National Recovery Plan for the Corangamite Water Skink *Eulamprus tympanum marnieae*

Garry Peterson and Peter Robertson







Department of Sustainability and Environment Prepared by Garry Peterson, Department of Sustainability and Environment, Victoria and Peter Robertson, Wildlife Profiles Pty Ltd.

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This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

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SUMMARY

The Corangamite Water Skink (*Eulamprus tympanum marnieae*) is endemic to Victoria where it is restricted to the rocky verges of a few wetlands on the Victorian Volcanic Plain. The skink has undergone a decline, disappearing from at least two historical locations, and is known from only 30 sites representing 11 discrete extant populations. Threats such as rock removal, vegetation clearance, inappropriate grazing, wetland loss and inappropriate water management have contributed to its decline and threaten the remaining populations. The Corangamite Water Skink is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, Threatened under the Victorian *Flora and Fauna Guarantee Act 1988*, and is considered Critically Endangered in Victoria (DSE 2007). This national Recovery Plan for the Corangamite Water Skink is a revised recovery plan which builds on the previous plan for the subspecies (Robertson 1998), and details its distribution, habitat, threats and recovery objectives and actions necessary to ensure its long-term survival.

SPECIES INFORMATION

Description

The Corangamite Water Skink (*Eulamprus tympanum marnieae*) (Hutchinson and Rawlinson 1995), is a medium-sized lizard of the family Scincidae. Adults grow to 100 mm snout-vent length, with a tail length up to 150 mm and a body mass of up to 25 grams. The dorsal colouration is pale olive to dark yellowish brown overlain by irregular black markings, some forming broken bands across the back and tail. A heavy, irregular, somewhat broken black stripe extends from the snout along the sides to the hind limbs, while the limbs are overlain by heavy black stripes and blotches. The throat varies from greyish-white with black patches to wholly black. Ventral colouration varies from bright yellow to pale greyish yellow, overlain by two thick black longitudinal lines of either small specks, thick patches or bars from the chest to the groin (Hutchinson and Rawlinson 1995).

The Corangamite Water Skink is a diurnally active, basking skink. However, unlike other water skinks, *E. t. marnieae* is extremely shy, and will often flee and take cover when a human observer is still tens of metres away (Hutchinson and Rawlinson 1995; G. Peterson pers. obs. 1997), taking refuge in deep gaps and fissures in the rock piles. It occupies small defined home ranges (most $<10m^2$) and is territorial (Malone and Peterson in prep). Home range size is influenced by proximity to a waterbody and increases as a function of the distance from the edge of the water-line, indicating that optimal microhabitats are situated close to water (Malone and Peterson in prep).

It is viviparous, producing one clutch per year of 2–7 live young (Peterson 2002). Females first reproduce at two or three years of age, depending on the population (G. Peterson unpubl.data 2009). Once mature, most females breed every year. Litter size and mass increase with female size (Peterson 2002). Juveniles generally occupying separate microhabitats and activity periods from that of adults (Peterson 2002). It is not known whether this is due to agonistic behaviour of adults towards juveniles or specific ecological requirements of juveniles, such as smaller prey items in the microhabitat they occupy. Offspring mortality appears high following birth, while sub-adult and adult survivorship is relatively high (G. Peterson unpubl. data 2009). Subadult survivorship is, however, influenced by population density. Estimated longevity of the Corangamite Water Skink in the field is nine years (G. Peterson unpubl. data 2009), although life expectancy may well be similar to that of *E. t. tympanum*, up to 15 years (Rohr 1997).

Diet is mainly invertebrates such as spiders, beetles and ants, as well as aquatic prey including mayfly and dragonfly nymphs (Knights 2003). It also consumes the fruit of the Tree Violet (*Melicytus dentata*), which may be an important component of the diet during some periods

(Peterson 1997). The lizard may also play an important role in the dispersal and germination of this plant. The seeds of the introduced African Boxthorn (*Lycium ferocissimum*) and other unidentified seeds have also been found in scats (Knights 2003).

Taxonomy

The Corangamite Water Skink is currently recognised as a subspecies of the widespread, cool temperate Southern Water Skink (Eulamprus tympanum tympanum) (Hutchinson and Rawlinson 1995). It is distinguished morphologically from E. t. tympanum by very small mid-body and paravertebral scales, the black dorsal markings arranged as short irregular transverse bars and the bold ventral patterns of black longitudinal strips on a yellow background. The initial conclusion following the discovery of E. t. marnieae was that it represented a new species. Subsequent collections of individuals intermediate in both colour pattern and scalation, however, suggested that intergradation with E. t. tympanum had occurred (Hutchinson and Rawlinson 1995). The notion of intergradation was further supported with the recent discovery of additional morphologically intermediate populations (Peterson 1999; Robertson and Lowe 1999). Recent molecular analysis also did not support the view of a new species. To the contrary, this work revealed that E. t. marnieae as currently recognised, is comprised of populations from two distinct genetic groups, each with separate evolutionary origins (Scott and Keogh 2003). These independent origins are aligned with a deep genetic separation identified within E. t. tympanum in south-western Victoria (Scott and Keogh 2003). As a consequence, a revision of the taxonomy of E. t. marnieae and E. t. tympanum within south-western Victoria is required.

Distribution

The Corangamite Water Skink is endemic to the Victorian Volcanic Plain IBRA bioregion in south-western Victoria, where it occurs as a number of isolated populations between Colac and Lake Bolac (Figure 1), over a maximum distance of about 100 km. Detailed maps showing the distribution of this taxon are available from the Department of Sustainability and Environment (DSE).



Figure 1. Distribution of Corangamite Water Skink

Habitat

Within the Victorian Volcanic Plain, the Corangamite Water Skink inhabits specific geological regions known as the Later Newer Basalts. Known colloquially as the 'stony rises', the Later Newer Basalts are geomorphic areas of extensive sheet basalt lava flows deposited over a period of 1.8 million years, from the late Tertiary to the Holocene (Joyce 1988). The rises are basalt ridges and boulder heaps often left by the collapse of lava tunnels (Skeats and James 1937; Ollier and Joyce 1964). Prior to European settlement, these Later Newer Basalts were broadly vegetated by Stony Knoll Shrubland, Stony Rises Woodland, Plains Grassland and Plains Grassy Woodland vegetation communities and their associated mosaics, on shallow stony loams and dark clay soils (Willis 1964; Ross 1999; NRE 2003).

Localities occupied by *E. t. marnieae* consist of large deeply fissured basaltic flows or outcrops, remnant vegetation and adjacent permanent or ephemeral wetlands (Peterson 1997; Robertson and Lowe 1999; Peterson 2000). The remnant vegetation generally comprises native plants such as Scrub Nettle (*Urtica incisa*), Variable Groundsel (*Senecio pinnatifolius*), Tall Sedge (*Carex appressa*) and Tree Violet (*Melicytus dentata*) (Peterson 1997). At most sites, the understorey consists largely of exotic pasture grasses, a legacy of its past agricultural history. Water bodies associated with *E. t. marnieae* sites include freshwater meadows, deep freshwater marshes, permanent open freshwater lakes, semi-permanent saline marshes and permanent saline lakes.

At the microhabitat level, *E. t. marnieae* selectively occupy moist and cool microenvironments in areas of high shrub density, large rock aggregations with numerous fissures and close to water (Peterson 1997; 2001). Individuals were observed foraging relatively infrequently in vegetation or in shallow water along the lake's edge (Malone and Peterson (in prep). Juveniles occur around small scattered rocks and dense vegetation cover, suggesting an element of microhabitat partitioning between adults and juveniles (Peterson 2001). The deeply fissured rock piles provide cool and humid refuges during the warm dry summer months when conditions elsewhere in the basalt plains environment would be intolerable to water skinks (Hutchinson and Rawlinson 1995). Proposed recovery actions include the determination of habitat critical to survival of *E. t. marnieae*.

