

Conservation of lizards in Otago Conservancy

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Cover: A grand skink (*Oligosoma grande*) surveys the tussock grassland of the lizard reserve at Macraes Flat from its home high on a schist tor. *Photo: Tony Whitaker*

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ABSTRACT

Goals and objectives, which address the aims of the Otago CMS, are set for the conservation management of the lizard fauna of Otago Conservancy. For each of the four Areas in the conservancy, priorities are established for research and surveys which will lead to better knowledge of the lizard fauna. Recommendations are made for management that should lead to threatened species becoming less vulnerable and more widely distributed. The long-term future of all other species at sites representative of their natural range should also be secured. Current knowledge of the distribution, ecology and conservation status of each of the 15 lizard species known from Otago Conservancy is summarised, and possible threats and limiting factors for these species are discussed. This information is then used to define management options that will enhance the species' conservation status. Any weaknesses in this information are identified as research needs.

Keywords: Reptilia, Squamata, Lacertilia, *Hoplodactylus*, *Naultinus*, *Oligosoma*, reptiles, lizards, geckos, skinks, conservation management, Otago, New Zealand

1. Introduction

For administrative purposes the Department of Conservation (DOC)¹ has divided New Zealand into three regions, together containing 13 conservancies. The conservancies are further divided into a variable number of Areas. Otago Conservancy (OC)—extending from the Waitaki River to the Catlins coast and west to the Main Divide—is part of the Southern Region. It contains four named Areas (Figure): Coastal Otago, Central Otago, Wanaka, and Wakatipu.

The boundaries of the administrative units within DOC are based primarily on geography. Although the conservation management of a few, generally rare or threatened species or habitats transcends conservancy boundaries, the close relationship between geography and the biota means that in most cases management decisions and actions can be conservancy-based, and what is important in one conservancy is not necessarily so in another where different priorities will apply. Against this administrative background, conservancies need to develop their own plans for the conservation management of the indigenous biota in their area.

The action plan presented here is modelled closely on conservancy-based plans for the conservation management of the herpetofauna recently prepared for Southland (Roberts 1999) and Nelson/Marlborough (Whitaker & Gaze 1999). Although, in turn, those two plans were loosely modelled on the established format for DOC's Species Recovery Plans (SRPs), they differed significantly in their approach by considering a **large group of species** in relation to a **specific geographic and administrative area**, irrespective of the species' distributions. They also differed by **including non-threatened species**—though in this latter respect they perhaps foreshadowed the latest approach to lizard species recovery planning wherein the lizard fauna is being treated on a genus-wide basis (Townes 1999; Townes et al. in press).

The species richness of the extant herpetofauna in OC, comprising 15 species of lizards, is not high in comparison to other conservancies (Appendix 1). Although native frogs (*Leiopelma* spp.) were once widespread in the South Island they have never been recorded from the Otago region, and tuatara (*Sphenodon* spp.), though common in subfossil deposits throughout Otago, are no longer present (Worthy 1987a, 1998; Worthy & Holdaway 1993, 1994, 1995, 1996a, b). Subfossil remains also show that Duvaucel's gecko (*Hoplodactylus duvaucelii*)—or a species very similar to it—was previously widespread on the South Island, including in Otago, but it is now locally extinct (Worthy 1998; Worthy & Holdaway 1994, 1995, 1996a, b). The kawekawau (*Hoplodactylus delcourti*) was included in the Otago fauna on the basis of two subfossil bones (Bauer & Russell 1988), a suggestion accepted by some (Clark et al. 1996) but considered equivocal by others (Worthy 1997, 1998).

There are five extant SRPs relating to the New Zealand herpetofauna (Newman 1996; Whitaker & Loh 1995; Townes 1999; Gaze 2001; Townes et al. in press),

¹ See section 8. Glossary and abbreviations, for a list of terms and abbreviations used in this text.

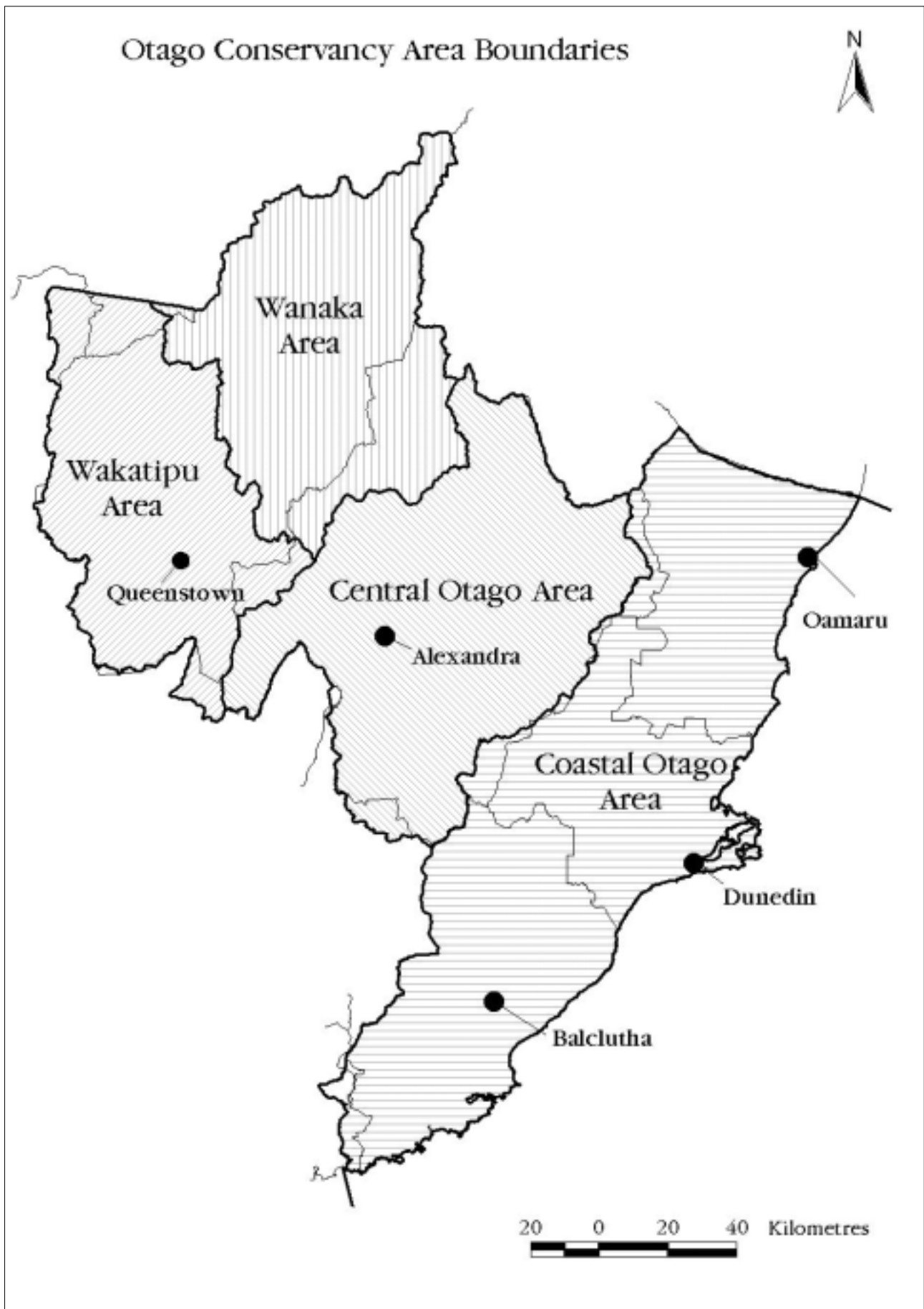


Figure 1. Boundaries of the four Areas within the Otago Conservancy.

only one of which relates to Otago species (Whitaker & Loh 1995). That SRP, covering both Otago skinks and grand skinks, takes precedence over the action plan presented here. It is currently in revision (Whitaker, A.H. in prep. Grand skink and Otago skink recovery plan [Draft July 1999]).

Eight species of geckos (*Hoplodactylus* and *Nautilinus*) and seven species of skinks (*Oligosoma*) occur within the OC (see Table 1 and Appendix 1). This lizard fauna is notable for the relatively high number of *Oligosoma* and *Hoplodactylus* species ($n = 7$ for both genera though, ironically, none of the *Hoplodactylus* species currently known from Otago is formally named). Furthermore, the proportion of the OC lizard fauna that is known only from the mainland localities (47%)² is the highest of any conservancy and the number of *Hoplodactylus* species that are endemic³ is relatively high in OC ($n = 3$).

TABLE 1. THE LIZARD FAUNA OF OTAGO CONSERVANCY, INCLUDING DISTRIBUTION (ENDEMISM).

SPECIES	COMMON NAME	DISTRIBUTION*
<i>Hoplodactylus</i> sp. 'southern forest'	southern forest gecko	regional
<i>Hoplodactylus</i> sp. 'Roys Peak'	Roys Peak gecko	endemic
<i>Hoplodactylus</i> sp. 'Central Otago'	Central Otago gecko	endemic
<i>Hoplodactylus</i> sp. 'Cromwell'	Cromwell gecko	endemic
<i>Hoplodactylus</i> sp. 'Otago/Southland large'	Otago/Southland large gecko	regional
<i>Hoplodactylus</i> sp. 'Southern Alps'	Southern Alps gecko	widespread
<i>Hoplodactylus</i> sp. 'southern mini'	southern mini gecko	regional
<i>Nautilinus gemmeus</i>	jewelled gecko	widespread
<i>Oligosoma chloronoton</i>	green skink	regional
<i>Oligosoma grande</i>	grand skink	endemic
<i>Oligosoma inconspicuum</i>	cryptic skink	regional
<i>Oligosoma maccanni</i>	McCann's skink	widespread
<i>Oligosoma nigriplantare polychroma</i>	common skink	widespread
<i>Oligosoma otagense</i>	Otago skink	regional
<i>Oligosoma waimatense</i>	scree skink	widespread

* Distribution categories are: endemic = confined to OC; regional = known from OC and one (or rarely two) adjacent conservancies; widespread = in three or more conservancies

Three of the lizard species in OC are sufficiently at risk to warrant inclusion in the international IUCN Red List, where they are all listed as 'vulnerable' (IUCN 1996; Bell 1997) (Table 2 and Appendix 1). However, seven taxa, all geckos, currently lack formal names and are therefore specifically excluded from consideration for IUCN listing. The three taxa on the IUCN list are also the only ones in OC included for conservation priority by DOC, where they are ranked in Category A or B (Molloy & Davis 1994)⁴. However, using the new threat

² 'Mainland' distribution is defined as North Island and/or South Island, and specifically excludes Stewart Island and any smaller sea or lake islands.

³ In this context 'endemic species' are defined as those found only within OC.

⁴ A fourth taxon—the 'Danseys Pass gecko' in Category B—is now known to be a distinctive population of the Otago/Southland large gecko (Rod Hitchmough pers. comm.).

TABLE 2. CURRENTLY ASSIGNED CONSERVATION PRIORITY, THREAT, AND CAPTIVE MANAGEMENT CATEGORIES FOR THE LIZARD FAUNA OF OTAGO CONSERVANCY.

COMMON NAME	DOC PRIORITY RANK*	DOC THREAT CLASSIFICATION†	IUCN RED LIST CATEGORY‡	DOC CAPTIVITY CATEGORY§
southern forest gecko	-	GD (1/1; DP, HI)	-	C
Roys Peak gecko	-	NC (1; DP)	-	C
Central Otago gecko	-	NT	-	C
Cromwell gecko	-	NT	-	C
Otago/Southland large gecko	-¶	GD (1/1; DP)	-	C
Southern Alps gecko	-	NT	-	C
southern mini gecko	-	RR	-	C
jewelled gecko	-	GD (1/1; HI)	-	B
green skink	-	GD (1/1; HI)	-	B
grand skink	A	NE (B1/1; CD, HI)	VU (C2a)	C
cryptic skink	-	GD (1/1; DP, HI)	-	C
McCann's skink	-	NT	-	C
common skink	-	NT	-	C
Otago skink	A	NE (B1/1; CD, HI)	VU (C2a)	C
scree skink	B	GD (1/1; HI)	VU (B1/B2b,d)	C

* Molloy & Davis 1994. Category A is the highest rank.

† Molloy et al. 2001; Rod Hitchmough, pers. comm. Threat categories relevant to OC are (in decreasing order): NC = Nationally Critical, NE = Nationally Endangered, GD = Gradual Decline, RR = Range Restricted, NT = Not Threatened; the qualifiers are: CD = conservation dependent, DP = data poor, HI = human induced.

‡ IUCN 1996.

§ DOC 1990. Category C is the highest rank. All new and undescribed species are assigned to Category C by default.

¶ The population at Danseys Pass was listed by Molloy & Davis 1994 under Category B.

classification categories (Molloy et al. 2001) the lizard fauna of Otago is the most at risk of any Conservancy with 60% ($n = 9$) of the fauna regarded as threatened compared with an average of 30% for the whole country (Table 2 and Appendix 1). This total includes one Nationally Critical species, two Nationally Endangered, and six Gradual Decline.

Species richness of lizards does not vary much across OC, ranging from 8–11 in each administrative Area, with the likelihood that further work will reveal an additional 1–2 species in each case (Table 3). Five species are widespread taxa that occur in all Areas; four are presently known from just a single Area—in two cases this containing their entire known range (Roys Peak gecko, Central Otago gecko). The highest number of taxa in an Area is eleven (Central Otago and Wanaka), with the greatest number of threatened taxa in any Area being two, (Coastal Otago and Wanaka). The largest lizard assemblages in OC are in the Macraes Flat–Middlemarch district in the west of the Coastal Otago Area where as many as seven species occur sympatrically at some localities (Townsend et al. 1985). Based on these criteria the Areas are equally significant for lizard conservation.

In pre-human times, lizards of one or more species would have occurred in every habitat in Otago Conservancy from the shoreline to at least 2,000 m in the

TABLE 3. DISTRIBUTION OF LIZARD SPECIES IN THE ADMINISTRATIVE AREAS OF OTAGO CONSERVANCY.

COMMON NAME	COASTAL OTAGO	CENTRAL OTAGO	WANAKA	WAKATIPU
southern forest gecko	O	–	–	–
*Roys Peak gecko	–	–	●	–
*Central Otago gecko	–	●	–	–
*Cromwell gecko	–	O	O	O
Otago/Southland large gecko	O	O	O	O
Southern Alps gecko	O	O	O	–
southern mini gecko	–	–	–	O
jewelled gecko	O	O	O	O
green skink	O	O	O	O
*grand skink	O	–	O	?
cryptic skink	O	O	O	O
McCann's skink	O	O	O	O
common skink	O	O	O	O
Otago skink	O	?	O	?
scree skink	–	O	–	–
No. lizard species ($n = 15$)	10	11	11	8
No. IUCN/DOC-ranked species [†] ($n = 3$)	2	1	3	0

* These species are endemic to Otago Conservancy.

† Molloy & Davis 1994; IUCN 1996; Bell 1997; Molloy et al. 2001 (only acutely threatened taxa).

● Indicates species with a national range limited to a single Area.

mountain ranges. They would have been an integral part of these ecosystems as consumers (primarily of invertebrates and fruit), prey to a variety of native birds, and for their role in plant reproduction (Whitaker 1987c). Following the introduction of kiore $\approx 2,000$ years ago (Holdaway 1996, 1999), widespread habitat loss and modification, and the more recent introduction of further mammalian predators, the lizard populations have been decimated (Townes & Daugherty 1994). A few species have become extinct (e.g. *Cyclodina northlandi*), some have been extirpated from most of their former range and now survive as isolated relict populations (e.g. Duvaucel's gecko), and for many others populations are now fragmented and isolated (e.g. speckled skink *Oligosoma infrapunctatum*). In OC, anthropogenic factors are believed to have led to the local extinction of Duvaucel's gecko (Worthy 1998) and the loss of Otago skinks and grand skinks from >90% of their former range (Whitaker & Loh 1995).

Throughout OC lizards and lizard populations continue to face a variety of very serious threats, including introduced mammalian and avian predators⁵, introduced competitors (fruit-eating birds and mammals, such as possums), and continued modification and loss of habitat as farm development and exotic forestry destroy indigenous grassland and shrubland environments. Unless

⁵ Feral cats, ferrets, stoats, weasels, hedgehogs, ship rats, Norway rats, kiore, house mice, feral pigs, little owls, magpies, starlings, blackbirds.

there is management intervention further losses from the lizard fauna will inevitably occur and there will be further reductions in range.

The action plan presented here defines the research, survey, and conservation requirements for the lizard species in OC and sets priorities for the management activities needed to achieve these goals. Like the Nelson/Marlborough plan (Whitaker & Gaze 1999), it has three main parts:

- The overall goal is set and the general objectives discussed.
- Conservation action priorities are set for the lizard species for each Area in the conservancy.
- The lizard fauna is considered on a species by species basis, with a summary of the distribution, conservation status, and threats facing each species, and listing specific research, survey and management needs to maintain or enhance their conservation status.

The plan concludes with an overall priority ranking of the top conservation actions required for lizards within the Otago Conservancy.

Throughout this action plan any list of actions or recommendations is given in decreasing order of priority.

2. Management plan for lizards in Otago Conservancy

2.1 GOALS AND OBJECTIVES

2.1.1 Long-term goal

Ensure the continued existence of all indigenous lizard species in the Otago Conservancy at sites that are fully representative of their natural range and the habitats they occupy.

Underpinning this long-term goal are three broad objectives:

Research objectives

- Understand the taxonomic status and genetic variation of all the lizard species occurring within the OC, and to determine those aspects of their biology and ecology critical to their conservation management.

Survey objectives

- Understand and map the current distribution of all the lizard species occurring within the OC—with particular reference to the geographical and altitudinal limits of range, and to the habitats occupied—in order to more accurately determine conservation needs and priorities.

Management objectives

- Ensure the continued existence of multiple populations of each threatened lizard species, if necessary through the establishment of new populations.
- Ensure the continued existence of multiple populations of less threatened species at a range of localities throughout OC that:
 - Secure the genetic variation of the species
 - Are representative of the geographical and altitudinal range occupied (including the geographic limits of distribution if these are within OC)
 - Are representative of the habitats used.
- Ensure the continued existence of representative lizard faunas within each Ecological Region in OC.

The goal and objectives of this action plan directly address the overall aims of the Otago Conservancy CMS (e.g. sections 4.2.1, 15.1), and many recommended actions are common to both documents, especially for high priority species such as grand skinks and Otago skinks (Anon. 1998).

The research and survey objectives will together determine the conservation status, and in turn establish the need for and guide the management objectives. The management objectives will be addressed through a range of management recommendations. In this plan many of the management recommendations for particular species or sites are really just general, common-sense requirements or management actions that apply to and broadly benefit the native biota as a whole (such as seeking legal protection of significant sites and habitats or

controlling introduced species—especially predators, browsers, and weeds). Others are precisely linked to lizard species or sites that are at risk.

Whenever possible, sites selected for conservation management action should aim to protect a diverse lizard fauna in situ, and recognise the significant role of lizards in fully-functional ecosystems. Securing lizard species or the lizard fauna may necessitate the acquisition or legal protection of some sites.

Whether the principal goals and objectives of this plan are met can only be determined by monitoring key lizard species, lizard populations or sites. The methodology of such monitoring will vary widely depending on the lizard species and the circumstances (see sections 2.4.3 and 2.4.4).

The general topics are discussed below (see sections 2.2-2.4), the specific topics are included in the species accounts (see section 4)

2.2 RESEARCH

Wise management decisions, insofar as they relate to the lizard fauna, require a clear understanding of the taxonomy, relationships and genetic variation of the lizard species. Whilst taxonomic research is outside DOC's terms of reference, the department must encourage and support projects that will improve this knowledge. It must also recognise that the provision of lizard specimens will be necessary to achieve this.

Conservation management of lizards is dependent on a good understanding of the biology and ecology of the species involved, including (but not limited to) habitat use, population density and dynamics, reproductive biology, diet, and the effects of predation. Clearly DOC staff will undertake some of this research but it is also likely that much will need to be contracted out or undertaken by other organisations, such as universities. All ecological and biological research relating to lizards that has a conservation application or benefit should be supported or, if needs be, such research should be actively sought.

Accurate survey data is essential for conservation management but unfortunately effective survey techniques for many lizard species are unavailable. Research to develop appropriate survey methodology for the lizard species in OC should be given priority.

2.3 SURVEY

An accurate understanding of a species' distribution is fundamental to its conservation management. Data on the distribution of lizards throughout New Zealand is held in the HERPETOFAUNA database⁶ managed by DOC (Appendix 4). Data from HERPETOFAUNA up to 1988 has been mapped in atlas form (Pickard & Towns 1988), or the whole database is available on-line and records

⁶ Formerly the Amphibian and Reptile Distribution Scheme (ARDS). See Appendix 4 for more information.

can be extracted in a variety of formats under a wide range of search parameters. However, it is important to remember that changed generic and specific names since the inception of ARDS mean that search parameters should be carefully chosen and that output should be cautiously interpreted.

Because of the attention given to Otago skinks and grand skinks there is arguably more comprehensive survey data for the lizard fauna of Otago than any other conservancy (Whitaker 1984, 1985a, b, 1986a, b, 1987a, b, 1988a, b, 1995; Whitaker & Loh 1990; Thorne 1998; McFarlane 1999; also Tocher, M.D.; Kappers, B. (in prep.) Otago and grand skinks of the Lindis District 1982–2001). Distribution data is also available from a wide range of broad biological surveys (e.g. Brumley et al. 1986; Mark et al. 1987; Fagan & Pillai 1992), site-specific biological surveys (e.g. Whitaker 1986c), site-specific research on lizards (e.g. Patterson 1985), species-based research (e.g. Patterson & Daugherty 1990), and from random records and reports. Nonetheless, there are still significant parts of OC (e.g. the mountainous area west of Lake Wakatipu and Lake Wanaka) and some key habitats (e.g. beech forests) for which there is virtually no information on lizards. These areas and habitats will require priority attention.

In some habitats—such as the montane beech forests—lizards are either so elusive or rare that formal surveys are unlikely to be an effective way of getting information on them. Under such circumstances most data on lizards is likely to come from chance encounters of lizards by members of the public or staff engaged in other activities. To gain from such encounters, **all** DOC staff should be made aware of the importance of recording these observations and reporting immediately. Each Area should implement an advocacy and basic training programme to ensure that the staff is well-informed.

Basic techniques for surveying, capturing and handling lizards have been defined (Whitaker 1994) but, because their application and execution varies widely depending on the target species and habitat, Areas should seek advice before undertaking any major survey projects.

