now at very low levels and study of the group began only recently, this plan takes the approach of simultaneously applying existing knowledge to management recommendations while undertaking research to increase what we know about snail recovery. Major themes are: obtaining accurate data on current population trends; establishing long-term legal protection for the remaining snail habitat; excluding stock and predators from small accessible snail colonies by fencing; determining optimum possum-control regimes, and facilitating a wider participation in the conservation of *Powelliphanta* by the dissemination of information. The inclusion in this plan of a distribution map and snail shell identification photograph for each subspecies is the first step in the latter process.

1. Background

1.1 INTRODUCTION

Long isolation, a rugged, dissected topography, subtropical – subantarctic climatic conditions and the absence of mammalian predators gave rise to a fantastic radiation in the land snail fauna of New Zealand. In addition to about 1500 species of pinhead-sized, mostly vegetarian snails, several groups of giant carnivorous snails evolved. Originally grouped in the New Zealand family *Paryphantidae* and lumped as the genus *Paryphanta*, they were separated by Climo (1977) into two genera, *Paryphanta* and *Powelliphanta*, and placed in the southern Gondwanian family *Rhytididae*. Both *Paryphanta* and *Powelliphanta* are endemic to New Zealand, with the monotypic genus *Paryphanta* found north of Auckland, and the large genus *Powelliphanta* (at least 21 species and 51 subspecies) occurring from East Cape to Fiordland (Plate 1).

Powelliphanta landsnails have fascinated people since they were first discovered. For most people, the beauty of their shining, colourful shells is the main attraction (and, until collecting the shells was made illegal in 1982, it was nearly a fatal attraction for the snails). Though the shell patterns vary greatly between species, most are delicately marked with numerous, variable bands in a myriad of shades of red, brown, yellow and black. The shell is usually very glossy. Some species are impressively large, such as the fist-sized, golden-shelled, *P. superba prouseorum*, which weighs as much as a tui. However, their lifestyle and biogeography are what excite admiration from others. '*Powelliphanta snails with their polymorphism and large size represent the pinnacle of evolution of this distinctively Gondwanian land snail family. Powelliphanta snails are an evolutionary acme in snail carnivory and are just as significant as the equivalent bizarre peak of ornithological development that is the kiwi*' (Climo 1986).

Because of the wide divergence of *Powelliphanta* from other Gondwanian land snails, it is thought that the ancestors of *Powelliphanta* were on the proto 'New Zealand' land mass at the breakup of Gondwanaland, 80 million years ago (mya)—along with ancestral tuatara, kiwi and moa. However, most of this land mass was under the oceans during the warm Oligocene period (30 mya), and it is likely that most of the ancestors of existing *Powelliphanta* species arose after the sea levels dropped during the Miocene period (5–20 mya). Genetic data point to today's species originating from the small, cold-adapted '*rossiana*'-like snail of tussock grasslands which presumably predominated during the repeated advances and retreats of glacial ice during the Pleistocene (2 000 000–10 000 years ago).

Today, *Powelliphanta* are found in both the North and South Islands. The greatest diversity of species is in the mountains of North West Nelson, though *Powelliphanta* are conspicuously absent from the central, most glaciated parts of that region.

Despite the wide geographic spread of *Powelliphanta*, many New Zealanders have never seen a *Powelliphanta* snail as most species occupy relatively small, discrete areas. In addition, many species are separated from other populations by forest habitat which, for obscure reasons, does not support snails at all.

Powelliphanta are poorly represented in New Zealand's fossil record, presumably because their shells crush and disintegrate easily under pressure. However, there is evidence that *Powelliphanta* once had a wider distribution. Small, flattened subfossil shells like those of *P. rossiana* have been found in significant numbers in thin gravel

layers about 1 m under pakihi peat bogs in at least six sites in North Westland (K.J. Walker, unpubl. data). Shells of larger *Powelliphanta* have been found in peat bogs in Paekakariki and Wallaceville near Wellington, and in cave deposits at Paturau (North West Nelson), the Wairarapa and in inland Hawkes Bay (Dell 1955) (Fig. 1).

Many populations of extant species of *Powelliphanta* have been lost in the last 150 years, as humans removed much of New Zealand's natural vegetation cover. Documented losses are populations formerly on Stephens Island, at French Pass and on Gordons Knob near Nelson, and by the East Cape lighthouse (Plate 1).

1.2 HOW MANY SPECIES ARE THERE?

Most of the larger *Powelliphanta* were described in a long series of papers by A.W.B. Powell (1930, 1932, 1936, 1938, 1946, 1947, 1949, 1961), after whom the genus was named (Climo 1977). Despite several 'lumping' efforts (Climo 1978; Parkinson 1979), Powell's nomenclature of 41 taxa (9 species, 34 subspecies, 4 forms) remains in common use.

Between 1970 and 1999, a further 20 taxa were discovered, including several very large snails. The recent discovery of such conspicuous animals was not the result of a revision and splitting of known taxa, but rather of better exploration of remote mountainous regions with dense ground covers of scrub and tussock (Climo 1971; Parkinson 1974; Walker 1982b; K.J. Walker, unpubl. data).

The early taxonomy of *Powelliphanta* was based mostly on shell characteristics (shape, size, colour, pattern and parietal callus texture). Powell counted the number of teeth on the radula, though tooth count did not seem to separate groups of *Powelliphanta* usefully.

Walker used allozymes in the early 1990s—in conjunction with foot colour and texture, slime and mantle colour, ecological niche and traditional shell morphology—to review the taxonomy of the group, including the more recently discovered but still undescribed taxa. The allozyme data supported most of Powell's original taxonomy, but revealed most of the newly discovered taxa to be more genetically distinctive than the better known snails (K.J. Walker, unpubl. data; Appendix 2). This research is unpublished, but a draft revised taxonomy using the results was produced in 1995 (K.J. Walker, unpubl. data; Appendix 3). Since that time, this proposed taxonomy has provided the basis for decisions about conservation management and for recovery planning by the Department of Conservation.

Publication of the new taxonomy remains a high priority to ensure that the recovery plan actions are properly targeted.

1.3 THE BIOLOGY AND ECOLOGY OF *POWELLIPHANTA*

There have been few systematic studies of the biology of *Powelliphanta*. A MSc study by Devine (1997) briefly examined aspects of density, movements, water uptake and predation of *P. traversi*. A wide variety of *Powelliphanta* species were reared in captivity by K.J. Walker and G.P. Elliott (unpubl. data) between 1986 and 1988 and diet, growth and reproduction were studied. They also investigated density, movements, predation levels and growth of a small sample of *P. lignaria johnstoni* on the West Coast between 1984 and 2002.

From unpublished research carried out by K.J. Walker between 1980 and 2002, it seems that *Powelliphanta* are long-lived; the average life span is about 12–14 years and some individuals live up to 20 years. Fecundity is apparently low. *Powelliphanta* are hermaphrodites, and can either self-fertilise or store sperm for long periods. They lay hard-shelled limy eggs during spring (October to December).

The eggs are large relative to the size of the snails—up to 29% of the maximum diameter of the adult shell in *P. spedeni* (O'Connor 1945). The eggs are laid in clusters of two or three in moist spots in moss or damp litter, and hatch after 2–6 months of development (K.J. Walker, pers. obs.). Shell growth is most rapid in the first 3–4 years, then continues more slowly. In colonies subjected to summer drought, annual growth checks can be seen in adult snails as axial ridges of thickened shell. Once growth has slowed it is difficult to judge a snail's age, except in some *P. gilliesi* subspecies in which the last whorl gradually drops and the aperture opening narrows until it is very difficult for the snail to emerge.

Sexual maturity is reached at about 5–6 years. Annual egg production appears to be c. 5–10 eggs, and no more than 20. Almost nothing is known of hatchling survival rate and recruitment. There are probably enough data on numbers of live snails and empty shells of *P. lignaria johnstoni*, collected from annual measurements at monitoring plots, to model its adult survival accurately, but for most species plots have not been re-measured frequently enough for this calculation.

Powelliphanta require a moist environment, and to conserve water they are largely nocturnal. In dry conditions they cease to feed or move (Devine 1997). Most large-sized species live in native forest and scrub, and shelter during the day under large logs, in moss or in litter. At least 10 species live under the skirts of tall tussock in alpine grasslands at, and occasionally well above, the bush line. Most of the alpine species spend up to 5 months of the year under snow and are obviously able to withstand below-freezing conditions.

Most information on *Powelliphanta* biology comes from studies of *P. lignaria johnstoni* and *P. traversi traversi*, both small to medium-sized lowland species. Growth rates and other parameters are likely to be substantially different for high-altitude species, and perhaps also for the very large subspecies of *P. superba* and *P. hochstetteri*. *Powelliphanta superba superba* lives sympatrically with many *P. gilliesi* snails and, on Parapara Peak in Golden Bay, all three species occur together. Presumably there are significant differences in diet and behaviour which enable these species to co-exist.

1.4. ARE *POWELLIPHANTA* POPULATIONS DECLINING?

According to the IUCN system of ranking species, several *Powelliphanta* taxa would be classified as 'endangered', the majority of taxa would be classified 'threatened' and a small number considered naturally rare. However, documented evidence of the decline of *Powelliphanta* populations is not easy to find.

Unlike the plentiful information on formerly widespread and conspicuous animals such as moa and kakapo, there are few even anecdotal accounts of the prehistoric abundance of *Powelliphanta*. Washbourne describes seeing the large native land snails *'… 4 inches across …'* (probably *P. superba mouatae* or *P. s. richardsoni*) lying *'like periwinkles on a mudflat'* when fire burnt their tussock habitat on the Gouland Downs, North West Nelson in 1863 (Washbourne 1933).

Declining numbers of snails were noted by A.W.B. Powell on the Horowhenua Plains in the 1930s and 1940s (1946). He described subspecies of *P. traversi* variously as *'doomed to destruction'* and *'all but exterminated'*, and the *'chances of survival'* [of several colonies and subspecies] as *'slender'*.

However, some *P. traversi* snails were present in healthy numbers during that period. In 1946 Powell collected and removed 250 adult *P. traversi latizona*, apparently with ease, from Greenaways Bush near Levin in a 'species drift experiment'. He was also able to examine 'about a hundred examples' of *P. superba prouseorum*, and an 'extensive series' of *P. s. mouatae* for taxonomic study.

Both the Auckland Institute and Museum, and the National Museum of New Zealand, house large collections of perfect, live-collected *Powelliphanta* shells that date from this era. Such large numbers of intact shells, let alone easily collected live snails (particularly *P. superba* subspecies), no longer exist in the wild.

In the late 1970s, large numbers of empty, damaged shells were conspicuous throughout the ranges of many upland taxa, and researchers found only small numbers of live snails. By 2000, even empty, broken shells were infrequently seen; declines in shell numbers of 50–90% were standard, and intensive searches indicated extremely low densities of live snails.

The first quantification of the population declines came from a study in North Westland between 1984 and 1993. The density of live snails in this study averaged about 100 snails/500 m^2 until possums started eating snails there in 1987. Predation caused the snail population to drop by 50% in one year, and the population continued to decline until only four animals remained by 1993 (K.J. Walker, unpubl. data).

There have been profound changes in the New Zealand environment since human contact, and most of the changes have been highly detrimental to large, slow, nocturnal, localised taxa such as *Powelliphanta*. Whether the snails can survive without assistance in the long term in the new landscape, albeit in much lower numbers, is unclear.

1.5 CAUSES OF SNAIL DECLINE

1.5.1 Habitat Destruction

The most obvious and direct cause of decline in populations of *Powelliphanta* was loss of their habitat. Almost all *Powelliphanta* have naturally small, localised distributions and specific habitat requirements. The wave of habitat destruction that swept over New Zealand in the 1800s and 1900s substantially reduced the range and size of each snail population that it touched.

The lowland species *P. traversi* and *P. gilliesi* were the snails most affected by the spread of pastoralism in the late 1800s, but more recent habitat destruction has been brought about by forest logging and the establishment of exotic forestry plantations in the higher-altitude habitats of *P. lignaria* and *P. hochstetteri* (until the 1990s). Burning, topdressing and over sowing of the tussock grassland habitat of *P. spedeni* in Southland continues.

Much of the remaining habitat has become drier and less suitable for land snails through drainage of nearby farmland (e.g. the habitat of *P. traversi* on the Horowhenua Plains) and by rooting, browsing and trampling by domestic cattle, feral pigs, goats and deer.

1.5.2 Predators

1.5.2.1 Native predators

Large, slow-moving *Powelliphanta* must always have been desirable prey. The main predators of land snails prior to human arrival were probably all ground-dwelling, strong-billed birds—though tuatara probably ate some eggs and juvenile *Powelliphanta*, tuatara were probably not common in the high, wet and cold environment favoured by many *Powelliphanta*.

The most important predator probably was (and still is) the weka which was widespread, crepuscular and mostly carnivorous.

The extinct adzebill had a massive, heavy, pointed bill which may have been used to smash snail shells open, and the extinct New Zealand crow also had a stout bill. However, there are some indications that both birds preferred open (or coastal) sites and were not common in the habitat of many *Powelliphanta* species. Moreover, like the extant takahe, the adzebill may have been primarily a herbivore (Gill & Martinson 1991).

Three species of moa lived in the wet forests favoured by *Powelliphanta*. Though capable of swallowing *Powelliphanta*, they were primarily vegetarians and probably not very abundant (ibid).

The extinct New Zealand owlet-nightjar and the extant kiwi are both flightless nocturnal insectivores, and probably ate eggs and juvenile *Powelliphanta* whole and occasionally found an adult snail outside its shell. However, the nightjar's bill was too small, and the kiwi's is too specialised, to smash open the large shells of *Powelliphanta*. The once widespread piopio often fed on the ground, hopping about like a blackbird, and may have occasionally eaten the eggs or juveniles of *Powelliphanta* species.

1.5.2.2 New exotic predators

The situation changed dramatically when humans arrived and introduced predatory mammals capable of eating large numbers of adult snails, not just juveniles. Most of the birds that had preyed upon *Powelliphanta* were exterminated by the new arrivals. They were replaced by a suite of far more destructive predators of snails: rats, pigs, hedgehogs and brushtail possum. Unlike the avian predators that found food largely by sight, the new arrivals hunted by smell and had strong specialised teeth for tearing flesh and biting open or crushing even very large adult snail shells. Once in New Zealand, the population densities of these new predators exploded.

According to recent archaeological evidence, kiore (*Rattus exulans*) may have preceded the other invaders by as many as 1600 years, and certainly at least 400 years. Though kiore were removed in the 1890s from most of New Zealand by later-arriving rodents and mustelids, they had probably already profoundly affected *Powelliphanta* numbers. Kiore are smaller than ship or Norway rats (*R. rattus* and *R. norvegicus*, respectively), but are capable of eating even large *Powelliphanta*. Kiore are the only rat present in the upland forest of D'Urville Island today, and large, rat-damaged *P. hochstetteri obscura* shells are regularly seen there (Buckingham & Elliott 1979; K.J. Walker, pers. obs.).

When kiore first reached New Zealand, they lived in all types of forest and grassland from sea level to the bush line at more than 1300 m a.s.l. (Atkinson & Moller 1990), and during years of heavy beech or tussock seeding, their numbers reached plague proportions (Meeson 1885; Best 1942). For the 400–1600 years in which kiore were the sole exotic mammal in New Zealand, it seems likely that the populations of *Powelliphanta* plummeted, in conjunction with the better known crashes in numbers of reptiles, sea birds and land birds.

Since 1900, rats have been virtually absent from forests and grasslands above about 800 m a.s.l. (Innes 1990), and the many species of *Powelliphanta* that are confined to high altitudes were free of most exotic predators for 60–70 years until possums arrived. From 1900 the ship rat had become dominant in New Zealand forests but, in conjunction with mice and stoats, they excluded kiore from most forests and alpine grasslands, they seemed unable to breed at high altitudes themselves except during warm winters (R.H. Taylor, pers. comm.). Mice continue to be present on the tops, but they are probably too small to eat heavy-shelled *Powelliphanta*, though juvenile *P. rossiana* may be at risk.

Today, lowland snails are eaten primarily by ship and Norway rats, hedgehogs, song thrushes and, in some places, possums. Upland snails are eaten mostly by possums, pigs and thrushes. Weka have disappeared from North Island snail habitats, but are still common and regularly prey on snails in the Marlborough Sounds and North Westland.

Although the introduced thrush is a specialist predator of snails—picking a snail up in its bill and smashing it against a rock or wood anvil—thrushes are able to kill only juveniles of many *Powelliphanta* species. The shells of most adult *Powelliphanta superba, P. hochstetteri, P. gilliesi, P. marchanti* and *P. traversi* are too large and heavy for thrushes to lift. However, thrushes kill large numbers of juvenile snails of these species, with piles of over 60 shells a common sight around favoured thrush anvils. In addition, thrushes can kill all age classes of the alpine species of *Powelliphanta* (e.g. *P. rossiana* and *P. fiordlandica*), as such species attain only small adult sizes. Rats, possums and pigs eat all sizes and ages of even the largest species of *Powelliphanta*.

While pigs are particularly effective snail predators and habitat modifiers, as well as competitors (earthworms are the major food of both species), some snail habitat appears to be too cold, wet and infertile for pig occupation. Ship rats too seem to be limited to warmer sites. The most devastating predator is relatively new: possums have apparently only recently learnt how to open snail shells, or only lately been driven to it by declining plant food resources.

Possum-damaged shells first appeared in the 1970s and at first were only found in snail colonies in high altitude beech forests in North West Nelson. As this pattern bore no resemblance to the distribution or abundance of possums, throughout the 1970s and 1980s possums were not recognized as the cause of the damaged shells. Finally, in 1992, trials were carried out in which live *Powelliphanta* snails were given to snail-wise possums (those captured in forest where damaged shells were common). Almost all possums in the trial readily killed and ate any snails offered, and in doing so, damaged the snail shell in the characteristic fashion (K.J. Walker, unpubl. data). Snail predation by possums gradually spread to more snail colonies throughout the 1990s. The snail-eating behaviour of possums seems to be learnt, and there are now several places where possums on one side of a large river are killing snails, while those on the other bank are not, despite apparently similar forest type and condition and snail and possum densities (K.J. Walker, unpubl. data).

Possums occupy all habitats of *Powelliphanta*, can reach high population densities, and can have major impacts on snail populations—an individual possum can eat 60 adult *Powelliphanta* over one or two nights (K.J. Walker, pers. obs.). Particularly in infertile or heavily browsed forest (where alternative possum foods are scarce), snails have apparently become an important food item, worth seeking even when snail (and possum) numbers are very low (K.J. Walker, pers. obs.).

1.6 ARE TRANSLOCATIONS A SOLUTION TO SNAIL DECLINE?

Translocation to a pest-free island has become an accepted tool for the management of endangered fauna in New Zealand, and is frequently suggested as an option for large land snail recovery attempts. However, the majority of translocations thus far have been re-introductions of birds to sites within their (usually large) natural range. Because birds are conspicuous and mobile, it has been relatively easy to keep records of such transfers, to reverse them when necessary, and to find appropriate refuge sites without compromising the distinctiveness of New Zealand's regions.

By contrast, translocation of *Powelliphanta* land snails is fraught with problems. On a purely practical level, too few islands with suitable habitat are available for the large number of threatened snails. A more serious issue however, is the loss of biogeographic information that would occur if snails were to be translocated. The combination of New Zealand's long and varied biogeographic past and the sedentary habits of *Powelliphanta* has caused an extraordinary radiation within the genus. In addition to the 63 taxa described in this plan, there are hundreds of distinctive populations, each one isolated on a mountain top or across a river and continuing the process of gradual speciation.

Although the relationships between *Powelliphanta hochstetteri* and *P. traversi* have been invoked as proof of Cook Strait land bridges (Te Punga 1953), most of the patterns of speciation in *Powelliphanta* remain a large, unexplored potential source of valuable information about New Zealand's biogeographic history. The translocating of snails

would meddle with those patterns before they are properly mapped, or even understood, and would throw away much of what we value in *Powelliphanta*.

Perversely, there seem few technical barriers to *Powelliphanta* translocations, with at least seven successful translocations having already been effected (Appendix 4). Although the snails in each have survived and presumably multiplied, the information about all but two of the transfers has not survived, illustrating the dangers of such actions.

The translocation of *Powelliphanta* should only occur within the known former range of any particular population and this, unfortunately, restricts its application to a very small number of taxa.

1.7 CURRENT CONSERVATION STATUS

Largely circumstantial evidence suggests that the densities of most extant populations of *Powelliphanta* are lower than they were when Europeans settled in New Zealand. The decline in snail numbers probably started at least 500 years earlier than European settlement, when the first Polynesian voyagers left kiore in New Zealand.

Observations over the last 20 years indicate reductions in the range and/or density of many upland species including all *P. superba* subspecies, *P. hochstetteri obscura*, *P. hochstetteri bicolor* and *P. hochstetteri consobrina*, and *P. lignaria rotella* and *P. lignaria johnstoni* (K.J. Walker, pers. obs.).

At the same time, several tiny remnant populations of lowland species, considered by A.W.B. Powell in the 1940s to be on the verge of extinction, are still extant.

It is possible that, because an individual snail seems to need less than 1000 m^2 (judging from the maximum movements of marked snails) and can live a long time, *Powelliphanta* can persist indefinitely, even at very low densities. However, since most species are confined to single areas, any management strategy based on that possibility would be too risky, and determining the density below which the species could not recover would take too long.

In the absence of information on the sustainability of today's impoverished snail populations, recovery plans, and conservation action — to halt continuing declines and to restore *Powelliphanta* as functioning and obvious components of their ecosystems— are required for many *Powelliphanta* taxa. A separate brief plan has been prepared for each taxon, as the conservation status and management requirements among *Powelliphanta* vary.

2. *Powelliphanta* recovery plan scope, goal and issues

This plan is intended to guide the *Powelliphanta* Recovery Group for the next 10 years and to outline a recovery vision for 2023, when the Long-term Goal (below) must be reviewed. The plan identifies research needs and provides an overall framework for the recovery of *Powelliphanta*. Recommendations from the *Powelliphanta* Recovery Group will be used to update the plan throughout its operating period.

LONG-TERM GOAL

To maintain the diversity of *Powelliphanta* land snails in the New Zealand landscape by restoring representative populations of each taxa to an ecologically viable and humanly visible size by the year 2023.

The goal is focused on 'representative' populations, in recognition of the fact that it is the high levels of biodiversity in this group, not just the charms of individual animals, that we are seeking to retain. It also allows that the conservation task is large, and that some populations may need to be left to fend for themselves.

By selecting a population size of 'humanly visible', we avoid the problems associated with not knowing what population size is ecologically viable, while being clear that part of the justification for spending conservation resources on giant snails lies in the public being able to see these fantastic creatures easily.

A glance at the map showing the distribution of *Powelliphanta* in New Zealand (Plate 1) plus the knowledge possum, pig or rat control is the main requirement for snail recovery at most of those sites, and the large scale of this goal becomes clear. However, while this plan advocates chiefly for *Powelliphanta*, forest communities as a whole will benefit from the application of the intensive pest-mammal control advocated here.

Three key uncertainties of this plan are:

1. Whether population declines in the possum-affected subspecies of *P. superba, P. hochstetteri, P. lignaria* and *P. gilliesi* can be reversed solely by possum control. There is some evidence that these snails have become functionally extinct, with snails now too sparsely distributed to meet and breed.

2. Whether predation by possums, even in areas with trap catch rates (RTC, residual trap catch) lower than 1%, exceeds snail productivity. It may be that eradication of possums, rather than just control, is required.

3. Whether current pest-mammal control for the protection of *Powelliphanta* is sustainable for the next 20–50 years—financially, biologically and politically—especially without more certainty as to its efficacy.

In addition, there are a number of more general issues, some of which have possible remedial actions that are apparent.

ISSUE 1

The size and diversity of the genus is both a plus and a minus in a conservation sense. *Powelliphanta* have a complex biogeographical pattern which can be of value in interpreting New Zealand's past and in understanding the speciation process in general. However, the size of the group makes focus difficult, and conservation of all its parts seem an overwhelming proposition.

The concentration of the diversity in North West Nelson generates a huge workload for several DOC area offices (15 *Powelliphanta* taxa in the Buller Area and 17 in Golden Bay) most with serious conservation problems.

Actions

Fund additional specialist staff in both the Buller and Golden Bay Area Offices of the Department of Conservation to coordinate and carry out recovery actions for *Powelliphanta*.

ISSUE 2

The relationship between possums, the forest environment and snail predation is complex: snails in lowland forest with high possum numbers are generally not preyed on by possums; snails on limestone soils are preyed on by possums, but snail numbers remain moderate, and snails in infertile or high-altitude forest suffer high rates of predation by possums and their populations crash.

Since 1994, substantial funds for possum control have been available for biodiversity protection (and tuberculosis, TB, control) and possum control for snail protection is underway. However, there is a lack of knowledge of the necessary timing and intensity of such control.

Actions

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.

ISSUE 3

Are *Powelliphanta* threatened with extinction, or just with becoming very rare? We need detailed information on population dynamics of a range of taxa so that we can model their survival prospects at very low densities.

Actions

Undertake detailed population studies on a range of *Powelliphanta* taxa.

ISSUE 4

Though large and handsome, *Powelliphanta* are surprisingly little known, both in New Zealand and abroad. Lack of general knowledge of the group, even within the Department of Conservation, makes conservation difficult and lessens the chances of obtaining funds for the required long-term pest control.

Actions

Distribute *Powelliphanta* distribution maps and identification guides widely in the Department of Conservation, and identification guides and generalised maps to the public. Promote public interest and involvement in the conservation of *Powelliphanta* by ensuring good public access to robust snail populations and freely distributing information about *Powelliphanta* projects. Support and encourage partnerships between DOC and other like-minded groups that are prepared to work for snail conservation.

ISSUE 5

There are many uncertainties about the most effective ways to manage *Powelliphanta* for the next 20 years, especially in the very large (> 10 000 ha) remote forest blocks with small and widely scattered populations of snails.

The ecology of *Powelliphanta* at the individual, population or community level is not well understood, and neither are the details of management techniques and strategies.

Actions

Undertake key research to underpin sustainable management. Research topics are detailed in the work plans and in Section 5.

3. The recovery plans

In this section a short account of each threatened *Powelliphanta* taxon is given, using the standard format prescribed for all Department of Conservation recovery plans (Brown & Molloy 1999). Because so many species require conservation attention, the taxa in each Department of Conservation Area are prioritised according to threat and a summary of recommended recovery actions given in Appendix 5.

For most taxa, little is known of the current rate of decline. As this is essential information, used to determine the urgency of recovery actions, the establishment of monitoring plots and several years of annual or biennial re-measurement is suggested for most taxa. While monitoring alone does not effect any recovery, and in fact consumes substantial recovery resources, the examination of fresh empty shells in monitoring plots provides valuable quantifiable information on the causes as well as the rates of snail decline.

In many instances the options for recovery actions are limited until the causes of decline are better understood. Research into the nature of and solutions to the decline of *Powelliphanta* is best done centrally, as most problems are common to many taxa. For this reason, general research topics are listed in Section 5.0 rather than within individual taxon accounts.

Various target densities for populations have been recommended as long-term goals within the plans, the target densities differing largely with species, but also with situation. Those species living sympatrically with other *Powelliphanta* species are presumed to occur naturally at lower densities than otherwise.

The average densities achieved by populations of *P. gilliesi subfusca* and *P. gilliesi kahurangica* where pests were absent or controlled were used as target densities for other coastal small *P. gilliesi* snails. Likewise, the average densities in populations of *P. hochstetteri hochstetteri* and *P. marchanti* when exotic predators were scarce were used as a guide to the former densities of large snails in montane beech forest. A few relatively pest-free populations of *P. lignaria lignaria, P. l. lusca* and *P. l. unicolorata* provided a guide for the target densities for all subspecies of *P. lignaria*.

Included in each recovery plan is a photograph illustrating the range of morphological variation within the taxon, as well as a map showing the taxon's distribution. On the maps, red stippling represents the known or reliably presumed range of the taxon, while solid red dots represent sites from where shells have recently been collected. Details of these collection sites are listed in the *Powelliphanta* database at the Department of Conservation, Nelson, where most of the shell collections are stored.

3.1 *POWELLIPHANTA MARCHANTI*

Description

At the type locality near the Mokai Patea Trig on the Ruahine Ranges, *Powelliphanta. marchanti* is a medium-sized snail (maximum diameter 54 mm; height 30 mm) with a yellowish brown to old-gold coloured shell. The dorsal surface and periphery are very sparsely lined with spirals of darker brown (Powell 1979).

Several other large *Powelliphanta* found in the ranges north and west of the Ruahines in the 1960s and 1970s were described by Powell as *P. marchanti* in his 1979 publication, on the basis of rather cursory examination of single specimens from each locality. More information on the snails on Mt Egmont, on Mt Manuoha in the Urewera National Park and on the Maungaharuru Range in Hawkes Bay, was gathered in the 1980s and 1990s, including a genetic profile of each. It became clear that these more recently discovered snails were distinctive taxa which should not be included in *P. marchanti*.

Powelliphanta from the southern Kaimanawa Ranges are similar in appearance to typical *P. marchanti*, but are always smaller (maximum diameter 52 mm). Snails from the Kaweka Ranges are small (maximum diameter 50 mm; height 22 mm) and plain gold in colour with no banding and may be better considered a subspecies of *P. marchanti*. However, the genetic make-up of the Kaweka and Kaimanawa snails have yet to be examined, and in the meantime they are considered within this Recovery Plan as important populations within *P. marchanti*.

Habitat

An upland species (1000–1470 m a.s.l.), found under bush rice grass and litter in red beech/mountain cedar forest at Ruahine Corner, under leatherwood/inaka scrub in the southern Ruahine Ranges and under the skirts of tall tussock in montane grasslands. Particularly common on limestone scarps and plateaux.

Found under litter in manuka and mountain beech forest in the Kaimanawa and Kaweka Ranges.

Distribution

In the western Ruahine Ranges, particularly in the northwest Ruahines on the Mangaohane limestone plateau and its surrounding limestone scarps (Potae – Makirikiri Ridge, Ohutu Ridge, Aorangi) and on the Mokai Patea and Otupae Ranges. However, also found in apparently localised populations in scrub and tussock above 1000 m a.s.l. on the Hikurangi, Whanahuia and Ngamoko Ranges to the west of the main Ruahines, and very patchily on the main Ruahine Ranges ridge line as far south as Takapari.

In the southern Kaimanawa Ranges, close beside the Rangitikei River from its junction with the Mangamaire River to its junction with Otamateanui Stream, and in the Otamateanui catchment.

In the Kaweka Ranges, in the headwaters of Kiwi Creek and Rocks Ahead Stream.

Cause Of Decline And Threats

1. Intense predation by possums from at least the mid-1970s until the early 1990s in the Ruahine Ranges population, and since the 1980s in most of the Kaimanawa Ranges populations (in 2000 there was still 120 ha with no possum-damaged shells and high snail numbers).

2. Deterioration of the snail's micro-habitat through: fire and stock grazing prior to 1960 in the Mangaohane Plateau; fires, stocking and consequent erosion on the Mokai – Patea Range; and deer browse in the Kaweka, Kaimanawa and Ruahine Ranges.

Past Conservation Efforts

1. Possum control (aerially delivered 1080) over a wide area in the northwest Ruahine Corner – Lake Colensoi area in 1994 to protect both the special vegetation and the snail population. The possum population has recovered gradually since then (5.3% RTC in May 1999; 13% RTC in 2002). Since 1995 possum numbers along the Potae ridge line have been controlled through regular (bimonthly) re-stocking of bait stations along the Potae Track with the poison Pest-off.

