Recovery from the brink of extinction

Victorian Grassland Earless Dragon

Critically Endangered → Endangered

2024 - 2030

ZOOS VICTORIA
Fighting Extinction

Contents

The Victorian Grassland Earless Dragon (VGED) provides arguably the most exciting conservation opportunity available in Australia. Presumed extinct in Victoria until January 2023, the VGED is poised to be downlisted within the next five to ten years based on focused interventions and identifying new habitat.

The species was discovered unexpectedly during a predevelopment environmental survey. Since discovery, 29 animals have been collected and brought to Melbourne Zoo to commence a Conservation Breeding Program. The first breeding season has delivered over 55 eggs, building on knowledge gained through caring for the Canberra Grassland Earless Dragon. Modelling shows that with a population of 500 individuals, we will be able to dependably release 100 VGED per year back into the wild.

We are embarking on a race against time to find suitable habitats and enhance them to meet the needs of VGED and what we hope will be a rapidly expanding population. It is possible that we will grow the population to over 2,500 individuals located across six or more populations, meeting the criteria of abundance, distribution, and positive trends in both indicators to significantly reduce the risk of extinction and downlist the species. Zoos Victoria is confident that with support we will be able to move the VGED from *Critically Endangered* to *Endangered* within the next decade, and *near threatened* then after.

The plan for the next five years identifies five goals that are essential to growing the size and quality of the ex-situ population to underpin recovery, securing the last known extant population, and successfully establishing an additional five populations through (re-)introductions. Collectively, these actions will set the species on a pathway to downgrading to *Endangered*.

Goal 1: Secure and appropriately managed rediscovery site, and essential monitoring and research implemented.

Goal 2: Ex-situ insurance and conservation breeding program of appropriate size to prevent extinction, maintain/improve genetic diversity, and facilitate reintroductions.

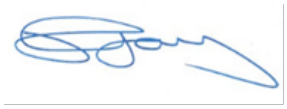
Goal 3: Additional habitat appropriately managed and further declines mitigated.

Goal 4: Multiple, self-sustaining populations of VGED across its natural geographical range leading to the downlisting of its conservation status.

Goal 5: Conservation activities and recovery of the VGED and its native grasslands effectively communicated.

This plan and opportunity to recovery a previously lost species is incredibly exciting. In only 10 months the VGED has gone from “presumed extinct” to over 80 individuals in ex situ care and one known wild population. Imagine what we might achieve over a five-year period.

Yours sincerely,



Dr Jenny Gray

Chief Executive Officer
Zoos Victoria

Organisation Description

Zoos Victoria (ZV) is a world-leading zoo-based conservation organisation, dedicated to fighting wildlife extinction. Across our four zoos, Healesville Sanctuary, Kyabram Fauna Park, Melbourne Zoo (MZ), and Werribee Open Range Zoo, we focus on conservation, education, social and behavioral change, and connecting people with the wildlife.

Each zoo provides a unique and immersive experience, attracting visitors from around the world. ZV is also a member of, and accredited by, the Australasian Zoo and Aquarium Association with world-leading welfare and husbandry standards.

Our zoos inspire animal lovers of all ages. By strengthening the connection between people and animals, we hope to protect wildlife and wild places.

In 2009, ZV took a stand, making conservation the foundation of everything we do. Over 14 years we have transformed into a world leading zoo-based conservation organisation. In 2014 we made a commitment to secure and recover 20 native threatened species due to their likelihood of extinction in the wild. In 2019 we strengthened that commitment by prioritising 27 threatened species in our 2019-24 Wildlife Conservation Master Plan where we outline the actions to secure and recover each species.

Our Threatened Species Teams apply specialised skills in monitoring, research and population management, and ex situ conservation breeding to secure the future of these species in partnership with First Peoples, community, government, and non-government organisations. ZV now runs and delivers more conservation breeding and recovery programs than any other institution within Australia. We are specialists in conservation breeding and insurance, translocation, and management of threatened species, leading the recovery of several herpetofauna including Baw Baw Frog, Southern Giant Burrowing Frog and Spotted Tree Frog. We have also played key roles establishing breeding management programs for Northern and Southern Corroboree Frog, Fijian Crested Iguana, Broad-headed snakes, and Canberra Grassland Earless Dragon. We lead or significantly contribute to conservation breeding and insurance for other iconic species such as Orange-bellied Parrot, Tasmanian Devil, Lord Howe Island Stick Insect and Helmeted Honeyeater. Our team of highly qualified experts and our facilities ensure we are well placed to deliver this project.

Specifically, MZ has played a fundamental role in establishing a Conservation Breeding Program (CBP) for the Canberra Grassland Earless Dragon (CGED). Our role in this program was born out of conservation breeding being identified as the likely key action required to ensure the persistence and recovery of the Victorian Grassland Earless Dragon (VGED) should it ever be rediscovered. Over the past four years our staff have honed and refined their husbandry skills on CGED and have bred many hundreds of animals which have been used for translocation to wild sites, research, and establishment of a second CBP. The success of this program has ensured ZV have the expertise, skills and husbandry protocols to rapidly establish a CBP/insurance population for the VGED.

Since the VGED rediscovery in early 2023, ZV have led the recovery effort. A Recovery Team was formed including representatives from ZV, the Victorian and Australian Government environment agencies, Museums Victoria, Traditional Owners, and Wildlife Profile Pty Ltd. ZV have also secured and directed funding to support the field survey and monitoring program and arranged for MZ to receive animals from the wild to establish the world's first VGED CBP.

Acknowledgements

The development of the VGED Conservation Action Plan has only been possible by the leadership, experience, insights and passion from several individuals and organisations. Support, inspiration, and leadership has been provided by Zoos Victoria's CEO Dr Jenny Gray, Director of Wildlife Conservation and Science Dr Sally Sherwen, and Director of Melbourne Zoo Sheri Horiszny.

The VGED Recovery Team have led the development and consultation for the plan. This includes contributions from Nick Clemann, Deon Gilbert, Rory Keenan, Alex Mitchell, and Garry Peterson from Zoos Victoria; Peter Robertson from Wildlife Profiles; Dr Joanna Sumner and Dr Jane Melville from Museums Victoria; Phil Papas from the Victorian Department of Energy, Environment & Climate Action and Tim McGrath Australian Department of Climate Change, Energy, the Environment & Water.

Dr Marissa Parrott, Zoos Victoria provided significant support through the develop and consolation on the Population Viability Analysis, which largely underpins this plan. Jodie Odgers, Zoos Victoria provided oversight, coordination, and encouragement throughout the development of the plan and entire process.

Special thanks to Nick Clemann, Peter Robertson, Garry Peterson, and Rick Hammond (Zoos Victoria) for providing the images throughout the document.

Foreword

As we find ourselves in the midst of the sixth mass extinction, largely driven by human impact, we face unprecedented global species extinction and biodiversity loss. The threats driving this loss are varied and complex and changing at a rapid rate, biodiversity conservation has never been more challenging. However, as the global community unites in our drive to reverse this trend and find solutions to fight for better environmental outcomes there is always the cause for optimism and persistence in the face of these wicked problems.

In amongst the despair there are moments of joy – the recent rediscovery of a beautiful lizard, the critically endangered Victorian Grassland Earless Dragon (*Tympanocryptis* pinguicolla; VGED). Thought to be lost forever it is now known to be clinging to existence in just a single remnant in the most rapidly disappearing ecosystem in Australia.

To the casual observer, the grasslands occupied by the VGED may lack the splendour of more iconic ecosystems such as rainforests, forests, and alpine ecosystems, yet they are just as important to their endemic biota. When you take a closer look, it is an awe-inspiring ecosystem, filled with flora and fauna found nowhere else on earth. Two hundred years ago Europeans pushed into southern Australia irrevocably changing the landscapes and in doing so, setting in motion catastrophic losses of biological diversity.

The native temperate grasslands of south-eastern Australia provided opportunities for exploitation. Mostly flat, and with palatable grasses, they were ideal for grazing farm animals, and for creating settlements that expanded to include Australia's largest city (Melbourne), and the State of Victoria's second largest city (Geelong). Not only were these grasslands cleared to the extent that today less than 1% remains, but they were also simultaneously degraded; invasive plants and animals came to dominate many areas; rocks were removed; the land was ploughed; and chemicals added to the soils.

Since the 1980s, a dedicated team of conservation ecologists have fought these losses and sought to learn about and conserve the native fauna of south-eastern Australia. While doing this, one or two animals took on an almost mystical aura; species that many thought were probably lost, but maybe – just maybe – might be hanging on in some little pocket of habitat. The VGED was one of these species.

In the very late 1960s, the last VGEDs were found near Geelong. Conservation ecologists had images of a small, feisty little agamid ('dragon') lizard. Longitudinal stripes along the creature's back; a pink mouth when the lizard reared in defense; beautiful yellow on the throats and belly of breeding males. And for more than 50 years that was all we had – a photographic record of loss. The area where the last VGEDs were found was lost under the inexorable waves of urban and industrial development.

Over the years these ecologists mounted search after search. They suffered through demoralizing days wading through weeds, driving past newly minted housing estates, driving new freeways carving up the landscape, and driving home on new roads through old grasslands, with nothing to show for long days of hope and perspiration.

The ecologists also needed to hold the line against an ever-growing view that the VGED was gone. They argued that small, ectothermic vertebrates had low energetic needs, and could therefore hang on in small patches. Maybe on roadsides with remnant native grassland relics. Maybe beside train tracks. Maybe on airfields for military land. Sometimes they heard claims that people had seen a VGED. 'Pictures or it didn't happen' became the increasingly frustrated reply!

Then, in early January 2023, someone produced pictures.

Victorian Grassland Earless Dragon. Credit: Nick Clemann, Zoos Victoria.

A little brown lizard with a russet dusting from the surrounding soil. With just the right stripes. From a grassland on the outskirts of greater Melbourne. Two young consultants were looking at a lizard that was different from what they usually found in these last vestiges of native grasslands. Calls were made. The identity of the lizard was confirmed by leading ecologists. Those same ecologists were on the ground within 48 hours, assessing, and quickly establishing both a field survey and monitoring program, and a Recovery Team for the rediscovered Victorian Grassland Earless Dragon.

Recovery efforts didn't stop there. A relationship was formed with the landholders; Melbourne Zoo reptile keepers, fresh from a remarkably successful breeding program with a closely related earless dragon, were mobilized, ready to receive lizards and start a conservation breeding program; the right people at all levels of government were briefed; genetic analyses were planned…

Zoos Victoria has a commitment that no Victorian terrestrial vertebrate species will go extinct on our watch. As with all our Fighting Extinction priority threatened species, Zoos Victoria is committed to securing the future of the Victorian Grassland Earless Dragon.

With your support, we will leverage our expertise and galvanise actions already underway through committed ongoing funding and put the VGED on a fast track to downgrading in threat status by 2030.

Yours sincerely,

Nick Clemann

Senior Biologist Herpetology
Zoos Victoria

Abbreviations

CBP: Conservation Breeding Program

CGED: Canberra Grassland Earless Dragon

DEECA: Victorian Department of Energy, Environment and Climate Change

DCCEEW: Federal Department of Climate Change, Energy, the Environment and Water

EPBC Act: The Federal *Environment Protection & Biodiversity Conservation Act 1999*; Australia's national threatened species legislation

FE: Zoos Victoria's Fighting Extinction program

FFG Act: The Victorian *Flora & Fauna Guarantee Act 1988*; the Victorian State-level threatened species legislation

MZ: Melbourne Zoo

NGO: Non-government organisations

NTG: Native temperate grasslands

PVA: Population Viability Analysis

SSC: Saving Species Challenge Program

VGED: Victorian Grassland Earless Dragon

WCS: the Wildlife Conservation & Science team within Zoos Victoria

WTOAC: Wadawurrung Traditional Owner Aboriginal Corporation

ZV: Zoos Victoria

Project Leaders

GARRY PETERSON *(BSc Hons, Zoology)*
General Manager Threatened Species, Zoos Victoria, and Chair VGED National Recovery Team

Garry has 30 years of experience in herpetological research in particular reptile ecology and conservation. He is the lead author of the Corangamite Water Skink National Recovery Plan, chair of three Recovery Team's including the VGED. Garry has extensive experience in researching, recovering, and managing grassland reptiles and associated habitats including Striped Legless Lizard and Corangamite Water Skink. He has led extensive surveys for the VGED from 2008-2013 using a variety of passive and active techniques.

PETER ROBERTSON *(BSc Hons, Zoology)*
Wildlife Profiles - Wildlife Ecologist

Peter has decades of experience working and researching reptiles and working towards their recovery including *Tympanocryptis sp*. and is leading the in-situ component for the VGED. Peter has conducted extensive targeted surveys for *T. pinguicolla* in Victoria between 1993 and 2017, worked on ACT species (now *T. lineata*), and *T. petersi* in NW Victoria and SW NSW, prepared the first National Recovery Plan for *T. pinguicolla* (Robertson and Cooper 2000), prepared the updated National Recovery Plan for *T. pinguicolla* in 2009, in conjunction with Murray Evans (ACT Department of Territory and Municipal Services), co-authored 'Reptiles of Victoria – a Guide to Conservation and Ecology' (Robertson and Coventry 2019), which included a summary of the then current knowledge of *T. pinguicolla*. Peter has led the field component of this project since the rediscovery.

NICK CLEMANN *(BSc Hons, Zoology)*
Senior Biologist Herpetology, Zoos Victoria

Nick has been leading programs on threatened species in south-eastern Australia for more than 25 years. He recently joined the Wildlife Conservation & Science division of Zoos Victoria. He also has an honorary position with Museums Victoria. He has published seminal papers on declines of Victoria's reptiles and is lead author of the book *Frogs of Victoria: A Guide to Identification, Ecology and Conservation*. He has been an invited participant on international wildlife expeditions in Uzbekistan, Kazakhstan, and Argentina.

DEON GILBERT *(PhD Candidate, Zoology; BSc Hons, Zoology)*
Threatened Species Biologist – Herpetofauna, Zoos Victoria

Deon has over 22 years of zoo husbandry and threatened species recovery experience with reptiles and amphibians at Melbourne Zoo and zoological institutions in Queensland. He also has extensive field and research experience with threatened amphibians and reptiles. Deon is responsible for strategic development of ZVs threatened herpetofauna programs including VGED and is a member of the VGED Recovery Team.