Important Populations

The Corangamite Water Skink is currently known from 30 sites that represent 11 discrete populations (Table 1). Most sites support extremely small populations (as few as four adults), although some sites may have up to 430 adults (Peterson 2000), with population size correlating to habitat availability and complexity (G. Peterson unpubl. data 2009). The small number of fragmented, extant populations of *E. t. marnieae* and their unique genetic lineages, combined with the decline of the subspecies and its grassland/wetland habitat indicate that all populations are extremely important for the survival of the taxon.

Population	Number of sites	Land Tenure
Dreeite	7	Public/Private
Red Rock	2	Public/Private
Wool Wool	3	Public/Private
Nalangil	2	Public/Private
Lake Colac	4	Public/Private
Derrinallum	3	Public/Private
Vite Vite	1	Private
Dundonnell	1	Private
Nerrin Nerrin	5	Public/Private
Lake Bolac	1	Public
Lismore	1	Private

Table 1. Population information for Corangamite Water Skink

DECLINE AND THREATS

The Corangamite Water Skink was first discovered in 1963, near Lismore in Victoria. Since then it has been found at several locations on the Victorian Volcanic Plain between Colac and Lake Bolac. Its historical distribution is not known, but it is highly likely that the taxon once occurred at other locations on the basalt plains. The main factors involved in the decline of *E. t. marnieae* appear to be habitat loss and fragmentation, and degradation of remaining areas of habitat by a range of processes including changed grazing regimes, weed invasion, rock removal, changed hydrology and/or water quality, cropping, use of agricultural chemicals and the impacts of introduced animals (foxes, cats, rabbits, mice, sheep, cattle) either by predation or by grazing (Robertson and Peterson 2000). Native grassland on the Victorian Volcanic Plain is one of the most threatened ecological communities in Australia, with less than 1% of its original extent remaining (Lunt *et. al.* 1998), and this community has been listed as Critically Endangered under the EPBC Act (DEWHA 2009).

The taxon is extinct from one site each at Lake Bolac and Lismore, and has undergone declines in other areas, generally coinciding with the prolonged drying of adjacent wetlands (Scroggie 2005; Peterson unpublished data). The population at the first site discovered (near Lismore) was probably destroyed during the rock clearing activities which produced the original specimens (Hutchinson and Rawlinson 1995). Remaining sites are patchily distributed and isolated, with the bulk of sites having very small areas of available habitat. The majority of populations are comprised of two or more sites or subpopulations that historically were probably connected by continuous habitat. Dispersal between fragmented sites now seems unlikely. Fragmentation of most sites has occurred as a result of processes such as vegetation clearing, rock removal and the drainage of wetlands. For small isolated populations, stochastic ecological and/or genetic isolation effects could become important, as could the potential for inbreeding depression. Synergistic effects of combinations of these threats may also be important. For example, cat predation may be more important in small populations close to urban areas.

Most populations of *E. t. marnieae* are found on private land generally used for agriculture, including dairy farming, grain cropping and beef and sheep farming. Aspects of all of these agricultural practices threaten the associated *E. t. marnieae* populations. These threats continue, to varying degrees, at all known sites. Populations are now extremely fragmented and many are very small. The native shrubs and forbs in these rocky grassland/wetland habitats may be particularly susceptible to grazing. As these shrubs and some forbs have been shown to be important to *E. t. marnieae* (Peterson 1997; 2000), it is likely that heavy grazing will be detrimental to *E. t. marnieae*. Grazing may also be detrimental to neonatal and juvenile skinks as the microhabitat they tend to inhabit is heavily vegetated and consequently heavily grazed. Appropriate grazing regimes have yet to be determined, however, it has been seen as prudent to exclude grazing from *E. t. marnieae* habitat wherever possible (Peterson 2006).

Irrigation for agricultural purposes through ground water extraction, in conjunction with the extended drought, has caused the drying of a number of water bodies associated with *E. t. marnieae*. In a number of cases, this has coincided with a decline in the adjacent *E. t. marnieae* populations (Peterson 2000, 2001). The loss of the cool moist refuges and overall deterioration in wetland habitat quality is thought to have driven these declines. Continued ground water extraction, in particular in concert with drought and/or climate change poses a significant threat to *E. t. marnieae*.

The use of agricultural insecticides associated with cropping may be detrimental to *E. t. marnieae* by impacting invertebrate prey availability at sites adjacent to crops. Southwestern Victoria has undergone a significant change in land use from broad acre grazing to cropping over the past decade, heightening this threat to *E. t. marnieae*.

The removal of basalt rocks to increase grazing land, enable pasture improvement and/or to provide rocks for the landscape garden market threatens *E. t. marnieae* by either directly removing habitat or by reducing dispersal routes and isolating populations. Populations have

already been fragmented at most sites, however further rock removal threatens sites where continuous habitat still persists. The loss of small wetlands and moist depressions and the resulting increase in inter-wetland distance may also further isolate populations (Gibbs 1993).

Long term, the impacts of climate change have the potential to be catastrophic to *E. t. marnieae*. Even in the absence of an ever increasing agricultural demand on water resources, the prolonged drying of wetlands predicted to be associated with climate change will potentially impact significantly on *E. t. marnieae*. Due to the hydrophilic nature of the taxon and its reliance on wetlands and associated moist microclimates, the impacts of climate change coupled with the agricultural demand for water resources, have the potential to be catastrophic to the subspecies and associated wetland ecosystems.

As many populations of *E. t. marnieae* are now severely fragmented, it is unknown whether the lizard will persist in the long-term in reserved or managed areas, or whether active intervention will be required. This will depend upon the size of the reserves or managed areas, on the threats present, and on the management regimes implemented. The size of most extant populations may not be large enough currently to prevent major restrictions of genetic variability, especially in the absence of natural gene flow, and management must be cognisant of this. Molecular research is at present being conducted to examine small scale movement and dispersal (J. Sumner pers. comm. 2009), the results of which will be used for developing various management requirements.

The life history of *E. t. marnieae* appears such that relatively quick population growth may be possible given adequate areas of habitat and amelioration of threats. Rapid increases in *E. t. marnieae* numbers were observed at three sites over a short period (i.e. three years) following the exposure of new habitat (Peterson 2001). Animals have also inhabited newly created habitat shortly after works were completed (G. Peterson unpubl. data 2004).

RECOVERY INFORMATION

Existing Conservation Measures

Implementation of the previous Corangamite Water Skink recovery plan (Robertson 1998) saw the majority of actions either fully or partially completed. These actions informed on the natural history, population demographics and ecological requirements of the subspecies as well as the agents driving its decline, enabling a comprehensive strategy for its long-term recovery and management to be devised. Major outputs and achievements from the previous plans implementation are outlined below:

Recovery Team

A Recovery Team for the Corangamite Water Skink was established in September 1997, and co-ordinates recovery efforts for the taxon. The Recovery Team liaises closely with university and other research groups, other relevant working groups, recovery teams such as the Striped Legless Lizard National Recovery Team and various grassland recovery groups. The studies co-ordinated by the Recovery Team, in conjunction with university and other groups, have provided most of the current knowledge of *E. t. marnieae* distribution, biology and ecology.

Organisations represented on the Recovery Team include:

- Department of Sustainability and Environment
- La Trobe University
- Zoos Victoria
- Trust for Nature
- Corangamite and Glenelg Hopkins Catchment Management Authorities
- Wildlife Profiles Pty. Ltd.
- Local conservation and landowner groups

Survey and Monitoring

Extensive targeted surveys to investigate the distribution and abundance of *E. t. marnieae* were conducted during the spring and summer of 1997/98 and 1998/99 (Peterson 1999; Robertson and Lowe 1999; Peterson 2000), which resulted in the present understanding of the distribution of the taxon. Populations at 14 sites have been monitored since 1996, including visual census and capture-mark-recapture (G. Peterson unpubl. data 2010). Analysis of these data has provided estimates of long-term mean trends in abundance (Scroggie 2005).