There are considerable difficulties associated with identifying many lizard species in the field. This problem is particularly acute in OC where there are several, as yet ill-defined, taxa within the *Hoplodactylus maculatus* species complex and a number of similar—and variable—small skink species. Although a regional ‘field guide’ will be issued in conjunction with this action plan there will be many situations when lizards will need to be captured and held for short periods for specialist identification (Appendix 5). This requires strict hygiene with field equipment to ensure lizard populations are not exposed to new pathogens or parasites.

2.4 MANAGEMENT ACTIONS

Conservation management of lizards is driven by four basic requirements

- Legal protection of the species
- Legal protection of key habitats/sites
- Maintaining or enhancing the quality of lizard habitat at key areas or sites
- Ensuring key lizard populations do not decline

These actions will all be affected by knowledge on the changing status of the species obtained by monitoring numbers and/or distribution, either before or after management is undertaken. This section is intended as a brief overview—specific recommendations are presented for each Area or species.

2.4.1 Legal protection of lizard species

All indigenous lizard species are fully protected under the Wildlife Act 1953 and its subsequent amendments (Wildlife Order 1981, Wildlife Order (No. 2) 1996). The combined effect of this legislation means no native lizards can be captured, handled or removed from the wild without a specific written permit issued by DOC under s.53 of the Act. The wording of the Act is such that taxa lacking formal names are also protected by this legislation.

Indigenous lizards can be kept in captivity **only** by authority from DOC (issued under s.53, Wildlife Act 1953) and provided they meet certain criteria. For this purpose all native lizard species have been assigned to one of three captive categories based on their conservation status—A, B, and C, where A is lowest (see Table 2) (DOC 1990). New taxa or those lacking formal names are automatically assigned to Category C.

Despite the fully protected status of the lizard fauna collectors for the international illegal trade in animals target some taxa, in particular green geckos (*Naultinus* spp.) and some of the more colourful *Hoplodactylus* species. Collection of these animals threatens the viability and survival of localised populations.

Management actions

All staff should be made aware of the fully protected status of lizards and alert to suspicious activity at sites where lizards occur. If illegal activities are suspected or detected they should report immediately to the Wildlife Enforcement Group, DOC.

2.4.2 Legal protection of lizard habitat

Any legislation protecting the natural environment (e.g. Wildlife Act 1953, Reserves Act 1977, National Parks Act 1980, Conservation Act 1987) provides legal protection for lizard habitat. The most widespread lizard species in OC (e.g. Otago/Southland large gecko, McCann's skink) probably have their full geographic, altitudinal and habitat range legally protected but for most taxa the data is incomplete and for some this goal is clearly not met. For example, the Roys Peak gecko is not currently known from reserved land at all and for the Otago skink and grand skink the significant limits of range in the Lindis district are not secured.

Management actions

Review existing protected areas, including properties under tenure review, in order to identify the need for additional protected land or habitats. If need be, seek formal protection of key sites. This can be achieved by a wide variety of means ranging from out-right purchase to covenants on private land.

2.4.3 Maintaining the quality of lizard habitat

Habitats for a variety of lizard species are relatively secure over significant areas of OC (e.g. high mountain areas, forests within parks or reserves). Unfortunately the habitats for many other species—and especially low elevation, open habitats—are at considerable risk of degradation or loss from a range of factors, including production activities (e.g. scrub clearance, cultivation, grazing, wild fires, plantation forestry, mining, closer settlement) and pests (e.g. introduced weeds and mammalian herbivores).

Management actions

Undertake detailed habitat assessments at key sites and for important lizard species. Implement monitoring at some key sites to detect whether detrimental changes in habitat quality are occurring.

These actions may identify the need to limit some production activities, to control or prevent some anthropogenic factors, or to control or eradicate some pest species. They may also indicate the necessity for restoration (re-vegetation) at some sites or for habitat enhancement (e.g. the provision of additional cover) for declining species.

2.4.4 Maintaining lizard populations

Predation by introduced mammals, and to a lesser extent by birds, is a very serious threat to the New Zealand herpetofauna. Since kiore (*Rattus exulans*) arrived in this country \approx 2,000 years ago (Holdaway 1996, 1999) at least three species of lizards have become extinct and many others now have disjunct or dramatically reduced distributions that are believed to result largely from predation (Towns & Daugherty 1994). The impact of even a single species of predator can lead to local extinctions of lizard species, changed habitat use or behaviour, or significantly reduced population densities (Whitaker 1978; Towns 1996).

Within OC, Duvaucel's gecko has become locally extinct (Worthy 1998), and Otago skinks and grand skinks now have clearly relict distributions. The exact reasons for these changes may never be known with certainty but predation by introduced species will unquestionably have had a major impact.

The problem of predation of lizards in OC is as serious now as it has ever been, with at least nine mammals and four introduced birds that are known to prey on lizards⁷ being widespread, and generally numerous, within the region. In fact, every part of OC, with the possible exception of a few very small coastal islands (and maybe lake islands), will have been reached by introduced lizard predators at some stage or other, and lizard faunas throughout Otago will now show various levels of modification. Unlike other conservancies, there are unlikely to be any sites where the primeval situation prevails.

Across OC the impact of introduced predators on lizards will vary widely depending on the suite of predators present, on the lizard guilds present, the lizard species' habits and habitat, and on the availability of relatively secure

⁷ Feral cat, ferret, stoat, weasel, hedgehog, Norway rat, ship rat, house mouse, feral pig, little owl, white-backed magpie, starling, blackbird.

habitat (e.g. creviced outcrops, boulder banks). The impact will also vary seasonally and from year to year as environmental changes lead to changes in predator densities, and indirectly as changes in the density of other prey species such as rabbits lead to changed foraging behaviour ('prey-switching') (Norbury 2001).

Research is currently underway to assess the impact of mammalian predators (feral cats and mustelids) on skink populations at Macraes Flat, primarily to determine the risk to Otago skinks and grand skinks. Other research in OC has investigated the role of lizards as prey of introduced species—such as feral cats, mustelids, hedgehogs, and magpies—and commented on the potential effects of predation (e.g. Baker 1989; Middlemiss 1995; Whiting 1996; Sluijs & Spitzen 2000; Norbury 2001), and studies elsewhere of other widespread and abundant predators indicate their impacts in Otago could be considerable (e.g. house mice, see Newman 1986, 1994). Even starlings and blackbirds, extremely abundant in Otago, are a potentially serious threat (Bell 1996; Thompson 2000).

Predator eradication or control programmes—whether on literal islands or in 'mainland islands'—are of demonstrable benefit to lizards. Existing lizard populations respond rapidly and spectacularly when released from predation, often showing not only significant increases in population density but changes in spatial distribution, habitat use, behaviour and body size as well (Newman 1994; Towns 1991, 1994, 1996; Brown 1997; Rufaut & Clearwater 1997). Programmes combining habitat restoration with predator control create opportunities for translocation and the establishment of new populations of lizards, either enhancing the security of threatened species or to completing lizard assemblages as part of fully-functional ecosystems (Towns & Parrish 1999).

Introduced competitors are also an issue for lizards. Many lizard species, including most if not all of those in Otago, are frugivorous and seasonally dependent on a diet of fleshy fruits (Whitaker 1987c, d; Patterson 1985; Wotton 2000). Studies of grand skinks even suggest that for some lizard species availability of fleshy fruits may be limiting within the habitat and that lack of fruit may affect reproductive performance of females (Doug Eifler pers. comm., March 1996). The abundance of fruit and fruiting plants is directly affected by browsing mammals such as possums and farm livestock. Several species of introduced birds are also frugivorous (e.g. blackbirds). Introduced insectivorous birds and mammals may reduce invertebrate populations, and in forest or shrubland situations introduced vespid wasps (*Vespula germanica* and *V. vulgaris*) often totally deplete invertebrate populations and honeydew, two staples of lizard diet. Wasps are also lizard predators (Thomas 1987; Rob Mason pers. comm., March 1997).

Lizards naturally carry a variety of pathogens and parasites (e.g. see Allison 1982; Ainsworth 1985a, b). The distribution of these within the lizard fauna and across the country is not well documented, and their impact on the host species and populations is unknown.

Management actions

For threatened lizard species and at key sites for lizard conservation, baseline data on lizard population densities should be collected and then monitoring implemented to detect changes (see Patterson 1992a; Elliot 1994). Any

situations that are likely to increase the risk to lizard populations must be given particular attention, e.g. periodic irruptions of predators, situations creating the potential for 'prey-switching', or significant habitat changes (including succession). If monitoring data indicate that detrimental changes are occurring, subsequent conservation actions could entail habitat management (see above) or necessitate control of predators and/or competitors in the form of short-term responses to specific events or long-term suppression of predator and competitor populations—the 'mainland island' approach.

The eradication of introduced mammalian predators from lake or coastal islands will usually lead to an improved conservation status for lizards—provided the virtual predator-free status of the island can be maintained. Detecting the [re-] colonisation of islands by predators will require a level of mammal monitoring, the frequency of which must take into account the speed with which predators such as rats can destroy reptile populations (Newman 1986).

Quarantine measures must be implemented to ensure lizard pathogens and parasites are not spread to naïve populations of threatened species. This should include the sterilisation of equipment used by field workers (e.g. collecting bags) and the non-return of any lizards temporarily removed from a site unless they have been held in strict isolation. Extreme care must be taken in any situation involving translocated lizards; captive-bred lizards should not be returned to the wild unless there are exceptional reasons for doing so.

To enhance the security of rare or threatened species the potential for establishing new populations should be fully investigated. Priority for this action must be given to rare species that clearly show relictual distributions (e.g. Otago skink, grand skink). Only in exceptional circumstances should species be translocated outside the ED in which they occur.

2.5 SPECIES PRIORITY RANKINGS

The 15 lizard species occurring within OC have been assigned a conservation management priority ranking on an arbitrary 3-point scale where:

High = active conservation management required to secure and improve the conservation status

Moderate = management intervention desirable to maintain or improve the conservation status

Low = not at risk and management intervention not required.

These OC priority rankings are listed in Table 4 in comparison to the national threat classification (Molloy et al. 2001; Rod Hitchmough, pers. comm.) and in relation to the administrative Areas within the conservancy. Although the national priority ranking (Molloy & Davis 1994), national threat classification (Molloy et al. 2001) and IUCN ranking (IUCN 1996; Bell 1997) of each species was considered when assigning these conservancy priority rankings—and the same criteria formed the basis of the OC rankings—the priorities given here apply **only within the Otago Conservancy**.

This action plan assigns 'high priority' to the conservation management of five (33%) of the 15 lizard taxa known from OC, including all three taxa listed as

TABLE 4. PRIORITY RANKING OF LIZARDS FOR CONSERVATION MANAGEMENT WITHIN OTAGO CONSERVANCY, AND LIZARD DISTRIBUTION IN THE FOUR AREAS, IN COMPARISON TO THE NATIONAL THREAT CLASSIFICATION (Molloy et al. 2001).

COMMON NAME	OC PRIORITY RANK	DOC THREAT CLASSIF.	COASTAL OTAGO	CENTRAL OTAGO	WANAKA	WAKATIPU
southern forest gecko	High	GD	O	-	-	-
Roys Peak gecko	High	NC	-	-	●	-
grand skink	High	NE	O	-	O	-
Otago skink	High	NE	O	-	O	-
scree skink	High	GD	-	O	-	-
Central Otago gecko	Moderate	NT	-	●	-	-
Cromwell gecko	Moderate	NT	-	O	O	O
Otago/Southland large gecko	Moderate	GD	O	O	?	O
southern mini gecko	Moderate	RR	-	O	-	O
jewelled gecko	Moderate	GD	O	O	O	O
green skink	Moderate	GD	O	O	O	O
cryptic skink	Moderate	GD	O	O	O	O
Southern Alps gecko	Low	NT	O	O	O	-
McCann's skink	Low	NT	O	O	O	O
common skink	Low	NT	O	O	O	O
No. lizard species	15		10	11	10	8
No. high-priority spp.	5		3	1	3	-
No. moderate-priority spp.	7		4	7	4	6
No. low-priority spp.	3		3	3	3	2

● Indicates species with a national range limited to a single Area.

high priority by DOC and vulnerable by IUCN (Molloy & Davis 1994; IUCN 1996; Bell 1997), and the three taxa regarded as acutely threatened (Molloy et al. 2001). Seven taxa (47%) are assigned 'moderate' priority and 3 (20%) are regarded as 'low' priority.

The Coastal Otago and Wanaka Areas each have the greatest number of high priority species ($n = 3$), but for all Areas more than 60% of the lizard fauna is ranked for conservation action of some kind.

2.6 TIME FRAME

This action plan is based on current knowledge. Although it will undoubtedly evolve as new information is acquired and the recommended management proceeds, the entire plan will be formally reviewed at approximately 5-yearly intervals.

3. Conservation management priorities

This section considers actions as they relate to the Otago Conservancy or the Areas within it. Actions that relate to particular lizard species are discussed in section 4 (below).

3.1 GENERAL

3.1.1 General actions

There are a number of priority actions that are universally applicable to all lizard species and/or all Areas within the Conservancy. These are:

Staff training

To effectively implement the recommendations of this plan it is very important that key Area staff (e.g. Programme Managers-Biodiversity (PMDs)) are properly trained and up-to-date in survey techniques, basic identification, and data collection for lizards.

Action—Technical Support Officer (TSO)-Fauna to arrange training courses and seminars for key Area staff, and to distribute significant new information on lizards and survey methods as soon as they are available.

Staff advocacy

It is important that all DOC staff are conscious of the importance of recording and reporting observations of lizards. This is most important for rare or threatened lizard species or in particular places (see elsewhere in this plan). Nonetheless, reporting lizard sightings is something that should become a matter of course for all observations except for those made at localities where lizards of known identity are known to be abundant. In the first instance all observations should be reported to the TSO.

Action—PMDs to raise awareness of lizards with all staff in their Area, including information on the species present, gaps in distribution, significant species or habitats, and so on, stressing the kind of data to collect and the need to report observations immediately.

Distribution data

Good data on the distribution of lizard species is pivotal to determining their conservation status. All lizard observations should be recorded on ARDS data cards and forwarded to the TSO. Three general principles relate to the collection of distribution data:

- Any reported sightings of lizards that are in the slightest way unusual, relate to species that are not well known (e.g. green skink), or are from localities where lizards are unknown or known to be scarce, should be followed up immedi-

ately. Significant new records are turning up by chance all the time, e.g. the Roys Peak gecko near Wanaka (Tocher 1998b; Tocher & Marshall 2001).

- To determine population trends, ARDS cards should be submitted for subsequent ('repeat') visits to the same site or locality unless it is a place where known species are known to be abundant (e.g. Macraes Flat)—though even in these situations cards should be submitted at least annually.
- Distribution data should be correlated with the EDs and an effort made to ensure the lizard faunas of each ED are sampled (Appendix 3).

Action—TSO and PMDs to have supply of ARDS cards on hand for distribution to staff. Distribution and abundance surveys of particular sites or species should be actively promoted (see section 2.3 and Appendix 4 for specific recommendations).

Public education and advocacy

Public support is essential for the success of conservation management for mainland lizard populations. Members of the public can also make significant contributions to knowledge of the lizard fauna by reporting finds and observations.

Action—TSO and PMDs should prepare and disseminate information on lizards for distribution to heighten public awareness of the lizard fauna and its importance. PMDs should develop and foster relationships with key land-holders.

3.1.2 Islands

Islands offer special conservation opportunities for lizards. Few lizard species are primary endemics on small islands. Nevertheless, throughout New Zealand, small islands that are free, or have remained largely free, of introduced mammalian predators provide refugia for vulnerable lizard species that were previously widespread on the mainland (Whitaker 1978; Towns & Robb 1986; Towns and Daugherty 1994). Some lizard species, notably the large *Cyclodina* skinks and Duvaucel's gecko (*Hoplodactylus duvaucelii*), have clearly relict distributions and are now confined to such islands. At present no relict lizard populations are known on islands within OC.

With the rapidly developing methodologies for successfully eradicating mammals from ever-larger areas, even islands presently inhabited by introduced predators have conservation potential for lizards. Removal of rodents from islands has allowed relict lizard populations to recover or made large areas of habitat available for the establishment of new populations of rare or threatened species through translocation, and for the restoration of diverse lizard communities as part of fully functional island ecosystems (e.g. Newman 1994; Towns 1994).

Within OC there are 14 small coastal islands or groups of islets along the Otago coastline between the Waitaki River mouth and Waikawa Harbour (the largest of which is Quarantine Island, in Otago Harbour, at ≈14 ha), there are eleven islands in lakes, and one in the Clutha River (Appendix 2)⁸. Relatively few of these islands have been adequately surveyed for lizards but results so far

⁸ Coastal islands exclude unconsolidated sand islands in estuaries, such as Rabbit Island (27 ha) in Blueskin Bay; lake islands include two that result from raised lake levels associated with damming.

indicate lizard faunas on islands in OC are depauperate compared to other parts of New Zealand. Lizards have been found on only three (21%) of the coastal islands (3 species in total) and on seven (64%) of the lake islands (4 species in total). However, the only detailed survey of lizards on OC islands—for *Hoplodactylus* species on the islands of Lake Wanaka and Lake Hawea (Jewell & McFarlane 1997)—recorded their occurrence on every island visited, suggesting these figures might well underestimate the true diversity.

Information on the current status of introduced predators is known for all of the OC islands. Mice have been eradicated from one lake island (Mou Waho Island) and possums from another (Pigeon Island), and rodent and mustelid bait stations are maintained on all lake islands. For lizards, priority islands for future predator management or control are those in the lakes as these offer a chance to restore a west Otago lizard community in the absence of predators and, if required, the only opportunity to establish populations of Otago skinks and grand skinks in a mammalian predator-free environment. However, as all the lake islands are within the swimming distance of stoats (King 1990), and are regularly visited by them, these sites would require an on-going programme to prevent re-colonisation by mustelids.

Although islands offer opportunities for translocation and the establishment of new populations of lizards two things must be stressed. Firstly, Unless there are very compelling conservation reasons for doing so earlier, all translocations of lizards to islands should be deferred until after detailed surveys have determined which species are naturally present.

Priority management actions relating particularly to islands are:

Maintain the predator-free status of all islands lacking or cleared of introduced mammalian predators. This is important for the security of island lizard populations, especially so if the islands are being (or could be) used for lizard community restoration.

Action—PMDs in Coastal Otago, Wanaka, and Wakatipu Areas.

Determine the lizard faunas of un-surveyed islands. The lack of detailed data on the lizard faunas of many islands in OC limits the ability to make conservation management decisions. It is possible that populations of lizard species of conservation significance (e.g. green skinks, jewelled geckos) are present on some of the small islands yet to be surveyed.

Action—PMDs in Coastal Otago, Wanaka, and Wakatipu Areas.

Undertake thorough lizard surveys of any islands from which predators have been eradicated. Some lizard species survive in the presence of predators at population densities so low they are almost undetectable. Following release from predation they may take several years to recover to levels at which they show up in surveys. For example, 4 years for goldstripe geckos *Hoplodactylus chryosireticus* on Mana Island (Whitaker 1993); 6 years for copper skinks *Cyclodina aenea* on Korapuki Island (Towns 1994); and 7 years for brown skinks *Oligosoma zelandicum* on Mana Island (Anon. 1996). Islands from which mustelids or rodents have been eradicated should be thoroughly surveyed for lizards not less than 5 years, but preferably 7–8 years, after the eradication is completed, using the most appropriate technique(s) available for detecting the lizard species known from the region.

Action—MDs in the Coastal Otago, Wanaka, and Wakatipu Areas.

Include lizards amongst the species for island restoration. Lizards are important components of fully-functional ecosystems as consumers, prey for other vertebrates, and for their role in plant reproduction (Whitaker 1987c). Irrespective of specific recommendations for the translocation of species as a conservation measure (see sections 4.11.9 and 4.15.9), re-establishing lizard assemblages should be an integral part of any island restoration project, **but** only after a proper environmental audit to determine the effects of doing so.

Action—PMDs in the Coastal Otago, Wanaka and Wakatipu Areas.

3.2 COASTAL OTAGO AREA

3.2.1 Current situation

Otago/Southland large geckos occur throughout Coastal Otago but are more frequent—and more abundant—in the drier schist country to the west of the coastal ranges. Jewelled geckos are equally widely distributed in the Area but records are patchy, especially west of the coastal ranges where forest or shrublands are scarce. Southern Alps geckos extend only into the extreme north of Coastal Otago (in the Waitaki Valley). Southern forest geckos are known only from forests in the Catlins district in the south.

Common skinks and McCann's skinks are common and widespread in Coastal Otago, especially in the drier inland districts, and they have adapted to some extent to habitat modification for farming. Green skinks and cryptic skinks are also widespread, but patchy and localised. Otago skinks and grand skinks are present in the Macraes Flat-Strath-Taieri district, the stronghold for these two threatened species. Otago skinks are somewhat more widely distributed, extending from Hyde to the southern Rock and Pillar Range. The status of populations of Otago skinks and grand skinks at sites where they were reported in the immediate past needs verification: for example, grand skinks at Warrington (Hardy 1977); Otago skinks at Kyeburn (Whitaker 1988a).

There is no indication that any other gecko species are present in coastal or lowland habitats but one of the as yet undefined montane taxa in the *Hoplodactylus granulatus* species complex (cf. Roys Peak gecko) may possibly occur in subalpine environments on the Kakanui Range or Rock and Pillar Range. There also remains uncertainty over the northern limit of distribution for the southern forest gecko with unconfirmed reports of 'forest geckos' from Dunedin (Pickard & Towns 1988). Scree skinks, present just outside the Coastal Otago Area in the Hawkdun Range (Whitaker 1985b), could be present in greywacke scree habitats on the higher parts of the adjacent Kakanui Range.

The richest lizard assemblage in OC—and the highest number of *Oligosoma* species (6) from any site anywhere—is at Macraes Flat, which has seven of the ten species known from the Area (Towns et al. 1985). Elsewhere in the Area cryptic skinks, McCann's skinks, and common skinks often occur together, for example, on the Rock and Pillar Range (Patterson 1992b).

The lizard faunas of the islands and islets along the coast of OC have been poorly studied compared to those in Southland Conservancy but the occurrence of both jewelled geckos and cloudy geckos (*Hoplodactylus nebulosus*) on islands in the Foveaux Strait/Stewart Island region indicates significant lizard populations could also be present in OC.

3.2.2 Immediate management opportunities

The montane tussock grasslands and schist outcrops in the North Branch Waikouaiti River and Nenthorn Stream support a high species diversity of lizards, including five of the seven species in Coastal Otago needing conservation action, two of which (grand skink and Otago skink) are nationally threatened taxa. Large parts of the key lizard habitat in this district are now in DOC ownership with the specific goal of management for lizard conservation. These sites also have other significant biological values. There is an immediate opportunity for a substantial part of this area to be managed as a 'mainland island', thus securing a remarkable biota and landscape.