RORY KEENAN

VGED Husbandry Specialist, Melbourne Zoo, Zoos Victoria

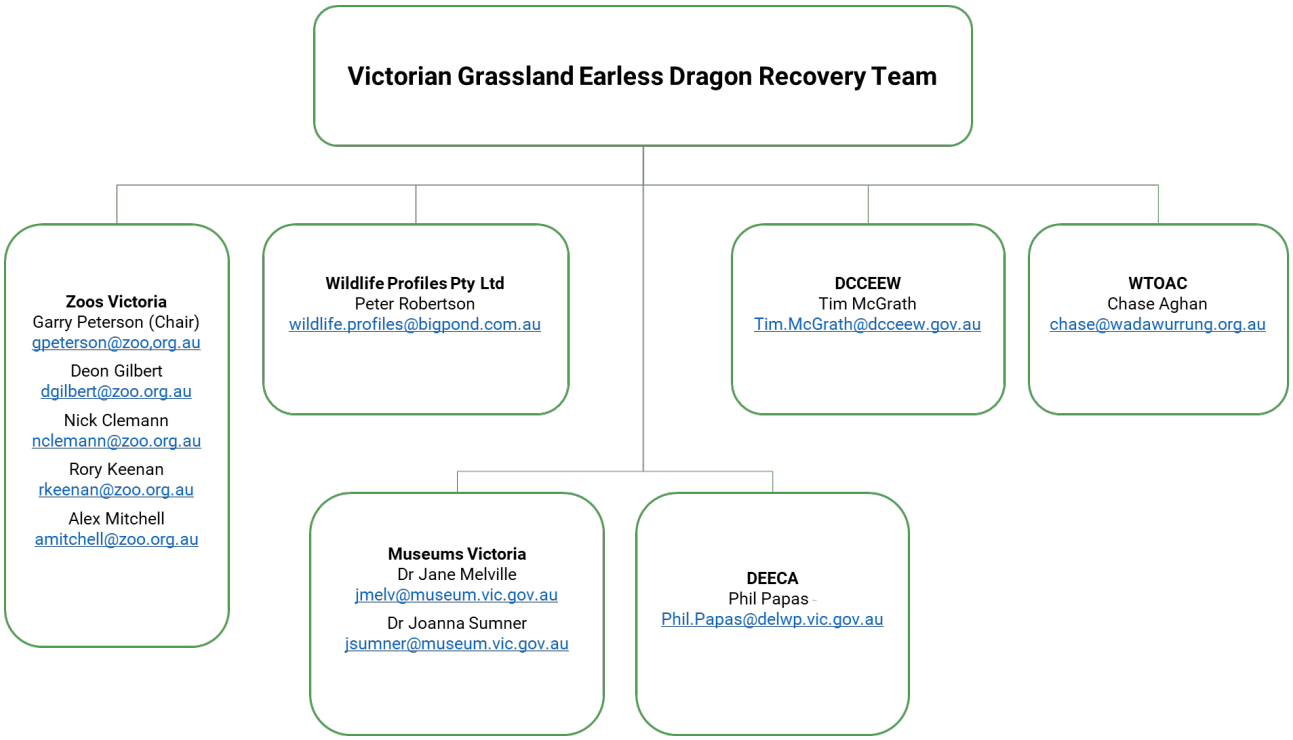
Rory has 16 years of captive husbandry experience with herpetofauna across multiple institutions and he is responsible for management of the reptile collection at Melbourne Zoo. Rory is responsible for the management of Canberra Grassland Earless Dragon (*T. lineata*) ex situ population at Melbourne Zoo. He has established the conservation breeding program for VGED at Melbourne Zoo and has already successfully bred VGED. Rory also has field survey experience for GED in Victoria, is the Zoo and Aquarium Association Species Coordinator for Fijian Crested Iguana and currently manages a studbook for Canberra Grassland Earless Dragon.

ALEX MITCHELL

Life Science Manager, Herpetology, Melbourne Zoo, Zoos Victoria

Alex has 19 years' captive husbandry experience with reptiles and amphibians at multiple institutions and is responsible for all operational aspects of the Herpetology Precinct at Melbourne Zoo. Alex is Co-convener of the Zoo and Aquarium Association Reptile Taxon Advisory Group, and Species Coordinator for the Broad-headed Snake. He is involved in the development of husbandry techniques for CGED at Melbourne Zoo.

Organisational Chart for the Implementation Team



Species Information

The VGED is Australia's most imperilled reptile (Tingley, R., et al. 2019; Geyle, H.M., et al. 2020; Garnett, S.T., et al. 2022) and until recently was presumed likely extinct. There have been no substantiated records of the species since 1969, and sightings then were considered rare. The VGED has a long history of habitat loss and degradation since European incursion, and losses continue. Surveys over past decades in remnants of suitable native grassland failed to find VGEDs; however, the species is very cryptic, and may have been present but not detected in some surveys.

Unexpectedly, in January 2023 this tiny lizard was rediscovered on farmland west of Melbourne, Australia's largest city. The current IUCN listing pre-dates a 2019, taxonomic revision that resulted in the Grassland Earless Dragon being split into four species, the VGED retained the scientific name *T. pinguicolla*. Since the taxonomic revision, the VGED has been assessed against IUCN criteria under Australian State (DELWP 2021) and Federal legislation (DCCEEW 2023) and classified as critically endangered under both. A submission for assessment by the IUCN was submitted in September 2023.

The VGED is currently known from a single site of approximately 90 ha of native grassland. It's possible this is the last of a remnant population, and on the brink of collapse and extinction, having already been through an extreme genetic bottleneck. Population size and extent is unknown, with 29 animals detected since rediscovery. The population was discovered during ecological surveys for a proposed urban/industrial development, and the rediscovery site and surrounding areas of similar remnant grasslands are at a risk of being destroyed for urban development.

Primary causes of historical decline and local extirpation are loss, degradation, and fragmentation of habitat from agricultural, and more recently, urban, and industrial development (CoA 2023). Remaining areas of habitat have declined from weed invasion, overgrazing, lack of biomass management, drought, and collapse of invertebrate fauna, which not only constitute the diet of the VGED, but also provide the spider burrows that are vital shelter sites for the lizard (CoA 2023).

Historical records are mostly from the Keilor Plains, an area of flat to undulating volcanic grasslands that stretched west from Melbourne to Geelong, an area of approx. 3,000 km^2 (CoA 2023) This area was historically dominated by tufted grasses such as wallaby and kangaroo grass and tussock poa. Very little of this habitat remains, and what does remain is often in small, isolated patches that are degraded, and often available for development under the Melbourne Strategic Assessment strategy (MSA); the rediscovery site abuts the MSA boundary, where destruction of native grasslands is occurring.

Invertebrate burrows are an important habitat attribute for VGEDs. They are used for shelter, egg laying, overwintering, protection from predators and temperature extremes. Of the dragons found since rediscovery, several were in wolf spider burrows. Invertebrates are the main food source of VGEDs, but there is anecdotal evidence of widespread and severe losses and declines of invertebrates, probably due to habitat destruction, a drying and warming climate, and widespread use of insecticides.

Like other species in the genus, the VGED is likely an annual species, maturing within one year and living for less than two years in the wild (CoA 2023). This makes them highly vulnerable to significant population fluctuations following poor conditions or stochastic events. Longevity can be extended to greater than five years in captivity, highlighting the extent of the threats and early life history mortality the dragons face in the wild.

History & Taxonomy

The VGED was initially described and known by the scientific name *Tympanocryptis lineata* (Lucas and Frost 1893). In 1948, Mitchell described the subspecies *T. lineata pinguicolla*. Later, the subspecies was elevated to full species status as *T. pinguicolla* and included the earless dragons known from around Melbourne, those occurring in the Australian Capital Territory and adjoining parts of New South Wales, and those on the Monaro Tablelands in New South Wales. In 2019, Melville et al. split *T. pinguicolla*, into four species, recognizing the Australian Capital Territory and Monaro Tablelands as new species, and demonstrating that *T. pinguicolla* was restricted to Victoria, from grasslands north and west of Melbourne, to greater Geelong, some 70 kms to the south-west of Melbourne. Since this revision, the common name for *T. pinguicolla* is accepted to be Victorian Grassland Earless Dragon (VGED). This taxonomic revision underscored the heightened extinction risk to each of these species, particularly the VGED, which, at the time of revision, had not been recorded since 1969 despite numerous targeted surveys, and occasional unsubstantiated claims of sightings. The holotype of *T. pinguicolla*, specimen R2468a, is held by the South Australian Museum; the locality on this specimen is given as 'Southern Victoria'.

Morphology and Physiology

Melville et al. (2019, page 17) provide the following information to distinguish *T. pinguicolla* from congeneric species:

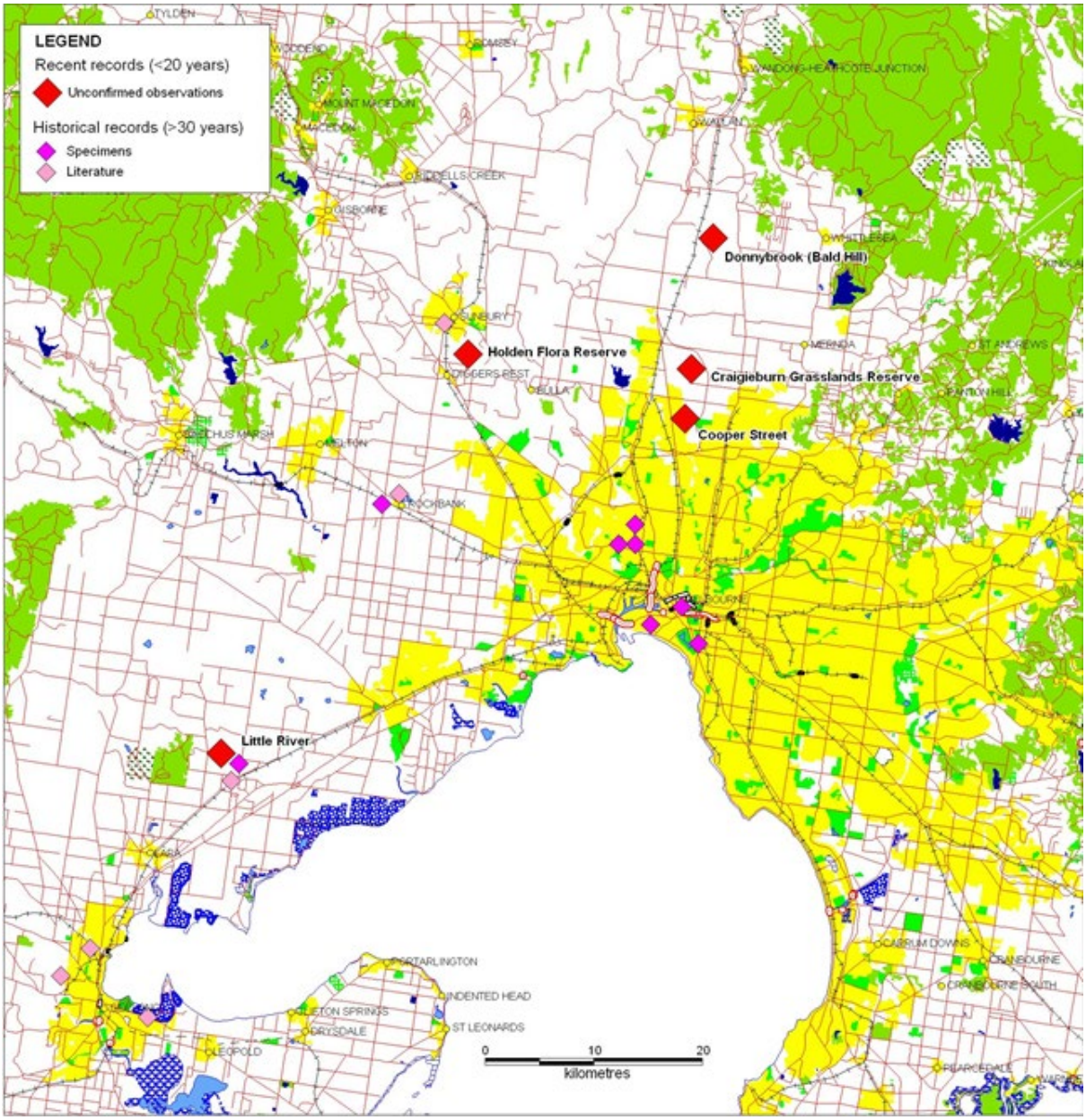
Comparison to other species. Tympanocryptis pinguicolla, with a distribution restricted to grasslands on the Victorian basalt plains around Melbourne, is geographically isolated and does not occur in close proximity to any other Tympanocryptis species. Tympanocryptis lineata, and T. osbornei sp. nov. are geographically closest (greater than 300 km). Tympanocryptis pinguicolla can be distinguished from all other Tympanocryptis in its almost vertically oriented dorsal tubercles that either lack a terminal spine or have only a small projection. They further differ from the two southern highlands species (T. lineata and T. osbornei) in the presence of enlarged tubercular scales scattered on the thighs, compared to the absence of this scalation, and differ from the currently undescribed populations of Tympanocryptis in northwest Victoria and adjacent South Australia in frequently having six or seven transverse dark dorsal bands (versus never more than five) and in the presence (versus absence) of a lateral skin fold.

Most lizards that do or might co-occur with VGEDs are skinks, which are readily distinguished from the VGED by their smooth, overlapping scales. The endangered Striped Legless Lizard, *Delma impar*, a limbless lizard, also has smooth, overlapping scales, and lacking limbs it is easily distinguished from co-occurring lizards. Unlike the VGED, the Marbled Gecko *Christinus marmoratus* has expanded pads on the tips of its digits. All these lizards lack the rough appearance and characteristic small spines of the VGED. The species that is mostly likely to be confused with the VGED is, like the VGED, an agamid lizard; the Tree Dragon (or Jacky Lizard) *Amphibolurus muricatus* which also has rough skin and some small spines on the body. However, *A. muricatus* has different body proportions to the VGED, and the easiest diagnostic characteristic for distinguishing these species is the presence (*A. muricatus*) or absence (VGED) of external ear openings. Broadly speaking, *A. muricatus* is usually associated with trees or rocks, whereas the VGED is usually associated with treeless or mostly treeless areas.

