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Conservation status of New Zealand indigenous terrestrial Gastropoda (slugs and snails)

Part 3. Rhytididae (carnivorous snails), 2022

Kath Walker, Kerry Walton, Eric Edwards, Rod Hitchmough, Ian Payton, Gary Barker and Pascale Michel

Department of Conservation
Te Papa Atawhai

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Powelliphanta gilliesi kahurangica in Kahurangi National Park. *Photo: Rod Morris*

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Part 3. Rhytididae (carnivorous snails), 2022

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Abstract

The conservation status of 109 taxa of medium to large land snails in the family Rhytididae in New Zealand was assessed using the New Zealand Threat Classification System criteria. In total, 74 taxa were assessed as being Threatened, 22 as At Risk, 5 as Not Threatened and 8 as Data Deficient (i.e. insufficient information was available to assess their conservation status). Forty of the taxa have yet to be formally described. The status of 6 taxa has improved and the status of 48 taxa has deteriorated since they were last assessed. Of note, 10 of the taxa previously assessed as Nationally Critical remain in this category, as only a fragment of their habitat remains, and 34 additional taxa have moved into this category. Many of these new additions to Nationally Critical are in the genus *Powelliphanta*, primarily due to the high rates of decline that have been measured in their populations over the last 17 years – declines that are predicted to continue. Some changes to rankings were also due to the improved way in which the population sizes of *Powelliphanta* taxa are now assessed, which involves measuring or estimating the area occupied rather than estimating the number of mature individuals alive. The expert panel highlighted the urgent need for action to combat climate change, protect habitat, and control exotic browsers and predators if many of the iconic large carnivorous snails of New Zealand are to survive.

Keywords: *Amborhytida*, *Delos*, *Delouagapia*, land snail, *Paryphanta*, *Powelliphanta*, *Rhytida*, *Rhytidarex*, *Schizoglossa*, *Wainuia*

1. Background

The New Zealand Threat Classification System (NZTCS) was developed in 2000–2001 to complement the International Union for Conservation of Nature (IUCN) Red List system. Categories and criteria were defined to reflect New Zealand's unique environments and to account for the country's relatively small size and diversity of ecosystems, as well as the large number of taxa with naturally restricted ranges and / or small population sizes (Molloy et al. 2002). The conservation status of terrestrial Gastropoda in New Zealand was first assessed using the NZTCS in 2002, when 538 taxa (including 98 rhytidid taxa) were listed (Hitchmough 2002). They were then reassessed in 2005, when 692 taxa were listed (Hitchmough et al. 2007).

The NZTCS methodology was refined in 2007 to ensure that all possible combinations of status and trend were covered within the different categories. The resulting manual (Townsend et al. 2008) was used to re-assess the conservation status of the terrestrial Gastropoda excluding *Powelliphanta* in 2010 (Mahlfeld et al. 2012), and again, this time including *Powelliphanta*, in 2022 (this report). Some minor changes to the categories, criteria and qualifiers proposed by Rolfe et al. (2021) were incorporated into this latest assessment, as follows:

- The qualifier Climate Impact (CI) has been added to reflect newly recognised pressures from changing environments and to acknowledge taxa that are or will be adversely affected by long-term climate trends and / or extreme events.
- The qualifier Conservation Research Needed (CR) has been added to indicate the need for research to better understand the cause of decline and / or a solution for recovery.
- The qualifier Data Poor (DP) has been split into three new qualifiers that identify the knowledge gaps that result in their use: Data Poor Recognition (DPR) to indicate the difficulty in identifying the taxon in the field, Data Poor Size (DPS) to indicate a lack of data on population size and Data Poor Trend (DPT) to indicate a lack of data on population trend.
- The qualifier Population Fragmentation (PF) has been added, covering some taxa that previously triggered the qualifier Sparse, to indicate that gene flow between sub-populations is hampered as a direct or indirect result of human activity.

1.1 Assessment process

NZTCS assessments are usually reviewed approximately every 5 years by panels of individuals from within and outside the Department of Conservation (DOC). Each assessment panel comprises experts in the fields of taxonomy, conservation biology and ecology who have deep knowledge on a specific taxonomic group and / or are recognised by their peers as active experts in the field, as well as people with a good technical knowledge of the NZTCS process to ensure consistent approaches across the various assessment panels.

Assessment criteria and categories are interpreted in the context of scientific evidence (e.g. population monitoring) and expert understanding of the ecology of each taxon (e.g. natural population fluctuations). The manual requires that a precautionary approach is applied where a taxon is on the border of two possible threat categories, resulting in the higher threat category being chosen.

The expert panel uses the previously published assessment as the starting point for the new assessment and then evaluates any new information available, both published and unpublished. Taxa are assessed according to the reported population size and recent trends, and the panel predicts future changes over the next 10 years or three generations, whichever is

longer. Taxa are assigned to the Data Deficient category when insufficient data are available to assess the conservation status.

1.2 This assessment

The expert panel for this assessment consisted of six members plus one administration / support staff. All but two of the panel members were external to DOC.

A substantial amount of new information has been gathered on the Rhytididae, and particularly *Powelliphanta*, since the previous assessment. Much of this has been learnt through the study of *Powelliphanta augusta* (Walker et al. 2008; Allan 2010; Gruner et al. 2021), including snails held in captivity since 2006 when open-cast coal mining on Stockton Plateau destroyed their habitat.

These studies showed that *P. augusta* reaches sexual maturity at 8 years of age in the wild, and individuals that have been collected in the wild as adults can live to an age of more than 25 years in captivity, with fecundity declining in old age. For alpine *P. augusta*, the mid-point in fertility is c. 12 years old, but lowland taxa mature a little faster (Walker et al. 2008). For the current assessment, an average generation time of 10 years was used across the genus, so three generations equated to 30 years. The generation time was presumed to be similar in large-bodied *Powelliphanta* and *Paryphanta*, but shorter in the much smaller-bodied members of the Rhytididae.

Notes from the expert panel meeting and rationale for the reclassification of taxa have been summarised in the present report. A summary of the rationale can also be found on the assessment page for each taxon on the NZTCS website (https://nztcs.org.nz/reports/1101).

2. Summary

The conservation status of New Zealand's indigenous terrestrial Gastropoda, excluding *Powelliphanta*, was last assessed in 2010 (Mahlfeld et al. 2012). *Powelliphanta* was excluded from that assessment because of ongoing research into the taxonomy of the genus, which had previously been assessed in 2002 (Hitchmough 2002) and 2005 (Hitchmough et al. 2007). A reassessment of terrestrial Gastropoda including *Powelliphanta* was initiated in 2014 but was not reviewed and completed until 2022. Reports on the new assessments are being published progressively in four parts: Part 1 (Barker et al. 2021) covers Athoracophoridae (leaf-veined slugs) and Succineidae; Part 2 (Walker et al. 2021) covers Achatinellidae, Bothriembryontidae (pūpūharakeke / flax snails), Euconulidae, Helicarionidae, Pupinidae and Vertigindae; Part 3 (this report) covers Rhytididae (carnivorous snails); and Part 4 will cover Charopidae and Punctidae.

This report includes 70 *Powelliphanta* taxa in its assessment of 109 taxa in the family Rhytididae. As taxonomic research on *Powelliphanta* is continuing, tag names rather than formal nomenclature have been used for 25 of the *Powelliphanta* taxa, which are as defined and described by Walker (2003) except where noted otherwise. Voucher specimens with registration numbers prefixed 'M.' are held at the Museum of New Zealand Te Papa Tongarewa (Wellington).

2.1 Changes to the list of taxa

One taxon, *Wainuia* "Umbrella Range" (M.127657), which was assessed as Data Deficient in 2010, was not reassessed in this report. This taxon is known from a single empty shell collected in 1997 on the west bank of the Pomahaka River to the northeast of Gore. While the shell is a species of *Wainuia*, the locality record is outside the known distribution of the genus and a visit to the site in 2013 failed to resight any *Wainuia* species. Consequently, this record is now considered erroneous, and *Wainuia* "Umbrella Range" has been deleted from the NZTCS list.

The names of eight taxa differ in this report from those used by Hitchmough et al. (2007) and Mahlfeld et al. (2012) (Table 1). Seven of these changes are refinements to the tag names of undescribed taxa, while the remaining one represents revised taxonomic concepts for taxa that had previously been named. A further 10 taxa are assessed for the first time in this report (Table 2). Conversely, eight taxa that had previously been assessed are now considered to be indistinct from other taxa (Table 3).

Table 1. Name changes affecting New Zealand indigenous terrestrial Gastropoda taxa in the family Rhytididae between the publication of Hitchmough et al. (2007; *Powelliphanta* only) or Mahlfeld et al. (2012; no *Powelliphanta*) and this report.