Biology and Ecology

General aspects of the habitat and biology of *E. t. marnieae* have been studied, including habitat and microhabitat selection and utilisation, reproductive life history, population dynamics, morphological variation and impacts of potential threats ((Peterson 1997; G. Peterson unpubl. data 2010), diet and factors influencing food availability (Knights 2003), home range (Knights 2003; Malone and Peterson in prep), the effect of grazing exclusion on *E. t. marnieae* and its habitat (Peterson 2006), and genetic variability within and between populations of *E. t. marnieae* and *E. t. tympanum* (Scott and Keogh 2003). Further research examining small-scale movement and dispersal and population structure at the microsatellite level is currently being conducted (J. Sumner pers. comm. 2009).

Reservation and Management

In 2004 an area of land identified as a high priority site for *E. t. marnieae* was purchased through the National Reserves System Program with funding from the Australian and Victorian State Governments (Robertson and Fitzsimons 2004). This is now the only population of *E. t. marnieae* protected within a conservation reserve. A number of other populations occur within or on the boundary of other public land (in particular lake reserves), but these cannot currently be considered secure due to undefined boundaries and/or permitted public access and associated activities. Currently two private properties that contain *E. t. marnieae* are protected under conservation covenants and a number of sites on private land are managed specifically for the lizard.

Since 2003 an extensive effort has been undertaken to implement the interim management guidelines developed by the recovery team (Robertson and Peterson 2000) at all *E. t. marnieae* sites. These actions have been funded primarily by the Australian Government via the Corangamite and Glenelg Hopkins Catchment Management Authorities, and generally implemented in partnership with groups such as Greening Australia's Borrell-a-kandelop project, Lismore Land Protection Group, Trust for Nature, Alvie Tree Planters, West Lake Colac Action Group, International Student Volunteers, Watershed 2000, local schools, Colac Otway Shire, Parks Victoria and Department of Primary Industries.

Approximately 24 km of fencing across 18 sites has been erected to protect and enhance the habitat of the skink. At all sites, the fencing was undertaken with the full agreement, support and enthusiasm of the land owner/manager, and at no or minimal costs to them. Habitat enhancement on private land through revegetation with native plants, building and extending rocky outcrops, weed removal and predator control have also occurred (Peterson 2006). Management agreements for *E. t. marnieae* on private land have been achieved through a variety of measures including conservation covenants arranged with Trust For Nature, incentive payments provided for ongoing habitat management through Plains Tender and Wetland Tender, Land for Wildlife membership, binding management agreements linked to Greening Australia and Landcare incentive programs, endorsed plans as prescribed in planning permit conditions and less formal agreements on land management practices. Rapid increases in *E. t. marnieae* numbers were observed at three sites over a three-year period following protection works and the creation of new habitat (Peterson 2001). Animals have also colonised newly created habitat shortly after works were completed (G. Peterson unpubl. data 2004).

Landowner participation in and support for this conservation program has, and will continue to be, crucial. Commitment from landholders towards conservation of this subspecies has included a range of measures including conservation covenants, conservation tenders, Land for Wildlife

membership, Greening Australia and Landcare incentives, co-operative agreements, and less formal agreements on land management practices to support conservation of the lizard. The Department of Sustainability and Environment has continually engaged with landholders and community groups and provided information on the recovery program through fact sheets, media releases and presentations at public forums (G. Peterson pers. comm. 2010).

Recovery Objectives

The primary, long-term recovery objective is to ensure the ability of the Corangamite Water Skink to survive, flourish and maintain its potential for evolutionary development in the wild, across its natural geographic range. The Specific Objectives for recovery over the next five years are to:

- 1. Investigate the biology and ecology of the Corangamite Water Skink to facilitate effective conservation management.
- 2. Determine and manage threats to the Corangamite Water Skink and its habitat.
- 3. Protect and manage habitat for the Corangamite Water Skink.
- 4. Determine population trends and viability for the Corangamite Water Skink.
- 5. Establish and maintain a captive population of Corangamite Water Skinks.
- 6. Determine if there is a need for salvage and translocation of Corangamite Water Skinks.
- 7. Increase landholder and community awareness of and participation in the recovery program for the Corangamite Water Skink.

Program Implementation and Evaluation

This Recovery Plan guides recovery actions for the Corangamite Water Skink and will be managed by the Victorian Department of Sustainability and Environment and overseen by the Corangamite Water Skink Recovery Team. The Recovery Plan will run for five years from the date of its adoption under the EPBC Act. Annual evaluation of implementation will be undertaken by the Recovery Team, and the Recovery Plan will be reviewed within five years of the date of its adoption.

Recovery Actions

A summary of recovery objectives, performance criteria and actions is provided in Table 2. Details of each recovery action are described in Appendix 1.

Implementation Cost

The estimated cost of implementing the national recovery plan is \$0.68 million over five years, as summarised below and detailed in Table 3.

Year 1	Year 2	Year 3	Year 4	Year 5	Total Cost
\$205,000	\$178,000	\$110,000	\$100,000	\$85,000	\$678,000

Table 2: Summary of Recovery Objectives, Performance Criteria and Actions

Specific Objectives	Performance Criteria	Actions		
Objective 1: Investigate the biology and ecology of the Corangamite Water Skink to facilitate effective conservation management.	The taxonomy, genetic variability and key elements of the life history and demography of <i>E. t. marnieae</i> are determined and the results incorporated into recovery management of the taxon.	 1.1 Reassess and if required, revise the taxonomy of <i>E. t. marnieae</i>. 1.2 Investigate the genetic variability of <i>E. t. marnieae</i> populations. 1.3 Determine the habitat requirements of <i>E. t. marnieae</i>, especially vegetation structure and floristics of grasslands/wetlands, relationship between the rock size, structure and aggregation pattern and waterbody characteristics. 1.4 Determine movements, seasonality and habitat use of <i>E. t. marnieae</i>. 1.5 Determine key ecological parameters of the life history of <i>E. t. marnieae</i>. 1.6 Investigate the interactions between <i>E. t. marnieae</i> and other species of sympatric rock-dwelling skinks 		
Objective 2: Determine and manage threats to the Corangamite Water Skink and its habitat.	There is no decrease in the number <i>E. t. marnieae</i> populations and sites occupied, and there is a stable or increasing total number of adult lizards.	 2.1 Investigate ground water/surface water interactions and the implications of ground water irrigation on <i>E. t. marnieae</i> habitat. 2.2 Investigate the effects of grazing on the habitat of <i>E. t. marnieae</i>. 2.3 Investigate the effects of recreational activity on the habitat of <i>E. t. marnieae</i>. 2.4 Investigate the effects of predation, particularly by introduced predators, on <i>E. t. marnieae</i>. 2.5 Undertake periodic threat assessments at all <i>E. t. marnieae</i> sites, determine the severity of these threats and implement remedial action. 2.6 Provide training for land managers involved in activities which may affect <i>E. t. marnieae</i> and its habitat. 		
Objective 3: Protect and manage habitat for the Corangamite Water Skink.	There is an increase in the total area of habitat on public and private land that is managed for the conservation of <i>E. t. marnieae</i> .	 3.1 Consider the inclusion of representative areas of the habitat of <i>E. t. marnieae</i> throughout its range in reserves. 3.2 Ensure long-term sympathetic management of <i>E. t. marnieae</i> and its habitat on non-reserve land, by developing conservation management agreements with landholders controlling <i>E. t. marnieae</i> habitat across the range of the taxon. 3.3 Establish and implement appropriate management arrangements and guidelines for reserves containing <i>E. t. marnieae</i>. 3.4 Liaise with grassland/wetland managers to establish and implement interim management guidelines for landholders responsible for non-reserve land which contains <i>E. t. marnieae</i> and/or its habitat. 3.5 Include <i>E. t. marnieae</i> habitat in specific local government 		