Distribution

The VGED is restricted to the Australian State of Victoria, where historical records exist from the late 19th century until the late 1960s; no substantiated records occurred since 1969 until it was rediscovered in January 2023 after an absence of records (despite numerous targeted surveys) of 54 years (see map below). It is currently known from a single private property west of Melbourne containing approximately 90ha of native grassland/grassy woodland. Based on an intensive survey and monitoring program on this property, all records since the species was rediscovered are from an area of approximately 30ha; noting access to the entire 90ha's was initially limited.

Historically, the species was known from grasslands to the north and west of Melbourne, extending south-west to the area that is now greater Geelong. Although considered 'not uncommon' in grasslands within this range in the late 19th and early 20th centuries (Kershaw 1927), only a very modest number of reliable records exist prior to the rediscovery; most of these reliable records are voucher specimens held by Museums Victoria and the South Australian Museum. The grassland habitat in many of the locations of the records that pre-date the rediscovery have been destroyed for urban or industrial development, or by destructive agricultural practices (such as ploughing). The remaining grassland habitat is largely degraded and fragmented, and much of it remains highly vulnerable to further urban and industrial development.



Map. Distribution of VGED records (both confirmed and unconfirmed) taken from Robertson and Evans (2009/2012).

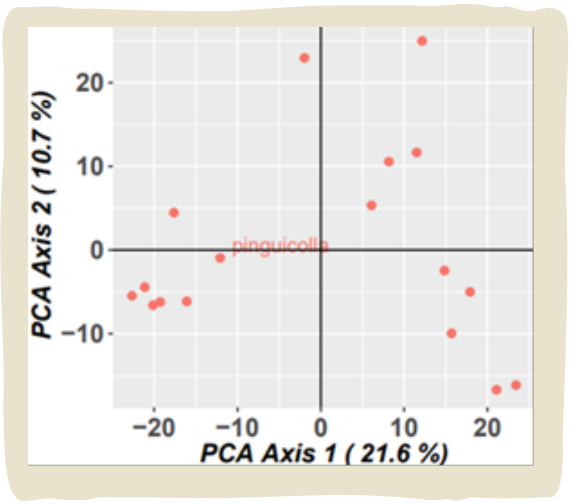
Abundance

Currently only one population of the VGED is known to persist. Whether other populations persist, where they are located, their demographics or trend, are unknown. However, it is possible that this is the only remaining population due to the extent of habitat loss across its range, the extent and duration of targeted and indirect surveys over the past 30 years, and the species' rapid decline during the first half of the 20th century. There is a strong possibility that the population is extremely small and continuing to decline.

Since the rediscovery of the VGED in January 2023, 29 individual VGEDs have been found (at the time of writing, November 2023). These comprise 17 males, 11 females, and one juvenile too small to be reliably sexed. All these lizards have been found in a small area on one property. A full genetic analysis is underway and due in coming months, with some preliminary results below.

In brief, Museums Victoria and the Bioplatforms Threatened Species Initiative analysed Diversity Arrays Single Nucleotide Polymorphism genotype data from >14,000 SNPs to determine the relatedness amongst 17 VGEDs then in captivity at MZ. This was an initial and time-critical step to provide data on Mean Kinship between the animals and determine appropriate pairings that could be undertaken during the animals first breeding season at MZ. A pairwise Relatedness matrix between all genotyped individuals indicated eight pairs of individuals for which there was either a Parent-Offspring or Full Sibling Relationship. Nine pairs with half-sibling relationship and 11 pairs with a level of relatedness equivalent to first cousins. Encouragingly, three individuals had no close relatives amongst the other VGEDs, and all animals have multiple suitable pairings available within the captive founder group. Overall relatedness levels indicate that this is likely a subset of a larger population as levels of relatedness vary within the animals analysed, and some animals have low levels of kinship. This provides hope that there are further animals, and further genetic diversity, yet to be discovered in the adjacent habitat.

A Principal Component Analysis (PCA), which summarises the structure and distribution of genetic variation between individuals, indicates that there is reasonable genetic diversity within the group of captive dragons (see below). However, it also indicates that the animals have been collected from a likely single population, as there are no distinct clusters within the data. Some animals have been collected from close to each other, and all have been collected from an area of approximately 6 ha (this is a consequence of the limited access to the property when the initial 17 animals were collected). A sample of 25-30 individuals will often encompass >90% of available genetic diversity in a population. Thus, further collections will be targeted at areas separated from the initial collection area by geographic distance to obtain the greatest level of genetic diversity and number of alleles. This will provide the best genetic health, adaptability, and resilience for the future. Analysis of allele number and rare alleles is currently underway, and results will be used to ensure the maximum genetic diversity of the species is maintained.



As would be expected from a likely isolated and single population, there is an indication of inbreeding, with the Observed Heterozygosity (Ho, 0.300) less than the Expected Heterozygosity (He, 0.329), and a positive individual inbreeding coefficient (FIS) of 0.11. The positive FIS suggests that mates are more closely related than would be expected on average, and there is a deficit of heterozygous alleles relative to the Hardy–Weinberg proportions. The level of genetic diversity, despite inbreeding levels, is quite high, suggesting there has been a rapid and recent decline in the population. Rapid breeding of the founder individuals in the conservation breeding program (CBP) at Melbourne Zoo will maintain this genetic diversity, with additional collection of further founders a high priority to expand the genetic base of the captive breeding and insurance program. Preliminary genetic data has been included in species-specific Population Viability Analysis (PVA) to provide guidance on conservation breeding requirements and the long-term maintenance of genetic diversity. Further analysis of these samples, and the inclusion of additional genetic samples, will provide further clarity on the genetic structure of the species.

At the time of writing, 29 individuals had been collected and brought to MZ to contribute to the conservation breeding and insurance program. Eleven clutches of eggs had already been laid in their first ex-site breeding season at the Zoo, and several more females were visibly gravid from mating either in the wild or at MZ. In late November 2023, successful hatching of one clutch had occurred.

Once the taxonomic revision is factored in, *T. pinguicolla* will be clearly eligible for listing as Critically Endangered under the IUCN criteria below. The IUCN Red List information on the four grassland earless dragon species has been collated and was submitted to the IUCN for assessment in September 2023. The following IUCN criteria support the listing of the species as Critically Endangered:

- B. Geographic range in the form of B2 (area of occupancy):
  - 2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a–c:
    - a. Severely fragmented or known to exist at only a single location.
    - b. Continuing decline, observed, inferred, or projected, in any of the following:
      - (i) extent of occurrence
      - (ii) area of occupancy
      - (iii) area, extent and/or quality of habitat
      - (iv) number of locations or subpopulations
      - (v) number of mature individuals.

Status population and trend

All records since the VGED was rediscovered in January 2023 are from three paddocks on a working sheep farm; thus, the only known wild population is not (yet, at least) eligible for IUCN Green Listing. As detailed above, the current IUCN Red List information and assessment of the VGED pre-dates the taxonomic revision of the species (Melville et al. 2019) and considers the range of *T. pinguicolla* to include populations in the Australian Capital Territory and New South Wales that are now known to be separate species. Given the VGED is now only known from a tiny area west of Melbourne, the species is eligible for, but has not yet been formally assessed for, listing as Critically Endangered under the IUCN Red List (details in preceding section). In Victoria the species is listed as Critically Endangered under the State-level *Flora & Fauna Guarantee Act* 1988. Since June 2023 the VGED is also listed as Critically Endangered at a national level under the *Federal Environment Protection & Biodiversity Conservation Act* 1999.

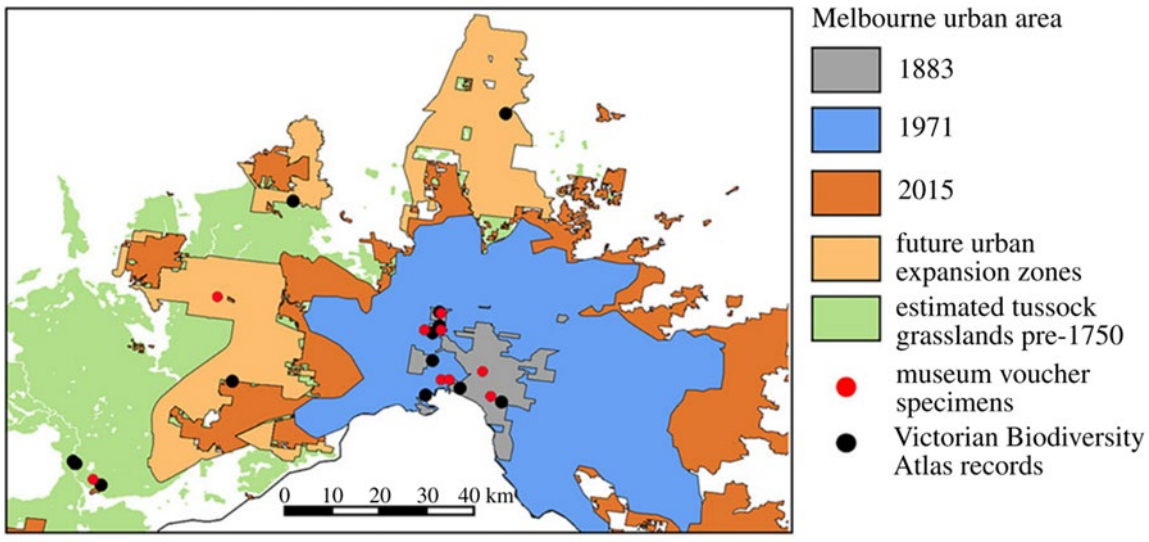


Figure 1. VGED historic distribution showing recorded sightings (Victorian Biodiversity Atlas) and museum voucher specimens. Note the current and future overlay of the Melbourne urban area. Taken from Melville et al. 2019.

This program will look to downgrade the proposed IUCN Red List classification by primarily expanding the number of in-situ populations from one to more than six by 2030 through successful (re-)introductions to the wild. This will assist in expanding the extant of occurrence and area of occupancy for the species by expanding the overall area of habitat the

species occupies through the new populations, and the extent occurrence by spreading the new populations spatially across the species historical range. The in-situ populations will also see the number of mature individuals increase rapidly through the (re-)introductions. Currently the single population is likely to number no more the 200 mature individuals. While the actual size of the recipient sites is currently unknown, a criterion of >100 ha of suitable habitat (and preferable >500 ha) has been set which should support a minimum of 200 individuals per site.

Habitat use

The VGED is dependent on one of the most threatened ecosystems in Australia, Natural Temperate Grasslands of the Victorian Volcanic Plains north and west of Melbourne. Historical VGED records are mostly from the Keilor Plains close to Melbourne, which were once dominated by tufted grasses such as *Austrodanthonia penicillata* (slender wallaby-grass), *Themeda triandra* (kangaroo grass) and *Poa labillardierei* (tussock poa) (Sutton 1916). Currently or historically occupied habitats are treeless or mostly treeless. Aspects of these habitats that are probably critical to VGED persistence include:

- The presence – but not necessarily dominance – of native grass tussocks is an important habitat attribute for the VGED. A 'Goldilocks' state of grasses and other ground-level vegetation, where the vegetation structure and amount of bare ground is just right – not too much, and not too little.
- Co-occurring native invertebrates are critically important in at least two ways – recent analyses of scats of wild VGEDs indicate that the lizard's diet comprises entirely of invertebrate prey, and the lizards use spider burrows to escape predators and weather extremes, and probably for laying their eggs. Invertebrate burrows are likely to be used for mating, egg laying, overwintering, and protection from predators and extreme low and high temperatures. Wolf spiders are abundant and widespread across Australia, including in grasslands of south-east Australia (Framenau & Baehr 2016; Humphreys 1973).
- Soil type and substrate structure is an important habitat attribute. Although the soil at the rediscovery site does not appear to crack during dry conditions, other earless dragon species use soil cracks for shelter and perhaps egg laying, and soil cracks may have been important for VGEDs in at least some areas; rocks (typically basalt) are a conspicuous component of the rediscovery site, and of most native grassland habitats within the historic range of the VGED. It is probable that suitable soil moisture is important for successful development of VGED eggs.
- Invertebrate burrows that are used by the VGED can be either positioned under, or alongside, loose basalt boulders, or they can be stand-alone burrows that are not associated with loose surface rock (Lucas & Frost 1894).

Habitat for the VGED consists of all areas that are currently occupied, or are either confirmed or inferred to have been occupied in the past based on:

1.The modelled distribution of the species, and

2.The actual or potential occurrence of important habitat attributes.

The VGED is cryptic and can be undetectable at known locations for extended periods of time despite intensive survey efforts (Clemann 2003; Clemann et al. 2013; Banks et al. 2017; numerous unpublished surveys, most led by Peter Robertson, using most techniques considered by the Recovery Team as suitable, such as pitfall trapping, artificial cover objects – usually roof tiles, artificial spider tubes, and rock rolling, although this last method is no longer recommended, because, even if rocks are returned to their original position, this methods degrades microhabitats used by numerous species). As a result, areas with important habitat attributes for the VGED that occur within the modelled distribution of the species may be occupied habitat where this species is has simply not been detected due to a lack of survey, or because surveys did not detect any VGEDs in the area.

Habitat for VGEDs occurs within the Critically Endangered Natural Temperate Grassland of the Victorian Volcanic Plain. However, VGEDs also occupy, and are likely to occupy, areas that fall below the condition thresholds for this threatened ecological communities. These are native grasslands and pastures with low floristic diversity that may have been subject to modification and degradation e.g., from intensive and prolonged grazing, fertiliser application, weed invasion, etc. As well as the possibility that VGED persist in less-than-pristine areas, these areas are important for the recovery of the VGED, particularly in relation to habitat restoration and reintroduction, and dispersal.

Major threats

The primary causes of historical decline and local extirpation of the VGED are clearing, degradation, and fragmentation of habitat from agricultural, and more recently, urban development. Remaining areas of habitat are often degraded by weed invasion, overgrazing or undergrazing, lack of biomass management, drought, and collapse of invertebrate fauna.

Native temperate grasslands (NTG) have been a conspicuous example of ecosystem destruction by colonising humans; less than 5% of earth's NTGs now occur in protected areas (Carbutt et al. 2017). At the time of incursion by European people, NTGs extended across the Victorian Volcanic Plains, but clearing, degradation, and fragmentation over the last two centuries by those people has been severe, and now less than 1% of these NTGs remain, and all of that is fragmented, and much of it is degraded. A direct consequence of these impacts is that all reptile's endemic to these grasslands in south-eastern Australia are listed as threatened (e.g., Adelaide Pygmy Blue-tongued Lizard *Tiliqua adelaidensis*, Striped Legless Lizard *Delma impar*, the 'lowland form' of Tussock Skink *Pseudemoia pagenstecheri*).

