Threatened species assessment on Macquarie Island

Voyage 5, April 2007



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Information has been accessed from the draft Macquarie Island Burrowing Petrel Recovery Plan 2007 – 2011 prepared by Martin Schulz and more recent survey information compiled by Helen Achurch (2007a, 2007b). This survey program was reviewed and approved by MIRAG and conducted under a MI Nature Reserve Access Authority Permit No. 07-08/32 (Bryant), No. 07-08/35 (Shaw), DPIW Threatened Fauna Collection Permit No. TFA 06522 and Threatened Flora Collection Permit No. TFL 07064.

Abbreviations

AAD	Australian Antarctic Division
AQIS	Australian Quarantine Inspection Service
AFS	Antarctic Fur Seal Arctocephalus gazella
BCB	Biodiversity Conservation Branch, DPIW
DEW	Commonwealth Department of the Environment and Water
DPIW	Department of Primary Industries and Water, Tasmania
DTAE	Department of Tourism Arts and Environment
EPBC	Commonwealth Environment Protection and Biodiversity Conservation Act
	1999
LMSA	Light Mantled Sooty Albatross
MIRAG	Macquarie Island Research Assessment Group
MSB	Millennium Seed Bank
NZFS	New Zealand Fur Seal Arctocephalus forsteri
PWS	Parks and Wildlife Service, DTAE
RTBG	Royal Tasmanian Botanical Gardens
SARDI	South Australian Research Development Institute
SAFS	Sub-Antarctic Fur Seal Arctocephalus tropicalis
TSP	Tasmania's Threatened Species Protection Act 1995
TSS	Threatened Species Section, DPIW
UTAS	University of Tasmania

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SUMMARY

A review of a range of threatened species values was undertaken on Macquarie Island between 9 and 17 April 2007. The review included an overview of the burrowing petrel program, a procedural review of the threatened fur seal research program, consideration of a range of MIRAG issues, conservation assessment of a range of flora including two species of endemic orchids, site selection and survey of plant populations requiring fencing to prevent rabbit damage, and a determination of the effectiveness of island management operations in lieu of the proposed pest eradication program.

Survey findings support the PWS recommendations that the highest priority for protection of conservation significant species on Macquarie Island is to commence the integrated pest management program for European rabbit, black rat and house mouse eradication by 2009 (Lynn 2006). The primary and secondary impact of rabbit browsing on six threatened burrowing petrel species and its likely causality in the consideration of five flora species for listing on the TSPA and EPBC acts further supports the need to urgently commence the eradication program as a state and national priority.

RECOMMENDATIONS

- Immediate commitment and implementation of the plan for the eradication of rabbits and rodents from Macquarie Island to ensure long-term protection for nationally and state listed threatened species.
- Exclusion fencing across the isthmus should be erected as an interim measure to slow the level of rabbit impact on North Head.
- Endorse the draft Macquarie Island Burrowing Petrel Recovery Plan 2007 2011 (TSS 2007) and implement its recovery actions.
- Install exclosure plots for key populations of uncommon plant species prior to spring 2007 and continue to monitor these species.
- Support the nomination of *Polystichum vestitum*, *Huperzia australiana*, *Nematoceras dienemum*, *N. sulcatum* and *Poa cookii* for listing on the EPBC Act 1999 and TSP Act 1995.
- Conduct searches of known plant populations which have not been observed in recent times eg *Galium antarctica* at Skua Lake.
- Undertake baseline assessment of the expansion of *Acaena magellanica*, *Epilobium pedunculare*, *Cerastium fontaum*, *Poa annua* and *Luzula crinita*.
- Collect and bank adequate seed of key plant species.
- Continue the burrowing petrel monitoring program and where possible expand monitoring to include lesser known species (eg Cape Petrel) and less visited sites.
- Support low level visitation to burrowing petrel colonies due to fragility of slopes but identify more robust sites for future research programs.
- Undertake localised rat control on offshore rock stacks as an interim measure to protect Blue Petrel breeding colonies.
- Continue to replace and refine colony marker pegs around burrowing petrel colonies to ensure an accurate historical and current record is maintained.
- Support the continuation of the fur seal research program (AAP 859) long-term and encourage completion of data analysis and biopsy samples to provide current information on hybridisation levels.
- Expand baseline assessment of the impacts of rabbits and rodents to include other restricted plant species (ie *Hymenophyllum falklandicum*)
- Maintain quarantine procedures to ensure no additional exotic species or disease outbreaks occur on the island.
- Report to MIRAG on current research proposals and suggestions on improvements to processes and flow of communication.