		 conservation zonings. 3.6 Periodically review guidelines for the management of <i>E. t. marnieae</i> habitat, as new information on the biology of the subspecies, and on threats and their amelioration, becomes available.
Objective 4: Determine population trends and viability for the Corangamite Water Skink.	Representative sites from each population are monitored annually, population viability analysis of selected populations have been conducted and the results used for conservation management of <i>E. t. marnieae</i> .	 4.1 Conduct annual monitoring on 14 representative sites (at least 1 site per population) to identify population trends of <i>E. t. marnieae</i>. 4.2 Undertake population viability analysis of <i>E. t. marnieae</i> populations and use results to prioritise management activities.
Objective 5: Establish and maintain a captive population of Corangamite Water Skinks.	If there is a demonstrated need or opportunity, a captive population of at least 10 adult <i>E. t. marnieae</i> will be established and maintained at a suitable facility.	 5.1 Define the need for and role of a captive population of <i>E. t. marnieae</i> and set objectives for captive management. 5.2 Determine the location and conditions for a captive population. 5.3 Source animals for captive maintenance, considering genetics and ensuring that wild populations are not compromised. 5.4 Maintain a captive population and use in biological studies as appropriate.
Objective 6: Determine if there is a need for salvage and translocation of Corangamite Water Skinks.	The need for and feasibility of salvage and translocation of <i>E. t. marnieae</i> from threatened sites is determined and, if required, appropriate protocols developed and implemented.	 6.1 Determine the circumstances under which <i>E. t. marnieae</i> may be salvaged from doomed sites, and develop agreed protocols. 6.2 Determine the potential objectives, feasibility and appropriateness of translocation. 6.3 Determine the circumstances under which <i>E. t. marnieae</i> may be translocated, and develop agreed protocols.
Objective 7: Increase landholder and community awareness of and participation in the recovery program for the Corangamite Water Skink.	There is an increase in the number of landholders participating in conservation management of <i>E. t. marnieae</i> and broader community involvement in conservation and on the recovery team is maintained.	 7.1 Identify and approach specific landholders with <i>E. t. marnieae</i> habitat on their land to participate in conservation management of the taxon, providing support such as land management incentives. 7.2 Encourage broader community involvements in projects directed at the conservation of <i>E. t. marnieae</i> and native grasslands/wetlands, especially on public land. 7.3 Produce information material on volcanic plain grasslands and wetlands, and <i>E. t. marnieae</i> conservation and management, for access by community groups, landholders, and private and government organisations. 7.4 Publicise in various media and at forums the conservation status of <i>E. t. marnieae</i>, up-dates and progress on its recovery and encourage the reporting of any sightings.

Management Practices

The underlying premise for this Plan is that recovery of *E. t. marnieae* will depend on a multipronged approach involving habitat conservation, restoration and management, combined with an understanding of the ecological and biological requirements of the subspecies. The emphasis is on using knowledge to better implement *in situ* management techniques that protect populations and promote breeding and recruitment. To achieve this, recovery actions are primarily structured to (i) acquire baseline ecological and biological data, (ii) assess habitat condition including ecological and biological function, (iii) protect populations to maintain or increase their size, and (iv) to engage the community in recovery actions. On-ground site management will aim to mitigate threatening processes and thereby insure against extinction.

Broad scale protection measures applicable to all populations include legal protection of sites (where possible – it will not be possible to provide this protection on some private land), habitat retention and liaison with land managers including private landholders to secure sympathetic management of the subspecies on their land. Management agreements with non-government landholders have and will continue to play a crucial role in the conservation of *E. t. marnieae*. It is clear that *E. t. marnieae* populations can persist in the long-term on rural agricultural land that is appropriately managed. Consequently, reserves are not the only solution to conserving the subspecies, and are viewed as only part of the management strategy.

Strategies to improve our knowledge of the ecological and biological requirements of *E. t. marnieae* and their response to environmental processes are currently underway, and further actions are advocated in this Recovery Plan. These actions focus on understanding the relationships between *E. t. marnieae*, its habitat and numerous threatening processes, and defining appropriate management. Community participation in recovery actions will continue to be sought, and the implementation of interim management will continue until optimal management guidelines are formulated.

Recovery and management of threatened fauna is heavily reliant on sound information utilised by a strong and communicative network of organisations and individuals from within government, universities, private consultants and other nature conservation interests. Implementation of this Recovery Plan will involve an integrated approach using a team of committed scientists, students, consultants and on-ground natural resource managers to ensure the most efficient and effective use of resources. Any actions contemplated which involve potential changes to the habitat of *E. t. marnieae*, should be referred to the Department of the Sustainability, Environment, Water, Population and Communities (DSEWPaC) in accordance with requirements of the EPBC Act.

Affected Interests

Several organisations have legislative and management responsibilities relating to *E. t. marnieae*, and will be involved in all stages of this Recovery Plan. At a national level, the taxon is listed as a threatened species under the EPBC Act, administered by DSEWPaC. Any action that will have, or is likely to have, a significant impact on a taxon listed on this legislation will trigger the EPBC provisions, necessitating approval from the Commonwealth Environment Minister.

In Victoria, the Department of Sustainability and Environment has responsibility for the management of threatened species in Victoria. As some populations occur in the parks system, Parks Victoria also has management responsibilities of this taxon within their estate. Most populations occur on private land, necessitating the involvement of private individuals. Under the EPBC Act, these individuals have a responsibility to ensure that any development on their properties does not harm *E. t. marnieae*. Any such developments commencing since the inception of the EPBC Act will trigger a referral. An action that would remove, modify or degrade habitat of *E. t. marnieae* and that results in a significant impact on the subspecies may require referral to the Commonwealth Environment Minister under the EPBC Act for a decision

on whether assessment and approval of the action is required. Private landowners can and have facilitated monitoring and recovery actions for *E. t. marnieae* by permitting access to habitat on their land, consulting with agencies and individuals involved in these activities, and ensuring that their own activities do not negatively impact the subspecies or its habitat on or near their properties.

Role and Interests of Indigenous People

Indigenous communities on whose traditional lands *E. t. marnieae* occurs have been advised, through the relevant regional Indigenous facilitator, of the preparation of this Recovery Plan and invited to provide comments and be involved in implementation of the Recovery Plan.

Biodiversity Benefits

The Recovery Plan includes a number of potential biodiversity benefits for other species and vegetation communities throughout the range of *E. t. marnieae*. Principally, this will be through the protection and management of habitat. There is a broad range of threatening processes that are acting upon populations of *E. t. marnieae*; mitigation of these processes will have wide-ranging benefits for maintenance of ecological processes and biodiversity conservation.

The broad habitat of E. t. marnieae occurs within the 'Natural Temperate Grasslands of the Victorian Volcanic Plain', an ecological community listed as Critically Endangered under the EPBC Act (DEWHA 2009). The subspecies is also intrinsically linked to wetlands of the volcanic plain, that have declined significantly since European settlement (Sheldon 2005). Consequently, the conservation of E. t. marnieae and its habitat will aid the conservation of such grassland and wetland areas and the suite of threatened species associated with them. Specific Victorian and Commonwealth listed threatened species that are associated with E. t. marnieae sites include the Growling Grass Frog (Litoria raniformis), Brolga (Grus rubicundus), Blue-billed Duck (Oxyura australis), Freckled Duck (Stictonetta naevosa), Basalt Greenhood (Pterostylis basaltica), Salt-lake Tussock Grass (Poa sallacustris) and Curly Sedge (Carex tasmanica). Management of E. t. marnieae populations on Lake Corangamite, which is part of the Western District Lakes Ramsar site, will contribute to the Australian Government's obligations as a signatory to the Ramsar Convention to maintain the lake's ecological character (DNRE 2002; Sheldon 2005). Threatened ecological vegetation communities that will benefit from the conservation of E. t. marnieae include Stony knoll shrubland, Plains grassland, Plains grassy woodland, Plains grassy wetland, Plains sedgy wetland, Aquatic herbland/Plains sedgy wetland mosaic and Saline lake verge herbland/sedgeland mosaic.

