

Grand and Otago Skink Recovery Plan
2006-2016

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Grand and Otago Skink Recovery Plan

Recovery Plans

This is one of a series of recovery plans produced by the Department of Conservation. Recovery plans are statements of the Department's intentions for the conservation of a particular species of plant or animal, or group of species, plant or animal community for a defined period. Recovery plans focus on the goals and objectives of recovery management, guide the Department in its allocation of resources and are used to raise public awareness of the recovery process.

Each plan has a term of 5- or 10-years.

The purpose of recovery plans is to achieve recovery of that species or group of species by empowering people to understand issues, make sound decisions and minimise uncertainties in the future.

Recovery of a species can be defined as 'establishing/enhancing multiple populations within the historic range, or at suitable sites, which may or may not require ongoing management' (Jansen 2001).

Recovery plans:

- Are proactive and operational in nature, focusing on specific key issues, providing direction and identifying roles to managers and technical workers.
- Set objectives for the recovery of species and outline measurable actions needed to achieve those objectives.
- Are primarily used by Department staff to guide their annual work programmes; however they also provide a forum for planned initiatives with tangata whenua, community interest groups, landowners, researchers and members of the public.
 - Stimulate the development of best practise techniques and documents, which can be transferable across similar species recovery programmes.

A recovery group has been established for grand and Otago skinks. This group consists of people with knowledge of the ecology and management needs of the species. The role of the recovery group is to achieve recovery of the species they represent through generation and provision of high quality technical advice. The recovery group prepared this plan in conjunction with people interested in or affected by this plan, or with an expert knowledge of the species. Drafts have been sent to relevant Conservation Boards for comment and to people or organisations with an interest in conservation management of grand and Otago skinks. Changes to the plan were made as a result of that consultation.

The recovery group will review progress in implementation of this plan and will recommend to Department managers any changes that may be required in management. Comments and suggestions regarding conservation of grand and Otago skinks are welcome and should be directed to the Grand and Otago Skink Recovery Group via any office of the Department or to the Manager, Biodiversity Recovery Unit, PO Box 10-420, Wellington.

The recovery planning process provides opportunities for further consultation between the Department, tangata whenua and others regarding management of this species. Those interested in being more involved in management of grand and Otago skinks or in receiving information should also contact the recovery group.

The Otago Conservator of the Department of Conservation formally approved this plan in ... (date). A review of the plan is due after (5 or 10 years) in (date), or sooner if new information or technology leads to a significant change in management direction. This plan will remain operative until a new plan has been prepared and approved. Or become redundant if recovery is achieved and management effort enters a 'maintenance phase'.

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ABSTRACT

The grand skink (*Oligosoma grande*) and the Otago skink (*O. otagense*) are two of New Zealand's largest and rarest lizards, and are classified as nationally critical. They occur only in Otago where they inhabit schist rock outcrops in montane tussock grassland in two separate populations in the east and west of their former range. Population modelling suggests a high probability of extinction for both species by 2010. Mammalian predation and habitat loss are considered to be the main causes, although the agents of decline have not been clearly identified. Eastern populations failed to recover from 1997 to 2002 following control of cats and ferrets. Experimental management has again been imposed on these skink populations in 2005 to determine if populations will recover if *all* mammalian pests are eradicated within a mammal-proof fence, or whether controlling *all* mammalian pests (except rodents) with conventional trap technology without a fence will enable recovery. It is anticipated that no treatment effects will be detected until the 2009 season due to experimental population sizes and the life-history traits of the grand and Otago skinks. Depending on the outcomes of the experiment, the next phase of recovery will either involve securing viable populations of grand and Otago skinks in captivity if neither treatment succeeds, building more mammal-proof fences if only the fence treatment succeeds, or controlling all pest species more widely if pest control is as or more successful as the fence. These latter options will require improved understanding of metapopulation dynamics. Grand and Otago skink recovery management cannot be implemented until these outcomes are known.

Actions that can be implemented now are:

Secure the species: Secure representative populations in captivity. The protection of the eastern and western genome of grand and Otago skinks will require research and management in captivity.

Monitoring: Ensure high-quality monitoring of experimental populations at least until 2009, and implement a regular monitoring programme for the western populations.

Community Awareness: Build better relationships with landholders, especially in the western range; provide support for community-led skink conservation initiatives; increase awareness by the general public about the conservation problem; explore sponsorship options to raise the profile of skink conservation.

Research: Undertake research on other potential agents of decline besides pests (parasitism and disease, food quality, interactions with habitat complexity), develop understanding of metapopulation dynamics of skinks, determine minimum number of skinks required to secure the genotype in captivity, and develop techniques that improve conservation status of skinks.

