

BIODIVERSITY AND CONSERVATION SCIENCE

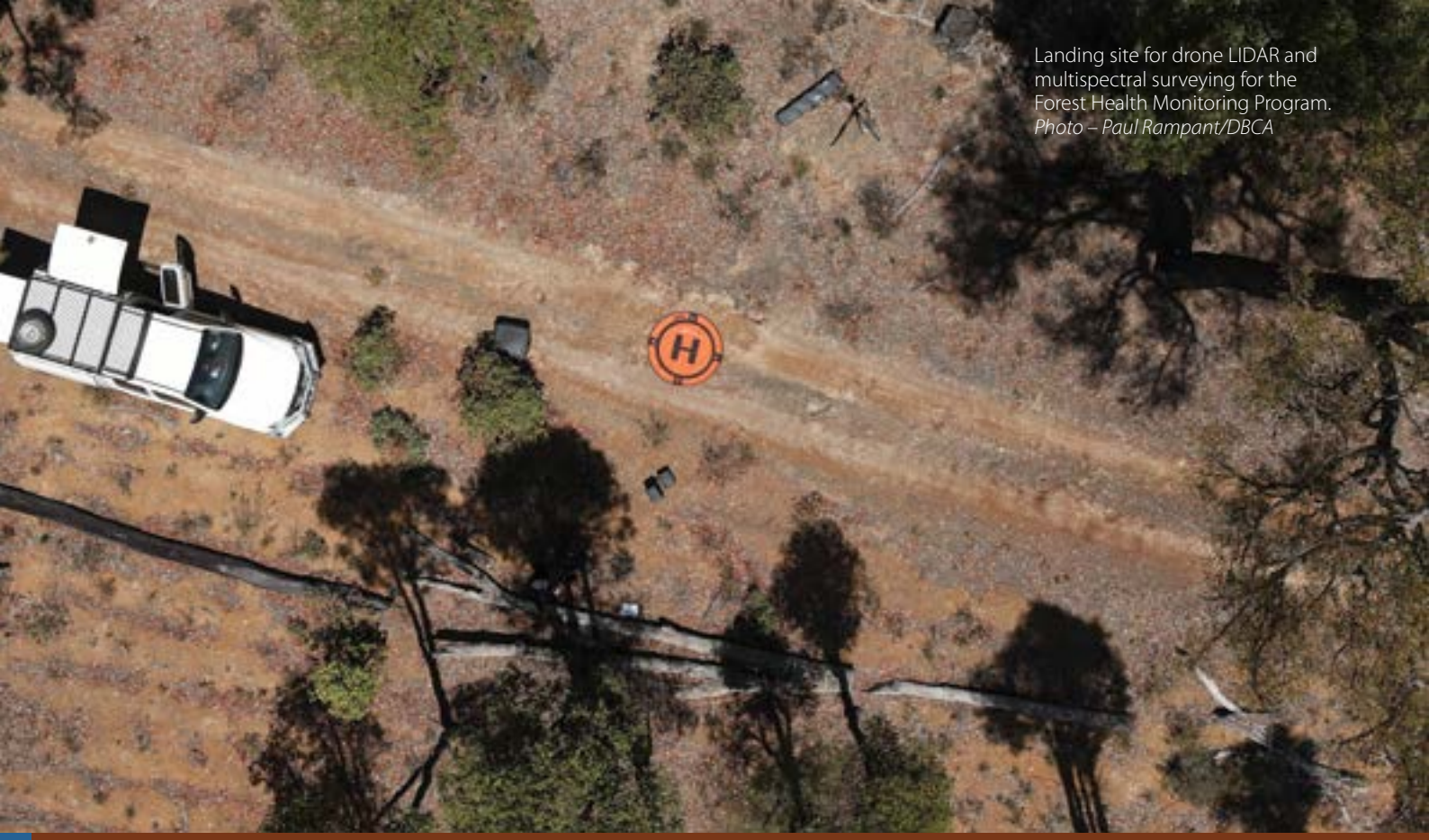
DIVISIONAL ANNUAL REPORT 2024–25

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Biodiversity and **Conservation Science**





Landing site for drone LIDAR and multispectral surveying for the Forest Health Monitoring Program. *Photo – Paul Rampant/DBCA*

ACKNOWLEDGEMENT OF COUNTRY

Our science is undertaken on the traditional lands of Aboriginal people. The Department of Biodiversity, Conservation and Attractions acknowledges the Traditional Owners of Country throughout Western Australia and their continuing connection to the land, waters and community. We pay our respects to them, their culture and to their Elders past and present.

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Top: Translocation of *Grevillea calliantha*. *Photo – Andrew Crawford/DBCA*

Bottom: Remote underwater surveys of coral bleaching at Coral Bay. *Photo – Blue Media Exmouth*

Department of

Biodiversity, Conservation and Attractions

Biodiversity and Conservation Science Annual Report

2024-2025

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Biodiversity and Conservation Science

Executive Director's Message

The Department of Biodiversity, Conservation and Attractions' (DBCA) consolidated Biodiversity and Conservation Science function has continued to provide science and biodiversity knowledge to support delivery of the Government's priorities and the functions of the Parks and Wildlife Service, Botanic Gardens and Parks Authority, Zoological Parks Authority and Rottnest Island Authority. This year's report highlights our world-class science, delivered across Western Australia through 11 science programs.

This has been a year of change for Biodiversity and Conservation Science and the department, with changes in leadership and structures, a State election and a new Minister for the Environment. The changes include Dr Margaret Byrne finishing as Executive Director Biodiversity and Conservation Science after starting in 2011. I would like to acknowledge her significant contribution in leading the evolution of the department's science programs, promoting and supporting innovation and excellence and developing and enhancing partnerships across Government, research institutions, non-Government organisations and industry. She guided, supported and mentored many staff since joining the department in 1996, and influenced corporate direction as a member of the department's leadership team.

Biodiversity and Conservation Science became part of DBCA's Science, Strategy and Governance group in May 2025, promoting closer integration between science and strategic policy, and reinforcing the critical importance of science in providing an evidence base to inform robust biodiversity conservation, land and fire management and policy development.

During 2024-25, Biodiversity and Conservation Science led a number of strategic initiatives including innovative research under the Climate Adaptation Initiative and development of the Natural Environment Sector Adaptation Plan, both key outputs of the Western Australian Climate Adaptation Strategy; the Perth and Peel Biological Survey, supporting release of land to respond to the housing shortage; and contributions to regional planning through the State's Native Vegetation Policy. While achievements over the year are too numerous to mention individually here, other selected highlights and key initiatives included:

- additional monitoring of the impacts of the marine heatwave to coral reefs and other marine ecosystems across the marine parks network in the Pilbara, Kimberley and Gascoyne regions, together with significant effort to engage and communicate with partners, stakeholders, public and media;

- appointment of an Invertebrate Ecologist to fill a key expertise gap, enabling focused efforts on better understanding the ecological requirements of trapdoor spiders, a first step towards improving our knowledge of these less well studied short range endemic species;

- trials of multiple forms of eDNA-based monitoring, including airborne eDNA, spider webs, plant swabs and soil samples for mammals that are otherwise hard to detect, including dibblers and mulgara on Dirk Hartog Island and heath mouse in Lake Magenta Nature Reserve;

- working with several universities to collect and analyse wetland sediment cores for palaeoecological reconstruction, including for water chemistry, fire and climate, so that we can better understand how current changes in wetland conditions compare to longer term natural dynamics;

- understanding the responses of trees, stands and ecosystems to ecological thinning as a management response to a drying climate in south-west forests through a multi-disciplinary approach, including ecophysiology, plant health, geophysics, fauna survey and hydrology;

- improving habitat condition in the Swan Canning Riverpark by drawing heavily on our understanding of biodiversity values, habitat distribution, ecosystem functioning and dynamics, with experimental trials, model frameworks and climate science supporting identification of the best possible approaches for management intervention and restoration action;

- improving the vegetation mapping of the Swan Coastal Plain from 1:250,000 to 1:50,000, which will provide better information for bushfire planning, understanding of ecological communities and inform environmental approvals; and

- publication of two papers with contributions from BCS staff in Nature, on the biodiversity conversation outcomes from the 2019-20 Australian megafires and on patterns of loss of genetic diversity in temporal, geographical, taxonomic, threat and conservation contexts.

I have greatly appreciated the support and generosity of all Biodiversity and Conservation Science staff during my time as Acting Executive Director from February to December 2025. This experience has only

reinforced with me the value of the very high quality of science delivered by the team, with partners and collaborators, and the critical importance of translating scientific outcomes into on-ground action to support the department's biodiversity conservation and land management functions and informing other parts of Government in protecting and restoring our natural environment.