Conservation efforts for *E. t. marnieae* will also contribute to efforts to educate the public about the plight of threatened species. The Corangamite Water Skink has acted as a 'flagship species' for highlighting broader nature conservation issues and threats, particularly associated with wetlands, such as habitat degradation, water quality issues and climate change.

Social and Economic Impacts

The implementation of this Recovery Plan will have minimal social and economic impact. Most populations of *E. t. marnieae* are on private land used mainly for agriculture. However, the area occupied by *E. t. marnieae* does not exceed 2% of any given landowner's property and in most cases is less. The remaining rocky habitat occupied by the skink also has very little agricultural value, so *E. t. marnieae* is an ideal threatened species for landholders to retain and preserve on their properties with no net loss in agricultural productivity, as has been evidenced by the cooperative approach from several landowners involved in conservation efforts for this lizard (Peterson 2006). Given the sympathetic attitudes of many landholders in the region, it has been possible to modify agricultural practices in the small areas occupied by *E. t. marnieae* such that adverse impacts on the habitat have been mitigated with little, if any, net loss in agricultural productivity. Some areas of public land where the taxon occurs are used for recreation or other

community activities, but conservation efforts (e.g. fencing, signage, track closures) will have minimal negative social impact.

There are considerable positive benefits in protecting *E. t. marnieae* habitats. The protection of these areas will augment intrinsic natural values enjoyed by visitors to such areas. These benefits complement the management aims of reserved land where this subspecies occurs, and visitors to these areas provide economic benefits for the local districts. Involving the community and private landholders in recovery efforts can foster a sense of pride in contributing to conservation programs and sense of ownership/responsibility for a threatened taxon present on their properties. Land acquisition to establish a system of managed reserves is extremely expensive, and may be possible in only a few instances. Conservation of *E. t. marnieae* must be viewed as a long-term and on-going process, to be achieved largely by sympathetic management of private lands via various agreements and management.

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REFERENCES

DEWHA. (2009). *Natural Temperate Grassland of the Victorian Volcanic Plain: A nationally threatened ecological community*. Policy Statement 3.8 Department of Environment, Water Resources, Heritage and the Arts, Canberra.

DNRE. (2002). Western District Lakes Ramsar Site: Strategic Management Plan Department of Natural Resources and Environment, East Melbourne.

Gibbs J. P. (1993). Importance of small wetlands for the persistence of local populations of wetland-associated animals. *Wetlands* **13**(1), 25-31.

Hutchinson M. N. & Rawlinson P. A. (1995). The Water Skinks (Lacertilia: *Eulamprus*) of Victoria and South Australia. *Records of the South Australian Museum* **28**(**2**), 185-207.

Joyce E. B. (1988). Newer Volcanic Landforms. In: *Geology of Victoria* (ed J. G. D. a. J. A. Ferguson) pp. 419-26. Jenkin Buxton, Melbourne.

Knights E. (2003). *Home range and feeding ecology of the Corangamite Water Skink, Eulamprus tympanum marnieae*. Unpublished B.Sc. Honours Thesis. La Trobe University, Bundoora.

Malone B. S. & Peterson G. N. L. (in prep). Spatial Ecology of the Endangered Corangamite Water Skink, *Eulamprus tympanum marnieae*, in Southern Australia. *Wildlife Research*.

NRE. (2003). *Victoria's native vegetation management: A framework for action* Department of Natural Resources and Environment, Melbourne.

Ollier C. D. & Joyce E. B. (1964). Volcanic physiography of the western plains of Victoria. *Proceeding of the Royal Society of Victoria* **77**, 357-77.

Peterson, G. (1997) Personal observation. Department of Sustainability and Environment, Warrnambool, Victoria.

Peterson, G. (2010). Personal communication. Department of Sustainability and Environment, Warrnambool, Victoria.

Peterson G. (2004). Unpublished data. Department of Sustainability and Environment, Warrnambool, Victoria.

Peterson G. (2009). Unpublished data. Department of Sustainability and Environment, Warrnambool, Victoria.

Peterson G. (2010). Unpublished data. Department of Sustainability and Environment, Warrnambool, Victoria.

Peterson G. N. L. (1997). Ecology, Evolution and Conservation of the Eulamprus quoyii complex in Central Southwestern Victoria. Unpublished B.Sc. Honours Thesis. La Trobe University, Bundoora.

Peterson G. N. L. (1999). *Distribution and conservation status of the Corangamite Water Skink* (*Eulamprus tympanum marnieae*) on the Victorian Volcanic Plain. Final Report to the Research Advisory Group of the Grassy Ecosystem Reference Group. Melbourne.

Peterson G. N. L. (2000). Corangamite Water Skink (Dreeite) Recovery Plan, Research Phase. Annual Report to September 2000. Unpublished Report to the Endangered Species Program, Environment Australia, Canberra.

Peterson G. N. L. (2001). Corangamite Water Skink (Dreeite) Recovery Plan, Research Phase. Annual Report to September 2001. Unpublished Report to the Endangered Species Program, Environment Australia, Canberra.

Peterson G. N. L. (2002). Corangamite Water Skink (Dreeite) Recovery Plan, Research Phase. Annual Report to September 2002. Unpublished Report to the Endangered Species Program, Environment Australia., Canberra.

Peterson G. N. L. (2006). *Corangamite Water Skink case study: Monitoring of modified management regimes*. Threatened Species and Farming, Department of Sustainability and Environment, East Melbourne.

Robertson H. & Fitzsimons J. (2004). *Dreeite Nature Conservation Reserve Management Statement* Department of Sustainability and Environment, East Melbourne.

Robertson P. (1998). *Recovery Plan for the Corangamite Water Skink (Eulamprus tympanum marnieae)* Unpublished report to Environment Australia, Canberra.

Robertson P. & Lowe K. (1999). *Corangamite Water Skink (Dreeite) - Ecology and Status* Unpublished Report to the Endangered Species Program, Environment Australia, Canberra.

Robertson P. & Peterson G. N. L. (2000). *Management Options and Guidelines for Eulamprus tympanum marnieae Sites*. Unpublished discussion paper to the Corangamite Water Skink National Recovery Team, Melbourne.

Rohr D. H. (1997). Demographic and life-history variation in two proximate populations of a viviparous skink separated by a steep altitudinal gradient. *Journal of Animal Ecology* **66**, 567-78.

Ross J. (1999). *Identification of Priority Areas for Protection and Establishment of Protected Areas: Victorian Volcanic Plain Bioregion*. Parks Flora and Fauna, Department of Natural Resources and Environment, Victoria, Melbourne.

Scott I. A. W. & Keogh J. S. (2003). Genetic variability within and between populations of Corangamite Water Skink (Eulamprus tympanum marnieae) and Southern Water Skink (Eulamprus tympanum) in western Victoria. Unpublished report to the Department of Natural Recourses and Environment, Melbourne. School of Botany and Zoology, Australian National University, Canberra.

Scroggie M. (2002). An assessment of monitoring requirements for the Corangamite Water Skink, Eulamprus tympanum marnieae. Department of Sustainability and Environment, Arthur Rylah Institute for Environmental Research, Melbourne.

Scroggie M. (2005). An analysis of monitoring data for the Corangamite Water Skink Eulamprus tympanum marnieae. Department of Sustainability and Environment, Arthur Rylah Institute for Environmental Research, Melbourne.

Sheldon R. A. (2005). *Corangamite Wetlands Strategy 2006-2011*. Corangamite Catchment Management Authority, Colac.

Skeats E. W. & James A. V. G. (1937). Basaltic barriers of Western Victoria. *Proceedings of the Royal Society of Victoria* **49(2)**, 245-78.

Sumner J. (2009). Personal communication. Museum Victoria, Melbourne.

Willis J. H. (1964). Vegetation of the basalt plains in western Victoria. *Proceedings of the Royal Society of Victoria* **77**, 397-419.