AIM OF THE WORK

- Undertake an overview of threatened burrowing petrel habitat, especially Grey, Blue and Soft-plumaged petrels in light of sustained rabbit impact and review the actions in the Draft Threatened Burrowing Petrels Recovery Plan (TSS 2007).
- Undertake surveys of plant species with restricted distributions and determine their conservation status.
- Identify sites of uncommon plant populations that require interim protection from rabbit damage.
- Conduct a review of the fur seal research program (AAP 859)
- Collect available ripe seed for the Millennium Seed Bank.
- Provide feedback to MIRAG on specific research issues.



Fig 1 Helicopter at station after transporting material for fencing exclosure plots.

ITINERARY

April 07	Location	Activity	Species Investigated
6	Hobart	Safety briefings, quarantine, departure from Hobart 4 pm on	
		'Aurora Australia'	
9	Macquarie Island	Helicopter deployment to field - Green Gorge	
	Sawyer Creek	Inspection of erosion at Sawyer Creek and overview of nesting	Light Mantled Sooty
		habitat of Light Mantled Sooty Albatross and Blue Petrel Sites	Albatross
		BP #15, BP #16. Survey & map MI Fern in Sawyer's Creek	Halobaena caerulea
	II C	Gully – search site 200 m x 50 m	Polystichum vestitum
	Upper Sawyer Creek	Quadrat and survey of type locality for southern Helmet Orchid. Pegged out boundary for exclosure fencing.	Nematocerus sulcatum
	South of Pyramid	Re-survey for Lycopod at known site on terraces below Pyramid	Huperzia australiana
10	Peak	Peak.	Duccellania sinenca
10	South	#187	Procenaria cinerea
	Green Gorge North facing Slope	Inspection of Blue Petrel Colony at Sites BP #17, BP#18, BP#1. Photo monitoring of existing vegetation exclosure plot.	Halobaena caerulea Herbfield community
	Green Gorge Track	Population survey and site assessment for MI Fern. Pegged out boundary for exclosure fencing. Inspect Grey Petrel Colony Site GP#186.	Polystichum vestitum Procellaria cinerea
	Green Gorge Basin West	Population survey and site assessment for MI Fern.	Polystichum vestitum
	Green Gorge Basin West	Overview of habitat at Soft-plumaged Petrel calling site.	Pterodroma mollis
	Green Gorge Basin	Population survey and site assessment for MI Fern.	Polystichum vestitum
	Green Gorge Basin	Population survey and site assessment for Lyconod	Huperzia australiana
	North B		The or the answer arrange
	Red River	Habitat and site condition for southern Helmet Orchid	Nematocerus sulcatum
11	Mawson Point	Inspection of erosion at Flat Creek, assess exclosure requirement.	Polystichum vestitum
		Photo-monitoring of existing vegetation plot. Overview of Blue	Halobaena caerulea and
		Petrel Colony BP#12 on rock stack and ground search for prion	Prion species
		nests in vegetation remnants.	D
10	Finch Creek Valley	Population survey and site assessment for small tussock.	Poa cooku
12	Finch Creek Valley	Survey & map MI Fern in Finch Creek- 500m x 200m.	Polystichum vestitum
	Sandy Bay	tussock grass with rust symptoms. Inspect tourist boardwalk &	Stilbocarpa polaris Pog foliosa
		viewing platform.	1 00 j011050
	Bauer Bay	Survey and site assessment for megaherb. Quadrat and survey of	Pleurophyllum hookeri
	,	type locality for northern Helmet Orchid. Pegged out boundary for exclosure fencing.	Nematocerus dienemum
	Douglas Point &	Overview of Blue Petrel Colony at off shore rock stack BP #9.	Halobaena caerulea,
	Langdon	Overview of habitat condition at White-headed Petrel colony.	Pterodroma lessonii
	Eagle Cave	Overview of habitat condition of burrowing petrel colonies.	Petrel species
	Handspike Corner	Quadrat and survey of type locality for <i>Poa litorosa</i> . Pegged out boundary for exclosure fencing.	Poa litorosa
13 April	North Head	Overview aof Grey Petrel sites GP#93-100, GP#54-57, GP#281-	Procellaria cinerea,
		283. Overview of Blue Petrel site BP#13 with H. Achurch	Halobaena caerulea
		(Project Officer- PWS). Inspect fur seal colonies at Secluded	
		Beach with S. Goldsworthy (Principal Investigator). View site of	Arctocephalus fosteri,
	Codoota Cully	proposed rabbit exclusion fence for North Head.	A. gazella, A. tropicalis
	Gaugets Gully	Seed collection for the Millenium Seedbark and Tas SeedSafe	Huperzia australiana
		(DPIW/RTBG).	Luzula crinita. Festuca
		Conducted site tour for eradication team (PWS & NZ consultant)	contracta. Uncinia
		for the proposed rabbit exclusion fence at dam (water supply) &	divaricata
		associated baiting issues.	
14	Lambing Gully	Seed collection for the Millenium Seedbank and Tas SeedSafe	Ranunculus biternatus,
		(DPIW/RTBG).	Epilobium pedunculare
17	Station (Next)	Data analysis & report writing.	A quastia and all - '
1/	Station / North	Co-ordinate exclusion lencing location with PWS staff.	Agrostis magellanica
	inau	(DPIW/RTBG).	
18	Macquarie Is	Dept Macquarie Island	
21	Hobart	Arrive Hobart - undergo quarantine - transfer plant samples	