Quarantine Island and Goat Island, in Otago Harbour, both have potential as islands for ecological restoration that includes lizard species but their proximity to shore (<200 m) would mean continuous maintenance against re-colonisation by mammalian predators.

3.2.3 Research priorities

- Implement all research facets of the SRP for Otago skinks and grand skinks (Whitaker & Loh 1995) that relate to the Coastal Otago Area—in particular population dynamics, habitat requirements, the impact of introduced predators and land management regimes, and the development of effective monitoring techniques.
- Resolution of the taxonomy of the *maculatus*-complex, including determining the boundaries between the taxa and the extent of hybridisation zones (if they exist), and formal naming of the species.
- Population ecology and conservation status of jewelled geckos.
- Genetic studies of jewelled geckos.

3.2.4 Survey priorities

- Follow up all earlier reports of grand skinks and Otago skinks to determine the current status of populations.
- Pastoral properties under tenure review (all lizards).
- All islands for which there is no lizard data (all lizards).
- Boulder beach habitats (all lizards).
- Forest/shrubland areas (for jewelled geckos and geckos in the *Hoplodactylus granulatus* complex).
- Subalpine boulder-fields and screes in Kakanui Range (for scree skinks).
- Subalpine boulder-fields, screes and outcrops screes on Rock and Pillar Range and Kakanui Range (for geckos in the *Hoplodactylus granulatus* complex).

3.2.5 Management priorities

- Implement all management facets of the SRP for Otago skinks and grand skinks (Whitaker & Loh 1995) that relate to the Coastal Otago Area.
- Through the tenure review process ensure that low altitude habitats and sites are protected for lizards.
- Achieve mammal-free status for Every Scientific Reserve and manage the environment for jewelled geckos.
- Protect and monitor representative populations of southern forest geckos, jewelled geckos and green skinks.

3.3 CENTRAL OTAGO AREA

3.3.1 Current situation

Five geckos in the *Hoplodactylus maculatus* complex occur in the Central Otago Area, all of them locally common in rocky habitats. In the central part of the Area is the Central Otago gecko—an unnamed taxon with a distribution apparently restricted to the relatively low-lying schist country between the Maniototo, Manuherikia and Clutha valleys. The Otago/Southland large gecko has a parapatric range that more or less surrounds the Central Otago gecko. In the north the widespread Southern Alps gecko occurs in the Hawkdun Range, the south-eastern limit of range of the Cromwell gecko extends into the Area in the vicinity of Lake Dunstan, and the southern mini gecko is present in the Garvie Mountains in the extreme south-west of the Area. ‘Green geckos’, presumably jewelled geckos, have been reported from Central Otago but records are scarce. Most are in the south, in the Clutha valley near Beaumont, but there is also a record from near Oturehua (Whitaker 1986b).

McCann’s skinks and common skinks are very widespread and abundant throughout Central Otago to at least 1,500 m on the ranges; cryptic skinks and green skinks are also widespread but populations tend to be localised and isolated, probably as a consequence of severe habitat modification associated with agricultural development. Scree skinks are present in the mountains in the north of the Area (Hawkdun Range and St Bathans Range) but their southern limit of range appears to be restricted by the southern limit of greywacke. Otago skinks were present just south of Alexandra until the 1960s but there is no evidence they survive there now (Whitaker 1986a). There are also earlier reports of them from Rough Ridge (Beattie n.d) and the Patearoa (Bathgate 1922).

Although there has been considerable survey work for lizards in Central Otago (e.g. Whitaker 1985b, 1986a, b, 1988b; Whitaker & Loh 1990) there is still the opportunity for significant discoveries. The Area lies well within the range of grand skinks and Otago skinks so it is possible they are present, and it is also possible that one of the as yet undefined montane taxa in the *Hoplodactylus granulatus* species complex (cf. Roys Peak gecko) may occur in subalpine environments on the Rock and Pillar Range, Old Man Range, Garvie Mountains or Dunstan Mountains. Unknown lizards have been reported from several sites—for example, a large ‘blotched’ skink reported from a scree at 1,550 m on

northern end of St Bathans Range (Whitaker 1984—possibly a scree skink as they are present further south on the range), small unidentified skinks >1,850 m on the top of the Hawkdun Range (Dave Massam pers comm., February 1990), and large ‘dark lizards’ from outcrops near Roxburgh (Whitaker 1986a).

3.3.2 Immediate management opportunities

The current tenure review process for high-country leasehold properties allows the opportunity for land with a high conservation value for lizards to come under more direct management by DOC. In the Central Otago Area tenure review is likely to have immediate relevance for the protection of habitat for green skinks and scree skinks. It can also provide for the protection of the other lizard taxa within each ER.

3.3.3 Research priorities

- Population ecology of scree skinks—in particular population dynamics, habitat use, the impact of introduced predators and land management regimes, and the development of effective monitoring techniques.
- Resolution of the taxonomy of the *maculatus*-complex, including determining the boundaries between the taxa and the extent of hybridisation zones (if they exist), and formal naming of the species.
- Genetic studies of scree skinks to determine variation throughout their range.

3.3.4 Survey priorities

- Follow up all earlier reports of Otago skinks to determine the current status of populations.
- Follow up all earlier reports of jewelled geckos to determine the current status of populations.
- Pastoral properties under tenure review (all lizards).
- Subalpine boulder-fields, screes and outcrops screes on Rock and Pillar Range, Old Man Range, Garvie Mountains and Dunstan Mountains (for geckos in the *Hoplodactylus granulatus* complex).
- Forest/shrubland areas (for jewelled geckos and geckos in the *Hoplodactylus granulatus* complex).
- Subalpine boulder-fields and screes in Dunstan Mountains (for scree skinks).

3.3.5 Management priorities

- Review the need for protection of low altitude habitats and sites for lizards and—if needed—use the tenure review process to redress deficiencies.
- Protect key populations of scree skinks, including securing habitat, addressing threats posed by predators and weed invasions, and monitoring population trends.
- Protect and monitor representative populations of Central Otago geckos, jewelled geckos and green skinks.

3.4 WANAKA AREA

3.4.1 Current situation

Three geckos in the *Hoplodactylus maculatus* complex are known from the Wanaka Area. The Cromwell gecko is an unnamed taxon confined the southern part of the Area and small parts of the adjoining Wakatipu and Central Otago Areas along the Shotover, Kawerau, and Clutha Rivers, respectively. Near Wanaka township its range meets the southern limits of distribution of the widespread Southern Alps gecko—there is a narrow zone of sympatry but the species are not syntopic (Jewell & McFarlane 1997). To the east these two species abut the range of the Otago/Southland large gecko which extends westwards at least as far the Dunstan Mountains and north to the St Bathans Range. These three taxa are locally abundant in rocky environments.

A montane species in the *Hoplodactylus granulatus* complex—the Roys Peak gecko—is known from subalpine outcrops at single site at the northern end of the Crown Range, and jewelled geckos have been found in montane shrubland and beech forests in the Hunter Valley, north of Lake Hawea. It is likely these two species will occur more widely in the mountains in the west of the Area.

The western populations of Otago skinks and grand skinks are in the vicinity of Lindis Pass. More specifically, the Otago skink populations are scattered through the mid-Lindis River catchment in the broad area between Camp Creek and Dip Creek, and the grand skink populations are slightly further north between Smiths Creek, Breast Creek and the shore of Lake Hawea (the ranges of the two species do not overlap in this area). McCann's skinks and common skinks are very widespread and abundant in the east and south of the Wanaka Area to at least 1,500 m, but there are few records from north or west of the lakes. Cryptic skinks are also widespread, but localised. Green skinks have been found in the Wanaka Area but records are scarce.

The lizard fauna of northern part of the Wanaka Area, along the Southern Alps north of the lakes and west of Lake Wanaka, is essentially unknown. A number of detailed lizard surveys have been undertaken in the southern part of the Area (e.g. Whitaker 1984, 1987a; Whitaker & Loh 1990; Jewell & McFarlane 1997; McFarlane 1999), but nonetheless, there are still opportunities for discoveries there. For example, scree skinks are present in the mountains immediately east of the Wanaka Area (St Bathans Range), and just to the north in Canterbury Conservancy, so it is highly likely they are present in the vicinity of Lindis Pass.

One survey has been made of the islands in Lake Hawea and Lake Wanaka (Jewell & McFarlane 1997), but it considered only the *Hoplodactylus* species. No information is available on the occurrence of green geckos or skinks on lake islands.

3.4.2 Immediate management opportunities

Two relatively large and isolated islands in Lake Wanaka—Mou Waho (140 ha, 1,100 m from shore) and Mou Tapu (117 ha, 1,300 m from shore)—present management opportunities of potential benefit to the Otago lizard fauna. Mice were eradicated from Mou Waho in 1998 and the only predatory mammals now remaining on these islands are stoats. Eradication of stoats, followed by on-

going management to control re-colonisation, would allow for the recovery or restoration of a lizard community in the absence of all predatory mammals. Provided suitable rock habitat is available, one possible option is the establishment of new populations of threatened Otago skinks and grand skinks in an environment essentially free of introduced predatory mammals. The other more direct benefit of predator-free islands is the chance to recreate—through ecological restoration—a fully-functional ecosystem containing the full complement of lizard species known from the region. Prior to any lizard translocations taking place it is vitally important that the recipient islands are thoroughly surveyed a suitable period after mammal control to ensure all lizards species naturally present have been recorded. It is also important that the impacts of the translocation(s) are thoroughly evaluated in relation to current and future conservation values and uses of the site.

The current tenure review process for high-country leasehold properties provides a mechanism by which land with a high conservation value for lizards can come under more direct management by DOC. In the Wanaka Area this process has immediate application for the protection of habitat for Otago skinks and grand skinks.

3.4.3 Research priorities

- Implement all research facets of the SRP for Otago skinks and grand skinks (Whitaker & Loh 1995) that relate to the Wanaka Area—in particular, population dynamics, habitat requirements, the impact of introduced predators and land management regimes, and the development of effective monitoring techniques.
- Detailed genetic and taxonomic studies of the Roys Peak gecko and formal naming of the species.
- Population ecology of Roys Peak gecko, including abundance, population dynamics, habitat requirements and threats.
- Resolution of the taxonomy of the *maculatus*-complex, including determining the boundaries between the taxa and the extent of hybridisation zones (if they exist), and formal naming of the species.
- Genetic studies of jewelled geckos.

3.4.4 Survey priorities

- Crown Range and adjacent ranges—to determine the frequency, distribution and extent of populations of Roys Peak geckos.
- Lindis Pass—local distribution and abundance of Otago skinks and grand skinks.
- Existing low-altitude protected areas that presently lack data on lizards.
- Islands in Lake Wanaka and Lake Hawea.
- Shrubland, forest and montane/subalpine environments of the Southern Alps (geckos and skinks).

3.4.5 Management priorities

- Implement all management facets of the SRP for Otago skinks and grand skinks (Whitaker & Loh 1995) that relate to the Wanaka Area, in particular seeking protection for key habitat areas and populations.
- Protect and monitor key populations of Roys Peak geckos, including (if necessary) addressing threats posed by predators.
- Maintain predator-free status of any islands lacking introduced predators or from which they have been removed, initiate standard rodent and mustelid monitoring protocols, and have in place a contingency plan for the accidental introduction of predators to these places.
- Protect and monitor representative populations of Cromwell geckos, jewelled geckos and green skinks.
- Include the re-introduction of lizards in restoration plans for lake islands from which predators have been (or are to be) removed.
- Review the need for protection of low altitude habitats and sites for lizards and—if needed—use the tenure review process to redress deficiencies.

3.5 WAKATIPU AREA

3.5.1 Current situation

Three of the geckos in the *Hoplodactylus maculatus* complex are known from the Wakatipu Area. The southern limit of distribution for the Cromwell gecko is in the Shotover River catchment and Kawerau Gorge. Parapatric with the Cromwell gecko, and extending to the south and west, are the Otago/Southland large gecko and the southern mini gecko. The widespread Otago/Southland large gecko is distributed at least as far west as the Dart River (Paradise); the southern mini gecko is restricted to the mountains south and east of Lake Wakatipu, where its northern limit of range abuts that of the Cromwell gecko at the northern end of The Remarkables. These three species are all locally common in rocky environments. The distributions of Otago/Southland large geckos and southern mini geckos overlap and at some sites they are syntopic. 'Green geckos', presumably jewelled geckos, have been reported from manuka shrubland west of Queenstown (Whitaker 1986b) and at Paradise.

McCann's skinks and common skinks are very widespread and generally abundant throughout the south-eastern part of the Wakatipu Area to at least 1,500 m; cryptic skinks and green skinks are also widespread in the same region but tend to be more localised in their occurrence. All four of these species occur sympatrically at some localities, for example, in montane tussock grassland in the Eyre Mountains. There are early records of Otago skinks from 'Queenstown' and grand skinks from The Remarkables (Hardy 1977) but there is no evidence of extant populations despite specific searches (Whitaker 1986b).

The lizard fauna in the mountain ranges of the Southern Alps is essentially unknown and there are very few records of lizards from north and west of Lake Wakatipu. Detailed lizard surveys have been made in open habitats in the Eyre

Mountains and the ranges east of the lake (Whitaker 1986b; Geoff Patterson pers. comm., February 1990).

Otago/Southland large geckos and cryptic skinks occur on Tree Island—the type locality for *Oligosoma inconspicuum*. Lizards are considerably more numerous there than on the adjacent mainland, and the geckos reach larger size, perhaps indicating introduced predators are absent (Southey 1986). The lizard faunas of Wawahiwaka Island and Matau Island are unknown.

Clear opportunities exist for interesting discoveries. There has been only one assessment of shrubland or forest lizard faunas anywhere in the Area (at Paradise), yet the status and taxonomic identity of green geckos is unknown. Geckos in the *Hoplodactylus granulatus* complex are probably present as they occur in subalpine habitats in Wanaka Area, Fiordland, and Southland. The only locality for an undefined, rare *Oligosoma* species—the Garston skink—is <5 km from the southern boundary.

3.5.2 Immediate management opportunities

Three islands in Lake Wakatipu present immediate management opportunities of potential benefit to the Otago lizard fauna—Wawahiwaka Island (170 ha), Matau Island (110 ha) and Tree Island (2 ha). Eradication of predatory mammals from these islands, followed by on-going management to control re-colonisation by rodents and stoats, would allow the recovery of the resident lizard populations or restoration of a lizard community in the virtual absence of all predatory mammals. If suitable rock habitat is present, one possible option is the establishment of new populations of threatened Otago skinks and grand skinks in a predator-free environment. A more direct benefit is to ecologically restore the islands to a fully-functional west Otago ecosystem containing the full complement of lizard species known from the region. Before any lizard translocations, and an appropriate time after mammal control, it is vital that the recipient islands are thoroughly surveyed for lizards to ensure all species naturally present have been recorded. Also, the impact of any translocation(s) must be thoroughly evaluated to ensure current and future conservation values and uses of the site are not compromised.

The current tenure review process for high-country leasehold properties provides a mechanism by which land in the Wakatipu Area that has high conservation value for lizards can be brought under more direct management by DOC.

3.5.3 Research priorities

- Resolution of the taxonomy of the *maculatus*-complex, including determining the boundaries between the taxa and the extent of hybridisation zones (if they exist), and formal naming of the species.

3.5.4 Survey priorities

- Follow up earlier reports of grand skinks and Otago skinks to determine the current status of populations.
- Follow up all earlier reports of jewelled geckos to determine the current status of populations.

- Forest and shrubland habitats along Southern Alps (geckos).
- Sub-alpine grassland, herbfield and rock habitats in Southern Alps (geckos and skinks)
- Islands in Lake Wakatipu.

3.5.5 Management priorities

- Maintain predator-free status of any islands lacking introduced predators or from which they have been removed, initiate standard rodent and mustelid monitoring protocols for all islands, and have in place a contingency plan for the accidental introduction of predators to these places.
- Protect and monitor representative populations of southern mini geckos, jewelled geckos and green skinks.
- Include the re-introduction of lizards in restoration plans for lake islands from which predators have been (or are to be) removed.

4. Species

4.1 INTRODUCTION

4.1.1 Identification of lizards

Identification

Many New Zealand lizards are extremely difficult to distinguish without considerable experience. In Otago this is particularly true for skinks in the *Oligosoma nigriplantare* cryptic-species complex (cryptic skink, McCann's skink, common skink) (Daugherty et al. 1990) and for geckos in the *Hoplodactylus maculatus* cryptic-species complex, of which there are at least five in OC (Hitchmough 1997).

It is not intended to provide full identification details for the lizard species of OC in this plan but to issue a conservancy-based field guide as a separate publication (cf. Whitaker & Gaze 1999 and Whitaker 2000). In addition, most of the species occurring in OC can be identified with reference to the following sources—Skinks: Hardy (1977), Patterson & Daugherty (1990), Patterson (1997); Geckos: Bauer (1990), Hitchmough (1997); All Lizards: Towns (1988), Gill & Whitaker (1996).

If there is **any doubt whatsoever** about the identity of a lizard, or if lizards are found at an unexpected locality—for example a significant range extension or atypical habitat—they should be retained in captivity until identified by a specialist (see Appendix 5 and Appendix 6). It is also important to take detailed photographs of the animal and the site where it was found.

If lizards are found dead or die accidentally while in captivity, they should be preserved immediately and forwarded the national repository at MONZ (see Whitaker 1994 for protocols and Appendix 6).

Taxonomic changes

Recent taxonomic changes, and the re-assessment of some locality records, mean some names in the literature and the HERPETOFAUNA database are no longer valid. Changes to generic names to keep in mind are the green geckos from *Heteropholis* to *Naultinus* (Bauer 1990), and the skinks from *Lygosoma* to *Leiopisma* (McCann 1955) and thence to *Oligosoma* (Patterson & Daugherty 1995).

Some specific names have also changed, mainly because it is now recognised that in several cases what were earlier believed to be widespread, variable taxa are in fact cryptic-species complexes. In OC this situation particularly applies to skinks in the *Leiopisma nigriplantare* group and geckos in the *Hoplodactylus maculatus* group. Thus, in Otago, skinks earlier referred to as the 'common skink' have changed from *L. zelandica* sensu McCann 1955 to *L. nigriplantare maccanni* sensu Hardy 1977, to finally be split to *O. inconspicuum*, *O. maccanni*, and *O. nigriplantare polychroma* (Patterson & Daugherty 1990). Similarly, the 'common gecko' has gone from *H. pacificus* sensu McCann 1955 to *H. maculatus* sensu Robb & Rowlands 1977 to finally be split to several as yet

unnamed taxa, none of which is reconcilable with either earlier specific name (Hitchmough 1997).

Another recent change affecting Otago lizards is the elevation of the Otago skink and the scree skink to full specific rank rather than forms of the same species, *Oligosoma otagense* sensu McCann 1955 (Patterson 1997).

Information sources

Sources of further information are summarised in Appendix 6.

4.1.2 Structure of the species accounts

In the species accounts the following points are considered:

Taxonomic status—Name and authority for taxon or, for undescribed taxa, the reasons they are regarded as distinctive. Morphometric and genetic variation within OC is described because of its relevance to conservation management decisions.

Description and habitat—Brief physical description (*not* suitable for identification), habits and habitat.

Distribution—Present distribution nation-wide and within OC (in relation to EDs for less common species), endemism at conservancy level, and occurrence within OC Areas. When the distribution of a species is given without reference to a publication the information has usually been derived from the HERPETOFAUNA database. Data from the HERPETOFAUNA database are mapped in Figs 2-7. (The colour maps are located in section 9: Distribution maps, on pages 76-81.)

The type locality data is listed only if it is (or if it is believed to be) within OC.

The past distribution of a taxon is only given when it is known to differ from the present. Subfossil deposits in OC contain the remains of both skinks and geckos, most of which are not clearly identifiable to species (Ritchie 1982; Clark et al. 1996; Worthy 1998). Some of these bones will undoubtedly be from taxa extant in the region but others clearly are not—for example, bones attributable to Duvaucel's gecko (*Hoplodactylus duvaucelii*) are widespread in Otago, as elsewhere in the North Island and South Island (Worthy 1987b; Worthy & Holdaway 1994, 1995, 1996a, b), yet the species has not reliably been reported from the mainland in historic times.

Conservation status—DOC threat classification (Molloy et al. 2001), DOC priority (Molloy & Davis 1994) and IUCN Red List categories (IUCN 1996; Bell 1997) at a **national level** (see these documents for the full list of criteria and an interpretation of the ranking categories).

The species are also assigned conservation priority **within Otago Conservancy** based on an arbitrary 3-point scale—high, moderate and low. These OC priority rankings are defined in section 2.5 and listed in Table 4.

Vulnerability, threats, research needs and survey needs—These are assessed **only** for OC and listed in priority order. Only research and survey needs required to better determine and undertake the management actions are listed here.

Management actions—The overriding objectives for management action are given, followed in priority order by the key tasks needed to achieve these objectives and the OC Area(s) responsible for carrying them out.

Key literature—References that provide core information about the taxon.

4.2 SOUTHERN FOREST GECKO

4.2.1 Taxonomic status

Hoplodactylus sp. ‘southern forest’—see Tocher et al. 2000

An apparently undescribed taxon within the *Hoplodactylus granulatus* species complex. Genetic, morphometric and reproductive data have revealed that the forest gecko, *H. granulatus* s.l. (Thomas 1981; Bauer 1990), comprises a cryptic-species complex that is still far from resolved (Hitchmough 1997). ‘Forest geckos’ in the Catlins district, on the boundary of OC and Southland Conservancy, appear to differ from those elsewhere. Latest mitochondrial DNA data indicates: they are genetically most similar to—though relatively deeply diverged from—the Roys Peak gecko from the Wanaka area (see section 4.3); and that together these two taxa are the sister group of the cloudy gecko (*Hoplodactylus nebulosus*) + Takitimu gecko (*Hoplodactylus* sp. ‘Takitimu’)⁹ (Rod Hitchmough pers comm., September 2000). This suggests that there is a clear southern group of taxa within *H. granulatus* s.l. and that the southern forest gecko is probably distinct at the specific level.

4.2.2 Description and habitat

Medium-sized gecko (SVL to about 85 mm). Appearance essentially the same as the forest gecko (i.e. characterised by transverse W-shaped markings on the back, orange interior to the mouth, and slender toes) but differs in that the dorsal surface is frequently marked with irregular orange or brick-red blotches and in some individuals the iris is distinctly bluish. Nocturnal; arboreal. Known only from lowland podocarp/kamahi and beech forests.

4.2.3 Distribution

Nation-wide—Presently known only from the Catlins district, an area bounded in the north by the Clutha River and in the west by the Mataura River.