TABLE 3: RECOVERY ACTIONS, COSTS AND TIMELINES

Action	Description	Priority	Responsibility	Feasibility	Cost estimate					
					Year 1	Year 2	Year 3	Year 4	Year 5	Total
1	Biology, ecology				\$0	\$0	\$0	\$0	\$0	\$0
1.1	Taxonomic review	1	RT, DSE	High	\$10,000	\$0	\$0	\$0	\$0	\$10,000
1.2	Population genetics	1	DSE, MV, ANU	High	\$20,000	\$15,000	\$0	\$0	\$0	\$35,000
1.3	Habitat requirements	1	DSE, LTU	High	\$25,000	\$25,000	\$0	\$0	\$0	\$50,000
1.4	Movement, habitat use	1	DSE, LTU	High	\$10,000	\$10,000	\$0	\$0	\$0	\$20,000
1.5	Life history	1	DSE, LTU, UB	High	\$10,000	\$10,000	\$10,000	\$0	\$0	\$30,000
1.6	Sympatric interactions	2	RT, DSE	High	\$5,000	\$0	\$0	\$0	\$0	\$5,000
2	Threats				\$0	\$0	\$0	\$0	\$0	\$0
2.1	Water management	1	RT, DSE	Medium	\$10,000	\$10,000	\$10,000	\$0	\$0	\$30,000
2.2	Grazing impacts	1	DSE, LTU	High	\$10,000	\$10,000	\$10,000	\$10,000	\$15,000	\$55,000
2.3	Recreational impacts	2	RT, DSE	High	\$5,000	\$0	\$0	\$0	\$0	\$5,000
2.4	Predation	1	RT, DSE	Medium	\$10,000	\$10,000	\$10,000	\$0	\$0	\$30,000
2.5	Threat assessments	1	DSE, RT, LTU	High	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$25,000
2.6	Training	1	DSE	High	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$15,000
3	Habitat Management				\$0	\$0	\$0	\$0	\$0	\$0
3.1	Reservation	1	DSE	High		Potenti	al cost unknow	'n		
3.2	Site management and liaison	1	DSE	High	\$25,000	\$25,000	\$25,000	\$25,000	\$25,000	\$125,000
3.3	Reserve management	1	DSE	High	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000
3.4	Manager liaison	1	RT, DSE	High	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000
3.5	Conservation zonings	1	DSE	High	\$15,000	\$5,000	\$0	\$0	\$0	\$20,000
3.6	Management guidelines	1	RT, DSE	High	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000
4	Population trends				\$0	\$0	\$0	\$0	\$0	\$0
4.1	Annual monitoring	1	DSE	High	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$75,000
4.2	Population viability analyses	1	RT, DSE	High	\$0	\$0	\$0	\$20,000	\$0	\$20,000
5	Captive population				\$0	\$0	\$0	\$0	\$0	\$0
5.1	Role and objectives	3	RT, ZV	High	\$2,000	\$0	\$0	\$0	\$0	\$2,000
5.2	Location, conditions	3	RT, ZV	High	\$2,000	\$0	\$0	\$0	\$0	\$2,000
5.3	Source	3	RT, ZV	High	\$0	\$5,000	\$0	\$0	\$0	\$5,000
5.4	Captive maintenance	3	RT, ZV	High	\$0	\$10,000	\$5,000	\$5,000	\$5,000	\$25,000
6	Salvage and Translocation				\$0	\$0	\$0	\$0	\$0	\$0
6.1	Salvage	2	RT	High	\$3,000	\$0	\$0	\$0	\$0	\$3,000
6.2	Translocation	2	RT, DSE	High	\$3,000	\$0	\$0	\$0	\$0	\$3,000
6.3	Translocation protocol	2	RT, DSE	High	\$0	\$3,000	\$0	\$0	\$0	\$3,000
7	Community Participation				\$0	\$0	\$0	\$0	\$0	\$0
7.1	Landholder liaison	1	DSE	High	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$25,000
7.2	Community participation	2	RT, DSE	High	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000
7.3	Information material	2	RT, DSE	High	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000
7.4	Publicity	2	RT, DSE	High	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000
	Totals				\$205,000	\$178,000	\$110,000	\$100,000	\$85,000	\$678,000

Abbreviations: DSE=Dept. Sustainability & Environment (Vic); RT=Recovery Team; ZV=Zoos Victoria; LTU=La Trobe University; MV=Museum Victoria , ANU=Australian National University , UB=University of Ballarat.

APPENDIX I: RECOVERY OBJECTIVES AND ACTIONS-DETAIL

Specific Objective 1. Investigate the biology and ecology of the Corangamite Water Skink to facilitate effective conservation management.

Performance Criterion: The taxonomy, genetic variability and key elements of the life history and demography of *E. t. marnieae* are determined and the results incorporated into recovery management of the taxon

Explanation: Although significant research has been undertaken recently, current knowledge of the ecology of *E. t. marnieae* is still not adequate for the informed formulation of a complete list of appropriate management guidelines. A program of targeted research is required to address specific management questions.

Action 1.1: Reassess and if required, revise the taxonomy of *E. t. marnieae*.

Recent molecular analysis revealed that *E. t. marnieae* as currently recognised, is comprised of animals from two distinct genetic groups, each with separate evolutionary origins (Scott and Keogh 2003). A revision of the taxonomy of *E. t. marnieae* is therefore required.

Responsibility: Recovery Team, Department of Sustainability & Environment

ACTION 1.2: Investigate the genetic variability of *E. t. marnieae* populations.

Knowledge of the levels of genetic variability within and between *E. t. marnieae* populations and the extent of isolation is essential to assist in determining various management requirements, such as: minimum population sizes; distribution of reserves/managed areas; maintenance and/or establishment of dispersal corridors, and the desirability/requirement for, and methodology of, any translocations. A project examining small scale movement and dispersal and population structure at the microsatellite level is currently underway.

Responsibility: Department of Sustainability & Environment, Museum Victoria, Australian National University

<u>ACTION 1.3</u>: Determine the habitat requirements of *E. t. marnieae*, especially vegetation structure and floristics of grasslands/wetlands, relationship between the rock size, structure and aggregation pattern and waterbody characteristics.

This work is required to assess the outcomes of direct management of vegetation, particularly with respect to grazing and habitat rehabilitation, the influence of size, seasonal persistence and water quality on *E. t. marnieae*, optimal wetland and water management conditions, habitat rehabilitation/reconstruction techniques and the mitigation of the effects of activities such as commercial rock removal and/or rock crushing.

Responsibility: Department of Sustainability & Environment, La Trobe University

ACTION 1.4: Determine movements, seasonality and habitat use of *E. t. marnieae*.

Field investigations to address this action have been completed as part of a postgraduate research project, by Knights (2003) and Malone & Peterson (in prep). Further interpretation of the results from the project is required.

Responsibility: Department of Sustainability & Environment, La Trobe University

ACTION 1.5: Determine key ecological parameters of the life history of *E. t. marnieae*.

Knowledge of key life history parameters, such as age-specific mortality, natality and migration is essential to conduct population viability modelling. Field investigations to address these parameters have been completed as part of a postgraduate research project and by Peterson (1997). Specific research to assess survivorship and recruitment of juveniles is still required.

Responsibility: Department of Sustainability & Environment, La Trobe University, University of Ballarat

<u>ACTION 1.6</u>: Investigate the interactions between *E. t. marnieae* and other species of sympatric rock-dwelling skinks.

Two species of large rock-dwelling skinks occur broadly within the habitat of *E. t. marnieae*. One – the Black Rock Skink (*Egernia saxatilis intermedia*) – is narrowly sympatric with some populations of *E. t. marnieae* and *E. t. marnieae*/*E. t. tympanum* intermediates. It may have the capacity to aggressively and/or competitively exclude the smaller water skinks from some areas. Research is required to determine the level of this perceived threat.

Responsibility: Recovery Team, Department of Sustainability & Environment

Specific Objective 2. Determine and manage threats to the Corangamite Water Skink and its habitat.