RESULTS

Burrowing Petrels

The habitat of all burrowing petrel colonies investigated showed evidence of rabbit damage. Impact varied from low (0-20%) to moderate (20-40%) on North Head colonies, to moderate (20-40%) to severe (80-100%) for other sites investigated. Observations of distant slopes with binoculars suggested that rabbit damage centred around seabird colonies then extended in a 'front' of damage across the slopes. Palatable foliage such as *Poa foliosa* tussock or *Polystichum vestitum* around colonies was denuded, closely cropped and in many cases dead (Fig 2, 3).



Fig 2 (Left) Slopes west of Green Gorge showing degradation of Blue Petrel Colony BP#1 and (Right) Soft-plumaged Petrel area now devoid of any living *Polystichum vestitum*.

Loss of vegetation had contributed to the exposure of burrow entrances and landing platforms. Observations in a 10m x 10m quadrat at the Grey Petrel Site #188A on a 50 degree slope was a total vegetation cover of 30%, 5-10% Poa tussock cover and bare soil component of 80%. There was significant evidence of vegetation being grazed, and the tussocks were reduced to pedestals measuring 70cm in height. Petrel burrow entrances average spacing was 2 m apart with the entire colony having large interspaces and more open to weather and predation risk (Fig 3).

These observations agree with Schulz *et al.* (2005) who found loss of tussock grassland created open interspaces between grass clumps and reduced cover in front of burrow entrances. Rabbit droppings were prolific throughout the landscape and at every survey point extended into seabird burrows and along seabird runs. Rabbit droppings, scrapings, rabbit burrows and extensive networks of rabbit warrens were numerous within and around seabird colonies and throughout the landscape generally.



Fig 3. (Left) Grey Petrel Colony GP #188A at Green Gorge showing denudation of vegetation and (Right) Exposed entrance to active petrel burrow with rabbit droppings and mounding inside.

When bird feathers, droppings or odour were absent it was difficult to identify whether birds or rabbits had excavated or occupied burrows. Rabbit droppings extended well inside burrows and often there was freshly balled soil outside the entrance. Live rabbits were observed everywhere during the day on slopes, flats and coastally (Fig 4). While some myxomatosis rabbits were observed (prolific under the boardwalk at Sandy Bay and around Mawson's Point) most rabbits appeared large and healthy and densities varied as shown by the estimates in Table 1.



Fig 4. (Left) Inspecting rabbit warrens behind Green Gorge and (Right) daytime rabbit and rabbit damage undermining raised beach edge at Green Gorge Beach.

Table 1 Indicative count of rabbits seen during the daytime.

Site	Count Area (estimate)	Rabbits Seen
Grey Petrel Site #188	100m x 40m	8
Sawyer Creek	100m x 50m	9
Near Mawson Point	100m x 40m	8* some myxomatosis affected
Finch Creek	100m x 50m	12
Finch Creek	5 m x 5 m plot	16 burrows, 2 mouse holes
(GDA 94 494069 / 3953783)		
Behind Eagle Cave	100 m x 50m	7
Wireless Hill	50 m x 50 m	0

A 5m x 5m vegetation quadrat at Finch Creek (GDA 94 494069 / 3953783) contained 16 rabbit burrows, 2 mouse holes and no live tussock or fern vegetation.

Burrow damage was evident on rock stacks at Mawson and Douglas Points containing Blue Petrel colonies (viewed with binoculars). This was confirmed by H. Achurch who also indicated signs of egg shell remnants and dead chicks indicative of rat impact.

Grey and Blue petrel colonies were visited on North Head and one Grey Petrel adult viewed on an egg. Burrowing petrel colonies at North Head appeared in significantly better condition than further away from the station being less exposed and surrounded by thicker and more intact vegetation. North Head is a priority site for burrowing petrels and is one of the few locations containing mixed colonies (Grey, Blue, Sooty and possibly Cape Petrel) in close proximity. While there is evidence of grazing this is reduced and therefore the installation of a fence and localized eradication techniques to slow the impact of rabbit and rat damage is supported as a priority for management (Fig 5).



Fig 5 (Left) Site where perimeter fencing is proposed for North Head and (Right) Grey Petrel colony on North Head showing varying degrees of rabbit damage. Note droppings outside burrow entrance on left.