I would like to welcome Dr Christine Lamont who commenced as Executive Director on 15 December 2025 and wish her and the entire team the very best for scientific success in the years ahead. Scientific innovation generating improved biodiversity knowledge will continue to be critical to conserving, valuing and appreciating Western Australia's unique and special native species, ecosystems and natural places.

Dr Fran Stanley
Acting Executive Director, Biodiversity and Conservation Science
December 2025

Contents

Service Delivery Structure **1**

Animal Science **2**

Adapting across climate gradients: enhancing connectivity and resilience in south-west Australia's fauna 2

Developing management strategies for south-west short-range endemic (SRE) invertebrates to build climate resilience 4

Improving the conservation management of range-restricted, endemic south-west vertebrates under climate change 5

Investigating the interactive impacts of fire and climate change on threatened fauna in south-west Australia 6

Managing connectivity, refuge availability and genetic variation of freshwater species in drying south-west catchments 7

Better understanding the status of the greater bilby in Western Australia 8

Securing the critically endangered Margaret River hairy marron in the wild 9

Building resilience to change for mammals in a multi-use landscape: identifying refugia and landscape connectivity for small mammals in the Pilbara 10

Distribution and conservation status of the heath mouse (Pseudomys shortridgei) in Western Australia 11

Genetics of Pilbara threatened bats 12

Ecology, threats and monitoring of the Pilbara olive python (Liasis olivacea barroni) 13

Felixer grooming trap trial: Feral cat control for threatened fauna conservation in the southern forests 14

Investigation into the decline of chuditch (Dasyurus geoffroii) in the south-west of Western Australia 15

Conservation of the night parrot 16

Dirk Hartog Island National Park ecological restoration project – fauna reconstruction 17

Improving the use of remote cameras as a survey and monitoring tool 18

Monitoring of threatened birds on Dirk Hartog Island 19

Barrow Island threatened and priority fauna species translocation program 20

Conservation and management of the bilby in the Pilbara 21

Conservation of south coast threatened birds 22

Genetic assessment for conservation of rare and threatened fauna 23

Rangelands restoration: reintroduction of native mammals to Matuwa (Lorna Glen) 24

Ecology and management of the northern quoll in the Pilbara 25

Impact of cane toads on biodiversity in the Kimberley 26

Development of effective broad-scale aerial baiting strategies for the control of feral cats 27

Biodiversity Information Office **28**

BIO biodiversity data platform 28
BIO data collation program 29
Ecosystem Science 31
Forest Health Monitoring Program 31
Forest ecosystem resilience and stand management 32
Evaluating the application of eDNA and metabarcoding as biodiversity and monitoring tools 34
Lifeplan: A planetary inventory of life 35
Tracking the condition of Ramsar wetlands in Western Australia 36
Investigating the causes of change in forest condition 37
Understanding the implications of a drying climate on forest ecosystem function to inform and improve climate change adaptation 38
Hydrological function of critical ecosystems 38
Taxonomy, zoogeography and conservation status of aquatic invertebrates 39
Responses of terrestrial vertebrates to management in the jarrah forest 40
Western Australian flora surveys 41
Management of invertebrate pests in forests of south-west Western Australia 42
Western Australian wetland fauna surveys 43
FORESTCHECK: Integrated site-based monitoring of the effects of timber harvesting and silviculture in the jarrah forest 44
Hydrological response to timber harvesting and associated silviculture in the intermediate rainfall zone of the northern jarrah forest 45
Fire Science 46
Fine-scale burn mosaics in south-west Forests 46
Development of a systematic approach to monitoring and reporting on the outcomes of prescribed burns and bushfires 47
Evaluation of synergies among fire and weed management in urban biodiversity and fire management 48
Long term response of jarrah forest understorey and tree health to fire regimes 49
North Kimberley Landscape Conservation Initiative: monitoring and evaluation 50
Fire regimes and impacts in transitional woodlands and shrublands 51
Kings Park Science 53
Conservation biotechnology 53
Conservation genetics 54
Orchid conservation and recovery 55
Restoration science 56
Seed science 58
Marine Science 59
Understanding the drivers of hypoxic events and impacts to the coral communities in Bill's Bay, Ningaloo Marine Park 59

Whale shark behavioural response to tourism interaction in Ningaloo Marine Park and implications for future management 60
Conservation and management of humpback whales in the Pilbara region 61
Benefits of marine parks for marine fishes in a changing climate 62
Primary productivity and energy transfer between marine ecosystems 63
Do marine reserves adequately represent high diversity cryptobenthic fish assemblages in a changing climate? 64
Understanding the key ecosystem services provided by the seagrass meadows of Western Australia 65
Distribution and abundance estimate of Australian snubfin dolphins at a key site in the Kimberley region, Western Australia 66
Habitat use, distribution and abundance of coastal dolphin species in the Pilbara 67
The influence of macroalgal fields on coral reef fish 68
Understanding movements and identifying important habitats of sea turtles in Western Australia 69
Marine monitoring program 70
Northwest Shelf Flatback Turtle Conservation Program 71
Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park 72
Spatial and temporal patterns in the structure of intertidal reef communities in the marine parks of south-western Australia 73

Perth Zoo Science 74

Anstisia frog breed and rear for release program 74
Behavioural observations of Perth Zoo collection animals for animal welfare purposes and establishment of baseline data 75
Numbat breed for release program 76
Western ground parrot husbandry 76
Western swamp tortoise breed for release program 77

Plant Science and Herbarium 79

Dieback detector dogs 79
Eco-physiological and ecological approaches to climate adaptation in threatened flora and ecological communities 80
Molecular approaches to climate adaptation in threatened flora and ecological communities 81
A digital Flora of Western Australia – a guide to the State’s botanical species diversity 82
Molecular characterisation of stinking passionflower (Passiflora foetida) 83
Herbarium collections management 84
Taxonomy of selected families including legumes, grasses and lilies 85
Taxonomy of undescribed taxa in the Ericaceae subfamily Styphelioideae, with an emphasis on those of conservation concern 86
The Western Australian Herbarium specimen data and digitisation 87
The Western Australian Plant Census and Australian Plant Census 88

Systematics of the triggerplant genus Stylidium 90
Taxonomic resolution and description of new plant species, particularly priority flora from those areas subject to mining in Western Australia 90
Taxonomic review and floristic studies of the benthic marine algae of north-western Australian and floristic surveys of Western Australian marine benthic algae 91
The Western Australian marine benthic algae online and an interactive key to the genera of Australian marine benthic algae 92
Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of conservation importance 93
Translocation of critically endangered plants 94
The population ecology of critically endangered flora 95
Seed biology, seedbank dynamics and collection and storage of seed of rare and threatened Western Australian taxa 97
Genetics and biosystematics for the conservation, circumscription and management of the Western Australian flora 98

Remote Sensing and Spatial Analysis 100

Species Distribution Modelling under Climate Change 100
Novel methods combining ground-based monitoring and remotely sensed observations to inform management and measurement of ecosystem condition in the rangelands 101
Dirk Hartog Island vegetation monitoring 102
Remote sensing and spatial analysis for fire management 103
Remote sensing monitoring 105
Spatial analysis and modelling 107
Spatial data management 108