2. Snail density was monitored in three 500 m^2 plots near Ruahine Corner in 1994 and one of these was re-measured each year between 1997 and 1999.

3. A 500 m^2 plot established in the Kaimanawa population in 1994 was re-measured in 1997 and a second plot set up in 1998.

4. A survey of the distribution and density of the Kaimanawa Ranges snail population was undertaken in 1997/98 (Husheer 1998).

5. In 2000 thirty-nine 10 m^2 plots were set up at 100 m intervals on transects through 250 ha on the true left of the Rangitikei River, Kaimanawa Ranges. A further thirty-two 50 m^2 plots were established in a non-treatment block on the true right of the river.

6. In 1999/2000 several ground-based possum-control operations reduced densities from about 20% RTC to less than 1% RTC in the 250 ha treatment area in the southern Kaimanawa Ranges.

Current Conservation Status

In the northwest Ruahine Ranges *Powelliphanta marchanti* is in moderate to high numbers (9.8 snails/100 m^2) and has a comparatively large range, but is dependent on on-going possum control and the maintenance of snail habitat in the privately-owned tussocklands. The status of the widely scattered snail populations of the southern Ruahines is unknown, but many of the shells had been damaged by possums, and snail density away from the calcium-rich soils of Ruahine Corner appear to be lower.

Probably due to the reduced and degraded nature of the Kaweka Forest, the population of *P. marchanti* there is now very limited in extent. However, there is no sign of predation on the snails by possums, and snail densities are apparently moderate (4 live snails/person hour in 2000; C. Ward, pers. comm.).

Powelliphanta marchanti is restricted to only a small part of the southern Kaimanawa Ranges and predation by possums has brought the numbers very low (0.6 snails/100 m^2) over at least 85% of its range. However, in the remaining area unaffected by possums, snail densities are still moderate (5.6 snails/100 m^2).

Powelliphanta marchanti is ranked in 'serious decline' by Hitchmough (2002).

Long-term Recovery Goal

Dense (> 12 snails/100 m^2) snail populations that are stable or increasing and representative of the full range of genetic and morphological diversity in *Powelliphanta marchanti*.

Objectives For The Next 10 Years

Objective One

Increase the size of the snail populations in the Ruahine and Kaimanawa Ranges by sustained predator control.

Explanation

Possums are the main cause of mortality for snails in both the Kaimanawa and Ruahine populations, but there is no sign of predation by possums in the Kaweka population.

Possum damage on northwest Ruahine snail shells was obvious in the mid-1970s, but it may have started much earlier: the possum-induced collapse of rata/ kamahi forest in the southern Ruahines began as early as 1947. On the other hand, the northern forests are much less favourable to possums than the southern Ruahine forest so possum numbers were probably always lower further north. By the mid-1980s, 88% of shells found at Ruahine Corner, and 90% of shells found on the Whanahuia Range, were from snails killed by possums. However, in 1994, the first live snail monitoring at Ruahine Corner found moderate to high snail densities (6–12 snails/100 m^2), presumably because *Powelliphanta* numbers in the wet forests on calcium-rich soils had been particularly high to begin with. Unfortunately, despite possum control, snail density steadily declined through the 1990s to only 3.1 snails/100 m^2 in 2002.

By contrast, the density of *Powelliphanta marchanti* on the greywacke soils of the Kaimanawa Ranges may never have been particularly high. A few possum-damaged snail shells were first noted in a 1981/82 New Zealand Forest Service survey (Whiteford 1983), and then through the 1990s hundreds and hundreds of possum-eaten shells were obvious. Live snail density when first measured at one site in 1994 was extremely low (0.8 snails/100 m^2). However, extensive and intensive snail-density monitoring around the Rangitikei – Otamateanui River junction in 2000 found a few areas still unaffected by possums. For example, although all 16 snail plots on the left bank of the Rangitikei had abundant possum-damaged snail shells and few live snails (113 broken shells, 9 live snails, a density of 0.6 snails/100 m^2), away from the Otamateanui Stream and on the right bank of the Rangitikei River, no possum-damaged shells and 67 live snails were found in only 12 plots (5.6 snails/100 m^2).

Although the vegetation is uniform beech forest throughout, and possums reached an eruptive peak in the Kaimanawa Ranges some time in the 1960s (C. Speedy, pers. comm.), snail-eating behaviour has taken more than 20 years to spread through the possum population. The physical barrier of the Rangitikei River may have slowed the spread, as the very large Karamea River did in a similar landscape at Karamea Bend, North West Nelson, thereby providing protection for a population of *P. lignaria oconnori*.

Once snail densities are very low, recovery of the population is extremely difficult, so it is vital that possums are controlled in the small remaining stronghold of *Powelliphanta* in the Kaimanawa Ranges.

Though possums are not eating Kaweka *Powelliphanta*, they have the potential to do so. Given this, it is a sensible precaution to keep possum numbers so low that those present do not face food shortages (and learn to eat snails), or cause deleterious changes to the forest itself.

Actions Required

1. In the southern Kaimanawa possum-control area (for *P. marchanti*), reduce possum abundance to under 1% RTC on all trap lines for the next 5 years. Monitor RTC annually, using at least five trap lines in snail areas affected and unaffected by possums. Aim to retain snail densities of 5.6 snails/100 m^2 in the northern treatment area and to reach this snail density in the southern block by 2012. Releaser snail plots at five-yearly intervals to determine the success of the management regime.

2. Review the possum control regime in the Potae – Makiriri snail colonies. Aim to keep possum numbers steadily below 3% RTC, preferably less than 1% RTC. Extend the snail-monitoring programme to include six to ten more 100 m^2 plots, scattered more widely over the snail area. Ensure that all snail monitoring teams have an experienced leader to avoid compromising results through confusion between *Wainuia* and *Powelliphanta* in the plots.

Objective Two

Determine population trends and conservation status of the Kaweka and southern Ruahine Ranges populations of *P. marchanti*.

Actions Required

1. Survey the extent of snail colonies in the southern and central Ruahines, on Mokai Patea Ridge, Otupae Ridge and in the Mangaohane tussocklands; and also in the Kaweka Ranges.

2. Establish five to ten 100 m^2 snail-density plots in each representative area across the snail's range and monitor snail numbers regularly to determine population size and trends and major causes of mortality.

Objective Three

Improve quality of snail habitat.

Explanation

Deer (mostly red) reach high numbers around the fertile, free-draining, limestone scarps at Ruahine Corner, and deer (mostly sika) are also in high numbers in both the Kaimanawa and the Kaweka Ranges. The dry and open understorey created by deer reduces the ground moisture essential for snail survival and recruitment, and makes it easier for thrushes to prey on the snails.

Actions Required

Keep deer populations throughout the range of *P. marchanti* at low levels.

Objective Four

Determine the variability within *P. marchanti*.

Explanation

In setting priorities and determining the urgency of actions to recover populations of *P. marchanti*, we must know the intraspecific variation that we are seeking to protect. On morphological characteristics the Kaweka snails are distinctive, and to a lesser extent, so are the Kaimanawa snails. The poorly known southern Ruahine Range snails are distant from the main population at Ruahine Corner, and their taxonomic status also needs examination.

Actions Required

1. Seek funds to compare the genetic profile of snails from the southern Ruahines to that of snails from the central Ruahines, and of snails from the Kaimanawa and Kaweka Ranges to that of *Powelliphanta* snails from Ruahine Corner and elsewhere.

2. The current taxonomy of *P. marchanti* includes genetically and morphologically distinctive snails from Mt Taranaki and Urewera. If appropriate, revise the taxonomy of *P. marchanti*.

Responsibilities

Ruahine Ranges: Palmerston North Area Office; Wanganui Conservancy.

Kaimanawa Ranges: Turangi/Taupo Area Office; Tongariro Conservancy.

Kaweka Ranges: Hawkes Bay Area Office; East Coast/Hawkes Bay Conservancy.

3.2 *POWELLIPHANTA* "MAUNGAHARURU"

Description

A small to medium-sized snail (maximum diameter 47 mm; height 23 mm) with burnished brown and tan spiral bands, of variable shade and width, covering the dorsal surface, and irregular brown axial stripes over the ventral surface. The background colour of the shell is olive to old gold, and the parietal callus is smooth and grey.

Habitat

Lives under the dense matt of fronds of prickly shield fern in high-altitude (1100 m a.s.l.) mist forest of mountain holly and kapuka. The trees are festooned with moss, and there is a tangled shrub understorey of weeping matipo, mountain wineberry and *Coprosma parviflora*.

The snails also occur under litter in damp gullies of red beech forest at slightly lower elevations (800–1000 m a.s.l.). The snail habitat lies on the calcium-rich talus slope of a great limestone scarp.

Distribution

Apparently only extant on the east-northeast slopes of Taraponui, which is the highest point on the limestone scarp of the Maungaharuru Range, in inland Hawkes Bay. Subfossil remains of *Powelliphanta* found in limestone caves near Patoka (Dell 1955), about 25 km from Taraponui, may be evidence of a much wider former distribution. However, the cave shell fragments are too small and weathered to identify to species.

The snails on Taraponui were discovered relatively recently (1961) and it is possible that other colonies still remain to be found elsewhere in the high country of northern Hawkes Bay. However, as apparently suitable forests immediately adjacent to Taraponui seem to be without *Powelliphanta* snails, the chances of finding colonies further afield seem somewhat remote.

The total known forest area now occupied by *Powelliphanta* "Maungaharuru" is about 80 ha, with about 8 ha within the privately-owned Taraponui holly forest remnants, and the remaining 72 ha in Cashes Bush, a Department of Conservation-administered Scenic Reserve.

Cause of Decline, and Threats

1. Loss of most of the forest clothing the Maungaharuru Range to fires, logging and then pasture creation.

2. On-going degradation and desiccation of the remaining forest habitat by the trampling and browsing of feral goats and deer and, in the holly forest remnants until the mid-1990s, by domestic stock. Feral pigs are damaging the lower parts of Cashes Bush.

3. Predation by rats, thrushes, hedgehogs and pigs in the lower, drier parts of the snail's range.

Past Conservation Efforts

1. A 500 m^2 snail-monitoring plot was established in one of the high-altitude remnants of holly forest in 1995 and re*measured in 1998 and 2000. A second 500 m^2 plot was established in Cashes Bush in 2000.

2. A 1-day survey for snails in the main bush remnants near Taraponui was carried out by six people in 1995.

3. About 1994, two of the holly forest remnants were protected through a covenant with the private landowner, and domestic stock fenced out of these remnants in 1995.

Current Conservation Status

Powelliphanta "Maungaharuru" is affected by rats, thrushes, pigs and probably hedgehogs, but compared to many other *Powelliphanta*, has a moderate density (6 snails/100 m^2). However, the total snail population is small and the habitat fragmented and degraded, with the taxon very vulnerable to normal stochastic events such as droughts and fires. *Powelliphanta* "Maungaharuru" is ranked as 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A healthy self-sustaining population (> 12 snails/100 m^2) in at least 300 ha over most of its presumed former range, and with most of the forest patches that support snails linked to each other.

Objectives For The Next 10 Years

Objective One

Increase the size of the *Powelliphanta* "Maungaharuru" population by increasing the quality and amount of snail habitat.

Explanation

The major cause of the vulnerable status of *Powelliphanta* "Maungaharuru" is the loss of habitat and the fragmented and degraded nature of some of the remnant forest.

The fertile Maungaharuru Range has only limited cover for feral goats and deer so, despite the stock fences, the remnant patches of snail bush are used as shelter by goats and deer far more frequently than would usually be the case. Deer control is difficult around Taraponui as the land is privately owned and deer are not seen as important pests by the owners. However, goat control on private land since 1990 over much of the Maungaharuru Range has brought goat numbers generally much lower now than they were previously.

At present, deer and pigs are not controlled in the publicly-owned Cashes Bush Scenic Reserve, although possums and occasionally goats are—the Reserve has not been a high conservation priority and it is acting as an important 'partial-treatment' area for the Boundary Stream Mainland Island.

Though probably difficult to achieve, Crown purchase of the three forest remnants known to have snails, in addition to the land between these sites and the land between Cashes Bush and the remnants, is highly desirable. A revegetation programme could be implemented to link the fragmented populations, and Crown ownership would allow for adequate wild animal control to improve the quality of the habitat for snails and for the natural vegetation.

Actions Required

1. Negotiate with the private owners of the Taraponui holly forest remnants for permission for the Department of Conservation to keep goat and deer numbers low in the immediate vicinity of the Taraponui snail colonies.

2. Bid for funds within the Department of Conservation to regularly control pigs, goats, deer and possums in Cashes Bush and, if allowed, in the snail colonies on adjacent private land.

3. Discuss with landowners strategies to enlarge, link and protect currently fragmented snail habitat, including Crown purchase and revegetation of habitat south of Cashes Bush.

Objective Two

Accurately determine the distribution of *Powelliphanta* "Maungaharuru", and the total population size.

Explanation

It is important to know whether other *Powelliphanta* "Maungaharuru" colonies exist, because a larger total population spread throughout different physical environments could alter recovery priorities significantly.

Our knowledge of the distribution of *Powelliphanta* "Maungaharuru" comes entirely from botanists systematically searching amidst native vegetation fragments on calcareous rock for rare plants. The first record came from A.P. Druce, who deposited a snail shell at the National Museum where it remained unremarked and labeled '*Powelliphanta marchanti*' for 28 years until two more botanists (Geoff Rogers and Geoff Walls) 'rediscovered' the colony on 12/4/89.

There was a focused 1-day search for snails in 1995 in the immediate vicinity of Taraponui, but the search area needs to be expanded. The characteristics of the known snail habitat need to be taken into account when selecting further areas to search. The micro-habitat on Taraponui is quite rare in Hawkes Bay, being a combination of great height and geology — the former causing Taraponui to catch and retain cloud and the latter providing a limestone substrate (*Powelliphanta* distribution is significantly correlated with that of limestone).

Highly localised colonies of *Powelliphanta* occur to the south on the Kaweka Ranges and to the north on Mt Manuoha, in Urewera National Park (the snails are similar to, but distinctive from *Powelliphanta* "Maungahaururu"), so any further colonies of *Powelliphanta* 'Maungaharuru' can exist only in the Mohaka River catchment.

Actions Required

1. Check the forest below the known colony on Taraponui (V19/320-225) and at Ahuateatua (V19/323-218 and V19/324-208) for snails.

2. Select possible snail habitat on high forest country west of the Mohaka River and gradually carry out systematic searches of the areas most likely to harbour snails.

Objective Three

Determine population trends and the impact of introduced predators.

Explanation

Too little information is currently available to determine whether the population of *Powelliphanta* "Maungaharuru" is stable or is declining through the impact of introduced predators and competitors. This knowledge is essential in forming and prioritising any snail recovery actions.

Regular re-measurement of live snails in the permanently marked plots, and collection and examination of empty shells from them, will provide data for population density, population trends and the identification of predators.

Actions Required

1. Establish five more 100 m^2 plots randomly within the snail habitat in Cashes Bush.

2. Releaser all the snail plots two-yearly for the next 5 years.

Objective Four

Determine the taxonomic status of *Powelliphanta* "Maungaharuru".

Actions Required

Facilitate mtDNA study of *Powelliphanta* "Maungaharuru" and its relationship with other *Powelliphanta* in the *marchanti – traversi* series. If appropriate, name and describe the Maungaharuru snail.

Responsibility

Hawkes Bay Area Office, East Coast/Hawkes Bay Conservancy.

3.3 *POWELLIPHANTA TRAVERSI TRAVERSI*

Description

A medium-sized snail (maximum diameter of shell 54 mm; height 27 mm) with a smooth, purplish grey parietal callus. The ground colour of the shell is a warm, yellowish brown, and narrow spiral bands of darker brown line the base.

Habitat

Under leaf litter in swampy lowland forests dominated by pukatea, kahikatea and maire tawaki, and on drier soils under tawa, kohekohe, karaka and totara.

Distribution

The original distribution of this snail was naturally small, probably occurring over less than 4000 ha on the narrow strip of deep moist soils on the Horowhenua Plains. To the west are dunes, too sandy and free-draining for snails, and separated by raupo and flax swamps which were too wet for snails; in the east the Tararua Ranges rise steeply and the habitat is unsuitable for snails.

Unfortunately, the best snail habitat was also the best soil for cultivation, and *Powelliphanta traversi traversi* is today restricted to the northeastern shores of Lake Papaitonga, the Waiopehu Scenic Reserve and a few fragments of trees in and around Levin city (a total area of about 40 ha).

Cause of Decline, and Threats

1. Loss of most of the snail's forest habitat is the major cause of decline. The magnificent lowland forests of the Horowhenua remained intact for a much longer period after European arrival than did most forests. However, though felling of the forest did not begin until 1887, clearance was extremely rapid and comprehensive, leaving virtually no trees by 1900.

2. Most of the fragments of original forest are now protected in reserves, but clearing is still a threat to the unprotected trees; about 1997, tiny Parks Bush in Levin was sold and turned into a restaurant carpark. Less dramatically, the snail habitat at other sites is continuing to degrade because the litter layer is drying out and forest regeneration is prevented through intensive human use, stock trampling and drainage ditches on neighbouring land.

3. Predation by introduced pests, particularly rats, but also hedgehogs and thrushes, remains a threat.

Past Conservation Efforts

1. At Papaitonga, possum numbers have been kept low since 1994 through bi-monthly poisoning with Talon in bait stations on trees around the perimeter of the forest and in fifty 50 m transects across the area. The bait stations were lowered in 1997 to make sure rats could easily access them.

   A 500 m^2 snail density-monitoring plot established at Papaitonga by DOC in 1994 found 29 live snails (5.8 snails/100 m^2). A MSc study was carried out at Papaitonga between 1995 and 1996 on aspects of the biology of *Powelliphanta traversi*, which included further density measurements. Seventeen 100 m^2 plots representing the full range of snail habitat were searched, and a mean live snail

density of 2.8 snails/100 m^2 was found (Devine 1997). The population of *P. t. traversi* at Papaitonga (which has about 95% of the remaining good habitat) was estimated to be about 10,000 individuals (Devine 1997).

2. At Waiopehu Scenic Reserve Conservation Corp workers trapped rats quarterly on a transect along the Reserve's southern perimeter, from 1991 to 1993, to protect the land snails. One 500 m^2 plot and two 25 m^2 plots established in 2001 contained 2.4 snails/100 m^2.

Current Conservation Status

Powelliphanta traversi traversi is ranked as 'nationally endangered' by Hitchmough (2002). The main colony at Papaitonga has only moderate snail densities (2–8 snails/100 m^2) partly because rats were found to be taking up to 25% of live adult snails annually (Devine 1997). Much of the remaining habitat of this snail is threatened: the Waiopehu Scenic Reserve and Prouses Reserve are, or are becoming, surrounded by houses—which bring land drainage and intense foot traffic. Even Papaitonga may be drying out through excessive ground water take (Park 1995).

Long-term Recovery Goal

A dense (> 12 snails/100 m^2) population of *Powelliphanta traversi traversi* that is stable or increasing, in at least two secure sites.

Objectives For The Next 10 Years

Objective One

Protect and restore quality of the habitat of *Powelliphanta traversi traversi*.

Actions Required

1. Encourage local councils to make definite foot tracks in both Waiopehu and Prouses Reserves and to discourage human use outside those tracks by construction of bicycle-deterring bars and by planting thick protective swathes of appropriate native species (seeds sourced from inside each Reserve) adjacent to the tracks.

2. Seek listings (Statement of Wildlife Values) of each Reserve in the District Scheme; contest further ground water take from around the Reserves and from between the Reserves and the Tararua Ranges, any new drainage ditches below the Reserves, and further subdivision around Waiopehu Scenic Reserve.

3. Remove the weed wandering willy from Prouses Reserve (taking care to find and relocate any snails sheltering among it) to allow forest regeneration. Attempt eradication of wandering willy from the margins of Papaitonga Scenic Reserve.

4. Seek funds to purchase, exclude stock by fencing and reforest the land on the west and south side of Lake Papaitonga and immediately adjacent to the existing forest.

Objective Two

Improve snail survival by sustained predator control at Papaitonga Scenic Reserve.

Explanation

Though possums at Papaitonga are not killing snails, they have the potential to do so. Given this, it is a sensible precaution to keep possum numbers so low that those present do not face food shortages (and learn to eat snails), or cause deleterious changes to the forest itself.

It would be desirable in the long term to fence rats, possums and hedgehogs out of Papaitonga rather than use poisons in perpetuity at this sacred and valuable site, but this is probably viable only if the whole lake is fenced and therefore depends on the now pastured south and west shore-line being turned into a reserve.

Actions Required

1. Keep rat and possum numbers steadily low (< 1% RTC for rats and < 5% RTC for possums). Rotate control methods, generally avoiding the use of accumulative anticoagulant poisons, such as Talon, and the use of the same acute poison on consecutive occasions. Use traps instead of poisons at regular intervals. When possible, use poisons and bait-station designs which kill both species equally well (1080, Feracol). Monitor rat and possum densities annually (before control operations).

2. Permanently mark at least ten new 100 m^2 plots throughout the range of habitat of *P. t. traversi* at Papaitonga. Measure live snail density in these and the existing 500 m^2 plot annually in winter for 2 or 3 years until a good understanding of the impact of the possum control on rat numbers, and of the rat control itself, is obtained; thereafter monitor less frequently.

Objective Three

Maintain diversity of *P. t. traversi*.

Explanation

It is important to have at least two populations of any taxon to make it less vulnerable to catastrophic events such as fire. Waiopehu Scenic Reserve has the only other colony of this snail with any hope of long-term survival, so conservation attention here, as well as Papaitonga, would be desirable. However, pest management at this site is complicated by the high public use, increasing residential use of the land nearby and the fact that it is under Horowhenua District Council, rather than Department of Conservation, control. In addition, the site may never have been prime habitat, and its relative dryness has been greatly increased over the last century as the headwaters of the Koputaroa Stream, which flows through the Reserve, has been progressively channeled and has had water extracted from it. Before investing too much into this site, the status of its snail population should be assessed.

Actions Required

1. Survey the distribution of snails and the impact of snail predators within Waiopehu Reserve.

2. In winter, measure snail density in six to eight 100 m^2 permanent plots placed randomly within the best snail habitat at Waiopehu.

3. If recovery and long-term survival of the snail population at Waiopehu looks feasible, discuss with the council administering Waiopehu the possibility of the Department of Conservation assuming management responsibility.

4. Investigate the option of erecting a possum-, rat- and hedgehog-proof fence around the Reserve for long-term predator control that does not rely on poisoning and trapping in this built-up area.

5. If a predator-proof fence is not possible even in the medium term, undertake a regime of regular pest control and monitoring of snail density, as outlined for Papaitonga.

Responsibility

Kapiti Area Office, Wellington Conservancy.

3.4 *POWELLIPHANTA TRAVERSI FLORIDA*

Description

A medium-sized snail (maximum diameter 54 mm; height 27 mm). The top surface of the dark reddish-brown shell is closely spirally lined and banded in darker brown, with the base almost completely dark brown (Powell 1979).

Habitat

Under litter in podocarp/hardwood forest.

Distribution

Probably once covered an area of less than 4000 ha beside the Ohau River on the Horowhenua Plains, just south of Levin. Because of forest clearance, this snail is confined to less than 100 ha in three small remnants of forest at: Forest Reserve (immediately adjacent to the Tararua Ranges forest), in Kimberly Scenic Reserve and in the southeast corner of Lake Papaitonga, where it is contiguous with a population of *Powelliphanta traversi traversi*.

Cause of Decline, and Threats

1. The main causes of decline were destruction of probably 90% of the snail's forest habitat, and predation by rats, thrushes and hedgehogs.

2. The main threat is now low survival because of predation by introduced pests.

Past Conservation Efforts

1. About 1991 the Department of Conservation fenced the western boundary of Forest Reserve to keep stock from trampling the understorey.

2. Intermittent possum control in Forest Reserve by Horowhenua District Council (for TB control) and the Department of Conservation (as part of a measure to protect the vegetation of the Tararua Ranges).

3. At Papaitonga Reserve, possum and rat control by the Department of Conservation, as described in the *Powelliphanta traversi traversi* plan. A 500 m^2 plot was set up in 1997 to measure snail density.

Current Conservation Status

Because of the small total area it now occupies (probably about 100 ha), low snail density (0.8 snails/100 m^2) and on-going uncertainty of the snail's ability to survive in the long term in the presence of exotic pests, *Powelliphanta traversi florida* was ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A dense (> 12 snails/100 m^2) population of *Powelliphanta traversi florida* that is stable or increasing, in at least two secure sites.

Objectives For The Next 10 Years

Objective One

Determine population trends.

Actions Required

1. Survey the distribution of *Powelliphanta traversi florida* in Forest Reserve.

2. Measure snail density through establishment of ten to fifteen 100 m^2 permanent plots randomly located within the snail's range in Forest Reserve, and at least five more plots in Kimberly Scenic Reserve. Releaser live snail density and mortality annually each winter for at least 4 years to assess population trends, and to obtain quantitative data on the impact of pests on the population.

Objective Two

Increase population size by sustained pest control.

Actions Required

1. Continue the work started in 1994 at Papaitonga to control rats and possums and to monitor snail and pest densities, as described in the plan for *P. t. traversi*.

2. If population monitoring of the Forest Reserve snail population indicates a continuing decline due to rats, instigate an annual rodent-control programme on the same lines as that at Papaitonga.

   It is important to maintain a good snail population at Forest Reserve as it is the largest remaining colony of *P. t. florida*, and its ecosystem has the best chance of long-term survival. The site is closer to the wet Tararua Ranges, and the soils are less prone to drying out, than are the free-draining river terraces of Kimberly Reserve. In addition, the geographic position of Forest Reserve makes it less vulnerable than other colonies to close residential settlement (which exacerbates pest and weed problems and reduces conservation management options).

3. Ensure possum numbers are kept below 5% RTC at both Forest Reserve and Kimberly Scenic Reserve.

Responsibility

Kapiti Area Office, Wellington Conservancy.

3.5 *POWELLIPHANTA TRAVERSI LATIZONA*

Description

A small to medium-sized snail (maximum diameter 44 mm; height 26 mm) with a dull, purplish grey smooth callus (Powell 1949). The background colour of the shell is yellowish-olive to old-gold, distantly but rather strongly spirally banded and lined in dark reddish-brown (Powell 1979).

As with all *Powelliphanta* in the Horowhenua area, the taxonomy of this snail has had a chequered history. It was first described as a subspecies of *P. traversi* (Powell 1949), then as a 'form' of *P. t. traversi* (Powell 1979). However, recent genetic examination has shown it to be more closely aligned to the upland *Powelliphanta* of the Tararua and Ruahine Ranges than to the lowland snails around Levin, and to be distinctive enough for at least subspecific status.

Habitat

Under fern fronds and litter in tawa/kamahi forest, and under the tree fern wheki on the margins of lowland rain forest.

Distribution

Powelliphanta traversi florida is endemic to the eastern flanks of the mid Arapaepae Range, on the foothills of the Tararua Ranges behind Levin. The snail is now confined to three forest remnants covering less than 45 ha on the Arapaepae Range. The largest area, traditionally known in its totality as Greenaways Bush is partly privately owned (the western end), with the remainder being in the Makahika Scientific Reserve. Two much smaller areas of snail habitat, Bentons Bush and Kohitere Covenant, are native forest remnants within the Kohitere Pine Plantation, just south of Greenaways Bush.

Cause of Decline, and Threats

1. Most of this snail's forest habitat was logged and burnt about 1900, and converted to pasture or exotic pine plantations.

2. In the remaining forest, introduced rats are a major threat and account for 50–80% of all adult snail deaths. Hedgehogs and thrushes prey on juvenile snails and, until recently, cattle trampling was a threat to snails on the edge of Greenaways Bush.

Past Conservation Efforts

1. The type locality at Greenaways Bush was purchased by the Department of Conservation in the 1990s and is now the Makahika Scientific Reserve. As a result of the land exchange agreement by which Makahika was purchased, the previous owner fenced the eastern boundary of the new Reserve to exclude stock.

2. The native forest remnants in Kohitere Pine Plantation were protected by conservation covenants in the 1990s.

3. Two 400 m^2 plots to monitor snail population trends were established by the Department of Conservation in 1996 (one in Makahika Reserve and one in Kohitere Covenant) and in 1997 a third 400 m^2 plot was established in Bentons Bush. In addition, in 1996 a student sampled five 100 m^2 plots in Makahika Reserve to determine snail density and the impact of predators on *Powelliphanta traversi latizona* (Devine 1997).

4. Since about 1997 the Department of Conservation has kept possum numbers low at Makahika Reserve through placement of poison (Talon) in bait stations along transects 500 m apart, every two months to begin with (as possum density was high—about 20% RTC), and latterly every 4 months.

5. Rats in Makahika Reserve have been targeted for control since 1998, when possum bait stations were lowered to ensure that rats could access them.

Current Conservation Status

Population density is low to moderate (3 snails/100 m^2) with an estimated total population of 10 000 individuals (Devine 1997). Most of the habitat is now legally protected, and pest control is regularly undertaken in the best habitat. However, the range of the snail is very small, and population trends are unknown: it remains a vulnerable subspecies. *Powelliphanta traversi florida* was ranked as 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A dense (12 snails/100 m^2) population that is stable or increasing, in at least 100 ha of protected habitat.

Objectives For The Next 10 Years

Objective One

Determine population trends.

Actions Required

Establish at least five new 100 m^2 plots within the snail habitat at Makahika Reserve, and measure these and the existing three 400 m^2 plots every winter until population trends are clear.

Objective Two

Increase population size through enhanced survival by sustained pest control.

Explanation

Though possums are not killing *Powelliphanta traversi latizona* snails, they have the potential to do so. Given this, it is a sensible precaution to keep possum numbers so low that they do not suffer food shortages (and learn to eat snails), or cause deleterious changes to the forest.

Actions Required

1. Keep rat and possum numbers low (< 1% tracking rate for rats and < 5% RTC for possums). Rotate control methods, generally avoiding the use of accumulative anticoagulant poisons, such as brodificoum, and the use of the same acute poison on consecutive occasions. Use traps instead of poisons at regular intervals. When possible, use poisons and bait stations which kill both species equally well (1080 and Feracol).

2. Use standard tracking and trapping methods to monitor rat and possum numbers annually, prior to control operations. Regularly monitor snail numbers within the permanent plots to assess the impact of the pest control regime.

Objective Three

Determine the taxonomic status of *P. t. latizona*.

Actions Required

1. Facilitate research into the genetic distinctiveness of *P. t. latizona* using DNA techniques.

2. If appropriate, revise taxonomy.

Objective Four

Increase area of snail habitat.

Actions Required

1. Negotiate with the private owner of the western end of Greenaways Bush to obtain legal protection of the snail habitat (either through purchase by the Crown or establishment of a covenant). Alternatively, seek a management agreement to enable the Department of Conservation to undertake pest control.

2. Begin negotiations to purchase and restore native forest on the pine plantation land around the bush remnants of Kohitere Covenant and Bensons Bush, and between them and Greenaways Bush. The aim is not just to increase the available habitat, but also to allow gene flow between the isolated subpopulations.

Responsibility

Kapiti Area Office, Wellington Conservancy.

3.6 *POWELLIPHANTA TRAVERSI TARARUAENSIS*

Description

A medium-sized snail (maximum diameter 53 mm; height 25 mm) with an olive-green coloured shell, tinged with russet brown on the top, with fine pale brown spiral lines and a few more distinct lines about the periphery. The parietal callus is smooth and grey.

Habitat

A mid-altitude snail found at 460–610 m a.s.l., particularly on flat areas where seepages are common and fertile alluvial soils and litter have accumulated. *Powelliphanta traversi tararuaensis* lives under litter and bush rice grass in rimu/miro forest with tawa, rewarewa and pigeonwood, and under low scrubby vegetation of the tree fern wheki where the forest has been logged.

