



**Biodiversity and
Conservation Science**

Climate Adaptation Initiative Research Development Strategy

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Department of **Biodiversity,
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1. Introduction

Western Australia (WA) is 1.3°C warmer on average than at the turn of the twentieth century, with mean annual temperatures predicted to rise by 1.2°C to 2.0°C above 1986-2005 levels by the middle of this century¹. Although rainfall has been increasing over most of WA over the past 100+ years, the far west and south-west has experienced a substantial decrease, amounting to a larger decline in rainfall than anywhere else in Australia. In addition, the number of days experiencing extreme and dangerous weather conditions has increased across the State. Without action to halve global carbon emissions by 2050, temperatures are predicted to increase by ~2 to 4°C above 1986-2005 levels by the end of this century, with associated changes in rainfall patterns and increases in fire season length and extreme weather conditions.

The State's rich and unique biodiversity, much of which is endemic, is recognised as being nationally and globally significant. WA is home to 141 of Australia's 207 mammal species, hundreds of thousands of invertebrate species, as well as 12,881 native vascular plant taxa, 50-80% of which are endemic to WA. As of October 2024, 250 fauna species and 450 flora taxa were listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act), in recognition of their extinction risk in the wild. As well as its intrinsic value, biodiversity provides ecosystem services that are essential to human survival, economic prosperity and wellbeing, including cultural and spiritual significance.

The changing climate is affecting species and ecosystems in a multitude of ways, such as driving changes in species' distribution and behaviour, altering the composition and functioning of ecological communities and exacerbating the impacts of other threats. Strategies are needed that will both minimise the impact of, and promote species and communities' adaptation to, climate change. Building the resilience of our most at risk threatened species and communities, is key to retaining their capacity to adapt to shifting climatic conditions and withstand the range of current, emerging, and future threats.

Conservation management actions that reduce the impact of established pressures on threatened species, such as controlling invasive pests and weeds and conserving habitat, can help to build the resilience of our native species and support their capacity to adapt to a changing climate. As parts of the landscape become climatically unsuitable for species' persistence, novel management approaches may be necessary. For example, translocations of species into new, more suitable locations outside of their historic range may be needed. Other approaches may include facilitated gene migration, habitat restoration, creation of new habitat and enhancing habitat connectivity, which could include planting new species or variants that are more likely to survive and thrive in a changing climate.

Effective biodiversity management is underpinned by knowledge gained through scientific research but there is a paucity of research into potential for the unique environments and biodiversity of WA to adapt to climate change. Addressing key knowledge gaps will be essential for informing decision-making to deliver improved climate resilience and adaptive capacity. In 2023, the WA State Government released the *Climate Adaptation Strategy: Building WA's climate resilient future*, which commits

to supporting climate adaptation research on Western Australia's biodiversity, focusing on threatened species and communities, and identification of on-ground actions to enhance climate resilience.

The Climate Adaptation Initiative (CAI) being undertaken by the Department of Biodiversity, Conservation and Attractions (DBCA) is a four-year program of research that aims to address climate adaptation knowledge gaps for priority threatened Western Australian fauna, flora and communities. Research conducted through this initiative will result in a better understanding of the vulnerability of threatened species and communities to climate change and their potential for adaptation to the changing environment. The initiative will investigate and trial different practical approaches to assist species in adapting to climate change, providing conservation and land managers with robust advice on the effectiveness of different climate adaptation strategies.

2. Objectives

The Climate Adaptation Initiative aims to:

1. Address key knowledge gaps to inform on-ground actions that support climate resilience and adaptation of WA threatened species and ecological communities.
2. Develop and apply innovative approaches to understand the impacts of climate change on WA threatened species and ecological communities.
3. Identify climate adaptation strategies and species and community responses to their implementation.
4. Develop partnerships and collaborations to leverage and maximise knowledge transfer and investment outcomes.