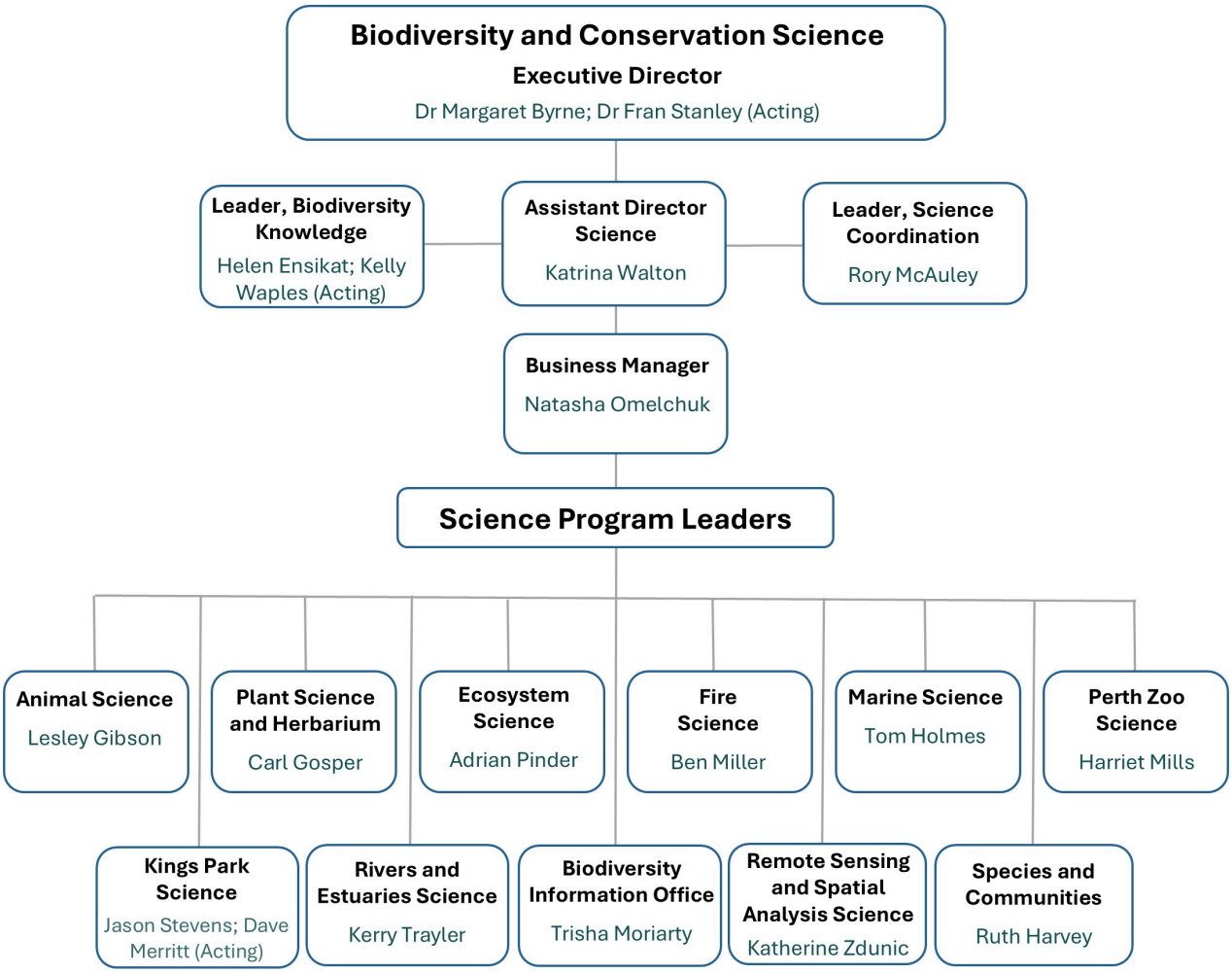
Rivers and Estuaries Science 110

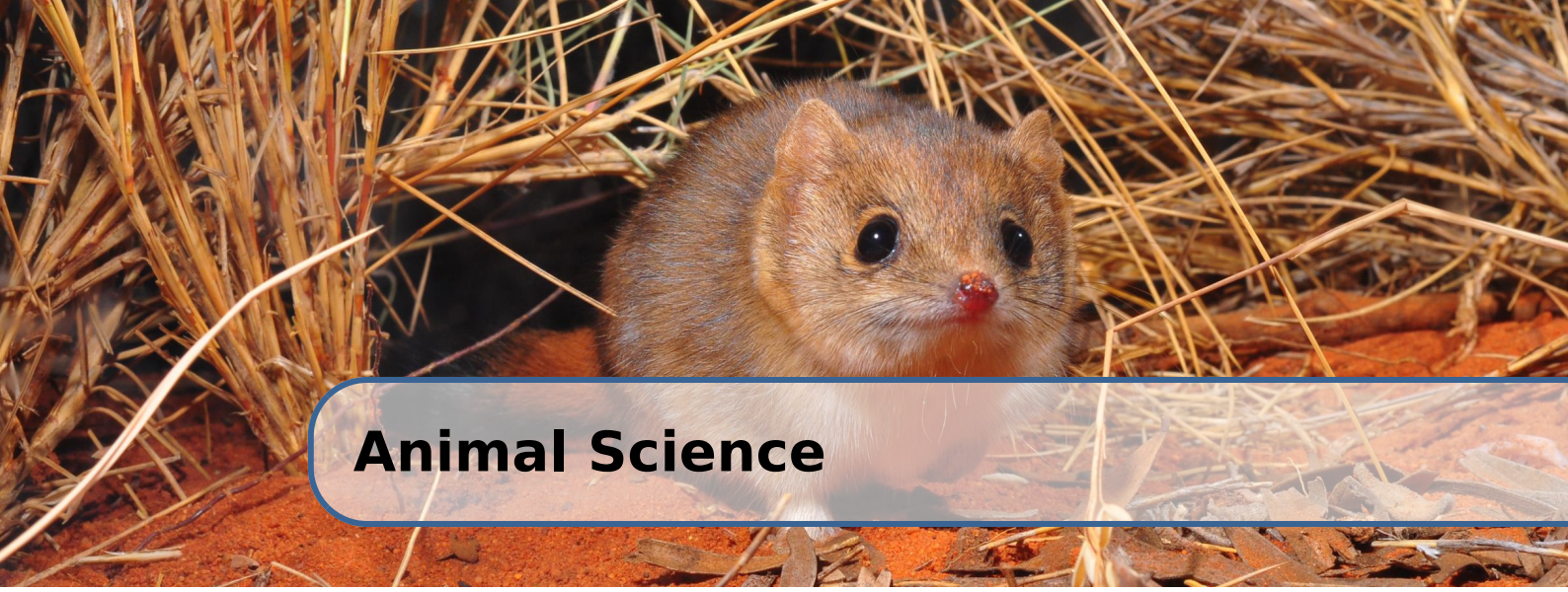
Derbal Yiragan Djarlgarro (Swan Canning) Estuary and Bindjareb Djilba (Peel Harvey) Estuary shoreline plastic contamination study 110
Ecological values of river pools and evaluation of interventions to improve in-stream habitat 111
Kent St Weir Pool - A case study in maximising environmental outcomes through better adaptive management 112
Southern River Catchment nutrient export modelling 113
Ellen Brook Catchment nutrient export: sources and pathways 114
Habitat enhancement approaches within the Swan-Canning Estuary. 115
Mapping habitat in the Swan-Canning Estuary. 116
Using Swan Canning Estuarine Response Model to optimise oxygenation plant efficiency 116
Apply acoustic technologies to investigate fish communities and movement 117
Investigations of contaminants in the Swan Canning 118
Swan Canning water quality monitoring 119
Algal blooms: investigations and control 120
Incident investigations, response and advice 121
Investigating fish communities as an indicator of estuarine condition 122

Model frameworks for estuarine reporting 123
Seagrass monitoring and evaluation 124
Species and Communities 125
Assessment and advice for conservation significant species and ecological communities 125
Biodiversity knowledge management 126
Conservation and recovery of threatened ecological communities 127
Fauna conservation and recovery 128
Flora conservation and recovery 130
Wetland mapping 131
Wetlands conservation 132
External Partnerships 133
Student Projects 140
Student Project Reports 143
Assessing congruence between morphological and molecular data in cyclopoid copepods from inland waters in southern Western Australia 143
Southern River - Upper Canning River Catchment Distributed Hydrological Model 143
Spore trapping for detection of airborne Quambalaria coyrecup, causal agent of Marri canker: An epidemiological study to aid forest management 144
Assessing pressure on coral communities from snorkellers at high visitation sites in Ningaloo Marine Park 144
Assessing the structure of boodie warrens using geophysics 145
Chemical indicators of groundwater disconnection from forested streams 145
Exploring the impacts of boat wakes and wind waves on Point Walter spit and their impacts on fairy tern nesting 145
Geophysical characterisation of peat 146
How has the invertebrate fauna of the Swan-Canning Estuary changed over the last 40 years .. 146
How marine parks affect benthic communities in the Swan River estuary 147
Molecular assessment of a recently discovered peatland endemic, Haemodorum sp. East Northcliffe 147
Radar remote sensing of lake hydrology 147
Investigating the mechanics of native seedling emergence 148
Understanding the hydrology of freshwater pools at Murujuga: Implications for freshwater refugia under a changing climate 148
Alexandrium spp. in Western Australia: characterisation, toxin mobility and control options 149
Chasing flamingos - tracking synthetic eDNA in a river network using passive sampling methods 149
Ecophysiology of seed dormancy of Hibbertia 149
Microplastic distribution, sources, ingestion and health impacts in urban estuarine environments 150

The influence of mining on the movement ecology and behaviour of the endangered northern quoll (Dasyurus hallucatus) 150
Dirk Hartog Island fauna reintroductions disease risk analysis 151
Environmental DNA as a tool to monitor fish movement in the Canning River 151
Understanding patterns of phenotypic and genetic divergence in island mammals to improve conservation outcomes 152
Assisted colonisation of the western swamp tortoise (Pseudemydura umbrina): the role of energy requirements in translocation decisions 152
Characterisation of mitochondrial function in the cryopreservation of threatened flora 152
Development of cryopreservation for the recalcitrant seeded Australian plants Syzygium australe and S. paniculatum 153
Role of redox homeostasis in recovery from cryopreservation in Arabidopsis thaliana 153
Survey methods and population estimates of the chuditch across its range 154
Taxonomy and evolutionary history of Australocypris giant ostracods from Australian salt lakes 154
Taxonomy and evolutionary history of Parartemia brine shrimp from Australian salt lakes 154
Assessing ecological resilience of post-mining restoration: testing fire recovery across a restoration chronosequence 155
Influence of fire history and seed distribution on the movements of granivorous finches in the East Kimberley 155
Shifting soil fungal communities in response to fire and weed management in urban banksia woodlands 156
Ecologically tolerable fire regimes for key banksia woodland plant species 156
Evaluating flowcam and machine learning approaches in water sciences 157
Factors affecting the success of threatened flora translocations 157
Publications and Reports 158
Summary of Research Projects 176

Service Delivery Structure





Animal Science

Program Leader: Lesley Gibson

Applied research undertaken by the Animal Science Program seeks to understand the factors and processes critical for conserving Western Australia's rich and unique native fauna. The major objectives of the program are to ensure the persistence of threatened species through local and landscape-scale management actions, including reducing key threats such as predation by foxes and feral cats, inappropriate fire regimes, competition and predation by introduced rodents on islands, as well as assessing cane toad impacts and reconstructing the fauna of rangeland and arid areas.



