THREATENED SPECIES RECOVERY PLAN SERIES NO.13

GIANT LAND SNAIL RECOVERY PLAN
Placostylus spp., *Paryphanta* sp.

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ABSTRACT

The kauri snail (*Paryphanta busbyi*) and the flax snails (*Placostylus* species) were widespread in many parts of Northland before human settlement; however, some are now severely restricted in distribution. Both genera of these giant land snails have been badly affected by mammalian and bird predators introduced into New Zealand and habitat destruction wrought by human settlers. These threats continue to grow and, without intervention, will limit recovery of snail populations. The long-term goal for conservation of giant land snails is to preserve and enhance populations of *Placostylus* and *Paryphanta* in their natural range, with emphasis on directing management towards the most genetically diverse and viable populations. The short-term goal for the duration of this recovery plan is to prevent the extinction of most of the recognised subspecies or genetically distinct populations.

Immediate objectives include:

I. Habitat improvement
2. Predator control
3. Research to establish long-term conservation requirements
4. Survey and monitoring to further establish distribution, abundance and population trends.

Key words: *Placostylus hongii*, *Placostylus ambagiosus*, *Placostylus bollonsi*, *Paryphanta busbyi*, Rhytididae, Bulimulidae, land snails, recovery plan, kauri snails, flax snails

Cover (clockwise): *Placostylus*, Poor Knights Islands, photo: Rod Morris;
typical *Placostylus* habitat, Cape Maria van Diemen, photo: Greg Sherley;
Paryphanta busbyi, Warkworth, photo: Rod Morris;
typical *Paryphanta* habitat, North Cape, photo: Kath Walker.

CONTENTS

1. INTRODUCTION

Paryphanta belong to the family Rhytididae, which occurs from South Africa to New Guinea, some of the high islands of the Southwest Pacific, Australia and New Zealand (Powell 1979).

The genus *Placostylus* belongs to the Bulimulidae family and the geographical range is the island groups of the Melanesian Plateau, Solomons, Vanuatu, New Caledonia, Fiji, Lord Howe Island and the Northland Peninsula of New Zealand (Powell 1979).

One species and two subspecies of *Paryphanta* and three species and 14 subspecies of *Placostylus* are endemic to New Zealand. Another seven subspecies of *Placostylus ambagiosus* are known from subfossil deposits only. The two genera contain some of New Zealand's largest snails with *Paryphanta* having a maximum diameter of 80 mm and *Placostylus* a maximum height of 115 mm. All species and subspecies (including subfossils) are protected under the Wildlife Act 1953. All the species and subspecies are under threat and all have been assigned a conservation status by Bell (1986) and Molloy and Davis (1992) (Table 1). Appendix 1 give fuller details on the individual species discussed in this recovery plan.

Table 1: Conservation status of *Paryphanta* and *Placostylus* in New Zealand (after Bell 1986 and Molloy and Davis 1992).

Subspecies	Author	
	Bell (1986)	Molloy & Davis (1992)
Paryphanta busbyi busbyi	T	C
Paryphanta b. watti	E	A
Placostylus bollonsi bollonsi	T	B
Placostylus b. caperatus	T	B
Placostylus b. arbutus	T	not listed
Placostylus ambagiosus ambagiosus	PE*	A
Placostylus a. consobrinus	E	A
Placostylus a. paraspiritus	PE*	B
Placostylus a. lesleyae	E	A
Placostylus a. pandora	E	A
Placostylus a. keenorum	E	A
Placostylus a. annectens	E	A
Placostylus a. michiei	T	B
Placostylus a. watti	E	A
Placostylus a. whareana	E	A
Placostylus hongii	RT	C

PE = presumed extinct
E = endangered
T = threatened
RT = regionally threatened

A = Highest priority threatened species
B = Second priority threatened species
C = Third priority threatened species

* Populations of both subspecies have been found subsequently (Sherley and Parrish 1989, Parrish and Sherley 1993)

2. DISTRIBUTION AND CAUSES OF DECLINE

2.1 Past Distribution

2.1.1 Placostylus hongii

Powell (1979) gives the distribution as "... from Whangaroa to Whangarei Heads, Poor Knights Islands, Chicken Islands and Great Barrier Island but most of the mainland colonies have become extinct. The type locality was Kerikeri." Powell (1938, 1979) also mentions colonies at Mokau, Mimiwhangata near Russell, Tauranga Bay, Whangamumu, Paparahi, Matapouri Bay, Goat Island, Smugglers Bay, Reotahi, Parua Bay and Mokohinau (Fanal) Island.

Hayward and Brook (1981) point out that Maori may have established populations of *P. hongii* outside their natural range - e.g., Chickens, Fanal and Great Barrier islands. Powell (1938) records living specimens taken from Great Barrier Island at Schooner Bay and fresh shells taken in 1924 at Maori Bay. N. and N. Gardner (pers. comm to Bruce Hayward, Auckland Institute and Museum) say that live *P. hongii* were near the entrance to Whangaparapara Harbour on Great Barrier in 1940.

2.1.2 Placostylus ambagiosus

This species is confined to the Te Paki Ecological Region in the far north of Northland. They were probably once widespread and numerous over the Cape Maria van Diemen-North Cape area because large numbers of subfossil shells of extinct subspecies can be found at Motuopao Island, Cape Maria van Diemen, Herangi Hill, Spirits Bay, Tom Bowling Bay, Waikuku and Whareana.

2.1.3 Placostylus bollonsi

The three described subspecies and two other populations are confined to the Three Kings Islands group. In the last glacial period the land exposed on the Three Kings Plateau would have been more extensive than at present and all of the islands joined (Brook and Laurenson 1992).

2.1.4 Paryphanta busbyi busbyi

Powell (1979) describes their distribution as "Northland Peninsula, from near Awanui to Woodcocks, near Warkworth, fairly generally distributed, Taranga, Hen and Chickens Islands".

2.1.5 Paryphanta busbyi watti

This subspecies is confined to the Cape Maria van Diemen, North Cape block. The type specimen was collected from Unawhao but it also occurs at Kohuronaki while subfossil shells occur in dunes at Cape Maria van Diemen (Powell 1979).

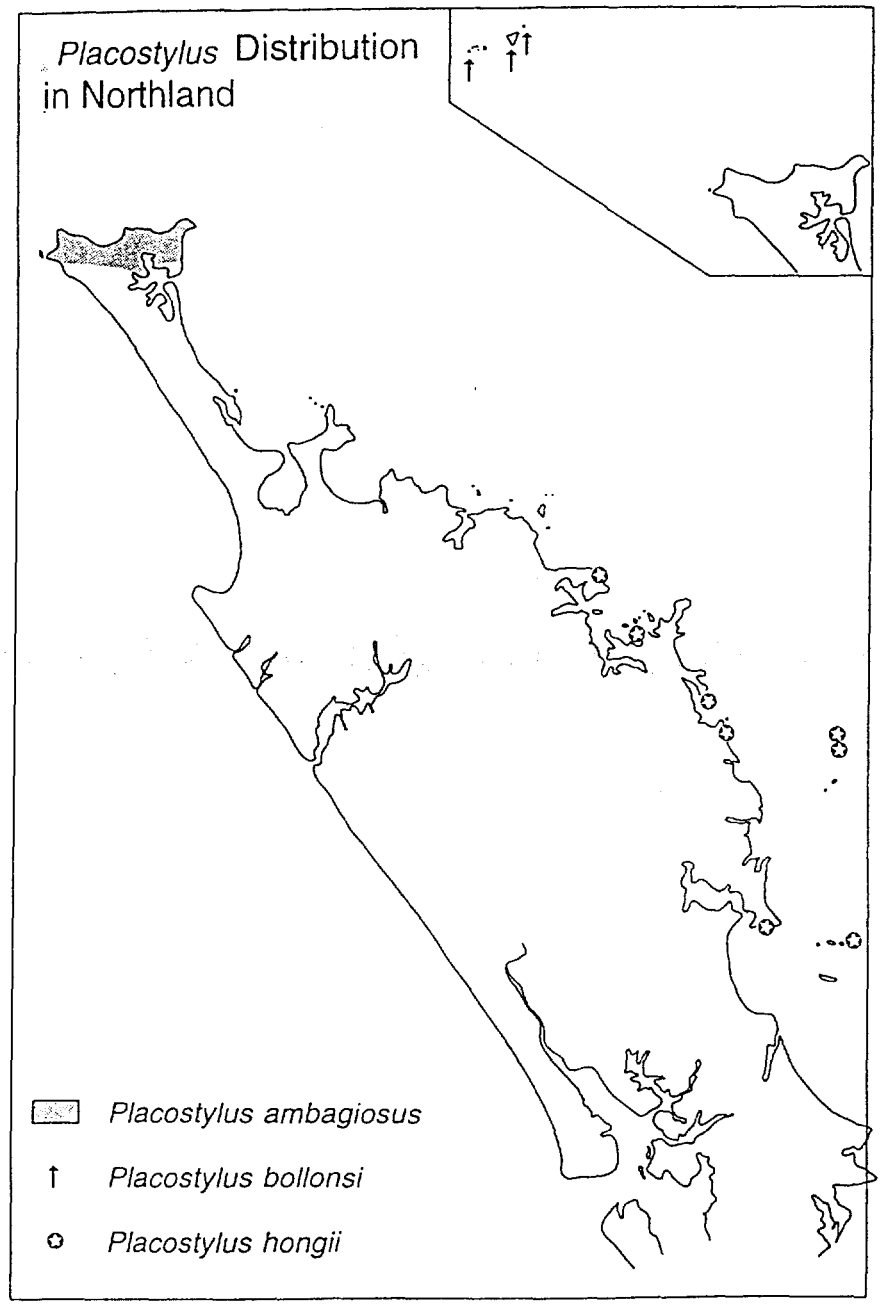
Table 2: Summary of snail colony status, threats and management needs.