INTRODUCTION

The grand skink (*Oligosoma grande*) and the Otago skink (*O. otagense*) are two of New Zealand's largest and rarest lizards. They occur only in Otago where they inhabit schist rock outcrops in montane tussock grassland. Both species now occupy a greatly reduced range in two separate population groups in the east and west of their former range. Their populations are in decline and are at risk of extinction by 2010 (Tocher & Norbury 2006). Total population estimates range from <5,000 to as few as 1,400–1,800 (Patterson 1992, Whitaker & Loh 1995, Whitaker 1996, Coddington & Cree 1997).

The first recovery plan for grand and Otago skinks was published 11 years ago (Whitaker & Loh 1995). A draft second plan was put on hold in 2002 while the recovery programme was reviewed and restructured (Hitchmough *et al.* 2003), and a new management team and recovery group put in place. The current plan combines parts of that draft with new information, new management methods and new strategic thinking that has occurred since then.

The viability of these species in the wild is more perilous than ever, and a sense of urgency must prevail.

Plan Term and Review Date

Term of the plan: 10 years from September 2006 – August 2016

Review date: 31 August 2009.

1. Context

Overview of Species

1.1. Species ecology and biology

Grand and Otago skinks are diurnal, active in sunshine and strongly associated with rocks. They inhabit deeply-creviced schist outcrops in montane tussock grassland. Although the species occur together at some sites, Otago skinks occur most frequently on extensive rock bluffs along steep-sided valleys and grand skinks are more commonly on ridge-tops (Townes 1985, Whitaker 1996). Their usual activities are confined to rock surfaces, however, both species make occasional long movements between habitat patches—up to 400 m for grand skinks and 2 km for Otago skinks—and these appear to be an integral part of metapopulation¹ dynamics (Whitaker 1996, Coddington & Cree 1997, Houghton 2000, Germano 2005, DOC, Otago Conservancy, unpublished data).

Both species are omnivorous, consuming a wide variety of invertebrates, soft fruit and vegetation. They occasionally eat small skinks, and flower petals. Seasonally, fruit is an important component of the diet (Tocher 2003). The optimum habitat quality for skinks is unknown. The seral nature of vegetation in Central Otago provides challenges in guiding recovery trajectories to desired states – which we presume to be native woody-dominated climax states.

Otago skinks live up to 16 years in the wild, and to their late 30s in captivity. They produce their first offspring at 4.8 years, have generally female-biased sex ratios, and low recruitment (c. 50%) of juveniles into the reproductive population. In any given year an estimated 64% of females of reproductive size bear young, and on average each reproductive female produces a clutch size of 1.98 (estimate by palpation during early pregnancy) (Cree 1994, Tocher unpublished data). Similarly, grand skinks live up to 17 years in the wild, produce their first clutch at 4.0 years of age, have a variable sex ratio, and up to 71% of reproductive females bear young every year. Each reproductive female grand skink produces an estimated average clutch size of 2.15 per year. Again, only half of the juveniles make it to reproductive size.

1.2. Species status and recovery principles

¹ A metapopulation consists of a group of spatially separated populations that interact at some level. The development of metapopulation theory, in conjunction with the development of source-sink dynamics, emphasises the importance of connectivity between seemingly isolated populations. The theory assumes that although no single population may be able to guarantee the long-term survival of a species, the combined effect of *many* populations will increase probability of persistence of a species.

In 2003, the threat classification of both species was elevated to 'Nationally Critical'. Population modelling, based on demographic data collected from 1996-2002, suggest 59% and 88% probabilities, respectively, that populations of grand or Otago skinks starting at 60 individuals will be extinct by 2010 (Tocher & Norbury 2006). Projecting population recovery is most sensitive to changes in survival, especially subadult survival. Annual survival rates of subadults and adults are currently about 0.54 for both species (Tocher 2006). These would need to be increased to 0.80 to achieve greater than 90% probability that a given population of 60 will exceed 100 individuals in 20 years.

As all remaining known populations of grand and Otago skinks are small (<60 adults), small changes in rates of survival (<0.1) may be undetectable. It will be necessary for survival to rates to climb to 0.75 for both species to be considered as a recovering population. Survival rates of below 0.6 will be considered as 'no alleviation of agents of decline'. Results falling between these two rates will be considered as neither success nor failure but justification to continue maintaining the experimental management and monitoring for definitive results.

The Recovery programme as a whole is in a phase of determining the agents of decline and securing the taxa in captivity. Significant progress on these issues must be made before substantive progress can be made on recovering grand and Otago skinks in the wild.

Most grand and Otago skink populations are widespread and isolated and, apart from those on land recently acquired by the department, are on freehold or leasehold land and often within intensively developed agriculture. The Recovery Programme's emphasis on understanding the agents of decline means that many of the often small skink populations will become extinct. The areas already acquired by the department, and those currently under consideration, are likely to be sufficiently large for successful management methods to lead to an increase in the total population size of both species. However, we do not know whether such an area is sufficient to maintain a viable metapopulation of either species in the longer term without ongoing management.