Fur Seal Research Program (AAP 859)

Access to Secluded Beach and Goats Beach is via a steep narrow track through thick tussock. While the track was wet and rutted it was mostly narrow and had not fanned or braided across surrounding vegetation. It is estimated that any consistent increase in use of this track may require monitoring to determine impact through increased rates of erosion.

Secluded Beach is approximately 150 metres in length, has several large rocky outcrops and is fringed by thick tussock. Seals can be surveyed by walking along the beach or from the ridgeline with the aid of binoculars (Fig 6). The degree of disturbance caused by researchers accessing and patrolling survey beaches is controllable by requiring researchers to focus activity along the beach rear. An observation hide had been installed on the lower slopes of the beach providing a good viewing point without the need to disturb territories or individuals at closer range. Rather than handling, observational work is scheduled during the most sensitive breeding time to minimise disturbance to the colony.



Fig 6 (Left) Site of fur seal research at Secluded Beach, North Head and (Right) 4 month old Antarctic Fur Seal pup with flipper tag.

Since 1993 every pup has been flipper tagged and micro-chipped (Fig 6). Pups are sampling only twice during their lactation period. Due to the high return of individuals this has enabled an understanding of age specific information and the role of immigration. New pups and first year animals viewed during the site visit appeared relaxed and in good condition. An understanding of techniques used during the catching of pups and sampling, including the collection of the 1mm tissue sample from flipper extremity, appeared to minimised trauma.

Plant species and vegetation condition assessment

The purpose of this survey was to quantify decline in species following the recent expansion of rabbits. The species with restricted island distributions and known to be grazed by rabbits were surveyed; *Poa cookii, Polystichum vestitum, Huperzia australiana, Nematocerus dienemum, N. sulcatum.* Two other species with restricted distributions *Poa litorosa* and *Carex trifida* were also visited at Handspike Corner to assess the degree of rabbit damage to these populations. Both species have previously been mapped in detail (Bergstrom *et al.* 2006).

Uncommon species with restricted distributions were identified and known populations (Copson 1984, Shaw 2005) were visited where logistically possible. For some orchid sites existing population data was available from previous research. Some remote *Poa cookii* populations (Sellick and Hell bays) were able to assessed through recent photo-monitoring images. At each site, populations were mapped to determine area of occupancy and extent of occurrence. Quadrats of varying size (relative to plant size) were surveyed to measure density of individuals, proportion of dead plants to live plants and total number (or area) of live healthy plants. The following were measured in three to five (depending on vegetation structure) random 2m x 2m plots; rabbit burrow density, grazing index, all other plant species present and percentage cover. Edaphic features were also recorded for each site; slope, aspect, substrate and altitude.

Rabbit exclusion

Prior to departure key sites were identified for uncommon plant species thought to be deleteriously affected by rabbit activity. Site determination and rabbit threat was based on knowledge of species distribution and current rabbit density after consultation with: K. Springer, H. Achurch, J. Whinam, T. Rudman and A. Terauds. Additional information relating to rabbit abundance was determined from photo-monitoring data (PWS, Scott UTAS, Shaw UTAS). Helicopter flight plans were determined and fencing materials packaged to cargo facilities according to field destinations.

Proposed sites were visited where logistically possible prior to fencing deployment. Accurate GPS locations were then given to helicopter pilots and K. Springer for material drop-off. Populations were assessed and 5m x 5m quadrats were surveyed for species presence, species cover, maximum plant height, rabbit burrow density, grazing index. Damage to key species was determined by measuring the proportion of dead plants to live plants (in severe cases the number of remaining stems) and assessing the health of remaining live plants. For large species such as *Poa cookii* and *Polystichum vestitum* original pedestal and leaf height were determined.

Millenium Seedbank

Assessments of floral development were made and species with ripe fruits were collected. Several species had commenced dispersal while some still had immature fruits. Ripe seed was collected as late as possible to ensure minimal storage at ambient temperature and humidity. Seed was collected as per the MSB Seed Collection Strategy (Visiou DPIW). Upon return to Hobart seed was stored at the RTBG MSB storage facility at 15% RH and 10 °C.