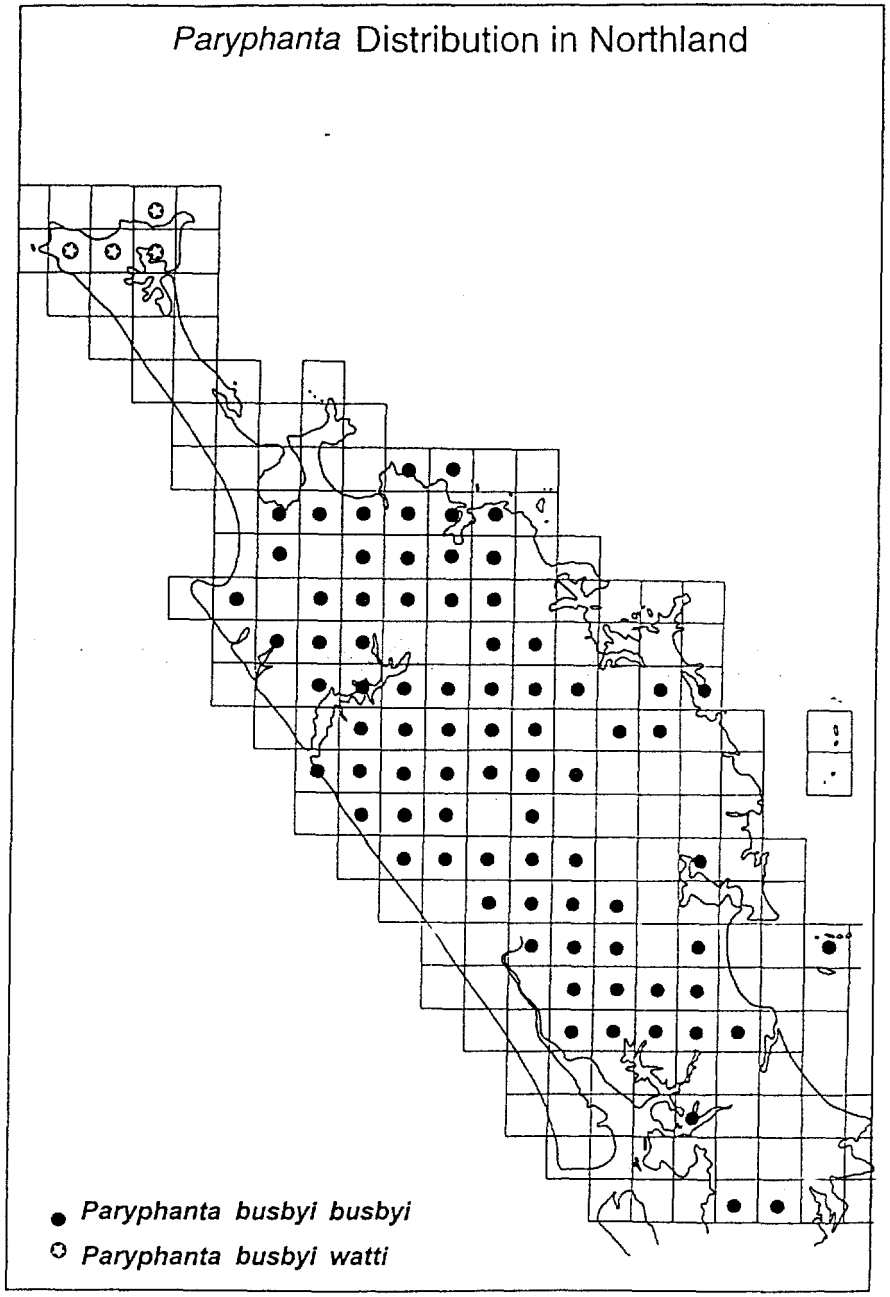
Subspecies/colonies	Locality	Status	Fencing	Presence of predators/habitat disturbers				Management Priority
				Pigs	Rodents	Birds	Stock	
Placostylus bollonsi sp.	West Island	100+	N/A	N	N	U/K	N	L
P.b. bollonsi	Great King	200+	N/A	N	N	U/K	N	L
P.b. arbutus	Great King	350+	N/A	N	N	U/K	N	L
P.b. caperatus	Great King	1-200	N/A	N	N	U/K	N	L
P. bollonsi sp.	North East	200+	N/A	N	N	U/K	N	L
Placostylus ambagiosus ambagiosus	Motuopao	< 10	N/A	N	N	L	N	H
P.a. consobrinus	Cape Maria	50-100	N	L	H	M	N	H
P.a. paraspiritus	Cape Maria	c 1000	N	L	H	L	N	H
P.a. sp.	Taupiri Island	U/K PE	N/A	N	U/K	U/K	N	L
P.a. sp.	Tirikawa Trig	c 100*	N	M	H	L	N	L
P.a. sp.	Tirikawa North	c 10	Y	H	H	L	N	H
P.a. sp. 'Nouvelle'	Ngaupoko	100+	N	M	H	L	N	M
Placostylus ambagiosus pandora	Pandora	100+	N	H	H	L	L	H
P.a. sp. (*pandora*?)	Pandora East	< 20*	N	U/K	U/K	U/K	U/K	L
P.a. lesleyae	Darkies Ridge	< 50*	N	H	H	L	N	M
P.a. sp.	Te Paki Trig	c 100	N	M	M	L	N	M
P.a. sp.	Kohuronaki	U/K PE	N	U/K	U/K	U/K	U/K	L
Placostylus ambagiosus keenorum	Maungapika West	c 100	Y	N	H	L	N	H
P.a. keenorum	Maungapika East	< 10	N	M	H	L	H	H
Placostylus ambagiosus annectens	Unawhao	< 10*	N	H	H	U/K	H	M
P.a. annectens	Matirarau Bay	c 50[1]	N	H	H	U/K	H	M
P.a. annectens	Ngaruariki	U/K	N	H	H	U/K	M	L
P.a. annectens	Te Huka West	c 50[1]	N	H	H	U/K	H	H
P.a. annectens	Te Huka East	< 10*	N	H	H	U/K	H	M
P.a. annectens	Te Huka Headwaters	c 100	Y	M	H	U/K	M	H