1.3. Past and present distribution

Subfossil remains, historical records, data with museum specimens, extrapolation from present habitat use, and the location of extant populations show that grand and Otago skinks were formerly widespread in Central Otago over an area of approximately 1.75 million hectares extending from Lake Wakatipu to Lake Hawea and the Lindis Pass in the west to Macraes Flat and Sutton in the east. This distribution correlates closely with the broad band of metamorphic (quartzo-feldspathic schist) rock that crosses Otago. At the surface this schist weathers to form the deeply-creviced tors, outcrops and bluffs that are the habitat of these species.

Grand and Otago skinks are now known from only two areas that together cover just 8% of their estimated former range (Figure 1).

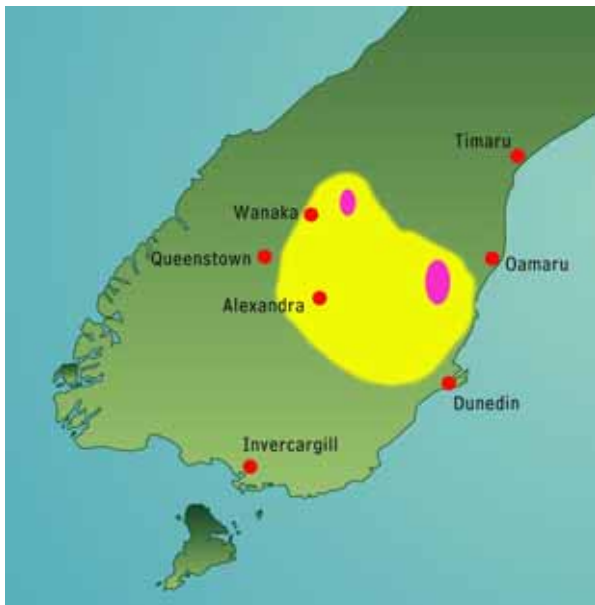


Figure 1. Estimated former range of grand and Otago skinks (yellow) and their current range (purple).

In eastern Otago, populations occur throughout the Macraes Flat/Middlemarch district, east of the Rock and Pillar Range. In the west, there are a few scattered populations between Lake Hawea and Lindis Pass. Within these latter areas the populations of both species appear to be small and isolated. The stronghold for both species is in the upper catchments of the Nenthorn Stream and the North Branch Waikouaiti River, between Macraes Flat and Nenthorn.

In both regions, Otago skinks are widely distributed but are thought to be less numerous than grand skinks (Roughton 2005). In the Macraes Flat/Middlemarch district, grand and Otago skinks co-exist at some sites but in the Lindis district they do not.

A disturbing trend is the localised extinction of several populations of both species in the last 30–35 years indicating that range reduction is an ongoing process. For example, Otago skinks were found in Alexandra as recently as the 1970s (Whitaker 1986). Less than half of the small populations of both species inspected in the late 80s and early 90s remained during revisits in the late 90s to 2002 (Graeme Loh, unpublished data).

1.4. Agents of decline and threats

The agents of decline have not been clearly identified for either species.

Mammalian predators are considered a key threat based on their sheer numbers, the presence of grand and Otago skinks in cat diet (Baker 1989, Daugherty & Towns 1991, Middlemiss 1995), the numbers of common and McCann's skink remains found in ferret, stoat and hedgehog guts (van der Sluijs & Spitzen, 2000), and the fact that lizard populations respond to the removal of mice on offshore islands (Newman 1994).

Habitat modification by conversion of shrub and tussock lands to pasture, and by grazing and burning, are also considered threats because they diminish native fruit and invertebrate resources for skinks, and expose skinks to predators as they disperse between

tors (Whitaker 1996). Mining, quarrying, forestry and invasion by woody weeds also cause localised habitat depletion. Currently these threats are mostly in the eastern part of the species' range. Habitat restoration is currently underway in parts of their eastern range at the Redbank Ridge/Emerald Stream Area at Macraes, through removal of domestic stock.

Predation and habitat destruction are likely to interact. Satellite imagery of land at the Redbank Ridge/Emerald Stream Area in 1990 and 2003 shows encroaching pastoral development. This has coincided with increasing rabbit abundance and possibly increasing predator trap rates (DOC unpublished data). Pastoral development generally leads to more rabbits in the system, which leads to more rabbit-specialist predators (Norbury 2001). Therefore, pastoral development may be exacerbating the predator problem. Other potential agents of decline have been considered. Parasite infection, food resource limitation and structural degradation of habitat have been identified.

Whilst parasite infection is clearly significant in the biology of grand and Otago skinks and has been implicated in cessation of breeding in captive Otago skinks, we do not have any data to suggest that high parasite loads in wild grand or Otago skinks impacts on their fitness (Dennis Keall pers comm., Reardon & Norbury 2005).