Adapting across climate gradients: enhancing connectivity and resilience in south-west Australia's fauna

SP-2025-2

K Rick, H Moore, R Lymbery, H Kilian, L Van Der Weyde

Context

The ongoing impacts of climate change pose a significant risk to fauna in Australia’s south-west region, a recognised biodiversity hotspot. Much of the research into climate change impacts to date has focused on species with highly restricted ranges that depend heavily on rainfall and moisture, such as the western swamp tortoise (*Pseudemydura umbrina*) and white- and orange-bellied frogs (*Anstisia alba* and *Anstisia vitellina*). However, south-west WA also supports threatened fauna with broader geographic distributions that span large climate gradients, including the western ringtail possum (*Pseudocheirus occidentalis*), western false pipistrelle (*Falsistrellus mackenziei*), and chuditch (*Dasyurus geoffroii*). These species offer a unique opportunity to assess the ecological implications of climate change, as some populations already experience hotter and drier conditions than others. This variation provides a ‘window into the future’ of how species may respond. By comparing populations across climate gradients, we can test whether responses to local climatic conditions influence occurrence, abundance or behaviour and whether neutral or adaptive genetic variation is associated with environmental differences.

Aims

- Use extensive occurrence records and genetic sampling of chuditch (*Dasyurus geoffroii*) across south-west climate gradients to assess how temperature, rainfall and habitat variables shape distribution, gene flow and adaptive genetic variation.
- Investigate the effects of declining rainfall on threatened fauna in the northern Jarrah Forest, a climate-sensitive hotspot, focusing on species such as the western false pipistrelle (*Falsistrellus mackenziei*) and quokka (*Setonix brachyurus*) to guide conservation efforts.
- Assess how climate-driven factors, particularly heatwaves, interact with threats like invasive predators and bushfire to impact the persistence of the western ringtail possum (*Pseudocheirus occidentalis*) on the Swan Coastal Plain.
- Assess how existing efforts to increase connectivity between Stirling Range and Fitzgerald River National Parks are enhancing genetic dispersal and, ultimately, the adaptive capacity of small vertebrates in the

face of climate change.
- Analyse long-term genetic data from breeding populations of white-tailed black cockatoos (*Zanda latirostris*, *Z. baudinii*) to understand patterns of genetic diversity, movement, and fitness in relation to climate variability.

Progress

- In the northern Jarrah Forest, 180 monitoring sites were established using remote cameras and acoustic recorders. More than 5600 independent camera detections were recorded, covering at least 75 vertebrate species. Notable detections included chuditch, quenda, woylie, quokka and western false pipistrelle. Approximately 1,000,000 bat echolocation pulses were detected, providing a rich dataset for assessing bat activity. Two manuscripts were submitted and one is in preparation.
- Fifteen western ringtail possums were collared across three sites on the southern Swan Coastal Plain using GPS and accelerometer loggers over summer. On days above 35°C, males reduced nocturnal activity by 32 per cent and increased daytime movement, while females showed an 11 per cent drop in night activity, indicating heat-driven behavioural trade-offs.
- Artificial habitat sites were established at 41 sites in the Fitz-Stirlings (with nine more planned) to survey reptile communities and assess habitat suitability in restored and remnant areas.
- A second batch of genetic sequencing of chuditch was conducted, comprising 229 samples with the aim of filling in gaps in the original sampling extent. Together with the first batch of sequencing, this comprises a total dataset of 446 sequenced samples. Bioinformatics have been completed on these data and single nucleotide polymorphisms (SNPs) have been identified. These SNPs are currently being analysed to determine patterns of genetic structure, diversity and relatedness across remnant populations.
- Samples from long-term monitoring of Carnaby's cockatoo breeding sites were sorted and archived, comprising a total of 1046 samples collected between 2014 and 2025. Samples for reference genomes of Carnaby's and Baudin's cockatoos were sourced from Perth Zoo and sent for HiFi long-read sequencing and Hi-C chromatin conformation capture.

Management Implications

- Camera and acoustic data collected in the northern Jarrah Forest provide a strong baseline for assessing the effects of key management activities, including predator baiting and prescribed burning, on threatened species.
- Data from western ringtail possum GPS collars demonstrate behavioural changes, heat-related mortality and sublethal stress during heatwaves, underscoring the need to provide for access to thermal refugia and water in DBCA-managed reserves.
- Artificial habitat surveys and upcoming camera deployments in the Fitz-Stirlings will provide key data on how restored and remnant habitats support small vertebrates, guiding restoration planning, identifying priority areas for improving connectivity and evaluating the role of artificial structures in enhancing climate resilience.
- Results of genetic analyses of chuditch will inform population management, including future translocations to ensure newly established populations are genetically diverse, representative of the species, and include putatively climate-adapted alleles.
- Genomic analyses of cockatoos will inform direct conservation actions including protecting at-risk colonies, guiding the release of rehabilitated birds and augmenting populations.

Future Directions

- Repeat surveys at the same 180 sites in the northern Jarrah Forest will continue in spring 2025 and 2026 to assess temporal changes in fauna activity and distribution.
- An additional 10 western ringtail possums will be collared in summer 2025–26 to expand understanding of behavioural responses to extreme heat.
- In the Fitz-Stirlings, 240 camera traps and 80 acoustic recording units will be deployed in summer 2025–26 to survey vertebrate communities. Artificial refuges will be checked and genetic material collected bimonthly.
- Analysis of SNP data for chuditch will be completed to determine population genetic structure, connectivity and putative climate adaptation.
- Reference genomes for Carnaby’s and Baudin’s cockatoos will be assembled, and breeding site samples sequenced to assess genomic diversity, population structure, climate adaptation, and vulnerability.



Developing management strategies for south-west short-range endemic (SRE) invertebrates to build climate resilience

SP-2025-5

R Lymbery, H Moore, H Kilian, L Van Der Weyde, S Cowen, B Howe, K Rick

Context

South-western WA contains a high diversity of invertebrates that naturally display short-range endemism, largely due to a reliance on discontinuous, isolated habitats that are locally cool and moist, low dispersal, and slow recruitment. Due to these attributes, impacts of climate change, including drought and increased fire severity and frequency, are expected to be among the most pressing threats to the persistence of short-range endemic (SRE) invertebrates. There is an urgent need to address critical knowledge gaps in south-west SRE invertebrates, so that appropriate management actions can be implemented. This project will target key invertebrate SRE groups, focusing initially on trapdoor spiders. An integrated set of approaches, including population genetic analyses, microhabitat characterisation and assessment of drought and fire responses will be applied. These will guide 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.

Aims

- Characterise and map the microhabitats required by SRE invertebrates, with a focus on defining climatic refugia.
- Assess how dispersal capacity, habitat fragmentation and climate influence neutral and adaptive genetic diversity, gene flow and population structure.
- Investigate the impacts of fire severity and frequency, droughts and heatwaves on SRE invertebrates.

Progress

- A total of 234 burrows of target trapdoor spider species (*Idiosoma jarrah, I. rhaphiduca* sensu lato, *Gaius cooperi*) were recorded across the Northern Jarrah Forest bioregion in south-west WA. Many of these records represent new sites for these taxa, such as Flint Forest Block and Midgegooroo National Park.
- 105 trapping events (defined as one trap set over one night) have been conducted across the range of burrow locations that were detected in the initial survey. 25 spiders were captured and genetic samples were taken from 23.
- To supplement collected samples, 65 tissue subsamples from recent (2015-2025) specimens of target species have been provided by the Western Australian Museum.
- DNA was successfully extracted from three samples each of *I. jarrah*, *I. rhaphiduca* s. lat., and *G. cooperi*, and genotype-by-sequencing trials were successfully conducted.
- Pre-existing burrow locations of the pygmy trapdoor spider (*Bertmainius mysticus* and *B. tingle*) have been re-surveyed and several active or recently active sites have been found, including new locations for both species. Ecological and micro-climate data related to these new sites are also being collected.