PREVIOUS NAME AND AUTHORITY	NAME AND AUTHORITY IN THIS REPORT
Amborhytida sp. 1 (M.173834)	*Amborhytida* sp. 1 "Aupōuri" (M.173834)
Powelliphanta "Gunner River"	*Powelliphanta superba* "Gunner River"
Powelliphanta "Haast"	*Powelliphanta rossiana* "Haast"
Powelliphanta "Mt Augustus"	*Powelliphanta augusta* K. Walker, Trewick & G.M. Barker, 2008
Powelliphanta "patrickensis" (sensu Powell, 1949)	*Powelliphanta patrickensis* (A.W.B. Powell, 1949)
Powelliphanta rossiana (Powell, 1930)	*Powelliphanta rossiana rossiana* (A.W.B. Powell, 1930)
Wainuia "Fiordland" (M.32755)	Rhytididae new genus 7 "Fiordland sp. 1" (M.032755)
Wainuia sp. 3. (M.305040)	*Wainuia* sp. 3 "Mount Oxford" (M.305040)

Table 2. Taxa assessed for the first time in this report.

ASSESSMENT NAME AND AUTHORITY
Powelliphanta gilliesi "Iwituaroa"
Rhytida australis F.W. Hutton, 1881
Rhytida greenwoodi (J.E. Gray, 1850)
Rhytida meesoni meesoni Suter, 1891
Rhytida meesoni perampla A.W.B Powell, 1946
Rhytida patula F.W. Hutton, 1882
Rhytida sp. 5 (M.308649)
Rhytididae new genus 7 "Fiordland sp. 2" (M.309312)
*Schizoglossa novoseelandi*ca (L. Pfeiffer, 1862)
Wainuia urnula (L. Pfeiffer, 1855)

Table 3. Taxa that have been excluded from this report because they are now considered to be indistinct from other taxa.

ASSESSMENT NAME AND AUTHORITY	CONSPECIFIC NAME IN THIS REPORT
Amborhytida pycrofti (Powell, 1932)	*Amborhytida dunniae* (J.E. Gray, 1840)
Amborhytida sp. 2 "Motukokako" (M.151457)	*Amborhytida dunniae* (J.E. Gray, 1840)
Amborhytida tarangaensis (Powell, 1930)	*Amborhytida dunniae* (J.E. Gray, 1840)
Powelliphanta hochstetteri anatokiensis (Powell, 1938) red form	*Powelliphanta hochstetteri anatokiensis* (A.W.B. Powell, 1938)
Powelliphanta hochstetteri anatokiensis (Powell, 1938) yellow form	*Powelliphanta hochstetteri anatokiensis* (A.W.B. Powell, 1938)
Powelliphanta lignaria "millertoni"	*Powelliphanta lignaria lignaria* (F.W. Hutton, 1888)
Rhytida sp. 3 "Mt Richmond" (M.120181)	*Rhytida* sp. 1 "Wairau River" (M.162834)
Wainuia sp. 2 "Upton Brook" (M.305041)	*Rhytida meesoni meesoni* Suter, 1891

2.2 Trends

Of the 109 taxa assessed in this report, 74 are categorised as Threatened, 22 as At Risk and 5 as Not Threatened (Table 4). The remaining eight taxa are categorised as Data Deficient, i.e. they could not be assessed because there was insufficient information about them. Of the assessed taxa, 38 (35%) have not yet been formally described.

Table 4. Comparison of the number of New Zealand indigenous terrestrial Gastropod taxa in the family Rhytididae in each status category between 2005 (Hitchmough et al. 2007; *Powelliphanta* only) or 2010 (Mahlfeld et al. 2012; no *Powelliphanta*) and 2022 (this report).

CATEGORY	2005 / 2010	2022
Data Deficient	6	8
Threatened – Nationally Critical	15	44
Threatened – Nationally Endangered	30	14
Threatened – Nationally Vulnerable*	16	16
At Risk – Declining*	14	17
At Risk – Relict	6	1
At Risk – Naturally Uncommon*	20	4
Not Threatened	1	5
Total	**108**	**109**

* *Powelliphanta* snails were last assessed in 2005, at which time different categories and set of criteria were being used (revised categories and criteria were introduced in 2008; Townsend et al. 2008). In this table, those obsolete categories are compared with the nearest equivalent categories that are currently used.

In total, 88 of the 109 taxa assessed in 2022 were last assessed in 2005. Since then, the status of 6 taxa has improved, the status of 48 taxa has deteriorated and the status of 34 taxa has remained unchanged (Tables 5 & 6). Of note, 10 of the taxa that were previously assessed as Nationally Critical remain in this category and an additional 34 taxa (mostly in the genus *Powelliphanta*) have moved into this category.

The primary reason why so many *Powelliphanta* taxa have moved into the Nationally Critical category is the high rates of decline that have been measured in their populations over the last 17 years, which show no signs of easing. Continuation of these high rates over the next three generations (30 years) would result in population declines of around 96% for most of these taxa.

Some of the other changes in rankings result from differences in the method used to assess population size for *Powelliphanta* taxa, which has changed from estimating the number of mature individuals alive to measuring the area occupied, rather than reflecting any real improvement or decline. This particularly affected taxa that have relatively large distributions within which snails are now sparse but for which reliable trend data are unavailable. Taxa in this position were mostly previously ranked as Nationally Endangered but are now ranked as Nationally Vulnerable, despite there not having been the improvement in their conservation status that such a shift would normally imply.

Table 5. Summary of changes to the number of New Zealand indigenous terrestrial Gastropoda taxa in the family Rhytididae for each conservation status between 2005 (Hitchmough et al. 2007; *Powelliphanta* only) or 2010 (Mahlfeld et al. 2012; no *Powelliphanta*) and 2022 (this report). A 'neutral' change refers to any movement into or out of Data Deficient or a change of conservation status name following the 2008 revision of the manual (Townsend et al. 2008).

DIRECTION OF CHANGE, REASON, CONSERVATION STATUS 2022	NO. TAXA
IMPROVED	**6**
Actual improvement	**2**
Threatened – Nationally Vulnerable	2
More knowledge	2
Threatened – Nationally Endangered	2
Reinterpretation of data	**1**
At Risk – Declining	1
Criteria changed	**1**
At Risk – Declining	1
WORSENED	**48**
Actual decline	**36**
Threatened – Nationally Critical	31
Threatened – Nationally Endangered	1
Threatened – Nationally Vulnerable	3
At Risk – Declining	1
Criteria changed	**1**
At Risk – Declining	1
More knowledge	**9**
Threatened – Nationally Critical	1
Threatened – Nationally Endangered	3
Threatened – Nationally Vulnerable	1
At Risk – Declining	4
Reinterpretation of data	**2**
Threatened – Nationally Critical	1
At Risk – Declining	1
NEUTRAL	**8**
Greater uncertainty	**5**
Data Deficient	5
More knowledge	**2**
Threatened – Nationally Vulnerable	1
At Risk – Declining	1
Reinterpretation of data	**1**
Data Deficient	1

Continued on next page

Table 5 continued

DIRECTION OF CHANGE, REASON, CONSERVATION STATUS 2022	NO. TAXA
NO CHANGE	**37**
No change	**34**
Data Deficient	1
Threatened – Nationally Critical	10
Threatened – Nationally Endangered	7
Threatened – Nationally Vulnerable	6
At Risk – Declining	5
At Risk – Relict	1
At Risk – Naturally Uncommon	4
Status name changed	**3**
Threatened – Nationally Vulnerable	2
At Risk – Declining	1
NEW LISTING	**10**
Data Deficient	1
Threatened – Nationally Critical	1
Threatened – Nationally Endangered	1
Threatened – Nationally Vulnerable	1
At risk – Declining	1
Not Threatened	5
TOTAL TAXA ASSESSED	**109**

Table 6. Summary of status changes of New Zealand indigenous terrestrial gastropod taxa in the family Rhytididae between 2005 (Hitchmough et al. 2007; *Powelliphanta* only) or 2010 (Mahlfeld et al. 2012; no *Powelliphanta*) and 2022 (this report). Numbers to the right of the diagonal (shaded green) indicate an improved status (e.g. 2 of the 15 taxa assessed as Nationally Critical in 2005 / 2010 moved to Nationally Endangered in 2022), numbers to the left of the diagonal (shaded pink) indicate a poorer status, numbers on the diagonal (shaded black) have not changed in status and numbers without shading represent taxa that were previously assessed as Data Deficient, were new to this assessment or are no longer considered to be distinct from other taxa that are assessed in this report.

		CONSERVATION STATUS 2022									
		Total*	DD	NC	NE	NV	Dec	Rel	NU	NT	TI†
		118	**8**	**44**	**14**	**16**	**17**	**1**	**4**	**5**	**9**
CONSERVATION STATUS 2005 / 2010	Data Deficient (DD)	**6**	1			1	1				3
	Threatened – Nationally Critical (NC)	**15**	2	10	2						1
	Threatened – Nationally Endangered (NE)	**30**	1	18	7	2					2
	Threatened – Nationally Vulnerable (NV)‡	**16**		6		8	2				
	At Risk – Declining (Dec)‡	**14**		5		3	6				
	At Risk – Relict (Rel)	**6**		1			4	1			
	At Risk – Naturally Uncommon (NU)‡	**20**	3	3	4	1	2		4		3
	Not Threatened (NT)	**1**					1				
	New listing	**10**	1	1	1	1	1			5	

* The total number of taxa includes the nine indistinct species that were removed from the analysis.