Similarly food quality may influence growth rates, offspring quality and survival under some circumstances, yet wild grand and Otago skinks appear healthy and robust with no evidence of malnutrition or starvation.

1.5. Past and current management

Land reservation

Most of the skink populations in the eastern part of their range are legally protected in approximately 2400 ha of land managed by the Department of Conservation near the Macraes Flat Township. The design of the Reserve is not optimal as it has accumulated through a number of land deals. Fewer skink populations are legally protected in the western part of their range. Here, tenure review has resulted in 448 ha of habitat with a minimum estimate of 34 Otago skinks present being reserved on Glenfoyle.

Surveys and monitoring

Distribution surveys were undertaken throughout the presumed former range of grand and Otago skinks in the 1980s and 1990s (e.g. Whitaker 1986). A database of individual grand and Otago skinks records exists for populations in the Macraes Flat area with individual records dating from the late 1980s. This monitoring programme was reviewed in 2004, and now occurs once annually to minimise disturbance. Skinks are identified remotely by digital photography and skin pattern recognition.

In the mid 1990s, 'rock-count' surveys began focusing on the occurrence of grand skinks over approximately 300 rocks on Redbank Ridge (Whitaker 1996). Rock count surveys were also reviewed in 2004 and integrated with more accurate methods for assessing 'rock occupancy', based on standardised methodologies and analytical procedures which account for relative detectability of skinks (MacKenzie & Bailey 2004, Roughton 2005). Rock patch occupancy is also recorded at all experimental populations (see later) and at

the Otago skink population on Glenfoyle. This approach can be integrated with population viability analyses when necessary.

Whilst base line data has now been generated for the Otago skink population at Glenfoyle in 2005/6, there is little meaningful data on the size, range or status of other grand or Otago skink populations in the west of their range.

Small mammal exclosures

Three mammal-proof exclosures (approx. 20×20 m) were constructed in 1999 to measure the effect of cat and ferret removal on grand skinks. The fences were designed to test the effects of removing only cats and ferrets and so they allowed entry by stoats, weasels, rats and mice. In 2002, one of the exclosures was modified to exclude all mammals, and the same modification was applied to the other two exclosures in 2003. Mammal monitoring inside the exclosures takes place once or twice per year and it is clear they are neither mouse-proof nor stoat-proof. There is an ongoing effort to rid the exclosures of mammals. The grand skink populations contained within have continued to decline.

Research

The life history of grand and Otago skinks is well documented. Research has been undertaken on capture, handling, marking and monitoring protocols, and there is a good understanding of the species' ecology and biology, including aspects of reproductive biology, social behaviour, population dynamics, habitat use, movements, and genetics (Patterson 1992, Cree 1994, Elliott 1994, Murphy 1994, Middlemiss 1995, Freeman *et al* 1996, Whitaker 1996, Coddington & Cree 1997, Stanley 1998, Eifler & Eifler 1999a & b, Houghton 2000, Marshall 2000, Germano 2005, Berry & Gleeson 2005, Berry *et al.* 2005).

A mark-recapture study was initiated at Macraes Flat from 1996-2002 to determine population trends and to collect demographic data from multiple grand and Otago skink populations. A predator control operation that targeted cats (and also caught ferrets) was undertaken over five study populations within the reserve from May 1999 to May 2002 to test whether predator control could recover populations. Four of the five grand skink populations, and both Otago skink populations, declined during this period. With the possible exception of a single population of each species, the predator control did not avert downward trends (Tocher unpublished data).

Parasitism was investigated in grand skinks, Otago skinks and other lizard species in the Macraes Flat area and revealed that both grand and Otago skinks carry significantly greater ectoparasite loads of the mites *Odontacarus lygosomae* and *Ophionyssus scincorum* than other species in the community. It also identified that both species carry infections of the hemogregarine protozoa, *Hepatozoon lygosomarum* (Reardon & Norbury 2004).

Eastern and western populations

In the medium and long term, decisions will need to be made about which of the eastern and western populations provide the best opportunities for securing the species in the wild. Although some eastern populations are protected from further land development by land reservation and management, and knowledge of skink populations there is very good, there is relatively little scope for expansion because the reserve is surrounded by highly modified freehold agriculture. The habitat in the west is more extensive and less modified and may provide better opportunities for in situ management in the future. The onus on

the land tenure review process which is currently underway in the west is to ensure large, intact areas are set aside for skink management.

Captive management programme

The captive management programme was reviewed in March 2006. Outcomes are to secure the genetic diversity of eastern and western populations, and provide captive animals for reintroductions and research in the future. The captive management plan will be updated as part of this recovery plan. There are currently 86 Otago skinks and 4 grand skinks in captivity. Otago skinks have been bred in captivity successfully for more than one generation. Currently, no grand skinks have bred successfully in captivity.