Species	Habit	Site	Material	Amount (g)
Festuca contracta	Small grass	Gadget Gully	infloresences	TBA
Agrostis magellanica	Small grass	North Head track	infloresences	TBA
Epilobium pedunculare	Prostrate herb	Lambing Gully	Fruits	TBA
Poa foliosa	Tall tussock grass	Razor back	infloresences	TBA
Luzula crinita	Small sedge	Gadget Gully	Fruits	TBA
Uncinia divaricata	Small sedge	Gadget Gully	Fruits	TBA

Millenium seedbank collections

Polystichum vestitum populations

Site	Area (m ²)	% pop'n Dead	# Live plants	Mean burrow	Damage Scale	Rabbit protection
	× /		found	density		•
Green Gorge	100	95	19 (9	$5 4m^{-2}$	bad	Exclosure plot
east			healthy)			
Green Gorge	200	99	3	7 4m ⁻²	severe- soil surface	
west					removed	
Sawyer Knoll	5000	100	0	6 4m ⁻²	severe- soil surface	

					removed	
Green Gorge north	2100	99	4	5 4m ⁻²	bad	Exclosure plot
Finch Creek	25 000	95	18	16 25m ⁻²	severe– soil surface removed	Exclosure plot
Sawyer Creek	100	99	2	4 4m ⁻²	severe– soil surface removed	
Lusi slopes	Photo interp				low –grazing front approaching from north	
Jessie Nicol	Photo interp				present but low	
Nuggets Rookery	Photo interp				bad	



Fig 7 Extent of damage to Polystichum vestitum at Finch Creek.

Site	Area (m ²)	% popn. Dead	# Live plants found	Mean burrow density	Damage Scale	Exclosure
Royal Colony Finch Ck	20 000	99	2	4 m ⁻²	severe	Unsuitable due to penguins
Sandy Bay	10 000	100	0	1 m ⁻²	severe	Unsuitable due to penguins
Sellick Bay	Photo interp				severe	
Hell Bay	Photo interp				severe	

Poa cookii populations



Fig 8 Close up of extent of death of *Poa cookii* at Royal Penguin colony Finch Creek.

Site	Area (m ²)	# Live plants found	Mean burrow density	Damage Scale
Bauer Bay Hut	400	20	<1 m ⁻² but numerous surface scratching	Bad
			disrupting soil & plants	
Handspike	25000	100s (in 2005)	Too wet for burrows	Intermediate
Corner			surface disturbance due to digging	

Nematocerus dienemum populations in exclosure plots.



Fig 9 Location of *Nematocerus atenemum* population in the foreground of Bauer Bay hut.

Site	Area (m ²)	# Live plants found	Mean Burrow density	Damage Scale	Exclosure
Upper	400	40	Too wet for burrows	Intermediate	Exclosure plot
Sawyer Ck			surface disturbance due to digging		
Mid Sawyer	4	25	Too wet for burrows	Intermediate	Exclosure plot
Ck			surface disturbance due to digging		_
Red River	TBA	TBA	not recorded	Bad	

Nematocerus sulcatum populations



Fig 10 Type locality of Nematocerus sulcatum at Upper Sawyer

Huperzia australiana populations	Huperzia	australiana	populations	
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Site	Area (m ²)	# Live plants found	# Dead plants found	Mean Burrow Density	Damage Scale	Exclosure
Overland	6	4 (unhealthy	2	<1 m ⁻² but numerous	Bad	Surveyed
track		& grazed		surface scratching	Poss. Mice	existing
		inside fence)		disrupting soil & plants	present	
Gadget track	20	6 (unhealthy	2	<1 m ⁻² but numerous	Intermediate	Exclosure plot,
		& grazed		surface scratching	Poss. Mice	expand existing
		outside fence)		disrupting soil & plants	present	fence



Fig 11 Huperzia australiana in exclosure plot on the overland track.

Landslips and Vegetation Loss

Personal observations by Selkirk-Bell, Shaw and geomorphological studies (Household 2007) report that the incident of landslips has increased over the last five years. Several recent slips were observed in areas of high rabbit damage, in particular; north Green Gorge Basin, Sawyer Creek, Stony Creek and Bauer Valley. In one instance a Light-mantled Sooty albatross nest was in a sub-optimal location and at risk of slippage (Fig 12, 13). The action of rabbit grazing and burrowing appeared to destabilised sloped areas with shallow peats and were a likely factor contributing to an increased rate of slope movement.



Fig 12 Arrow points to Light-mantled Sooty Albatross chick on a nest above Sawyer Creek.



Fig 13 Wide angle view of Fig 12 showing instability of slope and sub-optimal nest site.

The tourist boardwalk at Sandy Bay is closed to public access due to slope instability and the boardwalk structure being unsafe. It is also surrounded by an extensive zone of dead vegetation which makes the vista extremely unattractive and indicative of the impact and extent of rabbit damage (Fig 14).



Fig 14. Boardwalk at Sandy Bay showing extent of rabbit impact, dead vegetation and scene viewed by tourists.



Fig 15 Widespread damage to Cushion plants *Colobanthus muscoides* caused by rabbit scrapings was observed in numerous locations.