† TI = taxonomically indistinct, i.e. taxa that were assessed in 2005 or 2010 but are now deemed to be indistinct from other taxa in this report (see Table 3).

‡ *Powelliphanta* taxa were last assessed in 2005, at which time different categories and criteria were being used (revised categories and criteria were introduced in 2008; Townsend et al. 2008). In this table, those obsolete categories are compared with the nearest equivalent categories that are currently used.

2.2.1 Improved status

The conservation status of six taxa has improved since the previous assessment (Hitchmough et al. 2007). This includes two taxa (*Powelliphanta gilliesi aurea* and *P. g. montana*) that have shown actual improvements due to the control of predators and two taxa (*Powelliphanta traversi otakia* and *Powelliphanta* "Anatoki Range") for which there is improved knowledge about the extent of their colonies. The remaining two taxa (*Powelliphanta marchanti* and *Wainuia nasuta*) were given a lower threat ranking despite there being no change in the actual risks to them due to a change in the way population size was estimated (i.e. the reinterpretation of data) and are not discussed further below.

Moved out of Threatened – Nationally Critical

Two taxa that were previously classified as Threatened – Nationally Critical have been assessed to be in a lower threat category.

Both *Powelliphanta traversi otakia* and *Powelliphanta* "Anatoki Range" were previously thought to occupy only a tiny area, but the known area of occupancy has now increased, leading to their movement from Nationally Critical to Nationally Endangered.

Moved out of Threatened – Nationally Endangered

Two taxa that were previously classified as Threatened – Nationally Endangered now have an improved status.

The populations of both *Powelliphanta gilliesi aurea* and *P. g. montana* increased for nearly a decade following the last assessment due to the control of predators. Unfortunately, increasing predation by feral pigs (*Sus scrofa*) since 2019 has reversed this trend, but the numbers of both taxa are still higher than before the conservation efforts were made, resulting in the conservation status of both being changed to Nationally Vulnerable.

2.2.2 Worsened status

A total of 48 taxa have a worse conservation status in this report than in the previous assessments (Tables 5 & 6), including 33 taxa that have moved into the Threatened – Nationally Critical category. Twelve of these changes are based on improved knowledge, the reinterpretation of existing data or the use of different assessment criteria rather than observed declines. The remaining 36 taxa have moved into a worse category because of an actual deterioration in their condition. Table 4 compares the number of taxa in each category with the previous assessments (Hitchmough et al. 2007; Mahlfeld et al. 2012).

Moved into Threatened – Nationally Critical

The conservation status of 33 taxa has worsened to Threatened – Nationally Critical.

Norway rats (*Rattus norvegicus*) have invaded previously secure habitat of *Wainuia clarki* on Motutaiko Island in Lake Taupō / Taupōmoana, and mainland colonies of *W. clarki* are all badly affected by predation by ship rats (*Rattus rattus*), Norway rats, song thrushes (*Turdus philomelos*) and hedgehogs (*Erinaceus europaeus*), as well as drier forest floor habitat conditions. Consequently, this species has moved from Nationally Endangered to Nationally Critical.

Both *Amborhytida duplicata* and the Te Paki kauri snail *Paryphanta watti*, which are only found at the northern end of the Aupōuri Peninsula, have dropped to very low numbers and have been re-categorised from Nationally Vulnerable to Nationally Critical due to high rates of decline being observed.

Numbers of *P. watti* continue to decline, probably due to a combination of factors, with predation by rats and pigs interacting with climate and habitat factors. Ground rooting by pigs dries out the litter and thins out the undergrowth, which increases the risk of desiccation and predation, affecting kauri snail recruitment. The eggs need to remain in a moist place underground for up to 7 months to successfully hatch, and hatchlings remain underground for a further 3 months after emerging from their eggs, making them very susceptible to soil moisture loss. Furthermore, a considerable proportion of the diet of wild pigs consists of worms, which are also thought to be a key food for kauri snails.

Of increasing concern for both *A. duplicata* and *P. watti* is the impact of climate change, which already seems to be increasing the intensity of droughts in Northland and is predicted to increase the risk of wildfires and invasions by exotic ants and other introduced invertebrate predators. The arrival of the fungus *Austropuccinia psidii*, which causes myrtle rust, the pathogen *Phytophthora agathidicida*, which causes kauri disease, and possums (*Trichosurus vulpecula*) at Te Paki also have the potential to transform vegetation cover and hence the deep litter these snails depend on.

Powelliphanta patrickensis comprises two genetically distinct taxa (Daly et al. 2019), with those on Denniston Plateau considered a separate subspecies from those on Stockton Plateau. However, the threat ranking changes little whether these taxa are considered separately or together, as both populations face high levels of predicted decline. Open-cast coal mining is planned for much of the remaining high-quality snail habitat on both the Stockton and Denniston Plateaux over the next 30 years. There is little evidence that moving some of the snails beyond the mine footprint before their habitat is destroyed would maintain their overall population size or that the land could be returned to the high-quality environment that healthy *P. patrickensis* populations require once mining operations cease. On Denniston Plateau, monitoring in areas that are not currently being mined recorded a declining trend in the population of *P. patrickensis* between 2007 and 2021. This, in association with the planned opening of further open-cast coal mines within the next 30 years, has resulted in the status of this taxon being moved from Nationally Endangered to Nationally Critical.

Worryingly, a further 28 *Powelliphanta* taxa, including most subspecies within *P. superba*, *P. hochstetteri* and *P. lignaria* and some subspecies within *P. gilliesi* (Fig. 1), have also moved into the highest threat ranking. Prior to this assessment, only Rhytididae taxa with very small areas of remaining habitat were ranked as Nationally Critical, but now a very different suite of problems has led to larger numbers of *Powelliphanta* swelling its ranks.

Most of these taxa are medium- to large-bodied snails that are found at the top of the South Island. Many have comparatively wide ranges and correspondingly large populations that previously buffered them somewhat from any threat. Most became sparse in the 1990s after possums learnt how to open *Powelliphanta* shells (Walker 2003) but had started to recover following widespread possum control. However, since c. 2005, the numbers of live snails of these taxa in regularly surveyed plots have dropped alarmingly (Stephens 2019, 2021a, b, c; Butland 2022). The continuation of such high rates of decline over the next 30 years (i.e. three generations) would reduce the population size of each of these 28 taxa by 96% on average (see Table 7).

The exact mix of factors driving these declines is slightly different for each taxon depending on the suite of exotic predators and habitat modifiers present, the physical environments occupied, and the ecology and morphology of the taxon involved. However, these declines can commonly be attributed to a combination of:

- **Climate change**, which causes the death of snails and their eggs both directly and indirectly. Significantly increased summer soil moisture deficits over the last 30 years (https://cliflo.niwa.co.nz/) have caused desiccation (Figs 2 & 3), while warmer winters

have allowed the altitudinal range of ship rats to expand, leading to increased rat predation (Harris et al. 2022).

- **Habitat degradation** from trampling (Wardle et al. 2001), rooting and browsing by increasing populations of pigs, goats (*Capra hircus)*, red deer (*Cervus elaphus)* and hares (*Lepus europaeus occidentalis)*, which leads to the loss of deep, moist litter and worms in the snails' ground habitat (Fig. 4).
- **Predation** by possums (Sadlier 2000), which reduced *Powelliphanta* taxa in northwest Nelson to very low levels in 1980–2005 (Walker 2003), and predation by other exotic species such as rats, song thrushes and pigs, which are particularly hard to control over large areas (Figs 5 & 6).

On top of this, numbers of weka (*Gallirallus australis*; Fig. 5), which are native predators of land snails and now have few natural predators of their own, have increased to levels not previously seen for c. 50 years at the northwestern tip of the South Island (Beauchamp 1999; K. Walker, unpubl. data). There were three heavy beech masts in northwest Nelson in 2014, 2016 and 2019, which were at shorter intervals and stronger than any that had occurred there since the masts in 1982 and 1985 (https://docnewzealand.shinyapps.io/NPCP_shiny/). These autumn masting events will have resulted in plagues of mice (*Mus musculus*) the following winter and spring, providing an abundant food source for weka (Ogilvie 2010) at the beginning of their breeding season. King (2017 and references therein) described how '… during an eruption of forest rodents in Fiordland, western weka could be seen eagerly snapping up mice and swallowing them headfirst'. Similarly, McConachie (1966: 55) observed weka eating so many mice during a plague that the birds' intestines became bound up in fur, killing them. Therefore, these masting events likely increased weka productivity. It is also likely that the aerial 1080 operations undertaken in northwest Nelson after each of the 2014–2019 beech masts in order to reduce rat and mustelid numbers inadvertently increased the survival of weka by removing their main exotic predator, stoats (*Mustela erminea*), as recorded elsewhere (Kemp 2013; Tinnemans et al. 2019).