1.6. Preferred option for recovery

The vital experiments have not been undertaken to identify the agent(s) of decline. Therefore, the recovery programme is not at the stage of recovery but is still in the phase of identifying threats and securing the taxa by way of captive management.

Strategic Directives

This Recovery Plan supports the outcomes and outputs for the following three strategic documents:

New Zealand Biodiversity Strategy

The mandate for the conservation of these species is given in Goal 3 of the New Zealand Biodiversity Strategy—maintain and restore viable populations of all indigenous species and subspecies across their natural range, and maintain their genetic diversity.

Department of Conservation Strategic Direction

The Department's overall strategic direction was announced by the Director General in March 2006. At a strategic level the overarching purpose of the Department is to increase the value of conservation to New Zealanders. To do this:

- The Department will seek to entrench conservation as an essential part of the sustainable social and economic future of New Zealand.
- The Department will be recognised as an effective manager of the lands, waters, species, historic places and roles entrusted to it.
- The Department will lead, guide and facilitate conservation gains throughout New Zealand where ever conservation is most needed.

Statement of intent

An intermediate outcome of the Department's Statement of Intent (2005-2008) is that managed threatened species have a lower risk of extinction

Cultural Importance

Grand and Otago skinks are not included in the Ngai Tahu Deed of Settlement as a Taonga species. However, in terms of the overarching duty to give effect to the principles of the Treaty of Waitangi, the grand and Otago skink recovery programme will recognise

the manawhenua of Otakou, Makawhio, and Murihiku Runanga when dealing with western populations and the manawhenua of Puketeraki Runanga when dealing with Eastern Populations.

Public Awareness

Advocacy

Advocacy in the past has been low key and ad hoc. In recent years the skink recovery programme has gained good media publicity and community awareness.

Community trusts

The Central Otago Ecological Trust (COET) was established in 2005 with the primary goal of re-establishing a free-living population of Otago skinks within the Alexandra area. The Trust will be a key partner in the Recovery programme.

2. Goal(s)

A. Long-term recovery goal

The long-term recovery goal is to maintain and restore viable populations of grand and Otago skinks across their natural range, and to maintain their genetic diversity.

B. Goals for the recovery plan period 2006-2016

Given the perilous state of grand and Otago skink populations, the immediate and urgent goals for the Recovery Programme are to:

- a. Identify the agents of decline
- b. Secure both species in captivity

Other goals are to:

- c. Secure both species in the wild
- d. Raise community awareness and support for skink conservation

3. Implementation

Research

Topic 1: Agents of decline

Issues

The most pragmatic, safest and supposedly most guaranteed method known for recovering skinks in situ is to remove all the mammalian predators (consumers of skinks) and all the mammalian herbivores (consumers of skink habitat) inside a mammal-proof fence. There are eight species of potential mammalian predators (cat, ferret, stoat, weasels, ship rat, Norway rat, hedgehog, mouse), and two or more species of potential avian predators (magpie, falcon, harrier, starling). Consumers of skink habitat include livestock, possum, goats, rabbit, hare and pig. The previous focus of experimental management on cats as predators did not prevent ongoing declines in skink populations. Nevertheless, predation has been identified as the most likely agent of decline but other agents, such as parasites, poor habitat structure and poor food resources, have not been discounted. This is discussed in section 1.4.

It should be noted that the risk of not running simultaneous management experiments that test other potential agents of decline is that it may be too late to implement the appropriate mitigation measures. This is especially true if habitat restoration is the key to their survival because of the time required to restore habitat.

Three experimental mammal control treatments have been implemented at the Redbank Ridge/Emerald Stream Area.

1. Eradication of mammals inside a mammal proof fence
2. Suppression of mammals by intensive trapping
3. No mammal control

To date, these treatments consist of, respectively:

1. Xcluder© mammal proof fencing (1718 m) encompassing 18ha of skink habitat. Mammal poisoning and trapping commenced in July 2005. However, since this finished, mouse sign was detected in March 2006. As of April 2006, rabbits are still present.
2. Trap lines (56 km) of soft-jaw Victor, modified Timm, modified Conibear, Fenn Mark VI, DOC250 and DOC150 traps. Multiple bait types are used to target cats, ferrets, stoats, weasels, hedgehogs and rats. Approximately 1200 ha are covered to minimise mammal numbers in a central 50 ha area. Trapping is supplemented with spotlight hunting, dogs, and lures. Intensive rodent control using toxins as well as traps has not been attempted to date because of the technical and legal constraints of controlling rodents on the mainland.
3. Unmanipulated mammal populations outside the conservation management area.

Grand and Otago skink populations are monitored at all experimental sites. Survival and population growth rates are estimated using photo-mark-recapture methods. Habitat use, colonisation and extinction are monitored by occupancy surveys. The mammal-proof fence represents only 0.001% of the skinks' former range and about 1% of their remaining

numbers. The experimental fence is therefore by no means at a scale that will significantly contribute to saving these species in the long term.