3. Climate Adaptation Initiative Overview

Research partnerships will maximise investment and knowledge sharing to inform effective on-ground actions that support climate resilience in threatened species and communities. Research undertaken through this initiative will include spatial analyses, species distribution and biophysical modelling, ecological and genetic research and on-ground intervention trials to investigate how selected threatened species and communities are responding to climate change and how they respond to a variety of adaptation strategies.

A range of innovative climate adaptation strategies will be trialled and species' and communities' responses evaluated. The success of adaptation strategies and species and ecological community responses will help to inform on-ground conservation actions. Research projects will be identified using the following iterative approach.

1. Review existing knowledge of climate change impacts on Australian fauna, flora and ecological communities and current understanding of potential climate adaptation intervention strategies.

2. Identify focal study regions using a range of climate prediction scenarios, landscape and habitat characteristics and species distribution modelling.
3. Develop a preliminary list of priority threatened fauna and flora species and ecological communities within the study regions through consideration of their conservation status, pressures acting upon them and geographic, ecological, genetic or evolutionary traits that may be suitable for climate adaptation intervention.
4. Consult DBCA Regional staff and other stakeholders, including Traditional Owners, university researchers and NRM groups to refine priority study sites, species and communities and to better understand local environmental and anthropogenic pressures within the study regions.
5. Identify and prioritise potential intervention strategies to trial and design experimental treatments for evaluating them, through assessment of feasibility, costs and potential conservation benefits to study species and communities. Due to fundamental differences in the biology and ecology of fauna and flora, the types of potential adaptation strategies available for each are different. A subtly different approach will therefore be taken to identify and prioritise fauna and flora projects, as illustrated in Figure 1.
6. Partnership opportunities for priority projects will be sought.

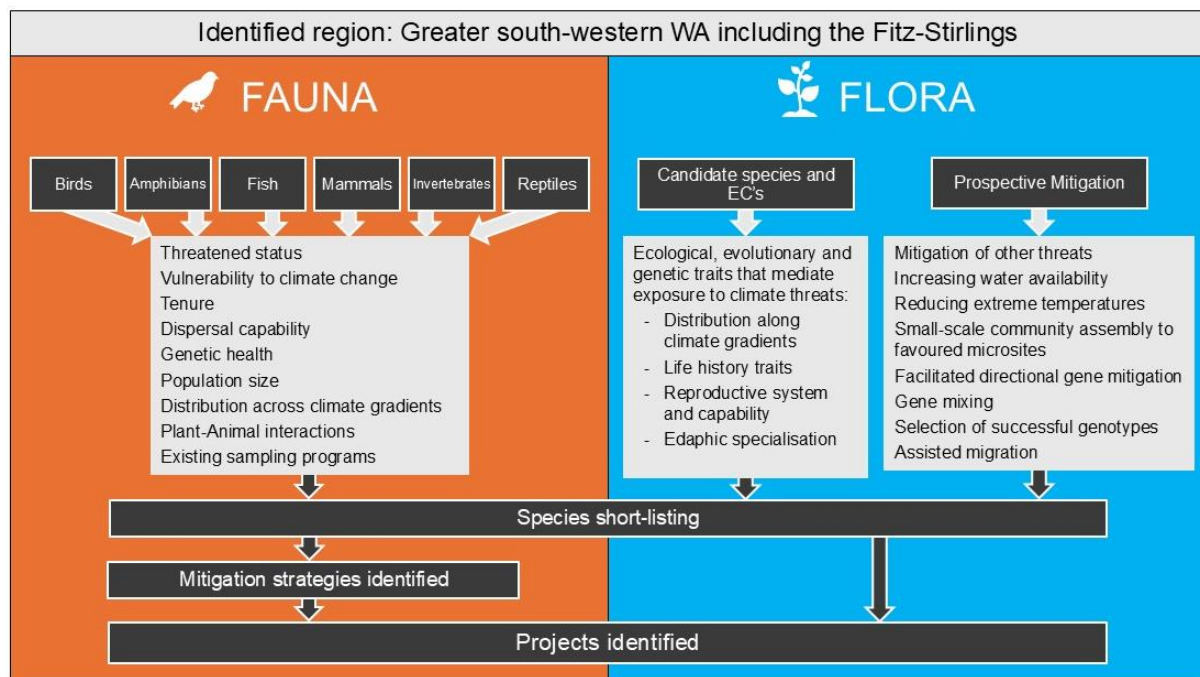


Figure 1: Climate Adaptation Initiative research project identification and prioritisation framework.