The large-bodied subspecies of *Powelliphanta superba* and *Powelliphanta hochstetteri*, all of which have large, comparatively thin shells with wide-open apertures, are particularly susceptible to moisture loss and consequently need damp ground and high humidity in the litter layer and understorey to thrive (Figs 1 & 3). Increasing soil moisture deficits in the summer months, even in north Westland where it is frequently wet, are exacerbating the ground-drying impacts of ungulates. Goats and pigs reached the Heaphy River area, a centre of diversity for *P. superba*, for the first time in 2021. In most forested *Powelliphanta* habitat, feral goats, deer and, in places, pigs and even stock are drying, removing and degrading the leaf litter that insulates and nourishes the habitat of both *Powelliphanta* and their earthworm prey (Fig. 4) – and such trampling has been shown to have severe effects on land snail communities (Costall 2012; Denmead et al 2015). At the bush edge in the ecotone between forest and alpine tussock grasslands that are favoured by many *Powelliphant*a taxa (due to the high humidity provided by this vegetation structure), browsing deer and hares shelter during the day and, in the process, browse and trample the tussocks, lowering that essential humidity.

Table 7 summarises the suite of threats and their (subjective) relative importance to each of the 28 *Powelliphanta* taxa whose threat status has increased to Nationally Critical due to a combination of predation and climate warming / ungulate-induced moisture loss, rather than the habitat loss that had previously threatened most of the Rhytididae placed in this category.

Table 7. *Powelliphanta* taxa whose threat status has increased to Nationally Critical due to very high ongoing observed or recorded rates of decline in monitoring plots in 2005–2022, and the main causes of those declines on a subjective scale (1–4, lowest to highest). Note that this table does not include *Powelliphanta patrickensis*, which is discussed in more detail in the text.

Powelliphanta TAXON	NUMBER OF 100 m^2 PLOTS (NUMBER OF SITES MONITORED)	POPULATION DECLINE IF TREND CONTINUES FOR THREE GENERATIONS	POSSUMS	RATS	PIGS	WEKA	HABITAT DEGRADATION
P. superba superba	20 (3)	66%	3		2	3	2
P. superba prouseorum			3	2	3	1	3
P. superba mouatae	10 (1)	81%	3	1	1	3	1
P. superba harveyi	36 (3)	82%	3	1	1	3	1
P. superba richardsoni	10 (1)	68%	3	1	1	3	1
P. superba "Gouland Range"			2	1		2	1
P. superba "Gunner River"	7 (1)	99%	3	3		3	3
P. annectens	35 (2)	99%	1	3		3	1
P. lignaria unicolorata	16 (2)	100%	3	3		2	2
P. lignaria ruforadiata	15 (1)	100%	2	3		3	2
P. lignaria oconnori	28 (2)	93%	3	3	1	2	3
P. lignaria rotella	9 (1)	72%	3	2	2	3	2
P. lignaria johnstoni	12 (2)	99%	3	1	2	3	2
P. hochstetteri hochstetteri yellow based	15 (1)	91%	2	1	2	3	3
P. hochstetteri hochstetteri brown based	48 (3)	87%	3	1	2	3	3
P. hochstetteri anatokiensis	18 (2)	93%	2	3	2	2	3
P. hochstetteri obscura			2	1	3	2	4
P. hochstetteri consobrina			2	2	3	3	4
P. gilliesi gilliesi	10 (1)	99%	3	3	3	2	2
P. gilliesi compta	12 (1)	96%	2	3	2	1	3
P. gilliesi jamesoni	6 (1)	100%	3	3		3	1
P. gilliesi kahurangica	7 (1)	84%	2	3	3		3
P. gilliesi "Heaphy"			2	3		1	2
P. "Parapara"	10 (1)	100%	3	1	2	2	2
P. "Buller River"	9 (2)	100%	1	4	2	1	3
P. "Kirwans"				2	3	1	3
P. "Matiri"	8 (1)	96%	2	2	2	1	3
P. "Nelson Lakes"				2	1		4

Figure 1. A selection of *Powelliphanta* shells. *Photo: Kath Walker*

Figure 2. Example of the damp forest that lowland species of *Powelliphanta* formerly thrived in. These habitats are becoming less suitable as climate change increases summer soil moisture deficits and unchecked populations of introduced browsing animals degrade the forest floor environment. *Photo: Kath Walker*

Figure 3. All *Powelliphanta* snails require moist soils and high humidity if they and their eggs are to survive. (A) Two consecutive summer droughts have led to shell growth checks in these *P. superba* specimens from the Heaphy River area, resulting in each snail in the population having visible ridges in the same position on their shells. (B) Freshly hatched snails and (C) taxa with wide, open apertures like *P. superba* are particularly vulnerable to drier conditions. *Photos: (A) Kath Walker, (B) Rod Morris, (C) John B*

Figure 4. (A) Pig rooting is common and widespread in the habitat of many Rhytididae snails and is extremely damaging, not only because pigs consume all the snails and earthworms they find but also because rooting dries out the overturned soil, killing any exposed snail eggs, buries the leaf litter needed to shelter the snails and support their earthworm prey, and uproots seedlings, affecting forest regeneration. (B) Undisturbed soil with deep, moist litter supports burrow-dwelling earthworms, which are important in the diet of *Powelliphanta*; such soils are increasingly scarce due to high densities of ungulates. (C) Two eggs laid by a *P. lignaria johnstoni* snail directly into moist soil in spring in the expectation that the soil will remain damp until the eggs hatch in autumn – an expectation that is less frequently met as the climate warms. *Photos: (A, B) Kath Walker, (C) Fiona Bockett*

Figure 5. (A) In the 1980s, possums learnt how to reach large *Powelliphanta* snails by placing a bite beside the shell entrance, after which these snails became an important source of food for possums in montane beech forests where there were limited alternative foods. (B) The sheer size of *P. superba prouseorum* saw it being sought out by possums. (C) Snail numbers were slowly recovering following possum control when populations of the snail's natural predator, the weka, erupted, causing further population declines. (D) *Powelliphanta hochstetteri hochstetteri* shells showing the characteristic damage caused by (clockwise from top left) possums (torn hole in the side with shells peeling outwards with claw scratch marks); weka (top of shell cleanly removed); pigs (×2 crunched shells split around the middle and flattened); rats (hole in shell with finely serrated edges through to the inner whorls and a few tooth marks showing false hole starts; note that a year earlier, a rat had gnawed the lip of this shell before the snail escaped and grew new shell from the gnawed edge); and song thrushes (×4 small shells that have been held by the lip and repeatedly bashed against an 'anvil' stone). *Photos: (A, B) Rod Morris, (C) Jeremy Taylor, (D) Kath Walker*

Figure 6. (A) The ship rat is probably the snail's greatest predator because it is so numerous, pervasive and persistent. (B) A single hole chewed in each of the outer and inner whorls allows a rat to consume the snail's entire body, and the rat then sometimes continues to gnaw at the now-empty shell until only the central pillar remains. (C) Song thrushes are only able to capture small snails but are specialist snail killers and almost impossible to control at scale. For taxa that reach only a small adult size and have comparatively fragile shells, such as *Powelliphanta fiordlandica* (pictured here) and *Wainuia clarki* (now Nationally Critical), thrushes are a major cause of decline. *Photos: (A) David Mudge, (B) Kath Walker, (C) Pure Salt NZ*

Moved into Threatened – Nationally Endangered

The conservation status of four taxa has worsened to Threatened – Nationally Endangered.

While no quantitative trend data exist, recent surveys for *Powelliphanta fletcheri* on the Hohonu Range and for *Powelliphanta* "Lodestone" on Lodestone found much lower than expected densities and, in the case of the latter taxon, evidence of habitat degradation. *Powelliphanta* "Matakitaki" was being badly affected by predation by ship rats and habitat degradation by hares, goats and deer in 2003, and none of these threats have been addressed since that time. Finally, several small additional populations of *Powelliphanta* "Egmont" have been discovered since the previous assessment, but predation on these snails by rats has also been noted for the first time, presumably driven by warming winter temperatures and stoat control facilitating an altitudinal increase in the range of rats on Mount Taranaki.

Moved into Threatened – Nationally Vulnerable

The conservation status of four taxa has worsened to Threatened – Nationally Vulnerable.

Powelliphanta spedeni lateumbilicata, *Powelliphanta hochstetteri bicolor*, *Powelliphanta gilliesi subfusca* and *P. g. fallax* are facing increasing pressures from difficult-to-control exotic predators (rats, song thrushes, pigs) and habitat degradation (goats, pigs, deer). The latter three *Powelliphanta* taxa are also affected by increasing summer soil moisture deficits due to a warming climate, which is decreasing survival and productivity.