DISCUSSION

Eleven species of burrowing petrel breeding on Macquarie Island are either currently listed on the TSPA and or EPBC Act, qualify for listing or are data deficient but likely to meet the criteria for listing on these two acts (Baker et al. 2002, Appendix). A further 10 species of burrowing petrel are recorded from nearby waters but are not currently known to breed on Macquarie Island. In 1999, Blue Petrels Halobaena caerulea re-established on the mainland of Macquarie Island, adjacent to a colony on an offshore stack at Green Gorge (Brothers 2000). From 2000 to 2004, main island colonies were established on many slopes across the islands, and a large stack on the main island at Douglas Point (TSS 2007). There are now 17 Blue Petrel breeding sites recorded on Macquarie Island (Achurch 2007b) the largest being in the Green Gorge area behind Green Gorge hut. Over 80% of Blue Petrel breeding sites in 2005/06 had 80-100% of P. foliosa tussock removed by rabbit grazing (Hedley & Terauds 2006). The increased exposure of burrow entrances may have elevated predation risk to welldeveloped chicks by the Subantarctic Skua. Exposure of Blue Petrel colonies to rat and Skua predation on offshore rock stacks may be limiting re-establishment of this species and could be managed through a localised baiting program. Advice should be sought on the most appropriate bait to avoid a build up bait tolerance or shyness prior to the start of the eradication program.

The Grey Petrel *Procellaria cinerea* was recorded breeding on Macquarie Island by E. Firth in May 2000 (TSS 2007). Since then over 26 sites have been confirmed with nesting Grey Petrels and approximately 153 burrows in total have been marked (Achurch 2007a). During the 2006 monitoring season Achurch (2007a) found of 86 Grey Petrel burrows with breeding activity of which 15 chicks were successfully fledged and 52 nests failed (22% breeding success). Schulz (in TSS 2007) found European Rabbit grazing may have contributed to a lowering of site usage at some sites, such as slopes behind Green Gorge, where vegetation was heavily grazed. Observations during this survey confirm the extent of impact on Grey Petrel colonies and its likely contribution to lowered breeding success and also noted one instance of a burrow collapsing causing a chick to be separated from its parent.

Soft-plumaged Petrel *Pterodroma mollis* have only just been recorded breeding on Macquarie Island. Targeted searches between 2001 and 2003 revealed calling over a number of slopes (S. Robinson and M. Schulz, unpublished records; Schulz and Lynn 2003a) with one bird being discovered in a burrow on slopes behind Brothers Point hut in 2002. In 2003 single birds were located in burrows north of Green Gorge and north of Waterfall Bay hut and another burrow with fresh activity was located on a north-facing slope of Stony Creek (TSS 2007). In Jan 2007 a chick was observed at Green Gorge. It was photographed on its nest with a rabbit in the rear.

In the past the distribution of the Black Rat was closely associated with tall tussock grassland around the island, (Copson and Whinam 2001) but more recently the species has expanded in some herbfield associations, particularly stands of *Pleurophyllum hookeri* (Copson 2004, Shaw *et al.* 2005). The impact of rats on burrowing seabirds is well documented (reviewed by TSS 2007) and relates primarily to predation on eggs and unattended chicks and destruction of vegetation through browsing and seed collection.

The Draft Threatened Burrowing Petrel Recovery plan (TSS 2007) prepared by Martin Schulz provides an excellent coverage of the history and decline of many of these petrel species through cat predation and feral pest impact. It lists a series of actions and recommendations that remain current and require immediate implementation to ensure these species long-term survival on Macquarie Island.

Fur Seal Research Program

Three species of fur seal occur sympatrically on Macquarie Island ie the New Zealand Fur Seal *Arctocephalus forsteri* (NZFS), sub-Antarctic Fur Seal *A. tropicalis* (SAFS) and

Antarctic Fur Seal *A. gazelle* (AFS). Cumpston (1968) details the rapid commercial exploitation and extermination of the fur seal species by the early 1800s by the sealing industry on Macquarie Island. Research conducted from the late 1940s to mid 1980s, mainly by P. Shaughnessy on pup production and species identification, documented the slow re-establishment of fur seal colonies and the emergence of hybridisation and cross breeding between the three species. In 1986 a systematic monitoring and research program headed by S. Goldsworthy continues to provide the foundation to our current understanding of hybridisation, population genetics and population demographics of these three fur seal species on Macquarie Island. A difference in arrival times between the sexes has resulted in hybrid offspring and, while information is still being gathered, this phenomenon may have arisen due to the breakdown in social behaviours and territory partitioning between AFS and SAFS.