Objective 1.1: Demonstrate that skink populations are recoverable in situ by removing mammals

Objective 1.2: Determine other agents of decline

Actions	Accountability	Priority
1.1 Eradicate mammalian pests inside two experimental mammal-proof fences, one containing Otago skink habitat (18 ha already installed at the Wildlife Site) and the other containing mostly grand skink habitat (c. 12 ha to be installed on Redbank Ridge – construction beginning late 2006).	Programme Manager (Grand & Otago Skinks), Coastal Otago Area.	Essential
1.2 Impose mammalian pest control that targets all mammal species within technical capability (already installed at the Redbank Ridge/Emerald Stream and beyond, covering 1200 ha).	Programme Manager (Grand & Otago Skinks), Coastal Otago Area.	Essential
1.3 Impose no mammal management to allow stronger inference about effects of Actions 1.1 and 1.2 (already installed at Alistair's Gully and Mandy's Rock).	Programme Manager (Grand & Otago Skinks), Coastal Otago Area.	Essential
1.4 Use robust techniques to monitor population responses in all treatments, (of both skinks and predators) at least until treatment effects are sufficiently revealed (already underway).	Programme Manager (Grand & Otago Skinks), Coastal Otago Area.	Essential
1.5 Determine impacts of two of the following potential agents of decline by 2009: rodents, small mustelids, and habitat quality	Programme Manager (Grand & Otago Skinks), Technical Support Manager, Otago.	High

Most likely outcomes of these experimental actions and their management implications:

If annual survival rates of below 0.6 are detected at the end of 2009 it will be considered that 'no alleviation of agents of decline' has occurred. Annual survival rates in excess of 0.75 for both species to be considered as a recovering population. Results falling between these two rates will be considered as neither success nor failure but justification to continue maintaining the experimental management and monitoring for definitive results.

Outcome A:

Fence and pest eradication treatment - no response

Predator control treatment - no response

No treatment - no response

Management implication: Salvage the species by moving a pre-determined number into captivity (see below).

Outcome B:

Fence and pest eradication treatment - positive response

Predator control treatment - no response

No treatment - no response

Management implication: Implement fencing and pest eradication at a sufficient scale to ensure survival of both species in the medium term and abandon further investment in conventional trapping control until species are secure.

Outcome C:

Fence and pest eradication treatment - positive response

Predator control treatment - positive response

No treatment - no response

Management implication: Implement either fencing/pest eradication or predator control more widely depending on cost/benefit analysis.

Topic 2: Genetics

Issues

The now isolated east and west populations of both grand and Otago skinks have distinctive genotypes (Berry & Gleeson 2005, Berry et al. 2005). As captive management skills are well developed for Otago skinks, and in development for grand skinks, conserving this diversity should not present a serious technical challenge. However, captive security for the species still relies on developing knowledge of the number of individuals required to secure that diversity, understanding the impacts of maintaining the species outside of their range, and developing basic management skills and techniques for grand skinks.

Objective 2.1: Determine the minimum number of skinks required to secure the genotype in captivity

Actions	Accountability	Priority
2.1 Utilise existing genotypic data on grand and Otago skinks to model minimum number required to adequately represent the species in captivity and to avoid genetic bottlenecks by 2010.	Programme Manager (Grand & Otago Skinks), Technical Support Manager, Otago, Science Manager (Threatened Species , RD &I)	Medium

Topic 3: Metapopulation dynamics

Issues

The successful long-term management of grand and Otago skinks relies on an understanding the dynamics of viable metapopulations. Minimum numbers of individuals and the habitat they require must be understood in relation to the probability of extinction through known impacts (return of predator pressure) as well as unpredictable stochastic events such as weather, fire, disease etc. Improved knowledge of metapopulation dynamics and management requirements can be gleaned from both monitoring extant populations and their behaviour, and predictive modelling developed from field data. By understanding the metapopulation dynamics for grand and Otago skinks we will then be able to identify minimum management areas required and judge any recovery in the species.

Objective 3.1: Determine minimum metapopulation required in the wild to ensure population persistence

Actions	Accountability	Priority
3.1 Undertake metapopulation modelling using colonisation and extinction rates of rock outcrops, and demographic data by 2009.	Programme Manager (Grand & Otago Skinks), TSM, Otago Conservancy. Science Manager (Threatened Species , RD &I)	Medium

Topic 4: Experimental management techniques

Issues

A management direction of either fencing/pest eradication or large-scale multi-species pest control will be implemented if outcome B or C results from the experimental treatments. A key part of the decision will be the costs and benefits of different management techniques. The completion of a cost/benefit analysis for both the eastern and western ranges will be required by 2009.