Management Implications

- Improved understanding of the distribution of key trapdoor spider groups in the Northern Jarrah Forest will help to guide conservation management and environmental impact assessments.
- Genetic sequencing and analysis will provide detailed understanding of the factors affecting occurrence and genetic connectivity of trapdoor spiders and identification of key populations and habitats that require protection, restoration or supplementation to facilitate persistence under climate change.

Future Directions

- Conduct surveys to characterise the microhabitat where burrows were found, along with control points to compare locations where there are no burrows, to better understand what features of the jarrah forest landscape are most important for suitability for trapdoor spider burrows.
- Undertake pre- and post-burn surveys for populations that fall within DBCA's burn plans, allowing stronger causal inferences about the temporal effects of fire on presence, abundance and recruitment.
- Create predictive micro-climate GIS layers from species distribution modelling for several species to better understand microhabitat requirements.
- Undertake further surveys to monitor impacts of pre- and post-fire survival on the pygmy trapdoor spiders.



Improving the conservation management of range-restricted, endemic south-west vertebrates under climate change

SP-2025-4

K Rick, R Lymbery, S Cowen, H Moore, M Dziminski, H Kilian, L Van Der Weyde

Context

The south-west region of Western Australia is a global biodiversity hotspot, home to numerous short-range endemic vertebrate species including the western swamp turtle (*Pseudemydura umbrina*), white-bellied frog (*Anstisia alba*) and orange-bellied frog (*Anstisia vitellina*). These species, with their highly specific habitat requirements and limited dispersal abilities, are particularly vulnerable to the impacts of climate change, especially increasing temperatures and prolonged drying trends. As their habitats become increasingly fragmented and inhospitable, conservation efforts must adapt to ensure their persistence. Potential strategies include translocations to suitable new or historically occupied habitats, intensive management of existing environments or integrated approaches combining both. This project aims to deepen our understanding of the ecological mechanisms that enable population persistence under environmental stress. By integrating insights from past conservation initiatives, this project will inform more effective, evidence-based strategies for safeguarding biodiversity in a rapidly changing climate.

Aims

- Investigate the ecological requirements and critical swamp habitat conditions necessary to support the persistence of *A. alba* and *A. vitellina* species in the south-west region, incorporating genetic analyses to understand population structure and adaptive capacity.
- Assess the effectiveness of past and ongoing translocations of target species, identify key factors influencing conservation outcomes and integrate population genetic analyses and predictive modelling of future habitat suitability to guide improved management strategies under a drying climate.
- Conduct genomic analyses of *P. umbrina* to evaluate the diversity, relatedness, and pedigrees of individuals in captive and wild populations to inform translocation strategies.
- Provide scientific advice regarding optimisation of monitoring protocols for species of interest, ensuring accurate and effective tracking of population trends and habitat use to help inform mitigation strategies under a drying climate.
- Conduct distribution modelling for relevant species to assist with management strategies under a drying climate (see SP 2024-11).

Progress

- Genetic samples collected from 67 *A. alba* individuals across eight populations. Additional samples were provided by Perth Zoo Science via the headstarting program, taking the total number to 81 samples across nine populations. These provide excellent geographic coverage of the extant high-density populations of this species on conservation estate. All samples have been successfully sequenced using DArT-seq technology with analysis underway.
- Distribution modelling is proceeding with preliminary outputs achieved, incorporating validation measurements of soil moisture and temperature recorded at *A. alba* sampling sites.
- A suitable *P. umbrina* voucher specimen was sourced for reference genome development, with Hi-Fi and Hi-C sequencing completed through the Bioplatforms Australia Threatened Species Initiative. Genome assembly has been completed.
- Over 1500 *P. umbrina* samples have been collated, spanning wild and captive-bred individuals from the 1980s to present. Laboratory trials have demonstrated successful DNA extraction from scute notches and allantoic egg sacs, with protocol optimisation ongoing.

Management Implications

- Genetic analyses will provide improved understanding of the factors influencing the persistence, connectivity and diversity of *Anstisia* species in the south-west region, which will enable more effective translocation strategies under a drying and warming climate.
- The development of a high-quality reference genome for *P. umbrina* may facilitate precise genetic assessments, including the identification of functional genomic regions linked to adaptation, disease resistance, and overall health, critical for management of both captive and wild populations. Integration of historical and contemporary genetic data provides a framework to evaluate the genetic composition of the *P. umbrina* captive breeding program, assess the outcome of past interventions and refine future conservation strategies to enhance population resilience.

Future Directions

- Undertake sample collection for *A. vitellina*, scheduled for October 2025, with samples to be processed using DArT-seq.
- Perform analyses of *Anstisia* genetic data to determine population structure, relatedness and diversity. Share relevant findings with stakeholders to support evidence-based conservation planning and management decisions, including the identification of source and target populations for translocations and supplementations.
- Collect high-quality *P. umbrina* samples as required for whole genome sequencing, aimed at investigating genetic load, inbreeding, and variation in key functional genes relevant to species resilience.
- Develop and validate a SNP MassArray panel for *P. umbrina* to enable cost-effective, long-term genetic monitoring and assess the accuracy of the captive breeding studbook, including the potential for sperm storage.
- Prepare and submit manuscripts for peer-reviewed publications.



Investigating the interactive impacts of fire and climate change on threatened fauna in south-west Australia

SP-2025-3

H Moore, R Lymbery, H Kilian, L Van Der Weyde, K Rick

Context

The south-west of Australia supports unique fauna, many of which are threatened by habitat loss and introduced predators. Climate change adds further pressure, with declining rainfall and rising temperatures already driving ecological change. Record low rainfall in 2023-24 caused mass dieback of Marri, Jarrah and Banksia trees, raising fears of large-scale forest collapse. These changes are likely to affect fauna both directly through increased drought and heat stress and, indirectly, by altering fire regimes that influence habitat structure and availability.

Understanding the combined effects of climate change and altered fire regimes is critical for conserving threatened fauna in the south-west and more broadly across Western Australia, although targeted research on these interactions remains limited. This project will address that gap by integrating high-resolution remote sensing data with field-based measurements of species presence and abundance to investigate how climate and fire jointly shape habitat suitability for threatened species.

Aims

- Quantify the interactive effects of climate change and fire regimes on habitat suitability for threatened and priority mammal fauna including chuditch (*Dasyurus geoffroii)*, quokka (*Setonix brachyurus*), woylie (*Bettongia penicillata*), brush-tailed phascogale (*Phascogale tapoatafa*), brush-tailed wallaby (*Notamacropus irma*), mardo (*Antechinus flavipes)*, and western false pipistrelle (*Falsistrellus mackenziei*).
- Assess how changes in vegetation recovery rates and habitat structure, driven by reduced rainfall and increased fire frequency, influence species recolonisation and persistence.
- Develop predictive models integrating remote sensing data and on-ground species measurements to inform conservation strategies for threatened species.

Progress

- In 2024, 180 monitoring sites were established using remote cameras and acoustic recorders.
- Over 5600 independent camera detections were recorded, covering at least 75 vertebrate species.
- Notable detections included chuditch (*Dasyurus geoffroii*, 49 sites), quenda (*Isoodon obesulus*, 20), woylie (*Bettongia penicillata*), quokka (*Setonix brachyurus*), and western false pipistrelle (*Falsistrellus mackenziei*).
- Red foxes (*Vulpes vulpes*) were detected at 22 (mostly unbaited) sites but feral cats (*Felis catus*) were rare.
- Nearly one million bat echolocation pulses were recorded. Species-level identification is underway using semi-automated methods and expert validation.
- Two manuscripts have been submitted. One evaluated the performance and cost of different cameras, finding that cheaper models offered comparable performance to more expensive units with significant savings. The second manuscript shows that fox detections were six times higher in unbaited areas.

- A third manuscript is in preparation, which explores prey activity shifts in response to predator suppression.

Management Implications

- Increased presence records for threatened species strengthen the evidence base for targeted management.
- Cost-effective cameras performed comparably to more expensive units, supporting broader landscape-scale monitoring within existing budgets.
- Data provide strong support for the effectiveness of predator baiting for controlling foxes (*V. vulpes*) across the Northern Jarrah Forest.
- Prey species expanded their temporal activity in baited areas, indicating that predator control provides both physical and behavioural refuge, with important implications for population recovery planning.
- Integrated acoustic and camera datasets offer a robust platform for evaluating interactions between fire, climate and predator management, informing adaptive strategies across DBCA and partner-managed lands.

Future Directions

- Repeat surveys in 2025 and 2026 will enable analysis of temporal changes in species presence, activity patterns and predator-prey dynamics.
- Ongoing analysis will assess how fire history, rainfall and predator activity interact to influence threatened species distributions.
- Refined identification of bat calls will support species-level analysis of habitat associations and responses to fire and climate.
- Results will inform habitat suitability modelling and guide adaptive fire and predator management strategies across DBCA-managed and partner lands.