Moved into or between At Risk categories

The conservation status of six taxa has worsened to the point that they are now considered At Risk – Declining.

Three of these taxa – *Wainuia* sp. 3 "Mount Oxford", *Rhytida otagoensis* and *Schizoglossa barrierensis* – were formerly categorised as Relict, while *Rhytida* sp. 1 "Wairau River" was categorised as Naturally Uncommon, *Powelliphanta* "vittatus" as Range Restricted and *Delouagapia cordelia* as Not Threatened.

The extinction risk to all six taxa has increased due to more knowledge of the impacts of predators (particularly hedgehogs and rodents on all taxa), the increase in habitat degradation by rabbits (*Oryctolagus cuniculus*) in *Rhytida otagoensis* habitat and ungulates in *Wainuia* sp. 3 "Mount Oxford" and *Rhytida* sp. 1 "Wairau River" habitat, and the increased frequency and severity of droughts due to climate change exacerbating these impacts and increasing the risk of large-scale fire.

2.2.3 Data Deficient

All eight taxa that have been categorised as Data Deficient are known from only a small number of shells and spot locations. However, minimal searches have been undertaken for all of these. The single live *Wainuia* "Mount Tuhua" snail collected on Tūhua is likely not in the genus *Wainuia* but rather in the genus *Rhytida*, with the label on the shell bag believed to have been accidentally swapped with the label of a species of *Wainuia* from Canterbury – genetic study of the animal itself may be able to resolve this. *Powelliphanta* "Waitotara" is likely locally extinct, as the site where the only two shells ever recovered were found has since been converted to pasture and it seems unlikely that the presence of an extant population of such a large-sized snail could have gone undetected in the subsequent 60 years. However, in the absence of any detailed searching in the backcountry of the Waitōtara valley, it seemed to the panel unreasonable to declare it extinct. The other six taxa that have been categorised as Data Deficient (*Powelliphanta rossiana rossiana*, *Powelliphanta* "Baton", *Powelliphanta* "Garibaldi", *Powelliphanta* "Paparoas", *Powelliphanta rossiana* "Fox" and Rhytididae new genus

7 “Fiordland sp. 2”) all live in remote and, in most cases, high-altitude habitat, so difficulty of access is the main reason there is insufficient information to assess their risk of extinction.

2.3 Use of qualifiers

Almost all of the taxa assessed were given one or more biological attribute, pressure, population state or population trend qualifiers to help define their assessment and facilitate the process of conservation prioritisation (Rolfe et al. 2021). Some of the qualifiers used are discussed below.

2.3.1 Climate Impact (CI)

The most frequently applied assessment qualifier was CI, with 91% of the 44 Nationally Critical taxa, 93% of the 14 Nationally Endangered taxa and more than half of all 109 taxa given this qualifier. Soil moisture is a primary limiting factor for land snails (Solem et al. 1981; Solem 1984; Martin and Sommer 2004), and climate change has resulted in decreasing soil moisture levels at the time of year when snails are already most susceptible to desiccation. It has been found that soil moisture deficits have significantly increased and rainfall has significantly decreased over the driest summer months (February–March) over the last 30 years across central New Zealand (The National Climate Database: https://cliflo.niwa.co.nz/), even on the famously wet West Coast where many *Powelliphanta* taxa are confined. Warming winter temperatures are also facilitating the spread of ship rats – one of the main predators of land snails in New Zealand – into places they previously could not occupy, such as frost basins and high altitudes (Harris et al. 2022).

2.3.2 Conservation Research Needed (CR)

The new qualifier CR identifies taxa for which knowledge gaps are impeding effective conservation management. For example, effective control measures are lacking for the introduced song thrush, which is a significant predator of many Rhytididae taxa that reach only a small to medium adult size, such as *Powelliphanta fiordlandica, Powelliphanta* “vittatus”, *Powelliphanta spedeni lateumbilicata, Wainuia clarki* and *Rhytida oconnori*. Equally, there are currently no tools available for the long-term suppression of feral pigs and hares at scale in remote sites.

Considerable advances have been made in understanding the taxonomy within this group through genetic and morphometric studies, but many of the taxa thus identified have still to be described. While tag names for these undescribed taxa are not a barrier to assessing their threat status, the lack of a formal description can often slow the conservation action needed to protect these taxa.

2.3.3 Data Poor (DPR, DPS, DPT)

There is an urgent need for surveys and monitoring to estimate the population size and trends for many of the smaller to medium-sized taxa of Rhytididae, and even for some of the largest-bodied and most iconic taxa such as kauri snails in the genus *Paryphanta*. A large number of *Powelliphanta* taxa that were previously presumed to be secure due to the extent of area occupied have now been recognised to be in steep decline following many years of systematic population monitoring effort (Stephens 2019, 2021a, b, c; Butland 2022), highlighting the high value of such information when assessing the threat of extinction. The lack of monitoring in

the remainder of this susceptible group has almost certainly resulted in lower threat rankings for some. A few taxa that have no monitoring programme in place but have close relatives that are well monitored in similar locations and facing the same threats were categorised based on the rates of decline measured in those close relatives. *Powelliphanta superba prouseorum* and *Powelliphanta hochstetteri consobrina* are examples of these taxa.

The 56 taxa with Data Poor qualifiers are shown in Table 8 in the hope that this will stimulate projects to address the paucity of monitoring.

Table 8. Taxa with one or more Data Poor qualifiers. DPR = Data Poor Recognition, DPS = Data Poor Size, DPT = Data Poor Trend.

TAXON	CONSERVATION STATUS	DPR	DPS	DPT
Rhytididae new genus 7 "Fiordland sp. 2" (M.309312)	Data Deficient	x		
Amborhytida duplicata	Nationally Critical		x	x
Paryphanta watti	Nationally Critical		x	x
Powelliphanta gagei	Nationally Critical		x	x
Powelliphanta hochstetteri consobrina	Nationally Critical			x
Powelliphanta superba prouseorum	Nationally Critical			x
Powelliphanta traversi tararuaensis	Nationally Critical			x
Wainuia clarki	Nationally Critical			x
Delos sp. 1 (M.029346)	Nationally Critical		x	x
Powelliphanta "Kirwans"	Nationally Critical		x	x
Powelliphanta "Matiri"	Nationally Critical		x	x
Powelliphanta "Parapara"	Nationally Critical	x		
Powelliphanta superba "Gouland Range"	Nationally Critical		x	x
Rhytida sp. 5 (M.308649)	Nationally Critical	x	x	x
Powelliphanta fletcheri	Nationally Endangered		x	x
Powelliphanta traversi florida	Nationally Endangered			x
Powelliphanta traversi koputaroa	Nationally Endangered		x	x
Powelliphanta traversi latizona	Nationally Endangered			x
Powelliphanta traversi otakia	Nationally Endangered			x
Powelliphanta traversi traversi	Nationally Endangered			x
Amborhytida sp. 1 "Aupōuri" (M.173834)	Nationally Endangered	x	x	x
Powelliphanta "Anatoki Range"	Nationally Endangered		x	x
Powelliphanta "Egmont"	Nationally Endangered		x	x
Powelliphanta "Lodestone"	Nationally Endangered		x	x
Powelliphanta "Matakitaki"	Nationally Endangered		x	x
Powelliphanta "Owen"	Nationally Endangered		x	x
Powelliphanta gilliesi "Iwituaroa"	Nationally Endangered		x	x
Powelliphanta fiordlandica	Nationally Vulnerable		x	x
Powelliphanta gilliesi aurea	Nationally Vulnerable		x	x
Powelliphanta hochstetteri bicolor	Nationally Vulnerable			x
Powelliphanta lignaria lignaria	Nationally Vulnerable			x

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Table 8 continued

TAXON	CONSERVATION STATUS	DPR	DPS	DPT
Powelliphanta lignaria lusca	Nationally Vulnerable			x
Powelliphanta spedeni lateumbilicata	Nationally Vulnerable		x	x
Powelliphanta spedeni spedeni	Nationally Vulnerable		x	x
Rhytida patula	Nationally Vulnerable		x	x
Rhytida stephenensis	Nationally Vulnerable			x
Schizoglossa gigantea	Nationally Vulnerable		x	x
Schizoglossa worthyae	Nationally Vulnerable	x	x	x
Powelliphanta "Urewera"	Nationally Vulnerable			x
Rhytida sp. 2 "Gunner Downs" (M.305044)	Nationally Vulnerable	x	x	x
Amborhytida dunniae	Declining			x
Amborhytida forsythi	Declining	x		x
Delouagapia cordelia	Declining			x
Paryphanta busbyi	Declining			x
Rhytida australis	Declining			x
Rhytida otagoensis	Declining		x	x
Schizoglossa barrierensis	Declining	x	x	x
Wainuia edwardi	Declining			x
Wainuia nasuta	Declining			x
Paryphanta sp. 1 "western clade" (M.305039)	Declining	x	x	x
Powelliphanta "vittatus"	Declining		x	x
Powelliphanta rossiana "Haast"	Declining		x	x
Rhytida sp. 1 "Wairau River"	Declining		x	x
Rhytididae new genus 7 "Fiordland sp. 1" (M.032755)	Declining	x	x	x
Wainuia sp. 3 "Mount Oxford" (M.305040)	Declining	x	x	x
Rhytidarex johnsoni	Naturally Uncommon			x

3. Conservation status of 109 taxa of New Zealand indigenous terrestrial Gastropoda

3.1 Assessments

The conservation status of 109 terrestrial gastropod taxa in the family Rhytididae (carnivorous snails) found in New Zealand is presented in Table 9. Taxa were assessed according to the criteria of Townsend et al. (2008) and have been grouped by conservation status and then alphabetically by scientific name. The Data Deficient list precedes the other categories, which are ordered by degree of loss, with Nationally Critical at the top of the list and Not Threatened at the bottom. Although the true status of Data Deficient taxa will span the entire range of available categories, taxa have been placed in that category mainly because they are very seldom seen, so most are likely to eventually be considered threatened and some may already be extinct. Indeed, the Data Deficient list is likely to include many of the most threatened species in New Zealand.