All records of the VGED, including the rediscovery site, occur in areas of historic and/current urban and industrial expansion. Many of the historical records occurred in areas that are now almost completely urbanized, such as the Melbourne suburbs of Essendon and Sunshine. Much of the current urban expansion is occurring in four 'growth' areas

around Melbourne totalling 60,000 hectares designated for urban development, where a process known as the Melbourne Strategic Assessment (MSA:) has occurred (https://www.msa.vic.gov.au/about). The MSA is an agreement between the Victorian State Government and the Australian Government to avoid individually assessing all areas of native vegetation that are to be destroyed in this urban growth program, and to offset these losses via the creation of two large reserves (the Western Grassland Reserve between Melbourne and Geelong, and the Grassy Eucalypt Woodland Reserve north of Melbourne). The reserves will ultimately comprise land that is currently native vegetation of varying condition, as well as areas of highly degraded land, such as former farmland.

While these reserves may contain areas that will be suitable for (re-)introduction of VGEDs, they will not be sufficient to provide enough habitat to secure the long-term conservation of the species; and it is probable that some of the grasslands that have been, are being, or will be destroyed are important for securing the VGED well into the future. It is also plausible that more grasslands will be needed for the VGED to cope with and adapt to a changing climate.

As well as outright loss of suitable native grasslands, a significant threat to the reptile fauna of these grasslands is degradation due to:

WEED ESTABLISHMENT AND SPREAD

Almost all remaining remnant grasslands within the historic range of the VGED contain weeds, and most have significant weed problems. The rediscovery site, which contains weeds but where weeds are also being managed, shows that VGEDs can persist in areas that have a moderate weed cover; however, the impact on VGED populations of different types and density of weeds is likely to be variable, and weed type and density is likely to interact with other abiotic and biotic factors in VGED habitat. For example, some weeds can shade-out the usually treeless grassland habitats, and various weeds can grossly affect the ground-level vegetation structure required by VGEDs. Weeds can also encourage or harbor both native and invasive predators (e.g., raptors, foxes, and cats). Weeds can also affect communities of native invertebrates that are essential elements of VGED habitat. Weed control methods such as slashing and the use of herbicides may also affect VGEDs and their habitats.

REMOVAL OR DESTRUCTION OF ROCKS

Native temperate grasslands within the known range of the VGED are typically rocky, with varying amounts of exposed bedrock and surface rocks and stones. Since the first years of farming by newly arrived European people, rock disturbance and removal has been common in these grasslands. In some areas the rocks have been used to make 'dry stone walls'; in other areas they are simply piled up; and many have been removed, often being sold in the landscape gardening trade. In recent years new machines are being used that strip rocks from grasslands, pulverize them, and deposit the resulting dust back onto the land; these machines can remove and destroy rocks that were too difficult to remove in the past. Thus, some rocky remnants that were too difficult to remove in the past, and remained as habitat for grassland fauna, are now able to be destroyed.

Rock rolling by reptile enthusiasts is a popular way of finding reptiles. Rocks disturbed in this way are often left displaced, but even when returned to their original location, the disturbance can render the under-rock habitat unsuitable for some or all the reptiles that shelter beneath rocks. This disturbance changes the microclimate and moisture regimes beneath rocks, and it can allow predators such as snakes to access sheltering animals; it frequently causes ants to swarm beneath the rocks, harming or expelling sheltering reptiles. Natural rock in these areas are millions of years old, but can be removed, degraded, disturbed, and destroyed very rapidly by humans.

Image: A 'dry stone wall' made of rocks removed from native temperate grasslands in southern Victoria (source: https://dswaa.org.au/dswaa-in-the-states/dswaa-in-victoria/)

APPLICATION OF CHEMICALS

Fertilisers, herbicides, and insecticides are commonly used on NTGs around Melbourne and Geelong. Fertilisers and herbicides grossly affect vegetation type, cover, and density. It is probable that that chemicals have also played a role in the severe decline in diversity and abundance of native invertebrates in these grasslands.

OVERGRAZING AND UNDERGRAZING

Both extremes on grassland biomass are detrimental to persistence of earless dragons. Overgrazing can result in almost total loss of ground-level vegetation structure, which can affect co-occurring invertebrate communities, and degrade or remove structure needed by VGEDs for thermoregulation, foraging, and shelter. Undergrazing of these grassland results in extremely dense vegetation, which probably detrimentally affects the lizard's ability to thermoregulate effectively, as well as their ability to see and capture invertebrate prey. Undergrazing is the probable proximate cause of the apparent demise of some populations of congeneric lizards in the Australian Capital Territory.

PLOUGHING/CROPPING

Ploughing and cropping of NTGs immediately renders areas unsuitable for VGED, because these activities disturb and/or remove rocks, destroy any remaining native vegetation, and destroy shelter sites such as spider burrows. The activity is also likely to kill individual lizards. It is not clear whether VGEDs will eventually recolonize areas that have been previously cropped; to do so would require a population of VGEDs within colonizing distance, and an absence of barriers. However, such areas could be suitable for habitat rehabilitation works to enable either natural recolonization or (re-)introduction of VGEDs.

INAPPROPRIATE FIRE REGIMES

Hot and unseasonal wildfires, which are likely to become more frequent and severe as the climate warms and dries, immediately remove most or all the vegetation cover in NTGs. Immediately after a fire, surface dwelling grassland reptiles such as VGEDs are more vulnerable to predators; both native and invasive predators (such as raptors and cats, respectively) are known to move into recently burnt areas to hunt (Doherty et al. 2023), and lizards in these areas may be doubly disadvantaged by the lack of vegetative cover, and because they stand out in the blackened landscape. Inappropriate fire may also alter vegetation composition and structure, reduce the availability of prey, and cause significant mortality to the lizards.

CLIMATE CHANGE/DROUGHT/WEATHER EXTREMES

Species that are rare, range-restricted, and/or have specialized habitat requirements are particularly susceptible to the effects of a changing climate. These effects can include changes to vegetation type, structure, and cover; extreme weather events; increased frequency, extent, and severity of droughts and fires. The eggs of the VGED require suitable temperatures and moisture regimes to develop, which will also be affected. A changing climate will affect co-occurring invertebrate communities, which will impact the diet of VGEDs, as well as potentially affecting the availability of suitable spider burrows for shelter and oviposition.

ELEVATED RATES OF PREDATION BY INVASIVE PREDATORS

Native predators that are likely to take VGEDs include elapid snakes, predatory birds, and perhaps some large predatory invertebrates. Invasive predators such as foxes, cats, mice, and rats may be particularly harmful to small, declining, and/or isolated populations of lizards; each of these invasive species are common at the rediscovery site, and within the historic range of the VGED.

POACHING, HABITAT DISTURBANCE CAUSED BY WILDLIFE ENTHUSIASTS

Rare and geographically restricted species are popular targets for poachers, and, as well as being highly desirable for local reptile keepers, they may command a high price from domestic and international collectors of reptiles. Wildlife photographers and those wanting to see rare species often also cause significant damage to reptile habitats as they attempt to find and capture these animals. The VGED Recovery Team have been careful to keep the rediscovery location from being widely known.

Use and trade

It is illegal under the *Victorian Wildlife Act* (1975) to capture, disturb, take, or trade in a range of native wildlife, including the VGED. However, as the rarest and most range-restricted vertebrate in Australia, the VGED is undoubtedly highly prized by people who wish to see, photograph, or even poach the species to keep or sell into the illegal wildlife trade. The risk these activities pose to the VGED is exacerbated by the fact that many people who have these interests are willing to cause catastrophic damage to critical habitat features (such as rock placement and burrows) to find and capture the lizards. Many areas around Melbourne and Geelong, including native grasslands, have been intensively 'worked over' by these types of people, with irreparable damage caused to habitats, including rock features that are many millions of years old. Impacts such as these are also exacerbated by the sharing of location information between people or groups, allowing even more people to target species such as the VGED.

Social media and digital photography have driven an upsurge in popularity of reptile photography. Amongst avid photographers, rare and threatened species are especially desirable. Unlike with bird and mammal photography, most reptile photography involves capturing and posing the animal, often after extracting it from shelter sites such as burrows or beneath rocks; much habitat is severely damaged in this way. It is probable that the VGED is currently the single highest priority for reptile photographers in Australia.

Australian reptiles are popular pets around the world, and illegal collection has long supported this trade. It is probable that the VGED would command high prices in the illegal wildlife trade, and both local and international interests are likely to be willing to pay locals to poach VGEDs.

Because of this, the location of the rediscovery site is shared by only those working on VGEDs. The Recovery Team are working closely with compliance staff from the Victorian Government to monitor the rediscovery site, and to try to detect any sharing of locality information.

Ex situ status

The VGED Conservation Breeding Program (CBP) has been established with support and endorsement from the National Grassland Earless Dragon Recovery Team, State and Federal Government, landowners, and partners. Animals are collected and cared for under independent Animal Ethics Committee approvals, with all necessary approvals from the Victorian Translocation Evaluation Panel and wildlife permits. The development and management of the VGED CBP follows strict husbandry and hygiene protocols, and is guided by genetic analyses, and a species-specific Population Viability Analysis (PVA).

The rediscovery of the VGED in January 2023 prompted several immediate actions to ensure the survival of this species. At present, the only ex situ population of VGED are housed at MZ. This population currently consists of 29 founder individuals housed across two bio secure facilities, and at the time of writing, eleven clutches have been laid in the program's first breeding season.

Prior to the rediscovery of the VGED, an intensive breeding program for the Canberra Grassland Earless Dragon *Tympanocryptis lineata* (CGED) was established at MZ to determine and refine suitable husbandry practices and assist in the conservation of that species. The CGED CBP program was very successful, resulting in hundreds of offspring, many of which were released to the wild in collaboration with partners in Canberra. Extremely high success rates with the CGED provided high confidence in the capability to keep and breed the closely related VGED. The husbandry protocols for VGED have been aligned closely to that of the CGED CBP program and have led to early successes in the nascent VGED program. Pairings of VGEDs were guided by genetic SNP analysis and known mean kinship of founder individuals that were collected with the intention to maximise the retention of genetic diversity and minimise inbreeding.

The small initial VGED facility is a bio secure, quarantined, and single-species facility specifically fitted out to house earless dragons. The captive facility is quarantined from other animals and staff at MZ, is highly secure, and is fitted with alarm systems to indicate power and equipment failure; it is also patrolled nightly by security personnel.

All VGED collected as founders for this CBP are quarantined in a species-specific and bio secure room with lizards housed individually during the quarantine period. Quarantine requirements follow ZV Reptile Health Screening Protocols for incoming animals, with any species-specific refinements at the discretion of the MZ Head Veterinarian. Hygiene management protocols minimise the risk of cross contamination between wild caught individuals during quarantine, and include the use of appropriate Personal Protective Equipment, glove changes between each enclosure, systematic cleaning and feeding, disinfecting all bench surfaces and equipment following appropriate disinfectant exposure times (F10, 1:1500 dilution for 1 min), and regular faecal testing and screening.

If any lizard is considered by MZ keepers or vets to present a significant health risk, separate rooms are available for housing and treatment until the animal is determined clear by veterinarian staff.

All animal health, breeding, movement, and other relevant data is stored within the global Zoo Information Management system (ZIMs), with a species-specific studbook and pedigree managed by MZ staff through the ZIMs Studbook system.

The following data is collected on incoming VGEDs that form part of the CBP:

- Morphometric data including weight, snout-vent length, and total length.
- Disease screening - In 2022/23 a Disease Risk Analysis was completed for the closely related species, CGED. Through this process it was determined that priorities for screening was for Adenovirus PCR (oral-cloacal samples), Microsporidium PCR (oral-cloacal samples; screening for *Encephalitozoon pogonae*), *Nannizziopsis*/Onygenales PCR (skin swab samples). Standard faecal screening for endoparasites including helminths and coccidian is completed by MZ veterinarians.
- Genetic analysis of founder animals; to build a breeding pedigree and better manage the CBP and wild population, tissue samples are collected for genetic analysis.
- Faecal sampling for wild diet analysis. To determine the diet profile of VGEDs, faecal samples are collected from incoming animals for the first 3 days, prior to being fed on the captive diet. Wild sampling/surveying of native invertebrate colonies at the rediscovery site is also taking place. When the resources and space are available, native invertebrate colonies that mimic at least part of the species' natural diet will be established at MZ.
- Detection Dog training. Various samples, including faecal samples, skin swabs and skin sloughs, have been collected for Detection Dog training. The MZ CBP has also provided the initial training steps for dogs prior to any in situ training; training sessions were conducted in a controlled setting at MZ. 5.3.0 captive VGEDs were used to capture the lizard's scent profile and variations between males and females.

Based on a species-specific PVA, a CBP of >500 lizards are needed to provide insurance against extinction, maintain genetic diversity, and enable the release of >100 lizards annually to establish new wild populations or augment wild populations (which is currently only the rediscovery site, but if more populations are found, the CBP program will also support those populations).

As well as the CBP providing an insurance population, recovery of VGEDs in the wild depends upon successful conservation breeding and release program of VGEDs. Thus, captive lizards are carefully managed to retain natural behaviours and to ensure optimum welfare and facilitate successful (re-)introduction and establishment in the future. Environmental enrichment, including live foods, plants, substrate, and furnishing, and variety in social interactions, etc., is provided to allow the lizards to exhibit and maintain natural behaviours. The sand and soil substrate allows for digging, burrowing, and nesting. In the future, further actions to improve behavioural fitness under captive conditions, and provide pre-release conditioning, will be explored in outdoor VGED enclosures (that are yet to be built) at Werribee Open Range Zoo. ZV follows a strict code of animal welfare and ethics to ensure the animals in our care thrive.

Previous Conservation Actions and Implications

Prior to rediscovery in early 2023, there were no substantiated records of VGEDs since 1969. Since the late 1980s various surveys targeting VGEDs have been conducted. These surveys have been a combination of searching in promising habitats (e.g., Clemann 2003; Clemann et al. 2013; Banks et al. 2017; numerous surveys led by Peter Robertson or Garry Peterson) or following up claimed sightings of the species. An example of the latter is the sightings reported by Beardsell (1997), who recorded observations of the VGED to the north and west of Melbourne; these sightings prompted surveys by Peter Robertson and Alan Webster, and Clemann (2003), but the species was not detected in these surveys.