Performance Criterion: There is no decrease in the number of *E. t. marnieae* populations and sites occupied, and there is a stable or increasing total number of adult lizards.

Explanation: Apart from establishing reserves and managed areas, this is probably the most critical measure required for the conservation of *E. t. marnieae*. All threats, including, development proposals, must be identified and their potential effects assessed.

<u>ACTION 2.1</u>: Investigate ground water/surface water interactions and the implications of ground water irrigation on *E. t. marnieae* habitat.

Wetland persistence is a major factor influencing the viability of *E. t. marnieae* populations. The relationship between ground water and surface water and the implications of ground water irrigation is required to direct water management and allocation that may be impacting *E. t. marnieae* habitat.

Responsibility: Recovery Team, Department of Sustainability & Environment

ACTION 2.2: Investigate the effects of grazing on the habitat of *E. t. marnieae*.

Field investigations to address this action have been completed as part of a postgraduate research project and by Peterson (2006). On-going monitoring is now required to assess the outcomes of direct management of habitat with respect to grazing.

Responsibility: Department of Sustainability & Environment, La Trobe University

<u>ACTION 2.3</u>: Investigate the effects of recreational pressures on the habitat of *E. t. marnieae* and on the demography of the subspecies.

Recreational pressures (camping, boating and angling) are high in some areas of *E. t. marnieae* habitat. It is essential to understand the effects of these potential disturbances on populations so that optimal management guidelines can be formulated.

Responsibility: Recovery Team, Department of Sustainability & Environment

<u>ACTION 2.4</u>: Investigate the effects of predation, particularly by introduced predators, on *E. t. marnieae* populations.

These effects are currently unknown, but may be significant, particularly given the high numbers of foxes and cats in *E. t. marnieae* habitats. The need for management of predators, and appropriate methodologies, must be determined.

Responsibility: Recovery Team, Department of Sustainability & Environment

<u>ACTION 2.5</u>: Undertake periodic threat assessments at all *E. t. marnieae* sites, determine the severity of these threats and implement remedial action.

This action proposes to undertake a periodic threat assessment at all populations of *E. t. marnieae* to ensure that identified threats are being managed and to detect and manage any new threats that may arise.

Responsibility: Recovery Team, Department of Sustainability & Environment, La Trobe University

<u>ACTION 2.6</u>: Provide training for land managers involved in activities that may affect *E. t. marnieae* and its habitat.

This action proposes to develop and implement a training program to educate land managers and others (e.g. utility maintenance) that may be working in or near *E. t. marnieae* habitat, about the lizard and its habitat and to avoid incidental or accidental damage or other problems.

Responsibility: Department of Sustainability & Environment

Specific Objective 3. Protect and manage habitat for the Corangamite Water Skink.

Performance Criterion: There is an increase in the total area of habitat on public and private land that is managed for the conservation of *E. t. marnieae*.

Explanation: Currently only one population of *E. t. marnieae* is included within a reserve gazetted primarily for the purpose of nature conservation. A number of other populations occur within other public land (i.e. lake reserves) but these cannot currently be considered secure due to undefined boundaries, existing long term leases and/or recreational activities. Currently two private properties that contain *E. t. marnieae* are protected under conservation covenants and a number of sites on private land are managed specifically for the lizard. Appropriate management across this system of reserves and managed land is essential to provide for the long-term maintenance of suitable habitat. To wait for the results of this research before implementing some habitat management measures at other sites would however be unacceptable and potentially disastrous for the subspecies. Accordingly, interim management guidelines have been formulated and implemented at other areas of habitat (Robertson and Peterson 2000). As further information becomes available from investigations into ecology, habitat, threat identification and monitoring, management guidelines will be continually refined and updated.

<u>ACTION 3.1</u>: Consider the inclusion of multiple representative areas of the habitat of *E. t. marnieae* throughout its extant geographic range in reserves.

A prioritised list of areas for the development of reservation proposals, management agreements and management guidelines has been developed and utilised by the National Recovery Team. The priorities for acquiring reserves and managed areas was governed by the application of principles that considered the subspecies distribution, genetic structure, extent of habitat, longterm viability, threats, composition and size of each population. In accordance with these principles and sites identified, continue the inclusion of high priority sites into formal or informal reserves.

Responsibility: Department of Sustainability & Environment

<u>ACTION 3.2</u>: Ensure long-term sympathetic management of *E. t. marnieae* and its habitat on non-reserve land, by developing conservation management agreements with landholders controlling *E. t. marnieae* habitat across the range of the taxon.

Most known sites which support *E. t. marnieae* are on private rural land or non-secure public land. In the majority of cases, the land managers or owners have no obligation to manage the land sympathetically for *E. t. marnieae*, and they have the ability to destroy populations through inappropriate land-use practices. Land management agreements have however in most cases been made with these land managers or owners. These private landowners have been informed about *E. t. marnieae* and native grassland/wetland conservation, and been assured that the presence of *E. t. marnieae* on their properties does not mean that they will lose their land or incur significant loss in productivity. On-going agreements and agreements with new managers/owners are essential. Differing mechanisms for developing co-operative conservation management agreements will be available, some examples of which include: conservation covenant, conservation tenders, Land for Wildlife, Public Area Management Agreements.

Responsibility: Department of Sustainability & Environment

<u>ACTION 3.3</u>: Establish and implement appropriate interim management arrangements and guidelines for reserves containing *E. t. marnieae*.

The Corangamite Water Skink occurs on public land with different management objectives. This action will develop management objectives for conservation of *E. t. marnieae* on public land and incorporate these into management arrangements for the various public land tenures.

Responsibility: Department of Sustainability & Environment

<u>ACTION 3.4</u>: Liaise with grassland/wetland managers to establish and implement interim management guidelines for landholders responsible for non-reserve land which contains *E. t. marnieae* and/or its habitat.

All landholders with land supporting *E. t. marnieae* have and will continue to be engaged by DSE. Workshops will continue to be held where landholders are provided with information about *E. t. marnieae* conservation and where open discussion of the issues relevant to the landholders can lead to appropriate conservation agreements. Landholder participation in conservation management activities is to continue to be encouraged and assisted. Interim management for which financial assistance to landowners should be provided includes: fencing to exclude grazing, revegetation programs, wetland rehabilitation and predator control. Other programs of potential benefit to the management of *E. t. marnieae* habitat should continue to be investigated and utilised (e.g. conservation tenders, Greening Australia and Landcare programs). Water authorities will be approached to develop management practices sympathetic to conservation of *E. t. marnieae*.

Responsibility: Recovery Team, Department of Sustainability & Environment

ACTION 3.5: Include *E. t. marnieae* habitat in specific local government conservation zonings.

An environmental significant overlay (ESO) has been developed across a number of *E. t. marnieae* habitat areas in one municipality. This will be expanded to cover all habitat areas in this municipality and in other local government areas.

Responsibility: Department of Sustainability & Environment, local government

<u>ACTION 3.6</u>: Periodically review guidelines for the management of *E. t. marnieae* habitat, as new information on the biology of the subspecies, and on threats and their amelioration, becomes available.

Management guidelines will be continually refined and updated as further information becomes available from the various investigative actions proposed in this plan.

Responsibility: Recovery Team, Department of Sustainability & Environment

Specific Objective 4: Determine population trends and viability for the Corangamite Water Skink.

Performance Criterion: Representative sites from each population are monitored annually, population viability analysis of selected populations have been conducted and the results used for conservation management of *E. t. marnieae*.

Explanation: Monitoring of *E. t. marnieae* populations and of their habitats and threats is essential to continually assess the effects of management actions, to enable rapid response should populations decline, and to provide feedback such that management is continually refined.

<u>ACTION 4.1</u>: Continue the implementation of a minimum disturbance monitoring strategy to identify population trends at a representative series of sites.