Brief descriptions of the NZTCS categories and criteria are provided in section 3.2. See Townsend et al. (2008) and Rolfe et al. (2021) for full definitions of categories, criteria and qualifiers, as well as an explanation of the assessment process.

The full data for the taxa listed in Table 9 can be viewed and downloaded at https://nztcs.org.nz/reports/1101.

Table 9. Conservation status of indigenous terrestrial Gastropoda taxa in the family Rhytididae (carnivorous snails) found in New Zealand.

Qualifiers are abbreviated as follows: CD = Conservation Dependent, CI = Climate Impact, CR = Conservation Research Needed, DPR = Data Poor Recognition, DPS = Data Poor Size, DPT = Data Poor Trend, IE = Island Endemic, OL = One Location, PD = Partial Decline, PE = Possibly Extinct, PF = Population Fragmentation, RR = Range Restricted, Sp = Sparse.

ASSESSMENT NAME AND AUTHORITY	CRITERIA	QUALIFIERS	STATUS CHANGE
DATA DEFICIENT (8)			
Taxonomically determinate (1)			
Powelliphanta rossiana rossiana (A.W.B. Powell, 1930)			Neutral
Taxonomically unresolved (7)			
Powelliphanta "Baton"			Neutral
Powelliphanta "Garibaldi"			Neutral
Powelliphanta "Paparoas"		RR, Sp	Neutral
Powelliphanta "Waitotara" (Whanganui Regional Museum 1805.719)		PE	No change
Powelliphanta rossiana "Fox"			Neutral
Rhytididae new genus 7 "Fiordland sp. 2" (M.309312)		DPR	New listing
Wainuia "Mount Tuhua"			Neutral

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Table 9 continued

ASSESSMENT NAME AND AUTHORITY	CRITERIA	QUALIFIERS	STATUS CHANGE
THREATENED (74)			
NATIONALLY CRITICAL (44)			
Taxonomically determinate (32)			
Amborhytida duplicata (Suter, 1904)	C	CI, DPS, DPT, RR, Sp	Worse
Delouagapia tasmani Goulstone & Brook, 1999	A(3)	CD, IE, OL	No change
Paryphanta watti A.W.B. Powell, 1946	C	CD, CI, DPS, DPT, RR, Sp	Worse
Powelliphanta annectens (A.W.B. Powell, 1936)	C	CD, CI, PD, RR	Worse
Powelliphanta augusta K. Walker, Trewick & G.M. Barker, 2008	A(1)	CD, CI, OL, PF	No change
Powelliphanta gagei (sensu stricta) (A.W.B. Powell, 1938)	C	CI, DPS, DPT, PF, Sp	No change
Powelliphanta gilliesi brunnea (A.W.B. Powell, 1938)	A(3)	CD, CI, OL	No change
Powelliphanta gilliesi compta (A.W.B. Powell, 1930)	C	CD, CI, OL	Worse
Powelliphanta gilliesi gilliesi (E.A. Smith, 1880)	C	CD, CI, OL	Worse
Powelliphanta gilliesi jamesoni (A.W.B. Powell, 1936)	C	CD, CI	Worse
Powelliphanta gilliesi kahurangica (A.W.B. Powell, 1936)	C	CD, CI, OL	Worse
Powelliphanta hochstetteri anatokiensis (A.W.B. Powell, 1938)	C	CD, CI	Worse
Powelliphanta hochstetteri consobrina (A.W.B. Powell, 1936)	C	CI, DPT	Worse
Powelliphanta hochstetteri hochstetteri (L. Pfeiffer, 1862) brown based	C	CD, CI	Worse
Powelliphanta hochstetteri hochstetteri (L. Pfeiffer, 1862) yellow based	C	CD, CI	Worse
Powelliphanta hochstetteri obscura (Beutler, 1901)	C	CD, CI	Worse
Powelliphanta lignaria johnstoni (A.W.B. Powell, 1946)	C	CD, CI, OL	Worse
Powelliphanta lignaria oconnori (A.W.B. Powell, 1938)	C	CD, CI	Worse
Powelliphanta lignaria rotella (A.W.B. Powell, 1938)	C	CD, CI, OL	Worse
Powelliphanta lignaria ruforadiata (A.W.B. Powell, 1949)	C	CD, CI, OL	Worse
Powelliphanta lignaria unicolorata (A.W.B. Powell, 1930)	C	CD, CI, OL	Worse
Powelliphanta patrickensis (A.W.B. Powell, 1949)	C	CI, OL, PF	Worse
Powelliphanta superba harveyi (A.W.B. Powell, 1946)	C	CD, CI	Worse
Powelliphanta superba mouatae (A.W.B. Powell, 1946)	C	CD, OL	Worse
Powelliphanta superba prouseorum (A.W.B. Powell, 1946)	C	CD, CI, DPT	Worse
Powelliphanta superba richardsoni (A.W.B. Powell, 1946)	C	CD, CI, OL	Worse
Powelliphanta superba superba (A.W.B. Powell, 1930)	C	CD, CI	Worse
Powelliphanta traversi tararuaensis (A.W.B. Powell, 1938)	C	CI, DPT, OL, PF	Worse
Rhytida oconnori A.W.B. Powell, 1946	C	CD, CI, Sp	No Change
Rhytida webbi A.W.B. Powell, 1949	C	CI, RR	No change
Rhytidarex buddlei (A.W.B. Powell, 1948)	A(3)	CD, CI, IE, OL	No change
Wainuia clarki A.W.B. Powell, 1936	B(2)	CI, DPT, PF, RR	Worse
Taxonomically unresolved (12)			
Delos sp. 1 (M.029346)	A(3)	CD, DPS, DPT, IE, OL	No change
Delos sp. 13 (M.029345)	A(3)	CD, IE, OL	No change
Powelliphanta "Buller River"	C	CI, RR	Worse
Powelliphanta "Kirwans"	C	CI, DPS, DPT, RR, Sp	Worse
Powelliphanta "Matiri"	A(3)	CI, DPS, DPT, RR, Sp	Worse
Powelliphanta "Nelson Lakes"	C	CI, RR, Sp	Worse
Powelliphanta "Parapara"	C	CD, CI, DPR, OL	Worse