Subspecies/colonies	Locality	Status	Fencing	Presence of predators/habitat disturbers				Management Priority
				Pigs	Rodents	Birds	Stock	
P.a. ?annectens	Poroiki Hill	< 10*	N	H	H	U/K	U/K	L
P.a. ?annectens	Taumataroa Flat	< 10*	N	H	H	U/K	U/K	L
P.a. ?annectens	Haupatoto Bush	c 20	N	H	H	U/K	U/K	M
P.a. ?annectens	Maukins Nook	U/K PE	N	H	H	U/K	H	L
P.a. michiei	Surville Cliffs	1000+	N	N	L	M	N	H
P.a. watti	North Cape	c 50*	N	H	H	U/K	M	H
P.a. whareana	Whareana	< 50	Y	H	H	U/K	H	H
Placostylus hongii	Cape Wiwiki Island	c 20	N/A	N	N	U/K	N	M
P. hongii	Orokawa Peninsula	c 20*	N	U/K	M	U/K	M?	H
P. hongii	Whangaruru North	100s	Y	N	M	U/K	N	M
P. hongii	Te Ruatahi Island	< 10	N	N	H	U/K	N	M
P. hongii	Poor Knights Islands	1000s	N/A	N	N	U/K	N	L
P. hongii	Peach Cove	100s	N	N	M	U/K	N	M
P. hongii	Motuhoropapa Island	?	N/A	N	H	U/K	N	M
Paryphanta busbyi busbyi	Northland	1000s		H	H	U/K	H	L
P.b. watti	Te Paki/Kohuronaki	10+	N	H	M	U/K	U/K	H
P.b. watti	Unawhao	< 10	N	H	H	U/K	H	H

PE = presumed extinct N/A = not applicable N = no Y = yes U/K = unknown H = high M = medium/moderate L = low

* = estimate based on low survey effort, other estimates based on better survey effort. ' = animals transferred to Te Huka Headwaters site.
Priorities set have incorporated recommendations in Triggs and Sherley (1993, p. 31).
P.b. busbyi is widespread in Northland and occupies too many sites to detail here.
Management priority is based on many factors including degree of threat, feasibility of control and preservation of genetic range.


Placostylus Distribution in Northland
Placostylus ambagiosus
Placostylus bollonsi
Placostylus hongii


Paryphanta Distribution in Northland
Paryphanta busbyi busbyi
Paryphanta busbyi watti

2.2 Present Distribution

The distribution of giant land snails in Northland is shown in Figure 1. Populations of *P. hongii* on Motuhoropapa Island (DoC - Auckland Conservancy) and *P. b. busbyi* in Waitakere Ranges, Awhitu Peninsula (DoC - Auckland Conservancy) and Kaimai Ranges (DoC - Bay of Plenty Conservancy) are not shown in this figure.

2.2.1 Placostylus hongii

This species is known to survive at six sites (listed below with comments on numbers and size of colony if known). Table 2 summarises the known colonies and includes one more (Te Ruatahi Island) where recent shells exist (1992) but no live snails have been found. Recent shells, but no live snails, have also been found on Coppermine Island (R. Parrish, pers. comm.).

1. Unnamed island near Cape Wiwiki: Discovered in 1989 by R. Parrish following a report from Robin Booth. Numerous dead shells found and two large live individuals located beneath broadleaf shrubs and flax. In 1992 10 adults and 11 juveniles were found following the eradication of ship rats *Rattus rattus* and possums *Trichosurus vulpecula* (Parrish and Shaw unpublished data).

2. Orokawa Peninsula, Bay of Islands: At the time of discovery (1985) the colony appeared on the brink of extinction. The area was overgrazed by cattle and the understorey almost non-existent. Very few live snails were found. A visit on 19 July 1991 found the condition of the vegetation much improved with a fairly dense understorey of kawakawa and no recent sign of cattle damage. Seven snails (3 adults and 4 juveniles) were located in 25 minutes of searching (R. Parrish pers. obs.).

3. Whangaruru North: Apparently a relatively large colony with numbers in the low hundreds although numbers seem to be declining (Sherley unpub. data). This colony is legally protected since it is situated within a scenic reserve.

4. Peach Cove, Bream Head: This colony appears to have decreased in recent years. Miller (1977) found 51 snails but visits in 1988 revealed only a few individuals. Rat control has been carried out systematically since then. Recent searches discovered in excess of 100 snails with numerous juveniles present (F. Brook, K. Burch pers. comm. and R. Parrish pers. obs.).

5. Poor Knights Islands: Many thousands of snails exist on seven islands within the Poor Knights group. The populations here would outnumber all the other colonies combined and may have originated in liberations by Maori (Hayward and Brook 1981).

6. Motuhoropapa Island: A translocated population released in the 1950s by Powell from the Poor Knights. Initially the snails thrived but the arrival of Norway rats reversed the population growth. The rats were removed in 1983/84

and the snails recovered to around 100. Recently rats have reinvaded but were again eradicated in 1991. The current status of the snail population is unknown.

2.2.2 Placostylus ambagiosus

There are now 25 known "colonies" of *P. ambagiosus* in the far north. Many of these "colonies" have been found in the last four years. The known sites are listed in Table 2 with comments on their status and any threats that are known. Future surveys may well discover further colonies and extend the known range of various subspecies. There is a tiny population of *P. a. pandora* on Motutakapu Island in the Cavalli group, the result of a release by the NZ Wildlife Service in 1984.

2.2.3 Placostylus bollonsi

There are five extant populations of *P. bollonsi,* three on Great Island and one each on North East and West Islands (Table 2).

2.2.4 Paryphanta busbyi busbyi

The present distribution is the same as described by Powell (1979) but land clearance in the past 150 years must have reduced its range and abundance. Large areas of kauri snail habitat were lost during the wide scale planting of pine trees in the 1980s. However, this species has been recorded using pine forest in Northland (Ballance 1986). Generally *P. b. busbyi* appears to be more widespread in the central and western parts of the Northland Peninsula and absent or rare from many parts of the eastern side except in the vicinity of Whangaroa and Mangonui. On Taranga Island it appears to be confined to the higher parts of the island.

Bruce Hayward (pers. comm.) reports that the Little Huia population was established by Harvey Turner and that another population, at Waiuku (Awhitu Peninsula), may have been introduced by "the well-known local land-snail conchologist Rev Webster in the first few decades of this century, though this may not now ever be able to be verified." Hayward also mentioned another introduction to Huia: "...one by Nuggets Thompson, a caretaker of Upper Huia Dam, who introduced *Paryphanta* to the area around his residence in the Huia Valley - now in water catchment." The population at Little Huia appears to be thriving (Montefiore 1994). Another introduced population occurs in the Kaimai Ranges (P. Mayhill pers. comm.).

2.2.5 Paryphanta busbyi watti

Still occurs in the same sites described by Powell (1979), Unawhao and Kohuronaki. Also known from Te Paki trig and one sighting reported midway between Te Paki and Kohuronaki (F. Brook pers. comm.). Six live snails were found at Te Paki trig in October 1991. It probably occurs in suitable habitat along the Te Paki/Kohuronaki ridge. Found around the high points of Unawhao, The Pinnacle and Tarure Hill and one sighting near Taumataroa Flat (G. Carlin pers. comm.). However, less than 20 live animals have been reported in the last 10 years.

2.3 Causes of Decline

The causes of decline for *Paryphanta* and *Placostylus* are similar and include habitat destruction, habitat modification by domestic or feral browsers and grazers (sheep *Ovis aries*, cattle *Bos taurus*, horse *Equus caballus*, goat *Capra hircus*, pigs *Sus scrofa* and possum) and/or predation, either by a variety of introduced mammals - including rodents (*Rattus* spp., *Mus musculus*), pigs, probably hedgehogs *Erinaceus europaeus* and possum - or by thrushes *Turdus philomelos*. Collection of live animals for their shells by humans may also once have had an effect.

3. ECOLOGY

3.1 *Placostylus hongii* and *P. ambagiosus*

P. hongii and *P. ambagiosus* may live to 20 years or more. Snails marked as adults in 1979 at Surville Cliffs were found alive in 1991. They reach maturity at 3-5 years (A. Penniket pers. comm.) when growth in the spire height ceases and the apertural lip starts to thicken. Penniket (1981) records the lip growing at 0.2 mm per year in *P. ambagiosus*. Mating appears to be triggered by climatic conditions (e.g. rainfall) and probably occurs every year except in periods of drought. Egg-laying was observed November-February (A. Penniket pers. comm.) on the Poor Knights and egg-laying was in progress on the night of 2-3 November 1991 (R. Parrish pers. obs.). Between 20-30 eggs are laid in a shallow nest in loose earth. Nests containing 30 or more eggs may well be the result of more than one snail laying in the same nest. Mating can last 10 hours or more and snails may mate several times with several different mates. The snails may be particularly vulnerable to predation during mating and egg-laying.

The eggs hatch in 6-15 weeks and the 5-7 mm hatchlings may spend an unknown period living in trees and shrubs up to 6 m above the ground (R. Parrish pers. obs.). Hatchlings have been observed attached to the underside of mahoe *Melicytus ramiflorus*, *Coprosma macrocarpa* and kawakawa *Macropiper excelsum* leaves and in the leaf axils of nikau *Rhopalostylis sapida* at Whangaruru North (R. Parrish pers. obs.).