Distribution

Powelliphanta traversi tararuaensis formerly occupied most of the basin in the headwaters of Kahuterawa Stream on the northern and northeastern slopes of Kaihinu, a low, western outlier of the northern Tararua Ranges.

There is a second, rather distinctive population further south in another perched basin informally known as 'Shannon Heights', on the saddle between the north- flowing Mangaore Stream and the south-flowing Makahika Stream (on the same outlier range of the Tararua Ranges).

The distribution of *P. t. tararuaensis* within the two basins is now small and fragmentary because most of the snail's forest habitat has been cleared and transformed into pasture or pine plantation.

Cause of Decline, and Threats

1. The major cause of decline is the loss of probably 80% of the forest habitat of *P. t. tararuaensis* to pasture and pine plantations.

2. Predation by rats, pigs, thrushes and probably hedgehogs, and trampling by domestic cattle, are contributing to an on-going decline.

3. The main threat today is the continuing fragmentation, degradation by stock and loss of the tiny remnants of remaining snail habitat.

Past Conservation Efforts

No efforts have yet been made towards conservation of this snail.

Current Conservation Status

Almost none of this snail's small remaining area of habitat is legally protected and, through gradual development of fields and forestry plantations, and road widening, the area is certain to shrink further. Population density and trends in the face of exotic predators are unknown: *Powelliphanta traversi tararuaensis* was ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

Dense (> 12 snails/100 m^2) snail populations that are stable or increasing, in at least 100 ha of secure habitat at both Shannon Heights and Kaihinu.

Objectives For The Next 10 Years

Objective One

Determine distribution and population size and trends.

Actions Required

1. Use timed shell searches and collections on transects to more accurately define the boundaries of the distribution of *Powelliphanta traversi tararuaensis* at both Shannon Heights and Kaihinu.

2. Establish ten to fifteen 100 m^2 snail-monitoring plots across the range of the snail at both Kaihinu and Shannon Heights. Measure live snail density in these plots annually until population trends and the main causes of mortality are clear.

Objective Two

Obtain long-term legal and physical protection for the habitat of *P. t. tararuaensis*.

Actions Required

1. Urgently seek Crown purchase or establish conservation covenants over all unprotected snail habitat, including transfer of road reserves to conservation-focused reserves, and protection of adequate buffer zones beside pine plantations to prevent further losses during logging.

2. Where practicable, purchase corridors of former snail habitat and encourage forest regeneration or start a revegetation programme to link the remaining fragmented snail populations.

3. Exclude stock from the snail reserves by erecting fences, and keep pig and deer numbers low enough to improve humidity, cover and food resources on the forest floor.

Objective Three

Increase population size by sustained predator control.

Actions Required

1. Depending on the outcome of the snail monitoring of Objective One, undertake a predator-control programme in at least one population of *P. t. tararuaensis*.

2. Continue monitoring snail density in the permanent plots in both the predator-controlled and uncontrolled areas to measure the impact of these conservation measures.

Objective Four

Determine the taxonomic status of *P. t. tararuaensis*.

Actions Required

1. Facilitate research into the genetic distinctiveness of *P. t. tararuaensis* using DNA techniques.

2. If appropriate, revise taxonomy.

Responsibility

Kapiti Area Office, Wellington Conservancy.

Palmerston North Area Office, Wanganui Conservancy.

3.7 *POWELLIPHANTA TRAVERSI KOPUTAROA*

Description

A medium-sized snail (maximum diameter 53 mm; height 27 mm) of rather flattened appearance. The shell is an almost plain, yellowish olive with a few dark bands around the periphery. Though described as a subspecies of *Powelliphanta traversi* in 1946, A.W.B. Powell later relegated it to a 'form' of *P. t. traversi* (1979). Because of its critically low numbers in the 1980s, the genetic make-up of this taxon has not been examined.

Habitat

Under the skirts of *Gahnia xanthocarpa* in swampy kahikatea forest on rich, alluvial lowland plains.

Distribution

The original distribution of this snail was naturally small, probably only covering about 6 km² of slightly elevated land just south of the Manawatu River near Koputaroa.

The distribution of *Powelliphanta traversi koputaroa* today is tiny, the snail being found in only two sites, Blakes Bush (< 1 ha) and Koputaroa Reserve (< 3 ha). The largest site was discovered in 1945 by A.W.B. Powell and 'the Prouse cousins'. Powell described the known range of *P. t. koputaroa* in 1946 as follows:

'An important discovery was a small colony of a low country form still persisting under adverse conditions in a small area of second growth native bush fringing a raupo swamp. The colony is situated on the Horowhenua Plain at approximately 1½ miles NNE of Koputaroa Railway Station. The Plain between Levin and the Manawatu River is now almost completely denuded of forest, the few small areas remaining being mostly low level Kahikatea remnants subject to flooding, and therefore without snails …'

Cause of Decline, and Threats

1. Clearance of almost the entire forest habitat for farmland.

2. Predation by introduced rats, thrushes and hedgehogs, and crushing by cattle.

3. Degradation of the remaining habitat through the farming practices on nearby land, i.e. digging of drainage ditches which lower water tables within the remnant bush, and trampling of the litter layer and browsing of the understorey by cattle. The resultant unnaturally dry forest floor meant an increased rate of snail mortality, particularly of eggs and young snails.

4. Collection of live snails for original taxonomic description (*'Three specimens taken by the Prouse cousins in September, 1945, are probably the last of* [the] *colony-doomed to destruction'*; A.W.B. Powell 1946) and for shell displays.

Past Conservation Efforts

1. The largest remaining area of snail habitat, a stand of young kahikatea adjacent to a raupo swamp, was purchased by the New Zealand Wildlife Service in 1985 and subsequently fenced to exclude stock. Rat and possum poison stations in this forest (Koputaroa Reserve) have been filled with the anticoagulant Talon at irregular intervals since about 1990.

2. The only other colony, comprising about five mature kahikatea trees, was fenced about 1983 by the landowner, Mr Blake. This bush (Blakes Bush) is not legally protected. It is surrounded by deep drainage ditches, and has become overgrown with blackberry.

3. Systematic searches for other colonies in the small forest remnants in the area were made in 1984 by R. Parrish and K.J. Walker as part of a fauna survey by the New Zealand Wildlife Service of the Horowhenua.

Current Conservation Status

Powelliphanta traversi koputaroa was considered critically endangered in 1984, but numbers probably stabilised following habitat protection and some limited conservation management. It is now ranked as 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A thriving population (density: > 12 snails/100 m^2) in two separate legally-protected colonies; and a total area of available snail habitat of more than 8 ha.

Objectives For The Next 10 Years

Objective One

Obtain legal protection for Blakes Bush.

Explanation

With only one small legally protected area of habitat, *P. t. koputaroa* is in danger of extinction through natural stochastic events (high flooding, droughts, etc.). Although Blakes Bush is very small and modified, it supports the only other known natural population of *P. t. koputaroa*, and it is highly desirable that its future as snail habitat be made more secure.

Actions Required

1. Examine forest protection options with landowner.

2. Seek funds to support chosen course of protection.

Objective Two

Increase the area of snail habitat available at Koputaroa Reserve.

Explanation

Although there are about 5 ha of land within the Koputaroa Reserve, only about 2 ha are forested and suitable as snail habitat, the balance being covered by exotic pasture grasses and gorse on slightly better drained areas, and raupo, flax and toitoi on very wet swampy sites.

The existing forest comprises two patches of secondary kahikatea separated by a large area of grass and several ditches. It would be highly desirable to revegetate the grassed area to allow gene flow between the two snail populations and to increase the total area of snail habitat available.

This would require some modification of the drainage ditches, dug around 1983, just before the snail colony was purchased and made a reserve. However, the impacts of the likely change of the water tables on the Reserve's fauna and flora (including a population of brown mudfish) would need to be considered carefully.

Natural regeneration beyond the present forest canopy is limited by the dense grass sward which grew after grazing ceased in 1986.

Unfortunately, some particularly troublesome weeds (barberry, blackberry, honeysuckle, gorse and willow) were not tackled when grazing was first excluded from the Reserve, and are now causing a real threat to natural revegetation.

Actions Required

1. Compile a revegetation plan for Koputaroa Reserve, drawing on the expertise of botanists, hydrological engineers, freshwater fisheries scientists and land snail experts. If appropriate, fill in ditches.

2. Seek funds for the production of 5000–10 000 plants from Koputaroa Reserve seed sources (kahikatea, pukatea, white and black maire, matai, tawa, hinau, pokaka, mapou, lemonwood, mahoe, narrow-leaved lacebark, karamu, putaputaweta, toro, small-leaved milk tree, kohuhu, pate and cabbage tree).

3. Eradicate woody weeds from the Reserve by a sustained cutting and poisoning programme. Keep the ground bare on the fringes of the existing forest to allow natural regeneration of kahikatea.

4. Densely plant the grassed area with native species; mulch and maintain grass control around native trees until they are well established.

Objective Three

Improve snail survival rates by more effectively controlling predators.

Explanation

Even for a second-generation anticoagulant such as brodificoum, resistance in the rat population can develop after prolonged use. After almost a decade of Talon use at Koputaroa Reserve, it would be wise to stop using it for a while. At present there are no indications that brodificoum detrimentally affects snails or their prey, earthworms, but there is little information on the effect of its use long term. The ideal is to establish a programme in which effective rat-control techniques (snap trapping, and 1080 and brodificoum poisoning) are rotated on a regular basis.

At present there is no sign of predation by possums on the snail population and, as both snail colonies are small, isolated, and surrounded by plentiful alternative possum food (pasture grasses), it is perhaps unlikely that possums will learn (or be driven) to eat the snails here. However, keeping possum numbers low is a sensible precaution and good for the snail's forest habitat. As with rodent control, methods used (trapping and poisoning with cyanide, cholicalciferol or 1080) should be regularly alternated to avoid shyness in possums.

Brodificoum should not be used against possums at Koputaroa as many equally effective possum control methods exist. The use of accumulative poisons such as brodificoum should be limited, especially at small sites such as Koputaroa where pest control will be necessary for many years. Brodificoum is better saved for occasional use against rats, as it is the best tool available for rodent control.

Rates of snail recruitment are almost certainly reduced at Koputaroa through predation by thrushes and hedgehogs, but the scale of the impact on *P. t. koputaroa* is unclear. The introduced snail, *Helix aspersa,* is very common at Koputaroa, and large numbers of their shells, broken by thrushes or hedgehogs, are obvious.

Restoration of a dense understorey and deep, wet litter layer may limit the impact of both thrushes and hedgehogs, but hedgehog numbers should be directly addressed through Fenn trapping.

Actions Required:

1. Place rat snap-traps and possum traps at 50 m intervals throughout Koputaroa Reserve and regularly trap rats and possums for 1 year.

2. In year two, carry out a poison operation against rats, hedgehogs, thrushes and possums using hand-distributed 1080.

3. In year three, poison rats with brodificoum in pegged-down (i.e. possum-proof) tunnels, and trap and poison possums with cyanide. Repeat the 3-year control cycle in subsequent years.

4. Place No. 6 Fenn traps in possum-proof boxes at 100 m intervals around Koputaroa Reserve. Bait regularly with eggs to control hedgehog numbers.

5. Investigate the cost effectiveness of replacing the pest-control regime (Actions 1–4) with rat- and hedgehog-proof fences around Koputaroa Reserve and Blakes Bush.

6. Establish five 100 m^2 snail-monitoring plots at Koputaroa to measure snail density and the effectiveness of the predator-control programme.

Objective Four

Determine the genetic distinctiveness of the Koputaroa snails, and if appropriate, formally restore to subspecific status.

Explanation

Snails from Koputaroa were not included in a genetic review of *Powelliphanta* in the mid-1980s because live snail collection was not feasible on the then very small snail population. Considerable genetic difference was found among the three forms of *P. traversi* which have been examined and, given the distinctive morphology of the Koputaroa snails, it is likely that the taxon should be re-instated as a subspecies.

Actions Required

1. Collect a small sample of live snails for genetic comparison with other *P. traversi* snails.

2. If appropriate, revise taxonomy.

Responsibility

Kapiti Area Office, Wellington Conservancy.

3.8 *POWELLIPHANTA TRAVERSI OTAKIA*

Description

A small to medium-sized snail (maximum diameter 50 mm; height 26 mm). The shell coloration is distinctive, the top being closely spirally lined in dark brown on an olive-brown to old gold ground, many of the lines being wavy or discontinuous, giving a speckled appearance. The base is uniformly dark brown, broken up only near the periphery into several broad bands. The parietal callus is pale blue-grey.

Habitat

Under litter in lowland broadleaf forest dominated by tawa, hinau and kohekohe, on swampy peat and alluvial soils.

Distribution

This snail was probably once common in the Otaki – Te Horo area but, because the land was rich and fertile, virtually all the original forests were destroyed after European settlement. *Powelliphanta traversi otakia* only just survived this era; only a few tiny populations remain, all in the immediate vicinity of Otaki.

Subfossil shell remains found in peat near Raumati and in the Wallaceville Swamp, Mungaroa Valley, east of Hutt Valley, may also have been of *P. t. otakia*.

Cause of Decline, and Threats

1. Clearance of almost the entire forest habitat for farmland.

2. Predation by rats, thrushes and hedgehogs.

3. Collection of live animals from the best remaining snail population for original taxonomic description—*'the … chance of survival of this subspecies appears slender … the type locality yielded a small series only, but a few were left, including all juveniles and half-grown examples'* (Powell 1946)—and for shell displays.

Past Conservation Efforts

1. A rat-poisoning programme was set up in 1980 at the Rahui Road colony, though at the time, one freshly dead snail was the only sign live snails were possibly still present.

2. Since then, fresh Talon 50 WB pellets have been left in 14 bait stations at this colony every two months (occasionally at much longer intervals).

3. A permanent 125 m^2 plot in the Rahui Road colony was searched for live snails in 1987, 1990, 1997 and in 2000. Snail numbers originally increased after the rat-poisoning programme, but there have been no clear trends in recent years.

4. In the late 1980s QEII covenants were placed over the Rahui Road and Manakau forest remnants. Stock were fenced from the Manakau colony and an active replanting programme of kahikatea forest was undertaken by the landowner.

5. Stock were excluded from the Te Horo colony in 1996, and one 500 m^2 and four 25 m^2 snail-monitoring plots were established in 2000.

Current Conservation Status

With fewer than 250 adults alive today, *Powelliphanta traversi otakia* was ranked as 'nationally critical' by Hitchmough (2002).

Long-term Recovery Goal

Population size of more than 1000 individuals in at least two separate, secure colonies.

Objectives For The Next 10 Years

Objective One

Improve and enlarge the habitat for all remaining colonies.

Explanation

The best remaining habitat at the Rahui Road colony is very small, and at present is incapable of supporting much of an increase in snail numbers. Snail habitat at Te Horo has been severely degraded by cattle, with snails surviving in only a very small, wet streamside area. However, the forest remnant at Te Horo is large enough to sustain a reasonable snail population in the long term, though it will take many years for the forest floor to recover.

Actions Required

1. Investigate options such as weed control that may make it possible for snails to utilise more of the forest floor at the Rahui Road colony.

2. Seek to purchase or to place under covenant snail habitat at Te Horo, and keep stock out and possum numbers low.

3. Extend the replanting programme at the Manakau site to include the main swamp area.

Objective Two

Increase snail survival by more effective and extensive rat and hedgehog control.

Explanation

Despite an intensive rat-control programme, rat-eaten shells continue to be found in the main snail colony. Rats here have been controlled using the second-generation anticoagulant poison brodificoum for almost 20 years, and it is highly possible that some resistance to the poison has built up in the rat population. Laboratory trials by Landcare Research found no sign that *Powelliphanta* were attracted to or affected by Talon poison. However, as in all pest-control operations, it is desirable to regularly switch control techniques to maximise pest control.

Until now, hedgehogs have not been targeted for control in the colonies of *P. t. otakia*, as their potential threat was unrecognised. It is possible that poison left for rats has also been taken by small hedgehogs (larger ones would probably have been kept from the bait by the small tunnel entrances to bait boxes), though little is known of hedgehogs' susceptibility to Talon. More specific hedgehog-control measures are required.

Actions Required

1. Set up a grid of rat snap-traps in both the Rahui snail colony and a nearby similar, but unpoisoned, bush remnant. Compare densities of rats at both sites. Test for brodificoum in the liver of rodents caught in the snail colony bush.

2. Continue a regular (every 4–6 weeks) programme of rodent trapping both in the core Rahui snail area and in the surrounding bush of the main snail colony. After 1 year, remove the rat traps and replace them with a regular programme of 1080 poison cereal pellets in rat tunnels. After 2 years switch to using Talon for rat control for 4 years, then repeat the whole 7-year cycle. Maintain a regular programme of cage-trapping hedgehogs or spotlighting and removing them throughout the cycle.

3. Seek funds for the erection of a rat- and hedgehog-proof fence around the Te Horo snail colony. During planning for such a fence, control rats in the lower part of the bush with a grid of snap traps or 1080 bait stations. Do not use anticoagulant poisons such as brodificoum, as it is important that the rat population does not build up a resistance to, or become shy of, brodificoum as it is the best eradication tool. Once the fence is in place, eradicate rats within using brodificoum, and eradicate hedgehogs with cage, pitfall or Fenn traps and spotlighting.

4. Evaluate the need for, and practicality of, rat and hedgehog control measures at the Manakau snail colony. Implement the appropriate control programme along the lines outlined for the main snail colony.

Objective Three

Increase snail recruitment by effective thrush control.

Explanation

Significant numbers of hatchling and juvenile *P. t. otakia* snails are killed by thrushes each year. However, even if thrush numbers could be controlled effectively inside the snail colonies, each colony is surrounded by pasture and gardens, and re-invasion is likely to be rapid.

It may be worth attempting to reduce thrush numbers using either a shotgun or air rifle.

An alternative approach is to reduce the opportunities of thrushes finding and killing snails by providing plenty of snail cover and by removing obvious thrush anvils. This is probably the only practicable option.

Actions Required

1. Cover, or if all else fails, remove, all stones or logs which are obviously used as thrush anvils. Keep in mind that big logs and stones are also likely to provide the best cool, stable and safe cover for the snails.

2. Keep site disturbance to a minimum to encourage the development of a dense litter layer and understorey.

3. Systematically assess the practicality and effectiveness of shooting, poisoning or trapping thrushes to reduce numbers in the snail colonies.

Objective Four

Determine population trends.

Actions Required

1. In order to assess snail density and the effectiveness of the pest-management regime establish three more 100 m^2 plots in the Te Horo colony.

2. Releaser the snail plots during winter every 2–3 years to monitor population trends.

Responsibility

Kapiti Area Office, Wellington Conservancy.

3.9 *POWELLIPHANTA HOCHSTETTERI HOCHSTETTERI*

Description

Powelliphanta hochstetteri hochstetteri was the first *Powelliphanta* snail to be formally described (as *Helix hochstetteri* in 1862) and is arguably one of the most beautiful. It is a large 'chunky' snail (maximum diameter 75 mm; height 35 mm), with many irregular spiral stripes, bands or zones (except on the umbilicus) on a khaki to old gold background.

The shell colour varies greatly over the length of the subspecies' range. Snails on the Pikikiruna Range are known as the yellow-based form, as shells north of the Takaka Hill Road all have a plain (unstriped) old gold base. Snails to the south, on the Arthur and Lockett Ranges, always have a warm, reddish brown (unstriped) base and are known as brown-based.

The spirals on brown-based snails are dark brown to black and are narrow and fine in the Flora area, and wider and more frequent in the Cobb area.

The spirals on yellow-based *P. h. hochstetteri* are alternately black and mahogany red, and vary enormously in width. Shells with fine sparse lines appear mainly old gold-coloured, while a neighbouring snail with wide stripes may appear essentially dark mahogany red. This inter-population variability is striking and uncommon in the *Powelliphanta* genus.

Habitat

A high-altitude snail found at 750–1200 m a.s.l. under litter and logs in silver and red beech forest with occasional southern rata and cedar. About 50% of *P. h. hochstetteri* habitat lies on calcium-rich soils formed on marble.

Distribution

In the headwaters of the Takaka River on the Pikikiruna, northern Arthur and Lockett Ranges and on the Cobb Ridge in Kahurangi and Abel Tasman National Parks, North West Nelson.

Cause of Decline, and Threats

1. Predation (on eggs, and even the largest adult snail) and habitat destruction by feral pigs.

2. Severe predation by possums since the late 1980s in the south of the snail's range, and from the mid-1990s in the Pikikiruna Range.

3. Logging of the forest habitat on Barron Flat and on the eastern Pikikiruna Range around Canaan and the Takaka Hill Road.

Past Conservation Efforts

1. Ground-based possum control over 1500 ha on the true left of Flora Stream annually since 1993, and numbers of live, brown-based *Powelliphanta hochstetteri hochstetteri* monitored in four 400 m^2 plots in 1993, 1997, 1998 and 2000.

2. Aerial 1080 poison operation to control possums in 2500 ha in the south branch of the Riwaka River in 1999 to protect brown-based *P. h. hochstetteri* and the southern rata-dominated forest habitat. Nine 100 m^2 snail-monitoring plots were established in 2000.

3. Aerial and ground 1080 poison operation to control possums in 2000 ha around Canaan to protect yellow-based *P. h. hochstetteri*, and establishment of thirteen 100 m^2 plots in 2001.

Current Conservation Status

1. Classified as in 'gradual decline' (Hitchmough 2002).

2. A brown-based *Powelliphanta hochstetteri hochstetteri* population has recovered well in the possum-controlled area in the Flora Valley (from less than 0.4 snails/100 m^2 in 1993 to 4.8 snails/100 m^2 in 1998). It is unclear whether intermittent possum control in the Riwaka catchment, where snail density was 1.5 snails/100 m^2 in 2000, is sufficient for recovery of the "brown-based" population.

3. The conservation outlook decreased during the 1990s for yellow-based *P. h. hochstetteri* snails and for the brown-based *P. h. hochstetteri* populations in the Cobb area with the sudden advent of predation by possums in addition to significant predation by pigs. Snail density was 5.7 snails/100 m^2 at Canaan in 2001 and in 2002 was 3.6 snails/100 m^2 in the Cobb.

Long-term Recovery Goal

A secure and relatively dense population (> 12 snails/100 m^2) over an area of at least 500 ha in at least four different sites (Canaan, Riwaka, Flora and Cobb Ridge) which, together, encompass the full range of morphological diversity in *Powelliphanta hochstetteri hochstetteri*.

Objectives For The Next 10 Years

Objective One

Increase population density at key sites by sustained predator control.

Explanation

Powelliphanta hochstetteri. hochstetteri is still preyed on regularly by its natural enemy, the western weka. Numbers of introduced rats, hedgehogs and thrushes are probably relatively low in the high-altitude frequently wet habitat of *P. h. hochstetteri*, and their impact on the snail seems to be only moderate. However, feral pigs are a serious problem in most colonies, even though recreational pig hunting occurs occasionally. Despite these introduced predators, snail numbers were moderate until the early 1990s when the introduced possum also began to prey in *P. h. hochstetteri* snails. From experience elsewhere, predation by possums always leads to snail decline.

The combination of predation by both possums and pigs is cause for concern, especially as all populations now seem affected. Equally, however, the recovery of snails in the Flora Valley is encouraging, as are the relatively high numbers of snails still at Canaan.

Actions Required

1. Maintain the annual possum-control programme at Flora Stream. Regularly review possum and snail numbers, and adjust the timing and techniques of control to minimise control effort for maximum snail response. Establish four 400 m^2 non-treatment snail-monitoring plots nearby.

2. Establish at least ten 100 m^2 snail-monitoring plots (or similar) in the Riwaka possum control area, and releaser two-yearly. Monitor the possum RTC two-yearly and repeat the 1080 aerial poisoning programme when RTC rises above 3%.

3. Extend predator control to include a representative population of yellow-based *P. h. hochstetteri*, preferably in the Canaan (Harwood's Hole – Rameka Track) area which is visited by large numbers of the public who would value the experience of a dense snail population. Keep possum and pig numbers at barely detectable levels in this area by frequent control operations. Establish at least ten 100 m^2 plots inside the Canaan control area, and a further ten in a non-treatment area nearby to compare changes in live snail numbers over time.

4. Establish an annual control programme for possums and pigs over a small area (about 300 ha) on Cobb Ridge to protect the western population of brown-based *P. h. hochstetteri*.

Objective Two

Increase snail recruitment through habitat improvement.

Explanation

Much of the land in the Canaan and Takaka Hill Road area is privately owned and stock graze the margins of the forest in this area. The grazing causes snail loss through crushing, and the trampling destroys the moist litter layer essential for snail survival. Feral goats and pigs over much of the range of *P. h. hochstetteri* cause similar habitat degradation, thus increasing juvenile snail mortality through desiccation, and also cause enhanced weka and thrush predation through the loss of protective vegetative cover. Logging from the area around Takaka Hill Road finally ceased in the late 1980s when the export of native wood chips was banned, but there remains some risk of logging for pasture and of development as a sustained forestry crop.

Actions Required

1. Encourage protection of privately-owned forest habitat of *P. h. hochstetteri* through advocating for the establishment of covenants and erection of stock exclusion fencing, and where possible by Crown purchase of the forest.

2. Carry out regular goat-control programmes in the best snail areas.

Responsibility

Flora and Riwaka: Motueka Area Office, Nelson/Marlborough Conservancy.

Canaan and Cobb Ridge: Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.10 *POWELLIPHANTA HOCHSTETTERI ANATOKIENSIS*

Description

A very large snail (maximum diameter 80 mm; height 35 mm) with a beautifully marked pattern of closely spaced, diffused, narrow reddish brown to black spiral lines and bands which, at the type locality in the headwaters of the Anatoki River, overlie a rich russet ground colour. In eastern populations of *P. h. anatokiensis* the background colour of the shell is yellow rather than red. The change in colour between the two forms is absolute; there is no gradual clinal change, and despite apparently suitable habitat in between, the red and yellow populations are physically discrete.

In places on the southeast flanks of Parapara Peak, *P. h. anatokiensis* is sympatric with the equally large *P. s. superba* and with the smaller *Powelliphanta* "Parapara" and *P. gilliesi fallax*.

Habitat

In the Anatoki headwaters, red-form *P. h. anatokiensis* lives under *Gahnia*, bush rice grass and the litter in forest of mountain beech and southern rata, mountain toatoa and *Dracophyllum traversi* 760–1050 m a.s.l.; and in red and silver beech forest with quintinia, Hall's totara, southern rata on river terraces at 610–750 m a.s.l.

The yellow form of *P. h. anatokiensis* is found largely on limestone, under litter in forests of red and silver beech with southern rata, pahautea and *Dracophyllum traversi* at 760–1240 m a.s.l.

Distribution

Red-form *Powelliphanta hochstetteri anatokiensis* occurs over about 200 ha, in the headwaters of the Anatoki River, on Yuletide Peak Ridge and on the river flats opposite the Anatoki Forks Hut, with low numbers of snails beside the river as far downstream as The Bend.

Yellow-form *P. h. anatokiensis* has a wider distribution, being found on the most easterly ridges of the Devil and Anatoki Ranges, and on Walker Ridge and the ridge between the Waikoropupu and Pariwhakaoho Rivers in Golden Bay.

Cause of Decline, and Threats

The main cause of the decline in both forms of *Powelliphanta hochstetteri anatokiensis* is predation by possums, but for the yellow form, predation by feral pigs is also a serious threat.

Past Conservation Efforts

1. In 1987 a systematic Protected Natural Area-type survey over the full range of *Powelliphanta hochstetteri anatokiensis* by the New Zealand Forest Service mapped snail distribution (S.P. Courtney, pers. comm.).

2. In 1995 and 2000 the Department of Conservation carried out a possum- control operation (aerially delivered 1080 poison) to protect the snails on Parapara Peak.

3. A 500 m^2 density-monitoring plot for yellow-form *P. h. anatokiensis* was established at Cedar Saddle (Walker Ridge) in 1995 and re*measured in 1998. In 2000, seven 100 m^2 plots were established on the eastern slopes of Parapara Peak to better monitor snail response to on-going possum control in the area, with a further four plots being established in 2002.

4. In 1996 a 500 m^2 plot for measuring the density of red-form *P. h. anatokiensis* was established at Anatoki Forks and re*measured in 1999 and 2001. A further ten 100 m^2 plots were established in 2001.

Current Conservation Status

When considered individually, both red-form and yellow-form *Powelliphanta hochstetteri anatokiensis* were ranked 'nationally endangered', and when assessed as a single unit were rated in 'gradual decline' (Hitchmough 2002).

Powelliphanta hochstetteri anatokiensis is now present in very low numbers (1.0 snails/100 m^2) throughout its range. While all the habitat of this snail is protected within Kahurangi National Park, recovery in snail numbers has been slow after the first attempts to reduce predation on the yellow form of *P. h. anatokiensis*. The status of *P. h. anatokiensis*, particularly the red form, remains very vulnerable.

Long-term Recovery Goal

Moderately dense populations (< 6 snails/100 m^2 when occurring sympatrically with other *Powelliphanta* species, and > 12 snails/100 m^2 elsewhere), that are stable or increasing, which incorporate the diversity in both the red and yellow forms of *P. h. anatokiensis*.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained pest control.

Actions Required

1. Keep possums steadily at very low levels (< 3% RTC and preferably < 1% RTC) at both Parapara Peak and Anatoki Forks, to protect both forms of this snail.

2. Monitor possum numbers annually before each control operation until the relationship between possum numbers and snail health is clearer.

3. Investigate methods to keep pig numbers low within the possum control area on Parapara Peak, and in at least one site in the snail habitat at Devil Range.

4. Regularly monitor live snail numbers at representative sites across the range of the snail to determine the impact of pest control measures, and the snail population trends in populations without pest control.

Objective Two

Determine the genetic basis of the morphological diversity apparent in *P. h. anatokiensis*.

Actions Required

Facilitate research that compares the genetic profile of red and yellow forms of *P. h. anatokiensis*.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.11 *POWELLIPHANTA HOCHSTETTERI OBSCURA*

Description

On D'Urville Island, west of the type locality, French Pass, *Powelliphanta hochstetteri obscura* is a large snail (maximum diameter 70 mm; height 39 mm) with a uniformly dark brown to almost black base and a green-brown to yellowish olive upper surface, spirally lined in brown. However, the colonies further east and south of French Pass are progressively smaller and the base is dark brown. Adult snails at Mt Stanley are only half the size of those on D'Urville Island (maximum diameter 50 mm; height 23 mm).

These morphological changes appear clinal. At Mt Kiwi and Bobs Knob in the central Marlborough Sounds *P. h. obscura* snails meet snails of *P. h. bicolor* and intermediate hybrids occur. The genetic differences between *P. h. obscura* and both *P. h. bicolor* to the east and *P. h. consobrina* to the south are clear but not large. Consequently, it is not expected that the morphological differences exhibited amongst *P. h. obscura* populations indicate differences at the sub-species level. However, each population is now entirely geographically isolated through the drowning of the Marlborough Sounds' land mass and, with time, is liable to become even more distinctive. It is important to conserve this diversity by protecting snails across the full range of *P. h. obscura*.

Habitat

Essentially a high-altitude forest dweller, found under logs and litter in silver and black beech forest from 600 m a.s.l. and higher. However, a small distinctive colony exists at sea level in broadleaf/beech/podocarp forest at Matai Bay; on D'Urville Island snails occur at 305 m a.s.l. on the northern and eastern flanks of Wells Peak, and populations formerly existed about 152 m a.s.l. on Stephens Island and at Emslie Bay.

