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

Species identification photographs by Gideon Climo, Kath Walker and Tim Skinner.

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Aunt

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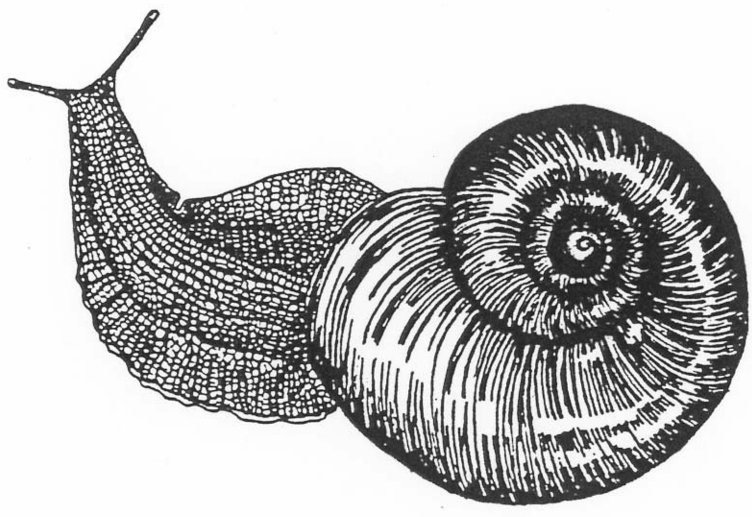
NOTES ABOUT THE ILLUSTRATIONS:

(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.

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