3.1 Identification of focal study region(s)

Historical rainfall and temperature data from across WA and future predictions under different climate scenarios from the most recent Coupled Model Intercomparison

Project model (CMIP6) produced by the World Climate Research Programme, were examined to identify areas that are likely to be most highly impacted by climate change and areas that may provide climate refugia under future climate scenarios. Due to the magnitude of temperature increase and rainfall decline already experienced in south-western Western Australia and projected into the future, the relatively steep climate gradients across the region and the number and scale of potential climate refugia, together with the intensity of anthropogenic pressures and the significant conservation values of the area, the initial focus of the Climate Adaptation Initiative will be the greater south-west of WA.

The selection of specific study sites within the focal area will be informed by species distribution modelling and records of species' and communities' occurrence locations. Models will be used to determine species' vulnerability to climate change as well as identifying where they are at risk, where they are most secure, the suitability of alternative locations and potential dispersal corridors. This knowledge and available genetic analyses will be used to identify key populations, and potential adaptation and management strategies for species. Study sites may be further refined and/or additional sites identified when regionally specific climate models showing finer resolution changes in temperature and precipitation are available.

It is anticipated that research projects will primarily be based on the conservation estate, where DBCA is best positioned to implement on-ground interventions. Some intervention strategies though, such as establishment of ecological corridors, may be broader in scale or otherwise more applicable outside of DBCA-managed lands and waters.

3.2 Species and community selection and prioritisation

Preliminary lists of candidate threatened fauna and flora study species and ecological communities, were developed through reviews of conservation status, pressures acting upon them and the geographic, ecological, genetic and evolutionary traits that may be suitable for potential climate adaptation interventions. Preliminary species selection also considered the inherent difficulties in working with threatened species, such as their low numbers, restricted geographic distributions, limited genetic diversity and availability of high-quality locational records. Species that are distributed across large climate gradients provide specific opportunities for testing various hypotheses about climate change responses, including whether localised populations are currently adapting to different climatic conditions across their ranges, and these species were identified as potential candidates for testing these hypotheses. For species that are impractical to study or lacking sufficient data, related or functionally similar species were included in preliminary lists as potential proxies.

Preliminary candidate species lists were discussed with DBCA Regional and District staff through a series of face to face and remote meetings during the first half of 2024, in an effort to align species prioritisation as much as possible with regional conservation planning, to determine optimal study locations, and to identify the most practical and beneficial future management interventions (see 3.3 below). Before final study species were determined, further input was sought from stakeholders and potential collaborators from universities, WA Museum, other government agencies

and non-government organisations. Because the biology and ecology of fauna and flora and their potential responses to climate change impacts and other pressures are fundamentally different, as are the potential climate adaptation intervention strategies available for each, a subtly different approach was taken to identify and prioritise potential fauna and flora research.

In addition to selecting fauna species for their distribution across climate (temperature and precipitation) gradients, candidate fauna species were selected based on their functional susceptibility to climate change impacts. The most susceptible functional groups were:

- short range endemics,
- species dependent on freshwater systems,
- fire sensitive species.

Candidate flora species and communities were chosen in the context of regional conservation priorities and to be suitable for addressing the following climate adaptation knowledge gaps:

- potential pace of adaptation,
- tolerance and proportional impacts of climate variables,
- efficacy of methods to reduce climate impacts,
- does population mixing provide climate adaptation advantages,
- are disjunct populations genetically adapted to different climatic conditions,
- does the genome of widely distributed species vary across climate gradients, and
- what parts of the genome afford climate resilience/vulnerability.