Managing connectivity, refuge availability and genetic variation of freshwater species in drying south-west catchments

SP-2025-6

K Rick, R Lymbery, L Van Der Weyde, H Moore, H Kilian

Context

The south-west of Western Australia, recognised as a global biodiversity hotspot, harbours freshwater fauna with high levels of endemism and vulnerability. Many species have experienced recent range contractions, with climate change emerging as a major threat to their persistence. Increasingly severe and prolonged droughts, along with altered hydrological regimes, are disrupting key ecological processes. These changes are limiting opportunities for reproductive migrations during high-flow periods, reducing recruitment and weakening population resilience. At the same time, the degradation and loss of permanent dry-season refuge pools are threatening the survival of aquatic species during periods when river flow ceases in summer and autumn. Effective management of river catchment hydrology, particularly the protection and restoration of these critical refuges, will be essential for conserving freshwater biodiversity. This project investigates how drying conditions affect the diversity, connectivity and movement of freshwater fish populations in the region and evaluates their capacity to persist through low-flow seasons. It will inform climate-adaptive management strategies, including identifying priority populations and habitats for protection, reconnecting fragmented populations via restored or newly established refuge pools and guiding genetic rescue and conservation translocations through the identification of suitable source and recipient populations.

Aims

- Assess genomic diversity, population structure and connectivity of focal freshwater fish taxa across catchments and among refuge pools to understand patterns of genetic resilience.
- Identify environmental and habitat features that influence gene flow between populations and refuge pools, highlighting factors that support or hinder long-term persistence.
- Characterise the distribution of putatively adaptive variation in relation to environmental gradients, with a focus on climatic variables, to assess potential for local adaptation.
- Compare genetic and ecological patterns across taxa with differing life history traits and geographic ranges to inform targeted, species-specific conservation strategies for freshwater communities under climate change.

Progress

- Collaboration with Murdoch University and the Department of Water and Environmental Regulation is supporting genetic sampling through ongoing freshwater surveys across multiple catchments.
- Sequencing support has been obtained from the Bioplatforms Australia (BPA) Threatened Species Initiative for salamanderfish and little pygmy perch.
- Samples were collected for reference genome assembly of salamanderfish and are currently in preparation for submission to sequencing providers.
- Provisional sequencing support has been provided by BPA Australian Fish Genomes Initiative for western minnow, black-striped minnow and western pygmy perch. Sequencing designs are currently being revised and resubmitted to BPA.

Management Implications

- Reference genomes will enable precise assessments of genetic diversity and adaptive capacity in target species and provide a foundation for designing long-term genetic monitoring.
- Genetic data may guide the identification of priority populations and habitats for protection, particularly under climate stressors such as reduced water availability and altered flow regimes. These insights may also support habitat connectivity and metapopulation management, enhancing species resilience in drying catchments.
- Genomic tools can inform the selection of source and recipient populations for conservation translocations, helping to reduce inbreeding and improve population viability.
- Continued engagement with multi-jurisdictional stakeholders ensures genomic findings are translated into effective, on-ground conservation actions.

Future Directions

- Complete reference genome sequencing and assembly for salamanderfish and undertake targeted population-level sampling for this range-restricted species. Analyse subsequent genetic data to determine patterns of diversity and structure.
- Plan and undertake broader regional-scale sampling across catchments for species of minnows and pygmy perch. Incorporate sampling of natural and artificial refuge pools along with in-stream sites during flow seasons. Use data to compare patterns of diversity, connectivity and adaptation across species and catchments, and between refuge pools.



Better understanding the status of the greater bilby in Western Australia

SP-2024-30

M Dziminski, A Desmond, B Howe

Context

Since European colonisation of Australia, the range and abundance of the greater bilby (*Macrotis lagotis*) has contracted severely and it is now listed as vulnerable. Since the late 1800s, bilbies have disappeared from at least 80 per cent of their former range and the closely related lesser bilby (*Macrotis leucura*), has become extinct.

Throughout the 2000s, in attempts to promote recovery of the species, three large scale reintroductions were attempted across Western Australia by DBCA. The success of the Shark Bay reintroduction (Project Eden) has never been assessed and the species' current status is unknown. The Peron Peninsula, in Shark Bay, is a 105,000 hectare area where introduced herbivores and feral predators are managed to some extent through the use of a fence, culling, aerial baiting and trapping. No survey or systematic monitoring has been undertaken to determine the status of bilbies on the Peron Peninsula. This project will involve better understanding of the status of bilby populations at selected sites across Western Australia, commencing with the Peron Peninsula population.

Aims

- Determine the occupancy of bilbies across selected areas of Western Australia, commencing with Peron Peninsula in Shark Bay.
- Determine the abundance of bilbies within populations, commencing with Peron Peninsula.
- Generate a habitat suitability model based on known occurrences and environmental variables, commencing with Peron Peninsula.

- Prepare a scoping report outlining the feasibility and options to reintroduce the bilby to nearby Muggon (Minangu lands) and threat abatement monitoring techniques.

Progress

- Field surveys of Peron Peninsula were undertaken in collaboration with Regional staff and Malgana Aboriginal Corporation Rangers and data are currently being collated and analysed.
- Sixty-seven 2-hectare sign plots were surveyed with three repeat visits to account for imperfect detection, with bilby presence recorded on 12 occasions.
- Camera images from an array of 85 cameras are being analysed to obtain occupancy estimates from these observations.
- Abundance of two bilby populations was surveyed with 215 bilby scat samples collected for SNP genotyping.

Management Implications

- As identified in the management plan for Shark Bay terrestrial reserves, the results from this survey will establish whether the translocation to Peron Peninsula was successful and where targeted management should be invested to maintain and manage the population.
- Information on the success of the reintroduction will provide baseline data for planned future joint management reintroductions in the neighbouring Minangu area.
- Establishment of translocated insurance populations on secure tenure can expand the existing population and ensure recovery and persistence of the species.

Future Directions

- Analyses of occupancy from sign plots and camera data.
- Genetic analyses of collected scat samples.
- Habitat suitability analyses.
- Develop a report outlining the feasibility and options to reintroduce the bilby to nearby Muggon (Minangu lands) and threat abatement monitoring techniques.



Securing the critically endangered Margaret River hairy marron in the wild

SP-2024-33

M Dziminski, B Howe, K Schell, J Richards

Context

The Margaret River hairy marron (*Cherax tenuimanus*) is an iconic, critically endangered, large freshwater crayfish, previously only found in the Margaret River. Introduction of the smooth marron (*Cherax cainii*) into the river led to the decline of the hairy marron through hybridisation and competition and previous attempts have demonstrated that this threat cannot be removed or managed. The hairy marron is likely to be close to being functionally extinct in the wild. There are currently 34 adults and 58 juveniles held in captivity across Perth Zoo and the Department of Primary Industries and Regional Development's (DPIRD) Pemberton Freshwater Research Centre (PFRC). The hairy marron is at high risk of extinction.

Historically, captive breeding trials have been sporadically successful but not reliable, although some stock has recently been captively bred at Perth Zoo. A single potentially suitable translocation site has been identified but more potential sites are urgently required to translocate captive animals.

Aims

- Identify alternate translocation sites through a desktop study considering criteria such as tenure, access, physical structure, seasonal effects and resilience to future effects of climate change.
- Survey shortlisted sites, including measuring water quality, identifying the presence of smooth marron and rakali (water rats), a potential threat to translocated marron.
- Trial the suitability of a department managed site in the south-west to support hairy marron by testing 'release' of juvenile hybrid smooth/hairy marron in Hexcyl basket enclosures in semi-natural ponds at the PFRC before repeating the trial with hybrids at the trial site.
- If hybrid trials prove successful, repeat the trial with hairy marron.

Progress

- Fieldwork and data collection have concluded with data analyses underway.
- Seven sites identified through the desktop study were visited to assess water quality and undertake aquatic and terrestrial fauna surveys.
- Three sites on the south coast were identified as potentially suitable translocation sites, with no smooth marron present and having suitable water quality. These sites are on conservation tenure.
- Hexcyl enclosure trial spanning six months using hybrid smooth/hairy marron in semi-natural ponds at PFRC was successful.
- This trial with hybrid marron was repeated in the field at the potential translocation site with success.
- The above trial was repeated using pure hairy marron at the potential translocation site and was successful.

Management Implications

- The outcomes of this project will help inform the conservation and recovery of the critically endangered hairy marron.
- Identification of potentially suitable future translocation sites provides options for establishing viable and resilient translocated populations, easing pressure on available and existing holding facilities and resources and providing an end point for the captive breeding pipeline.
- Successful trials of housing hairy marron in Hexyl enclosures in captivity and in the wild has provided a new option for growing out juvenile cohorts and holding hairy marron breeding stock. This technique is particularly useful in preventing intraspecific aggression and cannibalism, interspecific predation, and individual separation to prevent inbreeding within related cohorts.