Objective 4.1: Develop techniques that potentially improve the conservation status of skinks

Actions	Accountability	Priority
4.1 Develop control techniques for rodent populations in tussock habitat on the mainland by 2009.	Programme Manager (Grand & Otago Skinks), Technical Support Manager, Otago, Science Manager (Site & Threats, RD&I).	Medium
4.2 Develop habitat improvement techniques in collaboration with Landcare Research by 2009.	Programme Manager (Grand & Otago Skinks), Coastal Otago Area.	Medium
4.3 Complete a cost/benefit analysis of different fencing/pest control strategies before 2009.	Science Manager (Site & Threats, RD&I).	High

Topic 5: Ecosystems

Issues

Species other than grand and Otago skinks are likely to benefit from the experimental management. It is important that these collateral benefits are recorded because they signify potential side-benefits of threatened species management that will ultimately inform on improved management design for future phases of species recovery programmes. Landcare Research is undertaking most of this work in partnership with the Department.

Objective 5.1: Understand the effects of experimental treatments on the wider ecosystem

Actions	Accountability	Priority
5.1 Continue ecosystem monitoring in collaboration with Landcare Research.	Programme Manager (Grand & Otago Skinks).	Medium

Management

Topic 6: Review of experimental research

Issues

The current work programme has an emphasis on understanding the agents of decline for Otago and grand skinks. Modelling undertaken so far suggests a high probability of extinction of both species within 10 years. A review of the results of the research will be essential in 2009 to allow enough time for the required management actions to take effect.

Objective 6.1: Review results from experimental management.

Actions	Accountability	Priority
6.1 Analyse experimental data and decide by April 2009 at the latest (after the last population monitoring for that season) whether the treatments have benefited skinks.	Programme Manager (Grand & Otago Skinks), Coastal Otago Area. Grand & Otago Skink Recovery Group.	High
6.2 Present assessment of results to accountable managers by December 2009.	Programme Manager (Grand & Otago Skinks), Grand & Otago Skink Recovery Group.	High

Topic 7: Ex-situ and in-situ management

In situ issues

Given their genetic distinctiveness and isolation, in-situ management should be applied to the western populations, and at a large enough scale to encompass a functioning metapopulation. This is problematic as the ranges of grand and Otago skinks are not currently known to overlap in their western range.

If proven successful as a management technique, the current level of fencing at the Macraes Flat Reserve must also be expanded to include a functioning metapopulation. The problem is that we do not know the appropriate size of a metapopulation for grand and Otago skinks, and until then, we define it as *at least four distinct but interacting sub-populations, up to 1 km apart* (which we will call a 'quasi-metapopulation'). A single management unit should therefore aim to include one quasi-metapopulation. We also advise that at least two disjunct quasi-metapopulations be secured in each of the eastern and western ranges.

Secure sites should ideally be inside their former range and on the mainland where management staff can readily visit them. However, no such site currently exists and the methods for translocation and self-maintenance of grand and Otago skinks in the wild have not been tested.

There are many skinks scattered in small, unsustainable populations outside protected areas. They can either be left alone, monitored, or bought into captivity. The latter is the preferred option because it provides better security and allows greater options, such as research or translocation to secure sites.

Ex situ issues

There are a number of Otago skinks already in captivity – some of which are high-quality genetic stock and others which are highly inbred. The former are clearly important for maintaining genetic diversity in captivity. The latter are still useful for research and public awareness.

Translocation to offshore or lake islands will not be attempted at this point because no suitable habitat has been identified following investigation of the options, and also because no offshore island is known to be part of their former range. It is preferable to translocate to secure sites within the existing range if and when they become available.

Whilst Otago skinks are breeding in captivity, grand skinks are not. Attention must be devoted to developing captive management skills for grand skinks.

The captive management programme is critical as insurance against failure of the management treatments to restore skink populations. Currently, the captive operations lie entirely with private individuals or NGOs. If recovery in situ is unattainable and captive management becomes the central focus of the recovery programme, it will clearly need to be incorporated into Departmental operations.

Objective 7.1: Secure representative populations of grand and Otago skinks through captive management by 2007 for Otago skinks, and by 2008 for grand skinks

Objective 7.2: Secure representative populations of grand and Otago skinks in their eastern and western range

Actions	Accountability	Priority
7.1 Implement revised Captive Management Plan as insurance for the species' existence, by 2008.	Programme Manager (Grand & Otago Skinks), Coastal Otago Area. Captive Management Coordinator.	Essential
7.2 Determine the best use of skinks brought into captivity from satellite populations by 2008.	Programme Manager (Grand & Otago Skinks), Coastal Otago Area. Captive Management Coordinator	High
7.3 (<i>if experimental management provides outcome A</i>) Impose an expanded version of the Captive Management Plan to salvage the species from extinction, by 2010.	Conservator, Otago	Essential
7.4 (<i>If outcome B</i>) Impose large scale fencing and mammal eradication in the eastern and western ranges by 2010.	Conservator, Otago	Essential
7.5 (<i>If outcome C</i>) Impose either fencing/mammal eradication or large-scale multi-species mammal control (depending on	Conservator, Otago	Essential

cost/benefit analysis) in the eastern and western ranges by 2010.		
7.6 (If outcome B or C) Secure protection of key habitats by 2010.	Conservator, Otago	Medium
7.7 (If outcome B or C) Translocations to secure sites by 2010.	Conservator, Otago	Medium