The snails inhabit coastal broadleaf forest and scrub and have never been located more than 1 km inland for *P. hongii* and up to 3 km for *P. ambagiosus*. Although moisture is vital to the survival of molluscs, *Placostylus* appear to be able to survive in very arid conditions on small rock stacks in the Poor Knights Islands group and at Cape Maria van Diemen and Surville Cliffs (pers. obs.). On a small island near Cape Wiwiki the snails are found in an area of flax and broadleaf shrubs but are absent or rare in adjacent tawapou *Planchonella costata* dominated forest.

Key food plant species appear to be mahoe, *Coprosma* spp., karaka *Corynocarpus laevigatus*, wharangi *Melicope ternata* and hangehange *Geniostoma rupestre*.

3.2 *Placostylus bollonsi* (after Brook and Laurenson 1992)

Adult *P. bollonsi* snails are believed to lay small numbers of relatively large eggs (i.e. up to 18 mm in length) in spring and/or early summer, with most eggs hatching by late summer. Size frequency data indicate the possibility that juvenile snails increase in length by about 25-30 mm/year, and attain adult size at about 3 years of age. Rates of turnover of adults in populations are not known, but the average age of adult snails is likely to be at least as much as 8-10 years given the very low proportions of juvenile size classes in populations. Size frequency data for dead shells suggest that at least 60% of snails fail to attain adult size, and indicate that relative mortality rates of hatchlings are significantly higher than those of larger juvenile size classes.

Mortality of *P. bollonsi* probably occurs predominantly as a result of desiccation or old age.

The principal factors determining the distribution of *P. bollonsi* snails within colonies appear to be the presence of broadleaf food plants, and sheltered microhabitats in broadleaf litter or under groundcover plants. Live snails are typically sparsely and randomly distributed in areas with extensive, stable broadleaf litter, but are clustered in pockets of broadleaf litter or under groundcover vegetation on steep slopes and in areas where broadleaf food plants are sparsely or patchily distributed. *P. bollonsi* occurs at localised densities of up to 2-6 snails/m^2 within these microhabitat patches, but overall mean densities of populations determined from 25 m^2 quadrats range from 0.15-0.35 snails/m^2 (Brook and Laurenson 1992).

3.3 *Paryphanta busbyi*

Little is known of the biology of kauri snails. They may live up to 25 years with maturity reached at about three years of age (A. Penniket pers. comm.). They are carnivorous and probably feed primarily on earthworms, insect larvae and insects living in the leaf litter. They also feed on *Rhytida* snails and are cannibalistic (A. Penniket pers. comm.). The snails inhabit moist areas of forest and native scrub, and areas of scrub dominated by introduced species including wild ginger *Hedychium* spp. They can reach high densities in areas of high soil fertility with abundant earthworms. Being predatory animals, they are highly mobile for a mollusc and have been recorded moving 10 m over two weeks (A. Penniket pers. comm.). They lay limy, hard-shelled eggs in the leaf litter. Eggs of *P. b. busbyi* measure 12-12.5 mm x 9.5-10 mm while *P. b. watti* lays a larger egg (14 mm x 11 mm).

4. SPECIES RECOVERY TO DATE

4.1 Management

Management of snail colonies of *Placostylus* has been carried out since the early 1980s. Most of the management has consisted of poisoning rodents, enhancement planting, fencing of colonies and some limited control of pigs and stock. This has allowed some colonies/subspecies of *P. hongii* and *P. ambagiosus* to recover from near extinction to colonies of some hundreds - e.g. *P. a. paraspiritus, P. a. keenorum*. The removal of goats from Great King Island and the subsequent regeneration of broadleaf trees has led to a substantial increase in the number of *P. bollonsi* (Brook and Laurenson 1992). Eradication of kiore *Rattus exulans* from Motuopao Island in 1992 (McKenzie 1993) has significantly enhanced the survival prospects for the critically endangered *P. a. ambagiosus* subspecies.

Little management of *Paryphanta* has been undertaken to date although the regeneration of parts of Te Paki Farm Park since its purchase and reservation may have allowed *P. b. watti* to expand its range back into areas where it occurred before the land was cleared for farming.

4.2 Translocation

Undocumented translocations of *Paryphanta* have led to the establishment of populations at Awhitu Peninsula, Kaimai Ranges, Waitakere Ranges and near Warkworth.

Translocations of *P. ambagiosus* in the early 1980s have so far had little success. The NZ Wildlife Service translocated several subspecies onto islands in the Simmonds and Cavalli island groups. On present survey knowledge, only one translocation appears to have been successful (*P. a. pandora* to Motutakapu Island). Between 1990 to present, local translocations of *P. a. paraspiritus* have been successful (young produced by transferees) while the outcome *P. a. whareana* and *P. a. annectens* local translocations is uncertain (Sherley 1993).

4.3 Captive Breeding

There have been several attempts to keep *Placostylus* in captivity but only Ian Stringer and Liz Grant (Department of Ecology, Massey University) have managed to keep *Placostylus* adults until they have laid and reared juveniles until adulthood. In most other cases the snails died within one year of being taken from the wild.

4.4 Research

The ecology of *P. ambagiosus* and *P. hongii* was studied by Penniket (1981) and much of our present knowledge comes from that study.

The effects of rodent predation on *P. ambagiosus* have been studied and interim

results published (Sherley and Parrish 1989). Brook and Laurenson (1992) have studied aspects of the ecology and morphological variation of *P. bollonsi* while Triggs and Sherley (1993) have compared genetic variation using allozyme electrophoresis of *P. hongii, P. ambagiosus* and *P. bollonsi.* All of these studies have led to a better appreciation of the problems faced by *Placostylus* and have allowed effective management to be undertaken.

No studies of the life history of *Paryphanta* have been completed but a study of the ecology of *P. b. busbyi* in the Waitakere Ranges has been started by Richard Montefiore of Warkworth (Montefiore 1994).

5. OPTIONS FOR RECOVERY

Option 1: Do nothing

Under this option some populations (*P. bollonsi, P. hongii* on islands and *P. b. busbyi)* may well continue, and the island populations (except *P. a. ambagiosus* on Motuopao) will remain abundant. However, some populations of *P. ambagiosus, P. hongii* (mainland) and *P. b. watti* could become extinct.

Option 2: Maintain and increase island populations and some selected mainland populations across their geographical and genetic range.

Recent genetic studies by Triggs and Sherley (1993) indicate some subspecies of *P. ambagiosus* are very closely related. Some subspecies across the geographical and genetic range which are the most numerically strong could be managed while less genetically distinct and numerically weaker subspecies could be left to their own devices. This could lead to extinction of some populations but a range of morphological and genetic variation would be maintained.

Triggs and Sherley's (1993) recommendations for *P. ambagiosus* were summarised as (p.31):

> With fixation of a distinct allele at least one locus as a sign of isolation and evidence of a separate evolutionary path, the following groupings form the basis of a genetic conservation strategy (and potential subspecies names): 1, *michiei;* 2, *watti;* 3, *annectens* group -- *annectens, whareana;* 4, *keenorum;* 5, *pandora* group -- *pandora,* `darkies', *lesleyae* (the "pandora" name is given to this group as *lesleyae* appears to be extinct at its type locality and the population currently known as *lesleyae* is found a long distance from the type locality); 6, *consobrinus* group -- *consobrinus, paraspiritus,* `tirikawa', `nouvelle' (although, as noted above, *consobrinus* and *paraspiritus* could be treated separately). Further study of the relationships within the *consobrinus* group, particularly using DNA techniques, is desirable.

Option 3: Endeavour to maintain all existing taxa and every population through management in situ.

This would involve a high level of management input and hence cost with further survey, predator control, fencing, revegetation and legal protection where possible and ongoing monitoring of the success of these actions. This option would result in the majority of populations surviving and increasing in the long term - assuming the costs of this option could be afforded. If not then there would be a high chance of this option failing.

Option 4: Translocations of snails to less vulnerable locations.