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Table 9 continued

ASSESSMENT NAME AND AUTHORITY	CRITERIA	QUALIFIERS	STATUS CHANGE
Powelliphanta gilliesi "Haidinger"	C	CD, CI, OL, RR	No change
Powelliphanta gilliesi "Heaphy"	C	CD, CI, OL	Worse
Powelliphanta superba "Gouland Range"	C	CD, CI, DPS, DPT, OL	Worse
Powelliphanta superba "Gunner River"	C	CD, CI	Worse
Rhytida sp. 5 (M.308649)	B(3)	CI, DPR, DPS, DPT, RR, Sp	New listing
NATIONALLY ENDANGERED (14)			
Taxonomically determinate (6)			
Powelliphanta fletcheri (A.W.B. Powell, 1938)	C(3)	DPS, DPT	Worse
Powelliphanta traversi florida (A.W.B. Powell, 1946)	C(3)	CD, CI, DPT, OL	No change
Powelliphanta traversi koputaroa (A.W.B. Powell, 1946)	A(3)	CD, CI, DPS, DPT, OL, PF	No change
Powelliphanta traversi latizona (A.W.B. Powell, 1949)	C(3)	CD, CI, DPT, PF	No change
Powelliphanta traversi otakia (A.W.B. Powell, 1946)	A(3)	CD, CI, DPT, PF	Better
Powelliphanta traversi traversi (A.W.B. Powell, 1930)	C(3)	CD, CI, DPT, PF	No change
Taxonomically unresolved (8)			
Amborhytida sp. 1 "Aupōuri" (M.173834)	A(3)	CI, DPR, DPS, DPT, PF, RR	No change
Powelliphanta "Anatoki Range"	A(3)	CI, CR, DPS, DPT, RR, Sp	Better
Powelliphanta "Egmont"	C(3)	CI, DPS, DPT, RR, Sp	Worse
Powelliphanta "Lodestone"	A(3)	CI, DPS, DPT, RR, Sp	Worse
Powelliphanta "Matakitaki"	C(3)	CI, DPS, DPT, Sp	Worse
Powelliphanta "Maungaharuru"	C(3)	CI, OL, RR	No change
Powelliphanta "Owen"	C(3)	CI, DPS, DPT, RR, Sp	No change
Powelliphanta gilliesi "Iwituaroa"	C(2)	CD, CI, DPS, DPT, Sp	New listing
NATIONALLY VULNERABLE (16)			
Taxonomically determinate (14)			
Powelliphanta fiordlandica (Climo, 1971)	D(3)	CD, DPS, DPT, Sp	No change
Powelliphanta gilliesi aurea (A.W.B. Powell, 1946)	C(3)	CD, CI, DPS, DPT, OL	Better
Powelliphanta gilliesi fallax (A.W.B. Powell, 1930)	E(2)	CD, CI, OL	Worse
Powelliphanta gilliesi montana (A.W.B. Powell, 1936)	D(3)	CD, CI, OL	Better
Powelliphanta gilliesi subfusca (A.W.B. Powell, 1930)	D(3)	CD, CI	Worse
Powelliphanta hochstetteri bicolor (A.W.B. Powell, 1930)	E(2)	CI, DPT	Worse
Powelliphanta lignaria lignaria (F.W. Hutton, 1888)	E(2)	CI, DPT	No change
Powelliphanta lignaria lusca (A.W.B. Powell, 1949)	E(2)	CI, DPT	No change
Powelliphanta spedeni lateumbilicata (A.W.B. Powell, 1946)	D(3)	DPS, DPT, Sp	Worse
Powelliphanta spedeni spedeni (A.W.B. Powell, 1932)	D(3)	DPS, DPT, Sp	No change
Rhytida patula F.W. Hutton, 1882	C(3)	DPS, DPT, RR, Sp	New listing
Rhytida stephenensis A.W.B. Powell, 1930	D(3)	CD, CI, DPT, PD, PF	No change
Schizoglossa gigantea A.W.B. Powell, 1930	D(3)	DPS, DPT	No change
Schizoglossa worthyae A.W.B. Powell, 1949	D(3)	DPR, DPS, DPT, Sp	No change
Taxonomically unresolved (2)			
Powelliphanta "Urewera"	C(3)	CI, DPT	No change
Rhytida sp. 2 "Gunner Downs" (M.305044)	C(1)	DPR, DPS, DPT, RR, Sp	Neutral

Continued on next page

Table 9 continued

ASSESSMENT NAME AND AUTHORITY	CRITERIA	QUALIFIERS	STATUS CHANGE
AT RISK (22)			
DECLINING (17)			
Taxonomically determinate (10)			
Amborhytida dunniae (J.E. Gray, 1840)	C(2)	CI, DPT, Sp	No change
Amborhytida forsythi (A.W.B. Powell, 1952)	B(2)	CI, DPR, DPT	No change
Delouagapia cordelia (Hutton, 1883)	C(1)	CI, DPT	Worse
Paryphanta busbyi (J.E. Gray, 1840)	B(2)	CI, DPT, Sp	No change
Powelliphanta marchanti (A.W.B. Powell, 1932)	C(2)	CD, CI	Better
Rhytida australis F.W. Hutton, 1881	C(2)	DPT, PD, RR	New listing
Rhytida otagoensis A.W.B. Powell, 1930	B(1)	CI, DPS, DPT, PF	Worse
Schizoglossa barrierensis A.W.B. Powell, 1949	C(2)	DPR, DPS, DPT	Worse
Wainuia edwardi (Suter, 1899)	C(2)	CI, CR, DPT, PF	No change
Wainuia nasuta A.W.B. Powell, 1946	C(2)	CD, CI, DPT, PF, Sp	Better
Taxonomically unresolved (7)			
Paryphanta sp. 1 "western clade" (M.305039)	C(2)	CI, DPR, DPS, DPT, PF	No change
Powelliphanta "vittatus"	C(2)	DPS, DPT, Sp	Worse
Powelliphanta rossiana "Haast"	C(2)	DPS, DPT, Sp	No change
Rhytida sp. 1 "Wairau River" (M.162834)	B(2)	CI, DPS, DPT, OL, RR	Worse
Rhytida sp. 4 "Mt Tuhua" (M.023731)	B(2)	Sp	Neutral
Rhytididae new genus 7 "Fiordland sp. 1" (M.032755)	C(2)	DPR, DPS, DPT, Sp	Worse
Wainuia sp. 3 "Mount Oxford" (M.305040)	B(2)	CI, DPR, DPS, DPT, RR	Worse
RELICT (1)			
Taxonomically unresolved (1)			
Delos sp. 2 (M.038250)	B	RR	No change
NATURALLY UNCOMMON (4)			
Taxonomically determinate (3)			
Delos regia Climo, 1973		CD, IE, RR, Sp	No change
Delos striata Climo, 1973		CD, IE, OL	No change
Rhytidarex johnsoni (A.W.B. Powell, 1948)		CD, CI, DPT, IE, RR	No change
Taxonomically unresolved (1)			
Delos sp. 12 (M.154823)		CD, IE, RR	No change
NOT THREATENED (5)			
Taxonomically determinate (5)			
Rhytida greenwoodi (J.E. Gray, 1850)			New listing
Rhytida meesoni meesoni Suter, 1891			New listing
Rhytida meesoni perampla A.W.B. Powell, 1946			New listing
Schizoglossa novoseelandica (L. Pfeiffer, 1862)			New listing
Wainuia urnula (L. Pfeiffer, 1855)			New listing

3.2 NZTCS categories, criteria and qualifiers

Full details of the criteria and qualifiers included in Table 9 can be found in Rolfe et al. (2021). Summary definitions for the categories are presented below.

Data Deficient

Taxa that cannot be assessed due to a lack of current information about their distribution and abundance. It is hoped that listing such taxa will stimulate research to find out the true category (for a fuller definition, see Townsend et al. (2008)).

Threatened

Taxa that meet the criteria specified by Townsend et al. (2008) for the categories Nationally Critical, Nationally Endangered and Nationally Vulnerable.

NATIONALLY CRITICAL

A – very small population (natural or unnatural)

A(1) < 250 mature individuals
A(2) ≤ 2 sub-populations, ≤ 200 mature individuals in the larger sub-population
A(3) Total area of occupancy ≤ 1 ha (0.01 km^2)

B – small population with a high ongoing or forecast decline of 50–70%

B(1) 250–1000 mature individuals
B(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population
B(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

C – population (irrespective of size or number of sub-populations) with a very high ongoing or forecast decline of > 70%

C Predicted decline > 70%

NATIONALLY ENDANGERED

A – small population that has a low to high ongoing or forecast decline of 10–50%

A(1) 250–1000 mature individuals
A(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population
A(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

B – small, stable population (unnatural)

B(1) 250–1000 mature individuals
B(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population
B(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

C – moderate population and high ongoing or forecast decline of 50–70%

C(1) 1000–5000 mature individuals
C(2) ≤ 15 sub-populations, ≤500 mature individuals in the largest sub-population
C(3) Total area of occupancy ≤ 100 ha (1 km^2)

NATIONALLY VULNERABLE

A – small population (unnatural), increasing > 10%

A(1) 250–1000 mature individuals
A(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population
A(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

B – moderate population (unnatural), stable ± 10%

B(1) 1000–5000 mature individuals

B(2) ≤ 15 sub-populations, ≤ 500 mature individuals in the largest sub-population
B(3) Total area of occupancy ≤ 100 ha (1 km^2)

C – moderate population and population trend that has a low to high ongoing or forecast decline of 10–50%
C(1) 1000–5000 mature individuals
C(2) ≤ 15 sub-populations, ≤ 500 mature individuals in the largest sub-population
C(3) Total area of occupancy ≤ 100 ha (1 km^2)

D – moderate to large population and moderate to high ongoing or forecast decline of 30–70%
D(1) 5000–20 000 mature individuals
D(2) ≤ 15 sub-populations, ≤ 1000 mature individuals in the largest sub-population
D(3) Total area of occupancy ≤ 1000 ha (10 km^2)

E – large population and high ongoing or forecast decline of 50–70%
E(1) 20 000–100 000 mature individuals
E(2) Total area of occupancy ≤ 10 000 ha (100 km^2)

NATIONALLY INCREASING

This is a new name and category for At Risk – Recovering A of Townsend et al. (2008).

Taxa that have undergone a documented decline within the last 1000 years to a population size of 1000–5000 mature individuals or a total area of occupancy of ≤ 100 ha (1 km^2) and now have an ongoing or predicted increase of > 10% in the total population or area of occupancy, taken over the longer of the next 10 years or three generations.