Topic 8: Monitoring

Issue

Monitoring is an essential aspect of determining the outcomes of the management experiments and in generating data to understand trends in wild populations and the behaviour of populations (e.g. dispersal, colonisation, extinction). It is imperative that current monitoring methodologies are adhered to for the duration of the management experiment. These include photo-mark/photo-recapture for estimates of survival rates and abundance, and occupancy surveys of habitat patches.

Objective 8.1: Maintain knowledge of status of both species across their range

Actions	Accountability	Priority
8.1 Implement annual population monitoring for those western populations that are accessible to Department staff.	Programme Manager (Grand & Otago Skinks).	High
8.2 Continue population monitoring at Macraes study sites to infer longer-term effects of experimental management.	Programme Manager (Grand & Otago Skinks).	High
8.3 Investigate reports of new sightings of grand and Otago skinks.	Programme Manager (Grand & Otago Skinks).	Medium

Topic 9: Legal status of reserves

Issue

The classification of public land managed by the Department at Macraes Flat and Glenfoyle is not completed. The appropriate classification of these lands that are managed for grand and Otago skink conservation requires resolution to ensure that the most appropriate protection and designation is afforded to these lands.

Objective 9.1: Clarify classification and legal status of Public Conservation Estate that is managed for grand and Otago skinks.

Actions	Accountability	Priority
9.1 Undertake a formal classification exercise for the public Conservation land at Macraes Flat and Glenfoyle by 2007	Community Relations Manager, Otago Conservancy	Medium

Community Relations

Topic 10: Stakeholders

Issues

Public awareness of the conservation status and threats faced by grand and Otago skinks is lacking. Increased community awareness should lead to an increasing commitment to the conservation of grand and Otago skinks in the long term. The public profile of the skinks has risen significantly since 2004 and this momentum needs to be maintained. A number of skink populations remain on private land. Engaging with landowners, understanding the management pressures landowners face, and developing a mutually beneficial approach to the conservation of grand and Otago skinks will be necessary to provide a future for these populations. The establishment of the Central Otago Ecological Trust, which is focused on grand and Otago skink conservation through education, captive management and habitat restoration, is an opportunity for the recovery programme.

Objective 10.1: Raise community awareness and support for skink conservation.

Actions	Accountability	Priority
10.1 Build better relationships with landholders and stimulate awareness of grand and Otago skink conservation.	Programme Managers' (Community Relations, Coastal Otago, Wanaka, Central Otago), Community Relations Manager, Otago.	High
10.2 Foster support for community-led skink conservation initiatives including support for the development of COET initiatives.	Programme Managers' (Community Relations, Coastal Otago, Wanaka, Central Otago), Community Relations Manager, Otago.	Medium
10.3 Complete an information strategy to enable engagement with the community.	Community Relations Manager, Otago.	High
10.4 Encourage Otago schools in the grand and Otago skink programme with information and opportunities to be involved.	Programme Managers' (Community Relations, Coastal Otago, Wanaka, Central Otago), Community Relations Manager, Otago.	Medium

10.4 Stimulate awareness of grand and Otago skink conservation by the farming community generally.	Programme Managers' (Community Relations, Coastal Otago, Wanaka, Central Otago), Community Relations Manager, Otago.	Medium
10.5 Engage the general public and interest groups about grand and Otago skink conservation.	Programme Managers' (Community Relations, Coastal Otago, Wanaka, Central Otago), Community Relations Manager, Otago.	Medium
10.6 Consult with relevant runanga if significant change in direction of the programme, such as tikanga with skink translocations and salvaging skinks in captivity.	Programme Managers' (Community Relations, Coastal Otago, Wanaka, Central Otago), Community Relations Manager, Otago. Grand & Otago Skink Recovery Group.	Medium
10.7 Seek rural participation in the Recovery Group.	Conservator, Otago	Medium

Topic 11: Sponsorship

Issues

Corporate sponsorship is a means of promoting species like grand and Otago skinks and raising corporate profile and public awareness. First priorities for any corporate interest will be to increase the public profile of the skinks.

Objective 11.1: Explore sponsorship options to support skink conservation

Actions	Accountability	Priority
11.1 Explore sponsorship options to fund skink conservation by 2009.	Community Relations Manager, Otago, External Relations Group, Head Office.	Medium

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