Distribution

In the western Marlborough Sounds, on many of the high points west of St Omer and north of State Highway 1, including D'Urville Island and Maud Island, although surprisingly they do not occur on Lookout Knob. There were formerly populations on Stephens Island and at Emslie Bay, French Pass (the type locality) (Powell 1930), but with forest clearance these populations are now extinct.

Cause of Decline, and Threats

1. Severe predation (on eggs, to the largest adult snail) and habitat destruction by feral pigs over a long period of time.

2. Severe possum predation since about the 1970s on almost all populations except those on D'Urville Island.

3. Severe predation on juvenile snails by thrushes.

4. Predation by rats on the snail colony at sea level at Matai Bay.

5. Degradation and desiccation of the litter habitat by frequently high numbers of feral pigs, deer and, on the mainland, goats.

6. Conversion of forest habitat to farmland on Stephens, Maud and D'Urville Islands and on the hills near French Pass.

Past Conservation Efforts

1. Possum-control operation (aerially distributed 1080) in 1994 on all the Tennyson Inlet snail populations, followed by maintenance control of possums in 1998 on Mt Stanley, and bait-station possum control around the snail colonies on Editor Hill and Mt Stanley annually since 1999. Possum- control operation (aerially distributed 1080) in Kenepuru Scenic Reserve in 1998, with annual ground control around the snail colonies thereafter.

2. Sporadic goat control in the Tennyson Inlet area.

3. Two 1800 m^2 pig exclosures built in 1997 on Attempt Hill, D'Urville Island, and the density of live snails and earthworms inside and outside exclosures measured annually since then, to quantify the impact of pigs.

4. A 500 m^2 snail-monitoring plot established on Mt Stanley and another on Editor Hill (both in the Tennyson Inlet area) in 1994, and a third plot in Kenepuru Scenic Reserve in 1997. The Tennyson Inlet plots were re*measured in 1996, 1998 and 2001. Ten more 100 m^2 plots were established on both Mt Stanley and Editor Hill in 2001.

Current Conservation Status

1. Ranked by Hitchmough (2002) as in 'gradual decline'.

2. Despite intense pig predation over a long period on D'Urville Island, snails have survived in pockets where large rocks provide safety from pigs. Snail numbers on D'Urville Island are presumably much lower now than they were formerly. Snail numbers increased once pigs were excluded by fencing, with more snail eggs surviving and hatching inside the exclosure. However, the increase in population size was not as large as expected since, with more small juvenile snails available, predation by thrushes increased dramatically. Average population density 1997–2001 inside the fence was 5.4 snails/100 m^2 and just outside was 2.4 snails/100 m^2.

3. On the mainland, where there has been predation by possums since the 1970s on top of long-term pig predation, snail populations have shrunk in both range and density, and the extinction of colonies within 50 years at the present decline rate seems possible. In 2001, after 6 years of possum control, there were still only 1.4 snails/100 m^2 on Editor Hill and 0.9 snails/100 m^2 on Mt Stanley.

4. On Maud Island removal of cattle and forest regeneration is allowing the small snail population to slowly increase.

Long-term Recovery Goal

Healthy snail populations at least on Attempt Hill, Mt Maud, Stephens and Maud Islands, Mt Stanley and Bobs Knob and in Kenepuru Scenic Reserve.

Objectives For The Next 10 Years

Objective One

Increase population density at key sites by sustained predator control.

Explanation

Private ownership of most of the forest on D'Urville Island, and of pasture surrounding the Kenepuru Scenic Reserve, Bobs Knob and Mt Kiwi forests, mean that pig control in the snail colonies is hard to achieve. Pig hunting is a prized activity and landowners have little desire to allow others to kill enough pigs to make a difference to snails. There are also logistic difficulties in controlling pigs in the mainland Marlborough Sounds, where pig numbers are highest in the lower altitude, scrubby land rather than on the mountain tops (where the snail colonies are), and there is regular pig movement up and down the hills.

D'Urville Island is free of possums and ship rats, making snail conservation a better long-term option than in some of the mainland colonies. However, attempts to eradicate pigs from D'Urville Island are probably a waste of resources, as they would almost certainly be re-introduced by determined pig hunters.

Actions Required

1. Seek funds and landowner approval to build and maintain in perpetuity a pig- and deer-proof fence around the summit of Attempt Hill, using the road as the eastern boundary. Shoot and poison all pigs and deer inside the fence.

2. On the Devils Staircase and Editor Hill and in the Kaiuma Forest, carry out annual campaigns to reduce pig numbers using a mix of Warfarin poisoning, trapping and shooting.

3. Keep possum numbers steadily at very low levels (< 3% RTC, preferably < 1% RTC) at least on Mt Stanley and Editor Peak and in Kenepuru Scenic Reserve. Measure snail population trends at regular intervals.

Objective Two

Restore the habitat and snail populations of Maud and Stephens Islands.

Explanation

On both Stephens and Maud Islands most forest was cleared for pasture in the early 1900s, and the litter in the tiny remaining bush patches has been trampled and dried out by grazing stock. On Maud Island enough cover has remained for *Powelliphanta hochstetteri obscura* to survive, albeit in much reduced numbers, but on much smaller and drier Stephens Island they have disappeared entirely. A large shell collected by Captain Bollons and now held at the National Museum is the only confirmation of their former presence on Stephens Island.

Both these islands are now nature reserves, with an active revegetation programme on Stephens Island and rapid natural regeneration over much of Maud Island gradually restoring their suitability for snails. The islands are free of most exotic snail predators except song thrushes and, as such, could provide long-term security for both the big D'Urville Island form of *P. h. obscura* on Stephens Island, and for the smaller Tennyson Inlet form on Maud Island.

However, while the existing Maud Island snail population will probably continue to slowly expand without much in the way of further assistance, the outcome of any snail restoration programme on Stephens Island is less certain. Unless a great many snails are released on the island at once, it will be hard for a population to build up in the face of both tuatara and thrush predation in the open understorey conditions. It is also unclear whether the humidity is now high enough on the forest floor to support *Powelliphanta* at all. Probably the only place cool and moist enough is under the boulders in the Frog Bank, on the summit of Stephens Island.

Actions Required

1. Determine the average seasonal humidity of possible snail habitat on Stephens Island and compare it with that on D'Urville Island.

2. If (when) forest floor conditions become suitable on Stephens Island, and all necessary approvals are granted, during winter months translocate at least 50 adult snails from D'Urville Island to Stephens Island. Place all the snails in the same general area, choosing a site as moist and thickly vegetated as possible. Consider fencing the area to exclude tuatara, and shooting thrushes for the first few years until the snail population becomes established.

3. Prepare and publish a detailed report on all aspects of the translocation, taking particular care to record the grid references of the collection site, and the size and colour of each individual animal, as well as dates and descriptions of the release site(s).

4. Survey and map the distribution of *P. h. obscura* on Maud Island. Establish ten to fifteen 100 m^2 snail-monitoring plots in the main snail areas to measure the status of the snail population. Releaser about 5 years later to assess population trends. If possible, retire more land near the summit of the island from sheep grazing as soon as possible to extend the area of suitable snail habitat.

Objective Three

Improve snail recruitment through habitat improvement.

Explanation

Goats are common and widespread in the mainland Marlborough Sounds snail colonies. They form big groups and camp together for long periods in small areas, and their concentrated browsing and trampling destroys the moist forest litter layer essential for snail survival.

Actions Required

Carry out regular campaigns to control goats and deer to bring them to low levels within the snail colonies.

Responsibility

Sounds Area Office, Nelson/Marlborough Conservancy.

3.12 *POWELLIPHANTA HOCHSTETTERI BICOLOR*

Description

A medium to large snail (maximum diameter 70 mm; height 32 mm), rather flattened in appearance with a low apex. The shell is a light yellowish olive colour and has a few irregular brown spiral bands at the periphery. The base is free from spirals, but there is always a small circular zone of a dark chocolate colour in and surrounding the umbilicus.

A small colony of snails with characteristics intermediate between *Powelliphanta hochstetteri obscura* and *P. h. bicolor* exists on Bobs Knob (the western boundary between the two subspecies).

Habitat

Essentially a high-altitude forest dweller, found under logs and litter in silver and mountain beech forest with southern rata at 600 m a.s.l. and higher. However, also present in lower-altitude tawa forests on Arapawa Island and down to sea level in forest of kohekohe, tawa and nikau and in regenerating manuka and five-finger coastal forest on Blumine Island.

Distribution

The high points in the eastern Marlborough Sounds, including the Mt Stokes massif, Mt Cullen massif, the peaks west of Picton from Mt Robertson to Kahikatea and on Arapawa Island, and from sea level to the summit of Blumine Island.

Cause of Decline, and Threats

1. Conversion of forest habitat to farmland or pine plantation on Arapawa and Blumine Islands, and on Puzzle Peak and Mt Furneaux.

2. Severe predation (on eggs to the largest adult snail) and habitat destruction by feral pigs, over a long period (all *Powelliphanta hochstetteri bicolor* populations except Blumine Island).

3. Severe possum predation since the 1960s on the Mt Robertson – Piripiri populations.

4. Desiccation of the snail's forest floor habitat caused by high numbers of feral goats over a long period (all *P. h. bicolor* populations except Blumine Island). More limited understorey degradation by deer.

5. Reduced recruitment through predation by thrushes on all populations.

Past Conservation Efforts

1. Blumine Island was retired from farming and established as a reserve for the protection of fauna and flora in 1920.

2. Goats were fenced out of the Arapawa Island Scenic Reserve in the 1980s.

3. Deer and pigs swimming to (or being deliberately released onto) Blumine Island were removed by the New Zealand Wildlife Service and the Department of Conservation between 1970 and 1995.

4. Weka, which had been released on Blumine Island in the early 1970s, were almost entirely removed by the New Zealand Wildlife Service in 1982, though numbers have subsequently risen again.

5. Possums in 145 ha on the summit of Mt Robertson have been controlled annually since 1996 using bait stations and a variety of poisons. A snail-monitoring plot of 500 m^2 was set up in 1996, and a further four 100 m^2 plots were established in 1999.

6. Possums and goats have been controlled annually since 1997 over 2000 ha of Mt Stokes – Mt McMahon – Mt Kiwi by shooting goats and poisoning possums at bait stations set along a grid of tracks. A 500 m^2 snail-monitoring plot was established and snail density measured on Mt Stokes in 1995.

7. A 500 m^2 snail-monitoring plot was established on Blumine Island in 1984, re*measured annually and live snails tagged until 1988, then measured again in 1990, 1993, 1998 and 2001.

Current Conservation Status

On Blumine Island, snails were in high numbers (17 snails/100 m^2) in 1990 following an attempt to eradicate weka, but numbers gradually decreased to 3 snails/100 m^2 by 2001 with increasing weka numbers. Snails are common over much of the island, particularly near damp gullies and the unlogged bush, where native vegetation and snails had survived through the farming era.

Elsewhere, snail populations are now very low, with 0.8 snails/100 m^2 on Mt Robertson in 1999 and 0.9 snails/100 m^2 on Mt Stokes in 2001. *Powelliphanta hochstetteri bicolor* is considered in 'gradual decline' (Hitchmough 2002).

Long-term Recovery Goal

Moderately dense snail populations (>12 snails/100 m^2) on Mt Stokes and Mt Robertson, in Arapawa Scenic Reserve and on Blumine Island.

Continued existence of snail populations (at lower numbers than before pigs were present) over the full range of the subspecies.

Objectives For The Next 10 Years

Objective One

Increase population density at key sites by sustained predator control.

Explanation

It is clear from the snail densities achieved on possum/pig/goat-free Blumine Island that mainland *P. h. bicolor* colonies are a poor shadow of their former glory.

From Arapawa Island, where possums are absent but snail numbers are very low, it seems that high numbers of pigs and goats alone are enough to devastate snail colonies. The lower than usual altitude of the snail habitat on Arapawa Island may mean snail populations were never very dense, but with dense populations of snails to sea level on nearby Blumine Island, this is an unlikely explanation.

Pigs were first landed in New Zealand by Captain Cook in Queen Charlotte Sound in 1773 and they probably built up to very high numbers between 1840 and 1880, before they depleted the food resource. Pig numbers are now presumably lower, but efforts to reduce numbers to levels compatible with snail recovery have so far been ineffectual.

Because most *P. h. bicolor* colonies are on the top of mountains, and pigs are most common at lower altitudes, a seemingly endless number of pigs can move up into the snail areas at irregular intervals. Because recreational pig hunting occurs in the eastern Marlborough Sounds, poisoning of pigs is difficult politically (and safely). On Arapawa Island, though a fence was erected to keep goats out of the floristically important Scenic Reserve on the northeastern part of the island, unfortunately it was not constructed to be pig-proof, so pigs continue to affect the snail colony in the Reserve.

Constant vigilance is required to detect and remove pigs that pig hunters apparently strand on Blumine Island in a misguided effort to increase the size of individual pigs.

On Mt Stokes where there is regular pest control over a large area from a network of tracks, it should be possible to keep pig, goat and possum numbers low enough for eventual snail recovery. However as on Mt Robertson, where since 1997 possum numbers have been regularly controlled, the unnaturally low snail density at present makes a boom in snail reproduction unlikely in the short term.

Juvenile snails in all *P. h. bicolor* populations are preyed upon by the introduced thrush and also by their natural enemy, the western weka. With the eastern Marlborough Sounds area now a patchwork of farmland, scrub and forest, thrush numbers are probably relatively high. It is difficult to quantify their impact, but it appears large: around one small stone anvil seen under manuka scrub on Blumine Island in the 1980s, over 90 recently killed juvenile *P. h. bicolor* snail shells were counted (K.J. Walker, pers. obs.).

The impact of weka on *P. h. bicolor* may be unnaturally high because years of browse by deer, goats, pigs and possums have thinned the forest understorey, reducing the vegetative cover for the snails.

Actions Required

1. Regularly check Blumine Island for pigs, and kill any found. Mount an aggressive local advocacy campaign against pig-stranding.

2. Pig-proof the goat fence around Arapawa Island Scenic Reserve, and eradicate pigs inside the fence.

3. Keep possum numbers steadily below 3% RTC and preferably lower than 1% RTC within the snail habitat on Mt Robertson. Establish at least six more 100 m^2 monitoring plots on Mt Robertson and measure two-yearly. Carry out regular pig-control programmes on the Mt Robertson - Piripiri ridge.

4. Keep pig, goat, possum and deer numbers to barely detectable levels on Mt Stokes. Measure snail density within the monitoring plots regularly until trends are clear.

5. Establish at least fifteen 100 m^2 snail-monitoring plots randomly in areas of good snail habitat on Mt Cullen – Dukeshead, and regularly measure snail density in the absence of pest control.

6. Through research, determine the most effective pig control strategies for the Nelson/Marlborough situation.

Objective Two

Improve snail recruitment through habitat improvement.

Explanation

Goats are common and widespread in all mainland *P. h. bicolor* colonies. They form groups and camp together for long periods in small areas, and their concentrated browsing and trampling destroys the moist litter layer essential for snail survival and probably makes it easier for weka and thrushes to prey on snails.

Actions Required

Carry out regular campaigns to control goats and deer to bring them to low levels within the snail colonies.

Responsibility

Sounds Area Office, Nelson/Marlborough Conservancy.

3.13 *POWELLIPHANTA HOCHSTETTERI CONSOBRINA*

Description

A medium to large snail (maximum diameter 63 mm; height 27.5 mm) with a reddish yellow shell. The top of the shell is usually plain, but occasionally there are a few narrow black spiral lines. On the base a zone of dark reddish brown extends from the umbilicus halfway to the periphery. This basal zone does not stop cleanly, but instead has diffused edges and is variable in size between snails: in a few snails, particularly around Mt Duppa, the dark zone covers the whole base, as in *Powelliphanta hochstetteri obscura*.

Habitat

A high-altitude species, found at 884–1280 m a.s.l., *Powelliphanta hochstetteri consobrina* lives under litter and bush tussock in mountain and silver beech forest containing occasional mountain toatoa, pahautea and southern rata, on predominantly schist substrates.

Distribution

Powelliphanta hochstetteri consobrina occurs over a relatively wide area in the mountains between the Waimea and Wairau River valleys in eastern Nelson. It is found on the Richmond Range between Grass Knob and Mt Baldy, and on the Bryant Range between Mt Starveall and Trig 16, just north of Mt Duppa. According to Powell (1930) this snail was formerly also on Gordons Knob, but most of the forest there has subsequently been burnt and this population is apparently extinct.

Cause of Decline, and Threats

1. Burning of the snail's forest habitat on Gordons Knob and around Rocks Hut – Dun Saddle, and deterioration of snail habitat in all the remaining forests caused by pigs (rooting) and relatively high numbers of feral goats and deer.

2. Predation by introduced pigs, possums, thrushes and, in some years in the lower-altitude colonies, rats. On the Richmond Range in 1996, 41% of snails found dead had been killed by possums, while 2% had been killed by pigs. On the Bryant Range between 1997 and 2000 on average 56% of snails were killed by possums, 14% by pigs and 8% by rats.

Past Conservation Efforts

So far there have been few explicit conservation measures for *Powelliphanta hochstetteri consobrina*. However, in 1997 an aerial 1080 operation at Timms Creek would have provided some relief for snails on the upper boundary of the block. In addition, shells collected during survey work on the Richmond Range between 1994 and 1996 provide good indications of predator impact on *P. h. consobrina* during those years.

Current Conservation Status

1. From general searches for live snails and shells, apparently in low numbers at most sites, though no plot data are available to quantify this.

2. Ranked in 'gradual decline' by Hitchmough (2002).

Long-term Recovery Goal

Dense (> 12 snails/100 m^2) populations of *Powelliphanta hochstetteri consobrina* that are stable or increasing and which together represent protection of the full range of morphological diversity in the subspecies.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Explanation

Between 43% (Richmond Range) and 70% (Bryant Range) of *Powelliphanta hochstetteri consobrina* are killed by introduced pests (primarily possums, but significant numbers by pigs). This was not realised until the mid–late 1990s, and so far few efforts have been made to control pest populations. There are several practical difficulties associated with carrying out effective pest management in the Richmond Range. The snails live in low numbers on the tops of a long narrow chain of mountains and the shape of this distribution is not an ideal one for pest management. In addition, Mt Maungatapu is part of the water supply catchment of Nelson City, and approval for hunting pigs and goats, let alone aerial distribution of 1080 poison to control possums and rats, may be difficult to obtain. However, it is important that these issues be addressed and that programmes to control possums and pigs be undertaken in at least some key areas.

Actions Required

1. Keep possum and pig numbers steadily at very low levels in at least one key snail population on the Richmond Range and another on the Bryant Range. Preferred sites would be the areas around Mt Richmond, from Mt Maungatapu to Dun Mountain and from Saddle Hill to Mt Duppa. These sites are all dissected by popular walking tracks, and increased snail numbers would provide good opportunities for the public to see snails readily. They also incorporate much of the morphological diversity in *P. h. consobrina*.

2. Establish at least ten 100 m^2 plots in the snail habitat in each of the pest control areas and monitor snail numbers two-yearly at first, and then less frequently to assess the impact of predator control.

Objective Two

Improve quality of snail habitat.

Actions Required

Keep numbers of deer and goats at low levels in the possum/pig control blocks. The aim is to allow deep layers of moist litter to build up again to facilitate increases in snail recruitment and survival.

Responsibility

Motueka, Sounds and South Marlborough Area Offices, Nelson/Marlborough Conservancy.

3.14 *POWELLIPHANTA GILLIESI GILLIESI*

Description

A snail of only moderate size (maximum diameter 49 mm; height 24 mm) with a distinctly granulated parietal callus. At the type locality on Mt Burnett the top of the shell is warm brown, crossed by rather distantly spaced spiral bands of darker brown. The base is bright red-brown, like rosewood, with a large, sharply defined, dark red-brown, almost black area surrounding the umbilicus (Powell 1946).

In 1946, *Powelliphanta* snails were reported to be found further south along the Burnett Range as well, on the tops between Gorge and Coal Creeks (Powell 1946), but snails from there were critically examined only recently (K.J. Walker & G.P. Elliot, unpubl. data). These snails are significantly larger (maximum diameter 55 mm) and more lightly coloured than *Powelliphanta gilliesi gilliesi*. The top of the shell is a warm, light, orange-red with many fine, narrow spiral bands of dark reddish brown. The rich orange-red glossy colour on the base fades towards the periphery where there are a few narrow dark brown bands, rather than the wide solid black band of typical *P. g. gilliesi*. They are sympatric with *P. superba superba* on the eastern and western flanks of Trig L.

The southern snails are probably best regarded as a new undescribed subspecies of *Powelliphanta gilliesi*, but until genetic work can confirm this, they should be treated as a separate form of *P. g. gilliesi*.

Only *P. g. gilliesi* (*sensu stricta*) is considered in the following account.

Habitat

Mostly on calcium-rich soils on a dolomite substrate. Found under litter in dense podocarp/hardwood/broadleaved forest dominated at low altitudes by emergent northern rata and pukatea, and at high altitudes by silver beech, quintinia, kamahi and totara. While the snails occur from sea level to 640 m a.s.l., the densest colonies occur above 500 m a.s.l.

Distribution

Found between Plumbago Creek and Gorge Creek on the Burnett Range, north-west Golden Bay. Probably formerly present on the lowlands at the eastern side of the Burnett Range, but this area was cleared for farming early last century.

Cause of Decline, and Threats

1. Habitat loss in both lowland forest (farm land conversion) and upland forest (open-cast dolomite quarry).

2. Predation, since at least the early 1980s, by possums, and for a longer period though lesser extent, by rats, thrushes, hedgehogs and pigs.

3. Degradation of the understorey by cattle, goats and pigs.

Past Conservation Efforts

1. A possum-control operation (aerially distributed 1080 poison) was undertaken over the whole range of this snail by the Department of Conservation in 1994 and 2000. Ground control of possums at the base of Mt Burnett (where it meets farmland) has been carried out periodically between the two aerial operations to keep possum re-invasion low.

2. A 500 m² snail-monitoring plot was set up in 1994 near the summit of Mt Burnett, and re*measured in 1996, 1998 and 2000. An additional nine 100 m^2 plots were established in 2001 near Marble Creek and on the mid-eastern slopes and summit of Mt Burnett.

Current Conservation Status

After 7 years of possum control, snail density is now moderate on Mt Burnett with an average of 12 snails/100 m^2 in 2001, compared to 3 snails/100 m^2 in 1994.

If regular possum control can be maintained, the snail population as a whole may stabilise and increase in the long term. The best habitat is on the calcium-rich soils on dolomite substrate on the cool, wet summit of Mt Burnett, however, and this area is threatened by an expansion of open-cast quarrying for dolomite and by the forest clearance, roading and overburden-dumping associated with the quarrying.

Long-term Recovery Goal

No further retraction of the range, and the remaining population stable or increasing and no longer considered threatened.

Objectives For The Next 10 Years

Objective One

Protect the habitat of *Powelliphanta gilliesi gilliesi* from any further forest clearance.

Explanation

The habitat of *P. g. gilliesi* has been under attack since European settlement, and unfortunately still is. The lower slopes on the eastern flanks of the Burnett Range are still recovering from last century's logging, and clear felling on the western side in the headwaters of the Wairoa River was discontinued only in 1998. The summit of Mt Burnett has been cleared for a television translator, and an open-cast dolomite quarry has been operating on the southwestern flanks of the Three Sisters for many years. The proposed uphill extension of this quarry and the on-site dumping of more overburden would cause irrevocable harm to some of the best remaining snail habitat and destroy the type locality.

Actions Required

1. The current application for more conservation land on Mt Burnett for dolomite quarry purposes must not be granted.

2. All Crown-owned habitat of *P. g. gilliesi* should be included within Kahurangi National Park.

Objective Two

Increase population size and density by sustained predator control.

Explanation

Because the range of *P. g. gilliesi* now lies adjacent to farmland, and because much of it is at low altitude, in the last 150 years almost the full suite of potential snail predators has made impacts on the population: pigs (now in low numbers themselves), rats, thrushes and cattle.

In addition, in the 1980s possums began to prey on snails and the combination of older **and** more recent predators caused an alarming drop in the size of the snail population. However, the decline does not appear to have been as severe in the dolomite areas of the Burnett Range as it has been on the less fertile soils south and west of Mt Burnett, presumably because fertile forests contain many alternative possum foods.

Possums are ubiquitous throughout the range of *P. g. gilliesi*, unlike most of the snail's other predators. However, possums are relatively easy to control, and a reduction in their numbers directly benefits the snail's forest habitat. For these reasons, management efforts to control the predators of *P. g. gilliesi* should focus on possums.

Actions Required

1. Keep possum numbers steadily at very low levels (< 3% RTC, preferably < 1% RTC).

2. Where practicable, and particularly at lower altitudes, select possum-control techniques which are also effective in the control of rats (e.g. broadcast of cereal 1080 pellets).

3. Monitor two-yearly the density of live snails in the established snail plots until population trends are clear, and thereafter less frequently.

4. As soon as possible, fence stock from those parts of the habitat of *P. g. gilliesi* that are publicly owned.

5. Through regular hunting programmes, keep goat and pig numbers low within the snail's habitat.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.15 *POWELLIPHANTA GILLIESI* "HAIDINGER"

Description

A medium-sized snail (maximum diameter 55 mm; height 28 mm) with strong, wide, dark brown to black stripes on a gold background on the upper surface, and a dark reddish brown lower surface. The parietal callus is dark grey with distinct, fine granules. The shell whorls are inflated, and the inner whorls peaked.

The beautiful, strongly marked shell is hard to confuse with that of other subspecies of *Powelliphanta gilliesi*, largely because of the relatively wide banding. It was first discovered by Greg Napp and Simon Walls in 1995 and is still not formally described.

Habitat

Under litter and *Gahnia* tussock bases in mid-altitude manuka shrubland and kanuka forest (620 m a.s.l.) on leached and infertile coal-bearing sandstone soils.

Distribution

Apparently extremely localised, with only one population known, in a small remnant of forest on the summit of Mt Haidinger on the Burnett Range, northwest Golden Bay.

Cause of Decline, and Threats

1. Loss of most of the snail's forest habitat is the major cause of decline. The Haidinger Tops were burnt last century, probably during searches for minerals, and regeneration of the forest cover has been slow on the poor soils. The summit forest was cleared more recently to erect a trig station.

2. Introduced predators are a potential threat, but their present impact seems limited. There is no sign of predation by possums on this population. However, since possums to both the north and south along the Burnett and Wakamarama Ranges are having major impacts on other subspecies of *Powelliphanta gilliesi*, the potential threat is high. There is some predation by thrushes, and limited predation by weka, but rats, feral pigs and probably hedgehogs are absent.

Past Conservation Efforts

A possum-control operation (aerially distributed 1080 poison) was undertaken by DOC in 1994 and 2000 over the whole range of *Powelliphanta gilliesi* "Haidinger".

A 3-day survey of the Haidinger area for signs of *Powelliphanta* was carried out by Golden Bay Area staff in 1995, and in 2001 two 100 m^2 snail-monitoring plots were established in the colony.

Current Conservation Status

As a tiny relict population of a naturally rare species, this snail is one to watch closely. However, there is limited predation by exotic intruders at present and snail numbers in the tiny colony are low to moderate (5 snails/100 m^2). Because of the small total population, it is ranked 'nationally critical' (Hitchmough 2002).

Long-term Recovery Goal

A dense (> 12 snails/100 m^2) population throughout most of the snail's presumed former range on the summit of Mt Haidinger (approximately 30 ha).

Objectives For The Next Five Years

Objective One

Protect the remaining habitat of *Powelliphanta gilliesi* "Haidinger".

Explanation

Mt Haidinger lies within the Kahurangi National Park and so has legal protection as public conservation land. However, the forest habitat of this snail is now so small that considerable vigilance must be maintained to ensure that no further vegetation clearance occurs.

To a large extent, the remote location of the colony provides the best protection: there are no tracks and the terrain and dense vegetation make it very difficult to access.

Actions Required

Control human activities on the Haidinger Tops to minimise the risk of fire or clearance of further vegetation.

Objective Two

Estimate total population size.

Explanation

Transect searches to the north, west and east of the known colony made by two people over 3 days yielded the total information known about the distribution and density of this snail. It is important to determine whether the taxon has a wider distribution than assumed, as a larger total population would reduce the urgency of other conservation actions. That said, a substantially wider distribution does not look very likely. The previous search found that just north of Point Height 536, snails were more like *P. g. gilliesi* than like *P. gilliesi* "Haidinger". A search along the Wakamarama Range summit just south of the Kaituna River failed to locate any *Powelliphanta* (K.J. Walker, pers. obs.). Most other subspecies of *P. gilliesi* also have, apparently naturally, very restricted ranges.

Actions Required

1. Determine the boundaries of the known *P. gilliesi* "Haidinger" colony, and measure snail density across the range of micro-climates in which it occurs.

2. Carry out a comprehensive survey of the wider Haidinger area and map the presence and/or density of any additional populations.

Objective Three

Determine the level of genetic distinctiveness of the Mt Haidinger snails from other *P. gilliesi* snails. If appropriate, formally describe the taxon.

Explanation

Based on morphological characters, the Haidinger snails are clearly different from other snails of *P. gilliesi*, including those living only 1.5 km away. Because seven of the other subspecies of *P. gilliesi* studied so far have at least one unique fixed allelic difference, it is likely that genetic profiling of the Haidinger snails could be useful in resolving the group's taxonomy.

As the overall aim is to protect the diversity of *Powelliphanta*, assessment of the distinctiveness of this newly discovered taxon is a priority.

Action Required

1. Depending on the outcome of Objective 2, collect a small sample of live animals for genetic comparison with other *P. gilliesi* snails, and for storage as a type specimen and series.

2. If appropriate, formally describe and name the new taxon.

Objective Four

Maintain the current density of *P. gilliesi* "Haidinger" at its known location through vigilance against predation by possums.

Explanation

As with many other very small colonies of *Powelliphanta*, there is no sign of predation by possums on *P. gilliesi* "Haidinger" at present, though possums are certainly present. However, as possum damage was found on *P. g. gilliesi* shells just north of the *P. gilliesi* "Haidinger" colony, this situation may change. Given the small size of the *P. gilliesi* "Haidinger" population and the limited quantities of other preferred possum foods on the infertile soils, possums should not be allowed to develop a taste for snails in this area.

Actions Required

1. Keep possums consistently at low levels on the Haidinger Tops by intermittent (every 5–6 years) possum control over the wider Burnett Range area and, in the intervening years, by occasional trapping and poisoning programmes in the immediate vicinity of the colony.

2. Make annual checks for possum damage on shells lying around the colony. If it is found to be occurring, begin quarterly possum-control operations in the immediate vicinity of the colony to keep possum numbers very low and to eradicate the problem possums. In the medium to longer term, if the problem persists, either construct and maintain a possum-proof fence over a small part of the Haidinger colony, or take some snails into long-term captivity.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.16 *POWELLIPHANTA GILLIESI MONTANA*

Description

A medium-sized snail (maximum diameter 52 mm; height 28 mm) with a finely granulated parietal callus. The shell colour is a rich mahogany brown on the top surface and a deep red-dark brown on the bottom. A few fine, or occasionally wide, black spiral bands mark the periphery.

Habitat

In mid- to high-altitude forest (830–1100 m a.s.l.) on relatively infertile soils.

Lives under leaf litter in forests of silver beech, southern rata, quintinia, kamahi and toro, and in high-altitude leatherwood scrub.

Distribution

On the upper slopes of the Wakamarama Range, northwest Golden Bay. The type locality is Bock Peak (no longer named on topographical maps), and the snails are found along the summit of the range about 2 km both north and south of Bock Peak.

The much larger snail *Powelliphanta superba superba* occurs sympatrically with *P. gilliesi montana* throughout its range. The distribution of *P. g. montana* is reasonably well known, and is naturally small (250 ha).