Otago Conservancy—Occurs only in the extreme south-east of OC and in the adjacent part of Southland Conservancy (see Fig. 2 in section 9). The only known localities are in or adjacent to the Catlins Forest Park (Tahakopa ED).

Only in Coastal Otago Area.

4.2.4 Conservation status

DOC threat classification GD (1/1: DP, HI); unlisted by DOC for conservation priority; not on IUCN Red List.

⁹ Morphometric and genetic differences between the ‘Takitimu’ gecko and the cloudy gecko are so minor they should be treated as conspecific (Rod Hitchmough pers comm., September 2000).

Conservation status within OC—High

4.2.5 Vulnerability

Risk factors

- Apparently restricted range
- Range has become somewhat fragmented through logging and forest clearance for agriculture
- Population density appears to be low

Positive factors

- Relatively large areas of habitat remain
- Large parts of its range are protected
- Occupies seral habitats (seral shrubland and regenerating forest)

4.2.6 Threats

- Exposed to the full suite of introduced mammalian and avian predators
- Habitat degradation by possums or browsing mammals
- Habitat modification or loss through indigenous forest logging and clearance for agriculture or exotic forestry
- Continued loss of seral habitats
- Competition from vespid wasps for invertebrates, nectar and honeydew, and perhaps also at risk to predation by wasps (Thomas 1987); possible competition from possums and rodents for some foods (nectar and fruit)

4.2.7 Research needs

Further examine the genetic relationship of the southern forest gecko to the cloudy gecko, to other geckos in the *Hoplodactylus granulatus* species complex in western Southland, and to the forest gecko s.s.

Formal taxonomic description is required.

Basic data on the size and dynamics of populations are needed to more accurately assess the species' conservation status.

Assess the impact of introduced predators and the need for predator control.

4.2.8 Survey needs

Coastal Otago—Apparently suitable forest habitat for the southern forest gecko occurs in coastal Otago as far north as the Kakanui River. The eastern coast of the South Island, from the Clutha River north to Marlborough, is the only sizeable area of New Zealand from which geckos in the *Hoplodactylus granulatus* complex have not been reliably recorded—there is a specimen allegedly from 'Canterbury' (Burt & Burt 1932), a subfossil record of '*Hoplodactylus* cf. *granulatus*' from South Canterbury (Worthy 1997), and an unsupported report from Dunedin (Pickard & Towns 1988; HERPETOFAUNA). It is important to search forest remnants north of the Clutha River to determine the northern limit of distribution for the southern forest gecko.

Catlins district—The local distribution and relative abundance of southern forest geckos needs to be determined more precisely.

4.2.9 Management actions

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

Verify that the habitat of key populations is protected and to ensure these populations are not at risk to other factors (e.g. predation).

Action—Coastal Otago

4.2.10 Key literature

Hitchmough 1997; Tocher et al. 2000

4.3 ROYS PEAK GECKO

4.3.1 Taxonomic status

Hoplodactylus sp. 'Roys Peak'—see Tocher 1998b and Tocher & Marshall 2001.

An apparently undescribed taxon in the *Hoplodactylus granulatus* species complex which shows relationships to the southern forest gecko and the cloudy gecko *Hoplodactylus nebulosus* (see comments under section 4.2.1).

4.3.2 Description and habitat

Medium-sized gecko (SVL to 80 mm) with stocky build, short tail and slender toes. Colouration variable, but showing elements of *Hoplodactylus granulatus*, e.g. dark stripe diagonally back and down from eye and orange interior to mouth. Otherwise base colour varies from grey to olive brown, with continuous or semi-continuous dorso-lateral stripes, cross-bands or blotches (or herringbone) pattern on the back, and sometimes irregular patches of bright orange. Nocturnal; terrestrial, saxicolous. Inhabits schist bluffs and rock-falls in montane tussock grassland and herbfields to 1,600 m.

4.3.3 Distribution

Nation-wide—Known only from Central Otago.

Otago Conservancy—Presently known from just a single population—on the contiguous Roys Peak and Mount Alpha, near Wanaka (Wanaka ED) (see Fig. 2).

Endemic to OC; occurs only in the Wanaka Area.

4.3.4 Conservation status

DOC threat classification NC (1: DP); unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—High

4.3.5 Vulnerability

Risk factors

- Known from a single population
- Not known to occur on protected land

Positive factors

- The area of potential habitat in the mountains of western Otago—and elsewhere—is vast
- The habitat appears to be under little threat of modification

4.3.6 Threats

- Exposed to introduced mammalian predators, including at least feral cats and stoats

4.3.7 Research needs

Further examine the genetic relationship of the Roys Peak gecko to the cloudy gecko, to other geckos in the *Hoplodactylus granulatus* species complex in the southern South Island, and to the forest gecko s.s.

Formal taxonomic description is required.

Determine more precisely the species' habitat requirements and habitat on Roys Peak/Mount Alpha, particularly with respect to altitudinal limits of distribution and whether the species is exclusively saxicolous. This information will assist in broader surveys for the species, and has a bearing on accurately assessing the conservation status and the need for management intervention.

4.3.8 Survey needs

Localised survey on Roys Peak to more accurately determine the size and extent of the only known population. Include shrubland and forest habitats where they exist.

Crown Range—The Roys Peak gecko is presently known from a few sites above 1,400 m between Roys Peak and Mount Alpha, on the northern end of the Crown Range. The remainder of the Crown Range needs surveying to determine the local distribution of the species with respect to altitude and habitat.

Western Otago—Because this taxon has only recently been recognised, and because it occupies a habitat that has not previously been searched for nocturnal geckos, it is highly likely that it occurs elsewhere in the mountains of western Otago. Initial sites to search should be selected on their physical similarity to the northern end of the Crown Range but they should be widely spaced within the region. Recommended sites to start are the Eyre Mountains, Richardson Mountains, Pisa Range, and McKerrow Range. Knowledge on the geographic range is needed to determine the conservation status and need for management action.

4.3.9 Management actions

Objectives

Ensure the only known population remains secure and that the conservation status of the species does not decline.

Tasks

Seek protection for the habitat of the only known population.

Action—Wanaka

4.3.10 Key literature

Tocher 1998b; Tocher & Marshall 2001.

4.4 CENTRAL OTAGO GECKO

4.4.1 Taxonomic status

Hoplodactylus sp. 'Central Otago'—see Hitchmough 1997.

An undescribed species presently contained within *H. maculatus* sensu Robb & Rowlands 1977 (see also Bauer 1990).

Genetic research over the past decade has shown that *Hoplodactylus maculatus* sensu Robb & Rowlands 1977 is a cryptic-species complex comprising at least 10 taxa (Daugherty et al. 1994; Hitchmough 1997), most of them in the South Island. Although the taxonomy and relationships of this group of geckos have yet to be finally resolved it appears that at least five of these cryptic species are known from OC (see also sections 4.5–4.8).

Despite clear genetic differentiation (based on allozymes and/or DNA), the species in this complex have similar morphology and colouration, and some of them are particularly difficult to distinguish. Furthermore, in OC the problem of identification is exacerbated because some of these taxa have sympatric ranges whilst others are parapatric without evidence of hybridisation zones where they meet (Hitchmough 1997).

Hoplodactylus maculatus s.s. (see Hitchmough 1997) is not known from OC—its southern limit of distribution is in Marlborough and Nelson. This means that HERPETOFAUNA database records and literature references for *H. maculatus* sensu Robb & Rowlands 1977, or for the earlier synonym *H. pacificus* sensu McCann 1955, occurring in OC will refer other cryptic species in the *maculatus* complex. (*H. pacificus* s.s. is now known to be confined to the North Island; Hitchmough 1997.)

4.4.2 Description and habitat

A small (SVL to 68 mm) slender gecko. Body colour is brown, with brown eyes and a speckled belly. Nocturnal; saxicolous. Inhabits creviced schist outcrops in tussock grassland.

4.4.3 Distribution

Nation-wide—Known only from Central Otago.

Otago Conservancy—Occurs only in the central part of Central Otago in an area roughly contained by the catchments of the Manuherikia River and upper Taieri River (including Rough Range and Raggedy Range), and south to the northern slopes of the Old Man Range (Maniototo ED, Manorburn ED, and parts of Dunstan ED and Old Man ED) (Rod Hitchmough pers. comm., August 2000).

Endemic to OC; only in Central Otago Area.

4.4.4 Conservation status

DOC threat classification NT; unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Moderate

4.4.5 Vulnerability

Risk factors

- Known from restricted geographic range
- Known from restricted number of sites
- Occurs only in high density rabbit zone

Positive factors

- Potentially large area of habitat within its known range in central Otago

4.4.6 Threats

- Exposed to full suite of introduced mammalian predators over different parts of its range
- Habitat modification through agricultural development
- Tussock grassland fires
- Woody weeds

4.4.7 Research needs

Further investigate the genetic and taxonomic status of this taxon with respect to the other geckos in the *Hoplodactylus maculatus* species complex that occur in Otago.

Formal description is required.

Determine more precisely the species' habitat requirements and habitat. This information has a direct bearing on accurately determining the conservation status and the need for management intervention.

4.4.8 Survey needs

Determine the local distribution and relative abundance of Central Otago geckos at key sites within their range.

Undertake searches for Central Otago geckos at the periphery of their range to determine the limits of their range and whether it abuts or overlaps with other taxa in the *Hoplodactylus maculatus* species complex.

4.4.9 Management actions

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

Verify that key populations are protected.

Action—Central Otago

4.4.10 Key literature

Hitchmough 1997; Rock 1999; Rock et al. 2000.

4.5 CROMWELL GECKO

4.5.1 Taxonomic status

Hoplodactylus sp. 'Cromwell'—see Hitchmough 1997.

An undescribed species presently contained within *H. maculatus* sensu Robb & Rowlands 1977 (see comments under 4.4.1).

A population of geckos on the Pisa Range differs morphometrically from populations to the north and south (being similar in some respects to Otago/Southland large geckos) but allozyme analysis has shown it to be a distinctive form of the Cromwell gecko (Jewell & McFarlane 1997; Hitchmough et al. 1998).

4.5.2 Description and habitat

A small- to medium-sized gecko (SVL to 75 mm) (Jewell & McFarlane 1997). Very difficult to distinguish from other species in the *Hoplodactylus maculatus* species complex, particularly the essentially parapatric taxa, Central Otago gecko and Southern Alps gecko. There is a significant difference in size between this species and the Otago/Southland large gecko, which is longer and up to 300% heavier. Nocturnal; terrestrial, primarily saxicolous. Inhabits creviced schist outcrops, bluffs and screes to at least 1,200 m; rarely found in dense vegetation or beneath loose bark on trees.

4.5.3 Distribution

Nation-wide—Restricted to Central Otago.

Otago Conservancy—Widely distributed in the western part of Central Otago in an area roughly bounded by Wanaka, Queenstown (Shotover River) and Clyde (Wanaka, Shotover, Remarkables, Lindis, Dunstan, Pisa and Old Man EDs) (Hitchmough 1997; Jewell & McFarlane 1997) (see Fig. 3). The range of the Cromwell gecko is completely surrounded by that of the Otago/Southland large gecko (see section 4.6), and abuts that of the Central Otago gecko at Clyde (see section 4.4) and the southern mini gecko on the northern end of The Remarkables (see section 4.8) (Rod Hitchmough pers. comm., October 2000), and it overlaps slightly with that of the Southern Alps gecko in the Wanaka district (see section 4.7) (Jewell & McFarlane 1997). Present on Ruby Island in Lake Wanaka (Jewell & McFarlane 1997).

Endemic to OC.

Known from Wanaka, Wakatipu and Central Otago Areas.

4.5.4 **Conservation status**

DOC threat classification NT); unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation Status within OC—Moderate

4.5.5 **Vulnerability**

Risk factors

- Range is restricted
- Populations at low elevations have become fragmented by agricultural development
- Occurs only in high density rabbit zone

Positive factors

- Large areas of habitat remain
- Locally abundant
- Present on at least one island—Ruby Island in Lake Wanaka (Jewell & McFarlane 1997)
- Montane habitats are at low risk of development

4.5.6 **Threats**

- Mainland populations exposed to full suite of introduced mammalian predators.

4.5.7 **Research needs**

Further investigate the genetic and taxonomic status of this taxon with respect to the other geckos in the *Hoplodactylus maculatus* species complex that occur in the Otago region, paying particular attention to the relationship between taxa at the boundary zones.

Formal description is required.

There are minor morphological differences between populations of this taxon that require more detailed investigation to determine their conservation significance (Jewell & McFarlane 1997).

Determine more precisely the species' habitat requirements and habitat. This information has a direct bearing on accurately determining the conservation status and the need for management.

Assess the population density and dynamics at one (or more) sites to determine the impact of introduced predators and competitors, and whether management intervention is required.

4.5.8 **Survey needs**

Determine more precisely the geographic and altitudinal limits of distribution.

4.5.9 Management actions

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

Verify that key populations are protected.

Action—Central Otago, Wanaka

4.5.10 Key literature

Hitchmough 1997; Jewell & McFarlane 1997.

4.6 OTAGO/SOUTHLAND LARGE GECKO

4.6.1 Taxonomic Status

Hoplodactylus sp. 'Otago/Southland large'—see Hitchmough 1997.

An undescribed species presently contained within *H. maculatus* sensu Robb & Rowlands 1977 (see comments under section 4.4.1).

This is the least clearly defined of the *Hoplodactylus maculatus* species complex geckos in the Otago region; it is also the most widespread and abundant. Allozyme data has revealed several distinct populations within this taxon (Hitchmough 1997) but despite this wide genetic variation—and a similarly wide variation in morphology and habitat—any further taxonomic division is not warranted at this stage. Recent re-evaluation of these taxa¹⁰—and the so-called 'Danseys Pass gecko'—suggest that together they form a ring cline that completely surrounds two related taxa with limited distributions in the middle of Central Otago (Rod Hitchmough pers. comm., August 2000). Thus, the current view is that *H. sp.* 'Central Otago' (see section 4.4) and *H. sp.* 'Cromwell' (see section 4.5) are parapatric taxa that are more or less surrounded by *H. sp.* 'Otago/Southland large'. The extremes of the ring cline—both morphologically and genetically—occur in the Kakanui Range/Danseys Pass area, hence the former belief that the geckos there were distinct taxa.

4.6.2 Description and habitat

Medium-sized gecko (SVL to 90 mm); body proportions vary across the species' range from moderate- to very robust. Markings usually bold, generally with pale transverse blotches on a dark, often almost black, background; belly generally speckled. Colouration also varies across the species' range—some populations relatively drab, others containing longitudinally marked individuals. Difficult to distinguish from other species in the *Hoplodactylus maculatus* species

¹⁰ Forms of the Otago/Southland large gecko sensu Hitchmough 1997 that are now included in this taxon are the 'western form', 'eastern form', and 'Kakanui form'. Other forms recognised at that time are now regarded as a distinct taxon, the Central Otago gecko.

complex. Nocturnal; terrestrial, saxicolous or arboreal. Occupies a very wide range of habitats from the littoral zone, forest (beech forest in west) and shrublands, creviced schist outcrops in tussock grasslands, sub-alpine screes and rock bluffs. The species is remarkable for an apparently unique biennial reproductive cycle in at least some populations (Cree & Guillette 1995).

4.6.3 Distribution

Nation-wide—Southern South Island, south of the Waitaki River to Stewart Island.

Otago Conservancy—Very widespread in OC south of the boundary between greywacke and schist, but apparently absent from central part of Central Otago (where it is replaced by the Central Otago gecko and Cromwell gecko) (see Figs 3 and 4). Northern limit of distribution is the Kakanui Mountains and Horse Range; elsewhere along the greywacke/schist boundary it borders the Southern Alps gecko. Present on some coastal (Wharekakahu Island, Green Island) and lake islands (Tree Island). OC is the northern limit of distribution.

Present in all Areas within OC.

4.6.4 Conservation Status

DOC threat classification GD (1/1: DP); unlisted by DOC for conservation priority¹¹; not on IUCN Red List.

Conservation status within OC—Moderate. Because the taxonomic status of some populations is equivocal it is prudent take a conservative approach for management.

4.6.5 Vulnerability

Risk factors

- Some distinctive populations have restricted distributions
- Populations at low elevation have become somewhat fragmented through habitat loss and modification
- Sensitivity to predation by introduced mammals through nocturnal habits and relatively large body size (Whitaker 1978)

Positive factors

- Widespread in OC
- Locally abundant
- Occupies a wide range of habitats
- Large areas of habitat are on protected land
- Habitat at high elevations is appears to be largely stable

4.6.6 Threats

- Species is exposed to full suite of introduced mammalian predators.

¹¹ The Danseys Pass population of this taxon was earlier recognised as being distinct and as such was accorded a Category B ranking on the basis of its restricted range.

- Habitat loss or modification. At low elevations agricultural development and afforestation continues to degrade habitat; localised threat from rock removal.

4.6.7 **Research needs**

Further investigate the genetic and taxonomic variation within this taxon throughout Otago (including the previously recognised ‘western’, ‘eastern’, ‘Danseys Pass’ and ‘Kakanui’ forms (Hitchmough 1997)) in comparison to the other geckos in the *Hoplodactylus maculatus* species complex that occur in the region and paying particular attention to the relationship between taxa at the boundary zones.

Formal description is required.

Determine more precisely the species’ habitat requirements and habitat. This information has a direct bearing on accurately determining the conservation status, and the need for habitat protection and management.

Assess the population density and dynamics at one (or more) sites to determine the impact of introduced predators and competitors, and whether management intervention is required.

4.6.8 **Survey needs**

Determine the northern and western limits of distribution.

Determine occurrence on coastal islands.

Central and western Otago mountains. Determine altitudinal limits of distribution.

4.6.9 **Management actions**

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and which are representative of each genotype and of the major habitats occupied by the species.

Tasks

Verify that the habitat of key populations of each genotype protected.

Verify that the habitat of key populations at the northern limit of distribution is protected.

Action—Coastal Otago, Central Otago, Wanaka, Wakatipu

4.6.10 **Key literature**

Hitchmough 1997; Wilson 1998; Rock 1999; Rock et al. 2000; Spencer 1991; Spencer & Grimmond 1994.

4.7 SOUTHERN ALPS GECKO

4.7.1 Taxonomic status

Hoplodactylus sp. 'Southern Alps'—see Hitchmough 1997.

An undescribed species presently contained within *H. maculatus* sensu Robb & Rowlands 1977 (see comments under section 4.4.1).

In the southern part of its range (south Canterbury and Otago), *H.* sp. 'Southern Alps' shows wide variation in allozymes, but not in DNA—suggesting recent founder effects and genetic drift (Hitchmough 1997, and pers. comm. 2001).

4.7.2 Description and habitat

A small (SVL to 66 mm) greyish-brown gecko, generally with paler cross-banding. Iris colour usually greenish. Nocturnal; primarily terrestrial, saxicolous. Usually inhabits talus slopes, screes and shattered outcrops in open montane environments. Occasionally arboreal in shrublands and at one site (Silver Island) is arboreal in beech forest (Jewell & McFarlane 1997).

4.7.3 Distribution

Nation-wide—Along the eastern side of the Southern Alps from southern Marlborough to northern Otago (Hitchmough 1997). South-western limit of range is the southern shore of Lake Wanaka (Hitchmough et al. 1998).

Otago Conservancy—Only in the north of OC, including the Hawkdun Range (to Little Mount Ida and Falls Dam) (Hawkdun ED), Lindis Pass (Lindis ED), and Wanaka district (Wanaka ED) (Hitchmough 1997; Jewell & McFarlane 1997; Hitchmough et al. 1998) (see Fig. 3). Also present on islands in Lake Hawea (Silver Island) and Lake Wanaka (Stevensons Island, Bull Island, Mou Waho, Mou Tapu) (Jewell & McFarlane 1997; Hitchmough et al. 1998).

Within OC, only in Central Otago and Wanaka Areas.

4.7.4 Conservation status

DOC threat classification NT; unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation Status within OC—Low

4.7.5 Vulnerability

Risk factors

- Some populations localised and isolated

Positive factors

- Widespread and locally abundant
- Area of potential habitat is vast
- Much of the species' range is on protected land
- At higher elevations most of the species' habitat is at little risk of development
- Species' preferred habitat offers a level of protection from introduced mammalian predators

- Present on some lake islands

4.7.6 Threats

None identified at present.

4.7.7 Research needs

Investigate the genetic and taxonomic status of the southern (Otago) populations of this taxon in comparison to others further north.

Formal taxonomic description is required.

4.7.8 Survey needs

Determine the southern and western limits of the species' range. In particular, searches should include montane areas between Lake Wanaka and Lake Wakatipu.

North Otago mountains: determine upper and lower altitudinal limits of distribution.

4.7.9 Management actions

Objectives

Secure the southern limits of distribution and to ensure several representative populations survive in the long-term.

Tasks

Verify that the habitat of key populations at the southern limit of distribution is protected.

Action—Wanaka

4.7.10 Key literature

Tocher 1992a, b, 1993; Hitchmough 1997; Jewell & McFarlane 1997; Hitchmough et al. 1998.

4.8 SOUTHERN MINI GECKO

4.8.1 Taxonomic status

Hoplodactylus sp. 'southern mini'—see Hitchmough 1997.

An undescribed species presently contained within *H. maculatus sensu* Robb & Rowlands 1977 (see comments under section 4.4.1).

Allozyme data shows that *H.* sp. 'southern mini' is clearly differentiated from the other taxa in the *Hoplodactylus maculatus* species complex that occur in southern New Zealand and is most closely related to the goldstripe gecko (*H. cbryosireticus*) in the North Island (Hitchmough 1997). No genetic variation has been detected throughout its range but specimens from the southern Garvie Mountains are slightly larger and with bolder longitudinal markings than those from elsewhere.

4.8.2 Description and habitat

A small (SVL to 60 mm), but relatively stocky gecko. Can be distinguished by its relatively drab, olive or greyish-brown colouration with longitudinal dark streaks; very short, broad toes, and shallow rostral scale. Nocturnal; saxicolous. Inhabits screes, rock piles and creviced outcrops in montane to subalpine tussock grassland.

4.8.3 Distribution

Nation-wide—Very restricted range in western Otago and Southland between Lake Wakatipu and the Oreti River.

Otago Conservancy—Confined to mountainous areas in the south-west of OC, including The Remarkables and Hector Mountains (Remarkables ED), Garvie Mountains and Slate Range (Nokomai ED), Eyre Mountains (Eyre ED), and Thomson Mountains (Livingstone ED) (see Fig. 3).

Within OC known only from Wakatipu and Central Otago Areas.