3.3 Intervention strategies

As with the identification of candidate study species and communities, a range of potential intervention strategies that could be trialled was identified through reviews of existing knowledge and consultation with experts. The suitability of potential management interventions for each of the candidate species and community was assessed and a preliminary list of intervention strategies was developed. Experimental treatments for trialling and evaluating the benefits of identified interventions were considered and discussed with DBCA Regional and District staff during the meetings to refine candidate lists (see 3.2 above).

3.3.1 Fauna

Potential intervention strategies that could be trialled to determine their effectiveness in enhancing species' resilience to climate change, include the following:

- Habitat protection and restoration interventions to safeguard climate refugia, genetic diversity hotspots, dispersal corridors and habitat that is otherwise important to species persistence.
- Adapting existing broadscale management practices, such as prescribed burning and introduced predator control, to better support the habitat requirements of climate-vulnerable species.
- Artificial alteration of hydrology to maintain or improve the availability of aquatic habitats or to increase the number or area of potential assisted colonisation sites for freshwater dependent species.
- Genetic rescue measures, including facilitated gene migration and gene mixing to introduce genotypes that are better adapted to predicted future climates or to increase climate adaption potential by increasing overall genetic diversity. These outcomes could be facilitated or enhanced through other interventions, such as enhancing dispersal corridors and translocation.
- Translocation within species' natural ranges to repopulate areas that are predicted to retain suitable habitat under future climate change and to provide targeted gene migration and genetic mixing between populations.
- Where suitable habitat is unlikely to be retained in a species' native range, and the species has limited capacity for *in situ* genetic adaptation, assisted colonisation to new suitable locations outside its native range is an option.
- Provision of artificial refuges can provide shelter for species at risk, particularly those sensitive to extreme temperatures and predation. The deployment of artificial refuges is likely to be most effective in landscapes with reduced structural complexity, such as those recently impacted by severe fire.

3.3.2 Flora intervention strategies

Threatened flora in the Southwest Australian Floristic Region (SWAFR) are characterised by having small range sizes and occurrence on geologies of limited and often patchy spatial extent. Furthermore, the ability of these flora to follow their current climate niche over time is often limited by the absence of traits facilitating long-distance seed dispersal. Human-mediated movement of these species to track climate niche may also be difficult, with lack of suitable habitat (restricted geologies), risks of hybridisation and in some cases, specialised pollination/seed dispersal mutualisms. The CAI will investigate some of the following potential interventions to overcome these climate adaptation constraints, through a combination of molecular and experimental approaches.

- Increasing water availability for threatened species, for example by irrigation and modification of micro catchments (such as creating water run-off areas or restoring hydrology by removing water redirecting infrastructure).

- Investigating the role of plant nutrition in upregulating physiological responses to drought and hence resilience.
- Reducing temperature extremes with temperature-operated sprinklers or shade sails.
- Testing the physiological performance of populations with differential exposure to climate stress, such as between sites with southerly and northerly aspects.
- Assessing the prospects for facilitated gene migration to introduce genotypes that are better adapted to future climates into local populations.
- Assessing gene mixing between isolated populations to boost genetic diversity and enhance adaptive capacity.
- Identify adaptive alleles to guide selection of climate resilient genotypes for restoration and translocation to accelerate climate adaptation.
- Assisted colonisation, which may also require assisted colonisation of mutualists or co-occurring biota.
- Identification of species and communities with higher and lower tolerance to climate extremes and the location of climate refugia with lesser predicted environmental change.

4. Candidate themes

4.1 Fauna

4.1.1 Cross-climate gradients

The ongoing impacts of climate change pose a significant risk to fauna in Australia's biodiverse south-west region. Much of the research related to these impacts has so far focused on species most threatened by drying and those with highly restricted ranges (see section 4.1.2). However, south-west WA also supports threatened fauna with larger geographic distributions that span large climate gradients. These species provide a unique opportunity to assess the ecological implications of further changes in climate as some of their populations already experience hotter and drier conditions than others, giving us a window into the future to predict how species are likely to respond. This can allow testing of whether populations may be adapting to local climatic conditions by changes to their occurrence, abundance and behavioural attributes, and whether patterns of neutral or functional genetic diversity are associated with climatic differences. Species distribution modelling under several climate change scenarios will also be undertaken to identify potential translocation sites for once widely distributed species with currently restricted ranges.