Cause of Decline, and Threats

1. Intensive predation by possums since at least the 1970s.

2. Low recruitment through predation by thrushes, exacerbated by forest understorey changes caused by goats and deer.

Past Conservation Efforts

A possum-control operation (aerially distributed 1080 poison) was undertaken by DOC in May 1999 over the whole range of *Powelliphanta gilliesi montana*. In 1999, seven 100 m^2 snail-monitoring plots were established on transects in the snail habitat. These were re*measured in 2001 and a further five 100 m^2 plots were set up.

Current Conservation Status

A snail with a very localised natural range that declined dramatically in the 1970s and 1980s, and which is apparently still declining. Now at dangerously low numbers (0.25 snails/100 m^2) throughout its small range.

Long-term Recovery Goal

To increase snail numbers to a density of more than 12 snails/100 m^2 throughout most of the snail's range; and a stable or increasing total population.

Objectives For The Next 10 Years

Objective One

Increase population size and productivity by predator control.

Action Required

1. Keep possum numbers steadily at very low levels (< 3% RTC, preferably < 1% RTC) over the range of the snail.

2. Monitor snail numbers within the established plots regularly until it is clear that an effective management regime reversing the decline is in place.

Objective Two

Improve quality of snail habitat.

Actions Required

Keep goat and deer numbers low in the snail habitat by regular control programmes.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.17 *POWELLIPHANTA GILLIESI SUBFUSCA*

Description

Powelliphanta gilliesi subfusca is a medium-sized snail (maximum diameter 47 mm; height 26 mm), with fine, irregular, reddish brown spiral lines on the top, and a plain olive-brown dorsal surface that deepens to greenish or reddish brown towards the umbilicus (Powell 1930, 1946, 1979). The purple parietal callus is coarsely granulated.

Habitat

A lowland species (sea level to about 200 m a.s.l.) found on old sand-dunes and on sandy mudstones, siltstones and limestones. Lives under litter in forest of northern rata, pukatea and northern cedar, and also under kanuka in regenerating shrublands.

Distribution

Presumably once occupied all the forest in northwest Golden Bay from the North Head of Wanganui Inlet to Cape Farewell, and in the north Pakawau Forest from the coast to the headwaters of the streams draining west.

However, much of these forests has been cleared for farmland and *Powelliphanta gilliesi subfusca* is now confined to isolated, mostly small, forest remnants around Kaihoka Lakes, Greenhills Stream, Oyster Point and Mt Lunar. It also occurs sparsely in the northwestern edge of the cutover Pakawau Forest.

Cause of Decline, and Threats

1. Loss and fragmentation of forest habitat is the main cause of decline, and trampling of part of the remaining habitat by cattle and feral goats is a continuing threat.

2. Predation by rats, thrushes and hedgehogs at all sites.

Past Conservation Efforts

To protect the snail populations, the forest remnants at both Oyster Point and Greenhills Stream mouth were legally protected in the late 1980s and early 1990s, respectively. At the same time, both sites were fenced to exclude cattle.

Current Conservation Status

Snails are in high densities (33 snails/100 m^2) in the best parts of the best habitat (covering less than 1 ha around the Kaihoka Lakes), in low to very low density (below 0.01 snails/100 m^2) in Pakawau Forest and probably in low-moderate densities (about 3 snails/100 m^2) elsewhere. So far there is no sign of predation by possums in any of the colonies, and the habitat is recovering well at the recently fenced sites. *Powelliphanta gilliesi subfusca* is regarded as in 'gradual decline' (Hitchmough 2002).

Long-term Recovery Goal

All populations stable or increasing; removal from listing as a threatened taxon.

Objectives For The Next 10 Years

Objective One

Maintain population density and genetic diversity by habitat protection and enhancement.

Explanation

Much of the forest habitat of *Powelliphanta gilliesi subfusca* has been lost, and the remaining c. 200 ha is very fragmented—which hinders gene flow. In several colonies, the forest habitat is not legally protected and domestic stock continue to dry out the litter layer and trample snails. Feral goats and deer inhibit regeneration of the Pakawau Forest.

Actions Required

1. Seek to place snail habitat near Mt Misery and Kaihoka Stream Swamp under covenants or other legal protection; seek approval and funds to fence stock from those forest areas.

2. Encourage the regeneration of shrublands which could provide land bridges between *P. g. subfusca* colonies.

Objective Two

Determine the population biology of *P. g. subfusca* at Kaihoka Lakes, and the population trends in all colonies.

Explanation

Kaihoka Lakes Scenic Reserve is one of the few sites that has a relatively dense snail population and is easily accessible. As such it is an invaluable site from which to obtain information on the key population parameters of *Powelliphanta* today, and to examine the relative impact of predation by hedgehogs, thrushes and rats on *Powelliphanta* and techniques for their control.

Actions Required

1. In order not to compromise the value of Kaihoka Lakes Scenic Reserve for conservation research on *Powelliphanta*, all predator management at the site should be part of a formal written strategy.

2. Establish at least four 100 m^2 plots to monitor snail density in each colony of *P. g. subfusca*. Releaser annually for the first 2 years to determine population trends and the causes of any declines.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.18 *POWELLIPHANTA GILLIESI AUREA*

Description

A medium-sized snail (maximum diameter 56 mm; height 28 mm) with a dark red, densely granulated parietal callus. The shell is an olive-brown colour on the dorsal surface, spirally lined in dark chestnut and with a few dark green lines; the base is golden to olive coloured, with a small area of reddish brown about the umbilicus (Powell 1979).

Habitat

Occurs from 50 to 300 m a.s.l., though much more common at higher elevations. Found in litter under dense pukatea/northern rata forest with abundant kiekie and supplejack. The soils are calcium rich, formed on a scarp and talus slope of Tertiary limestone.

Distribution

Powelliphanta gilliesi aurea is now restricted to probably less than 50 ha of limestone cliffs just west of Mangarakau in North West Nelson.

Cause of Decline, and Threats

1. The main cause of the decline of *Powelliphanta gilliesi aurea* is the destruction and conversion to pasture of the forest habitat over much of its naturally small range.

2. Continuing forest loss and predation by introduced rats, pigs, thrushes, probably hedgehogs and, only recently, possums.

Past Conservation Efforts

1. Part of the snail's habitat is legally protected within the Mangarakau Scenic Reserve.

2. Three 100 m^2 snail-monitoring plots were established in the lower part of the Reserve in 2001, and a brief survey was completed.

Current Conservation Status

Despite substantial predation by pigs and rats, *Powelliphanta gilliesi aurea* was in better numbers than many other *Powelliphanta* until recently. However, sometime between 1996 and 2001, possums began preying on the snails. Very low numbers of snails (0.3 snails/100 m^2) and, for the first time, many possum-damaged shells, were found during the 2001 survey. *Powelliphanta gilliesi aurea* was ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A dense (> 20 snails/100 m^2) population that is stable or increasing, on legally protected habitat throughout the snail's range.

Objectives For The Next 10 Years

Objective One

Increase population size by predator control.

Explanation

Like many other low-altitude fertile sites with abundant possum-preferred vegetation and presumably high possum numbers, until recently there was no sign that possums preyed on snails at Mangarakau. However, for unknown reasons this changed recently. Given the devastating effect of possums and the difficulties of snail recovery once predatory behaviour is widespread in the possum population, it is urgent that possum numbers be drastically reduced throughout the Mangarakau Scenic Reserve.

Action Required

1. Measure the density of possums before any control is undertaken to better understand the relationship between possum densities, forest type and snail predation.

2. Reduce possums to very low densities in the Mangarakau Scenic Reserve. Select possum-control techniques that keep rat numbers low.

3. Maintain a regular programme of pig control in the Mangarakau forests and scrub.

Objective Two

Accurately determine distribution and total population size.

Explanation

It was formerly presumed that most *P. g. aurea* habitat was protected within Mangarakau Scenic Reserve. However, snails are only present in the northeastern end of the Reserve, and are in relatively low numbers on the limestone talus slope. The core habitat of *P. g. aurea* seems to be on the highest points of the western-facing limestone scarp itself, around the type locality at 250 m a.s.l. Only a remnant of original intact forest remains at this altitude, as fires from the west swept up to and over the scarp both north and south of the type locality.

When Powell described *P. g. aurea* in 1946, he compared its distribution with that of *P. g. brunnea* (found only in 0.5 ha), noting 'both *aurea* and *brunnea* are restricted to small areas and their survival is uncertain' (Powell 1946).

The distribution of snails on the western slopes needs to be ascertained as the remaining forest and scrub is privately owned. Their legal protection should be sought.

Actions Required

Survey the distribution and density of *P. g. aurea* on the western slopes of the Mangarakau scarp, and determine the accurate boundaries of the snail's range to the north and south of Mangarakau School.

Objective Three

Determine population trends.

Actions Required

1. Establish ten to fifteen 100 m^2 plots in sites representative of the range of habitats in which *P. g. aurea* is found.

2. Annually measure the density of live snails within each plot until population trends are clear.

3. Examine each plot's annual crop of empty shells to determine cause of death, and rates of induced mortality.

Objective Four

Maintain and increase the area of the habitat of *P. g. aurea* and improve habitat quality.

Actions Required

1. Seek legal protection for snail habitat that is privately-owned forest or regenerating scrub.

2. Ensure that domestic stock is securely excluded from areas of snail habitat and, also if possible, from areas of former snail habitat in which forest cover is likely to naturally regenerate.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.19 *POWELLIPHANTA GILLIESI BRUNNEA*

Description

A medium-sized snail (maximum diameter 56 mm; height 32 mm). The shell is bright reddish brown. The base is entirely plain, but dark brown fine lines circle the upper surface.

The parietal callus is dark brown to black, and crowded with fine granules.

Habitat

Under litter in coastal lowland forests of cabbage tree, mahoe, kawakawa, nikau, kiekie and flax, on sandy soils with limestone outcrops.

Distribution

Only known from near the mouth of the Paturau River on the northwest coast of Golden Bay. Confined to a tiny 0.2 ha patch of remnant forest now surrounded by pasture and within 30 m of a farm house and utility buildings.

The distribution was formerly more extensive (according to A.W.B. Powell (1979), it was found north along the coast for about 3 km), but no trace of snails has been found in any of the nearest remaining forest habitat (about 1 km away) or to the south of the Paturau River.

Cause of Decline, and Threats

1. Clearance of almost the entire forest habitat for farmland, and degradation of the remaining fragment through cattle trampling and grazing.

2. Predation by rats, hedgehogs and thrushes.

Past Conservation Efforts

1. The site was fenced by the New Zealand Wildlife Service in 1980.

2. In 1985 flax plants were transferred from the beach edge, several hundred metres away, to the area between the fence and the bush. This was done to increase available snail cover, protect the bush from wind damage and eliminate the rank grass that had resulted from fencing. Until at least 1985 the owner regularly put stock inside the fence to reduce the fire risk that the rank grass had created.

3. In 1991 two plots were established: a 100 m^2 plot in the northeastern corner of the bush and a 50 m^2 plot beside a limestone outcrop in the south corner. The number of live snails in each plot was measured then (6.6 snails/100 m^2), and re*measured in 1998 (10 snails/100 m^2).

4. Poisoned rat bait was left in bait stations at the colony sporadically in 1991. Bait stations were regularly refilled (about every 6 weeks) with Talon from 1999.

5. Several unsuccessful attempts have been made since 1985 to legally protect the forest remnant through purchase by the Crown or placement under a QEII covenant.

Current Conservation Status

Ranked by Hitchmough (2002) as 'nationally critical', and considered endangered because of: the very small size and degraded nature of the remaining habitat, and the low juvenile and adult survival brought about by introduced predators.

After 15 years without stock, the habitat is greatly improved and a deep moist litter layer has aided recruitment, and probably also reduced predation, making the outlook for this snail much brighter than it was 20 years ago. To secure its survival, some intensive management will be required for at least another decade.

Long-term Recovery Goal

To increase total wild population size to more than 5000 breeding adults, and to at least double the size of available habitat.

Objectives For The Next 10 Years

Objective One

Increase population density in the Paturau colony to over 20 snails/100 m^2 through improved recruitment and survival by sustained predator control.

Explanation

The nature of the remaining colony's micro-habitat means that thrushes, hedgehogs and rats are particularly common and will require on-going regular control efforts if their numbers are to be kept low enough to improve snail recruitment. There is no sign of predation by possums at present, and in this isolated forest remnant it is unlikely that possums will learn snail-eating behaviours. However, as a precaution possum numbers should be kept low.

Actions Required

1. The optimum, though initially more expensive, option is to erect a rodent- and hedgehog-proof fence around the Paturau snail colony and, through a poisoning and trapping programme, eradicate rats and hedgehogs inside the fence. The fence could also be built to exclude possums, but this would make it much more expensive and conspicuous. The preferred option is to install a number of possum kill-traps in the forest, thus keeping on-going maintenance costs low and the degree of protection afforded very high.

2. An interim, short-term solution for rat control is to regularly re-supply (every 6–8 weeks) fresh rat poison to 10–20 dog-proof bait stations within the forest. At intervals of 3 or 4 years the poisoning regime should be suspended and replaced for 6 months with regular rat trapping using standard break-back snap traps to avoid the development of poison resistance in the rat population. Future attempts to eradicate rats may be compromised by the prolonged use of poisons, even second-generation anticoagulants, and this risk should be kept in mind when determining rat control plans.

3. A short-term solution for hedgehog control is regular patrols of the bush just after dark or in the early hours of the morning with a spotlight, particularly during spring before the start of the hedgehog breeding season.

4. Adequate control of thrushes is probably not practicable. Scattering a bird poison such as clorophase in the forest may kill some thrushes, but such actions would need to be on-going, and the side effect of non-target bird kills makes this option unpalatable. An alternative approach is to reduce the opportunities of thrushes finding snails by providing plenty of snail cover and by removing obvious thrush anvils. The natural regeneration of the forest after stock removal has already greatly increased the amount of natural snail cover, and this is probably a sufficient thrush deterrent.

Objective Two

Increase population size by increasing the area of habitat available.

Actions Required

1. Seek landowner permission to extend the size of the existing habitat by fencing stock from the relict tall native trees in the southwest corner of the colony (i.e. on the seaward side of the farm drive and behind the bach). Some weed control and judicious replanting will be required once this land is fenced off. As with the adjoining original colony, purchase of the site or placing it under covenant is highly unlikely given its proximity to the main farm buildings. Snails should expand into this area of their own accord once numbers in the original colony increase and ground cover in the newly fenced area is dense enough.

2. Seek landowner permission to purchase or place under covenant a nearby second area of forest in which snails were not formerly present. Prepare the site by fencing to exclude stock. Because of the rocky terrain it is probably impossible to make the fence rodent- and hedgehog-proof, but options for this should be investigated before cattle fencing proceeds.

Objective Three

Translocate snails to the new habitat.

Actions Required

1. Before translocation, maximise the size of the donor population (via Objective 1) and accurately census the population through systematic density searches across all the micro-habitats in Paturau Bush. Only translocate the snails when the actions of Objective 1 have increased the population sufficiently.

2. Little is known about the natural rate of snail increase, but indications are that it is highly density dependent. Because of this, construct a snail-proof enclosure within a small part of the best of the young forest habitat, and put all the translocated snails within it, thereby maximizing snail density while minimizing the number of snails needed in the transfer.

3. Control predators in the release site, at least until the snail population becomes properly established.

Objective Four

Prevent collection of the live snails through advocacy.

Explanation

The *P. g. brunnea* colony at Paturau is well known by shell enthusiasts, but fortunately collecting land snails has greatly decreased since the giant snails were protected by law.

Action Required

A display detailing the conservation status of *P. g. brunnea* and the conservation management measures being undertaken at Paturau should be erected on the site. The illegal nature of, and potential harm done by, collecting live *P. g. brunnea* should be highlighted.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.20 POWELLIPHANTA GILLIESI KAHURANGICA

Description

A medium-sized (maximum diameter 54 mm; height 28 mm) snail with dark reddish base and strong narrow spirals on the upper surface. The purple callus is heavily granulated.

Habitat

On sandy, free-draining soils under primary forests of hard beech, northern rata and pukatea. Also under regenerating forest of manuka, kanuka and nikau. Ground cover in all sites: scrambling rata, *Carex* spp. and bush rice grass.

Distribution

Confined to about 400 ha at Kahurangi Point, North West Nelson.

The centre of distribution appears to be the sand-dune country in the catchment of Camp Creek, but they occur from just south of the Kahurangi River mouth to Lagoon Creek, and from the coastline, inland up to about 300 m a.s.l.

Cause of Decline, and Threats

1. Clearance of the forest habitat for farmland; degradation of much of the remaining habitat by cattle trampling.

2. Predation by introduced rats, pigs, possums, thrushes and hedgehogs.

Past Conservation Efforts

1. A number of attempts have been made over the last decade to limit the impact of possums on *Powelliphanta gilliesi kahurangica*. In 1993 ground-based possum control was carried out over several months in the immediate vicinity of Kahurangi Point. In 1997 a much larger and more effective control operation using aerially distributed 1080 poison was carried out. In addition to causing a major reduction in possum numbers, the 1080 probably killed most rats present, thereby greatly reducing predation pressure on the snails. It would have taken up to a year for rodent numbers to increase again.

2. A 500 m^2 plot to monitor snail density was established in 1996 and re*measured in 1999, 2000 and 2002. Three 100 m^2 snail-monitoring plots were added in 1999, two within the possum-control area and one outside it, and were re*measured in 2000 and 2002.

Current Conservation Status

Snail density increased dramatically after possum control and on the Camp Creek dunelands snail numbers are very high (32 snails/100 m^2) in the few small fragments of original forest, and low-moderate in the surrounding regenerating shrublands.

The snail is still regarded as 'nationally endangered' (Hitchmough 2002).

Long-term Recovery Goal

Maintenance of a strong core population through predator control, and increase in colony size through rehabilitation of former habitat.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained control of possums.

Explanation

Possums were first seen at Kahurangi Point about 1959 (McClennan & McCann 1991). The vegetation is luxuriant in the warm wet climate, and possum numbers increased to relatively high numbers (46% RTC in 1996). Perhaps because there was such a large alternative food supply, there was no sign of snail predation by possums until the early 1990s.

When the first snail-monitoring plot was measured in 1996, 64 shells of possum-killed snails were found but there were still 54 live snails present in the 500 m^2 plot—amongst the highest snail densities found in *Powelliphanta* today. It seems likely that only a proportion of possums at Kahurangi Point had learnt to prey on snails.

With the reduction of possum numbers to 0.03% RTC in 1997, snail numbers increased dramatically to 147 live snails (about 100 of them less than 2 years old) in the monitoring plot by mid-1999, and no sign of any recent predation by possums. By 2002 there were 152 live snails in 400 m^2 of the plot (51% of them juveniles), but also 14 possum-damaged shells.

It is expected that possum numbers in this vegetation will recover relatively quickly (RTC was 3.6% by December 1998). To maintain the gains in snail numbers, possum control will need to be repeated at perhaps 3–4-yearly intervals. Monitoring of this situation is required, and when possum control is needed again, consideration should be given to using techniques that kill rats too.

Actions Required

1. Annually check snail plots in Camp Creek for signs of freshly killed snails (i.e. possum-damaged shells). Because of the fragility of the sandy litter layer and the number of easily desiccated juvenile snails present, do not disturb the litter but only collect shells from the surface.

2. Measure possum density (RTC) when evidence of fresh possum-killed snails first reappears.

3. Repeat possum control within 1 year of detecting renewed predation, and select poisons and techniques which also control rodents.

Objective Two

Improve snail recruitment and survival through habitat restoration.

Explanation

Most of the forest habitat of *Powelliphanta gilliesi kahurangica* was destroyed by the fires associated with European settlement. Construction of the lighthouse settlement was probably the reason for the original forest clearance, but ever since then cattle farming around the lighthouse and on nearby private land has restricted regeneration and caused on-going degradation of all the remaining forest and regenerating shrublands—even those on public conservation land. Cattle are also killing young snails and eggs directly by crushing them and killing snails indirectly by trampling and drying out the litter layer which is particularly fragile on the sandy soils. Beach access during low tides and shifting sand-dunes make the option of fencing out of stock not cost effective.

Actions Required

1. As a matter of urgency, seek removal of cattle from Kahurangi Point, preferably through Crown purchase of the enclave of private land.

2. If land purchase cannot be achieved, seek to either provide on-going compensation payments to the farmer for **not** grazing the land, or fence cattle out of some of the best snail habitat.

Objective Three

Maintain high snail density in Camp Creek by supporting initiatives to control pigs, hedgehogs, thrushes and rats.

Explanation

The Kahurangi Point landscape is a patchwork of open country and lowland coastal scrub and forest on light soils, so hedgehogs and thrushes are likely to be common. They are probably affecting snail recruitment, but the scale of the problem is unknown.

Feral pigs caused high snail mortality from at least the 1970s to the 1980s, but increased hunting pressure seems to have significantly decreased pig numbers lately.

While at present the most cost-effective measures seem to be possum control and habitat restoration, methods should, where possible, be selected for their ability to also control and quantify the impacts of smaller predators.

Actions Required

1. Using spotlights along transects at night around the Kahurangi House, roughly quantify the number of hedgehogs present at Kahurangi Point.

2. Encourage pig control initiatives at Kahurangi Point which do not harm kiwi (e.g. baited wire-mesh pig traps).

3. Releaser the numbers of snails in the permanent plots at Kahurangi Point two-yearly.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.21 *POWELLIPHANTA GILLIESI JAMESONI*

Description

Powelliphanta gilliesi jamesoni is a small to medium-sized snail (maximum diameter 46 mm; height 24 mm) with a smooth, dark grey parietal callus. Snails at the type locality near the Gouland Downs Hut have a russet-coloured shell, spirally lined and radially streaked with darker brown.

According to Powell (1946) there are *'at least three recognisable forms of this species along the Gouland Downs track from the vicinity of* [Gouland Downs Hut] *… to the Collingwood* [County] *Boundary. Collingwood Boundary examples can be readily distinguished from those of … the type locality by their more reddish-brown colour, strong spiral banding of the top and peripheral area and obsolescence of the basal dark axial streaks. A third form from near Saxon Creek has dense narrow spirals on the dorsal surface … but the base is bright reddish-brown with strong subperipheral broad black spiral bands …'* He believed, *'further collecting, especially from intermediate localities, is essential before these forms of jamesoni can be satisfactorily evaluated'*.

Unfortunately, this was never done. Samples collected for genetic comparisons of *P. g. jamesoni* with other *Powelliphanta* were all from the type locality near Gouland Downs Hut, so the genetic basis for the morphological differences obvious within the *P. g. jamesoni* group has not been examined.

Habitat

Powelliphanta gilliesi jamesoni is an upland snail, living at 610–762 m a.s.l. In the bush at Gouland Downs Hut *P. g. jamesoni* lives under bush rice grass in silver beech forest on calcium-rich limestone soils. Elsewhere the snails live in infertile, highly leached granite soils, under moss, red tussock or *Gahnia* skirts on the edge of boggy clearings in stunted manuka forest, or in forest of quintinia, kamahi, southern rata, silver beech and *Dracrophyllum traversi*.

Distribution

Even if the habitat of all three forms of *P. g. jamesoni* is included, the natural range of this snail is small. It occurs in a narrow band over about 600 ha on the southern and western flanks of the Slate Range, in the Saxon River headwaters and in the Gouland Downs Hut bush (beside the Heaphy Track in Kahurangi National Park).

Cause of Decline, and Threats

1. Intense predation by possums since the late 1970s in all western colonies, and moderate predation by possums in Gouland Downs bush; some predation by rats in Gouland Downs bush.

2. Some loss of forest habitat between the 1860s and 1900 through burning and sheep grazing.

Past Conservation Efforts

1. Possum control (aerially delivered 1080) over the Saxon – Slate Range snail colonies in 1994, and over the Gouland Downs Hut bush in 1995. Ground-based possum control over about 60% of the Saxon population, annually since 2000.

2. A 300 m^2 density-monitoring plot established in the upper Saxon River area in 1991 was re-measured in 1994, 1996 and 1999. Two smaller 100 m^2 plots were established in the same general area in 2000, with a further two set up in 2001.

3. A 500 m^2 density-monitoring plot was set up in Gouland Downs Hut bush in 1995 and re-measured in 1998 and 2000. A 100 m^2 plot was also set up there in 2000.

4. A 500 m^2 snail enclosure was built near the Saxon River in 2000 and six live snails from the Collingwood County Boundary were placed inside it. Possum numbers are being kept very low in the vicinity of the enclosure and snail numbers inside monitored to see if the snails will increase when predation is kept very low and snail density is artificially increased.

Current Conservation Status

1. *Powelliphanta gilliesi jamesoni* is ranked as 'nationally endangered' (Hitchmough 2002).

2. Numbers of *P. g. jamesoni* at the type locality are moderate-low (1.8 snails/ 100 m^2), low at the Collingwood County Boundary (0.4 snails/person hour) and very low (0.6 snails/100 m^2) at Saxon River.

3. The Saxon River form and probably also the Collingwood County Boundary form of *P. g. jamesoni* would be classified as 'nationally critical' if considered as subspecies rather than forms. The small, individual ranges of the three forms make them all particularly vulnerable.

Long-term Recovery Goal

Moderate densities (> 12 snails/100 m^2) of snails in stable or increasing populations over most of the range of each of the three distinctive forms of *Powelliphanta gilliesi jamesoni*.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Actions Required

1. Keep possum numbers steadily at barely detectable levels (< 1% RTC) throughout the snail's range.

2. Rotate methods of possum control, using (when possible) methods which also kill rats at Gouland Downs Hut bush (1080, feracol), but generally avoiding the use of accumulative poisons, such as brodificoum, and the use of the same acute poison on recent consecutive occasions. For both pests, use traps instead of poisons at regular intervals.

3. Monitor pest-mammal numbers annually prior to control operations to determine the relationship between predator density and snail population health.

Objective Two

Determine population trends.

Actions Required

1. Increase the number and geographic spread of snail-monitoring plots so all three forms can be adequately monitored.

2. Measure snail density regularly until the impacts of intensive predator control and artificially enhanced snail density are clear; thereafter monitor less frequently.

Objective Three

Determine the taxonomic status of the three forms of *P. g. jamesoni*.

Actions Required

1. Facilitate research into the genetic distinctiveness of the three forms of *P. g. jamesoni*.

2. If appropriate, revise taxonomy.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.22 *POWELLIPHANTA GILLIESI* "HEAPHY"

Description

A medium-sized snail (maximum diameter 47 mm; height 22 mm) with a purplish brown, smooth callus. The dorsal surface is lined with fine, dark brown to almost black spiral bands. The ventral surface is a rich, dark reddish brown, with two thick black spiral bands near the periphery. This snail was only discovered c. 1990, and has yet to be formally described.

Habitat

A mid-altitude calcicol, found at 180–310 m a.s.l. on Tertiary limestones. Lives under litter in tall forest dominated by northern rata, kamahi, silver beech, toro and nikau.

Distribution

So far, this snail is known only from a 30–40 ha area on the true left of the Heaphy River just above its junction with the Gunner River. Judging from the availability nearby of similar habitat, its total range is likely to be no more than 1000 ha, and probably much less. Throughout its range *Powelliphanta gilliesi* "Heaphy" is sympatric with the much larger and more widespread *P. superba* "Gunner River".

Cause of Decline, and Threats

1. Predation by possums and rats are the main cause of this snail's unnaturally low density.

2. High numbers of possums and deer are threatening the viability of the forest ecosystem, causing extensive canopy dieback and browsing the understorey. The forest collapse is likely to have started with a pathogen attack on a particular tree species, as the collapse is widespread on the slopes of the lower Heaphy Valley.

Past Conservation Efforts

1. A 500 m^2 snail density-monitoring plot was established in 1995.

2. A possum-control operation (aerially distributed 1080 poison) was undertaken by DOC in 1994 and 1999 over the known range of *P. gilliesi* "Heaphy" to protect both the snails and the northern rata forest.

Current Conservation Status

1. From the small area sampled, density is apparently moderate to low (1.6 snails/100 m^2).

2. Ranked as 'nationally endangered' (Hitchmough 2002).

Long-term Recovery Goal

A moderately dense (> 6 snails/100 m^2) population that is stable or increasing throughout most of the range of *P. gilliesi* "Heaphy".

Objectives For The Next 10 Years

Objective One

Increase population size and productivity by sustained predator control.

Actions Required

1. Keep possum numbers steadily very low (< 3%, preferably < 1% RTC) over the range of the snail.

2. Select possum-control techniques, particularly in beech mast years, which also kill rats.

3. Extend geographic coverage, and increase the number, of snail density-monitoring plots and releaser at three-yearly intervals.

Objective Two

Extend knowledge of the conservation status of *P. gilliesi* "Heaphy".

Explanation

The late discovery of this large snail is due to the remote and difficult nature of the land it occupies. The area is away from main routes, and the combination of dense wet lowland forest on karst topography make walking and navigation difficult. However, to properly assess the urgency and priority of conservation management actions for *Powelliphanta gilliesi* "Heaphy", better knowledge of its range and population size is essential. Most other *P. gilliesi* subspecies have ranges that are very restricted, and early indications are that the range of *P. gilliesi* "Heaphy" will also be small.

Actions Required

Survey the Heaphy River catchment to determine the distribution and density of *P. gilliesi* "Heaphy", particularly just north of its known range and including the area between Cadigan Creek and the mid-Heaphy River, and the limestone areas between Ryan Creek and the middle stretch of the Gunner River.

Objective Three

Formally describe *P. gilliesi* "Heaphy".

Actions Required

1. Assess the genetic closeness of *P. gilliesi* "Heaphy" to its geographical and morphological nearest neighbour, the Saxon River form of *P. gilliesi jamesoni*.

2. If appropriate, formally describe the taxon.

Objective Four

Improve quality of snail habitat.

Actions Required

Keep deer numbers low in the snail habitat by regular control programmes.

Responsibility

Buller Area Office, West Coast Conservancy.

3.23 *POWELLIPHANTA GILLIESI COMPTA*

Description

Powelliphanta gilliesi compta is a medium-sized snail (maximum diameter 48 mm; height 28 mm) with a dark pinkish grey parietal callus, lightly scattered with granulations. The shell colour is warm golden brown, with fine dark brown spiral lines on the dorsal surface and periphery, and a secondary series of lines in light green. The base is largely plain, but deepens to streaks of russet brown around the umbilicus. Unlike all other *Powelliphanta*, *P. g. compta* shells all have a light brown zone inside the umbilicus which is rough in texture, almost like freshly sanded wood, so that the shell base appears matt rather than glossy.

Habitat

A mid-altitude snail that lives at about 610 m a.s.l. on the back slopes of a Tertiary limestone scarp in litter under a forest of silver beech, kamahi, toro, southern rata and rimu.

Distribution

The distribution of *Powelliphanta gilliesi compta* seems naturally small, with snails restricted to less than 300 ha on a remnant of limestone, The Castles, perched above the Rocky River on the eastern Aorere peneplain in Golden Bay.

Cause of Decline, and Threats

1. Burning of part of the snail's habitat during searches for gold in the 1860s, and logging of most of the lower-altitude forest in the 1950s and 1960s.

2. Predation on all ages of snail by rats and latterly possums, and predation on juvenile snails by thrushes and possibly hedgehogs.

3. Deterioration of the snail's micro-habitat through trampling and browsing by feral goats and deer.

Past Conservation Efforts

1. Possum control (ground trapping and cyanide poisoning) over the whole range of *Powelliphanta gilliesi compta* in 1995, followed by aerially delivered 1080 in 2000.