Until recently there has been no way of determining genetic purity of pups and hence recovery has been assessed in terms of total pup production. From 1950 to 1980 the total pup production was 10 or less pups per year (4.6% growth rate). From 1980 to 1990 pup production increased to 50 pups per year and from 1990 onwards has increased a further 6 to 7 fold to over 200 total pups annually. In 1991 the first AFS male established a territory and every year since there has been an increase in the establishment of territories between the AFS and SAFS. From 1992 to 2006 population monitoring and analysis of tissue biopsies has shown that the degree of hybridisation between the AFS and SAFS has begun to decline suggesting a return toward natural genetic separation.

Over 20 years of continuous monitoring of the fur seal colonies, mainly in Secluded Bay, has enabled the gradual recovery of the three fur seal species to be documented and better understood. Inter-specific matings between the three fur seal species resulting in mixed species hybridisation, is extremely rare in the animal kingdom and from an evolutionary perspective this is a significant research opportunity. The program forms part of an international collaborative study documenting the species recovery throughout their entire breeding range and is contributing important insights into effects of climate change on fur seal breeding ecology. The long-term dataset provides a fascinating and significant research insight into the natural divergence of two fur seal species during hybridisation and gradual recovery toward genetic purity. Improving technology and refinement of techniques suggests that every effort is being made to minimise impact on the species. The annual increase in pup production and high rate of individual returns suggests that the project is not significantly impeding species recovery. Project staff were apparently well briefed and trained in techniques and handling prior to arrival on the island. This further supports efforts to improve quality control and minimise disturbance to fur seal species.

Despite failure of initial attempts to obtain genetic material from cored peat samples collected during the pilot study, the 'uplandseal' is an important component in the attempt to explain genetic ancestry of fur seals on Macquarie Island. Extraction of DNA from fossil hair or other material could potentially identify the distribution and origin of fur seals breeding on Macquarie Island in past but recent periods and therefore shed light on the evolutionary heritage of species now recolonising after near extinction. However, rather than collect cores of peat which potentially date back thousands of years, surveying should focus on collecting fossil evidence from along the edges of raised beaches which potentially may yield more recent material. Further advice on these methods should be gained.

Vegetation Conservation and Management

There are 45 species of vascular plants on Macquarie Island comprised of small grasses, herbs, cushion plants, ferns, orchids, mega-herbs and large tussock grasses The vegetation communities are made up of different combinations and abundances of these species. While some species are widespread, there are several that have very restricted distributions (Copson 1984). There are four described endemic species for Macquarie Island.

Research over the last 50 years has identified the deleterious impacts of rabbit grazing and other pests on the island's ecosystem, plant community structure, and individual species (Taylor 1955, Costin & Moore 1960, Carrick 1964, Jenkin 1982, Scott 1983, 1988, Brothers 1984, Copson & Whinam 1998, Shaw 2005, Shaw *et al.* 2005, 2006). The large leafed megaherbs, tussocks and ferns are known to be negatively impacted, however, conservation assessment of these species has not been undertaken.

Almost all species with naturally restricted distribution on Macquarie Island were found to be negatively impacted by rabbits. *Polystichum vestitum* has been severely grazed at the majority of sites visited with the only known intact healthy populations occurring at Jessie Nicol Creek (H. Achurch & E. Firth PWS pers comm.). The southern most population South Lusitania is intact, however, a grazing front approaches from the north and south. Past monitoring (Scott unpub data, PWS unpub data) indicates that rabbit grazing moves in fronts or waves across slopes, and as such the population is at risk. Surveys indicate that all other populations are subject to intense grazing and as such the species on Macquarie Island is at risk of extinction. Rabbit grazing removes above ground fronds restricting growth and removing the opportunity for spore production and dispersal. This impacts upon population survival, expansion and recovery. At most sites no pre-emergent viable fronds could be found. Macquarie Island is the only occurrence of the species in Australia. This species warrants consideration for listing on the TSP and EPBC acts.

Poa cookii is a smaller tussock grass (80 cm high) than the dominant *Poa foliosa. Poa cookii* only has a competitive advantage in nutrient rich areas adjacent to sea bird colonies and on scattered rock outcrops along the coast. The species has been severely reduced by rabbit grazing across the island. At the Sandy Bay population there was no live tissue detected, while only one pedestal was found with leaf material at Finch creek a population occupying 400 m². A population at Nuggets rookery is also extremely damaged and botanical researchers have been unable to locate any individual *P. cookii* plants alive. West coast populations (Hell and Sellick bays) have been severely grazed and photomonitoring of these areas has indicated that these populations have been drastically reduced. PWS staff report that there is no live tussock pedestals at sea level in these bays. This species warrants consideration for listing on the TSP and EPBC acts.