This theme aims to deepen understanding of how the drying and warming impacts of climate change are likely to interact with existing threats, such as large or intense wildfire and predation from introduced predators, such that targeted management strategies can be implemented to improve population resilience. Improving our

understanding of the role of connectivity in increasing population persistence by increasing genetic dispersal and adaptive capacity is a further aim.

A combination of species distribution and broad scale occupancy modelling, landscape scale genomics and genotype-environment association analyses will be used.

Candidate study species:

- chuditch (*Dasyurus geoffroii*)
- heath mouse (*Pseudomys shortridgei*)
- noisy scrub-bird (*Atrichornis clamosus*)
- black cockatoos (*Zanda latirostris*, *Z. baudinii*, *Calyptorhynchus naso*)
- western three-lined skink (*Acritoscincus trilineatus*)
- western false pipistrelle (*Falsistrellus mackenziei*)
- western ringtail possum (*Pseudocheirus occidentalis*)
- Australasian bittern (*Botaurus poiciloptilus*)
- crawling toadlet (*Pseudophryne guentheri*)

4.1.2 South-west short range endemics (SREs)

4.1.2.1 Vertebrate SREs

The south-west region of WA supports a host of short-range endemic vertebrates, the majority of which are highly vulnerable to the effects of climate change. The western swamp tortoise (*Pseudemydura umbrina*), white and orange-bellied frogs (*Anstisia alba*, *Anstisia vitellina*) and the sunset frog (*Spicospina flammocaerulea*) are particularly at risk due to their highly restricted geographic ranges, specific habitat requirements and limited dispersal capacity. These species inhabit specialised microhabitats that are increasingly threatened by drying and warming trends. For example, naturally occurring populations of western swamp tortoise can only be found in ephemeral clay pans of the Swan Coastal Plain, which, like the tortoise, are listed as critically endangered. Similarly, the habitat of sunset frogs and white and orange bellied frogs is primarily comprised of isolated swamp/peat systems, which have historically been able retain moisture year-round but are now drying rapidly as annual rainfall continues to decline across their distribution.

It is now clear that translocations into new or formerly occupied habitats, intensive management of existing habitats, or a combination of both will be required to ensure the persistence of these species. The success of these intervention strategies hinges on our ecological understanding of these species and the environmental conditions they require to survive and reproduce. This theme aims to build on knowledge gained from previous management efforts, including translocations, habitat restoration and threat mitigation, to better understand factors contributing to the success or failure of those interventions, and to develop novel methods to improve conservation outcomes in the future. Persisting populations will also be investigated to enhance our ecological understanding and link these insights to translocation efforts to ensure more effective and sustainable conservation strategies.

Under this theme, factors contributing to the decline and extinction of historic populations, factors influencing the success of translocation efforts, effectiveness of

habitat restoration in supporting species persistence, and spatial requirements and behaviour of *in situ* populations will be assessed.

Candidate study species:

- western swamp tortoise (*Pseudemydura umbrina*)
- sunset frog (*Spicospina flammocaerulea*)
- white-bellied frog (*Anstisia alba*)
- orange-bellied frog (*Anstisia vitellina*)

4.1.2.2 Invertebrate SREs

South-west WA contains a high diversity of invertebrate species that naturally display short-range endemism, largely due to their reliance on discontinuous and isolated habitats that are locally cool and moist, low dispersal capabilities and slow recruitment. Invertebrate groups that contain particularly high proportions of SRE species include trapdoor (mygalomorph) spiders, schizomids, snails, millipedes, velvet worms and crayfish. Due to their reliance on mesic microhabitats and low movement rates, the impacts of climate change, including drought and increased severity and frequency of fires, are expected to be the most pressing threats to the persistence of SRE invertebrates. However, these taxa are poorly studied and little detail is known about their biology, ecology, genetic diversity and population dynamics. There is an urgent need to address these critical knowledge gaps, so that appropriate management actions can be implemented to ensure their survival under future climate conditions.