Images: Pit fall trapping for VGED at grassland site. Left: Ecologist setting up trap lines. Right: Close up of a trap.

Prior to rediscovery in January 2023, the last substantiated record of the VGED was in 1969. Since 1969, the following surveys have been conducted:

- Intensive monthly rock-rolling surveys at two sites, Boundary Road, Laverton North, and Leakes Road, Rockbank for 18-24 months between 1977 and 1980.
- Pitfall trapping surveys in Derrimut Grasslands Reserve and Laverton Grassland Reserve in the late 1980s.
- Beardsell (1997) mentions five sightings of VGED during his surveys, but provides further comment on only four records, and dates for only three records (all observations were by a single observer, stationary for considerable periods watching for any activity):
    - One VGED observed on 18 October 1988 at Merri Creek near Bald Hill;
    - One VGED observed in January 1990 at Little River Gorge upstream of Little River township;
    - One VGED observed on 4 March 1990, “in a rock wall” on the eastern boundary of the Craigieburn Grasslands; and
    - a record at Jacksons Creek near Diggers Rest.
- Intensive pitfall trapping and artificial burrow (‘spider tube’) surveys by Peter Robertson and Alan Webster between 1993 and 1996 at all of the sites of the Beardsell (1997) sightings, as well as suitable habitat in nearby areas: Little River, Holden Flora and Fauna Reserve (Sunbury), Craigieburn Grassland Reserve, Bald Hill (Donnybrook), Organ Pipes National Park, Balliang, Live Bomb Range (Werribee), Laverton - Mt Cottrell area.
- Pitfall trapping in the Kororoit Creek Road (Altona area), 1997.
- Pitfall trapping in the Burnside area, 2003.

- Intensive rock rolling survey in the Craigieburn Grassland (Clemann 2003).
- Repeated surveys by Peter Robertson and colleagues using artificial burrows ('spider tubes') at six grassland sites between Lara and Tarneit, 2010. Rock-rolling, and burrow/soil cracks were examined with an endoscope.
- Repeated surveys by Garry Peterson and Donna McMaster using artificial burrows ('spider tubes') at thirteen grassland sites between Geelong and Werribee (Little River, Avalon, Lara) between 2008 and 2011. Rock-rolling, and burrow/soil cracks were examined with an endoscope.
- 'Trail' camera surveys in grasslands between Melbourne and Geelong (Clemann et al. 2013).
- Camera trap survey by Peter Robertson and Melbourne Zoo staff targeting VGEDs at ten grassland sites in the Little River to Ballan Road area, 2014.
- Camera trap survey by Peter Robertson and MZ staff targeting VGEDs at ten grassland sites between Werribee and Dundonnell in 2016 (Banks et al 2017).
- Survey by Adam Lee and ZV staff using mini pitfall traps at Edgars Road, Little River and Live Bomb Range, Bulban Road, 2018.
- Many surveys conducted by consultants associated with development and infrastructure proposals undertaking habitat assessment surveys for Striped Legless Lizard *Delma impar* using artificial cover objects (roof tiles deployed in transects or grids) at grassland sites between Melbourne and Geelong from 1985 to the present. These surveys are likely to have totalled hundreds of thousands of tile checks with no detection of VGED. Ironically, the rediscovery involved an VGED found under a tile during a survey for the Striped Legless Lizard.

Since the VGED rediscovery, ZV have led the recovery effort for the species. A Recovery Team was formed involving the most relevant and experienced experts on the species, and representatives from State and Federal Government environment agencies. A positive relationship was formed with the landholders, enabling the establishment of passive monitoring grids (artificial spider burrows and cover objects in the form of roof tiles) across part of the property (<5 ha). This enables regular monitoring and collection of VGEDs for the CBP/insurance population. The landholders have been encouraged to manage the land as they have for the past 80 years. Options to protect the site in perpetuity are being explored by State and Federal agencies.

Images: Left: Surveying spider burrows. Right: A VGED retrieved from a wolf-spider burrow.

Invertebrate surveys by ZV's Invertebrate Specialist are conducted to understand the diversity, abundance, and seasonal variability of invertebrates at the rediscovery site. These surveys show the availability of invertebrates, and how particular species or orders contribute to the VGED's diet, which is being studied via analysis of the contents of scats from wild lizards. The invertebrate surveys also determine which spider species create the burrows used by VGEDs. Genotyping using SNPs of all animals in the CBP is underway to determine relatedness and inform breeding and further collections. Phylogenetic analysis shows the recent VGEDs group with a historical sample from 1906, further supporting that VGED are an independent evolutionary lineage with deep genetic divergence.

A drone has been used to create fine scale maps and baseline habitat condition at the rediscovery site. Habitat characterization and modelling to identified similar sites has been completed, and these sites will be surveyed in spring.

Due to the cryptic nature of VGEDs and low detection rates from all current survey techniques, ZV are training detection dogs to find VGEDs. Laboratory trials have been successful, and field trials have commenced. If successful, the dogs will be trained to detect other species of grassland earless dragons.

In 2019, ZV identified a CBP as a key action to ensure the persistence and recovery of the VGED, should it be rediscovered. To ensure ZV was ready, staff honed husbandry skills over four years through a successful CBP for the critically endangered CGED. This program produced hundreds of CGEDs for release to the wild, research, and establishment of a second CBP in Canberra. The success of this earlier program enabled the rapid establishment of the CBP/insurance population for the VGED.

Data Gaps

Until rediscovery in January 2023, surveys targeting VGED since 1969 were not successful. Since rediscovery, there has been an enormous amount of work undertaken at the rediscovery site, the CBP, and in planning for the future of the rediscovery site, and long-term conservation of VGEDs. However, the program is only 10 months old, and much remains to be learned about the species. Important data and knowledge gaps include:

PERSISTENCE IN AREAS BEYOND THE REDISCOVERY SITE

Experience at the rediscovery site since January 2023 has shown that, even with sustained intensive targeted survey using several survey methods, long periods of time can pass between detection of VGEDs. This has profound implications for interpretations of failure to detect the species in previous surveys (i.e., VGEDs may have been present but not detected during some of these surveys). It also has significant implications for interpreting the results of surveys that are conducted in NTGs prior to destruction within the historic range of the VGED – previous and current surveys are wholly inadequate in terms of intensity and duration to give any certainty about the presence or absence of VGEDs. Furthermore, it is improbable that the intensity and duration of survey necessary to provide acceptable certainty about the presence of the species would be acceptable to regulatory agencies, planning agencies, and developers. For these reasons, the Recovery Team currently recommends that presence of VGED should be presumed in any NTG within the known and modelled range of the VGED. However, survey and monitoring at the rediscovery site, and modelling of the attributes of the site, are refining both survey methods, and choice and prioritisation of other sites to survey.

RESPONSES TO PREVIOUS LAND MANAGEMENT

Land use changes over time, and it can be difficult to understand all the changes over the last two centuries. The Recovery Team believes that some practices, such as ploughing, destroy habitat, and other practices, such as rock removal and weed invasion, degrade habitat. But these impacts occur along a gradient of severity and scale, and what degree of impact's VGED populations can survive are not yet fully understood. For example, weeds occur at the rediscovery site, but VGEDs have persisted; it may be that the type of weeds and history of weed control at this site have been pivotal in the lizard's persistence. Similar questions remain around other threats, including invasive predators and herbivores (such as rabbits), the use of biocides, removal, or disturbance of rocks, and so on.

RESPONSES TO THREATS AND MANAGEMENT ACTIONS

While the effects of some threats, such as destruction of habitat, are obvious, more information is needed to fully understand the relative severity and impact of other threatening processes. For example, there are concerns about the effects of drought on the fate of egg clutches in the wild, but how much this affects reproduction and recruitment rates is unknown. Similarly, invasive predators such as foxes, cats and introduced rodents (all of which occur at the rediscovery site) pose a potentially significant threat to populations of VGED, but the severity of this threat, and whether VGEDs have anti-predator behaviours allowing them to persist despite some predation from invasive predators is unknown. How various management actions will affect VGEDs is also largely unknown. For example, it is probable that there are interactions between foxes and cats, and even that effective control of one of these invasive species could exacerbate predation of lizards by the other species. In terms of conservation actions, how successful some actions will be, including weed and pest animal controls is unknown, and even the factors that will allow (re-)introductions of VGEDs to be successful.

KEY POPULATION PARAMETERS

Parameters that affect population size, stability, and persistence are not known in any detail. Despite sporadic insights from detections at the rediscovery site, the following matters are all largely unknown: home range size (and whether this varies between sexes or age classes); dispersal distances, and whether this differs between age classes and the sexes; mating system and mate choice; key attributes of oviposition sites; sex ratios of hatchlings, and what affects these ratios; longevity in the wild and in captivity (it's suspected that VGEDs mostly do not survive into a third year in the wild, but also it's known from the longevity recorded in captive CGEDs indicates that longevity in captivity may be substantially greater than in the wild); species-wide genetic diversity and health.

DETECTION OF VGED BEYOND THE REDISCOVERY SITE

Rediscovery of the VGED has given the Recovery Team a renewed perspective on previous surveys for the species, showing how easily the species can be missed during surveys. Rediscovery has also provided both a focal point for attempts to find more occupied habitat near the site, as well as potentially important biotic and abiotic factors to consider when choosing and prioritising surveys.

THE HUMAN DIMENSIONS OF VGED CONSERVATION

From political and economic pressures to societal values to poaching, various human dimensions have had and will have a profound effect on conservation of the VGED. Both the species' historic range and the location of the rediscovery site are highly prized for agriculture and urban development, which means that the land in these areas has quite extreme monetary value. These land values affect VGEDs via developers wanting to destroy habitat, landowners wanting to maximise the sale price of their land, and even ecological consultants wanting to 'cash in' on the high profile of the species in areas slated for development. The fact that VGEDs eluded detection for more than five decades has resulted in the species having a certain mystique, which underpins desires in some people to find, photograph, and even collect the lizards for private keeping or sale on the black market.

Conservation Action Plan

Victorian Grassland Earless Dragon

Overview

The following section outlines a Conservation Action Plan for the VGED and progression to downgrading its IUCN Red List conservation status, for the period 2024 – 2030.

As Australia's most imperilled reptile, this plan and associated goals, objectives and actions are critical in preventing the extinction, and initiating the recovery, of the VGED. This action plan has been developed by the Victorian Grassland Earless Dragon Recovery Team and is based on knowledge gained since the species rediscovery in early 2023 and experience from the closely related Canberra Grassland Earless Dragon (CGED).

The current central conservation issues for the VGED are the very small size and vulnerability of the single, wild population on private land, and the continued loss of extent and quality of the limited potential habitat remaining across the species range. These factors account for its IUCN Critically Endangered conservation status as determined in the recent Red List assessment application and assessments under Victorian (DELWP 2021) and Australian (DCCEEW 2023) legislation using the IUCN Red List criteria. The recovery of the VGED, and downgrading of its IUCN Red List classification, will therefore be dependent on the establishment and persistence of new populations, which will be underpinned by a successful Conservation Breeding Program.

Conservation breeding programs (CBP) are often the difference between extinction and survival. Zoos Victoria has a proven track record of developing ex situ insurance and recovery programs, including for the closely related CGED, and have established several programs that have prevented wild extinction, and translocated zoo-bred animals back to the wild to boost and/or establish new populations.

The goals, objectives and actions that form this plan are informed by the IUCN criteria under which the VGED has been assessed and provide a framework for progress toward recovering the species to improve its conservation status from Critically Endangered to Endangered and meet the longer-term recovery vision. This plan broadly proposes to (i) expand the CBP and insurance population, including incorporating new founders from the wild population, (ii) determine and establish a minimum of five recipient sites for establishment of new populations through (re-)introductions, (iii) plan and execute translocations to establish new populations, and supplementation of any natural sites as required, (iv) maintain appropriate management at the current and any newly discovered natural sites, and the (re-)introduced sites, and (v) advocate for the protection and conservation of the remaining native grasslands within the VGED's range; to ensure the VGED can persist, recovery and thrive. These elements have been presented in the Conservation Action Plan under the following five goals.

- Secure and appropriately managed rediscovery site, and essential monitoring and research implemented.
- Ex-situ insurance and conservation breeding program of appropriate size to prevent extinction, maintain/improve genetic diversity, and facilitate reintroductions.
- Additional habitat appropriately managed and further declines mitigated.
- Multiple, self-sustaining populations of Victorian Grassland Earless Dragon across its natural geographical range leading to the downlisting of its conservation status.
- Conservation activities and recovery of the Victorian Grassland Earless Dragon and its native grasslands effectively communicated.

The VGED ex situ program will provide critical insurance against the extinction of the species and further loss of genetic diversity while new locations are prepared for reintroduction. Population Viability Analysis modelling by Zoos Victoria indicates that a CBP of 500 or more lizards will be required to provide insurance against extinction, maintain >95% genetic diversity, and provide 100 or more animals for release annually to establish new wild populations.

Initiating the establishment of a minimum of five additional populations has been identified as achievable within the lifetime of this plan, however the longer-term objective for the species recovery is 10-15 populations. Each of the five populations will require a minimum of 100 ha of suitable habitat, although several sites of 500 ha or more will be targeted to ensure its area of occupancy is maximized. The populations within the larger sites are also more likely to be able to bounce back following periods of poor conditions such as drought. While carrying capacity will vary depending on habitat quality and conditions, it is anticipated that a 100 ha's should support approximately 200 - 250 individuals. The additional populations will be distributed across the VGED's geographical range to improve its extent of occurrence and spread the risk from stochastic events including bushfire.