Huperzia australiana has a very restricted distribution with only approximately four known populations. Historically, however there were more recorded and Laird (unpub 1949 in Copson 1984) described the species as being "widely distributed over the island at plateau levels and in deep gorges below plateau level", Taylor (1955) reported 12 populations and Copson (1984) reported 7 sites. Copson defined the species as "apparently in danger of complete elimination" the results of this survey further support this. Of the two populations both surveyed showed signs of grazing with evidence of a reduction in number of individuals. Both populations were fenced (PWS) in late 2006 dead plants were detect outside of the fencing. Interestingly there appeared to be some sign grazing within the exclosures, the small size of chew marks suggests that rats or mice may be responsible. Further investigation is needed. Plants at both populations appeared unhealthy, yellow and dry with some browning and blackening of leaf and stem tips. Personal observations in previous years suggest this is abnormal and not seasonal senescence. This species warrants consideration for listing on the TSP and EPBC acts.

Both species of endemic orchid have very restricted distributions. *Nematoceras sulcatum* has only recently been described (Clements *et al.* 2006). The species was detected in 2005 by researchers from ANU and CSIRO. At present its distribution is in the southern half of the island from Sawyer Creek valley to Red River basin. Skotnicki (pers. com) confirmed that the specimens detected by PWS staff in spring 2006 had leaf attributes of *N. sulcatum*. This area and the Sawyer Creek Valley are subject to rabbit grazing, with Red River having the highest rabbit count ever record in early 2007. A small population in Sawyer Creek (north of the large patch) had rabbit diggings and scratchings amongst plants. Introduced slugs were observed eating the leaves of *N. sulcatum*.

Nematoceras dienemum occurs in the northern half of the island, particularly on the west coast. The population at Bauer Bay was surveyed and found to be disturbed by rabbit diggings and scratchings. A site assessment was conducted for populations at Boiler Rocks and Handspike Point. Rabbit grazing activity was particularly intense at these sites with much surface disturbance and removal of large vegetation (megaherbs and tussocks). Disturbance to soil surface as observed at Sawyer Creek and Bauer Bay had negative impacts on both species of orchid, as it removes bulbs (previously obs. 2001) and seed banks. Additionally this disturbance can promote dominance of the liverwort *Marchantia berteroana* and introduced grass *Poa annua*. *N. dienemum* can occur under *Stilbocarpa polaris* (Copson 1984) the removal of this canopy alters the microclimate (Shaw 2005) the impacts of this on *N. dienemum* are unknown. Both these orchid species warrant consideration for listing on the TSP and EPBC acts.

CONCLUSIONS

Observations made during this field survey confirm the findings of recent research and management programs of significant impact to a range of important flora and fauna values caused by European rabbits and rats and mice. The impact of rabbit browsing from a geoheritage perspective results in the removal of vegetation critical for soil and slope formation and stability. This loss of vegetation not only directly accelerates the natural rate of erosion but acts to interfere with the natural balance between soil water, groundwater and surface runoff, again increasing the rate of erosion caused by increased surface water run-off. An important factor is that although the Macquarie Island landscape is well known for slope instability, rabbit browsing has acted to increase the rate of these natural processes.

Overgrazing and associated destabilisation has led to a high level of exposure of burrowing petrel nest sites in all areas but to a lesser degree at North Head. Fragility of slopes, due to rabbit burrowing and vegetation removal has exacerbated peat slumping and collapse. Given the high number of listed fauna species and now a number of flora species likely to meet the State and National listing criteria, it is imperative that the pest eradication program is supported and implemented at the earliest possible stage.

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APPENDIX

Table 1: Burrowing petrels of Conservation Significance on Macquarie Island (from TSS 2007).

Species	Breeding	EPBC Act	TSP Act
	Status	listing	Listing
Threatened Species			
Blue Petrel	Confirmed	Vulnerable	Vulnerable
Halobaena caerulea			
Fairy Prion (southern)	Confirmed	Vulnerable	Endangered
Pachyptila turtur subantarctica			
Soft-plumaged Petrel	Confirmed	Vulnerable	Endangered
Pterodroma mollis			
Grey Petrel*	Confirmed	++	Endangered
Procellaria cinerea			
White-headed Petrel	Confirmed	+	Vulnerable
Pterodroma lessonii			
Wilson's Storm-Petrel **	Confirmed	++	Rare
Oceanites oceanicus			
Qualify for Listing			
Cape Petrel	Confirmed	+	-
Daption capense			
Antarctic Prion	Confirmed	+	-
Pachyptila desolata			
South Georgian Diving-Petrel	Confirmed	+	-
Pelecanoides georgicus			
Data Deficient Species			
Slender-billed Prion	Unconfirmed	+	-
Pachyptila belcheri			
Grey-backed Storm-Petrel	Unconfirmed	+	-
Oceanites nereis			

+ = Listed as a Marine Species under *EPBC Act*, ++ = Listed as both marine and migratory species under *EPBC Act*,

* = Listed under ACAP; ** = Listed under JAMBA.