Under this theme, key invertebrate SRE groups will be targeted using an integrated set of research approaches. This may include: population genetic analyses to assess neutral and adaptive diversity, connectivity and structure; detailed habitat characterisation and mapping; assessment of species' responses to drought, fire and heatwaves; and testing the feasibility of management approaches such as translocations and relocations, which are likely to be critical for ensuring the persistence of these refugial-reliant species under climate change.

Candidate study species:

- trapdoor spiders (including *Bertmainius* spp, *Idiosoma* spp, *Teyl* spp., *Euoplus* spp.)
- land snails (*Bothryembrion* spp.) and freshwater snails (*Austroassiminea letha*)
- millipedes (*Atelomastix* species).

4.1.3 Freshwater systems

The global biodiversity hotspot of south-west WA contains a freshwater fauna with extraordinary levels of endemism and vulnerability. For example, of 11 native freshwater fish species, nine are regionally endemic, the highest rate (~82%) of endemism of freshwater fishes for any region in Australia. Many freshwater species have suffered recent range declines, with nine species of south-west freshwater fish, three species of freshwater crayfish and the only freshwater mussel in south-western Australia, all listed as threatened or near threatened. Climate change has rapidly become one of the most pressing threats facing this unique fauna. In south-west WA, winter rainfall has decreased by 20-30% since the early 1900s, translating to a 60-80% reduction in streamflow. This hydrological change, coupled with longer and more

severe droughts, is having two main impacts on freshwater species. Firstly, it is reducing the magnitude of reproductive migrations during high-flow periods and thus recruitment to populations. Secondly, it is causing the loss or severe reduction in size and quality of permanent dry-season pools that provide essential refugia for the survival of aquatic species when river flow ceases over summer and autumn. The management of river catchment hydrology, particularly refuge pools, will have a critical impact on the conservation of these species.

This theme aims to characterise the effects of drying conditions on the diversity, connectivity, and movement of south-west freshwater fauna populations and the capacity of species to survive through low-flow seasons. It will identify and test critical strategies for the conservation management of freshwater species under climate change, including identification of critical populations and habitats for protection, re-connecting populations and maintaining or developing new permanent refuge pools, and informing source and target populations for genetic rescue and conservation translocations.

Under this theme, a combination of landscape scale genomics, genotype-environment association analyses, species distribution modelling, habitat and hydrological characterisation will be employed to test a variety of conservation management strategies to improve connectivity, refuge availability, and movement into critical habitat.

Candidate study species:

- freshwater fish, including western pygmy perch (*Nannoperca vitatta*), Balston's pygmy perch (*Nannatherina balstoni*), little pygmy perch (*Nannoperca pygmaea*), western minnow (*Galaxias occidentalis*), black-stripe minnow (*Galaxiella nigrostriata*), western trout minnow (*Galaxias truttaceus*), salamanderfish (*Lepidogalaxias salamadroides*).
- freshwater crayfish, including koonacs (*Cherax preissii*, *C. glaber*) and gilgies (*C. quinquecarinatus*, *C. crassimanus*),
- rakali (*Hydromus chrysogaster*)
- carter's mussel (*Westralunio carteri*)

4.1.4 Fire sensitivity

South-west WA's unique fauna, many of which are already threatened with extinction, is thought to be especially vulnerable to the direct impacts of climate change, such as decreases in rainfall and increases in temperature. Drying trends have been particularly pronounced in the south-west forested region. For example, an extreme lack of rainfall over the 2023-2024 summer has led to the death of tens of thousands of mature Marri, Jarrah, and Banksia trees, raising concerns about potential forest collapse.