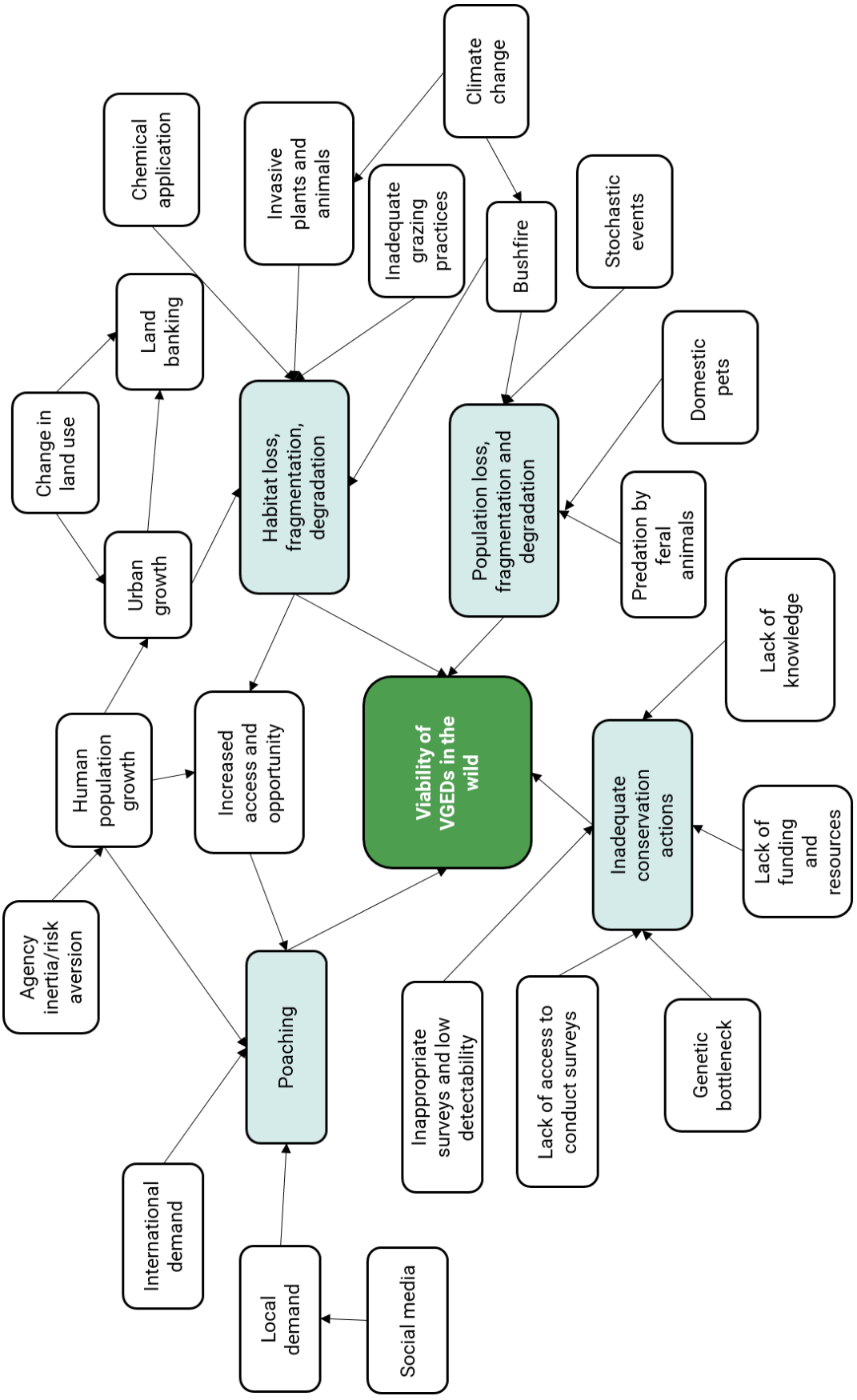
Vision

Multiple robust and genetically viable Victorian Grassland Earless Dragon populations exist within healthy, functional, and where possible, connected wild grassland ecosystems that are protected and managed appropriately for the species. An ex-situ insurance and conservation breeding program and associated facilities of at least 500 animals are established, and genetically representative individuals from any newly discovered populations are added to the breeding program. The species is downlisted from Critically Endangered to Endangered on the IUCN Red List, and local communities are proud of and care for VGEDs, placing a high value on retaining, connecting, and expanding the network of functional grasslands that provide habitat for the species.

Goals

1. Secure and appropriately managed rediscovery site, and essential monitoring and research implemented.
2. Ex-situ insurance and conservation breeding program of appropriate size to prevent extinction, maintain/improve genetic diversity, and facilitate reintroductions.
3. Additional habitat appropriately managed and further declines mitigated.
4. Multiple, self-sustaining populations of VGED across its natural geographical range leading to the downlisting of its conservation status.
5. Conservation activities and recovery of the VGED and its native grasslands effectively communicated.

Issues


Climate change
Chemical application
Invasive plants and animals
Inadequate grazing practices
Bushfire
Stochastic events
Land banking
Change in land use
Habitat loss, fragmentation, degradation
Population loss, fragmentation and degradation
Domestic pets
Predation by feral animals
Urban growth
Lack of knowledge
Human population growth
Increased access and opportunity
Viability of VGEDs in the wild
Inadequate conservation actions
Lack of funding and resources
Agency inertia/risk aversion
Poaching
Inappropriate surveys and low detectability
Lack of access to conduct surveys
Genetic bottleneck
International demand
Local demand
Social media

Goals, Objectives and Actions Overview

Goal 1. Secure and appropriately managed rediscovery site, and essential monitoring and research implemented

Objective 1.1 Maintain appropriate management at the current and any newly discovered sites

1.1.1 - Continue to work with the landholder to maintain the current management practices, including grazing regime, via a management plan.

1.1.2 - Provide support for or undertake threat abatement at the rediscovery site including weed and introduced animal control.

1.1.3 - Facilitate stewardship payments to the landholder to support current management and threat abatement.

1.1.4 - Continue to pursue options for permanent protection of the rediscovery site.

1.1.5 - Ensure appropriate management is continued and/or initiated at any newly discovered populations

Objective 1.2 Monitoring and research of extant population

1.2.1 - Continue intensive monitoring and survey of rediscovery site to understand population status, ecology, and facilitate collection of additional founders for ex-situ insurance and CBP.

1.2.2 - Investigate life history attributes of the extant population including age specific dispersal, survivorship, and reproductive outputs to inform management.

1.2.3 - Investigate habitat use, dispersal, distribution, and movement at the extant population to inform management.

1.2.4 - Investigate the relationship between VGEDs and invertebrates including spider presence/abundance, use of invertebrate burrows and prey invertebrate communities.

Goal 2. Ex-situ insurance and conservation breeding program of appropriate size to prevent extinction, maintain/improve genetic diversity, and facilitate reintroductions

Objective 2.1 Continue collection of founders for the ex-situ insurance and conservation breeding program

2.1.1 - Conduct population viability analysis to inform conservation breeding program requirements including additional founders, and regularly update with additional genetic and demographic information.

2.1.2 - Continue the collection of independent founders in conjunction with population monitoring (1.2.1) from the broader rediscovery site and from any newly discovered populations (3.1.5).

2.1.3 - Conduct genotyping of all new founders, and insurance population across time, to determine relatedness and inform pairings based on mean kinship.

Objective 2.2 Initiate conservation breeding program

2.2.1 - Commence breeding based on genotyping results from initial founders.

2.2.2 - Develop stud book and conservation breeding strategy based on genetic results from founders collected across the first 12 months, with the aim of increasing genetic diversity within the CBP.

2.2.3 - Achieve and maintain insurance population and CBP population of 500 or more individuals.

Objective 2.3 Expand ex-situ insurance and conservation breeding program to appropriate size to prevent extinction, provide insurance, maintain/improve genetic diversity, and facilitate reintroductions

2.3.1 - Establish initial interim facilities at Melbourne Zoo to enable the housing of founders and commencement of breeding (2.2.1).

2.3.2 - Establish additional climate-controlled facilities at Melbourne Zoo to accommodate a carrying capacity of >500 individuals, and outdoor enclosures at Werribee Open Range Zoo.

Goal 3. Additional habitat appropriately managed and further declines mitigated

Objective 3.1 Identify a minimum of five recipient sites for establishment of new populations

3.1.1 - Recruit full-time VGED Translocation Field Officer.

3.1.2 - Develop habitat and reintroduction criteria for potential recipient sites.

3.1.3 - Identify likely recipient sites via spatial modelling.

3.1.4 - Visit likely recipient sites and assess for suitable habitat characteristics against criteria including vegetation, soil types, invertebrate (including spider) diversity and densities, past and current management, weed risk, introduced predators, etc.

3.1.5 - Where habitat is suitable, survey for presence of existing VGED populations and collect additional founders from any newly detected populations.

Objective 3.2 Address threats and implement management at a minimum of five recipient sites

3.2.1 - For sites that meet required habitat and reintroduction criteria (3.1.2) select the most appropriate sites and negotiate permission for releases and on-going land management agreements with the land managers.

3.2.2 - Implement necessary threat abatement, habitat restoration, and appropriate management at recipient sites and establish release (e.g., soft release enclosures, fencing, etc.) and monitoring infrastructure (e.g., spider tubes, pitfall traps, tile grids, invertebrate monitoring plots).

Objective 3.3 Mitigate further declines in extent and quality of habitat and or unknown populations

3.3.1 - Work with relevant regulatory agencies to identify and protect areas of suitable habitat critical to the species recovery.

3.3.2 - Refine survey techniques to improve detectability, including the use of detection dogs.

3.3.3 - Engage and lobby land managers to implement best-practice grassland habitat management to maximize the extent and quality of habitat to enable longer-term VGED recovery.

GOAL 4. Multiple, self-sustaining populations of VGED across its natural geographical range leading to the downlisting of its conservation status

Objective 4.1 Develop a detailed translocation plan for Victorian Earless Dragon (re-)introductions to recipient sites

4.1.1 - Develop a comprehensive captive to wild translocation plan for the establishment of VGED (re-)introduced populations including success criteria, contingencies, and risk analysis.

4.1.2 - Seek input from IUCN Conservation Translocation Specialists and other relevant scientists from within and outside the Recovery Team, especially those with experience in translocating congeneric species, such as the CGED.

4.1.3 - Update population viability analysis models to help determine the variables most likely to influence VGED population establishment, growth, and persistence in the wild.

4.1.4 - Trial the use of radiotracking transmitters on a subset of VGED at the outdoor enclosures at Werribee Open Range Zoo to inform post-release monitoring.

4.1.5 - Develop a post-release monitoring plan that includes radio tracking of VGED's to determine dispersal, habitat use and survival plus overall population growth, maintenance of genetic diversity, and persistence post-release.

4.1.6 - Gain the necessary approvals and permits for the reintroduction plan (e.g., Animal ethics committee approval, Translocation Evaluation Panel approval, Wildlife research permit, Parks Victoria access agreement).

Objective 4.2 Establish new populations via captive to wild translocations

4.2.1 - Commence translocations at a subset (two) of selected sites and conduct post-release monitoring and radiotracking to inform indicators of success.

4.2.2 - Review progress towards meeting indicators of success, and if required adapt release strategies, monitoring etc. in line with contingency plan.

4.2.3 - If initial releases meet indicators of success after two years, conduct releases at remaining recipient sites and conduct post-release monitoring and radiotracking to inform indicators of success.

Objective 4.3 Supplementation of new and/or extant population

4.3.1 - Conduct supplementation release at recipient sites following initial three years if required.

4.3.2 - Conduct supplementation at the rediscovery site (or any other newly discovered sites) as needed should the population rapidly decline due to a stochastic event or known manageable threat, or if a decline in genetic diversity is detected.

Goal 5. Conservation activities and recovery of the Victorian Grassland Earless Dragon and its native grasslands effectively communicated

Objective 5.1 Communicate the plight of grasslands and the objectives and achievements of the Victorian Grassland Earless Dragon recovery program

5.1.1 - Establish a dedicated media team including but not limited to Recovery Team and project partners.

5.1.2 - Prepare a communication and media plan, together with the SSC program.

5.1.3 - Document all steps throughout the life of the project and collate materials that will aid in communications during and at completion of project.

5.1.4 - Prepare and communicate project progress and achievements to a range of audiences and through a variety of different mediums.

5.1.5 - Engage local communities and schools to promote the program and conservation of grasslands using ZV's established programs – e.g., fighting extinction schools, love your locals and safe cat safe wildlife.

5.1.6 - Develop and publish peer reviewed journal and popular articles to share the knowledge gained from the program.

Goals, Objectives and Actions (Unabridged)

Goal 1. Secure and appropriately managed rediscovery site, and essential monitoring and research implemented.

Objective 1.1 Maintain appropriate management at the current and any newly discovered sites

Rationale:

The VGED has persisted at the rediscovery site when it has apparently been lost from most or all other areas; persistence at this site reflects the historic and current management of the rediscovery site. It is essential that management of the rediscovery site continues as it has, and that lessons from this management are applied to any other sites where the species is subsequently discovered. This management regime will also inform the selection, preparation, and ongoing management of (re-)introduction sites. With the rediscovery site on private land, the population is also vulnerable to ploughing or 'as of right' activities like heavy grazing, slashing, burning, and herbicide, pesticide or fertilizer application, all of which could rapidly lead to species loss. As such, working with the landholder and documenting the appropriate and inappropriate activities via a management plan are essential to ensure the historical management is maintained (Action 1.1.1).

As the site is on a working farm, support to the landholder to manage environmental threats (e.g., weeds or introduced animals) to the VGED and or its habitat (Action 1.1.2) and maintain the historical management and not intensify the agricultural practices is required (Action 1.1.3).

Despite the positive relationship with the landholders, private ownership can limit management options and/or ownership can change. To ensure the long-term protection of the rediscovery site, several alternative options for permanent protection maybe available and need to be explored and considered with the current landholders (Action 1.1.4).

For any newly discovered populations, it's likely that the historical management has been conducive to the VGED. To ensure these populations persist, the historical management must be maintained, or reestablished should new management known to be detrimental to grassland earless dragons be occurring (Action 1.1.5).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
1.1.1	Continue to work with the landholder to maintain the current management practises, including grazing regime, via a management plan.	On-going	VGED Recovery Team, ZV	Continued access. Maintenance of appropriate management.	Goodwill, positive relationship and genuine interest and support from the landholder. Draft management plan.	Finalised management plan.
1.1.2	Provide support for or undertake threat abatement at the rediscovery site including weed and introduced animal control.	On-going	VGED Recovery Team, ZV, Vic DEECA, Federal DCCEEW	Key threats are actively managed and don't surpass Feb 2023 levels.	Expertise.	Coordinated management. Better understanding of threat impacts.
1.1.3	Facilitate stewardship payments to the landholder to support current management and threat abatement.	On-going	ZV, Vic DEECA, Federal DCCEEW, Melbourne Water	Agreement in place and activities delivered annually.	Expertise. Landholder interest. Initial funding for 2024.	Formal agreement for 2024. Further funding (likely via Federal DCCEEW/Melbourne Water).
1.1.4	Continue to pursue options for permanent protection of the rediscovery site and preferred option delivered.	Options determined by mid-2024 Preferred option delivered mid-2026	Vic DEECA, VGED Recovery Team, landholder	Agreement on preferred option for permanent protection. Preferred option achieved.	Good will and interest from the landholder. Expertise. Networks.	To be determined when options are finalised.
1.1.5	Ensure appropriate management is continued and/or initiated at any newly discovered populations.	On-going if new sites discovered	VGED Recovery Team, Vic DEECA, Federal DCCEEW, landholders/managers	Management agreements in place and activities delivered annually.	Expertise.	Newly discovered populations.