2. A 125 m^2 snail density-monitoring plot set up in 1991 was expanded to 500 m^2 and re*measured in 1995, 1998 and 2001. Ten more 100 m^2 plots were established in 2001.

Current Conservation Status

Now in moderate numbers (5.5 snails/100 m^2) over most of its very small range, *Powelliphanta gilliesi compta* was ranked 'vulnerable' by Hitchmough (2002).

Long-term Recovery Goal

Throughout the remaining forest at The Castles, a dense (> 12 snails/100 m^2) population of *Powelliphanta gilliesi compta* that is stable or increasing.

Objectives For The Next 10 Years

Objective One

Increase population density by sustained predator control.

Actions Required

1. Keep possum numbers steadily at very low levels (< 3% RTC, preferably < 1% RTC) over the range of the snail.

2. Select, particularly in beech mast years, possum-control techniques which also kill rats (1080, feracol). Use standard tracking and trapping methods to monitor rat and possum numbers annually so that the data can be used to both guide future control plans and determine the relationship between pest-mammal density and the health of the snail population.

3. Select a small part of the snail's habitat within which it is practicable to keep rat and hedgehog numbers low between possum-control operations. Grid the area with tracks and, using traps and poisons, annually carry out rat and hedgehog control.

4. To reduce the risk of poison shyness developing in the possum and rat populations, rotate control methods, and use possum-proof bait stations for rat control.

5. Ensure that there are at least four 100 m^2 plots for monitoring snail density within the rodent control area and measure snail density within all the plots regularly until the impact of pest control and snail population trends are clear.

Objective Two

Increase snail recruitment through habitat restoration.

Explanation

The block and fissure nature of the karst landscape of the The Castles makes it easy for introduced thrushes to find anvils to smash open the shells of *P. g. compta*. Low goat and deer numbers will assist in restoring a dense, moist forest understorey, which will in turn decrease the chances of thrushes locating and killing snails, and will reduce losses of juvenile snails to desiccation.

Actions Required

Keep goat and deer populations at very low levels throughout the range of *P. g. compta*.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.24 *POWELLIPHANTA GILLIESI FALLAX*

Description

A small to medium-sized snail (maximum diameter 48 mm; height 26 mm) of variable colouring. On most shells the base is a greenish colour with black axial streaks, but on others it is an unstreaked dark reddish brown. Narrow spiral bands of dark brown and green line the upper surface. The parietal callus is dark purplish brown and completely smooth.

In 1990, allozyme data showed unequivocally that *Powelliphanta gilliesi* snails at high altitude on Walker Ridge, on the southern end of Parapara Peak, with uniformly strong radial striping, were not *P. g. fallax* as originally thought, but a cryptic new species, *Powelliphanta* "Parapara".

Even among the remaining, largely low-altitude *P. g. fallax* snails, the genetic distance between snails from the northern and southern extremes of the range is as large as the genetic distance between many of Powell's original subspecies. Further taxonomic study of *P. g. fallax* is required.

Habitat

Powelliphanta gilliesi fallax is mostly a lowland species, though it occurs from sea level to at least 600 m a.s.l. It lives in the litter in calcium-rich soils on limestones and siltstones under forests of northern rata and pukatea with dense nikau understorey, and on relatively infertile soils under beech and rimu forests and in regenerating manuka shrublands.

Distribution

Powelliphanta gilliesi fallax occurs on the northern and eastern flanks of Parapara Peak in Golden Bay between the Parapara and Waikoropupu Rivers.

In the higher parts of its range, *P. g. fallax* is sympatric with the much larger *P. hochstetteri anatokiensis* and *P. superba superba*, and with the smaller, still undescribed snail, *Powelliphanta* "Parapara".

Cause of Decline, and Threats

1. Predation by rats, thrushes, hedgehogs, pigs and, in some populations, possums.

2. Destruction of forest habitat.

Past Conservation Efforts

1. In 1983 and 1985 the New Zealand Wildlife Service successfully lodged objections with the Planning Tribunal to mineral prospecting applications in *P. g. fallax* habitat on Parapara Ridge.

2. A systematic grid-square survey of the fauna and flora of the Parapara area, undertaken in 1986 by the New Zealand Forest Service, provided data on the distribution of *P. g. fallax* (S.P. Courtney, pers. comm.).

3. Since the mid-1980s, J. Walls has continuously trapped a variety of snail predators on about 15 ha of privately-owned habitat of *P. g. fallax* at Onekaka. This predator-control operation has focused on possums, but rats have also been caught.

4. A 500 m^2 snail-monitoring plot was set up in 1995 in the Pariwhakaoho catchment and was re*measured in 1998 and 2001. A further three 100 m^2 plots there, plus one at Waikoropupu, were established in 2001.

5. Possum-control operations (aerially distributed 1080 poison) carried out by the Department of Conservation in 1995 and 2000 on the upper slopes of Parapara Peak reduced possum numbers over about 50% of the range of *P. g. fallax*.

6. To protect *P. g. fallax*, rat, possum and hedgehog trapping over 5 ha of privately-owned snail habitat at Parapara Bush was initiated in 1999 by K.J. Walker and G.P. Elliott.

Current Conservation Status

While the habitat of this snail is continuing to be fragmented through vegetation clearance for farming and lifestyle blocks, *Powelliphanta gilliesi fallax* has successfully recolonised some areas of tall, dense manuka and gorse scrub.

The snail's main natural predator, weka, disappeared from the area in the mid-1990s. However rats, and to a lesser extent pigs, thrushes, hedgehog and possums, are having a substantial impact on the population density of *P. g. fallax*. In the snail-monitoring plots at Pariwhakaoho snail density was moderate (5.6– 6.2 snails/100 m^2) in 1995–98, but dropped to 0.9 snails/100 m^2 by 2001. The decline was apparently caused by a beech mast, the resultant rat plague and the onset of predation by possums. Snail densities are similarly low at Waikoropupu and Parapara.

Powelliphanta gilliesi fallax was ranked in 'gradual decline' by Hitchmough (2002).

Long-term Recovery Goal

Dense populations (> 12 snails/100 m^2) in at least three areas which protect the full range of diversity of *Powelliphanta gilliesi fallax*. Continued existence (albeit at lower numbers than before rats were present) over the full range of the taxon.

Objectives For The Next 10 Years

Objective One

Maintain a number of high-density representative snail populations by sustained predator control.

Explanation

The privately-initiated predator-control programmes at Onekaka and Parapara should be encouraged and supported to maximise the benefit to *Powelliphanta gilliesi fallax*.

The possum-control programme on Parapara Peak should be refined to ensure that as much lowland forest as possible is included in it, and that control techniques take into account the need to control rat numbers.

Actions Required

1. Provide the private landowners who are committed to voluntary predator control for *P. g. fallax* with sufficient rat, possum and hedgehog traps to carry out the work effectively.

2. Establish at least five 100 m^2 plots to monitor snail numbers in the predator control sites at both Parapara Bush and Onekaka, and an additional four in the Waikoropupu area where predators are not controlled. Regularly releaser all the plots to determine the level of predator control required for effective *P. g. fallax* conservation.

3. Use 1080 poison as the method to control possums, as frequently as the risk of 1080 shyness allows, as this poison also suppresses rat numbers for up to six months.

4. Through consultation, seek to extend the existing aerial possum-control programme at Parapara Peak to cover key privately-owned snail habitat.

5. Reduce possum numbers to low levels (< 3% RTC, preferably <1% RTC) on the north, east and southern flanks of Parapara Peak, and prevent possum numbers rising much beyond those levels.

6. Encourage and facilitate recreational pig hunting in the habitat of *P. g. fallax*.

Objective Two

Understand the genetic diversity within *P. g. fallax*.

Explanation

A better knowledge of the genetic make-up of *P. g. fallax* will ensure that conservation resources are managed to preserve the diversity within the taxon.

Actions Required

1. Collect representative empty shells of *P. g. fallax* from the Onehau, Onekaka and Waikoropupu powerhouse areas and compare their morphology with those from Parapara Bush and with the *P. g. fallax* type snails found on the mid-slopes (about 600 m a.s.l.) of eastern Parapara Peak.

2. Facilitate a study of mitochondrial DNA of all Parapara Peak *Powelliphanta*.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.25 *POWELLIPHANTA* "PARAPARA"

Description

A small to medium snail (maximum diameter 48 mm; height 26 mm). The shell has faint traces of dark narrow spiral stripes on the upper surface, similar to those of *Powelliphanta gilliesi*, but the main impression is of abundant, crowded, irregular brown and green wavy axial stripes over most of the shell. The parietal callus is smooth and dark purplish brown.

Allozyme and morphological data show *Powelliphanta* "Parapara" to be equi-distantly related to the *P. gilliesi* group and to *Powelliphanta* "Anatoki Range"—a high-altitude snail of tussock grasslands found just south of the range of *Powelliphanta* "Parapara". Snails similar to *Powelliphanta* "Anatoki Range" have been reported within the range of *Powelliphanta* "Parapara" on the alpine summit of Parapara Peak (Peter Jamieson, pers. coll.; and a single specimen marked 'Parapara Peak' in the Takaka Museum collection). It is possible that *Powelliphanta* "Parapara" arose from an early cross between *P. gilliesi* and *P.* "Anatoki Range". However, several intensive searches on the top of Parapara Peak have so far failed to locate any further evidence of *Powelliphanta* "Anatoki Range" presence. Today, *Powelliphanta* "Parapara" seems a highly stable species across a fairly large area with no sign of hybridization where it overlaps with *P. g. fallax*.

Habitat

Powelliphanta "Parapara" is an upland snail, found at 600–900 m a.s.l. under leaf litter in forest of silver beech, southern rata, quintinia and kamahi on calcium-rich soils on a marble substrate.

Distribution

The range of *Powelliphanta* "Parapara" is naturally small, being limited to the high montane southern and eastern slopes of Parapara Peak. It is sympatric with the much larger snails *P. superba superba* and *P. hochstetteri anatokiensis*, and in the lower part of its range, overlaps with the similarly sized snail *P. gilliesi fallax*.

Cause of Decline, and Threats

1. Severe predation by possums since about the 1970s, affecting the entire population.

2. Predation by feral pigs on some populations, and widespread predation of juvenile snails by thrushes and possibly hedgehogs, though the impact of the latter species is likely to be limited.

Past Conservation Efforts

1. Possum-control operations (aerially distributed 1080 poison) carried out by the Department of Conservation in 1995 and 2000 over about 75% of the range of *Powelliphanta* "Parapara".

2. A 500 m^2 snail-monitoring plot was set up in 1995 at Cedar Saddle, west of Walker Ridge, and re*measured in 1998. An additional nine 100 m^2 plots were established on the eastern slopes of Parapara Peak and on Walker Ridge in 2002.

Current Conservation Status

Density of *Powelliphanta* "Parapara" is now low (1.3–2.5 snails/100 m^2), and there is little sign of recovery since the first possum knock-down operation (although snail monitoring was probably inadequate to be sure of this).

Powelliphanta "Parapara" was ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A moderately dense (> 6 snails/100 m^2) population that is stable or increasing, in most of its naturally small range.

Objectives For The Next 10 Years

Increase population size by sustained predator control.

Explanation

Possums apparently began preying on *Powelliphanta* (all species) on Parapara Peak in the late 1970s, and now they are the primary cause of mortality in *Powelliphanta* "Parapara".

Feral pigs are uncommon but, along with thrushes, contribute to keeping snail numbers very low.

Actions Required

1. Throughout the habitat of *Powelliphanta* "Parapara", keep possum numbers steadily very low (< 3% RTC, preferably <1% RTC).

2. Encourage recreational pig hunting within the snail habitat.

3. Establish several more 100 m^2 snail-monitoring plots on Walker Ridge and releaser them two-yearly to assess the effectiveness of the possum-control regime.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.26 *POWELLIPHANTA SUPERBA SUPERBA*

Description

Powelliphanta superba superba has a large (maximum diameter 80 mm; height 40 mm) inflated shell, uniformly yellowish old gold in colour with a smooth, dark brown parietal callus. The body of the snail is a pink-grey colour, with a pale but distinct white frill along the margins of the foot.

Habitat

Lives in high-altitude forests (800–1150 m a.s.l.) on relatively infertile soils. Found under leaf litter, *Gahnia* skirts and bush rice grass and in high-altitude silver and mountain beech forests with quintinia, kamahi, *Dracophyllum townsoni*, southern rata, toro and occasional cedar.

Distribution

In forests on both the western and eastern sides of the Aorere Valley, in Golden Bay. It is found in a few small areas on the Burnett Range, from Mt Higgins to Mt White on the Wakamarama Range, on the southwestern slopes of Mt Olympus, on Cedar Ridge (the type locality) and Brown Cow Ridge on the Haupiri Range, and on the western, southern and northern flanks of Parapara Peak.

Sympatric with smaller *Powelliphanta gilliesi gilliesi*-like snails above Knuckle Hill and in the headwaters of Coal Creek, with *P. g. montana* at Bock Peak, with *P. g. compta* at The Castles, and with *P. g. fallax, P. "*Parapara*"* and the large *P. hochstetteri anatokiensis* on Parapara Peak.

Cause of Decline, and Threats

1. The major cause of the dramatic decline of this taxon has been intensive predation by possums at all sites since at least the 1970s. In the late 1970s, large numbers of empty, possum-damaged shells were conspicuous throughout the range of *Powelliphanta superba superba*. In three shell collections made between 1978 and 1981, 681 shells were collected and 96% of them were recently possum damaged (K.J. Walker, pers. obs.). By 2000, empty shells were much less frequently seen—2 shells/person hour on Parapara Peak and 15 shells/person hour on Bock Peak (G. Napp, pers. comm.), compared to 30 shells/person hour in 1979 (K.J. Walker, pers. obs.). Intensive searches for live snails found very low densities (< 0.3 snails/100 m^2). Unfortunately, live snail densities prior to 1970 are unknown, so the full scale of the population decline, presumed from changes in shell numbers and condition, cannot be determined.

2. Forest clearance and fires at the type locality.

3. Predation by thrushes and hedgehogs is also a threat, but the scale of their impact is unknown.

Past Conservation Efforts

1. Possum-control operations (aerially distributed 1080 poison) were under-taken by the Department of Conservation in 1995 and 2000 on Parapara Peak and in 1999 on the mid-Wakamarama Range.

2. A 500 m^2 snail-monitoring plot was set up in 1995 at Cedar Ridge, and re*measured in 1998. Only one live snail was found in this plot initially, and no snails were found in 1998.

3. Snail density was measured in seven 100 m^2 plots scattered to the north and south of Bock Peak, Wakamarama Range, in May 1999. In 2001 these were re*measured and a further five 100 m^2 plots were set up.

Current Conservation Status

Snail density declined dramatically in all colonies between the 1970s and the 1990s, and is now dangerously low (0.3 snails/100 m^2 at Bock Peak). It is very possible that without specific management action, the smaller populations will disappear within 25 years. *Powelliphanta superba superba* is classified as in 'serious decline' (Hitchmough 2002).

Long-term Recovery Goal

As a minimum goal: maintenance of a large stable population in the two largest colonies, on the southern Wakamarama Range and Parapara Peak, where they co-exist with many other *Powelliphanta* taxa. Preservation of a population at the type locality is also highly desirable.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Explanation

Most potential snail predators are either in low numbers (i.e. thrushes, hedge-hogs) or absent (i.e. rats, pigs) from the high-altitude forests where *Powelliphanta superba superba* lives, and this snail was apparently in good numbers till about the 1960s. Since then, predation by possums has become the prime cause of mortality, and even though possum numbers are relatively low, possums continue to have a major effect on the snail population.

The population of *P. s. superba* on Parapara Peak failed to respond to a reduction in possum numbers in 1995, though snail monitoring was limited to small areas and may have failed to detect pockets of recovery. Snail numbers before possum control had shrunk to less than 1 snail/500 m^2, and such a density is probably too low for snails to meet easily and breed, especially in the presence of other 'back-ground' causes of enhanced mortality (e.g. drought; predation by weka, thrush, hedgehog).

The present regime at both Parapara and Bock Peaks consists of a single possum-control operation every 6–7 years, with possum numbers rising considerably between knockdowns. If possum numbers are kept **steadily** very low for a long period, the snail population may gradually recover. However, it is probably not safe to assume the taxon will survive without some greater intervention and the best option may be to artificially increase the density of snails at several sites to trigger a more immediate response. This would require research into suitable techniques.

Actions Required

1. Keep possum numbers steadily at very low levels (< 3% RTC, preferably < 1% RTC) in at least two of the main colonies (Parapara Peak and the southern Wakamarama Range).

2. Regularly monitor snail numbers until the effect of the management regime becomes clear.

Objective Two

Improve quality of snail habitat.

Explanation

Deer and feral goats occur in most of the range of *P. s. superba* and low to moderate numbers of pigs live on parts of the Haupiri Range and Parapara Peak. All species degrade the snail habitat and reduce recruitment and survival.

Actions Required

Keep ungulate numbers low in the snail habitat by regular control programmes.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.27 *POWELLIPHANTA SUPERBA RICHARDSONI*

Description

Powelliphanta superba richardsoni is a large snail (maximum diameter 76 mm; height 36 mm), superficially similar in appearance to *P. s. superba*. However, the shapes of their shells differ, with the shell of *P. s. richardsoni* being more depressed than in typical *superba*. The inner whorls of *P. s. richardsoni* are sunken so that the apex barely appears above the outer or last whorl. The ground colour of the shell is old gold, but darker than in typical *superba*, and diffused with narrow, very pale reddish brown axial streaks and olive-coloured axial lines. Genetic studies found this snail quite distinct from neighbouring *P. s. superba* and *P. s. mouatae*.

Habitat

An upland snail, found at 850–1220 m a.s.l. on highly leached, infertile granite soils. *Powelliphanta superba richardsoni* lives under bush rice grass and litter beneath lichen-festooned silver beech forest with an understorey of *Dracophyllum traversi* and kapuka.

Distribution

Found from about Mt Perry to Kaka Saddle on the north end of the Gouland Range in Kahurangi National Park.

Cause of Decline, and Threats

1. Burning of about 50% of the snail's habitat from the 1860s to the 1880s during exploration and attempts at pastoralism.

2. Intense predation by possums at all sites since at least the 1970s.

Past Conservation Efforts

1. The Department of Conservation carried out possum control (aerially delivered 1080) over the whole range of the snail in 1995.

2. Establishment of a 500 m^2 plot to monitor snail density in 1995 and re-measurement in 1998 and 2000. A further five 100 m^2 plots were established in 2000.

Current Conservation Status

Powelliphanta superba richardsoni is in a poor state, with densities of live snails very low (0.7 snails/100 m^2) and no sign yet of recovery following initial possum control operations. It was ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A moderately dense (> 12 snails/100 m^2) population that is stable or increasing throughout the range of *P. s. richardsoni*.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Actions Required

Keep possum numbers steadily low (< 3% RTC, preferably < 1% RTC), throughout the range of the snail.

Objective Two

Determine population trends.

Actions Required

1. Increase the geographic spread and number of snail-monitoring plots. Establish eight to ten new 100 m^2 plots in sites representing the full range of *P. s. richardsoni* habitat.

2. Releaser the snail plots annually until population trends and the impacts of predator control are clear.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.28 *POWELLIPHANTA SUPERBA HARVEYI*

Description

A handsome subspecies with conspicuous broad axial streaks in reddish brown upon a yellowish brown glossy shell. The parietal callus is brown and sparsely but distinctly granulated. The spire is almost flat, with the sutural area deeply sunken (Powell 1979). It is a large snail, with a maximum diameter of 64 mm and height of 31 mm.

Habitat

Powelliphanta superba harveyi is an upland snail occurring at about 762 m a.s.l. under moss and *Gahnia* in stunted forest of mountain beech, pahautea, tanekaha and yellow-silver pine, and also under the skirts of red tussock in boggy clearings. The granite soils are highly leached and infertile, and the topography a gently undulating peneplain.

Distribution

This snail has a naturally limited range on the MacKay Downs, northwest of Heaphy River in Kahurangi National Park.

Cause of Decline, and Threats

1. Severe predation by possums since the late 1970s.

2. Loss of some forest and habitat degradation caused by fire and sheep grazing in the late 1890s.

Past Conservation Efforts

1. In 1994 a 500 m^2 snail-monitoring plot was established, and the numbers of live snails present was re*measured in 1996.

2. In 1993/94 a ground-based possum-control operation (traps and cyanide) was carried out over much of the range of *Powelliphanta superba harveyi*. Hand-laid 1080 poison was applied over much the same area in 1995, and possum numbers were monitored in 1996. In 1999 an aerial 1080 operation over all the Mackay Downs reduced possum numbers to 0.3% RTC.

Current Conservation Status

Powelliphanta superba harveyi was classified as 'nationally endangered' by Hitchmough (2002). Despite some possum control, snail numbers were still very low when last checked in 1996 (0.5 snails/100 m^2), and the long-term survival of the subspecies is uncertain.

Long-term Recovery Goal

A moderately dense (> 12 snails/100 m^2) population of *Powelliphanta superba harveyi* that is stable or increasing throughout most of its natural range.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Explanation

Although possum numbers are low in these infertile forests (3% RTC before possum control began in 1993), possums seem to be driving this snail to extinction. Large numbers of empty possum-damaged shells were visible on the MacKay Downs in early 1980s, but today both shells and live snails are rare.

Actions Required

1. Keep possum numbers steadily below 1% RTC over most of the range of *Powelliphanta superba harveyi* (including in the immediate vicinity of the Heaphy Track to ensure trampers have a chance to see snails) through regular control operations.

2. Regularly monitor possum density until the relationship between possum and snail numbers is better understood.

Objective Two

Determine population trends of *P. s. harveyi*.

Explanation

The existing single snail-sampling plot is too small and the population density too low to yield valid data about population trends. More monitoring plots are required, and they need to be spread to sample a wider area.

Actions Required

1. Establish at least ten to fifteen 100 m^2 snail-monitoring plots throughout the snail habitat.

2. Releaser both the existing and new plots two-yearly until the population trends are clear; thereafter as frequently as required to assess the impact of pest control measures.

Responsibility

Buller Area Office, West Coast Conservancy.

3.29 *POWELLIPHANTA SUPERBA MOUATAE*

Description

Powelliphanta superba mouatae is of medium size (maximum diameter 62 mm; height 36 mm) and the shell is a plain, cinnamon brown colour, with a few irregular axial streaks of darker brown. The whole shell appears glossy, and the parietal callus is dark brown and quite smooth.

Habitat

Lives under litter in high-altitude (600–900 m a.s.l.) silver and mountain beech forest with occasional cedar and southern rata; less frequently found under red tussock skirts in boggy clearings within the forest.

Distribution

Powelliphanta superba mouatae has a naturally limited distribution of less than 1200 ha in the headwaters of the Saxon River on the Gouland Downs, Kahurangi National Park. The range of this subspecies abuts that of *P. s. superba* on the northern slopes of the Slate Range, and that of *P. s. harveyi* west of Mt Teddy. *Powelliphanta superba mouatae* is sympatric with the smaller snail *P. gilliesi jamesoni* on the lower southern and western slopes of the Slate Range.

Cause of Decline, and Threats

1. Severe predation by possums since the late 1970s. In the 1980s large numbers of empty damaged shells were conspicuous throughout the range of *Powelliphanta superba mouatae*. The cause of death for the great majority of these snails was predation by possums, which had probably reached high numbers in the area only in the late 1960s. By 2000, empty shells were seldom seen and intensive live snail searches found very low densities of live snails. Unfortunately live snail densities before the possum invasion in the 1960–70s are unknown, so the full scale of the population decline, presumed from changes in shell numbers and condition, cannot be determined.

2. Loss of some forest habitat to fire and sheep grazing in the late 1890s.

Past Conservation Efforts

1. In 1994, an aerial 1080 poison operation to control possum numbers over the entire range of *Powelliphanta superba mouatae*. Annual possum control using feratox and traps has been undertaken over 100 ha of habitat in the Saxon River headwaters since 2000.

2. A 300 m^2 plot to monitor snail density was established in 1991 and a second 400 m^2 plot was set up in 1994. The number of live snails in these plots was re-measured in 1994, 1996 and 1999. A further six 100 m^2 plots were set up in 2000/01.

Current Conservation Status

Ranked as 'nationally endangered' (Hitchmough 2002), with snail numbers everywhere now being very low (1.1 snails/100 m^2). No recovery has yet been detected following the start of predator control. It is unclear whether *Powelliphanta superba mouatae* can persist, at very low densities, or whether it is headed for extinction in the medium term (about 50 years).

Long-term Recovery Goal

A moderately dense population (> 12 snails/100 m^2) over most of the snail's range.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Explanation

Most of the usual introduced predators of *Powelliphanta* are either absent (pigs) or rare (rats and hedgehogs) in the high-altitude forests where *Powelliphanta superba mouatae* occurs. However possums, though rare (11.1% RTC in 1994 before the first possum control operation; 1% RTC in 1995, but about 5.5% RTC by 1999), seem to be driving this snail to extinction.

The forests in the headwaters of the Saxon River contain limited numbers of plant species which possums find palatable. For this reason snails may be an important component of the possum diet, and may be sought out even when scarce. The gradual increase of possum numbers after each possum control operation exacerbates this problem.

Actions Required

1. In most of the habitat of *P. s. mouatae*, keep possum numbers steadily below 1% RTC (i.e. to barely detectable levels) through regular control operations.

2. Regularly rotate possum control methods (cyanide and 1080 poisons, and trapping) to avoid shyness.

3. Due to the presence of great spotted kiwi and weka in the Saxon headwaters, set all traps and bait stations at least 1.5 m above the ground.

4. Establish five more 100 m^2 snail-monitoring plots throughout the possum control area, and measure the snail density two-yearly in these and the existing two larger plots.

Objective Two

Artificially increase snail density to trigger a population recovery.

Explanation

There is some evidence that the lack of response by *P. s. mouatae* and most other *P. superba* subspecies to lower possum numbers is a result of the very low densities to which the snails have been reduced. The snails are now so sparse that they probably meet and mate only rarely, and thus have a low productivity. As a result, even at very low possum densities, the rate of predation by possums may exceed snail productivity.

Population density should be experimentally increased in a small area, while keeping possum numbers steadily very low. Snail population size and structure should be regularly measured in both the area of enhanced snail density and that of low snail - density. This detailed study of *P. s. mouatae* could provide information useful for other less accessible *P. superba* subspecies.

Actions Required

1. Erect several 500 m^2 snail-proof enclosures in good snail habitat in the Saxon River headwaters.

2. Collect up to 30 adult *P. s. mouatae* from the near each enclosure; measure and number each snail and place it inside the enclosure.

3. Keep possum numbers around the enclosures very low (through Objective One).

4. Annually assess live snails for size and health inside the enclosures and compare the density data with that from the standard monitoring plots described in Objective One, Action 4.

Responsibility

Golden Bay Area Office, Nelson/Marlborough Conservancy.

3.30 *POWELLIPHANTA SUPERBA PROUSEORUM*

Description

The largest *Powelliphanta* is *P. superba prouseorum* which measures a gigantic 90 mm across (height 40 mm). The fist-sized snail weighs over 90 g, about the same as a tui. It has an old-gold coloured shell, with a finely granulated, purplish brown parietal callus. The granulated callus and larger size is the feature which best distinguishes it from the similarly coloured *P. s. superba*. There is substantial morphological variation within *P. s. prouseorum*; for example, snails just north of the Heaphy River mouth are only half the usual size (maximum diameter 65 mm). Along the eastern edge of its range *P. s. prouseorum* meets and overlaps the range of *P. s. harveyi*.

Habitat

A mid- to high-altitude (450–610 m a.s.l.) snail, usually found under litter and *Gahnia* clumps in forest of southern rata, quintinia and mountain beech. Also under red tussock in boggy clearings amid mountain beech and bog-pine scrub. *Powelliphanta superba prouseorum* mostly occurs on highly leached and impoverished granite soils.

Distribution

Between the Anaweka and Heaphy Rivers, along the western flanks of the MacKay Downs and the Iwituaroa Range in northwestern Kahurangi National Park.

Cause of Decline, and Threats

Since the late 1970s, intensive predation by possums.

Past Conservation Efforts

So far there have been no efforts towards conservation of *Powelliphanta superba prouseorum*.

Current Conservation Status

Powelliphanta superba prouseorum is classified as 'nationally endangered' (Hitchmough 2002), having high levels of pest-induced mortality, low numbers throughout its range and no restorative management programme yet in place.

Long-term Recovery Goal

A moderately dense (> 12 snails/100 m^2) population that is stable or increasing over most of its natural range.

Objectives For The Next 10 Years

Objective One

Determine population size.

Explanation

The distribution and density of *Powelliphanta superba prouseorum* is poorly known because of the comparatively remote nature of its habitat. As with other upland *P. superba* snails in the Heaphy area, gaining information on population trends is likely to be a slow process due to the difficulties of meaningful monitoring when population numbers are so low.

Actions Required

1. Undertake walk-through transects in specific areas, collecting all shells found in timed searches. Identify cause of death for all fresh shells found.

2. Once the snail's distribution is better understood, establish at least fifteen 100 m^2 snail plots across the core snail habitat. Monitor plots every two years until population trends and the impact of conservation measures are clear.

Objective Two

Increase population size by sustained pest control.

Explanation

Possums were first seen at Kahurangi Point in 1959, and their spread at first was apparently slow. In the 1960's there was little sign of snail predation by possums, with 34 intact shells and one possum-damaged shell found by F. Climo in the mid-upper Kahurangi River in 1964 (Museum of New Zealand collection). Les Pracy trapped only four possums in the Heaphy Valley in the early 1970s. However, by 1980 the situation had changed dramatically, with 76% of 80 shells found in the upper Kahurangi River damaged by possums, and by 1988, though many possum-damaged shells were found, it took over 6 person hours to find one small live snail (K.J. Walker & G.P. Elliott, pers. obs). In 1999 a walk across the middle of the snail's range, from Rocks Point to the top of the MacKay Downs, yielded only three *P. s. prouseorum* shells (G. Napp, pers. comm.).

Since 1994, possum numbers have gradually been lowered in all the adjacent forests and tussocklands, and to prevent re-invasion of those lands, as well as to protect *P.s. prouseorum*, the possum control programme should be expanded to include all *P.s. prouseorum* habitat.

Actions Required

1. Keep possum numbers steadily low (< 1% RTC).

2. Monitor possum numbers prior to control operations, to determine the correlation between possum density and any snail recovery.

Responsibility

Buller Area Office, West Coast Conservancy.

3.31 *POWELLIPHANTA SUPERBA* "GUNNER RIVER"

Description

A medium- to large-sized snail (maximum diameter 61 mm; height 28 mm) with a finely granulated tan parietal callus. The shell is also tan, lighter on the top than on the bottom, and completely covered in reddish brown, yellow and tan axial streaks.

There is substantial variability within the taxon, with the shells of lowland populations being larger (up to 67 mm diameter), darker and more uniform in colour than those in the high-altitude colonies. The lowland populations have a smooth parietal callus.

The snail was first discovered in 1982 (Walker 1982b) during a survey of the distribution of *Powelliphanta annectens*, and has yet to be formally described. It is very likely that the lowland and upland Gunner River snails should be considered as two new subspecies of *P. superba* rather than as one.

Habitat

Under moss and litter in high-altitude (914 m a.s.l.) forests of silver beech on limestone and in mountain beech forests (and occasionally under red tussock) on granite soils; and under litter in low-altitude (30–305 m a.s.l.) silver beech and northern rata forest on karst landforms, and in nikau forest on alluvial river flats.

Distribution

On the northeastern flanks of the Gunner Downs in the headwaters of the Gunner River; and on limestone plateaux on either side of Gunner River near its confluence with the Heaphy River in Kahurangi National Park. On the northern side of the lower Gunner River, it is sympatric with another undescribed snail, *Powelliphanta gilliesi* "Heaphy".