While the impact of drought events in the south-west is likely to be substantial, fauna species are also likely to be affected by subsequent changes to local fire regimes. A higher frequency of extreme fire weather is expected to result in reduced intervals between fires, and increase in fire intensity, altering the composition of flora communities and overall habitat structure. Similarly, reduced rainfall is likely to affect the rate at which vegetation recovers from fire, potentially increasing the time it takes

for fauna to recolonise affected areas. Quantifying the interactive impacts of climate change and fire is a priority for the conservation of threatened fauna in the south-west, and Western Australia more generally. Despite this, targeted research into these interactions has so far been limited.

Under this theme, high resolution remote sensing data will be combined with on ground measurements of species presence and abundance and broad scale correlative modelling using DBCA's existing species presence data to investigate the interactive impacts of climate and fire in influencing habitat suitability for threatened species.

Candidate study species:

- Honey possum (*Tarsipes rostratus*)
- Chuditch (*Dasyurus geoffroii*)
- Quokka (*Setonix brachyurus*)
- Dibbler (*Parentechinus apicalis*)
- Western ringtail possum (*Pseudocheirus occidentalis*)
- Woylie (*Bettongia penicillata*)
- Quenda (*Isodon fusciventer*)
- Common brushtail possum (*Trichosurus vulpecula*)
- Western pygmy possum (*Cercartetus concinnus*)
- Western false pipistrelle (*Falsistrellus mackenziei*)

4.2 Flora

4.2.1 Genetic mixing

Maintenance of standing genetic variation (within population allelic variation at a locus) is a key factor for adaptation to changing conditions in native habitats. Small populations of threatened species often present depleted genetic variation and such small populations may not be tracking the optimal phenotype because of genetic drift.

Even over small spatial scales, non-interbreeding populations are likely to have different genetic composition to one another, which may be due to genetic drift if population size is small, local adaptation if the populations experience different environmental conditions or a combination of both. Mixing reproductively isolated populations may boost their standing genetic variation and potentially give them an advantage both in the shorter term and in coping with future climate conditions in the longer term. Indeed, maximising progeny heterozygosity by crossing between different populations (always considering the potential for outbreeding depression) can result in heterosis, with increased vigour and fitness of seedlings.

This project will undertake genomic analysis to understand the genetic composition of the sampled populations and, where feasible, will test the fitness of mixed and unmixed individuals under controlled experimental conditions to guide potential genetic rescue efforts.

Candidate study species:

Lambertia fairallii (CR)

4.2.2 Adaptive alleles

Several threatened species in the south-west corner of Australia have large gaps in their distribution range, with populations separated by hundreds of kilometres and likely experiencing different climatic conditions. The mixing of non-interbreeding populations can boost the genetic diversity of declining populations, but in this case, given the large disjunctions, the introduction of genes from populations naturally occurring in different climatic zones can also introduce adaptive alleles from the drier end of the distribution. Disjunction studies share a similar underlying concept as the population mixing theme (4.2.1) but operate over a broader spatial scale.

This project will undertake genomic analysis to understand the genetic composition of the sampled populations, explore genotype-environment association (GEA) to identify candidate loci for climate and environmental adaptation and, where possible, will test the genotypic fitness of mixed and unmixed individuals under controlled experimental conditions to guide potential genetic rescue efforts.

Candidate study species:

- *Gastrolobium crenulatum*
- *Andersonia echinocephala*
- *Daviesia obovata*
- *Conospermum quadripetalum*

4.2.3 Assisted gene migration

Adaptation to particular climatic conditions through natural selection results in patterns of local climate adaptation whereby local populations experience higher fitness compared to non-local counterparts. Recent improvements in DNA sequencing and statistical methodology have made it possible to investigate genetic divergence and the effects of climatic factors on the process of local genetic adaptation. The capacity for local adaptation among widespread key species, as well as among small, threatened plant populations and the migration of advantageous alleles to track suitable climate is critical to their long-term survival, especially in the context of rapidly changing and extreme climate conditions.

As species may be unable to disperse or adapt quickly enough to keep up with predicted rates of climate warming, assisted gene migration represents a viable conservation tool for species that are unlikely to naturally adapt to future climatic conditions. This project will sample and genotype populations across climatic gradient and explore GEA using different statistical tools (e.g. LFMM or RDA) to identify putative loci under selection and identify key drivers of population differentiation.