Objective 1.2 Monitoring and research of extant population

Rationale:

The recency of the rediscovery of the VGED means that much remains to be learned about its biology and ecology, population dynamics, and its response to both threats and conservation management actions. It is essential that intensive monitoring continues to enable the population status and trends, distribution, and dynamics to be understood, and for intervention to occur should it be required (Action 1.2.1). The acquisition of information relating to the species life history (Action 1.2.2) and habitat and movement (Action 1.2.3) are essential for both management and as key knowledge gaps for the species in-situ PVA.

Invertebrate burrows are an essential habitat attribute for the VGED. They're used for shelter, breeding, overwintering, protection from predators and temperature extremes. Invertebrates are also their key food source. Understanding this dependency will be critical to both the persistence at the rediscovery site and also the establishment of new populations (Action 1.2.4).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
1.2.1	Continue intensive monitoring and survey of rediscovery site to understand population status, ecology, and facilitate collection of additional founders for ex-situ insurance and CBP.	On-going	ZV, VGED Recovery Team	VGED population at the rediscovery site is stable or increasing in numbers and area.	Expertise. Monitoring infrastructure on site. Approvals and permits.	Funding to support / expand survey and monitoring.
1.2.2	Investigate life history attributes of the extant population including age specific dispersal, survivorship, and reproductive outputs to inform management.		VGED Recovery Team, ZV	Key life history attributes are well understood, and used to guide ongoing management of the population and any newly discovered or established populations	Expertise. Survey and monitoring infrastructure. Likely undertaken as a post-graduate research project	Funding to support research.
1.2.3	Investigate habitat use, dispersal, distribution, and movement at the extant population to inform management.		VGED Recovery Team, ZV	Habitat use, dispersal, distribution, and movement at the extant population are well understood, and factored into conservation management.	Expertise. Survey and monitoring infrastructure.	Funding to support research.
1.2.4	Investigate the relationship between VGEDs and invertebrates including spider presence/abundance, use of invertebrate burrows and prey invertebrate communities.		VGED Recovery Team, ZV	Relationships between VGED and invertebrates are understood, and factored into conservation management	Expertise, including entomologists on the Recovery Team. Initial investigation commenced. Survey and monitoring infrastructure. Expanded work likely undertaken as a post-graduate research project	Funding to support expanded research.

GOAL 2. Ex-situ insurance and conservation breeding program of appropriate size to prevent extinction, maintain/improve genetic diversity, and facilitate reintroductions.

Objective 2.1 Continue collection of founders for the ex-situ insurance and conservation breeding program

Rationale:

The population viability analysis is required to collate information based on research and expert elicitation and to explore, using computerised simulation models, how to establish a conservation breeding and insurance population of VGEDs which will 1) provide long-term insurance against extinction; 2) maintain >95% genetic diversity over a 20 year timeframe; and 3), provide suitable animals to establish new populations that could remain viable over the long-term, independent of the ex situ population. It also serves to investigate factors which may influence the success and survival of the current, and future, wild populations and instigate further research and discussion of threat mitigation and future planning (Action 2.1.1).

The collection of additional targeted founders will provide unrelated animals to the CBP and insurance population. This will increase the level of genetic heterozygosity and allelic richness and help protect and maintain as much genetic diversity as possible from the extant population and any newly discovered populations (Action 2.1.2). Maximising genetic diversity within the insurance population will provide the best genetic health, adaptability, and resilience for the future. The additional founders will also assist in overcoming the level of relatedness between individuals currently in captivity, thus providing a greater pool of individuals for pairing (Action 2.1.3).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
2.1.1	Conduct population viability analysis to inform conservation breeding program requirements including additional founders, and regularly update with additional genetic and demographic information.	As additional information becomes available	ZV, VGED Recovery Team	Expansion and refinement of model following acquisition of additional information.	Expertise. Initial PVA which has informed requirements for ex situ insurance and CBP.	Species specific information and new genetic data to refine the PVA. Key knowledge gaps addressed.
2.1.2	Continue the collection of independent founders in conjunction with population monitoring (1.2.1) from the broader rediscovery site and from any newly discovered populations (3.1.5).	Until 2026 for the rediscovery site. Immediately for any newly discovered populations.	ZV, VGED Recovery Team	>80% survival rate 6 months post collection. Additional unrelated individuals from the broader rediscovery site. Addition of animals from any newly discovered populations.	Expertise. Approvals and permits. Monitoring and survey infrastructure in place at rediscovery site.	Funding to survey new sites. Improved detectability.
2.1.3	Genotyping of new founders to determine relatedness and inform pairing based on mean kinship.	Annually until 2026 for the rediscovery populations and immediately for any newly discovered populations.	VGED Recovery Team, Museums Victoria, ZV	An increase in genetic diversity and unique alleles above that currently in the CBP.	Expertise. Access to leading Australian academics and labs.	Funding for annual genotyping of new founders.

Objective 2.2 Initiate conservation breeding program

Rationale:

Due to the VGED's perilous situation, prevention of extinction, and then recovery, are dependent on the urgent establishment of an insurance population and CBP. Through the CBP and insurance population, the overall number of individuals will be rapidly grown while genetic issues are improved and managed. As of November 2023, the CBP at MZ had a total of 29 VGEDs. Due to their short lifespan, delays in breeding puts at risk older animals, which may be lost before they can contribute to the breeding program. As such, initiating breeding once relatedness is determined is critical (Action 2.2.1).

An initial PVA undertake to inform the ex-situ program indicates that a CBP of >500 lizards will be required to provide insurance against extinction, maintain genetic diversity and provide >100 animals for annual release to establish new wild populations (Action 2.2.3). The CBP aims to incorporate all wild genetic diversity found and maintain at least 95% of founder genetic diversity over at least 20 years, via rapidly growing the CBP population and managing pairings based on genetic results and mean kinship analysis (Action 2.2.2).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
2.2.1	Commence breeding based on genotyping results from initial founders.	Spring 2023	ZV	Reproductive success and rearing of offspring from suitably paired founders within two years. >80% egg incubation & rearing to adult success.	Unrelated founders suitable for breeding (verified via Mean Kinship analysis) Breeding success from 100% of paired founders. Clutches currently incubating. First eggs hatched successfully.	Additional facilities for increased capacity.
2.2.2	Develop stud book and conservation breeding strategy based on genetic results from founders collected across the first 12 months, with the aim of increasing genetic diversity within the CBP.	Completed by spring 2024	ZV	VGED Studbook updated and maintained on ZIMs. Conservation breeding strategy completed and approved by Recovery Team.	Expertise in studbook development and conservation breeding. VGEDs added to the ZIMs system, with data being regularly updated and maintained. A conservation breeding strategy is being developed with a PVA available to inform the strategy.	Development of a VGED ZIMs studbook is under discussion with the ZAA, to be managed by MZ staff. Further genetic results to inform a conservation breeding strategy.
2.2.3	Achieve and maintain insurance population and CBP population of 500 or more individuals.	Carrying capacity of >500 summer 2025/26 Maintenance of ex situ population on-going until recovery in the wild achieved	ZV, VGED Recovery Team, Vic DEECA, and Federal DCCEEW,	Insurance population and breeding program objective of 500 individuals reached by summer 2025/26. >100 individuals available for release annually by spring 2026.	Expertise. Initial facility and founders. Successful breeding in first season. Community support.	Funding for expanded facilities, animal care and staffing. Additional unique founders.

Objective 2.3 Expand ex-situ insurance and conservation breeding program to appropriate size to prevent extinction, maintain/improve genetic diversity, and facilitate reintroductions

Rationale:

The VGED ex-situ program will provide critical insurance against extinction of the species and further loss of genetic diversity while new locations are prepared for (re-)introduction. The CBP's key outcome will be the ability to rapidly breed and grow the ex-situ insurance population and provide the key action needed to avoid extinction and set the species on the path to recovery (Action 2.3.1). New facilities will increase the number of founders the program can accommodate and hence the level of genetic diversity maintained. This will enable broader pairing and breeding, allow rapid growth of the population to maintain at least 95% of wild founder diversity, and set the CBP on a fast path to producing suitable and abundant animals for translocation to appropriately managed recipient sites to establish new wild populations, and to bolster the extant population (Action 2.3.2).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
2.3.1	Establish initial interim facilities at Melbourne Zoo to enable the housing of founders and commencement of breeding (2.2.1).	Winter/spring 2023	ZV	Initial space fitted out. >80% survival rate 6 months post collection. Successful breeding initiated spring 2023.	All indicators of success meet. Funding for 2023/24 for fit out and staffing from Colossal Biosciences	
2.3.2	Establish additional climate-controlled facilities at Melbourne Zoo to accommodate a carrying capacity of >500 individuals, and outdoor enclosures at Werribee Open Range Zoo.	By 2025	ZV, VGED Recovery Team, Vic DEECA, and Federal DCCEEW,	Expansion to accommodate 350 individuals by late 2024. Purpose-built conservation breeding facility to accommodation 500+ individuals built by late 2025. Outdoor enclosures established early 2025.	Funding pending for 2024 expansion. Seed funding for outdoor enclosure development. Access to designs of outdoor enclosures for CGED.	Funding for purpose-built conservation breeding facility, animal care and staffing.

Goal 3. Additional habitat appropriately managed and further declines mitigated.

Objective 3.1 Identify a minimum of five recipient sites for establishment of new populations

Rationale:

The VGED is currently known from a tiny area at a single rediscovery site. Long-term conservation of the species will necessitate 10+ healthy self-sustaining populations. In the short- to medium-term a minimum of five (re-)introduction sites are needed to secure the species and downgrade its IUCN Red listing. A dedicated resources is required to identify recipient sites, negotiate and coordinate management, and plan and execute translocations of the VGED to these recipient sites (Action 3.1.1).

As the VGED is, like its congeneric species, a habitat specialist, several unique habitat characteristics will be required for a site to be potentially suitable as a recipient site (Action 3.1.2). With the VGED's habitat primarily cleared and remaining areas highly fragmented and spread across numerous different land tenures, identification of suitable sites will require spatial analysis to assist site selection (Action 3.1.3) before ground assessments occur (Action 3.1.4).

While the rediscovery site might be the only VGED extant population remaining, further small, isolated populations may persist. To ensure every effort is made to detect and conserve these populations, surveys for VGED in areas of suitable habitat are required (Action 3.1.5). The addition of VGED individuals from these populations, if they exist, is also critical to improving the genetic diversity of the ex-situ insurance population. Surveys of the chosen recipient sites are also required to ensure relic resident populations don't already inhabit the sites.

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
3.1.1	Recruit VGED full-time Translocation Field Officer.	Position to commence by winter 2024	ZV, VGED Recovery Team	Recruitment of the position.	Expertise. Support network.	Funding for position.
3.1.2	Develop habitat and reintroduction criteria for potential recipient sites.	Developed by spring 2024	ZV, VGED Recovery Team	Criteria developed.	Expertise and access to grassland experts. Knowledge from rediscovery site.	Capacity to develop criteria. Completed by Translocation Field Officer.
3.1.3	Identify likely recipient sites via spatial modelling.	By spring 2024	ZV, VGED Recovery Team, Vic DEECA	Several sites of remnant grassland of adequate size (>100 ha but preferably >500 ha) identified. Access to >60% of sites granted.	Contemporary VGED habitat distribution model developed since the rediscovery. Habitat modelling and site selection based on habitat characteristics from the rediscovery site. Initial site selection and assessments at a subset of sites completed spring/summery 2023. Networks to facilitate access.	
3.1.4	Visit likely recipient sites and assess for suitable habitat characteristics against criteria including vegetation, soil types, invertebrate (including spider) diversity and densities, past and current management, weed risk, introduced predators, etc.	By autumn 2025	ZV, VGED Recovery Team	Ten or more sites >100 ha but preferably >500 ha meet criteria.	Expertise and access to grassland experts. Spatial information to inform past management.	Funding and capacity to conduct assessments. Would be completed by the Translocation Field Officer.
3.1.5	Where habitat is suitable, survey for presence of existing VGED populations and collect additional founders from any newly detected populations.	On-going	ZV, VGED Recovery Team, Vic DEECA	Additional populations detected. Additional founders collected.	Expertise and extensive experience. Networks to facilitate access. Trained detection dogs	Funding to survey new sites. Improved detectability. Access to sites.

Objective 3.2 Address threats and implement management at a minimum of five recipient sites

Rationale:

Due to the varying land tenures across the fragmented grassland remnants within the VGED's historic geographical range, access and long-term agreements for (re-)introduction and on-going management will need to be negotiated with the relevant land manager (Action 3.2.1). The identified recipient sites are likely to be a combination of public reserves and private agricultural land.

The key threats to the persistence of grassland earless dragons at sites appears to be inappropriate management and an inability to recover following unsuitable conditions such as drought. For sites to be suitable for the (re-)introductions of VGED's, key threats will need to be minimised or eliminated, and appropriate management regimes, particularly biomass management, will need to be implemented and maintained (Action 3.2.2).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
3.2.1	For sites that meet required habitat and reintroduction criteria (3.2.1) select the most appropriate sites and negotiate permission for releases and on-going land management agreements with the land managers.	By winter 2025	VGED Recovery Team, ZV, Vic DEECA, Parks Victoria, landholders/managers	Access to five or more sites >100ha but preferably >500ha in size negotiated. Management plans developed and agreed to with land managers.	Networks to facilitate negotiations. Access to experts to assist in development of management plans.	Capacity to negotiate and develop management plans. Would be completed by the Translocation Field Officer.
3.2.2	Implement necessary threat abatement, habitat restoration, and appropriate management at recipient sites and establish release (e.g., soft release enclosures, fencing, etc.) and monitoring infrastructure (e.g., spider tubes, pitfall traps, tile grids, invertebrate monitoring plots).	Initiated by summer 2025	VGED Recovery Team, ZV, Vic DEECA, Parks Victoria, landholders/managers	Threats reduced to defined level prior to release. Deliverables outlined in management plans met annually.	Knowledge on appropriate management, particularly around biomass from rediscovery site and CGED. Possible access to funding from DEECA for sites within the MSA and or within the Western Grassland Reserve. Support from State and Federal Governments.	Capacity to oversee management implementation. Would be completed by the Translocation Field Officer. Funding for threat abatement and management for sites outside of the MSA. Funding for release infrastructure. Commitment from land managers to allow reintroductions.