Cause of Decline, and Threats

1. Intensive predation by possums since the late 1970s.

2. Predation by rats and song thrushes in the lowland colonies.

Past Conservation Efforts

1. A 500 m^2 density-monitoring plot was established in 1994 in the low-altitude population near the Heaphy River.

2. Possum numbers were reduced over much of the low-altitude and some of the high-altitude habitat of *P. superba* "Gunner River" by aerially delivered 1080 poison in 1993/4, with follow-up ground control in 1996/7 beside the lower Heaphy and Gunner Rivers.

3. Possum control was carried out in the northern end of the snail's range between Ryans Creek and the Heaphy River using aerially delivered 1080 in 1999, and on the lower Heaphy River flats using ground trapping in 2000.

Current Conservation Status

Powelliphanta superba "Gunner River" is classified as 'nationally endangered' (Hitchmough 2002).

Long-term Recovery Goal

A moderately dense (>12 snails/100 m^2) population that is stable or increasing, of both the lowland and upland forms of *Powelliphanta superba* "Gunner River".

Objectives For The Next 10 Years

Objective One

Determine population size and conservation status.

Explanation

The remote and rugged nature of the habitat of *Powelliphanta superba* "Gunner River" is the cause of its late discovery and poorly known status. Some limited possum predation was apparent in the upland colony in 1982, but it has almost certainly increased greatly since then, as it did for every other population of *P. superba* in the Heaphy area in the 1980s and 1990s. More information on the status of upland *P. superba* "Gunner River", and on the location of the northeastern boundaries of both the upland and lowland populations, is needed to guide conservation management activities.

Actions Required

1. Survey the distribution of *P. superba* "Gunner River" in the forests on the northern and southeastern flanks of Charlies Flag and Mt Ross by walk-through transects, collecting all shells found in timed searches. Identify cause of death for all fresh shells collected.

2. Establish fifteen 100 m^2 snail-monitoring plots in accessible sites to collect data representative of the full range of the upland populations, and a further ten 100 m^2 plots in the lowland colonies. Monitor plots every two years until population trends and the impact of conservation measures are clear.

Objective Two

Increase population size by sustained predator control.

Actions Required

1. Keep possum numbers steadily at very low levels (< 3% RTC, preferably < 1% RTC) in the low-altitude colonies and, depending on the outcome of Objective One, also in the high-altitude population. Select possum-control techniques for the low-altitude colonies which also kill rats (1080, fercol).

2. Monitor possum and rat density before each control operation and monitor snail density plots regularly to establish the nature of the relationship between pest density and snail health.

Objective Three

Determine the taxonomic status of the Gunner River snails.

Actions Required

1. Facilitate a study of the genetic distinctiveness of the Gunner River snails (both lowland and upland forms) and the relationship between the Gunner River snails and *P. superba* and *P. annectens*.

2. If appropriate, describe and name the Gunner River *Powelliphanta*.

Objective Four

Improve quality of the habitat of lowland *P. superba* "Gunner River".

Explanation

Moderate to high deer numbers in the lower Heaphy River Valley have caused a thinning of the understorey and forest floor, allowing thrushes to find and kill large numbers of juvenile *P. superba* "Gunner River". Around the 1980s a (presumably natural) wide-spread die-off of beech trees in the terraces above the lower Heaphy River caused forest collapse, and a substantial deer population is inhibiting their recovery.

Actions Required

Reduce deer numbers on the limestone plateaux and river flats in the lower Gunner River and Heaphy River valleys.

Responsibility

Buller Area Office, West Coast Conservancy.

3.32 *POWELLIPHANTA ANNECTENS*

Description

Powelliphanta annectens is a very large snail (maximum diameter 85 mm; height 38 mm) with a deep purple parietal callus, thickly crowded with large granules. The top third of the shell has a matt appearance because it is densely sculptured with fine spiral striae, but the remainder of the shell is glossy. The background colour of the shell is reddish brown, striped with close, narrow axial streaks of claret brown, sepia and black. The black foot has a white frill around the edge; the only *Powelliphanta* to be decorated so, although a faint trace of a frill is seen on *P. superba* (K.J. Walker, pers. obs.). In the northern part of its range, *P. annectens* merges in a clinal fashion on Bellbird Ridge with the undescribed upland snail *P. superba* "Gunner River", and overlaps at the Heaphy Hut with the distinctive lowland form of *P. superba* "Gunner River".

Habitat

The densest populations of *Powelliphanta annectens* are: in silver beech forest at high altitudes (between 610 m and 975 m a.s.l.) on granite soils; on alluvial soils on limestone substrate in silver and red beech forest with occasional rimu at 150– 245 m a.s.l., and in nikau forests on alluvial soils on coastal flats at the mouths of small creeks just above sea level. *Powelliphanta annectens* also lives in low to very low densities in the mid-altitude forest of kamahi, quintinia, rimu and southern rata found between the areas of high snail density.

Distribution

Powelliphanta annectens occurs in a narrow band beside the lower and middle Oparara River, on the plateau west of the Oparara River, and on the western flanks of the Gunner Downs between the Kohaihai River and Bellbird Ridge. There are three small outlying populations of uncertain status: one on the northern end of the Stormy Range, one on the eastern slopes of the Fenian Range above the mid-reaches of the Ugly River, and one on both sides of the Karamea River near its junction with Fuschia Creek.

Cause of Decline, and Threats

1. Possum predation since the 1970s on all populations, with particularly severe impacts in the high-altitude snail colonies.

2. Logging of a large proportion of the snail's habitat in the Oparara Valley in the 1980s, followed by fires in the remnant vegetation and replanting with exotic species.

3. Predation by rats in all the low-altitude colonies, and by thrushes particularly along tracks and roads and in open areas.

Past Conservation Efforts

1. Comprehensive survey in 1982 of the distribution and density of *Powelliphanta annectens* (Walker 1982b) as part of the New Zealand Wildlife Service submission to the New Zealand Forest Service, seeking a halt to the Oparara logging.

2. A 500 m^2 plot to monitor *P. annectens* density at the Heaphy River mouth was established in 1994 and re*measured in 1996, 2000 and 2002. A further three 100 m^2 plots were established there and on Bellbird Ridge in 2000, and in 2002, three more were added on Bellbird Ridge.

3. Possums were trapped and poisoned in a narrow band of coastal forest between the Kohaihai and Heaphy Rivers in 1993/4 and over a small area around the Heaphy Hut in 1996/7, largely for northern rata protection. Possums were poisoned (aerially delivered 1080) on the western flanks of the Gunner Downs between the Bellbird Ridge and Katipo Stream in 1993/4, and in 1999.

Current Conservation Status

Powelliphanta annectens was ranked in 'serious decline' by Hitchmough (2002). Its conservation status varies considerably across its range, with small localised populations at the mouths of the Swan Burn and Heaphy River having relatively high numbers in 2002 (24 snails/100 m^2), the upland populations in low numbers (3.5 snails/100 m^2), and the populations at the Oparara Arches being somewhere between.

Long-term Recovery Goal

Stable or increasing snail populations representative of the full range of genetic and morphological diversity in *Powelliphanta annectens*.

Objectives For The Next 10 Years

Objective One

Determine the population trends in both low-altitude and upland populations of *Powelliphanta annectens*.

Explanation

Unfortunately, the monitoring plots at the Heaphy River mouth are measuring a somewhat atypical *P. annectens* colony, where rats rather than possums are the major cause of mortality. Additional information on population trends in the high-altitude snail colonies and in the Oparara Valley and Plateau is urgently required.

Actions Required

1. Establish at least five 100 m^2 plots on the ridges between Katipo Creek and the Swan Burn at 760–1000 m a.s.l.; five 100 m^2 plots between Little Arch and the Top Arch in the Oparara Valley; two 100 m^2 plots on the Oparara Plateau, and one 100 m^2 plot near the quarry where the Oparara River emerges from the hills.

2. Measure snail numbers in the new plots every two years until the population trends in the different environments are apparent.

Objective Two

Increase population size by sustained predator control.

Actions Required

1. Keep possum numbers steadily below 3% RTC (preferably < 1% RTC) on the western flanks of the Gunner Downs and in the Oparara Valley.

2. Rotate possum control methods, and in lowland sites use methods which also kill rats.

3. Monitor possum numbers regularly, including prior to control operations to allow information to be gathered on the relationship between pest numbers and snail health.

Objective Three

Increase population size by increasing the area of snail habitat available.

Actions Required

After the first crop of exotic trees is harvested from the Oparara Valley, allow the native forest to regenerate rather than replanting with exotic plantation species, and legally protect the land from future logging.

Responsibility

Buller Area Office, West Coast Conservancy.

3.33 *POWELLIPHANTA LIGNARIA LIGNARIA*

Description

A medium-sized snail (maximum diameter 65 mm; height 39 mm) with a beautiful, very distinctive shell. The base is glossy and has a yellowish ground colour while the top has a reddish ground colour and is minutely spirally sculptured so that it appears matt. The colour division occurs sharply, just above the periphery and coincides with the outer extremity of the spiral sculpture. The whole shell is covered with axial stripes of dark reddish brown to almost black. These stripes tend to be narrow so that much of the ground colour shows through.

Habitat

Under litter and logs in dense, low-altitude rain forest of beech, northern rata, rimu, supplejack and kiekie. The substrate is calcium-rich, formed largely on limestone, although a small part of the snail's range is on a sandstone basement.

Distribution

Found just north of the Mokihinui River mouth, between the Karamea Bluffs Road and the coast, with the snail's northern boundary being the ridge between Kongahu Point and the saddle between Carlins Flat and Corbyvale.

Cause of Decline, and Threats

1. Predation by rats and possums, and to a much lesser extent thrushes and probably hedgehogs.

2. Podocarps were logged from almost 50% of the forest habitat of *Powelliphanta lignaria lignaria* in the early 1900s, but this caused only a temporary loss of snail habitat as fortunately much of the logged area was left to regenerate. Conversion to pasture occurred in the headwaters of Six Mile Creek (Carlins Flat), around Stillwater and Mumm Creeks and on the coast south of Gentle Annie Point, causing the loss of between 5% and 10% of the forest habitat of *P. l. lignaria*.

Past Conservation Efforts

1. Ground-based and, subsequently, aerial 1080 possum control for TB protection by the West Coast Regional Council over at least 50% of the range of *P. l. lignaria* in 1994/95 would have incidentally helped *P. l. lignaria*. The Department of Conservation carried out limited ground control of possums in 1997 between the Karamea Bluffs and Six Mile Creek, reducing possum numbers from 18.5% RTC to 5% RTC. It also carried out an aerial 1080 operation in the northern end of the snail habitat in 2000, while the West Coast Regional Council carried out ground control along the southern boundaries.

2. A 500 m^2 plot established on the Karamea Bluffs in 1994 to monitor live snail density was re*measured in 2000 and 2002, and an additional six 100 m^2 plots were established at Sawyer and Six Mile Creeks in 2000.

Current Conservation Status

Until the late 1980s *Powelliphanta lignaria lignaria* was considered relatively secure as the snails were still present in about 85% of the original 5400 ha range, and only rats seemed to be having a significant impact on the snail population.

However, in the early 1990s, predation of *P. l. lignaria* by possums began, and live snail numbers were found to be much lower (2.7 snails/100 m^2 in 2000) than originally thought. Because of the patchwork of land ownership, comprehensive and consistent reduction in possum numbers over the snail's range has been difficult to achieve. *Powelliphanta lignaria lignaria* is now ranked as 'vulnerable' (Hitchmough 2002).

Long-term Recovery Goal

A stable, dense (> 12 snails/100 m^2) population of *Powelliphanta lignaria lignaria* over most of its naturally small range.

Objectives For The Next 10 Years

Objective One

Increase population density by sustained predator control.

Explanation

Given the area of habitat available, it is likely that the snail population could survive, albeit at substantially reduced densities, if rats were the only significant predator. Unfortunately predation by possums, by itself, can cause snail populations to collapse, and when it is combined with predation by rats, is cause for considerable concern.

Hedgehogs are a potential problem for *Powelliphanta lignaria lignaria.* Their presence in wet forests was, until recently, unsuspected and their potential impact probably underestimated. However, hedgehogs, like thrushes, can attack only juvenile *P. l. lignaria* so their effect is probably much less than that of possums and rats.

Actions Required

1. Keep possum numbers consistently low (< 3% RTC, preferably < 1% RTC) over the full range of *P. l. lignaria*. Regularly alternate traditional methods of possum control (cyanide and trapping) with use of 1080 poison, as this poison will also significantly reduce rat numbers for up to six months. Use 1080 in any winter that follows a beech mast summer when rat numbers will be particularly high.

2. Establish at least ten 100 m^2 snail-monitoring plots throughout the snail's range, and releaser snail density within the plots every 2–3 years.

Objective Two

Increase size of snail population by habitat protection and enhancement.

Actions Required

1. Pursue the protection of privately-owned habitat of *P. l. lignaria* through purchase by the Crown or arranging private covenants.

2. Encourage restoration of forest margins by fencing to exclude stock.

Responsibility

Buller Area Office, West Coast Conservancy.

3.34 *POWELLIPHANTA LIGNARIA LUSCA*

Description

Powelliphanta lignaria lusca is a medium-sized snail (maximum diameter 58 mm; height 35 mm) with a solid, heavily calcified shell. The shell is similar to, but readily distinguished from, that of *P. l. lignaria*. The ground colour of the shell is reddish brown and the whole shell is covered with dark reddish brown to black axial stripes. The base of the shell is glossy, but above the periphery minute spiral sculpturing gives the surface a matt appearance. The parietal callus is white and smooth.

Habitat

A lowland species, found on calcium-rich limestone soils from sea level to 30 m a.s.l. *Powelliphanta lignaria lusca* lives under bush rice grass and litter in forests of rimu, miro, silver and red beech, kamahi and toro, often with an understorey of tree ferns. Though snails occur in hard beech forest on drier ridges, the highest snail numbers are found on fertile alluvial soils in moist river valleys.

Distribution

From the mouth of Little Wanganui River to Kongahu Point, and inland to State Highway 67 on the Karamea Bluffs, North Westland.

Cause of Decline, and Threats

1. Predation by rats and, since the 1980s, possums; to a much lesser extent, predation by thrushes and probably hedgehogs.

2. Conversion of the snail's forest habitat into pasture at Corbyvale, at the mouths of Glasseye Creek and Falls Creek and from there, along a narrow coastal strip to Kongahu Point.

3. About 50% of the habitat of *P. l. lusca* is privately owned, and there is an on-going threat of further forest logging and conversion to pasture.

4. Construction of a highway through prime snail habitat around Happy Valley Saddle has led to locally high mortality (road kill).

Past Conservation Efforts

1. A walk-through survey of snail presence between Lake Hanlon and the road bridge over Glasseye Creek was carried out in 1986.

2. A possum-control operation over much of the habitat of *Powelliphanta lignaria lusca* was carried out by the West Coast Regional Council for TB control in 1993/94 and an aerial 1080 operation over the eastern edges of the block in 1998. In 2000 the Department of Conservation carried out an aerial 1080 operation over the southern end of the snail habitat.

3. A 500 m^2 plot to measure live snail density was established at Lake Hanlon in 1994 and another at Happy Valley Saddle in 1995 (re*measured in 2000). An additional 100 m^2 plots were set up at the mouth of Glasseye Creek and three more below Glasseye Creek bridge in the summer of 2000.

Current Conservation Status

The average density of *Powelliphanta lignaria lusca* is moderate to low, at 2.7 snails/100 m^2. However, the status of the populations varies greatly, with a few colonies near the coast suffering very little predation and in high numbers (7 snails/100 m^2), those at Happy Valley in moderate health (2.8 snails/100 m^2) and those at Lake Hanlon almost extinct (< 0.01 snails/100 m^2). The subspecies was ranked as 'vulnerable' by Hitchmough (2002).

Long-term Recovery Goal

A dense (> 12 snails/100 m^2) population of *Powelliphanta lignaria lusca* that is stable or increasing over most of its natural range.

Objectives For The Next 10 Years

Objective One

Increase population density by sustained predator control.

Actions Required

1. Keep possum numbers steadily low (< 3% RTC, preferably <1% RTC) over the full range of *Powelliphanta lignaria lusca*. Regularly alternate traditional methods of possum control (cyanide and trapping) with use of 1080 and feracol poisons, as these will also reduce rat numbers. Use 1080 in any winter that follows a summer of heavy beech seeding when rat numbers will be particularly high.

2. Increase the number and geographic spread of snail-monitoring plots. Measure live snail density every two years until the impact of pest-control measures and snail population trends are clear. Monitor possum and rat density prior to each control operation to determine the relationship between pest-mammal density and snail health in this environment.

Objective Two

Improve quality and quantity of snail habitat.

Actions Required

1. Negotiate legal protection of the forests in privately-owned snail habitat near Corbyvale and Little Wanganui.

2. Encourage restoration of forest margins by fencing to exclude stock from the snail habitat.

3. Keep deer numbers low to allow regeneration of a dense forest understorey, to protect the snails from predation by weka and thrushes.

Responsibility

Buller Area Office, West Coast Conservancy.

3.35 *POWELLIPHANTA LIGNARIA OCONNORI*

Description

A medium to large snail (maximum diameter 52 mm; height 42 mm) with a smooth, bluish white parietal callus. At the type locality in the Leslie Valley, the background colour of the shell is a warm cinnamon brown. Very fine, narrow, reddish brown to black spiral lines cover the whole shell, and these are overlaid by a smaller number of irregular diffused dark brown to black axial stripes.

The shells of snails to the east of Leslie Valley have an orange-brown background and only a few sparse black axial stripes. In the western snail populations the axial stripes are abundant and the shell appears much darker.

Habitat

Powelliphanta lignaria oconnori is a low- to mid-altitude snail, mostly living at 335–488 m a.s.l., but also occurring down to 180 m a.s.l. and up to 900 m a.s.l. It is found almost exclusively on calcium-rich mudstone and limestone substrates. It lives under litter in red and silver beech forest, and also on alluvial flats in forests of matai, kahikatea, totara and rimu.

Distribution

This snail is known from two separate localities in the lower and middle reaches of the Karamea River in Kahurangi National Park. It is found around the lower reaches of Kakapo River and at Paryphanta Saddle near the Karamea Gorge, and on limestone tallus slopes and alluvial terraces beside the middle reaches of the Karamea River between the Leslie and Crow Rivers.

It is possible that the two populations are contiguous, with snails occurring on the true left of the Karamea River on the footslopes of Garabaldi Plateau. A small population is already known to exist on the true right of the Karamea River near its junction with the Roaring Lion.

The distribution of *Powelliphanta lignaria oconnori* is closely correlated with the distribution of limestone in the area.

Cause of Decline, and Threats

1. Predation by rats and thrushes in all colonies.

2. Since about 1990, predation by possums on some of the snail populations in both the Leslie and Kakapo Valleys. The extension of predation by possums into all colonies is a threat.

3. Probably increased predation by weka, made possible by deer – and in the upper Karamea goat – induced thinning of the forest understorey.

Current Conservation Status

Powelliphanta lignaria oconnori was ranked 'vulnerable' by Hitchmough (2002) because, relative to other *Powelliphanta*, it has a wide distribution, has two separate populations, and snail numbers are moderate despite significant predation by rats in the colonies in podocarp forests. However, possums also began to prey on some snail colonies in both populations in the early 1990s, putting the populations at greater risk.

The average density of *P. l. oconnori* in 2000 was moderate, at 4.1 snails/100 m^2. However, the status of the populations varies widely; a few small sites suffer very little predation and are in very high numbers (20–30 snails/100 m^2), while most are in moderate numbers and a few are in very low numbers (0.6 snails/100 m^2).

Past Conservation Efforts

A single 500 m^2 snail density-monitoring plot was established in each snail population in the mid-1990s, and re*measured in 2000. An additional twelve 100 m^2 plots were established near Karamea Bend and Wilkinson Creek in 2000.

Long-term Recovery Goal

Dense (> 15 snails/100 m^2) and stable or increasing snail colonies in both the Kakapo and mid-Karamea populations of *Powelliphanta lignaria oconnori*.

Objectives For The Next 10 Years

Objective One

Increase snail numbers by predator control.

Explanation

Possums have only recently turned to eating *Powelliphanta lignaria oconnori* snails, so snail density is still moderate and populations may be capable of relatively rapid recovery with possum control alone. From experience elsewhere, for best effect it is important to begin possum control early, before snail populations become too sparse to respond.

Possum numbers should be reduced over most of the range of this snail to decrease predation in presently affected populations and to decrease the likelihood of predation starting in other snail colonies. If possum populations are kept below the carrying capacity of the vegetation, it is possible that predation of snails may never occur.

While about 50% of snail deaths are caused by possums, in heavy podocarp fruiting years rats account for a further 25%, and in the areas selected for possum control, rat numbers should be also kept low.

Actions Required

1. Keep possum density steadily below 3% RTC, preferably under 1% RTC, within the core snail areas.

2. Choose possum-control techniques and strategies which are also effective in controlling rat numbers (1080, feracol), particularly in the winters following heavy beech or podocarp seeding.

3. On the river flats between the mid-Leslie River and the junction of the Crow and Karamea Rivers, where podocarps predominate and rat numbers reach high densities, keep rat numbers low through poison-baiting or trapping programmes at six-monthly intervals in the periods between the (less frequent) possum control operations.

Rat control here will make snails more visible in an area heavily used by recreationalists; will increase the productivity and survival of birds such as kaka, parakeet and robin which breed in the podocarp forest, and will allow better regeneration of these significant stands of lowland forest as less seed will be destroyed by rats.

Objective Two

Determine population trends of *P. l. oconnori*.

Actions Required

Increase the number and geographic spread of snail-monitoring plots in the Kakapo Valley, and releaser these and the existing plots in the upper Karamea regularly until the impact of predator control measures is clear.

Objective Three

Improve snail recruitment and survival by improving habitat quality.

Explanation

The sunny limestone bluffs beside the Karamea River provide good goat habitat, and goats and deer are reasonably common throughout the snail's range. However, goat- and deer-induced thinning of the forest understorey is probably increasing predation by weka and thrushes on *P. l. oconnori*.

Actions Required

Keep numbers of feral goats and deer low within the snail habitat.

Objective Four

Define more accurately the distribution of *P. l. oconnori*.

Actions Required

1. Systematically survey for *P. l. oconnori* in the headwaters and on the true right of the Leslie River; on the true left of the Karamea River between Karamea Bend and Karamea Gorge, and around the margins of the Kakapo Valley population.

2. Carry out timed searches for shells during the distribution survey and examine all shells found for cause of death to determine the status of the boundary snail populations.

Responsibility

Karamea-Leslie: Motueka Area Office, Nelson/Marlborough Conservancy.

Kakapo Valley: Buller Area Office, West Coast Conservancy.

3.36 *POWELLIPHANTA LIGNARIA RUFORADIATA*

Description

A snail with a medium–large (maximum diameter 58 mm; height 29 mm) inflated shell having irregular, dark reddish brown axial streaks on a khaki background. The parietal callus is smooth.

Habitat

Low- to mid-altitude (150–400 m a.s.l.) forests on fertile soils; the largest populations (and biggest individuals) occur on calcium-rich limestone and mudstone substrates. Found under leaf litter and bush rice grass in beech forest.

Distribution

On the lower slopes of Maori Gully (type), with smaller populations on river terraces on the north side of Mokihinui River near the Mokihinui Forks.

Powelliphanta lignaria ruforadiata on the floodplains between Sinclair Creek and the Hemphill River mouth show signs of hybridization with the snail of the south Mokihinui River, *P. l. unicolorata*. These two taxa have probably been brought into contact during major flood events on the Mokihinui River.

The north and south branches of the Mokihinui River drain large wet catchments, but all the water gathered must pass through the long, narrow bottleneck of the Mokihinui Gorge. The most recent large-scale flooding incident at Mokihinui Forks followed the Murchison earthquake in 1929 in which a slip dammed the Mokihinui River just below the Forks. In this case the flood waters would certainly have mixed snails above the Forks, forming the hybrid colony described.

When the dam finally burst, live snails of both *P. l. ruforadiata* and *P. l. unicolorata* were apparently carried rapidly downstream. As the river emerged from the gorge it slowed, and some snails washed up in bends. A small hybrid colony formed at Chasm Creek when *P. l. ruforadiata* and *P. l. unicolorata* from the upper catchments of the Mokihinui River, along with *P. l. rotella* from the Seddonville terraces, washed up against an existing *P. l. johnstoni* colony. Another colony formed at Sawyers Creek when *P. l. ruforadiata* washed up against a *P. l. lignaria* colony, and a third formed at Waimare when *P. l. ruforadiata, P. l. lignaria* and *P. l. unicolorata* snails met.

Cause of Decline, and Threats

1. Predation by possums since about the early 1980s.
2. Predation by rats and song thrushes.
3. A relatively large deer population thinning the forest understorey, leaving the snails more exposed to weka (still abundant in the area) and thrushes.

Past Conservation Efforts

1. Density of live snails in a 500 m^2 monitoring plot in Maori Gully was measured in 1995 and 2002, and eight more 100 m^2 plots were established in 2002.
2. A ground-based possum-control operation was carried out by contractors over 500 ha on the true right of lower Maori Gully in 1999.

Current Conservation Status

Throughout its restricted range, *Powelliphanta lignaria ruforadiata* is affected by high numbers of almost the full suite of snail predators. It is in very low numbers (0.5 snails/100 m^2) and is ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

Restoration of a strong population (> 12 snails/100 m^2) in at least 400 ha around the type locality (mid-Maori Gully).

Objectives For The Next 10 Years

Objective One

Improve snail survival by sustained predator control.

Explanation

The inaccessibility of the habitat of *Powelliphanta lignaria ruforadiata* will make sustained predator control difficult to achieve, but it is a core requirement for the long-term survival of this taxon.

The small size and elongated shape of the core snail area, plus its high fertility and low altitude, mean that re-invasion by possums after control operations will be rapid. An annual possum control programme (or intermittent control over a much larger area, incorporating substantial buffer zones) is required indefinitely.

The poison 1080 should be the possum control tool every 3–5 years because it will also kill rats and help control deer. However, if possum control is carried out annually the methods used need to be alternated regularly to prevent resistance or shyness in the pest population.

It is important to synchronize the use of 1080 with the beech mast cycle. In the year following a heavy beech seedfall, rat numbers will be particularly high and their impact on snails will be correspondingly more severe.

The remote nature of *P. l. ruforadiata* habitat makes rat control a very expensive option. It is possible that intermittent rat control (as a byproduct of 1080 possum control) is sufficient to allow snail recovery, particularly if there is long-term relief from the major snail predator (possums). Accordingly, no specific rodent control programme is suggested for the first 5 years of this plan.

Actions Required

1. Keep possum numbers steadily below 3% RTC, and preferably under 1% RTC, in the core snail habitat in Maori Gully through an annual possum-control programme (or less frequent control over a larger area).

2. Use 1080 cereal pellets as the preferred possum poison as frequently as the risk of 1080 shyness allows, to also reduce rat and deer numbers. Use 1080 in the season following a heavy beech seedfall whenever possible.

3. Establish six to eight more 100 m^2 snail-monitoring plots and regularly releaser all plots until population trends and the effect of the management regime are clear.

Objective Two

Determine the size of the *P. l. ruforadiata* population through distribution and density surveys.

Explanation

Snails are not present on, or westward of, Mt O'Connor, nor are they on the Johnson Ridge. Beyond that, however, their distributional boundaries within the Maori Gully area are not well known. While *P. l. ruforadiata* has not yet been found above 1000 m a.s.l., it is possible that they may occur higher on Webb Ridge.

The lower slopes above Lake Dora, and on the north (true right) bank of the Mokihinui River Gorge, should also be surveyed.

Actions Required

Make transect searches for snail shells outwards from the known range of *P. l. ruforadiata*.

Responsibility

Buller Area Office, West Coast Conservancy.

3.37 *POWELLIPHANTA LIGNARIA UNICOLORATA*

Description

A small to medium-sized snail (maximum diameter 50 mm; height 29 mm) with a smooth white parietal callus. The shell is a plain olive-brown colour, occasionally streaked with a few wavy, irregular, reddish axial bands.

Habitat

A lowland species found at 80–500 m a.s.l., particularly on flat areas with deep litter on limestone soils. They live under litter in red and silver beech forest with rimu and kahikatea, a subcanopy of kamahi, toro, mountain wineberry and putaputaweta, and an understorey of tree ferns, small-leaved *Coprosma* species and crown fern.

Distribution

In North Westland, on both sides of the South Branch of the Mokihinui River from Silver Creek to the Forks, and on the true left of the Mokihinui River between the Forks and Chasm Stream at the western end of the Seddonville Flat. Patchily distributed in the South Branch of the Mokihinui River, with most snails on the limestone areas between the mouths of Silver and Mountain Creeks, near the mouth of Limestone Stream, and near Goat Creek.

Cause of Decline, and Threats

1. Destruction of the snail's forest habitat on the river flats at Seddonville.

2. In all colonies, predation by rats and, since the 1980s in some colonies, predation by possums.

Past Conservation Efforts

1. A 500 m^2 snail-monitoring plot was established near Mountain Creek in 1995, and re*measured in 2000. An additional four 100 m^2 plots were established near Goat Creek in 2000.

2. Ground control of possums over about 200 ha between Mountain and Silver Creeks was carried out in 1995, 1997 and 1999 to protect the snails. In 1996 a 1080 operation by the West Coast Regional Council over a wide area around Seddonville for TB possum control, would have helped the small population of *Powelliphanta lignaria unicolorata* near the mouth of Mokihinui Gorge.

Current Conservation Status

Too small an area has been sampled to be confident of the conservation status of *Powelliphanta lignaria unicolorata*. Near Goat Creek the snails are in high numbers (17.8 snails/100 m^2) with little sign of predation, but they are in much lower numbers (1.2 snails/100 m^2) at Mountain Creek where predation by possums is common. Relative to other *Powelliphanta*, the distribution of *P. l. unicolorata* is wide and there are still pockets where snails are common. It is ranked as 'vulnerable' by Hitchmough (2002).

Long-term Recovery Goal

Stable or increasing populations in at least two sites: in the South Branch of the Mokihinui River and at the eastern end of the Seddonville Flat.

Objectives For The Next 10 Years

Objective One

Determine more accurately the distribution and density of *Powelliphanta lignaria unicolorata*

Explanation

Our knowledge of *P. l. unicolorata* comes largely from the most accessible areas. To ensure that the most appropriate areas for management have been selected, more detailed information on distribution and density is needed.

Actions Required

1. Survey the distribution of *P. l. unicolorata* above the South Branch of the Mokihinui River (both sides) and above the Mokihinui River Gorge to determine the altitudinal limit of the subspecies.

2. During the distribution survey, systematically make timed collections of shells at regular intervals to determine snail density and predation levels.

Objective Two

Determine population trends.

Actions Required

1. Establish ten more 100 m^2 plots in the densest snail populations, ensuring that most representative areas are covered.

2. Measure snail density in all plots two-yearly.

Objective Three

Increase population density through improved recruitment and survival by sustained predator control.

Explanation

In a comprehensive collection of all shells found within a large part of the range of *P. l. unicolorata* (in 1979), 60% of shells were from animals killed by introduced pests: 47% by rats and 13% by thrushes (Meads et al. 1984). In this collection, as in one made in 1971, there was no sign of predation by possums—it must have begun some time in the 1980s. Most collections from 1990 have shells of possum-killed snails. When the first snail-monitoring plot near Mountain Creek was measured in 1995, 83% of shells within it were possum damaged, and live snail density was low (1.2 snails/100 m^2). However, there are still some sites where possums, though present, are not yet preying on snails and snail density remains high (i.e. 17.8 snails/100 m^2 at Goat Creek). It is important to control possums at such sites before snail density declines too drastically.