4.8.4 Conservation status

DOC threat classification RR; unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Moderate

4.8.5 Vulnerability

Risk factors

- Very restricted range
- Populations at low elevations have become somewhat fragmented by agricultural development

Positive factors

- Large areas of habitat remain
- Locally abundant
- Habitat, especially at higher levels, appears relatively stable
- A large part of its range is protected land

4.8.6 Threats

- Exposed to full suite of introduced mammalian predators
- Habitat loss or modification, especially at lower elevation, through afforestation and agricultural development; weed infestation (e.g. wildling conifers) is also a risk at some sites

4.8.7 Research needs

Formal taxonomic description is required.

Determine more precisely the species' habitat requirements and habitat. This information has a direct bearing on accurately determining the conservation status and the need for management.

Assess the population density and dynamics at one (or more) sites to determine the impact of introduced predators and competitors, and whether management intervention is required.

4.8.8 Survey needs

Determine the geographic and altitudinal limits of the species' range.

4.8.9 Management actions

Objectives

Secure the northern limits of distribution and to ensure several representative populations survive in the long-term.

Tasks

Verify that the habitat of key populations at the northern limit of distribution is protected.

Action—Central Otago, Wakatipu

4.8.10 Key literature

Hitchmough 1997.

4.9 JEWELLED GECKO

4.9.1 Taxonomic status

Naultinus gemmeus (McCann 1955)—see Bauer 1990, Hitchmough 1997 and Pringle 1998.

Populations of jewelled geckos in Canterbury—at least as far south as Lake Pukaki—are sexually dichromatic (males brown or grey, females green) whereas those in Otago and Southland are not. There are also minor differences in morphology and colouration (Hitchmough 1997). However, the suggestion that these populations might be taxonomically distinct (Meads 1982; Robb 1986) is unsupported by recent genetic research, based on material from Banks Peninsula, Hakataramea Pass (south Canterbury), and the Otago Peninsula, which detected no differences in the 16-s gene sequences (Pringle 1998) and only minor differences between Hakataramea and the other populations in allozymes (Hitchmough 1977). Furthermore, this genetic data showed that together these populations are the most divergent of all *Naultinus* species. Nonetheless, should future research show they are distinct the name *N. gemmeus* will apply to the taxon in Canterbury (the type locality is Rangiora) and that in Otago will require a new name.

4.9.2 Description and habitat

Moderate-sized gecko (SVL to 80 mm) characterised by bright green colouration, with or without white or pale dorso-lateral blotches or stripes, and a brilliant blue interior to the mouth (populations in Canterbury are sexually dichromatic, but this has not yet been recorded in OC). Diurnal; arboreal.

Inhabits shrubland and forest (including both lowland broadleaf and montane beech *Nothofagus*). Also found in seral shrubland (including kanuka *Kunzea ericoides* and manuka *Leptospermum scoparium*), matagouri (*Discaria toumatou*) shrubland, and in subalpine shrubland and sub-shrub vegetation up to ≈1,000 m. Has been reported from exotic woody vegetation, including gorse (*Ulex europaeus*) and pines (*Pinus* sp.).

4.9.3 Distribution

Nation-wide—Mid Canterbury to Stewart Island, east of the Southern Alps (Pickard & Towns 1988; Hitchmough 1997; HERPETOFAUNA).

Otago Conservancy—Throughout, but populations scattered and often localised (see Fig. 2). Most common in coastal Otago—northernmost record is the Kakanui Range (Waianakarua ED); the southernmost is Nuggets Point (Tahakopa ED); inland records are scarce, but the species is reported more frequently from the eastern foothills of the Southern Alps than Central Otago. Jewelled geckos are particularly widely distributed and abundant on Otago Peninsula (Dunedin ED), which remains one of the strongholds for the species. Not recorded from lake islands.

Present in Coastal Otago, Central Otago and Wanaka Areas; ‘green geckos’—probably jewelled geckos—are also known from Wakatipu Area.

4.9.4 Conservation status

DOC threat classification GD (1/1: HD); unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Moderate

4.9.5 Vulnerability

Risk factors

- Range has become fragmented through the loss of lowland forest and shrubland habitats
- Some populations are small and isolated
- Appeal to the illegal pet trade

Positive factors

- Widely distributed
- Large areas of habitat remain
- Able to occupy seral habitats such as regenerating manuka or kanuka shrubland
- Present at a number of protected sites
- Relatively high population densities at some sites on Otago Peninsula

4.9.6 Threats

- Exposed to full suite of introduced mammalian and avian predators
- Large areas of low-altitude, seral shrubland habitat being lost to exotic forestry or cleared for agriculture

- Montane shrubland habitats burned for pastoral farming
- Urban development on Otago Peninsula and the periphery of Dunedin is causing accelerated habitat loss and probably increased predation (domestic cats)

4.9.7 **Research needs**

Determine more precisely the species' habitat requirements and habitat. This information has a direct bearing on accurately determining the conservation status and the need for management.

Assess the population density and dynamics at two (or more) sites to determine the seriousness of the threat from introduced predators and competitors, and whether management intervention is required. One of these sites should be the Every Scientific Reserve, on Otago Peninsula, where a predator-proof fence excludes all mammals except for mice.

Continue investigations into the genetic and morphometric status of animals in Otago with particular reference to:

- Their relationship to Canterbury populations, especially with respect to the southern limit of dichromatism
- The relationship of the eastern (coastal) and western (Southern Alps) populations in OC
- The relationship to the Southland populations

4.9.8 **Survey needs**

Central Otago—Records of green geckos from Central Otago are very scarce and are unsupported by specimens or photographs to confirm the identity. Need to identify at least one population that can be protected (if it is not already on protected land).

Queenstown—The identity of green geckos reported from the Queenstown region (Whitaker 1986a) and eastern Fiordland needs to be substantiated, and need to determine that at least one population is on protected land.

Otago Peninsula—The Otago Peninsula is nationally a significant area for the conservation of jewelled geckos. Although the species is widespread on the peninsula, and local population densities are relatively high, the habitat at many sites is not protected. The current status of the gecko populations and their habitat (both habitat health and protection level) at all known sites needs to be re-assessed. (Compare with the survey undertaken in 1992 by Duggan & Cree 1992.)

Wanaka/Hawea district—Need to determine that at least one population is on protected land.

Catlins Coast—All records of green geckos from south-eastern Otago and eastern Southland are >30 years old. The specific identity and current status of these populations needs to be determined.

4.9.9 Management actions

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

Establish long-term monitoring of two (or more) populations on the Otago Peninsula, one of which should be the Every Scientific Reserve.

Eradicate all remaining mammals, apart from mice, from the enclosure at Every Scientific Reserve and ensure the boundary fence is properly maintained and secure. Investigate option of making boundary fence mouse-proof or undertaking control of mouse population.

Ensure key populations are protected to secure the full geographic range of jewelled geckos within OC.

Action—Coastal Otago, Central Otago, Wanaka, Wakatipu

4.9.10 Key literature

Duggan 1991; Duggan & Cree 1992; Chambrone 1994; Shaw 1994; Hitchmough 1997; Pringle 1998; Wilson 1998; Schneyer 2001.

4.10 GREEN SKINK

4.10.1 Taxonomic status

Oligosoma chloronoton (Hardy 1977)—see Hardy 1977

Oligosoma chloronoton (Hardy 1977) is very difficult to distinguish from *Oligosoma lineoocellatum* (Duméril & Duméril 1851), with which it appears to be parapatric in South Canterbury. Genetic studies (allozymes and DNA) have revealed differences between these taxa (Hardy 1977; Hay 1998), but as they are based on very limited material their meaning is unclear. It is possible that the *O. chloronoton/O. lineoocellatum* complex contains other cryptic species.

4.10.2 Description and habitat

Large, robust skink (SVL to 125 mm) characterised by a bright green dorsal surface lacking a mid-dorsal stripe and conspicuously marked with black-edged, pale green flecks. Underside grey, throat speckled. Diurnal; terrestrial. Inhabits a wide range of [generally] well-vegetated, open habitats from the coast to at least 1,700 m. Sites include small rocky islands, supra-littoral vegetation on rocky and sandy shores, pastureland, tussock grassland, sub-alpine grassland and herbfields, boulder-banks.

4.10.3 Distribution

Nation-wide—Localised and patchy distribution from South Canterbury (Waitaki Basin) to Stewart Island and surrounding islands (Hardy 1977; Pickard & Towns 1988).

Otago Conservancy—Widespread, but localised, throughout OC east of the Main Divide (Hardy 1977; Pickard & Towns 1988) (see Fig. 5). Not known from lake islands, but recorded from Wharekakahu Island, Otago Peninsula.

Paratype from Clinton (Waipahi ED) (Hardy 1977).

Present in all Areas within OC.

4.10.4 **Conservation status**

DOC threat classification GD (1/1: HD); unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Moderate

4.10.5 **Vulnerability**

Risk factors

- Complex and unresolved genetic diversity
- Relatively few populations on mainland
- Populations very isolated and localised
- Large body size increases risk of predation (Whitaker 1978)

Positive factors

- Very wide distribution
- Large areas of potential habitat available
- Some populations occur on protected land
- Habitats at high elevation appear to be relatively stable
- Present on some predator-free islands

4.10.6 **Threats**

- Unresolved taxonomy (meaning restricted cryptic species could be at risk)
- Mainland populations exposed to full suite of introduced mammalian and avian predators
- Populations at low elevations at risk to habitat modification or loss to exotic forestry and agricultural development
- Tussock grassland fires (Patterson 1984)

4.10.7 **Research needs**

Taxonomic research—the *O. chloronoton*/*O. lineocellatum* complex is the least understood of all New Zealand lizard complexes.

Determine the species' precise habitat requirements and habitat in order to better assess its vulnerability and the threats it faces.

Assess population density and dynamics at one (or more) mainland sites to determine effects of introduced predators and whether management intervention is required.

Assess population density and dynamics on Wharekakahu Island.

4.10.8 **Survey needs**

Broad-scale surveys to better understand the distribution and frequency of green skink populations in OC.

Localised surveys to more accurately determine the size and extent of populations at key sites.

Survey islands along the Otago coast to locate new populations. Currently the species is known only from Wharekakahu Island.

Confirm identification and determine the current status of population reported from Queenstown area (Whitaker 1986a).

Determine altitudinal limits of distribution.

4.10.9 **Management actions**

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

Verify that the habitat of key populations is protected.

Monitor 2–3 key populations.

Action—Coastal Otago, Central Otago, Wanaka, Wakatipu

4.10.10 **Key literature**

Hardy 1977.

4.11 GRAND SKINK

4.11.1 **Taxonomic status**

Oligosoma grande (Gray 1845)—see Hardy 1977.

No significant morphometric differences have been detected between populations of grand skinks. Preliminary genetic studies did not detect genetic differentiation between the eastern and western populations of grand skinks despite their wide geographical separation and—presumably—long isolation (Daugherty 2000).

4.11.2 **Description and habitat**

Large (SVL to 110 mm, 27 g); characterised by black colouration with numerous cream or golden flecks arranged longitudinally and by relatively small body scales (40–51 MSR). Diurnal, heliothermic, saxicolous. Occupies deeply creviced schist outcrops in montane tussock grasslands (350–950 m); in very rocky areas occasionally found beneath loose stones on the soil surface.

4.11.3 Distribution

Nation-wide—Known only from the Central Otago region and presumed to have always been restricted to this area (Hardy 1977; Whitaker & Loh 1995).

Otago Conservancy—Early museum specimens show that grand skinks were once widespread in Central Otago (Hardy 1977, Whitaker & Loh 1995). Extant populations are known only from two areas—in the east between Macraes Flat and Pukerangi (Macraes, Waipori and Maniototo EDs), and in the west between Lindis Pass and Lake Hawea (Lindis ED) (see Fig. 5). The current range covers ≈8% of the former range (Whitaker & Loh 1995).

Type locality not known (Hardy 1977).

Endemic to OC; only in Coastal Otago and Wanaka Areas.

4.11.4 Conservation status

DOC threat classification NE (B1/1: CD, HI); Category A ranking by DOC; VU (C2a) on the IUCN Red List on the basis of the small and isolated nature of the populations and their continuing decline.

Conservation status within OMC—High

4.11.5 Vulnerability

Risk factors

- Populations are highly fragmented into very small sub-populations by the patchy nature of the rock outcrop habitat they occupy, and the skinks have to regularly move across unfavourable habitat for the metapopulation to survive.
- Most populations appear to be small and isolated placing them at risk to stochastic events.
- Relatively large body size means they are less able to evade predators than small lizard species (Whitaker 1978).
- All populations are in places infested with rabbits and where mammalian predator numbers are relatively high, thus greatly increasing the skinks risk to predation (Norbury 2001).
- Many populations, including all those in the west near Lindis Pass, are on private land.

Positive factors

- In the east near Macraes Flat large areas of habitat, containing the largest grand skink populations, have been reserved and are being managed specifically for the conservation of the species.
- Local population densities at some sites are high.
- Extensive areas of potential habitat occur throughout Central Otago.

4.11.6 Threats

- Habitat degradation from agricultural development, including burning of tussock grassland, fertiliser application and over-sowing, cultivation, and increased subdivision and higher stocking densities (Whitaker & Loh 1995; Whitaker 1996).

- Predation by introduced species, particularly feral cats and mustelids. Other potentially serious predators abundant within grand skink habitat include magpies (Whiting 1996), starlings (Thompson 2000), hedgehogs (Anon. 1999; Sluijs & Spitzen 2000), and mice (Newman 1986, 1994).
- Competition for fleshy fruits from introduced birds and mammals.
- Habitat degradation through colonisation by introduced woody weed species, e.g. barberry (*Berberis* spp.), briar (*Rosa rubiginosa*), and broom (*Cytisus scoparius*).
- Habitat loss to mining or plantation forestry.
- Exposure to toxic baits during pest control and/or increased predation resulting from prey-switching by introduced mammals following pest control (Spurr 1993; Freeman et al. 1996; Brown & Keedwell 1998; Norbury 2001).
- Localised habitat degradation from human disturbance—collection of decorative stone and destruction of microsites when seeking lizards.

4.11.7 **Research needs**

Determine genetic status of eastern and western populations.

Collect basic data on the size and dynamics of populations to more accurately assess the species' conservation status

Define key elements of habitat.

Determine the impact of introduced predators.

Determine impact of different grazing regimes and land management.

Develop accurate and appropriate survey and monitoring techniques.

4.11.8 **Survey needs**

The periphery of the species' range to more accurately define the limits of distribution, including sites where the species is poorly known, to confirm current status of the population (e.g. Breast Hill (Lake Hawea) (Roberts 1984), Sutton Stream (Whitaker 1987b), Taieri Ridge (Whitaker 1988a, 1992), Kyeburn (HERPETOFAUNA)).

Sites from which the species has been recorded in the past—in particular, this includes The Remarkables (Remarkables ED) and the Warrington district (Waikouaiti ED) (Hardy 1977; Whitaker 1986b).

Localised surveys to more accurately determine the size and extent of populations at key sites.

Follow up all reports of grand skinks from localities where they are not currently known.

4.11.9 **Management actions**

Objectives

Ensure the continued survival of grand skink populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Improve the conservation status (IUCN and DOC) of grand skinks through active management of selected sites to enhance local populations.

Tasks

Finalise the second edition of the Species Recovery Plan (see Whitaker in prep. on page 4) and the Captive Management Plan (Tocher, M.; Kean, M. in prep. Management plan for captive Otago skinks and grand skinks.), and proceed with their implementation. Until these new plans take effect, implementation of the recommendations in the existing SRP (Whitaker & Loh 1995) should continue.

Monitor populations at 2–3 key ‘indicator’ sites in both the eastern and western parts of the species’ range.

Continue the programme of habitat protection, particularly with respect to the populations in the Lindis/Lake Hawea district (which represent the western limit of distribution) and to secure the limits of distribution in the east.

Implement appropriate management of the habitat at protected sites including (but not limited to) predator and weed control, and grazing regimes.

Develop contingency plans to address predation or weed issues, or irregular events such as wild fires, should they arise unexpectedly.

Investigate the potential for ‘mainland island’-type management of part of the land protected for skink conservation at Macraes Flat, and the potential to extend such a programme to the Lindis Pass district if land protection issues are resolved.

Identify lake islands (Lake Wanaka or Lake Wakatipu) that could be used for the establishment of a translocated population, if deemed necessary, and develop translocation protocols.

Implement an advocacy programme to raise public awareness of the significance and conservation status of grand skinks.

Action—Coastal Otago and Wanaka

4.11.10 Key literature

Towns et al. 1984; Towns 1985; Preest 1985; Patterson 1992a; Rebergen 1993; Murphy 1994; Murphy & Loh 1995; Whitaker & Loh 1995; Whitaker 1996; Coddington & Cree 1997; Stanley 1998; Tocher 1998a; Wilson 1998; Eifler & Eifler 1999a, b; McFarlane 1999; Daugherty 2000; Marshall 2000; Houghton 2000; Houghton & Linkhorn 2002; Tocher & Kappers in press.

4.12 CRYPTIC SKINK

4.12.1 Taxonomic status

Oligosoma inconspicuum (Patterson & Daugherty 1990)—see Patterson & Daugherty 1990.

Formerly included with *Oligosoma maccanni* and *O. nigriplantare polychroma* in the *Leiolopisma nigriplantare* species complex under the name *L. nigriplantare maccanni* sensu Hardy 1977 and, prior to that, within

Leiopisma zelandica sensu McCann 1955 (Daugherty et al. 1990) For this reason the identity of many skinks in literature and HERPETOFAUNA records from Otago and Southland is unclear, particularly as two or more of these taxa often occur sympatrically.

4.12.2 Description and habitat

A small (SVL to 70 mm) brown, striped skink. Can be difficult to distinguish from McCann's skink and common skink, with which it is sympatric, but colouration usually 'chestnut' brown with speckled dorsal surface. Underside yellow in adults, with speckled throat. Diurnal; terrestrial. Usually inhabits damp, densely-vegetated microsites in grassland, herbfields and open shrublands from the supra-littoral zone to at least 1,700 m.

4.12.3 Distribution

Nation-wide—Otago and Southland, including islands on north side of Foveaux Strait.

Otago Conservancy—Widespread, but localised, throughout OC east of the Main Divide (see Figs 6 and 7). Present on Tree Island (Lake Wakatipu) (Richardson ED) (Patterson & Daugherty 1990).

Type locality—Tree Island, Lake Wakatipu (Richardson ED) (Patterson & Daugherty 1990).

Present in all Areas within OC.

4.12.4 Conservation status

DOC threat classification GD (1/1: DP, HI); unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Moderate

4.12.5 Vulnerability

Risk factors

- Populations often isolated and localised.

Positive factors

- Widespread and occupying a wide range of habitats
- Present in many areas where the land is protected
- Occurs on at least one lake island—Tree Island—plus several islands in Foveaux Strait

4.12.6 Threats

- Mainland populations exposed to the full suite of introduced mammalian predators
- Mainland habitats at low elevation are at risk of modification or loss to exotic forestry and agricultural development
- Tussock grassland fires (Patterson 1984)

4.12.7 **Research needs**

None identified at present.

4.12.8 **Survey needs**

Determine more precisely the northern and altitudinal limits of distribution.

Coastal and lake islands.

4.12.9 **Management actions**

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

Verify that the habitat of key populations is protected.

Monitor 2–3 key populations.

Action—Coastal Otago, Central Otago, Wanaka, Wakatipu

4.12.10 **Key literature**

Patterson 1992b; Patterson & Daugherty 1990.

4.13 MCCANN'S SKINK

4.13.1 **Taxonomic status**

Oligosoma maccanni (Hardy 1977)—see Patterson & Daugherty 1990.

Formerly included with *Oligosoma inconspicuum* and *O. nigriplantare polychroma* in the *Leiolopisma nigriplantare* species complex under the name *L. nigriplantare maccanni* sensu Hardy 1977 and prior to that, within *Leiolopisma zelandica* sensu McCann 1955 (Daugherty et al. 1990) For this reason the identity of many skins in literature and HERPETOFAUNA records from the southern part of the South Island is unclear, particularly as two or more of these taxa often occur sympatrically.

4.13.2 **Description and habitat**

Small (SVL to 73 mm), brown, striped skink. Often difficult to distinguish from the common skink and the cryptic skink. Colouration is highly variable but within OC usually has a prominent 'checker-board' pattern on dorsal surface. Diurnal; terrestrial. Occurs only in open habitats, usually occupying dry, rocky environments. Especially abundant in montane grassland.

4.13.3 **Distribution**

Nation-wide—East side of the Main Divide from mid-Canterbury (Banks Peninsula) to Southland (Patterson & Daugherty 1990).

Otago Conservancy—Occurs throughout OC from sea-level to at least 1,500 m (see Figs 6 and 7). Not recorded from any lake islands.

Type locality 30 km west of Ranfurly (Maniototo ED) (Hardy 1977; Patterson & Daugherty 1990).

Present in all Areas within OC.

4.13.4 **Conservation status**

DOC threat classification NT; unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Low

4.13.5 **Vulnerability**

Risk factors

None identified at present.

Positive factors

- Very widespread and common in OC
- Local population densities can be very high
- The total extent of potential habitat in Otago is vast
- Present in many localities that have protected status
- Can survive in some highly modified habitats

4.13.6 **Threats**

- Exposed to the full suite of introduced mammalian and avian predators
- There is a risk of significantly enhanced predation levels if RHD or other pest control measures lead to prey-switching by cats or mustelids (Brown & Keedwell 1998; Norbury 2001)
- Habitat loss to intensive agricultural development
- Tussock grassland fires (Patterson 1984)

4.13.7 **Research needs**

None identified at present.

4.13.8 **Survey needs**

None identified at present.

4.13.9 **Management actions**

Objectives

Ensure continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

None identified at present.

Action—N/A

4.13.10 **Key literature**

Patterson 1985, 1992b; Patterson & Daugherty 1990; Spencer 1991; Spencer & Grimmond 1994; Wilson 1998.

4.14 COMMON SKINK

4.14.1 **Taxonomic status**

Oligosoma nigriplantare polychroma (Patterson & Daugherty 1990)—see Hardy 1977 and Patterson & Daugherty 1990

Formerly included with *Oligosoma inconspicuum* and *O. maccanni* in the *Leiolopisma nigriplantare* species complex under the name *L. nigriplantare maccanni* sensu Hardy 1977 and, prior to that, within *Leiolopisma zelandica* sensu McCann 1955 (Daugherty et al. 1990) For this reason the identity of many skinks in literature and HERPETOFAUNA records from the southern part of the South Island is unclear, particularly as two or more of these taxa often occur sympatrically.

In a genetic analysis of 19 common skink populations from throughout its geographic range, the five sites sampled in OC—Eyre Mountains, Alexandra area (3 sites), Rock and Pillar Range—clustered closely and showed little variation in allozymes, morphology or colouration (Daugherty et al. 1990). The Otago populations were grouped with those from Canterbury, but differed markedly from populations further north in the South Island and in the North Island. Furthermore, the variation shown throughout the very wide geographic range of the common skink indicated that more detailed genetic analysis might reveal the presence of further cryptic species (Daugherty et al. 1990).