Objective 3.3 Mitigate further declines in extent and quality of habitat and or unknown populations

Rationale:

The habitat of the VGED, native temperate grasslands (NTG), are perhaps the most cleared ecosystem in Australia. Remaining NTGs within the historic range of the VGED (and in potential climate refuges) are now critical for the long-term conservation of this species. These habitats, as well as the extant population, and any subsequently discovered, populations, must be protected from further loss and decline. As the VGED's historic range largely sits within the urban and future growth areas of Australia's largest city, productive engagement with planning and regulatory agencies is needed to ensure habitat critical to the species recovery is protected and conserved (Action 3.3.1). Appropriate management of these critical remnants is also required to ensure they remain suitable for any remaining cryptic VGED populations, and other grassland species, as well as for future VGED (re-)introductions (Action 3.3.3).

There is little doubt VGED populations have been lost over the past few decades through urban development due to the low effectiveness of survey techniques and/or reluctance to require surveying due to the survey limitations and high effort need. Similarly, conservation surveys may have missed detecting the species despite the high effort and standards applied. As such, to ensure detectability and confidence in survey techniques is improved, refinement of existing techniques and exploration of novel techniques is urgently required (Action 3.3.2).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
3.3.1	Work with relevant regulatory agencies to identify and protect areas of suitable habitat critical to the species recovery.	On-going	Vic DEECA, federal DCCEEW, Victorian Planning Authority, local government, VGED Recovery Team,	All areas of potential habitat proposed for development adequately assessed with input from relevant experts/VGED Recovery Team. Areas identified as critical for the recovery of VGED conserved.	Expertise within the VGED Recovery Team. Broad understanding of potential habitat.	Improved assessment process including application of the precautionary principle. Improved survey techniques and detectability. Great protection of potential habitat.
3.3.2	Refine survey techniques to improve detectability, including the use of detection dogs.	By 2025 with continued refinement	VGED Recovery Team, Vic DEECA, Federal DCCEEW	Improved detectability via traditional and novel techniques.	Expertise within the VGED Recovery Team. Information from the rediscovery site and continued monitoring/survey. Funding to trial detection dogs for 2023/24. Trained detection dogs with initial positive results Trial of eDNA techniques.	Surveys using traditional methods at new sites to increase sites and data sets.
3.3.3	Engage and lobby land managers to implement best-practice grassland habitat management to maximize the extent and quality of habitat to enable longer-term VGED recovery.	On-going	Vic DEECA, Federal DCCEEW, local government, Catchment Management Authorities, Traditional Owners, VGED Recovery Team	Landowners and managers are engaged and implementing best practise management of habitat on their properties. Best-practice management implemented at all sites identified as critical for the recovery of the VGED. Best-practice management implemented at additional sites.	Knowledge on appropriate management, particularly around biomass.	Improved management on public land.

Goal 4 Multiple, self-sustaining populations of VGED across its natural geographical range leading to the downlisting of its conservation status.

Objective 4.1 Develop a detailed translocation plan for Victorian Earless Dragon (re-)introductions to recipient sites

Rationale:

Successful translocations are more often than not due to the detailed planning that is painstakingly undertaken in the months and even years before the first animals are moved. To maximise the success of the (re-)introductions of the VGED, a comprehensive captive to wild translocation plan will be developed throughout 2025 and early 2026 (Action 4.1.1). It will cover in detail the release strategies to be used, the monitoring methods and associated indicators to measure progress and success, the contingencies if things don't go to plan, and the risks and mitigations. Through the development of the plan, species and IUCN translocation specialists will be extensively consulted (Action 4.1.2). The VGED PVA will be used to inform the variables likely to influence translocation success as well as to determine optimum release numbers and expected growth rates that will inform the translocation plan (Action 4.1.3).

Trialling of tracking methods will be undertaken on ex-situ VGEDs to ensure they are effective and ready to use on released animals to measure specific indicators of success and inform on individuals' dispersal, behaviour, habitat use, and survivorship post-release (Action 4.1.4). The tracking methods and other monitoring techniques will be outlined in a detailed post-release monitoring plan that will form part of the broader translocation plan (Action 4.1.5).

Several permits and approvals will be required before the translocation of VGEDs can take place to the recipient sites (Action 4.1.6). Underpinning these applications will be the translocation plan. The VGED Recovery Team have extensive experience with the relevant permits and approvals processes, and some permits are already in place for the wild to captive translocation of VGED founders for the CBP.

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
4.1.1	Develop a comprehensive captive to wild translocation plan for the establishment of VGED (re-)introduced populations including success criteria, contingencies, and risk analysis.	Compete by May 2026	ZV, VGED Recovery Team	Plan developed.	Expertise in translocation and plan development. General understanding of translocation requirements based on recent CGED releases. Wild PVA to inform numbers and potential growth rates.	Capacity to develop plan. Would be completed by Translocation Field Officer.
4.1.2	Seek input from IUCN Conservation Translocation Specialists and other relevant scientists from within and outside the Recovery Team, especially those with experience in translocating congeneric species, such as the CGED.	2026	ZV, VGED Recovery Team	Effective input received from IUCN Conservation Translocation Specialists and other relevant scientists	Access to CGED experts and researchers. Access to IUCN specialist teams and expertise.	
4.1.3	Update population viability analysis model to help determine the variables most likely to influence VGED population establishment, growth, and persistence in the wild.	As new information becomes available and prior to completion of translocation plan	ZV, VGED Recovery Team	Refinement and updating of model following acquisition of additional information.	Expertise. Initial PVA which has informed in situ requirements and key knowledge gaps.	Species specific information to refine the PVA. Key knowledge gaps addressed.

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
4.1.4	Trial the use of radiotracking transmitters on a subset of VGED at the outdoor enclosures at Werribee Open Range Zoo to inform post-release monitoring.	2025	ZV, VGED Recovery Team	No animal welfare or behavioural impacts on VGED involved in the trial. Transmitters work and stay attached for desired period. Trials completed; methods ready to apply to wild populations.	Expertise in radiotracking and transmitter refinement. Certified drone pilots and equipment to aid air borne tracking. Access to researchers radiotracking CGED.	Funding for transmitters and associated equipment. Animal ethics approval. Outdoor enclosures at Werribee Open Range Zoo.
4.1.5	Develop a post-release monitoring plan that includes radio tracking of VGED's to determine dispersal, habitat use and survival, plus overall population growth, maintenance of genetic diversity, and persistence post-release.	By early 2026	ZV, VGED Recovery Team	Plan developed.	Expertise in radiotracking and monitoring. Access to researchers monitoring releases of CGED.	Capacity to develop plan. Would be completed by Translocation Field Officer.
4.1.6	Gain the necessary approvals and permits for the reintroduction plan (e.g., Animal ethics committee approval, Translocation Evaluation Panel approval, Wildlife research permit, Parks Victoria access agreement).	By spring 2026	ZV, VGED Recovery Team	Applications developed and submitted. Approvals and permits granted.	Expertise in developing translocation approvals. Current approved permits to use as a template for future work.	Capacity to develop approvals. Would be completed by Translocation Field Officer.

Objective 4.2 Establish new populations via captive to wild translocations

Rationale:

The key to the IUCN Red List downlisting of the VGED will be largely dependent on the success of the captive to wild translocation and establishment of new self-sustaining populations. Through this program the number of in-situ populations will be expanded from one to six or more through (re-)introductions to five or more recipient sites spread spatially across the species historical range. The releases will be staged due to the number of VGEDs that will be available annually for release from the CBP (Action 4.2.1), and to enable release strategies, monitoring, or other parts of the program to be adapted should the indicators of success not be achieved (Action 4.2.2). If the initial releases are successful after two years, releases to the remaining recipient sites will be conducted and monitored (Action 4.2.3).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
4.2.1	Commence translocations at a subset (two) of selected sites and conduct post-release monitoring and radiotracking to inform indicators of success.	Initial release of individuals (50 per site) in spring 2026. Three subsequent releases of 50 individuals per site each spring and late summer to February 2028.	ZV, VGED Recovery Team	Survivorship of released animals >50% first 6 months. Successful breeding identified in spring/summer. Other indicators of success are met as per translocation plan.	Expertise. Capacity to support translocations. Access to researchers translocating CGED.	Capacity to organise, deliver and monitor translocations. Would be led by Translocation Field Officer, with opportunities for involvement for zoo staff.
4.2.2	Review progress towards meeting indicators of success, and if required adapt release strategies, monitoring etc. in line with contingency plan.	As required following each release in line with indicators of success	ZV, VGED Recovery Team	Suit of indicators of success are met as per translocation plan. Successful adaptation and implementation of contingencies if indictors of success aren't met.	Expertise and experience in adaptive management associated with translocations.	
4.2.3	If initial releases meet indicators of success after two years, conduct releases at remaining recipient sites and conduct post-release monitoring and radiotracking to inform indicators of success.	Initial release of individuals (50 per site) in spring 2028. Three subsequent releases of 50 individuals per site each spring and late summer to February 2030.	ZV, VGED Recovery Team	Survivorship of released animals >50% first 6 months. Successful breeding identified in spring/summer.	Expertise. Capacity to support translocations. Access to researchers translocating CGED.	Capacity to organise, deliver and monitor translocations. Would be led by Translocation Field Officer, with opportunities for involvement for zoo staff.

Objective 4.3 Supplementation of new and/or extant population

Rationale:

It is probable that the population at the rediscovery site and (re-)introduced populations once established, will require periodic supplementation to maintain genetic diversity and or rebound following stochastic events or known manageable threats. As such, individuals will be available to supplement the (re-)introduced populations following year three of the initial translocations should monitoring (population and genetic) indicate a need (Action 4.3.1). Similarly, monitoring of the population at the rediscovery population, and any other newly discovered populations, will indicate whether supplementation is required (Action 4.3.2).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
4.3.1	Conduct supplementation release at recipient sites following initial three years if required.	As required	ZV, VGED Recovery Team	Survivorship of released animals >50% first 6 months. Recruitment of offspring from released animals into population. Population numbers and genetic health is stable or increasing. Other indicators of success are met as per translocation plan.	Expertise.	Capacity to conduct and monitor supplementations.
4.3.2	Conduct supplementation at the rediscovery site (or any other newly discovered sites) as needed should the population rapidly decline due to a stochastic event or known manageable threat, or if a decline in genetic diversity is detected.	As required	ZV, VGED Recovery Team	Survivorship of released animals >50% first 6 months. Recruitment of offspring from released animals into population. Population numbers and genetic health is stable or increasing. Other indicators of success are met as per supplementation plan.	Expertise.	Capacity to conduct and monitor supplementations.

GOAL 5. Conservation activities and recovery of the Victorian Grassland Earless Dragon and native grasslands effectively communicated.

Objective 5.1 Communicate the plight of grasslands and the objectives and achievements of the Victorian Grassland Earless Dragon recovery program.

Rationale:
Long-term success of the VGED recovery program will require support from the public, agencies, landowners, and governments. Effective communication is key to securing and maintaining this support. Communicating the remarkable recovery of a once believed extinct species, and the hope and optimism such a story can provide will be critical and will require the essential elements of the story to be adequately documented and communicated to leverage the greatest possible impact, globally.

In collaboration with the Saving Species Challenge Program, the profile of the VGED will be raised, and updates and outcomes of this recovery program will be effectively communicated. A dedicated media team comprising, as a minimum, staff from the Recovery Team and partner organizations as well as the SSC program (Action 5.1.1) will prepare a communications and media plan (Action 5.1.2), that includes all commitments to the SSC program, and will review and endorse all communications. The steps of this program will be documented, and materials gathered along the way that may aid in communicating the story, including images, video, and interviews (action 5.1.3). The project partners and the SSC Program will work together to communicate project updates and outcomes to a broad range of audiences through a variety of mediums (Action 5.1.4).

Engagement with local communities and schools will also take place to engender a sense of ownership of grasslands and the VGED and highlight their plight as well as hope and optimism and opportunities for positive conservation actions (Action 5.1.5).

Communicating the knowledge and learnings gained through this program to the conservation sector and academia will take place through peer reviewed publications and popular articles (Action 5.1.6).

NO.	ACTION	TIMING	RESPONSIBILITY	INDICATORS OF PROGRESS/SUCCESS	WHAT WE HAVE	WHAT WE NEED
5.1.1	Establish a dedicated media team including but not limited to Recovery Team and project partners.	By early-2024	ZV, VGED Recovery Team, SSC program, Vic DEECA and Federal DCCEEW	Team established.	Existing inter-agency comms & engagement team that manages VGED Recovery Team comms & engagement. Experienced comms and media team.	Participation from the SSC Program.
5.1.2	Prepare a communication and media plan, together with the SSC program.	By mid-2024	ZV, VGED Recovery Team, SSC program, Vic DEECA and Federal DCCEEW	Plan prepared	Expertise.	Participation from the SSC Program.
5.1.3	Document all steps throughout the life of the project, collate materials that will aid in comms during and at completion of project.	On-going over the life of the project.	ZV, VGED Recovery Team, Vic DEECA and Federal DCCEEW	All steps documented. Good records of activities and milestones, including visual materials.	Expertise	
5.1.4	Prepare and communicate project progress and achievements to a range of audiences and through a variety of different mediums.	On-going over the life of the project.	ZV, VGED Recovery Team, SSC Program, Vic DEECA and Federal DCCEEW	Comms delivered. Quality of items communicated to target audiences. Satisfaction with communications of key stakeholders.	Dedicated and experienced communications and media team.	Participation and guidance from the SSC Program.
5.1.5	Engage communities and schools to promote the program and conservation of grasslands using ZV's established programs e.g., FE schools, Love your locals, safe cat safe wildlife.	On-going over the life of the project.	ZV	Local schools and communities engaged and educated on grassland conservation and the VGED recovery program. Individuals actively participate in grassland conservation.	Dedicated community conservation program and staff.	Funding to expand the program.
5.1.6	Develop and publish peer reviewed journal and popular articles to share knowledge gained from the program.	On-going over the life of the project.	ZV, VGED Recovery Team, SSC Program	Journal and popular articles published. Findings used to help zoos and conservation bodies protect and recover other species.	Expertise in writing journal articles.	

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