This would involve translocating populations to "islands" either through harvesting source populations or using captive reared snails. It could involve moving animals to locations outside their current ecological range, a practice unacceptable to some conservationists as there is insufficient islands with the necessary habitat within the Ecological Districts for some subspecies e.g. *P. ambagiosus, Paryphanta b. watti.* This option would require detailed preparatory research on (1) the best methods to use, (2) intensive post-translocation monitoring and probably follow-up reintroductions, and (3) undesirable impacts on existing biota in accordance with translocation protocols in the Department of Conservation's translocation protocols policy. Practical problems also be set this option such as the extreme difficulty in finding translocated snails in low densities. In theory, the translocation option would ensure the long-term survival of all taxa.

FOR THE DURATION OF THIS RECOVERY PLAN OPTION 2 IS THE PREFERRED OPTION.

Option 4 will be used if ecologically acceptable and translocation guidelines laid down by Protected Species Policy Division, Department of Conservation are followed.

6. RECOVERY STRATEGY: GOALS AND OBJECTIVES

LONG-TERM GOAL: To preserve and enhance populations of *Placostylus* and *Paryphanta* in their natural range with emphasis on directing management towards the most genetically diverse and viable populations.

SHORT-TERM GOAL: To prevent the extinction of most of the recognised subspecies or genetically distinct populations.

OBJECTIVES

6.1 Protect Existing Snail Colonies.

(a) Fence colonies to protect snails from pigs and stock

Fences have been erected around or close to colonies of *P. ambagiosus* at Tirikawa South, Maungapika West, Te Huka Stream headwater and Whareana.

Six of the seven known colonies of *P. hongii* do not require fencing as they occur on islands or within Scenic Reserves whose boundaries are already fenced. Orokawa is the one colony where fencing would be of benefit as cattle have had access in the past.

Fences for *Paryphanta b. watti* are not envisaged at this stage but should discrete areas containing snails be found then those should be fenced. Three out of seven sites recently protected under Queen Elizabeth II Trust Covenants or through the Forest Heritage Fund containing *Paryphanta b. busbyi* have been fenced. A number of other sites containing kauri snails are under investigation.

(b) Control or eradicate predators within snail colonies

Eradication of predators has been achieved on three sites: Motuhoropapa Island (Norway rats), Motuopao Island (kiore) and on an unnamed island near Cape Wiwiki (ship rats and possums).

Control of rodents has been carried out at a number of *P. ambagiosus* colonies and at two *P. hongii* colonies. This should continue.

Pig control to date has been limited to directing hunters to areas around *P. ambagiosus* colonies or by excluding the pigs by fencing.

(c) Revegetate colonies

Revegetation, particularly with preferred food species, would assist in the recovery of some colonies damaged by stock, pigs or fire. In some colonies, regeneration following fencing will be sufficient without the need for plantings. However, with the invasion of possums into Te Paki Reserves, existing populations and any replantings of palatable species (hence important species for *P. ambagiosus) will* be threatened.

(d) Ensure island security where snail colonies exist

Maintaining regular surveillance of islands with snail colonies and confirming absence of rodents at least every 1-2 years at these sites will help ensure long-term survival of these populations. Pest invasion contingency plans will be needed for the larger island groups where snails occur.

6.2 Monitor Population Trends at Selected Snail Colonies.

Monitoring of snail colonies where management has been carried out is needed to gauge the success of the management. Monitoring of *Placostylus a. paraspiritus* at Cape Maria van Diemen and two translocation sites of *P. a. paraspiritus, P. a. michiei* and *P. hongii* at Whangaruru has been carried out since 1988. This monitoring is based on quadrats 2 m x 2 m and 2.5 m x 12 m for *P. a. paraspiritus, P. michiei* and *P. hongii* respectively. Monitoring of the *P. a. whareana, P. a. annectens* and *P. a. keenorum* colonies is also carried out by searching the colonies and recording snails found per person-hour spent searching.

The method can produce uncertain results depending on the skill of the observer and how the habitat is selected for searching. A standard quick effective form of monitoring is required (see 7.1.4).

6.3 Instigate Research on Priority Topics (for details see section 8) .

(a) Rodent control regimes

(b) Pig control

(c) Population dynamics of *Placostylus* and *Paryphanta*

- population viability analysis of *Placostylus*
- conservation status, distribution, habitat use and ecology of an endangered kauri snail *P. b. watti*
- fencing methods
- isolating predators
- genetic studies of *Placostylus* and *Paryphanta*

6.4 Translocation of Snails to Less Vulnerable Sites.

Although translocations have had limited success to date (see 5.2), it is a technique that could be used where populations are threatened with extinction. Two recent

translocations of *P. a. paraspiritus* to sites 500 m from the parent colony and the placing of *P. a. annectens* and *P. a. whareana* within fenced enclosures need to be closely monitored and the success/failure determined before further translocations are contemplated. However, some "top-up" translocations of these populations are probably required to enhance this survival of the founder populations.

A land snail workshop convened by the Department of Conservation in June 1990 recommended that translocations of land snails to sites outside of their current ecological range be avoided as the evolution of snails is considered to be closely fixed to the geography (soils, landform and climate), geology (presence of minerals) and vegetation of the sites they occupy at present (Department of Conservation, unpublished minutes). This recommendation is adopted in this recovery plan. Opportunities to introduce giant land snails to additional offshore islands have therefore not been proposed in this plan.

7. WORK PLAN

The following tasks are given in priority order for each species.

7.1 Placostylus hongii

7.1.1 Survey/monitoring

The recent discovery of additional colonies indicates that other colonies may exist on the mainland or small islands between Whangaroa and Bream Head. Two recently discovered colonies were the result of reports of members of the public; further reports should be investigated as soon as possible. Surveys of the eastern mainland coast and small islands should be carried out in the next three years to gather detailed information on the species distribution and abundance.

ACTION: DoC (Northland Conservancy);
Save Our Snails Society;
Whangarei Shell Club

The current status of the Motuhoropapa Island and Great Barrier Island populations is unknown. A survey should be carried out to obtain an up-to-date assessment.

ACTION: DoC (Auckland Conservancy)

7.1.2 Habitat protection

Two of the mainland colonies (Whangaruru North and Peach Cove) are protected within scenic reserves. The unnamed island near Cape Wiwiki is unalienated land. The Department of Conservation should seek custodianship of the island and reserve status.

ACTION: DoC (Kerikeri Field Centre)

The colony at Orokawa is situated on privately owned land. The Department has investigated ownership in the past and this information is available on file. The Department should now negotiate with the owners to obtain a conservation covenant over the area or a management agreement.

ACTION: DoC (Russell Field Centre)

7.1.3 Predator control

Control of rats is currently undertaken at Peach Cove and ship rats have recently been eradicated on the unnamed island near Cape Wiwiki. Pigs are not known to be present in any of the colonies. If pigs do invade the colonies then control/eradication should be implemented. Although thrushes and/or blackbirds are known to be

significant predators of *P. ambagiosus* no evidence of this has been found in colonies of *P. hongii.*

The effects of other possible predators such as hedgehog, mice and possum are unknown and no control measures are advocated unless research shows them to be significant.

ACTION: Maintenance of permanent rat bait stations on unnamed island near Cape Wiwiki; DoC (Kerikeri Field Centre)

Rat control at Peach Cove; DoC (Whangarei Field Centre)

Rat control or eradication at Motuhoropapa Island; DoC (Auckland Conservancy)

7.1.4 Maintenance of island security

The Poor Knights Islands currently support the largest known population of *P. hongii.* The introduction of introduced mammals known to be predators or potential predators would seriously affect the viability of the species or cause them to become extinct. The introduction of introduced mammals has of course serious implications for a range of other endemic and endangered species on the Poor Knights Islands such as Poor Knights giant weta, Poor Knights giant cave weta, tuatara, Poor Knights karo weevil and a range of land and seabirds.

The preparation of a Pest Invasion Contingency Plan to prevent or eradicate any possible invasion of introduced mammals is seen as a priority.

ACTION: DoC (Northland Conservancy, Whangarei Field Centre)

7.2 *Placostylus ambagiosus*

7.2.1 Survey/monitoring

Distribution and abundance data for these subspecies is still urgently required. Survey should identify the main threats to a population and any relevant management that is necessary. Monitoring of many populations is needed to record changes in numbers and extent of colonies, especially those receiving intensive management.

ACTION: DoC (Northland Conservancy, Te Paki Field Centre); DoC (Science and Research)

7.2.2 Predator control

Control of rats (with TALON wax baits) is currently undertaken at 12 *P. ambagiosus* colonies. Snail densities have increased at some of these colonies, probably as a direct

result of this poisoning. Eradication of rodents should be attempted on Cape Maria van Diemen headland. Possums (a potential predator and certainly a threat to habitat) are currently being trapped at Te Paki. This should continue, unless a more efficient method of control can be established. Pig hunting by Te Paki locals and visiting hunters should be actively encouraged and directed where-ever possible to areas where *P. ambagiosus* colonies are most seriously threatened by pig predation.