4.14.2 **Description and habitat**

Small (SVL to 76 mm), brown, striped skink characterised by a blunt snout and unmarked, (usually) yellow underside. Frequently difficult to distinguish from the cryptic skink and McCann's skink but all OC populations are distinctively marked with prominent, straight-edged, longitudinal markings, including a mid-dorsal stripe that extends along the tail. Diurnal; terrestrial. Occupies a very wide range of generally open habitats up to 1,800 m including small rocky islets, littoral and supralittoral zones, driftwood on sandy beaches, grasslands, shrublands, rocky sites, and subalpine grasslands and herbfields. Where it is sympatric with McCann's skink and the cryptic skink it generally occupies dry grassland (cf. dry rocky or damp densely-vegetated microsites, respectively). It is one of the few lizard species to readily adapt to urban and farmland environments.

4.14.3 **Distribution**

Nation-wide—Central North Island (roughly south of a line from Gisborne to Turangi to southern Taranaki) southwards to Stewart Island (Pickard & Towns 1988; Patterson & Daugherty 1990).

Otago Conservancy—Occurs throughout OC except for high alpine areas (>1,800 m) and densely forested ranges (e.g. Catlins Forest Park), although in the latter it is often present along open river margins (see Figs 6 and 7). Less common in the very arid areas where it is replaced by McCann's skink.

Present in all Areas within OC.

4.14.4 **Conservation status**

DOC threat classification NT; unlisted by DOC for conservation priority; not on IUCN Red List.

Conservation status within OC—Low

4.14.5 **Vulnerability**

Risk factors

None identified at present.

Positive factors

- Very widespread in OC
- Occupies a wide range of habitats
- Able to occupy highly modified habitats (e.g. farmland, urban environments)
- Local population densities can be very high
- Present in many localities that have protected status
- Present on some coastal and lake islands, including predator-free islands

4.14.6 **Threats**

- Mainland populations are exposed to the full suite of introduced mammalian predators
- There is a risk of significantly enhanced predation levels if RHD or other pest control measures lead to prey-switching by cats or mustelids (Brown & Keedwell 1998; Norbury 2001)
- Loss of habitat to exotic forestry and intensive agricultural development
- Tussock grassland fires (Patterson 1984)

4.14.7 **Research needs**

None identified at present.

4.14.8 **Survey needs**

None identified at present.

4.14.9 **Management actions**

Objectives

Ensure the continued survival of populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Tasks

None identified at present.

Action—N/A

4.14.10 Key literature

Hardy 1977; Patterson 1985, 1992b; Patterson & Daugherty 1990.

4.15 OTAGO SKINK

4.15.1 Taxonomic status

Oligosoma otagense (McCann 1955)—see Hardy 1977 and Patterson 1997.

No significant morphometric differences have been detected between populations of Otago skinks. The wide geographical separation and presumably long isolation of the eastern and western populations means genetic differentiation between these regions is possible although this has not yet been investigated.

4.15.2 Description and habitat

Very large and robust (up to 130 mm SVL, 46 g); characterised by black colouration with prominent cream, yellowish or greenish transverse blotches and by small body scales (46–72 MSR). Extent of pale markings varies widely (from almost totally black to very pale individuals); markings always much more prominent on juveniles. Diurnal, heliothermic, saxicolous. Occupies deeply creviced schist outcrops and bluffs in montane tussock grasslands (200–960 m), most commonly along valley sides.

4.15.3 Distribution

Nation-wide—Presently known only from Central Otago (Whitaker & Loh 1995, Patterson 1997); there is an unconfirmed report from the Hokonui Hills in central Southland (Hokonui ED) (Thomas 1982; Roberts 1999)

Otago Conservancy—Early records and museum specimens show that Otago skinks were once widespread in Central Otago (Hardy 1977, Whitaker & Loh 1995, Patterson 1997). Extant populations are known only from two areas—in the east between Hyde and Macraes Flat in the north to Pukerangi and the southern Rock and Pillar Range in the south (Macraes, Waipori and Maniototo EDs), and in the west between Lindis Pass and Lake Hawea (Lindis ED) (see Fig. 5). The current range covers »8% of the former range (Whitaker & Loh 1995).

Type locality is ‘Otago’ but the exact locality is unknown (Hardy 1977; Patterson 1997).

Within the OC, now occurs only in the Coastal Otago and Wanaka Areas.

4.15.4 Conservation status

DOC threat classification NE (B1/1: CD, HI); Category A ranking by DOC; VU (C2a) on the IUCN Red List largely on the basis of the small and isolated nature of the populations.

Conservation status within OC—High.

4.15.5 Vulnerability

Risk factors

- Most populations appear to be small and isolated placing them at risk to stochastic events.
- Large body size means they are less able to evade predators than small lizard species (Whitaker 1978).
- All populations are in places infested with rabbits and where mammalian predator numbers are relatively high, thus greatly increasing the skinks risk to predation (Norbury 2001).
- Many populations, including all those in the west near Lindis Pass, are on private land.

Positive factors

- Large areas of habitat in the east near Macraes Flat, containing the largest Otago skink populations, have been reserved and are being managed specifically for the conservation of the species.
- Local population densities at some sites are high.
- Extensive areas of potential habitat occur throughout Central Otago.
- Known to occur at some sites that have experienced extreme anthropogenic changes in the past, e.g. Nenthorn.

4.15.6 Threats

- Habitat degradation from agricultural development, including burning of shrubland and tussock grassland, fertiliser application and over-sowing, cultivation, and increased subdivision and higher stocking densities (Whitaker & Loh 1995)
- Predation by introduced species, particularly feral cats and mustelids; other potentially serious predators present within the habitat of Otago skinks include magpies (Whiting 1996), starlings (Thompson 2000), hedgehogs (Anon. 1999; Sluijs & Spitzen 2000), and mice (Newman 1986, 1994)
- Competition for fleshy fruits from introduced birds and mammals
- Habitat degradation by shrubby weed encroachment on to outcrops at some sites; for example, barberry (*Berberis* spp.), briar (*Rosa rubiginosa*), broom (*Cytisus scoparius*) and thyme (*Thymus vulgaris*) are widespread and serious weeds, in many places colonising outcrop habitats, leading to shading
- Habitat loss to mining or plantation forestry
- Exposure to toxic baits during pest control and/or increased predation resulting from prey-switching by introduced mammals following pest control (Spurr 1993; Freeman et al. 1996; Brown & Keedwell 1998; Norbury 2001)

- Localised habitat degradation from human disturbance; for example, collection of decorative stone and destruction of microsites when seeking lizards
- Illegal capture—the rapidly escalating, illegal, international trade in reptiles means that the large and colourful Otago skink must be considered a potential target

4.15.7 **Research needs**

Determine genetic status of eastern and western populations.

Collect basic data on the size and dynamics of populations to more accurately assess the species' conservation status

Define key elements of habitat.

Determine the impact of introduced predators.

Determine impact of different grazing regimes and land management.

Develop accurate and appropriate survey and monitoring techniques.

4.15.8 **Survey needs**

The periphery of the species' range to more accurately define the limits of distribution.

Sites from which the species has been recorded in the past—in particular this includes Patearoa (Rock and Pillar ED), Alexandra district (Old Man ED), Rough Ridge (Manorburn ED) and Queenstown (Shotover ED) (Beattie n.d.; Bathgate 1922; Hardy 1977; Whitaker 1986a).

Localised surveys to more accurately determine the size and extent of populations at key sites.

Follow up all reports of Otago skinks from localities where they are not currently known.

4.15.9 **Management actions**

Objectives

Ensure the continued survival of Otago skink populations at sites that secure the full geographic range and are representative of the major habitats occupied by the species.

Improve the conservation status (IUCN and DOC) of Otago skinks through active management of selected sites to enhance local populations.

Tasks

Finalise second edition of Species Recovery Plan (Whitaker in prep.) and the Captive Management Plan (Tocher & Kean in prep.), and proceed with their implementation. Implementation of the recommendations in the existing SRP (Whitaker & Loh 1995) should continue until these new plans take effect.

Monitor populations at 2–3 key 'indicator' sites in both the eastern and western parts of the species' range.

Continue the programme of habitat protection, particularly with respect to the populations in the Lindis district (which represent the western limit of distribution) and to secure the limits of distribution in the east.

Implement appropriate management of the habitat at protected sites including (but not limited to) predator and weed control, and grazing regimes.

Develop contingency plans to address predation and weed issues, or irregular events such as wild fires, should they arise unexpectedly.

Investigate the potential for 'mainland island'-type management of part of the land protected for skink conservation at Macraes Flat, and the potential to extend such a programme to the Lindis Pass district if land protection issues are resolved.

Identify lake islands (L Wanaka or Lake Wakatipu) that could be used for the establishment of a translocated population, if deemed necessary, and develop translocation protocols.

Implement an advocacy programme to raise public awareness of the significance and conservation status of grand skinks.

Action—Coastal Otago and Wanaka

4.15.10 Key literature

Towns et al. 1984; Towns 1985; Preest 1985; Patterson 1992a; Rebergen 1993; Whitaker & Loh 1995; Coddington & Cree 1997; Tocher 1998a; Wilson 1998; McFarlane 1999; Marshall 2000; Houghton 2000; Houghton & Linkhorn 2002; Tocher & Kappers in press.

4.16 SCREE SKINK

4.16.1 Taxonomic status

Oligosoma waimatense (McCann 1955)—see Patterson 1997.

Preliminary genetic studies have shown the only Otago population tested (Mount Ida) is clearly distinct from two populations further north (Tekapo and Wairau), perhaps at the specific level (Daugherty 2000). Significant colour variations occur in some South Canterbury populations but such divergence is not apparent in any populations in OC.

4.16.2 Description and habitat

Large (up to 110 mm SVL); characterised by a greyish or fawn colouration with transverse black markings, often forming bands, and small body scales (50–68 MSR). Diurnal; terrestrial, saxicolous. In Otago is known only from active greywacke screes in montane tussock grasslands (800–1,250 m), but further north in its range is known from elevations between 400–1,600 m and also from subalpine greywacke outcrops and bluffs, and rarely limestone screes and talus slopes.

4.16.3 **Distribution**

Nation-wide—South Island along the eastern side of the Southern Alps from north-eastern Marlborough to north Otago (Patterson 1997); there are unconfirmed reports from the Takitimu Mountains in Southland (Roberts 1999).

Otago Conservancy—Known from just two localities in OC—on the Ida Range near Naseby (Hawkdun ED) (Whitaker 1985b) and the adjacent St Bathans Range (St Bathans ED) (Whitaker & Loh 1990) (see Fig. 5). These are the southernmost known populations of the species.

Within the OC, occurs only in the Central Otago Area.

4.16.4 **Conservation status**

DOC threat classification GD (1/1: HI); Category B ranking by DOC; VU (B1/B2b, d) on the IUCN Red List largely on the basis of the small and isolated nature of the populations.

Conservation status within OC—High

4.16.5 **Vulnerability**

Risk factors

- Most populations appear to be small and isolated leaving them at risk to stochastic events
- Most populations in OC are on private land or crown lease
- Large body size means they are less able to evade predators than are smaller lizard species (Whitaker 1978)

Positive factors

- The area of potential habitat in the mountain ranges of North Otago appears to be extensive and in many places contiguous scree habitat covers many hundreds of hectares
- The habitat at higher elevations appears to be relatively stable
- The habitat does not at present have agricultural or forestry potential

4.16.6 **Threats**

- Populations are exposed to the full suite of introduced mammalian predators
- Weed encroachment on to scree habitat. Near Naseby wildling pines (*Pinus* spp.) are invading scree skink habitat, leading to stabilisation, shading, and hastening re-vegetation by other species
- Damage to screes by livestock

4.16.7 **Research needs**

Basic data on the size and dynamics of populations are needed to more accurately assess the species' conservation status.

Assessment of the impact of introduced predators and the need for predator control.

Determine habitat use and requirements.

4.16.8 Survey needs

Broad-scale surveys to better understand the distribution and frequency of scree skink populations in OC, particularly in relation to the limits of distribution in the south and west.

Localised surveys to more accurately determine the size and extent of populations at key sites.

4.16.9 Management actions

Objectives

Ensure that several populations, representative of the geographic range and the variety of habitats occupied, survive in the long-term.

Secure the southern limit of distribution of scree skinks.

Tasks

Seek protected status for the land on which scree skink populations occur.

Monitor scree skink populations at 2-3 key (indicator) sites, with a view to management intervention if necessary.

Develop a contingency plan for predator management at key sites should the need be demonstrated or suddenly arise through some irregular event (e.g. prey-switching following sudden decline in mammalian prey).

Undertake weed assessments and develop weed control plans for key sites at which scree skinks occur.

Action—Central Otago

4.16.10 Key literature

Preest 1985; Patterson 1997; Daugherty 2000.

5. Conclusions

The lizard fauna of OC is not large yet it has the greatest proportion of species that are confined to the mainland and a species richness of both *Oligosoma* and *Hoplodactylus* that is amongst the highest. Three species in the conservancy are regarded as seriously at risk and are ranked by DOC and the IUCN for immediate conservation management. Although some lizard sites (e.g. Macraes Flat) and species (e.g. Otago/Southland large gecko, jewelled gecko, Otago skink, grand skink) are amongst the best studied in the country, many species in the conservancy are poorly known and data on lizard distribution and abundance for much of the region is deficient. Clearly further research and survey work is needed to determine the true conservation status of many lizard species and the need for management action.

Conservation management of lizard species and populations in OC is challenging because it has to focus almost entirely on mainland sites and habitats—the conservancy largely lacks the opportunities for conservation based on predator-free islands that are present in many other conservancies. For many lizard species in OC large areas of habitat are theoretically protected within the DOC estate, yet the presence of browsing mammals and weeds means these habitats are far from secure. Furthermore, most protected areas are at higher altitude and/or in high rainfall areas, sites that do necessarily provide the best safeguards for the lizard fauna. Lizard species on private land, including some highly threatened taxa such as Otago skinks and grand skinks, face on-going and widespread habitat loss or degradation from agricultural or forestry development, and from closer settlement. Irrespective of land tenure, all mainland lizard populations are exposed to the full suite of introduced predators and competitors, and the effect of these on lizard species and populations is not understood. To guarantee their continued survival some lizard species will clearly require very specific management programmes, for others all that is required at this stage is that a ‘watching brief’ is kept of their status.

In OC there are limited opportunities to manage lake islands for the conservation benefit of lizards. Five islands are sufficiently remote that eradication of mammalian predators would be effective for all but stoats, but even stoats could be virtually eliminated with sustained control (*cf.* Maud Island). If predators are removed from these islands spectacular increases in the abundance of resident lizard species could be expected and the way would be cleared to restore the full diversity of the Otago lizard fauna at those sites. However, as these islands are relatively close to shore—and are open to the public—vigilance will be required ensure introduced predators do not re-establish, and contingency plans must be prepared and staff ready for action in the event that they do.

This action plan identifies a number of actions that are considered crucial for assessing the status of and preserving the lizard fauna in OC. These actions include:

- Research to determine the taxonomic diversity of the lizard fauna and to fully understand those aspects of the species’ biology and ecology relevant to their conservation

- Surveys to accurately determine the distribution and abundance of the lizard species
- Management activities relevant to the conservation of those species that require them

The most important actions in each category, in priority order, are listed below.

5 . 1 R E S E A R C H

1. Habitat and population studies of rare and threatened species
2. Investigation of the impacts on lizard populations of predation and competition by introduced species
3. Investigation of the impact on lizard populations of habitat degradation through weed incursion, agricultural development, farm management practices, and closer settlement
4. Use genetic techniques to re-assess the taxonomic status of different populations of widespread, variable species and to interpret hybridisation zones of closely-related, parapatric taxa
5. Formal description and naming of the un-named taxa in the *Hoplodactylus maculatus* and *H. granulatus* cryptic-species complexes

5 . 2 S U R V E Y

1. The local distribution of rare and threatened species
2. Districts for which there is inadequate data (e.g. Balclutha/Catlins, west Otago along Southern Alps)
3. Major habitats for which there is inadequate data (e.g. littoral habitats, shrubland and forest in Coastal Otago, shrubland in Central Otago, beech forest along the Southern Alps, subalpine habitats throughout the conservancy)
4. Set the geographical limits of distribution for species confined to, or extending to, the conservancy
5. All islands for which no lizard surveys have been undertaken, or where data on lizards is clearly inadequate (this includes islands from which predators have recently been eradicated)

5 . 3 M A N A G E M E N T

1. Legally secure representative sites for species that do not have habitat already covered by formal protection
2. Monitor the populations of key species at key sites and develop contingency plans for a reactionary response
3. Undertake staff training and advocacy, and promote lizard conservation with the public and other stakeholders

4. Use 'mainland island'-type management and predator control for conservation benefit of key lizard populations
5. Maintain predator-free status of key islands and include lizards in restoration plans for island ecosystems

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8. Glossary and abbreviations

allopatric	having distributions that do not overlap
ARDS	Amphibian and Reptile Distribution Scheme database, the forerunner to the HERPETOFAUNA database (see Appendix 4 for details)
ARO	annual reproductive output
BRU	Biodiversity Recovery Unit, Department of Conservation
cline	quantitative gradation in characteristics of species across its range
CMS	Conservation Management Strategy
dichromatic	sexes with markedly different colouration
DOC	Department of Conservation
ectotherm	'cold-blooded' animal in which body temperature is largely determined by external temperature sources and controlled by behavioural means
ED	Ecological District
ER	Ecological Region
GIS	geographical information system
herpetofauna	amphibian and reptile fauna
HERPETOFAUNA	the national amphibian and reptile distribution database, formerly the Amphibian and Reptile Distribution Scheme (ARDS) (see Appendix 4 for details)
herpetology(ist)	study of (person studying) amphibians and reptiles

IUCN	International Union for the Conservation of Nature and Natural Resources
key sites	significant localities for the core aspects of the conservation of lizards. Of necessity the selection of key sites will be somewhat subjective and based to a large degree on existing knowledge of the lizard fauna.
monitoring	systematic measurement of population parameters over time to determine change.
MONZ	Museum of New Zealand—Te Papa Tongarewa
MSR	mid-body scale rows
N/A	not applicable
n.d.	no date
NP	National Park
NZHS	New Zealand Herpetological Society
NZMG	New Zealand mapping grid
OC	Otago Conservancy
OM	Otago Museum
parapatric	having distributions that abut but do <i>not</i> overlap
PMD	Programme Manager—Biodiversity
RHD	rabbit haemorrhagic disease
rostral	large scale at the tip of the snout
saxicolous	rock-dwelling
sensu	as defined by
s.l. = sensu lato	in the broadest sense
s.s. = sensu stricto	in the strictest sense
SRARNZ	Society for Research on Amphibians and Reptiles in New Zealand
SRP	Species Recovery Plan
SRU	Science and Research Unit, Department of Conservation
STIS	Science Technology and Information Services, Department of Conservation
survey	once-off field work over a relatively short time to gather information on distribution, habitat use and population parameters.
SVL	snout-vent length
sympatric	having distributions that overlap, occurring in the same place
syntopic	occurring in the same place <i>and</i> in the same microhabitat
TSO	Technical Support Officer-Fauna
VSR	ventral scale rows
VUW	Victoria University of Wellington

9. Distribution maps

The following maps graphically show the distribution of the lizard species in OC in relation to the administrative boundaries and main geographic features. These maps, derived largely from the HERPETOFAUNA database (see Appendix 4), are **indicative of distribution** only and are **not comprehensive**. As such they reveal inadequacies in the quality, quantity and coverage of the records held in the database, thus hopefully prompting the contribution of further field records and leading eventually to a much better understanding of the lizard fauna.

When using these maps, the following key points should be noted.

- The statements on distribution given in the species accounts (see section 4) are based on a wide variety of sources, many of which are not in the HERPETOFAUNA database. Thus they complement the data shown in the maps.
- The precision of records shown on the maps is dependent on the quality of the original data submitted to HERPETOFAUNA. Further loss of precision has resulted from the conversion of records, mostly the earlier ones, from the imperial grid to the metric NZMG, or when records were located only to grid square (which for mapping is always taken as the co-ordinates of the SW corner). Thus, in extreme cases, conversion of records originally based on the imperial 10,000-yard grid can result in the position of the map symbols being displaced by as much as 10 km—although usually the precision will be <1 km.
- The species mapped together were selected to minimise the chance of an overlap at any one location. However, where this occurred the symbols were moved apart slightly so that each can be clearly seen. This will have resulted in a minimal loss of accuracy.
- Many records of *H. maculatus* s.l. and *Oligosoma nigriplantare maccanni* in the HERPETOFAUNA database cannot retrospectively be assigned to one of the taxa currently recognised from Otago. However, because these provide valuable insight into the distribution of lizards in Otago they have been plotted to show the broad geographic distribution of these species-complexes and to indicate localities that need to be re-surveyed to determine just which taxa are present.

In the following maps the broad distribution of the lizard species in Otago is shown in relation to the Conservancy and Area boundaries (black lines, see also on Fig. 1, page 2).