Future Directions

- Installation of long-term water quality data loggers at the identified potential future translocation sites to monitor changes in quality, particularly pH and salinity, and water level across seasons to help inform translocation decisions.
- Installation of long-term remote cameras to monitor the prevalence of predators (water birds, rakali) at potential future translocation sites to inform threat management.
- Occasional sampling at the potential future translocation sites to confirm absence of smooth marron.
- Assess the genetic structure of local marron populations in the catchment downstream of potential translocation sites to determine if they differ between catchments, whether this is important and any potential adverse effects if hairy marron were to move from translocation sites and interbreed with the local smooth marron lower in the catchment.
- A future trial of Hexcyl enclosures with a treatment consisting of the base of enclosures embedded within the substrate together with an unembedded control to determine if this provides a way of reducing blister disease within the captive population.
- Trial marking technologies such as micro-PITs (passive integrated transponders) and VIEs (visible implant elastomer tags) to enable tracking of individuals for future captive breeding and assess survival.
- Sampling of the Margaret River to obtain pure individuals for captive breeding and a concurrent assessment of the status of pure individuals in the wild.



Building resilience to change for mammals in a multi-use landscape: identifying refugia and landscape connectivity for small mammals in the Pilbara

SP-2021-8

K Ottewell, L Gibson, M Byrne, J Kinloch, K Zdunic, B Huntley

Context

To promote species' resilience over vast landscapes, long time-scales and under current rates of environmental change, it is essential for best-practice conservation strategies to: (i) identify historical refugia, areas that offer temporally and climatically stable habitat that species can retreat to, persist in and expand from under changing environmental conditions; (ii) protect key habitat in species' current distributions; and (iii) promote population connectivity to maintain metapopulation viability and to retain species' evolutionary potential.

Spatio-temporal landscape genetics, combined with Species Distribution Modelling (SDM), offers a novel approach to multi-species conservation planning. This project will provide current and historical insight into how small-medium sized mammals use the Pilbara landscape, providing information for conversation actions

and habitat management. Therefore, this project is significant in bringing together key government and industry stakeholders engaged in conservation management in the Pilbara. Furthermore, the framework developed for integrating these findings into conservation priorities will be applicable for conservation management, globally.

Aims

- Locate core habitat and connectivity pathways (corridors) for species under current environmental conditions by modelling habitat suitability and contemporary gene flow.
- Locate key areas for persistence under changing climatic conditions by inferring locations of evolutionary refugia from population genomic data and spatial modelling of range dynamics under historical and predicted future environments.
- Identify strategies to enhance and protect these areas for optimal combinations of threatened and non-threatened species conservation.

Progress

- A manuscript is in preparation describing core-habitat for 19 mammal species (identified with SDM), as well as species richness and identification of guilds of small-medium sized mammal species in the Pilbara.
- The feasibility of including SDMs in the Western Australian Biodiversity Science Institute's Shared Environmental Analytics Facility to increase industry access to models is being investigated.
- SDMs were generated for the Pilbara leaf-nosed bat and ghost bat that include foraging and roosting habitat, with the associated manuscript in final stages. This is linked to the Pilbara bat project (SP-2021-24).

Management Implications

- The generation of high-resolution genetic data for 11 mammal species, including four species listed as threatened under the *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), has assisted in the detection of historical refugia, key dispersal corridors, genetic diversity hotspots and potentially locally adapted populations that may act as foci for conservation protection.
- The spatial-genetic maps generated in this project are being made available to a range of end users to assist in various conservation-related activities, including assessment of development impacts in the Pilbara, survey planning for conservation translocations and fire management.

Future Directions

- Finalise manuscripts for the multispecies population genetics study, the refugia and population expansion study and the multi-species SDM/species richness and landscape connectivity results.
- Continue to disseminate decision-support spatial products to stakeholders in the Pilbara as required.



Distribution and conservation status of the heath mouse (*Pseudomys shortridgei*) in Western Australia

SP-2021-46

S Cowen, L Gibson, B Howe

Context

The heath mouse *Pseudomys shortridgei* (50-80g) is one of several native rodent species that have declined in distribution and abundance since European colonisation. Originally collected in 1906 near Pingelly in WA's wheatbelt, the heath mouse was thought to be extinct in WA until its rediscovery in 1987. Until 2019, the last confirmed record of the heath mouse in WA was in 2004, from Lake Magenta. Targeted surveys in 2019 resulted in their detection at two locations, confirming that the heath mouse was still extant in WA. Further surveys in 2020 failed to detect the species despite sampling in areas where they had previously been recorded. As there is evidence of a significant decline in the distribution and abundance, further targeted survey is critical to determine the current conservation status of the species in WA and inform recovery action.

Aims

- Establish the current range and conservation status of heath mouse in WA.
- Identify populations that may be suitable for ongoing monitoring.

- Assess the possibility of sourcing heath mice for a captive breeding colony to provide founders for reintroductions.

Progress

- Camera trap surveys (30 cameras per site) were implemented at two sites in Dragon Rocks Nature Reserve and two sites in Lake Magenta Nature Reserve. Sites at Dragon Rocks were identified using existing Species Distribution Models, whereas sites at Lake Magenta focused on areas where heath mice have been detected since 2023. There were no camera detections of heath mice at Dragon Rocks and data from Lake Magenta are yet to be processed.
- Trapping surveys were carried out at Dragon Rocks. No heath mice were captured and capture success for all mammals was very low. One southern ningaui (*Ningaui yvonneae*) was captured, the first record there since 1987.
- One trapping survey took place at Lake Magenta, targeting areas where heath mice have been detected since 2023. One western mouse (*Pseudomys occidentalis*) was captured.
- A trial of eDNA techniques to survey for heath mice was undertaken and analysis of samples is underway.

Management Implications

- Despite confirmation of the presence of heath mice at Lake Magenta, they remain at virtually undetectable densities. Camera surveys at Lake Magenta and Dragon Rocks represent useful baseline datasets for evaluating the impact of ongoing predator management at these reserves but further surveys are needed to detect change in abundance in response to additional introduced predator control (feral cat baiting), which commenced in autumn 2024.
- The generally low densities of small native mammals at both Lake Magenta and Dragon Rocks is concerning. No heath mice were detected at Dragon Rocks and the species may be locally extinct in this reserve. Potential interacting threats include competition from house mice (including a 'plague' in 2022), introduced predators and an extended period of lower-than-average rainfall in 2023-24. Ongoing management of introduced predators is likely to be important in facilitating a recovery of heath mice and other native fauna, including at Dragon Rocks where conservation significant species like western mouse and malleefowl (*Leipoa ocellata*) were detected.

Future Directions

- Ongoing camera surveys at Lake Magenta will help to better assess the status of heath mice and other native mammals in the reserve, including their responses to feral cat management.
- Further surveys in other areas where heath mice have been previously detected, such as in the Ravensthorpe area.
- Further investigation of eDNA approaches for detecting the heath mouse.



Genetics of Pilbara threatened bats

SP-2021-24

K Ottewell, D Prada, R Sun, L Umbrello, R Shaw, M Millar

Context

The orange leaf-nosed bat (*Rhinonicteris aurantia*) and the ghost bat (*Macroderma gigas*) were both once widespread across Australia but are now restricted to patchily distributed habitat across northern Australia. Isolated populations occur in the Pilbara bioregion, where a distinct form of the orange leaf-nosed bat is recognised (hereafter Pilbara leaf-nosed bat). Both species are considered to be declining in the Pilbara, being highly threatened by habitat loss through mining activity, and are consequently recognised as vulnerable under State and Commonwealth environmental legislation. Genetic analyses are providing insight into landscape-scale and fine-scale patterns of genetic structure and connectivity in these species. The development of novel genetic techniques for non-invasive monitoring of ghost bats is providing rich insights into roost occupancy patterns and animal movement. Further research is required to address priority knowledge gaps for the species, including estimation of population size and identification and characterisation of critical habitat for each species.

Aims

- Understand the historical and contemporary genetic diversity and landscape-scale genetic structure of Pilbara bat species.

- Understand the fine-scale patterns of genetic connectivity of bat populations and sex-biased dispersal.
- Undertake SNP genotyping of non-invasive samples for genetic monitoring of ghost bat populations.
- Undertake development and refinement of mark-recapture analyses to assist development of standard monitoring protocols.
- Integrate genetic, spatial and distributional data to identify and understand critical habitat for Pilbara bat species.