ACTION: DoC (Te Paki Field Centre)

7.2.3 Habitat enhancement

The limited success of some *Placostylus* transfers into fenced exclosures may be due to the poor state of the fenced habitat. Food species planted into habitats may have assisted in the recovery of snails elsewhere at Te Paki. The technique should be implemented in colonies that are safe from stock and pig invasion. Local plant stock must be used.

Given that pig control is feasible within the recreation reserve, snail colonies that occur in areas still threatened by stock and pigs should be fenced. In some instances, one-hectare exclosure plots will be acceptable. Other areas, e.g. North Cape Scientific Reserve, may lend themselves to being entirely fenced off to protect the endemic flora and fauna from stock and pigs (and possibly possums). Discussion with iwi/landowners will hopefully result in some improvement of conditions for endemic snails on DoC and private land.

The removal of all stock from the Te Paki Recreation Reserve is seen as a high priority. This may require some fencing and cattle stop repair, and regular monitoring of stock reinvasion around the eastern edge of the reserve. The extremely fast rate of recovery of *Placostylus* plant food species inside the new Whareana stock exclosure plot graphically illustrates the threat posed by stock browse on *Placostylus* habitat.

ACTION: DoC (Te Paki Field Centre)

7.2.4 Captive breeding

Many people have attempted to keep both *P. ambagiosus* and *P. hongii.* In many instances adults have laid eggs which have hatched but few have successfully raised the young to adulthood. There appears to be a point when massive die off of the juveniles occurs. In one instance the presence of nematode worms appears to have been the cause (Norm Douglas, pers. comm.). The release and successful establishment of *P. a. pandora* on Motutakapu Island (Cavalli Islands) from juveniles raised by NZ Wildlife Service staff at Kerikeri was poorly documented and monitored and the techniques needed for successful captive breeding are still unknown.

However, there is a need for captive breeding because it can ultimately provide DoC with snails (of rare forms) for translocation as well as data on reproductive rates,

growth rates, preferred food sources, security against extinction in the wild, and for advocacy purposes.

The Ecology Department of Massey University are currently attempting to breed *P. a. paraspiritus* and *P. hongii*. They have recorded adults laying and their hatchlings surviving. One juvenile was collected accidentally with the adults. This individual has survived and grown to adult size. Details of the Massey University research have been reported in writing to DoC but await publication. This endeavour should be encouraged and supported.

ACTION: Ecology Department, Massey University;
DoC (Northland Conservancy, Te Paki Field Centre);
DoC (Science and Research)

7.3 *Placostylus bollonsi*

Because *P. bollonsi* ssp are restricted to the Three Kings Islands and are currently recovering extremely well from past disturbances (Brook in prep.) intensive management is not envisaged. Two actions are required and these are detailed below.

7.3.1 Monitoring

The status, range and recovery of *P. bollonsi* ssp. has been well documented by Powell (1948), Climo (1973) and Brook and Laurenson (1992). This monitoring needs to continue on a 5- to 10-year basis.

ACTION: DoC (Northland Conservancy)

7.3.2 Maintenance of island security

Isolation of *P. bollonsi* on the Three Kings Islands has to date helped preserve the species. However, their isolation could mean that any accidental or deliberate introduction of exotic mammals could lead to their extinction. The preparation of a Pest Invasion Contingency Plan for this and all other islands under DoC care is required to help prevent any possible invasion of introduced pests and to determine appropriate actions should any future pest invasion occur.

ACTION: DoC (Northland Conservancy)

7.4 *Paryphanta busbyi* ssp.

7.4.1 Habitat protection

Although the range of *P. b. busbyi* is still contracting primarily through land clearance and habitat modification, it is not in danger of extinction, at least in the short term. The subspecies occurs in a wide range of protected areas and should continue to survive there unless other factors such as predation is particularly heavy. Half of the

known range of *P. b. watti* occurs on Crown land within the Te Paki Farm Park, the other half occurs on land owned by the Muriwhenua Incorporation.

The Department of Conservation should endeavour to increase the amount of habitat under protective status through district schemes, conservation covenants and purchase of lands.

ACTION: DoC (Northland and Auckland Conservancies)

7.4.2 Survey

The exact distribution of *P. b. busbyi* and *P. b. watti* is unknown. There is a need to determine the distribution and status of the subspecies particularly around the periphery of the known range. The Department of Conservation, Northland Conservancy, conducts Sites of Special Biological Interest (SSBI) surveys throughout Northland and records this information on SSBI sheets. There is provision on these sheets to record the presence and an indication of densities of kauri snails. There is no perceived need to survey for *P. b. busbyi* specifically, but further surveys for *P. b. watti* are needed urgently.

ACTION: DoC (Northland and Auckland Conservancies, Te Paki Field Centre)

7.4.3 Maintenance of island security

Because of its long isolation, the Taranga Island *P. b. busbyi* population may show genetic differences from the mainland populations. Kiore occur on Taranga Island and may be contributing to the apparent low numbers of kauri snail on the island. The conservation status of *Paryphanta* on Taranga would be enhanced by the eradication of kiore from this island. The introduction of other species of rats or other potential predators could cause the extinction of this subspecies from the island. The preparation of Pest Invasion Contingency Plans to prevent or eradicate any possible invasion of introduced mammals is seen as a priority.

ACTION: DoC (Northland Conservancy)

8. RESEARCH

8.1 Priority Research Topics

Research on the following topics is required so that the results can guide managers in the correct management strategies.

8.1.1 Rodent control regimes (high priority)

Although rodent control using anti-coagulants has been used around snail colonies for many years, it is still not known what methods are the most effective e.g. providing bait all year round or pulse baiting at certain times of the year or at what time of the year. Neither is it known if other poisons, e.g. 1080, would be more effective. This research would ideally have been conducted 1992-94.

8.1.2 Pig control (high priority)

Research on long-term pig poisoning regimes is being carried out by Landcare Research NZ Ltd. The result of this and other studies need to be assessed and a pig control programme (using hunting and/or poisoning) devised for Te Paki Farm Park.

8.1.3 Population dynamics of *Placostylus* and *Paryphanta* (high priority)

(a) Population viability analysis of *Placostylus*

Placostylus land snails in the Far North have long been known to be preyed on by rodents. Management of these species will necessarily be mainland based in perpetuity. This is because the option of transfer to rodent free islands may induce changes in their morphological characteristics since it is felt that different environments may be responsible for the shell morphology. Because rodents cannot be eradicated from the mainland, management of the snails will have to continue in the face of some (unknown) level of predation. At present a low level of rodent poisoning is in practice at 12 colonies. An aim of research already under way is to document whether there will be any increase of snails in comparison with a population which experiences no rodent predation over a short term - relative to the life expectancy and time to reach breeding age of these long lived snails. For long term management to be successful, however, we will need to know whether a given poisoning regime will result in a stable population which has sufficient recruitment to sustain the mortality from rodents and other causes (e.g. desiccation, pigs etc.).

In order to know whether a given poisoning regime is satisfactory for ensuring survival in the long term, the following characteristics of *Placostylus* populations will have to be recorded: recruitment of breeding age snails, fecundity, and longevity of adults.

The rodent population(s) of rodents will also need research to establish seasonal and annual variations in population density. These changes in density will need to be

related to snail predation rates to place a perspective on the importance of rodent predation over time.

At present nothing is known about the dynamics of *Placostylus* snail populations with or without rodent predation controlled or of mainland populations of rodents.

The Te Paki populations of *Placostylus* offer an opportunity to study the dynamics of snail and rodent populations with and without poisoning management and model the effects. The results have implications for other conservation projects in New Zealand (e.g. kokako and kaka), all of which involve managing mainland populations in the presence of rodent populations.

Note: This proposal complements the current research project #55060/176 "Status and conservation of the flax snail *Placostylus ambagiosus* in Northland".

RESEARCH OBJECTIVES:

To monitor the causes of mortality of *Placostylus* from three populations.

To monitor the recruitment and longevity of adults of *Placostylus* snails from three populations: one with rodent control, and one without any rodent predation at all.