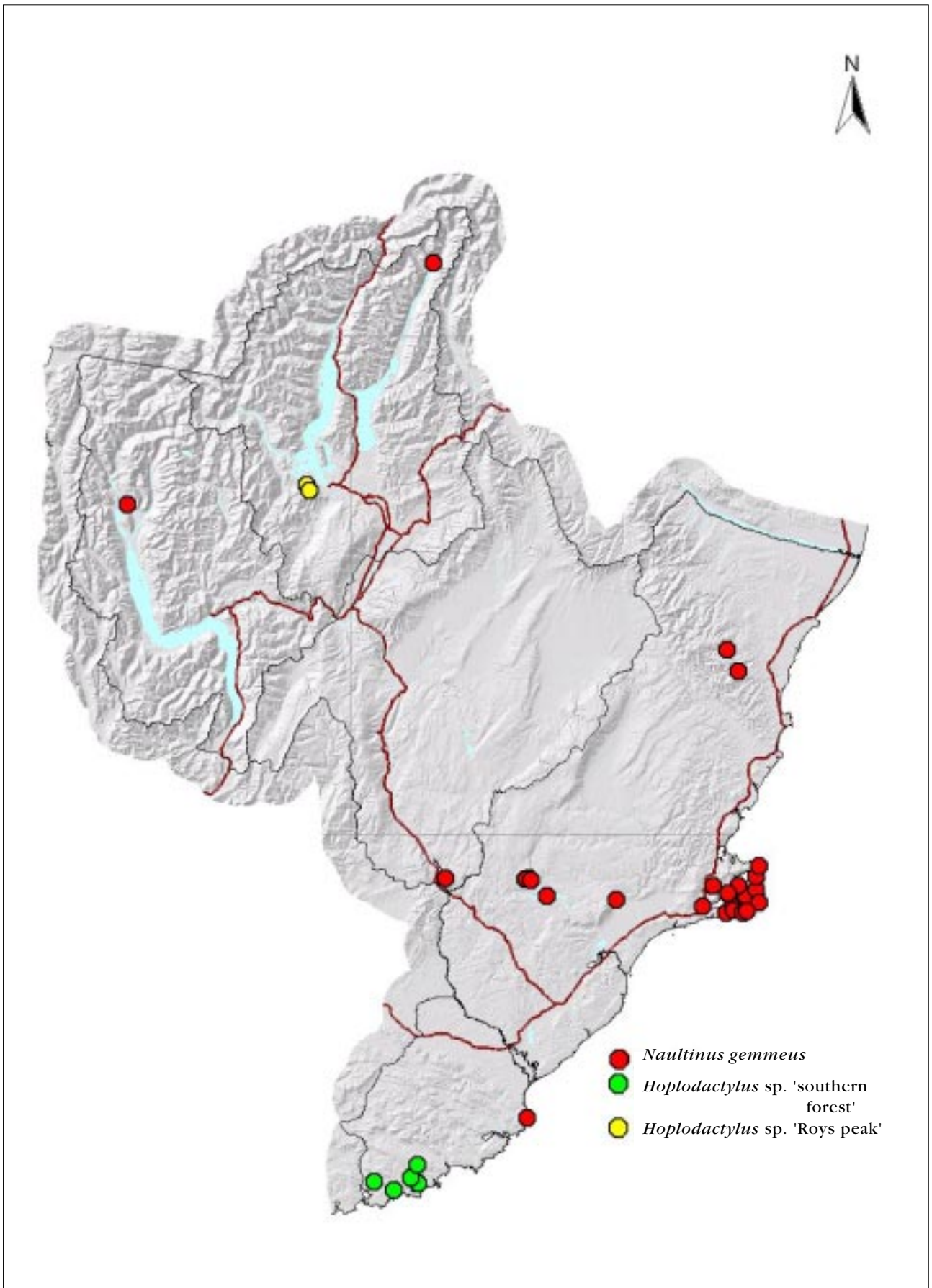


Figure 2. Distribution of *Nautilus gemmeus*, *Hoplodactylus* sp. 'southern forest', and *Hoplodactylus* sp. 'Roys Peak'.

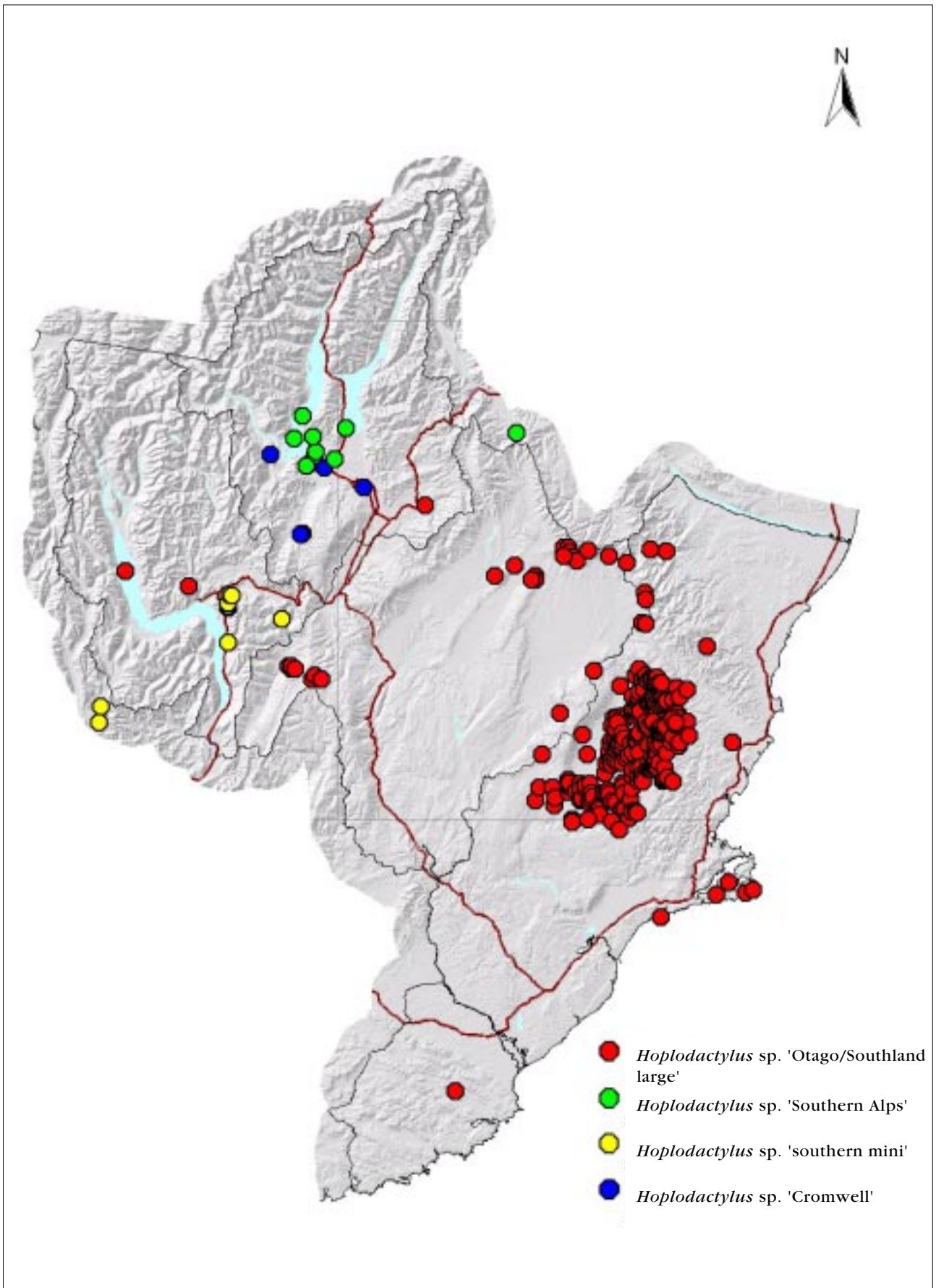


Figure 3. Distribution of *Hoplodactylus* sp. 'Otago/Southland large', *Hoplodactylus* sp. 'Southern Alps', *Hoplodactylus* sp. 'southern mini', and *Hoplodactylus* sp. 'Cromwell'.

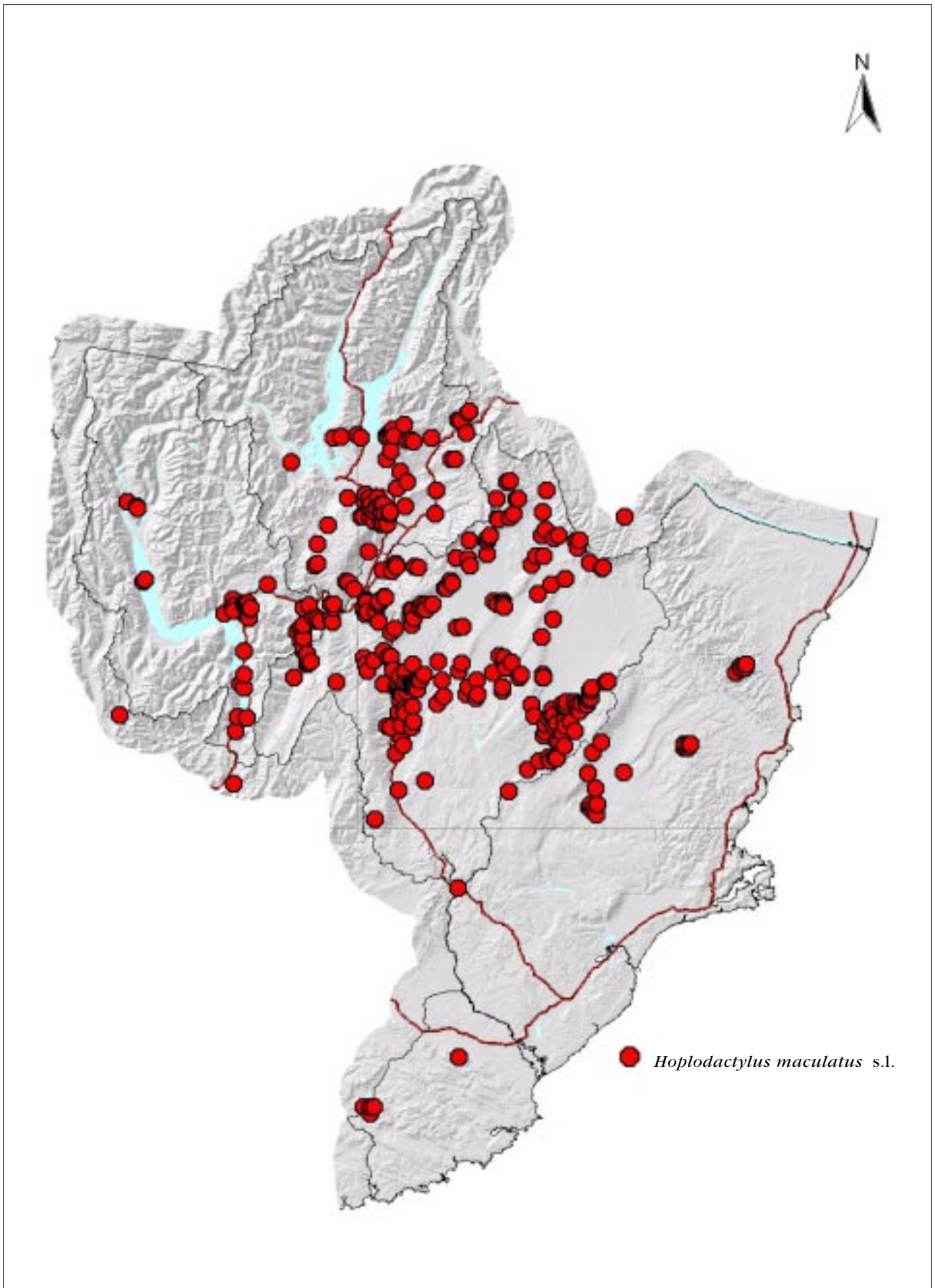


Figure 4. Distribution of *Hoplodactylus maculatus* s.l., i.e. all records that can not be assigned to a currently recognised taxon in the *maculatus* species complex.

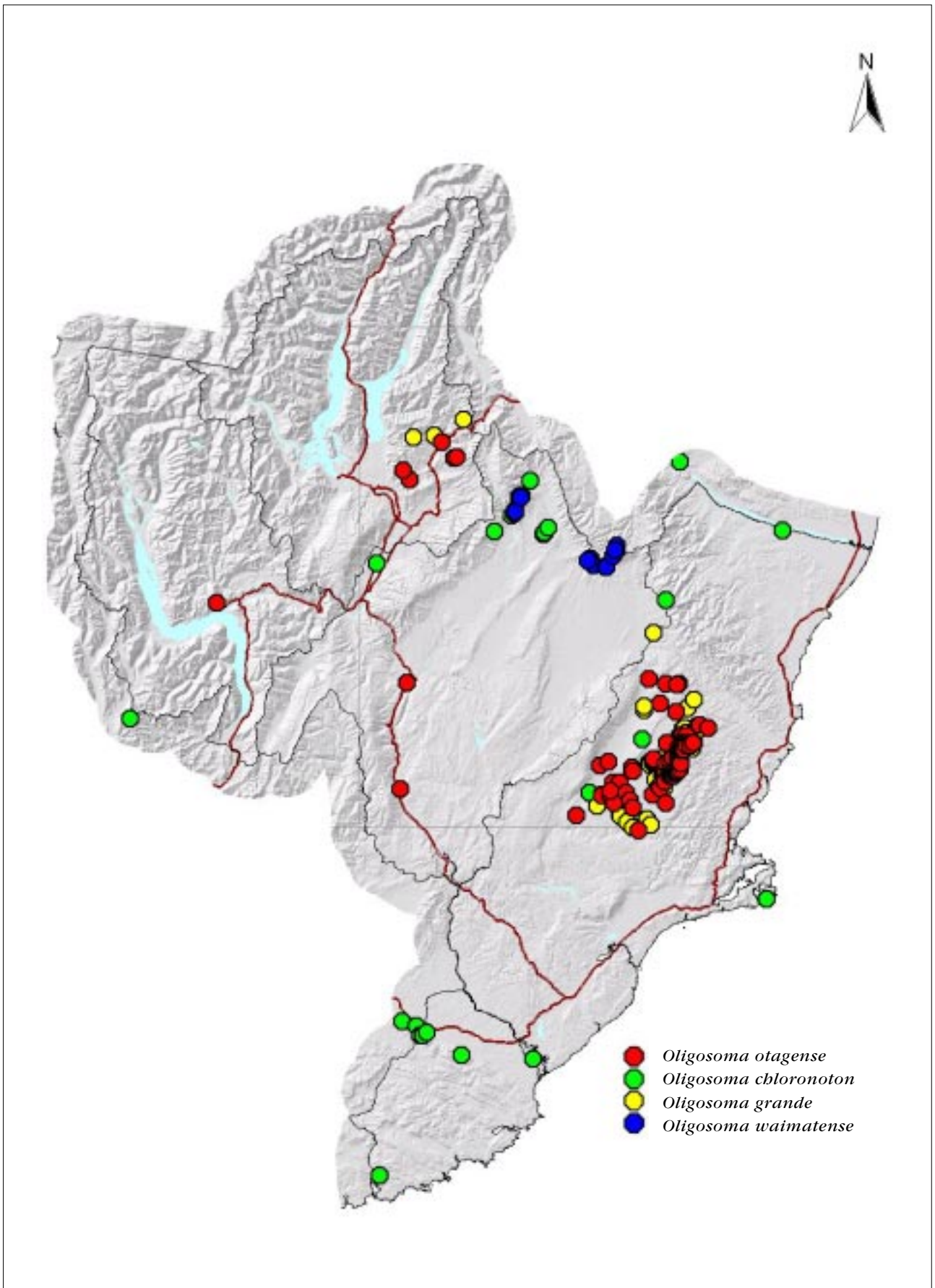


Figure 5. Distribution of *Oligosoma otagense*, *Oligosoma chloronoton*, *Oligosoma grande*, and *Oligosoma waimatense*.

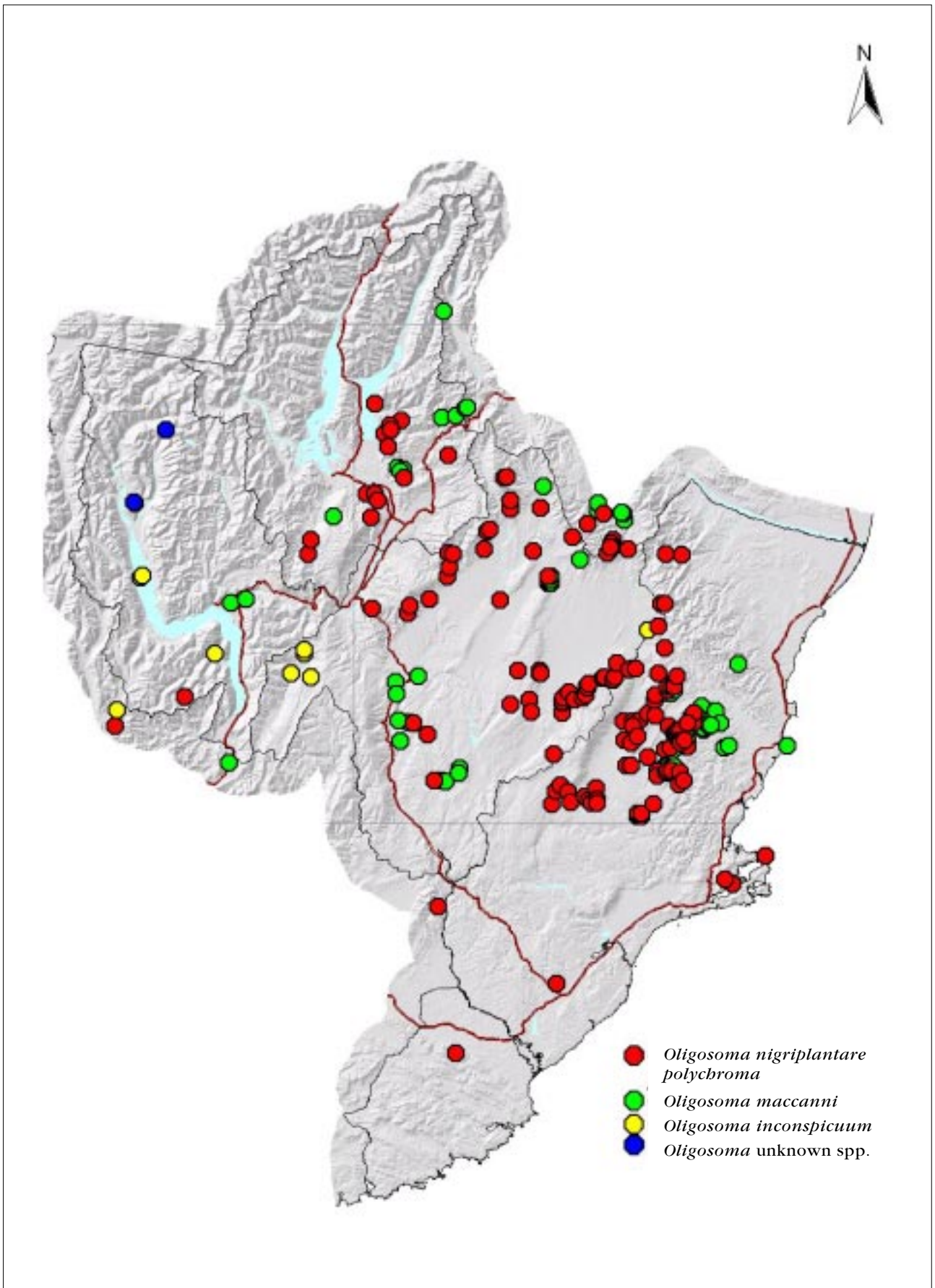


Figure 6. Distribution of *Oligosoma nigriplantare polychroma*, *Oligosoma maccanni*, *Oligosoma inconspicuum*, and *Oligosoma* unknown sp.

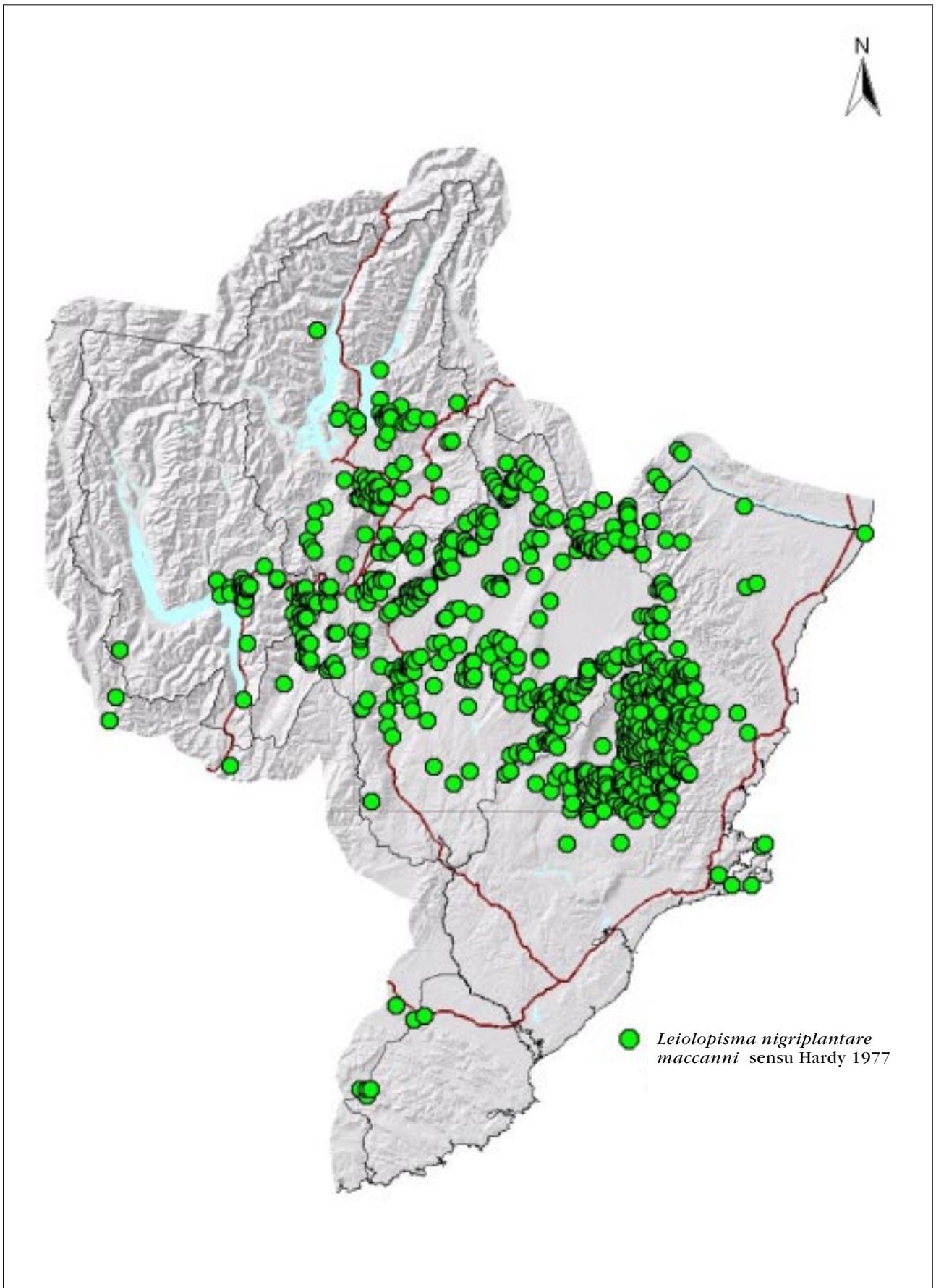


Figure 7. Distribution of *Leiolopisma nigriplantare maccanni* sensu Hardy 1977, i.e. including all records that can not retrospectively be assigned to the new taxa *O. inconspicuum*, *O. maccanni*, and *O. nigriplantare polychroma*.

Appendix 1

CONTEXT OF THE HERPETOFAUNA

A summary of the New Zealand herpetofauna in relation to Department of Conservation Conservancies (listed north to south).