Taxa that are increasing but have a population size of < 1000 mature individuals (or a total area of occupancy of < 10 ha) are listed in one of the other Threatened categories, depending on their population size (for more details, see Townsend et al. (2008)).

At Risk

DECLINING

A – moderate to large population and low ongoing or forecast decline of 10–30%
A(1) 5000–20 000 mature individuals
A(2) Total area of occupancy ≤ 1000 ha (10 km^2)

B – large population and low to moderate ongoing or forecast decline of 10–50%
B(1) 20 000–100 000 mature individuals
B(2) Total area of occupancy ≤ 10 000 ha (100 km^2)

C – very large population and low to high ongoing or forecast decline of 10–70%
C(1) > 100 000 mature individuals
C(2) Total area of occupancy > 10 000 ha (100 km^2)

RELICT

Taxa that have undergone a documented decline within the last 1000 years and now occupy < 10% of their former range and meet one of the following criteria:

A 5000–20 000 mature individuals; population stable (± 10%)
B > 20 000 mature individuals; population stable or increasing at > 10%

The range of a relictual taxon takes into account the area currently occupied as a ratio of its former extent. Relict can also include taxa that exist as reintroduced and self-sustaining populations within or outside their former known range (for more details, see Townsend et al. (2008)).

NATURALLY UNCOMMON

Taxa whose distributions are confined to a specific geographical area or which occur within naturally small and widely scattered populations, where these distributions are not the result of human disturbance.

Not Threatened

Resident native taxa that have large, stable populations.

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5. References

Allan, T.E. 2010: Husbandry of the carnivorous land snail, *Powelliphanta augusta* (Gastropoda: Pulmonata:Rhytididae). Unpublished MSc thesis, Victoria University of Wellington, Wellington. 75 p.

Barker, G.M.; Brook, F.J.; Mahlfeld, K.; Walker, K.; Roscoe, D.J.; Hitchmough, R.A.; Edwards, E.; Rolfe, J.R.; Michel, P. 2021: Conservation status of New Zealand indigenous terrestrial Gastropoda (slugs and snails), 2020. Part 1. Athoracophoridae (leaf-veined slugs) and Succineidae (amber snails). *New Zealand Threat Classification Series 32*. Department of Conservation, Wellington. 15 p.

Beauchamp, A.J. 1999: Weka declines in the north and north-west of the South Island, New Zealand. *Notornis 46*: 461–469.

Butland, S. 2022: *Powelliphanta* monitoring Golden Bay to May 2022. Department of Conservation (unpublished report; DOC-7193587). 29 p.

Costall, J.A. 2012: The effects of restoration on the structure and function of litter invertebrate communities in New Zealand native forest remnants. Unpublished PhD thesis, Massey University, Palmerston North. 293 p.

Daly, E.E.; Walker, K.J.; Morgan-Richards, M.; Trewick, S.A. 2019: Spatial genetics of a high elevation lineage of Rhytididae land snails in New Zealand: the *Powelliphanta* Kawatiri complex. *Molluscan Research 39(3)*: 280–289.

Denmead, L.H.; Barker, G.M.; Standish, R.J.; Didham, R.K. 2015: Experimental evidence that even minor livestock trampling has severe effects on land snail communities in forest remnants. *Journal of Applied Ecology 52*: 161–17.

Gruner, I.; Walker, K.; Anderson F.; Phillips, R.; Flanagan, L.; Matini, S.; Weston, K.; Marshall, J. 2021: *Powelliphanta* Recovery Strategy 2021–2031. Department of Conservation (unpublished report; DOC-6946289). 43 p.

Harris, H.A.L.; Kelly, D.; Innes, J.; Allen, R.B. 2022: Invasive species and thermal squeeze: distribution of two invasive predators and drivers of ship rat (*Rattus rattus*) invasion in mid-elevation *Fuscospora* forest. *Biological Invasions 24*: 2547–2559.

Hitchmough, R. (comp.) 2002: New Zealand Threat Classification System lists—2002. *Threatened Species Occasional Publication 23*. Department of Conservation, Wellington. 210 p.

Hitchmough, R.; Bull, L.; Cromarty, P. (comps) 2007: New Zealand Threat Classification System lists—2005. Department of Conservation, Wellington. 194 p.

Kemp, F. 2013: Predator control and the health and abundance of North Island weka – an unpublished report on the Motu Project, November 1999–2012. Department of Conservation, Rotorua.

King, C.M. 2017: Contemporary observations of predation on the buff weka (*Gallirallus australis hectori*) by ferrets in the South Island during the nineteenth century. *Notornis 64*: 52–55.

Ogilvie, S.C. 2010: Weka (*Gallirallus australis*) predation of a house mouse (*Mus musculus*). *Notornis 57*: 101–102.

Mahlfeld, K.; Brook, F.J.; Roscoe, D.J.; Hitchmough, R.A., Stringer, I.A.N. 2012: The conservation status of New Zealand terrestrial Gastropoda excluding *Powelliphanta*. *New Zealand Entomologist 35*: 103–109. doi:10.1080/00779962.2012.686313

Martin, K.; Sommer, M. 2004: Relationships between land snail assemblage patterns and soil properties in temperate-humid forest ecosystems. *Journal of Biogeography 31*: 531–545.

McConachie, N. 1966: You'll learn no harm from the hills. A.H. & A.W. Reed, Dunedin. 199 p.

Molloy, J.; Bell, B.; Clout, M.; de Lange, P.; Gibbs, G.; Given, D.; Norton, D.; Smith, N.; Stephens, T. 2002: Classifying species according to threat of extinction. A system for New Zealand. *Threatened Species Occasional Publication 22*. Department of Conservation, Wellington. 26 p.

Rolfe, J.; Makan, T.; Tait, A. 2021: Supplement to the New Zealand Threat Classification System manual 2008: new qualifiers and amendments to qualifier definitions, 2021. Department of Conservation, Wellington. 7 p.

Sadleir, R. 2000: Evidence of possums as predators of native animals. Pp. 126–131 Iin: Montague, T. (Ed.): The brushtail possum: biology, impact and management of an introduced marsupial. Lincoln, New Zealand, Manaaki Whenua Press, Lincoln. Pp. 126-131.

Solem, A. 1984: A world model of land snail diversity and abundance. Pp. 6–22 in Solem, A.; van Bruggen, A.C. (Eds): World-wide snails. Biogeographical studies on non-marine Mollusca. Brill / Backhuys, Leiden.

Solem, A.; Climo, F.M.; Roscoe, D.J. 1981: Sympatric species diversity of New Zealand land snails. *New Zealand Journal of Zoology 8*: 453–485.

Stephens, C. 2019: Kakapo, Cuckoo, Gunner Downs, Whitecliffs and Karamea Bluffs snail plot monitoring report 2019. Department of Conservation (unpublished report; DOCM-5999232). 9 p.

Stephens, C. 2021a: Heaphy Valley *Powelliphanta* snail monitoring report 2021. Department of Conservation (unpublished report; DOC-6671451). 8 p.

Stephens, C. 2021b: Mokihinui *Powelliphanta* snail report 2021. Department of Conservation (unpublished report; DOC-6667523). 8 p.

Stephens, C. 2021c: St Andrews and Charming Creek snail plots 2021. Department of Conservation (unpublished report; DOC-6662662). 9 p.

Tinnemans, J.S.A.; Elliott, G.P.; Rawlence, T.E.; McDonald, A.; Nydeggar Bell, M.A.; Bell, C.W.; Moran, K.J. 2019: Costs and benefits of aerial 1080 operations to Western weka (*Gallirallus australis australis*). *New Zealand Journal of Ecology 43(1)*: 33–53

Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2008: New Zealand threat classification system manual. Department of Conservation, Wellington. 35 p.

Walker, K.J. 2003: Recovery plans for *Powelliphanta* land snails. *Threatened Species Recovery Plan 49*. Department of Conservation, Wellington. x + 208 p. + 64 plates.

Walker, K.; Brook, F.J.; Barker, G.M.; Roscoe, D.J.; Edwards, E.; Hitchmough, R.A.; Rolfe, J.R.; Michel, P. 2021: Conservation status of New Zealand indigenous terrestrial Gastropoda (slugs and snails), 2020. Part 2. Achatinellidae, Bothriembryontidae (pūpūharakeke), Euconulidae, Helicarionidae, Pupinidae and Vertiginidae. *New Zealand Threat Classification Series 33*. Department of Conservation, Wellington. 9 p.

Walker K.J.; Trewick S.A.; Barker G.M. 2008: *Powelliphanta augusta*, a new species of land snail, with a description of its former habitat, Stockton coal plateau, New Zealand. *Journal of the Royal Society of New Zealand 38(3)*: 163–186.

Wardle, D.A.; Yeates, G.W.; Barker, G.M.; Bonner, K.I.; Ghani, A. 2001: Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences. *Ecological Monographs 71*: 587–614.