To monitor the density of rodents at the three snail populations and relate these numbers to the recruitment of *Placostylus* snails.

To model the population regulation in *Placostylus* land snails over a 5 to 10 year period.

Two populations of snails are already being monitored under investigation number 55060/176. A third *Placostylus* population experiencing rodent predation but no poisoning will be monitored to provide information on the population dynamics under the "worst scenario" of management (i.e. no poisoning). All live snails are marked in 2 x 2 m quadrats and all empty shells within the quadrats are scored and removed. One of the advantages of working with snails is that the cause of death can be relatively easily determined - hence a precise determination of the impact of a given mortality factor can be calculated. Quadrats will be scored annually at the same time as the other research is being done. Marked snails will also be searched for outside the quadrats so that dispersal can be estimated.

Rodents at all three snail populations will be monitored using tracking tunnels three times a year: mid-summer, mid-winter and late spring. Twenty tracking tunnels per site will be used and "set" for one week at each season.

Depending on the quality of data forthcoming standard modelling techniques will be used to describe (and predict) changes in the density of age groups snails in relation to rodent density.

(b) Conservation status, distribution, habitat use and ecology of an endangered kauri snail *P. b. watti.*

This kauri snail is listed in *Setting priorities for the conservation of New Zealand's threatened plants and animals* (Molloy and Davis 1992) as a "Category A" species - one that is a "Highest priority species for conservation action".

Observations made by Northland Conservancy staff and Greg Sherley (Science and Research) suggest that the kauri snail is indeed threatened. Less than 15 live snails have been observed over the last four years despite specific searches which have been made in areas known to be snail habitat (see file reports on *Placostylus* research and management) and despite searches made by conservancy and field centre staff during the course of their usual duties. Most evidence of the presence of kauri snails is usually empty whole shells or those eaten by pigs or rodents.

The urgent need for conservation work on this species has been recognised by the snail recovery group. Almost nothing is known formally about the ecology, distribution, habitat use and causes of mortality of this kauri snail, although *P. b. watti* may be more common in scrubland (B. Hayward, pers. comm.).

RESEARCH OBJECTIVES:

To determine the distribution of *P. b. watti* in Te Paki.

To determine the causes of mortality of *P. b. watti.*

To describe the habitat (vegetation community, topography, soil type etc) where *P. b. watti* occur.

To describe basic characteristics of the ecology of a close relative *P. b. busbyi* near Auckland.

Search mature remnant forest patches and adjacent scrubland on Te Paki Farm Park in the Far North for the presence/absence of live/dead snails and during this process record: number of live/dead shells, size of shell, causes of mortality, description of forest species, topography (altitude, slope, erosion etc), depth of leaf litter and presence of pig foraging.

Establish a small ecological study using one of the *P. b. busbyi* found in the South Manukau Harbour region. In the first year a population will be labelled and growth, natural mortality (pigs are absent) and dispersal will be noted. Data on movements and habitat use (on a local scale) will enhance search efforts for *P. b. watti* and data on basic biology will aid management decisions.

Desirable outputs include a distribution map of *P. b. watti* in Te Paki (the subspecies is only known from this area), and technical reports (two including a scientific paper) on the conservation status, predator threats and habitat use of *P. b. watti.*

(c) Fencing Methods (high priority)

Snail colonies have been fenced with Hurricane netting with warratahs every metre to exclude pigs. The feasibility of erecting electrified fences to exclude possums and rodents is being investigated by Northland Conservancy with the view to fencing off the North Cape headland and enclosing populations of endangered plants. This technology could be used to protect snail colonies thereby eliminating the need to poison rodents and other predators.

(d) Isolating Predators (high priority)

The predation effects of rodents, pigs and thrushes upon *Placostylus* and *Paryphanta* and the sign they leave behind are well known. The effects of hedgehogs and possible other predators are unknown. Research is needed to ascertain the impacts of these other likely predators.

(e) Genetic Studies of *Placostylus* and *Paryphanta* (medium priority)

Recent genetic studies using allozyme gel electrophoresis have shown marked differences between species and even subspecies of *Placostylus.* Several newly located colonies of *P. ambagiosus* and *P. hongii* should be compared genetically with already genetically described subspecies.

Any collecting for research should not compromise the conservation status of the population, either through habitat disturbance from collecting efforts or by significantly lowering population numbers. Collecting should follow some pre-set protocol such as determining a minimum population of 30 before collecting, and thereafter one in five taken for research. However, a case-by-case assessment may be required, since this protocol may involve too much habitat disturbance or be seen to involve too much reduction in the population size.

1994/95 Tasks

Priorities, however high or apparently urgent, may not be all achievable at once. The budget allocated will indicate how much is achievable in each year. In 1994/95 the urgent tasks are:

Survey *P. b. watii* and *P. ambagiosus,* control rats around *P. ambagiosus* and *P. hongii* colonies, test feasibility of pig control at Te Paki and fence critically threatened *P. ambagiosus* colonies.

8.2 Further Research Topics on *Placostylus*

Examination of the research topics discussed at length in Section 8.1 would have an immediate effect on management of land snail populations as they are now recorded and targeted. The topics listed below provide information basic to continued effective management of land snail populations in Northland and elsewhere in the country.

8.2.1 Genetic differentiation between populations

Aim: To continue work started by Triggs and Sherley (1993) "Allozyme differentiation of populations of *Placostylus* using gel-electrophoresis and implications for their conservation". Determine the genetic distinctiveness of recently-discovered populations of *P. ambagiosus* relative to those already analysed by Triggs and Sherley. This includes the three populations of *P. hongii* found at Cape Wiwiki, Orokawa and Bream Head.

8.2.2 Dispersal behaviour of transferred and resident snails

Aim: To determine the distance moved and direction of transferred snails to new localities under different regimes including total numbers moved (hence density of founder population), distance moved and time of year of transferral. As a basis for comparison parallel studies are required on the dispersal behaviour of snails from existing colonies.

8.2.3 Demography of preyed on, transferred or founder populations and existing populations of *P. ambagiosus*

Aim: To determine the age/size related mortality frequency distributions for the three types of populations as a means of determining: (i) whether poisoning rats under different regimes is allowing recruitment of adults over and above what would occur without poisoning; (ii) what constitutes "normal" mortality and recruitment rates ("baseline" data); and (iii) the ability of small founder populations to establish (hence minimum transfer numbers).

8.2.4 Captive rearing studies

Aims: (1) Determine captive rearing techniques required to produce large numbers of sub-adult snails for transfer in autumn of a given year. (2) Determine basic life history characteristics under the following headings: Time-activity budgets related to varying environmental conditions; breeding characteristics - age at first breeding, clutch size, incubation time, hatching success, behaviour of hatchlings; foraging behaviour (e.g. preferred conditions and food species); and growth rate characteristics.

8.2.5 Pig control in Te Paki Farm Park

Aim: To determine a method of control of pigs especially in high risk (= vulnerable) snail populations, e.g. using dog-shooter or long-lasting poison techniques or some combination of these.

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APPENDIX 1: SPECIES DESCRIPTION AND TAXONOMY (after Powell 1979)

Placostylus hongii

A solid calcified shell with a thin reddish-brown to chocolate-brown periostracum. Shell moderately large with a tall spine measuring 62-85 mm x 27-37 mm (Powell 1979) although shells in a recently discovered colony near Cape Wiwiki reached 95 mm. The interior of the aperture is orange to bright red and the basal lip contains one slight tubercle or calloused protuberance. The animal itself is dark slate grey.

Placostylus ambagiosus

Similar to *P. hongii* in shell colour but varies between subspecies with those in exposed habitats being generally light brown while those in heavily forested habitats are chocolate-brown to blackish-brown. The degree of orange and red within the aperture also varies.

The apertural lip in *P. ambagiosus* can be heavily calloused in some subspecies with up to 5 tubercles being present. Shell dimensions range from 69-94 mm x 31-39 mm (Powell 1979).

Placostylus bollonsi

The largest of the New Zealand *Placostylus* with the largest subspecies measuring 115 x 42 mm. Their conical shells differ in many respects from *P. hongii* and *P. ambagiosus* in having a chalky appearance with a periostracum of matt brown instead of shiny; a simple aperture without denticulate processes and a large bulbous axially costate protoconch. The adult shell sculpture is of wrinkles, growth lines and striations.