Actions Required

1. Using the information gained from Objective One, select several areas representative of the diversity within *P. l. unicolorata*, including one area upstream from hybrid influences of other *P. lignaria* taxa. The areas should have a relatively high density of snails and be of a shape, size and location that will be practical for long-term pest control.

2. Keep possum numbers steadily at less than 3% RTC, preferably under 1% RTC, within the selected areas. Regularly alternate traditional methods of possum control (cyanide and trapping) with use of poisons which also kill rats (1080, feracol). Use the latter poisons in any winter after beech mast summers when rat numbers will be particularly high.

3. Support research on the timing of possum control that best protects snails from rats.

4. Monitor rat and possum numbers annually at first to better understand the relationship between pest numbers and snail density, and the impact of possum-control techniques on rat numbers in the Mokihinui Valley.

Responsibility

Buller Area Office, West Coast Conservancy.

3.38 *POWELLIPHANTA LIGNARIA ROTELLA*

Description

A medium-sized snail (maximum diameter 43 mm; height 28 mm) with a dense pattern of dark reddish brown spiral lines on the upper surface. Only very faint lines on the otherwise plain, yellowish olive base.

Habitat

A lowland species, confined to highly leached, infertile, poorly drained soils. Found under *Gahnia* and moss in forest and scrub of yellow-silver pine and mountain beech.

Distribution

Naturally small distribution on the poorer soils of Mokihinui Forest, between Charming Creek and the Glasgow Range.

Cause of Decline, and Threats

1. Logging of over 75% of the forest habitat of the snail; and burning, draining and conversion to exotic pines of about 50% of the logged area (including the type locality).

2. Predation by possums.

3. Mineral prospecting and mining activities (particularly for coal and gold) are a past problem and potential future threat to the habitat.

4. Illegal burning of the land to attract deer.

Past Conservation Efforts

1. The entire remaining range of the snail was threatened by proposed gold prospecting activities in 1983. The New Zealand Wildlife Service appeared at a Planning Tribunal hearing for the prospecting application and gave evidence that resulted in the proposal being declined.

2. In 1986, New Zealand Wildlife Service submissions to the Protected Areas Scientific Advisory Committee resulted in recommendations that the snail habitat in native forest be given Ecological Area status. Subsequently the habitat was protected as public conservation land under the Blakely Accord.

3. A possum-control operation (aerially distributed 1080 poison) was undertaken in the least modified snail habitat in 1995, and over the central and western parts of the snail habitat in 2000.

4. A 500 m^2 plot set up near St Andrew pakihi in 1994 to monitor recovery of live snails following possum control, was re*measured in 2000. An additional five 100 m^2 plots were established in 2000.

Current Conservation Status

Ranked as 'nationally endangered' by Hitchmough (2002). In low numbers (2.3 snails/100 m^2) because of many years of intensive predation by possums and habitat destruction.

Long-term Recovery Goal

A thriving population (density of live snails > 12 snails/100 m^2) in over 300 ha of the best habitat, and no further range reductions.

Objectives For The Next 10 Years

Objective One

Increase population density and size by sustained possum control.

Explanation

The remaining area of habitat of *Powelliphanta lignaria rotella* is small, and it abuts Timberlands' pine plantations in which possum numbers are not controlled. These features make the current regime of intermittent possum control for snail protection ineffectual, as possum re-invasion of the snail habitat is relatively fast.

Actions Required

1. Instigate a programme of intensive possum control (annual, or even more frequent, ground operations) in the core habitat of *P. l. rotella* to keep possum numbers steadily below 3% RTC, preferably under 1% RTC.

2. Cycle control techniques to avoid possum resistance.

3. Regularly monitor possum numbers to provide information on the relationship between the size of the snail population and possum density.

4. About every 5 years, carry out possum control over the wider Ngakawau – Mokihinui Forest area and in the core snail habitat, to keep possum numbers low in a wide buffer zone.

5. Establish at least ten 100 m^2 snail-monitoring plots throughout the range of *P. l. rotella* and releaser two-yearly.

Objective Two

Increase snail population size by restoration of degraded habitat.

Explanation

The type locality for *P. l. rotella* is the St Andrew pakihi. In 1982 this was burnt by the New Zealand Forest Service and planted in *Pinus radiata* and *Eucalyptus* spp. To help the trees grow, the ground was v-bladed to break up the pakihi pan and drain the swamp.

When the pakihi was burnt, it became clear it had been prime habitat for *P. l. rotella* as thousands of burnt shells were found on the site. Because of this finding and because the site is entirely surrounded by native forest, the pakihi was finally legally protected as conservation land in 1986, despite the fact it had been converted to pine forest and despite the scarcity of snails by then. It was considered to have good potential as snail habitat if appropriately restored.

Between Chasm and Coal Creeks, and between Chasm and St Andrew Streams, snails have recolonised some areas of former habitat now in exotic trees with a dense understorey of regenerating native vegetation. However, when these forests are harvested, log hauling and burning or bulldozer clearing of the undergrowth before replanting will reverse any recovery of the snail population.

Actions Required

1. Seek to purchase the remaining habitat of *P. l. rotella* covered by exotic forestry species and in private ownership, protect it as a conservation reserve and restore its ecological value.

2. Harvest the crop of pine trees on the St Andrews pakihi (and also at Chasm Creek if possible) with great care, avoiding ground hauling logs in order to maintain a good topsoil and litter layer. Carefully protect all gully remnants of native forest during pine felling as they are likely to be harbouring snails and are good sources of recolonising snails. Ensure that all machinery is thoroughly cleaned of weed seeds.

3. When the existing crop of exotic trees is harvested, do not replant with pines, but instead allow regeneration of the native forest. In the areas which were v-bladed, consider options for blocking up the ditches immediately after the pines are harvested.

Objective Three

Obtain the understanding and support of the local community towards protection measures for *P. l. rotella*.

Explanation

Community acceptance of the value of *P. l. rotella* is required to reduce the likelihood of further destructive fires in the pakihi habitat.

Actions Required

1. Advocacy in local schools on the special land snail fauna of the Mokihinui area.

2. Publicity in the local Westport area news media on the actions being taken for the recovery of *P. l. rotella*.

Responsibility

Buller Area Office, West Coast Conservancy.

3.39 *POWELLIPHANTA LIGNARIA JOHNSTONI*

Description

A medium-sized snail (maximum diameter 46 mm; height 25 mm) with a smooth off-white parietal callus. The background colour of the shell is a yellowish olive and, except for a plain yellow area around the umbilicus, the whole shell is conspicuously spirally lined with a variable number of dark reddish brown fine bands. The width of bands, particularly on the upper surface, varies so much that shells appear either mostly red or mostly yellow.

Habitat

This lowland (300 m a.s.l.) snail lives in acidic soils which have frequent coal measure exposures and are leached by high rainfall. The snail lives under litter and moss in silver beech and rimu forest, and in shorter forest and scrub of manuka, yellow-silver pine, mountain beech, *Dracophyllum* spp. and rimu.

Distribution

Occurs patchily in the catchment of Charming Creek and its tributaries, Watson Stream and Frank Stream, in the Mokihinui Forest, between Ngakawau and Seddonville, North Westland.

Cause of Decline, and Threats

1. Between 1900 and 1999, logging and burning of the snail's forest habitat for coal mining and timber extraction. Reforestation of some areas with exotic pines involving very hot burns of remnant natural cover and some drainage and root-raking of the soil.

2. In small parts of the remaining habitat, snail numbers remained high into the 1980s, perhaps because of a surprisingly low density of rats for a site of such low altitude. However, predation by possums in all populations since the 1980s has caused a major population decline.

Past Conservation Efforts

1. In 1981 a comprehensive survey of the distribution and density of *Powelliphanta lignaria johnstoni* was undertaken (Walker 1982a). Snail conservation recommendations were made by the New Zealand Wildlife Service to New Zealand Forest Service's land-use planning process in 1982.

2. Proposals for Ecological Area status for parts of the Mokihinui Forest to protect *P. l. johnstoni* were approved by the Protected Areas Scientific Advisory Committee in 1986, and enacted during the land transfers of the Blakely Accord in the early 1990s.

3. A 500 m^2 snail-monitoring plot was established in 1984 near Charming Creek and has been re*measured annually. Snails inside the plot are individually marked and data on growth rates and movement collected. Four more 100 m^2 plots were established in 2000.

4. Possum control over 300–500 ha of forest in the middle of the snail's range has been carried out annually by the Department of Conservation since 1993. A variety of ground-based trapping and poisoning techniques have been used, but it has proved difficult to keep possum numbers low.

5. In 1995, possum numbers were reduced over a wide area on the north end of Radcliffe Ridge and between Seddonville and the end of the Charming Creek Walkway by the West Coast Regional Council. The operation, involving aerial distribution of 1080 poison for TB control, would also have benefited *P. l. johnstoni.*

Current Conservation Status

The logging of this snail's forest habitat has finally come to a halt and, with care, the damaged forests may eventually recover. The main problem now is a large, recent population decline caused by predation by possums, and a very slow recovery under the current possum-control regime. Snail numbers dropped from 20 snails/100 m^2 before possums became a problem (in 1986), to 0.8 snails/100 m^2 during the early 1990s, and then rose slowly to 3.5 snails/100 m^2 in 2001. *Powelliphanta lignaria johnstoni* is ranked 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

Moderate snail densities (> 12 snails/100 m^2) in most parts of the taxon's former range.

Objectives For The Next 10 Years

Objective One

Increase population size by sustained predator control.

Actions Required

1. Keep possum numbers in the core snail habitat steadily below 3% RTC, and preferably under 1% RTC. Monitor possum numbers before each control operation to determine the relationship between possum and snail density.

2. Intermittently, carry out possum control over the entire Mokihinui Forest, including Radcliffe Ridge, to slow possum re-invasion in the core snail area and to provide some protection for the rest of the *Powelliphanta lignaria johnstoni* population. Measure possum density in this area just before control operations.

3. Establish four to eight more 100 m^2 snail-monitoring plots away from the core area and re-measure two-yearly to allow a comparison of snail recovery under an intensive predator control regime with recovery under an intermittent one.

Objective Two

Increase population size and genetic flow between populations through habitat restoration.

Explanation

The total range of *P. l. johnstoni* is naturally small—less than 1500 ha. As late as the 1975–90 period, over 600 ha of the snail's forest habitat was clear felled and most of that was burnt and replanted in exotic trees by the New Zealand Forest Service, later Timberlands. This included some of the best snail habitat, and shells of hundreds of snails, burnt alive, were visible following the fires preparatory to pine planting.

The logged forests that were not planted in pines were transferred to the Department of Conservation in 2002. Though barren now, with some weeds that arrived with the logging and roading machinery, these areas will regenerate with predominantly native forest species and in time will become suitable snail habitat again.

The land under the plantation forest was transferred from the Crown to Nga Tahu as part of a Treaty of Waitangi settlement, with the timber still managed by Timberlands. The trees are ready, or nearly ready, for harvest but snails have re-invaded some of the older pine plantations where a dense understorey of native vegetation has regenerated. If the plantation area is to be regularly logged and replanted, snails will gradually be completely excluded, thereby reducing the total population size, and permanently fragmenting the gene pool.

The poor soils at Mokihinui and the site's remote location make exotic plantation forests only marginally economic. The time has come for proper protection of an irreplaceable natural area and of species badly served by humans thus far.

Actions Required

1. Seek to purchase of the snail habitat in private ownership in Mokihinui Forest, protect it as a conservation reserve and restore its ecological values.

2. When the existing crop of pine trees is harvested on land under Crown management, do not replant with pines, but instead allow regeneration of the native forest. In the areas that were root-raked, consider options for filling in the drainage ditches immediately after the pines are harvested. Carefully protect all native forest remnants in gullies during pine felling as they are likely to be harboring snails, and are good sources of recolonising snails. Select a logging technique which protects the soil and litter layer, and the snails inhabiting it.

Responsibility

Buller Area Office, West Coast Conservancy.

3.40 *POWELLIPHANTA* "BULLER RIVER"

Description

A small snail (maximum diameter 40 mm; height 20 mm). The shell colour is a plain yellowish brown, rather similar to nearby *Powelliphanta lignaria unicolorata*, but the shell itself is shaped quite differently. The shells of adult *Powelliphanta* "Buller River" snails have a very distinctive high peaked apex and a rapidly-dropping body whorl. The parietal callus is smooth and dark brown. Allozyme data (Appendix 2) indicated *Powelliphanta* "Buller River" has no close relatives and should be described as a separate new species (K.J. Walker, unpubl. data).

Habitat

A lowland species, found at 50-100 m a.s.l. on alluvial soils. The main colony occurs on mudstone/siltstone soils overlain with limestone talus.

Distribution

Powelliphanta "Buller River" was first discovered by Peter Cresswell about 1978 in regenerating forest below White Cliffs Bluff, just south of Inangahua Junction in the middle Buller River gorge. Snails appear to be confined to the lower slopes where a few tiny pockets of primary forest remain.

Numerous comprehensive searches in the vicinity near the original locality on White Cliffs have failed to find additional populations, but in 1996 David Roscoe found a second small colony near the mouth of Ten Mile Stream in the lower Buller Gorge.

Cause of Decline, and Threats

1. It seems likely that the main White Cliffs population was formerly much larger and that its range included the river terraces across the road from the colony. However, these terraces may occasionally be flooded, and in addition, they have now been completely deforested and the lowland forest replaced with pasture. The habitat of the extant White Cliffs colony was also logged but, being on reasonably steep hill country, the gullies were left intact and the rest of the habitat regenerated into secondary forest and scrub.

   Most of the White Cliffs colony is on private land, and habitat destruction was recently renewed with vegetation cleared for lifestyle blocks in the 1990s. Forest on the southern edge of the snail colony was logged by Timberlands and cleared for Heaphy Coal Mine activities in the 1980s and 1990s.

2. Rats are significant predators of this snail in both its colonies, and pigs also prey on the White Cliffs colony. Thrushes and probably hedgehogs prey on snails at both colonies, but the scale of their damage is unknown.

Past Conservation Efforts

1. A 500 m^2 plot established at the White Cliffs colony in 1995 to monitor the density of snails was re*measured in 1999 and 2002.

2. Brief surveys of the extent of the White Cliffs colony were carried out by a Conservation Corp team in 1991, by K.J. Walker and G.P. Elliot in 1993, by R. Buckingham in 1999 and by DOC staff in 2002.

3. An operation to control possums over the White Cliffs area, including the snail colony, was carried out by the West Coast Regional Council in 1995 for TB control.

Current Conservation Status

Powelliphanta "Buller River" is in low numbers at White Cliffs (1.4 snails/100 m^2) and apparently at Ten Mile Stream. It is vulnerable because the total known population is small, the continued existence of the main habitat is not secure and introduced predators are having a detrimental and continuing impact on both populations. It is ranked as 'nationally endangered' by Hitchmough (2002).

Long-term Recovery Goal

A dense (> 12 snails/100 m^2) population that is stable or increasing, over at least 10 ha in at least two secure sites.

Objectives For The Next 10 Years

Objective One

Maintain a viable population by long-term protection of snail habitat.

Explanation

The Ten Mile Stream snail habitat is protected as a scenic reserve, but there is a strong likelihood of further habitat loss at White Cliffs through forest clearance.

Actions Required

Seek to purchase and reserve, or protect through the establishment of covenants, the privately-owned snail habitat at White Cliffs.

Objective Two

Determine the natural range of *Powelliphanta* "Buller River'.

Explanation

The immediate White Cliffs vicinity has been searched fairly well for the presence of snails, but there have been no searches further afield. The recent finding of snails at Ten Mile Stream supports the possibility of a larger distribution for the taxon. Knowledge of total population size is important in assessing the intensity of conservation management required at the existing colonies, and information on former range helps in understanding habitat requirements.

Actions Required

1. Seek out historical information from library and local farmer sources of snail presence, vegetation changes and river flooding levels on the flats opposite the main White Cliffs snail colony.

2. Survey the wider area around Ten Mile Stream to determine the extent and density of the snail colony.

3. Search for snails at other sites along the Buller Gorge which are similar in character to Ten Mile Stream. Also survey Orikaka Forest on the true right of the Buller River, particularly on the northern extension of the Whitecliffs limestone scarp.

Objective Three

Determine the taxonomic status of *Powelliphanta* "Buller River".

Explanation

Allozyme studies in the 1990s found *Powelliphanta* "Buller River" to be genetically very different from its nearest (geographic) neighbour, *P. lignaria unicolorata* from the South Branch of the Mokihinui River (four fixed differences at five loci). It is also very different from the small alpine snail *P. gagei* on the Paparoa Range (K.J. Walker, unpubl. data). In addition to these genetic differences, the snail is morphologically very distinctive. Formal recognition of the species would make the conservation measures required for its long-term survival much easier to achieve.

Actions Required

Facilitate work aimed at formal description of the Buller River *Powelliphanta*.

Objective Four

Determine the identity and impact of predators of *Powelliphanta* "Buller River" and monitor population trends.

Actions Required

1. Supplement the existing snail-monitoring plot with five to ten 100 m^2 plots throughout the range of the snail at White Cliffs, and with five to ten plots at the Ten Mile Creek colony. Releaser at least two-yearly for the first 4 years so that any shells found are fresh enough to determine cause of death.

2. There is limited sign of pig and/or possum damage to shells seen recently, probably because the snail populations are so small and localised. However, both pests substantially degrade the snail's forest habitat, and their control in the snail colonies is highly desirable.

Responsibility

Buller Area Office, West Coast Conservancy.

3.41 *POWELLIPHANTA* "PATRICKENSIS"

Description

A small snail (maximum diameter 35 mm; height 21 mm) with a thin, smooth, polished and glossy, almost entirely chitinous shell, reddish brown in colour with numerous radial dark-brown stripes (Powell 1949), found on the Stockton – Denniston Plateau.

The published name for this snail is *Powelliphanta rossiana patrickensis*, but an examination of the genetic make-up of *Powelliphanta* in the 1990s found very large genetic differences between South Westland *Powelliphanta rossiana* and the Stockton – Denniston snails (K.J. Walker, unpubl. data; Appendix 2).

On a genetic basis, the closest relatives to *Powelliphanta* "patrickensis" are *Powelliphanta* on the Garabaldi Plateau, and more distant relatives are those on Baton Saddle and Kirwans Hill, though there are substantial morphological, ecological and genetic differences between those groups. *Powelliphanta* "patrickensis" has a distinctive blue mucous that is unique amongst *Powelliphanta* (most have clear mucous), though some of the other alpine snails of western Nelson have faint traces of this colour (K.J. Walker, unpubl. data).

Because *Powelliphanta* "patrickensis" live on infertile, sour coal measures, their shells lack the usual calcium lining and are thin and fragile. This is in marked contrast with their closest genetic relative, *Powelliphanta* "Garabaldi" which are calcicols, living only on limestone.

Due to the size of the genetic, ecological and morphological differences between *Powelliphanta* "patrickensis" and other *Powelliphanta*, it is likely to be elevated to full species status.

Considerable morphological variation exists within *Powelliphanta* "patrickensis". The shells of snails around the type locality are much redder on the upper surface than shells from further south, and those below the confluence of the Wilson Creek and Waimangaroa River are finely sculptured on the dorsal surface so that the upper half of the shell appears matt rather than entirely glossy. Whether these differences in shell morphology reflect genetic diversity within the taxon is unknown.

The profound habitat differences between the very exposed acidic conditions on coal measures and more benign land snail environments on the alluvial flats on mudstones in the Happy Valley area of the Upper Waimangaroa River may be expressed in shell morphology.

Habitat

Powelliphanta "patrickensis" is confined to the infertile, poorly drained Brunner coal measures and siltstones and mudstones (Kaiata Formation) of the Stockton – Denniston Plateau. The plateau is frequently covered with mist and although it is not particularly high (the snails occur at about 550–850 m a.s.l.), it is generally a cold wet environment.

The snails live in stunted manuka and wire rush shrubland where they shelter beneath *Gahnia* and mountain flax; in more open red tussock/bogpine/manuka shrub tussockland on peaty soils on alluvial flats, and occasionally in low southern rata-mountain beech/podocarp forest.

Distribution

Powelliphanta "patrickensis" occurs sparsely and patchily within about 1500 ha in the upper Waimangaroa and Whareatea Rivers and in the headwaters of St Patrick Stream in the highest parts of a large, uplifted, faulted tableland collectively known as the Stockton – Denniston Coal Plateau, north of Westport.

The type locality for this snail is the very head of St Patrick Stream (Powell 1949), and the core area of occupation extends from this point to near the junction of Deep Stream and Waimangaroa River.

While *Powelliphanta* "patrickensis" may be more common in this zone where coal measures meet the more benign conditions on the Kaiata Formation mudstones, their distribution also extends up to Mt Rochford on the southern Denniston Plateau and Mt Frederick on the Stockton Plateau. The lower western slopes of the Mt William Range marks their eastern-most boundary.

Cause of Decline and Threats

The causes of the decline of *Powelliphanta* "patrickensis" are the dual impacts of habitat loss and increased levels of mortality—the latter brought about by new exotic predators and increased efficiency among natural predators in the now degraded habitat.

Much of the snail's habitat has already been lost to mines, overburden dumps, human-made lakes, and extensive roading associated with coal prospecting as well as mine operation.

Much of the remaining snail habitat has suffered from repeated burning, and at times even the thin peat soils themselves burnt, reducing some areas to rock pavements (Overmars 1992). In the most infertile and exposed sites the fires removed the dense, ground-level vegetation which formerly provided some protection from the snail's natural predator, the weka. At the same time, exotic thrushes, possums and rats arrived, and the combination of habitat degradation and new, efficient predators has proved formidable.

The planned development of a large, open-cast coal mine, which would affect most of the best remaining snail habitat beside the upper Waimangaro River, poses the most substantial threat yet to survival of *Powelliphanta* "patrickensis".

Current Conservation Status

Powelliphanta "patrickensis" is classed as 'endangered' by Hitchmough (2002).

Long-term Recovery Goal

Maintenance of a strong core population through habitat protection and predator control, and an increase in colony size through rehabilitation of former habitat.

Objectives For The Next 10 Years

Objective One

Protect the snail habitat from any further reduction in size or quality.

Actions Required

1. Seek formal reservation of the remaining snail habitat.

2. Through appropriate constraints on human activity in the snail habitat, protect it from further mining, burning and roading.

Objective Two

Increase population density and size by sustained possum control.

Explanation

Because of the extreme fragility of the shells of snails on the coal measures, it is more difficult than usual to determine the cause of death from marks on the shells.

In a large survey in 1998, where 528 shells were collected from across much of the snail's range, the cause of death for almost 40% was indeterminable because of shell collapse, but more than half of these showed signs of predator attack. Of the remaining 320 shells, 31% had been killed by possums, 13% by thrushes and 4% by rats.

The only practical way to limit predation by thrushes is through restoration and maintenance of a deep litter layer and dense covering vegetation. Direct control of possum numbers is, however, achievable in this accessible area. Possums are likely to be having an impact on the snail population quite out of proportion to their numbers on the Plateau. In harsh infertile environments, with few palatable species, snails are probably a valuable food resource for possums, even when both predator and prey are at low densities.

Actions Required

1. Keep possum numbers at barely detectable levels within the core snail habitat.

2. Monitor the density of live snails in up to forty 25 m^2 plots through the possum control area and in a similar non-treatment area.

Responsibility

Westport Area Office, West Coast Conservancy.

3.42 *POWELLIPHANTA SPEDENI SPEDENI*

Description

A small snail (maximum diameter 43 mm; height 25 mm), but globose. The base is smooth, shiny and dark greenish brown in colour, while the reddish-coloured dorsal surface is finely and regularly striated giving the upper half of the shell a matt finish. There is a cline in shell morphology and colour, with snails in the east having more dorsal sculpturing and red colour on the shell than those in the west.

Powelliphanta spedeni spedeni eggs are large relative to the size of the snail, with eggs being about 29% of the maximum diameter of an adult snail, compared with only 16% in the much larger *P. hochstetteri anatokiensis*.

Habitat

Powelliphanta spedeni spedeni most commonly occurs at or just above the upper limit of mountain beech and *Dracophyllum* scrub, though the snails are also found well above the forest and scrub in pure tussock, and occasionally well down in the forest. The snails live in moist sites under litter and fern in beech forest, and under the dense skirts of *Astelia nervosa*, narrow-leaved snow tussock and red tussock in grassland, at altitudes of 750–1300 m a.s.l.

Distribution

Found very patchily in small parts of the less modified tussock grasslands in the southern Eyre Mountains, on the Garvie Range and on the Umbrella Range (including Leithen Bush) in northern Southland.

Cause of Decline, and Threats

1. The main cause of decline is widespread and repeated burning of the snail's tall tussock habitat. This led to the loss of many populations, and to the genetic isolation of those remaining in a fragmented landscape. Fire to promote new grass growth remains a significant threat in privately-owned snail habitat.

2. Browsing and trampling by both feral deer and farmed cattle and sheep destroyed the moist litter habitat. In many places, particularly in beech forest, conditions are now too dry and there is too little protective ground cover for eggs and young snails to survive.

3. Most shells found today are broken, probably by song thrushes, hedgehogs and perhaps mice. Enhanced mortality levels caused by introduced pests are a factor of unknown dimensions in the snail's decline.

Past Conservation Efforts

1. Protected Natural Area (PNA) surveys of Nokomai and Umbrella Ecological Districts in the 1980s, and invertebrate surveys of South West Otago in the early 1990s recorded all *Powelliphanta spedeni spedeni* shells found.

2. A 10 person-day survey of the distribution of *P. s. spedeni* in the Windley River headwaters, southern Eyre Mountains, was carried out in March 1990. A broader survey incorporating timed searches in many of the known sites was carried out in 1999.

3. In the Eyre Mountains in 2000, 150 m^2 of snail plots and 39 *Astelia nervosa* plants were searched. In 2001 several 100 m^2 plots were established in the same general area.

Current Conservation Status

Powelliphanta spedeni spedeni is one of the more widely distributed *Powelliphanta*, occurring in four adjacent ecological districts. However, it is present only in fragments of habitat, many of them unprotected and/or degraded, within this range. Population density is very patchy, ranging from 0.2 snails/person hour to 9.8 snails/person hour, but averaging about 3.5 snails/person hour. From very limited area-based density data there are 2.7 snails/100 m^2 in good snail habitat.

The snail is ranked in 'serious decline' by Hitchmough (2002).

Long-term Recovery Goal

Moderate densities and stable or increasing populations of *Powelliphanta spedeni spedeni* within representative parts of most of its natural range.

Objectives For The Next 10 Years

Objective One

Determine the population size, and identify key areas for habitat protection.

Explanation

Land development is continuing to lower the chances of the long-term survival of *Powelliphanta spedeni spedeni*. The best remaining habitat on each of the three mountain ranges where the snail occurs needs to be identified and management agreements sought with the landowners to protect and enhance the snail habitat.

Actions Required

1. Examine land tenure and management regimes in each of the known snail locations, to determine the level of on-going habitat modification. The urgency of the following actions depends on the outcome of this assessment.

2. Systematically survey live snail numbers within the known snail localities, and identify key habitat characteristics.

3. Identify apparently similar habitat in the northern Southland ranges and systematically survey for snail presence in these locations.

4. Select those areas with both good numbers of snails and reasonable chances of landowner consent for habitat protection, and attempt long-term habitat protection through the most appropriate tool (purchase by the Crown, lease exchange agreements, establishing covenants, land management agreements etc.).

Objective Two

Determine population trends.

Explanation

Population trends will determine the urgency of recovery actions for *P. s. spedeni*. Population monitoring also provides representative samples of shells useful for understanding causes of any population change noted.

Actions Required

1. Establish at least ten 100 m^2 snail-monitoring plots randomly in representative parts of the range of *P. s. spedeni*. Plots should be established in both pristine and developed tussocklands and within a range of rainfall regimes and altitudes. Suitable sites with easy access include the Argyle Burn in the Umbrella Ranges, off the Garston/Nevis road in the Garvie Mountains and on the Mt Bee Ridge in the Eyre Mountains. Less accessible sites to sample include high-altitude forest and grassland in the Windley headwaters (Eyre Mountains) and near Lake Gow (Garvie Mountains).

2. Counting the snails in tussock plots is particularly time consuming and destructive because of the dense nature of the vegetation. After 4 years of two-yearly counts to determine mortality rates and causes, re-measure most sites at only five-yearly intervals.

Objective Three

Identify the main snail predator(s).

Explanation

In common with most high-altitude *Powelliphanta* species, *P. s. spedeni* has a shell that is only thinly calcified and therefore easier for predators to break into than the larger, heavier shells of lowland *Powelliphanta*. This means that there are fewer visible signs left on the damaged shell by which the predator can be identified. The ability to identify the predator responsible is further reduced by the high degree of sun exposure which empty shells on the open alpine tops receive as, once broken, the thin shells often curl, deform and fragment in the heat.

On the positive side, there are fewer potential snail predators in the harsh environment well above the bush line in New Zealand. The main predators of *P. s. spedeni* are thought to be mice, hedgehogs and thrushes. Because of the high costs and difficulties associated with control of any of these species in the high country, more certainty as to their identity and impact is required.

Actions Required

1. Ensure that the tussock ground cover in the snail colonies is as dense and healthy as possible (via Objective 2) to improve snail productivity, recruitment and survival, and to reduce their vulnerability to predators.

2. If a large enough population of *P. s. spedeni* is found (see Objective 1) for a few snails to be sacrificed without threatening the population further, run trials feeding snails of varying size to wild caught mice, thrushes and hedgehogs to identify any characteristic signs of damage left on the shells by each potential predator.

3. Critically examine shells found in snail-monitoring plots to determine the proportion of the population killed by exotic pests. Model the impact such predation is having on the snail population to determine if the enhanced mortality is significant.

4. If pest control is required, identify the abundance of predator(s) within the snail colonies, and design and implement a predator control programme.

Responsibility

Murihiku Area Office, Southland Conservancy.

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 *Gahnia* 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^2. 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^2 plot in apparently suitable habitat (Clarkson 1999). Other than this plot, almost all snail searches so far have been made under the skirts of *Gahnia* 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 *Gahnia* 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 *Gahnia* 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^2 or fifteen 100 m^2 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^2 plots, the *Gahnia*-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 *Gahnia* 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 *Gahnia* (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^2 (Daniel 1992). In 1997 in a 500 m^2 plot on Manuoha, 19 live snails and 18 shells were found (3.8 snails/100 m^2).

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^2 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 des-criptions 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^2 monitoring plots or forty 25 m^2 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 cholicalciferol poisoning). Use of brodificoum 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 Gouland 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 Gouland 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.* "Gouland Range".

Powelliphanta superba "Gouland 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 Gouland on the southern Gouland 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 Gouland 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 Gouland Downs declined drastically between 1980 and 2000 because of predation by possums, so it is likely that the density of *P. s.* "Gouland 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 "Gouland 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 became 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^2 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^2 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^2 in 1997–99 in a 300 m^2 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^2 permanent plots were established in 1997 and a further six in 1999 (300 m^2 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^2 permanent monitoring plots in both the Speargrass and Mt Murchison populations and releaser 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 Matakitaki 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, Garabaldi 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 deter-mine 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 Matakitaki *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^2 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 *Gahnia 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^2 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^2 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^2 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^2 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 Green-land, 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 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^2 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/kamahi 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^2 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 Kaherekou 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^2 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^2 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. h. hochstetteri*; D'Urville Island and mainland populations of *P. h. 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, Matakitaki, Matiri, Garabaldi, Baton, Kirwans Hill, Nelson Lakes, Owen, Lodestone, Anatoki Range, Gouland 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.

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