Candidate study species are key members of threatened Banksia woodland ecological communities:

- *Banksia ilicifolia*
- *Banksia menziesii*.

4.2.4 Potassium supplementation to increase plant resilience

Potassium (K) has a multifunctional role in physiological and metabolic functions involved in a plant's response to drought conditions. K can improve drought tolerance by acting as an osmolyte to maintain cellular turgor, reducing water loss by tightening stomatal control and mitigating oxidative stress by combating reactive oxygen species which can otherwise cause irreversible cellular damage that plant impair function and structure. Several crop species have shown improved drought tolerance with K treatments but there have been no published studies on Australian flora, nor are there any published reports of K toxicity in Australian flora. Before community-level implementation can be trialled, controlled environment experiments, allowing for manipulation of growing conditions, will assess the benefits and potential negative effects of varying concentrations of K application. Results from controlled experiments will inform subsequent field trials which will evaluate the effectiveness in practice.

Candidate study species:

Key species of Banksia woodlands threatened ecological communities.

4.2.5 Increasing water availability

Declining soil water is contributing to individual mortality, changes in reproduction and recruitment rates and altered community composition. Reductions in water availability are occurring through ongoing climatic drying across most of the south-west of WA, sometimes compounding anthropogenic alterations to local hydrology. This study will examine a targeted management intervention strategy suitable for shallow rooted threatened species that are being impacted by reduced water availability. Portions of populations will be provided with supplemental water over the growing season and soil moisture, atmospheric conditions and plant response (emergence, flowering and fruiting) will be monitored and compared over multiple seasons at watered and unwatered plots.

Candidate study species:

Caladenia graniticola.

4.2.6 Inter-population variation in climate resilience

The local environmental conditions in which populations have evolved can shape their genetic composition and ecophysiological performance. Some populations in close geographic proximity occur in locations of divergent exposure to climate stress, such as populations on north-facing aspects experiencing higher temperatures and greater evapotranspiration than those on nearby southern aspects. In other contexts, populations inhabiting similar climatic conditions may exhibit inter-population variation in genetics and morphology, which may reflect their adaptability to hotter and drier conditions.

In this theme, the physiological performance of populations with varying exposure to climate stress will be compared, coupled with analysis of genetic differentiation. If populations with exposure to greater climate stress over evolutionary time have improved physiological function, introducing adaptive alleles from these populations

into those that have not been historically exposed to climate stresses could improve the adaptive capacity of these populations.

Should microclimate variation be identified as the primary factor in influencing physiological function, this would provide critical information for defining suitable habitats for future translocation efforts.

Candidate study species:

- *Banksia solandri*
- *Conospermum undulatum*

4.2.7 Climate tolerance and refugia

Key knowledge gaps that constrain management of climate change impacts include understanding of the susceptibility of individual species to changing climate, species' ability to persist in place or disperse to suitable locations and how the aggregation of many responses at the species level combine to shape community change. In this theme, we will quantify changes in plant populations (measuring mortality, seed production, dispersal and recruitment) and the composition of communities in response to climate extremes. Recent extreme climate events that will be examined include the unprecedented dry and hot summer along the west coast in 2023-24. This research will assist in identifying species and communities most vulnerable to climate extremes and locations that can effectively function as climate refugia.

Candidate study species:

- Stirling Range threatened flora (e.g. *Banksia montana*, *B. brownii*, *Persoonia micranthera*)
- Proteaceae dominated Kwongkan shrubland threatened ecological community (South Coast) and kwongkan shrublands (Mid West)
- Eucalypt woodlands of the Great Western Woodlands (Goldfields, Wheatbelt, South Coast).

5. References

[Climate Adaptation Strategy – Building WA's climate resilient future.](#)

[Climate Resilient WA.](#)

[Climate Change in Australia.](#)

[Western Australian Climate Policy](#)