P. bollonsi belongs to a different subgenus *(Basileostylus)* than *P. hongii* and *P. ambagiosus (Maoristylus)* and the species is confined to the Three Kings Island group. Powell (1979) describes three subspecies. Two recent taxonomic studies have produced differing results. Brook and Laurenson's (1992) study based on shell morphology identified consistent differences in shell shape between five extant *P. bollonsi* populations, and from historical information concluded that the observed shell morphological differentiation is genetically based. However, Triggs and Sherley (1993) did not find evidence of any significant genetic differentiation between four extant populations using allozyme electrophoresis.

Paryphanta busbyi busbyi

A large, depressed, discoidal shell with rapidly increasing whorls. There is a solid calcareous ostracum layer and a thick, shining dark green periostracum; bluish within the aperture. Major dimensions of the shell are 60-79 mm x 33-44 mm (Powell 1979). The animal is slate grey in colour, extends a long way out of the shell when travelling and has a prominent "skirt" to the foot.

Paryphanta busbyi watti

This subspecies' shell is smaller (53-62 mm x 22-33 mm), is tawny-olive to warm black instead of greenish and is more depressed with the last whorl increasing more rapidly than *P. b. busbyi.* The animal is similar to *P. b. busbyi.*

APPENDIX 2: PREDATOR CONTROL

Rat Control

Apart from pigs, stock and people, rats are the other great threat to kauri and flax snails. Evidence does not exist to show that rats are capable of killing adult flax snails, however, they do prey on juvenile and subadult flax snails and on kaari snails of all ages. As a result of this, rats have been poisoned at flax snail colonies for many years. Recent surveys have indicated that colonies are benefiting from the poison regime. However, recently there has been some questioning of the continued use of anticoagulants on a regular long term basis and the value of poisoning on an "island in a sea of rats", as many colonies can aptly be described. Suggested alternatives include eradication where possible, eg. Cape Maria van Diemen headland, and using 1080 poison which rodents cannot become immune to.

Eradication of rodents on Cape Maria van Diemen headland is seen as quite possible and would be beneficial to more than just snails. It has been budgeted for in the first year of this plan. A change in the type of poison and/or alternating poisons used to control rats on snail colonies needs further discussion and expert advice.

Pig Control

In the past the approach to pigs on reserve land at Te Paki has been more farming than control. Rules governing hunting pigs aimed at leaving pigs unmolested during their main breeding season and restricting the taking of pigs to the winter months when limited vehicle access protected those pigs any distance from main roads.

These practices are inconsistent with DoC's mission managing reserves under the Conservation Act 1987. Outlined below are a number of options that should be investigated, between DoC and Ngati Kuri, as suitable ways of controlling the destructive influence of pigs while still retaining the kai whenua resource for tangata whenua and a recreational opportunity for hunters.

(i) Opening up the reserves to year round pig hunting (firearms permitted) with encouragement given, eg. kennels at campgrounds, annual competitions.

(ii) Periodic control of pigs on the reserve complex using the most efficient/acceptable means available, eg. contract hunters with dogs, poison baits.

(iii) Handing over the control of pigs to tangata whenua and other recreational hunters with monitoring of numbers by DoC. This would provide tangata whenua with a kai whenua resource and may provide snails with acceptable conditions for recovery.

(iv) Excluding stock and pigs from large areas of the reserves with small fenced plots or larger plots that may require some electric fencing.

(v) A combination of the above, e.g. periodic control in the recreation reserve, some fencing in Mokaikai with control of pigs left up to tangata whenua and recreational hunters, fencing off North Cape Scientific Reserve with removal and exclusion of pigs, stock and perhaps possums.

The preferred option for Te Paki is Option v. The work plan and budget pertaining to Te Paki have been written with this in mind. Should the Recovery Group decide on other options these will change and need to be rewritten.

APPENDIX 3: KEY CONTACTS (October 1994)

Paryphanta

Research
Ray Pierce, CAS, DoC, Northland Conservancy
Greg Sherley, Science and Research, DoC, Wellington
Richard Montefiore, Warkworth
Ian Stringer, Massey University, Department of Ecology.

Captive Breeding
Kath Walker, CAS, DoC, Nelson Conservancy
Ian Stringer, Liz Grant, Department of Ecology, Massey University, Palmerston North
Mike Meads, Landcare Research NZ Ltd, Lower Hutt

Management
Mike Aviss, DoC, TSU, Wellington
Trevor Bullock, DoC, Te Paki Field Centre
Shaarina Boyd, DoC, Auckland Conservancy
Richard Parrish, DoC, Northland Conservancy

Knowledge of *Paryphanta*
Richard Parrish, DoC, Northland Conservancy
Frank Climo, Museum of New Zealand Te Papa Tongarewa
Pauline Mayhill, Tauranga
Kath Walker, CAS, DoC, Nelson Conservancy

Placostylus

Research
Greg Sherley, Science & Research, DoC, Wellington
Susan Triggs, Department of Health, Wellington
Andrew Penniket, National Film Unit, TVNZ, Dunedin
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Captive Breeding
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Elizabeth Grant, Dept of Botany & Zoology, Massey University
Ian McFadden, Science & Research, DoC, Auckland
Andrew Penniket, National Film Unit, TVNZ, Dunedin

Management
Mike Aviss, DoC, TSU, Wellington
Trevor Bullock, DoC, Te Paki Field Centre
Dave Taylor, DoC, Kerikeri Field Centre
Shaughan Anderson, DoC, Russell Field Centre
Shaarina Boyd, DoC, Auckland Conservancy
Richard Parrish, DoC, Northland Conservancy

General Knowledge of *Placostylus*
Andrew Penniket, National Film Unit, TVNZ, Dunedin
Andrew Jeffs, Save Our Snails Society, Auckland
Ian McFadden, Science & Research, DoC, Auckland
Fred Brook, DoC, Northland Conservancy
Frank Climo, Museum of New Zealand Te Papa Tongarewa, Wellington
Pauline Mayhill, Tauranga
Richard Parrish, DoC, Northland Conservancy

Recovery Group
Te Paki Field Centre Manager
Northland Conservancy Office Staff: Richard Parrish, Fred Brook, Scientist
Threatened Species Unit representative
Tangata whenua representative
NGO representative
Leader chosen from the above group.

APPENDIX 4: Expenses for *Placostylus/Paryphanta* Management at Te Paki

Activity	Cost
1st Year	
40 days for Conservation Officer, Te Paki	$4,700
15 days each for Parrish, Sherley and Flux	$12,429
1500 m of fence	$12,000
40 kg of rat poison	$50
2 pig hunters and dogs for 2 months	$8,000
TOTAL	$37,179
2nd Year	
30 days for Conservation Officer, Te Paki	$3,500
15 days each for Parrish, Sherley and Flux	$12,429
1500 m of fence	$12,000
40 kg of rat poison	$50
TOTAL	$27,979
3rd Year	
20 days for Conservation Officer, Te Paki	$2,400
6,000 shrubs	$6,000
8 volunteers for 2 days	$300
40 kg of rat poison	$50
TOTAL	$8,750
4th Year	
20 days for Conservation Officer, Te Paki	$2,400
6,000 shrubs	$6,000
8 volunteers for 2 days	$300
40 kg of rat poison	$50
TOTAL	$8,750
5th Year	
20 days for Conservation Officer, Te Paki	$2,400
6,000 shrubs	$6,000
8 volunteers for 2 days	$300
40 kg of rat poison	$50
TOTAL	$8,750

PUBLISHED RECOVERY PLANS

South Island saddleback ($15) . . . . . Approved 1994

Takahe ($15) . . . . . Approved 1994

Dotterel ($15) . . . . . Approved 1993

Tuatara ($15) . . . . . Approved 1993

Mohua ($15) . . . . . Approved 1993

Subantarctic teal ($15) . . . . . Approved 1993

Kowhai ngutukaka ($15) . . . . . Approved 1993

Chevron skink ($15) . . . . . Approved 1993

Black stilt ($15) . . . . . Approved 1993

Whitaker's and robust skinks ($15) . . . . . Approved 1992

North Island kokako ($15) . . . . . Approved 1991

Kiwi ($15) . . . . . Approved 1991

Yellow-eyed penguin . . . . . Approved 1991

Available: from Otago Conservancy,
Department of Conservation, Dunedin

Blue duck ($10) . . . . . Approved 1991

Available: *Science & Research Internal Report No.30*
Science & Research Division, Department of Conservation,
Wellington

Kakapo . . . . . Approved 1989

Out of print

Copies may be ordered from:

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P.O. Box 10-420
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