Species richness—number of species in each conservancy where *n* is the total fauna. The total herpetofauna is determined from Daugherty et al. (1994), with additions from Patterson & Daugherty (1994), Hitchmough (1997), Patterson (1997), Bell et al. (1998), and Rod Hitchmough and Clare Miller (pers. comm., 2002)

Endemism—number of species with an extant distribution confined to a single conservancy

Distribution—number of species with an extant distribution confined to the ‘mainland’ (North Island and/or South Island only), or to coastal and lake islands (including Stewart Island)

Conservation status—the DOC conservation priority ranking (Molloy & Davis 1994), DOC threat classification (Molloy et al. 2001), and the IUCN Red List threat category (IUCN 1996; Bell 1997).

Bold numerals indicate row maxima.

CONSERVANCY →	NORTHLAND	AUCKLAND	WAIKATO	BAY OF PLENTY	TONGARIRO/TAUPO	EAST COAST/ HAWKES BAY	WANGANUI	WELLINGTON	NELSON/ MARLBOROUGH	WEST COAST	CANTERBURY	OTAGO	SOUTHLAND
A. Species richness													
Total herpetofauna (n = 79)	24	18	19	14	7	10	12	14	23	16	13	15	17
Frogs (n = 4)	1	1	2	1	-	1	-	-	2	-	-	-	-
Tuatara (n = 2)	1	1	1	1	-	-	-	-	2	-	-	-	-
Lizards (n = 73)	22	16	16	12	7	9	12	14	19	16	13	15	17
Geckos (n = 38)	9	5	6	5	2	3	5	6	13	8	7	8	7
<i>Hoplodactylus</i> (n = 30)	8	5	5	4	1	2	4	5	9	6	4	7	6
<i>Naultinus</i> (n = 8)	3	1	1	1	1	1	1	1	4	2	3	1	1
Skinks (n = 35)	11	10	10	7	5	6	7	8	6	8	6	7	10
<i>Cyclodina</i> (n = 8)	7	5	5	2	1	2	2	4	-	-	-	-	-
<i>Oligosoma</i> (n = 27)	4	5	5	5	4	4	5	4	6	8	6	7	10
B. Lizard endemism													
Lizards	8	2	-	-	-	-	-	1	4	7	1	4	7
Geckos	6	1	-	-	-	-	-	1	4	3	1	3	3
<i>Hoplodactylus</i>	4	1	-	-	-	-	-	1	3	3	1	3	3
<i>Naultinus</i>	2	-	-	-	-	-	-	-	1	-	-	-	-
Skinks	2	1	-	-	-	-	-	-	-	4	-	1	4
<i>Cyclodina</i>	1	-	-	-	-	-	-	-	-	-	-	-	-
<i>Oligosoma</i>	1	1	-	-	-	-	-	-	-	4	-	1	4

Table continues on next page →

CONSERVANCY →	NORTHLAND	AUCKLAND	WAIKATO	BAY OF PLENTY	TONGARIRO/TAUPO	EAST COAST/ HAWKES BAY	WANGANUI	WELLINGTON	NELSON/ MARLBOROUGH	WEST COAST	CANTERBURY	OTAGO	SOUTHLAND
C. Lizard distribution													
Lizard spp. only on mainland	2	-	-	-	-	-	-	1	7	7	5	7	6
Endemic spp. only on mainland	2	-	-	-	-	-	-	-	3	5	-	3	2
Lizard spp. only on islands	9	6	3	1	-	-	-	1	1	2	-	-	3
Endemic spp. only on islands	4	2	-	-	-	-	-	-	-	2	-	-	3
D. Lizard conservation status													
DOC conservation priority													
Category A (n = 8)	1	3	1	2	2	1	2	-	-	1	-	2	2
Category B (n = 12)	3	1	3	-	-	-	-	2	5	1	2	1	2
Category C (n = 4)	2	-	-	-	-	-	1	1	-	-	-	-	1
Category I (n = 1)	-	-	-	-	-	-	-	-	-	-	-	-	1
DOC threat classification													
Acutely threatened (n = 7)	-	1	-	-	-	-	-	-	-	2	-	3	2
Chronically threatened (n = 15)	3	2	3	4	3	3	4	4	5	2	6	6	5
At risk (n = 31)	13	6	6	2	-	-	1	3	8	3	2	1	7
Not Threatened (n = 14)	6	6	6	5	3	6	6	7	6	5	5	5	2
Data deficient (n = 6)	-	1	1	1	1	-	1	-	-	4	-	-	1
IUCN Red List													
Vulnerable (VU) (n = 13)	3	3	4	2	2	1	2	2	4	-	2	3	1
Lower risk (LR) (n = 12)	3	2	3	2	1	-	2	2	5	2	2	-	4

Bold numerals indicate row maxima.

Appendix 2

DISTRIBUTION OF LIZARDS ON ISLANDS

Distribution (O) of lizard species on the 14 coastal and 12 lake/river islands in the Otago Conservancy. Where separate islets in a group are not individually named they are treated together and the number of islets is given in parenthesis. In such situations the occurrence of a lizard species means only that it has been recorded on at least one islet. Unconsolidated, inshore sand islands, such as Rabbit Island in Blueskin Bay, are excluded.

ISLAND NAME	<i>H. sp. 'Cromwell'</i>	<i>H. sp. 'Otago/Southern large'</i>	<i>H. sp. 'Southern Alps'</i>	<i>O. chloronoton</i>	<i>O. inconspicuum</i>	<i>O. maccanni</i>	<i>O. n. polycbroma</i>
Coastal islands							
Motukiekie	-	-	-	-	-	-	-
Goat	-	-	-	-	-	-	-
Quarantine	-	-	-	-	-	-	O
Wharekakahu	-	O	-	O	-	-	-
Gull Rocks (3+)	-	-	-	-	-	-	-
Bird	-	-	-	-	-	-	-
White	-	-	-	-	-	-	-
Green	-	O	-	-	-	-	-
Moturata (=Taieri)	-	-	-	-	-	-	-
Nuggets (5)	-	-	-	-	-	-	-
Tuhawaiki	-	-	-	-	-	-	-
Cosgrove	-	-	-	-	-	-	-
Rainbow Isles (?)	-	-	-	-	-	-	-
Kinakina	-	-	-	-	-	-	-
No. of coastal islands for each species	-	2	-	1	-	-	1
Lake/River islands							
Silver* (Lake Hawea)	-	-	O	-	-	-	-
Mou Waho (Lake Wanaka)	-	-	O	-	-	-	-
Mou Tapu (Lake Wanaka)	-	-	O	-	-	-	-
Bull (Lake Wanaka)	-	-	O	-	-	-	-
Stevensons (Lake Wanaka)	-	-	O	-	-	-	-
Ruby (Lake Wanaka)	O	-	-	-	-	-	-
Tree (Lake Wakatipu)	-	O	-	-	O	-	-
Wawahiwaka (= Pigeon) (Lake Wakatipu)	-	-	-	-	-	-	-
Matau (= Pig) (Lake Wakatipu)	-	-	-	-	-	-	-
Hidden (Lake Wakatipu) (2)	-	-	-	-	-	-	-
[unnamed]* (Poolburn Dam) (2+)	-	-	-	-	-	-	-
Birch (Clutha River)	-	-	-	-	-	-	-
No. of lake/river islands for each species	1	1	5	-	1	-	-
Total islands for each species	1	3	5	1	1	-	1

* Recently created as the result of dam construction.

Appendix 3

DISTRIBUTION OF LIZARDS IN ECOLOGICAL DISTRICTS

Distribution (O) of lizard species in the 12 Ecological Regions and 37 Ecological Districts that lie wholly or partly in the Otago Conservancy (McEwen 1987).

Records for *Hoplodactylus maculatus* s.l. may include one or more of the taxa in the *maculatus*-complex, thus rows may not add exactly.

ECOLOGICAL REGIONS/ DISTRICTS	<i>H. sp.</i> 'southern forest'	<i>H. sp.</i> 'Roys Peak'	<i>H. maculatus</i> s.l.	<i>H. sp.</i> 'Central Otago'	<i>H. sp.</i> 'Cromwell'	<i>H. sp.</i> 'Otago/Southeast large'	<i>H. sp.</i> 'Southern Alps'	<i>H. sp.</i> 'southern mini'	<i>N. gemmeus</i>	<i>O. chloronoton</i>	<i>O. grande</i>	<i>O. inconspicuum</i>	<i>O. maccanni</i>	<i>O. n. polychroma</i>	<i>O. otage</i>	<i>O. waitatense</i>	Total species	
Aspiring																		
51.05	Okuru	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51.06	Arawata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51.07	Dart	-	-	O	-	-	O	-	-	-	-	-	-	-	-	-	-	1
Wainono																		
62.02	Glenavy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62.03	Oamaru	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waitaki																		
64.02	St Mary	-	-	-	-	-	O	O	-	-	-	-	O	O	-	-	-	4
64.03	Hawkdun	-	-	O	-	-	-	O	-	-	-	-	O	O	-	O	-	4
64.04	St Bathans	-	-	O	-	-	-	O	-	-	O	-	O	O	-	O	-	5
Kakanui																		
65.01	Duntroon	-	-	-	-	-	-	-	-	O	-	-	O	-	-	-	-	2
65.02	Dansey	-	-	O	-	-	O	-	-	O	-	-	O	O	-	-	-	4
65.03	Waianakarua	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	-	1
Lakes																		
66.01	Huxley	-	-	-	-	-	-	-	O	-	-	-	-	-	-	-	-	1
66.02	Wanaka	-	O	O	-	O	-	O	-	-	-	-	O	O	-	-	-	5
66.03	Richardson	-	-	O	-	-	O	-	-	-	-	O	-	-	-	-	-	2
66.04	Shotover	-	-	O	-	O	-	-	-	-	-	-	O	-	?	-	-	3
66.05	Remarkables	-	-	O	-	O	O	-	O	-	O	O	O	-	-	-	-	6

Table continues on next page →

ECOLOGICAL REGIONS/ DISTRICTS		<i>H. sp.</i> 'southern forest'	<i>H. sp.</i> 'Roys Peak'	<i>H. maculatus</i> s.l.	<i>H. sp.</i> 'Central Otago'	<i>H. sp.</i> 'Cromwell'	<i>H. sp.</i> 'Otago/Southland large'	<i>H. sp.</i> 'Southern Alps'	<i>H. sp.</i> 'southern mini'	<i>N. gemmeus</i>	<i>O. chloronoton</i>	<i>O. grande</i>	<i>O. inconspicuum</i>	<i>O. maccanni</i>	<i>O. n. polychroma</i>	<i>O. otagensis</i>	<i>O. waimatensis</i>	Total species
Central Otago																		
67.01	Lindis	-	-	0	-	-	-	0	-	-	-	0	-	0	0	0	-	5
67.02	Pisa	-	-	0	-	0	-	0	-	-	0	-	-	0	0	-	-	5
67.03	Dunstan	-	-	0	-	0	0	-	-	-	0	-	-	0	0	-	-	5
67.04	Maniototo	-	-	0	-	-	0	0	-	-	0	0	0	0	0	0	0	9
67.05	Old Man	-	-	0	0	0	0	-	-	-	-	-	0	0	-	0	-	6
67.06	Manorburn	-	-	0	0	-	-	-	-	-	-	-	-	0	0	-	-	3
67.07	Rock & Pillar	-	-	0	-	-	0	-	-	-	-	-	-	0	0	-	-	3
Lammerlaw																		
68.01	Macraes	-	-	0	-	-	0	-	-	-	0	0	0	0	0	0	-	7
68.02	Waipori	-	-	0	-	-	-	-	-	0	0	0	0	0	0	0	-	8
68.04	Lawrence	-	-	0	0	-	-	-	-	0	-	-	-	-	-	-	-	2
Otago Coast																		
69.01	Waikouaiti	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	2
69.02	Dunedin	?	-	0	-	-	0	-	-	0	0	-	-	0	-	-	-	4
69.03	Tokomairiro	-	-	-	-	-	-	-	-	0	0	-	-	-	0	-	-	3
69.04	Balclutha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catlins																		
70.01	Waipahi	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	1
70.02	Tahakopa	0	-	0	-	-	-	-	-	0	0	-	-	-	-	-	-	4
Mavora																		
73.01	Livingstone	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	1
73.02	Eyre	-	-	0	-	-	0	-	0	-	0	-	0	0	0	-	-	6
Waikaia																		
74.01	Nokomai	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	3
74.02	Umbrella	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	2
Gore																		
75.01	Gore	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-	2
Total EDs for each species		1	1	24	3	6	13	7	3	6	14	5	7	24	15	5	3	

Appendix 4

HERPETOFAUNA DATABASE

The HERPETOFAUNA database, formerly the Amphibian and Reptile Distribution Scheme (ARDS), is the national repository for all herpetological distribution records. It is an invaluable resource for information on the distribution of lizard species and hence for making decisions necessary for conservation action to prevent losses or to restore biodiversity.

The original database was established in the early 1970s at Ecology Division, DSIR, passing to the New Zealand Wildlife Service in 1983, and then to the Science and Research Division of DOC in 1987 where it was managed by SRU. During 2001 ARDS was completely redesigned and reconstructed, and by mid-2002 will be available on the DOC intranet. There are also plans to allow limited access via the internet and the DOC website. HERPETOFAUNA is managed by SRU, with administrative support from Southern Regional Office, but is currently based in the Otago Conservancy office at Dunedin.

Records stored in the database include the usual data-fields: date, collector, locality, grid reference, altitude, species, weather, habitat, and so on. All grid references have been converted to, and are stored in, NZMG format. It is possible to extract records on a wide range of parameters such as species, location, grid reference, date or observer, and these can be printed directly as distribution maps through GIS software (e.g. ArcView™). However, changing nomenclature since ARDS/HERPETOFAUNA was established means the species parameters must be carefully defined and the output interpreted with caution.

Until the full HERPETOFAUNA database is available on-line enquiries for data should be made through the TSO or addressed directly to the database manager at the Otago Conservancy office (as at 2002 the managers are Dr Mandy Tocher **mtocher@doc.govt.nz** and Benno Kappers **bkappers@doc.govt.nz**). Interim data is available in Access™ or Excel™ format. Data from HERPETOFAUNA to 1988 is available in atlas form (Pickard & Towns 1988).

For the HERPETOFAUNA database to remain effective it is important that it is kept right up to date. Continued contributions to the scheme are essential and all people working with or making observations on lizards in OC should submit records. Blank copies of the ARDS record form are available from the TSO at the conservancy office or can be photocopied. Completed record forms should be sent to the TSO for submission or directly to the database manager.

In filling out ARDS forms it is important to strive for correct identification. Unfortunately, the difficulties in identifying many species, especially within the *H. maculatus* species complex, mean this is not always easy or possible. Because any record is better than none, contributors are urged to include detailed notes on the identifying features they use for any animals they are unsure about. It is also important to note whether specimens or photographs were taken, and whether expert assistance was used with the identification.

Appendix 5

HOLDING AND TRANSPORTING LIZARDS

Lizards will often have to be captured for identification. In some cases it may also be necessary to hold them captive for a short time, take them briefly from the field, or even to send them away to specialists.

By far the most effective field containers for lizards are cloth bags. Soft material (such as the polyester/cotton used for bed sheets) provides more than adequate ventilation, and bags are cheap to make, light to carry, and take up very little space when not in use. However, care must be taken to not crush any lizards they contain. Bags should be carefully sewn with rolled seams to ensure there are no loose threads that might entangle or damage the lizards. They should be tightly fastened with a tie **around the outside**—a drawstring should **not** be used because this will leave a narrow opening that lizards can force their way through. Alternatives for field containers are small, **well-ventilated** wooden or plastic boxes (e.g. 2 litre ice-cream tubs).

Two or three lizards can be comfortably kept together in a cloth bag without packaging, but if more are to be held—or if a box is used—it is kinder to provide some loose packing material (such as grass or leaves). This allows the lizards to keep away from each other and will prevent them getting knocked around when the container is moved. **Do not** be tempted to re-create ‘habitat’ within a field container—lizards can be injured if stones or pieces of wood get dislodged. Large predatory species, such as Otago skinks, must not be put into a container with smaller animals!

Any bags or boxes containing lizards **must be kept in a cool place**. Lizards are ectotherms and unless they can maintain their body temperature below a critical threshold by behavioural means will rapidly become stressed and may die. Containers must not be left in direct sunlight or in hot places, such as inside closed vehicles.

Captive lizards will not need to be fed if they are held for only a short period (i.e. less than 5–7 days), especially if this is during cool weather when they are naturally inactive. However, it is very important that they are not allowed to dehydrate. In hot, dry weather containers holding lizards should be moistened regularly, and a shallow dish of drinking water should be provided in any temporary housing.

It is important that proper guidance on housing and husbandry is sought if lizards have to be held for extended periods (i.e. longer than 3–4 weeks). DOC has protocols on the captive maintenance of lizards and the TSO can provide introductions to experienced herpetoculturists if needed. Additional information on lizard husbandry can be obtained from the NZHS or from the society’s publications (Porter 1989; Rowlands 1999).

The best way to send live lizards to specialists for identification is by courier. The lizards should be packed into a relatively small, robust container, with a tightly-fitting lid and adequate ventilation, e.g. a plastic 2-litre ice-cream tub

with numerous small (2–3 mm) holes drilled or punched into it. For additional security and safety the animals should be tied into a cloth field bag inside this container (or if this is not possible the container should be loosely filled grass or leaves to avoid the lizard(s) being tossed around during transit). The bag or packing material must be lightly moistened, but **not** sodden. The lid should be taped securely shut to prevent it being dislodged and the container loosely wrapped in paper. Clearly mark the package ‘LIVE ANIMALS—KEEP FROM HEAT’, and include the **full addresses and contact phone numbers** for both the recipient and sender. **Before** sending the package advise the intended recipient to expect it so that someone will be ready to receive it—this is particularly important for shipments to places such as universities, where typically couriers deliver only to the institution, not to the addressee. Provided the weekend is avoided, courier service to all parts of New Zealand is less than 48 hours and properly packaged lizards will comfortably survive for well over a week.

If a lizard unfortunately dies while being captured or in held in captivity—or a lizard is found dead—remember that in almost all cases it has a scientific value. The preferred preservative is 70% ethanol. Either inject some preservative or open the body cavity (not along the mid-line) to ensure rapid and complete preservation. If ethanol is not available, specimens can be stored temporarily in a domestic freezer or alternative preservatives (e.g. 10% formalin) can be used. Note that even dried or decomposed specimens have value if they are rare species or if they can be converted to skeletal specimens. The Museum of New Zealand–Te Papa Tongarewa is the national repository for all indigenous reptile specimens (see Appendix 6).

Appendix 6

INFORMATION SOURCES

A6.1 Identification

Only two field guides to New Zealand lizards are currently in print. *New Zealand frogs and reptiles* (Gill & Whitaker 1996, reprinted with corrections 2001, available through bookshops) has keys to the herpetofauna, plus brief accounts of the morphology, colouration, distribution, habits and habitats and a colour photograph of each species recognised at that time. *A field guide to the lizards of New Zealand* (Towns 1988) only has keys to the lizard species, along with other recent popular guides to the entire lizard fauna (Barnett 1985; Robb 1986) this will be available in libraries. Some regional publications also have good information on lizard faunas (e.g. Peat & Patrick 1999).

Identification keys, plus taxonomic and biological summaries, are given for the gecko fauna by Bauer (1990). Bauer & Henle (1994) contains only keys to the geckos. Hitchmough (1997) provides the most recent review of the genus *Hoplodactylus*, but this thesis study is currently unpublished. Taxonomic reviews and identification keys for skinks are given by Hardy (1977). Additional papers important for identifying skinks within OC are Patterson & Daugherty (1990, 1995) and Patterson (1997).

Interest in and research on New Zealand lizards has burgeoned since the 1960s. One consequence of this is that the taxonomy seems to be in a constant state of flux as field research discovers completely new species and increasingly sophisticated genetic techniques identify cryptic species within what were previously regarded as widespread, variable taxa. Many taxa recognised by specialists remain undescribed and unnamed. Correct specific identification is essential for conservation decision-making and management yet many of the lizard species are difficult—or even impossible—to distinguish on morphological characters alone. The TSO at the conservancy office can provide advice on the latest taxonomic information and on which specialists to consult for assistance with lizard identifications.

A6.2 Distribution

The primary source of distribution data is the HERPETOFAUNA database (see Appendix 4). The *Atlas of the amphibians and reptiles of New Zealand* (Pickard & Towns 1988) contains distribution maps created from HERPETOFAUNA data to 1988. Distribution maps for geckos based on a slightly different dataset to HERPETOFAUNA (i.e. they are based almost entirely on literature records) are given by Bauer (1990) and Bauer & Henle (1994). Distribution maps or detailed summaries of locality data are also included in most taxonomic or review papers (e.g. Hardy 1977; Patterson & Daugherty 1990; Patterson 1997).

A6.3 Literature

The primary literature source is *New Zealand lizards: an annotated bibliography* (Whitaker & Thomas 1989, available from Landcare Research—Manaki Whenua, Private Bag 6, Nelson). This is an all-inclusive list of published and unpublished references to 1988, including a précis of each entry plus comprehensive indices under specific name, geographical area and subject. Bauer (1990) and Bauer & Henle (1994) contain detailed literature reviews for each gecko species and exhaustive reference lists. Most other review papers (e.g. Hardy 1977) also provide good access to the literature. *SRARNZ notes* (see below), contains lists of New Zealand herpetological literature—published and unpublished—since 1992.

A6.4 Current contacts (as at 2002)

The first point of contact for all enquiries on lizards is the TSO, who will be able to give up-to-date advice on where to get further information.

DOC currently employs four full-time herpetologists in SRU (Dave Towns, Auckland; Keri Neilson, Hamilton; Don Newman, Wellington; Mandy Tocher, Dunedin) and one part-time in BRU (Rod Hitchmough). Beyond them, a number of other staff in various parts of the country have detailed local or regional knowledge of the lizard fauna.

Two New Zealand museums have an active role in herpetology. The Museum of New Zealand—Te Papa Tongarewa, in Wellington, is the national repository for all indigenous reptile and amphibian specimens (current curator Raymond Coory); the Auckland Museum has a regional interest in New Zealand species and is the national repository for Pacific species (current curator Brian Gill).

Several universities have staff with special interests in herpetology or promote herpetological studies amongst students. At present those with the greatest interest in lizards are Massey University, Palmerston North (current contact Doug Armstrong), Victoria University, Wellington (current contact Charlie Daugherty), and Otago University, Dunedin (current contact Alison Cree).

The Society for Research on Amphibians and Reptiles in New Zealand (SRARNZ), formed in 1987 to promote the scientific study and conservation of the indigenous herpetofauna, has an active and well-informed membership of over 100. A regular newsletter—*SRARNZ notes*—provides an up-to-date source of information on discoveries, research, and the people involved with herpetology in New Zealand (current contact is the secretary, Kelly Hare, Victoria University).