Fourteen monitoring transects have been established across the distribution of *E. t. marnieae*. These transects have been monitored annually, at a minimum, via a statistically certified visual census technique (Scroggie 2002) since the late 1990s. In concert with the visual census at three transects, a capture-mark-recapture program has also been implemented. The monitoring has been used to track population changes and assess population demographics, to experimentally assess effects of imposed management, and to refine management.

Responsibility: Department of Sustainability & Environment

<u>ACTION 4.2</u>: Undertake population viability analyses of *E. t. marnieae* populations, to assist in determining appropriate management.

When adequate information is available from the other research actions, population modelling and viability analysis to assess extinction risk should be undertaken to enable refinement of management guidelines.

Specific Objective 5: Establish and maintain a captive population of Corangamite Water Skinks

Performance Criterion: If there is a demonstrated need or opportunity, a captive population of at least 10 adult *E. t. marnieae* will be established and maintained at a suitable facility.

Explanation: A captive colony of *E. t. marnieae* derived from salvaged individuals or from the off-spring of translocated animals could be held in a zoo or reptile park for scientific studies, and secondarily displayed to educate the public about the state of threatened grasslands and their component species. The well-interpreted display of threatened species is an acknowledged role of zoos in conservation, with the aim of increasing visitor understanding of the range of threats and their respective solutions.

<u>ACTION 5.1</u>: Define the need for and role of a captive population of *E. t. marnieae* and set objectives for captive management.

Currently there are no *E. t. marnieae* held in captivity, and the taxon does require a captive breeding program as part of its conservation. However, this may change, especially if there are genetically significant populations threatened with imminent extinction. The need for and role of any captive population needs to be documented in case a future need for captive management arises, and/or there is an opportunity to take animals into captivity (e.g. from salvage).

Responsibility: Recovery Team, Zoos Victoria

ACTION 5.2: Determine the location and conditions for a captive population.

Should a captive population proceed, the location of such a population and conditions under which the taxon is to be held and displayed need to be documented.

Responsibility: Recovery Team, Zoos Victoria

<u>ACTION 5.3</u>: Source animals for captive maintenance, considering genetics and ensuring that wild populations are not compromised.

The source of any captive population needs to be carefully considered. Animals may become available from salvage efforts, or from the off-spring of animals to be translocated. Animals will not generally be taken directly from the wild for captivity unless there is an over-riding management need.

Responsibility: Recovery Team, Zoos Victoria

ACTION 5.4: Maintain a captive population and use in biological studies as appropriate

Should a captive population of *E. t. marnieae* be established, it will be held at an appropriate zoo or reptile park, for the primary purpose of supporting the recovery program for the taxon, such as use in biology and ecology studies. There may be secondary opportunities for display to educate the public about the state of threatened grasslands and their component species.

Responsibility: Recovery Team, Zoos Victoria

Specific Objective 6: Determine if there is a need for salvage and translocation of Corangamite Water Skinks.

Performance Criterion: The need for and feasibility of salvage and translocation of *E. t. marnieae* from threatened sites is determined and, if required, appropriate protocols developed and implemented.

<u>Explanation</u>: The removal of lizards from the wild for salvage purposes should be considered only as an absolute last resort. However, periodically, development decisions may cause sites supporting populations of *E. t. marnieae* to be unavoidably destroyed. If such developments proceed, then contingencies must be made to minimise effects on the overall conservation of *E. t. marnieae*. One possible contingency is the salvage of animals, either for captive maintenance, or for potential translocation to other sites. Clear guidelines are needed on the circumstance under which such measures might be contemplated, their potential contribution to the recovery program, and their feasibility. A protocol must be established for their conduct.

<u>ACTION 6.1</u>: Determine the circumstances under which *E. t. marnieae* may be salvaged from development sites, and develop agreed protocols.

An approved project, with identified facilities and other appropriate resources must be available, and any costs of removal and maintenance are to be met by the developer/proponent.

Responsibility: Recovery Team, Department of Sustainability & Environment (resources to be provided by any developer/proponent of approved actions)

ACTION 6.2: Determine the potential objectives, feasibility and appropriateness of translocation

Translocation of animals from a site should only be contemplated in exceptional circumstances. Currently, there is a much higher priority placed on adequately conserving existing populations than on restoring or creating others. However, translocation of animals for genetic purposes or for reintroduction is a potentially valuable tool in wildlife management. It is a complex and long-term undertaking, for which rigorous protocols must be in place, in accordance with international, commonwealth and state and territory guidelines. In the case of *E. t. marnieae*, a clear need must be established before translocation(s) are contemplated. For re-introductions, it will then be necessary firstly to identify sites where *E. t. marnieae* populations were once present but have since disappeared, and secondly to understand the cause of the local extinction, and eliminate or minimise the threat.

Responsibility: Recovery Team, Department of Sustainability & Environment

ACTION 6.3. Determine the circumstances under which *E. t. marnieae* may be translocated, and develop agreed protocols

If translocation is considered appropriate, either for genetic reasons or for re-establishing populations, an agreed protocol will be developed according to current international, commonwealth and state guidelines. One important consideration in any translocation program is the development of effective procedures for monitoring translocated animals, without which it is impossible to determine the success or failure of the translocation.

Specific Objective 7: Increase landholder and community awareness of and participation in the recovery program for the Corangamite Water Skink.

Performance Criterion: There is an increase in the number of landholders participating in conservation management of *E. t. marnieae* and broader community involvement in conservation and on the recovery team is maintained

Explanation: There is great potential for community involvement in the conservation of E. t. marnieae, natural temperate grasslands, and volcanic plain wetlands. As many of the remaining patches of these environments are on private land, the involvement of the community will be critical to the successful recovery of both E. t. marnieae and its habitat. In particular, landowner participation in and support for conservation programs will be crucial. Commitment from landholders towards conservation of this subspecies may include a range of measures such as conservation covenants, conservation tenders, Land for Wildlife membership, Greening Australia and Landcare incentives, co-operative agreements, or less formal agreements on land management practices. There are already several community groups which have made great contributions to E. t. marnieae conservation. Greening Australia, Catchment Management Authorities, Trust for Nature, Landcare groups and local government bodies have and will continue to be pivotal in co-ordinating community efforts. All of these organisations, other similar groups, and individuals will be instrumental in the implementation of this Recovery Plan, and will be included in many actions.

<u>ACTION 7.1</u>: Identify and approach specific landholders with *E. t. marnieae* habitat on their land to participate in conservation management of the taxon, providing support such as land management incentives.

As most locations where *E. t. marnieae* occurs are either partially or totally on private land, conservation management of the species is dependent upon a cooperative approach with landowners. There is other potential habitat on private land, and this also offers opportunities for establishing new sites for the taxon through habitat rehabilitation. This action will identify likely areas and liaise with landholders to protect more sites where the taxon occurs.

Responsibility: Department of Sustainability & Environment

<u>ACTION 7.2</u>: Encourage broader community involvement in projects directed at the conservation of *E. t. marnieae* and native grasslands/wetlands, especially on public land.

There is the opportunity for community participation in the recovery program for *E. t. marnieae* including in survey, monitoring, habitat rehabilitation works on public land and reporting sightings of the taxon to authorities. This will be encouraged and facilitated by the Recovery Team.

Responsibility: Recovery Team, Department of Sustainability & Environment

<u>ACTION 7.3</u>: Produce information material on volcanic plain grasslands and wetlands, and *E. t. marnieae* conservation and management, for access by community groups, landholders, and private and government organisations.

Information brochures and other material will be produced and distributed such as at field days and made available on the web, to keep the community informed of conservation issues for the taxon and its habitat, and on broader conservation issues on the Victorian Volcanic Plain.

<u>ACTION 7.4</u>: Publicise in various media and at forums the conservation status of *E. t. marnieae*, up-dates and progress on its recovery and encourage the reporting of any sightings.

Reporting on the progress to recovery for *E. t. marnieae* will be an important aspect the program, to keep stakeholders up-to-date with what is happening, and informing the broader community and maintaining support for the program.