Progress

- Population genetic assessment of the Pilbara ghost bat using mitochondrial and microsatellite data has been published in *Journal of Heredity*.
- Four genetic monitoring reports for Pilbara ghost bats have been completed for industry.
- Curation of the Pilbara ghost bat genetic monitoring database has enabled assessment of recapture rates and other summary data across 10 years of sampling.
- Assembly and annotation of the ghost bat genome is complete and a manuscript is in preparation.
- Species distribution modelling based on roosting and foraging data has been completed for both bat species and a manuscript is nearing completion.
- A combined genetic assessment of the Pilbara leaf-nosed bat and orange leaf-nosed bat is being undertaken using SNP sequence data from multiple projects. A field trip to undertake further sampling of northern populations of both ghost bats and leaf-nosed bat is in advanced planning.
- Presentations of research findings have been made to industry and State and Commonwealth government groups.

Management Implications

- Genetic analysis of non-invasively collected samples and refinement of robust mark-recapture protocols for the ghost bat will assist monitoring of abundance and population trajectories, enabling better assessment of development impacts and/or mitigation approaches for the species.
- Species Distribution Models (SDM) will assist in identification of critical roosting and foraging habitat for both bat species to inform development guidelines as well as providing a guide for targeted surveys.
- Range-wide genomic analysis of orange leaf-nosed bat will assist in resolving the taxonomy of the species, including the identity of the Pilbara form.

Future Directions

- Undertake ghost bat genetic monitoring projects as requested.
- Complete draft manuscript on mark-recapture approaches for ghost bats.
- Complete ghost bat genome manuscript in collaboration with University of Sydney.
- Complete SDM manuscript for Pilbara leaf-nosed bat and ghost bat.
- Following field sampling, complete range-wide genomic analyses of orange leaf-nosed bat.



Ecology, threats and monitoring of the Pilbara olive python (*Liasis olivacea barroni*)

SP-2020-6

D Pearson

Context

The Pilbara olive python (*Liasis olivaceus barroni)* is a threatened species confined to the Pilbara and adjacent northern part of the Gascoyne IBRA region. Little is known about its ecology, habitat preferences and conservation threats. It is an introduced predator consuming a diet of large birds, reptiles and mammals as an adult, including other threatened species such as northern quolls. A number of potential threats confront Pilbara olive pythons, but their relative importance is not understood. They include the loss of important prey items due to introduced predators; habitat loss and modification from mining activities and infrastructure development; and on a local scale, increases in road kills by vehicular traffic due to resource projects and tourism. The project will resolve some of the unknown life history parameters important for conservation of this species and for effective population monitoring. In particular, research will focus on important habitat elements, the reproductive cycle of the species and the predation of juvenile snakes.

Aims

- Collate and publish existing information on Pilbara olive python biology and management, including the proceedings of a 2013 workshop.
- Document the ecology of Pilbara olive pythons focusing on habitat preferences and life history characteristics (diet, shelter sites, juvenile mortality, reproductive frequency, etc.) likely to be influential in population dynamics and impacted by threats such as bushfire, grazing and mining activities
- Undertake experiments to determine threats to juveniles, the population cohort likely to be most affected by feral animal predation and habitat changes due to fire or grazing.
- Trial and improve existing and novel survey and monitoring techniques to enable more effective assessment and mitigation of potential impacts of resource projects and other land uses on Pilbara olive pythons.

Progress

- Radiotelemetry of 20 Pilbara olive pythons at the study site in Millstream-Chichester National Park continued, enabling the collection of detailed data on habitat use, home ranges and dietary preferences, and the impact of bushfires in November and December 2023.
- While two telemetered pythons were able to flee the slow-moving fire in November 2023, one telemetered and several other olive pythons were observed killed by the fire despite being in close proximity to pools where they could have escaped.
- Cover and prey were removed over a large area by the December 2023 fire, and one large python was killed by a feral cat (the first recorded cat predation event for this species), while others have left their usual overwinter sites and none were detected breeding in the year following the fire.
- A paper on the taxonomic position of the Pilbara olive python is being revised following comments from colleagues on a final draft with the incorporation of further genetic data.

Management Implications

- While it had been established that a number of olive pythons were directly killed by the fire, radio-telemetry data has revealed delayed indirect effects due to the removal of spinifex cover and impacts to prey populations. The predation of one large python by a cat, the general poor condition of telemetered pythons and no breeding indicates that bushfire is a major threat to the species and requires management.
- Information has been provided to fire managers about the importance of limiting patch burning along the Fortescue River in winter months to areas occupied by over-wintering pythons and the need to keep patches small and avoid burning rocky cliff-lines that are important for shelter sites.

Future Directions

- Ongoing radiotelemetry of Pilbara olive pythons will document habitat preferences, microhabitat use, diet, reproductive behaviour and assess conservation threats following the revelation of the impact of bushfire.
- Continue trials of genetic and telemetry monitoring techniques and their suitability for various geological surfaces and population densities of Pilbara olive pythons.



Felixer grooming trap trial: Feral cat control for threatened fauna conservation in the southern forests

SP-2020-23

A Wayne, M Maxwell, C Ward

Context

Feral cats are one of the most significant threats to native terrestrial vertebrate species in Australia. The Felixer™ cat grooming trap is a novel method of controlling feral cats that uses LiDAR and image recognition to discriminate a feral cat from a non-target species. Identified targets are sprayed with a lethal dose of 1080 toxic gel onto the fur. The feral cat instinctively grooms itself to remove the gel and, in doing so, ingests a lethal dose of the poison.

Proper testing of this new technology is essential to validate if the Felixer is an effective and low-risk feral cat management tool and at what scale they are most effective. This project is a research trial to assess the effectiveness of these traps to deliver feral cat control at a meso-spatial scale (around 10,000 - 30,000 ha) for threatened fauna conservation and recovery in high conservation value areas in the southern jarrah forest.

Aims

- The first stage of this project (2020-2023) assessed the safety of the Felixer™ grooming trap for use in the presence of the native fauna in the southern jarrah forest; determined whether Felixer™ grooming traps can reduce feral cat densities by at least 60 per cent at a meso-spatial scale (>10,000 hectares); and identified ways to improve the efficiency and effectiveness of Felixer™ grooming traps.
- The current second stage of the project (2024-2026) aims to assess the capability of an integrated lethal control program (Felixer™ grooming traps and Probait) to sustain a reduction of feral cats and foxes in a 30,000 hectare area of high-value southern jarrah forest.

Progress

- Arrays of remote sensor cameras have been deployed to monitor fauna activity at four sites: one treatment site, a comparative reference site with ongoing fox control using Probait and two reference sites with no introduced predator control. Monitoring commenced approximately eight weeks before the 12-month treatment trial began in January 2025 (12 Felixer™ traps and monthly Probait deployment along about 190 km of transect, supplementing the standard quarterly aerial baiting conducted by the Western Shield program).
- Monitoring will continue throughout the treatment phase and for several months afterwards so that target and non-target fauna activity can be compared, before, during and after the treatment phase and between the treatment and reference sites.
- Preliminary results from the first four months of the treatment phase indicate that Felixer™ traps have successfully targeted 31 feral cats and 26 foxes, and that feral cat activity in the treatment area has reduced by approximately 70 per cent.

Management Implications

- The Felixer units are safe to use in the presence of native fauna present in the southern jarrah forests of Western Australia.
- Early indications are that these units may be able to remove a substantial proportion of the feral cat individuals present at a meso-spatial scale and therefore be an important and complementary tool to deliver improved conservation outcomes for threatened species vulnerable to feral cat and fox predation in the jarrah forest.

Future Directions

- The enhanced integrated introduced predator control trial will continue throughout 2025. Associated monitoring using remote sensor cameras will continue during and after the control trial at all four study sites.
- Results will be published in a report and peer-reviewed scientific paper.



Investigation into the decline of chuditch (*Dasyurus geoffroii*) in the south-west of Western Australia

SP-2019-29

A Wayne, H Moore, M Drew, L Gibson, K Ottewell

Context

Comprehensive information about the distribution, abundance and genetic diversity of the chuditch in Western Australia is lacking. Information to date has largely been captured using Western Shield monitoring, and while this has provided some data for selected locations, the monitoring sites and methods used are designed to capture information on a range of species. Consequently, captures of chuditch are often sparse and monitoring is not comprehensive across its distribution. Analysis of Western Shield data suggests that there has been a significant decline in the relative abundance of chuditch in the period 2013-17, although inconsistent trap effort in some years may have confounded this result. Further analyses suggested that the currently sparse data could not provide reliable population size estimates for the species. This project will undertake targeted surveys in poorly sampled areas to fill information gaps using an approach specific to chuditch. Concurrent DNA sampling will improve understanding of the genetic structure across the entire species range. The information gained will help to inform decisions both in relation to the effective conservation management of chuditch, as well as sourcing animals for translocations to ensure newly established populations are genetically diverse and representative of the species.

Aims

- Evaluate survey and monitoring methods to improve future assessments of population change in chuditch.
- Improve knowledge on the distribution of the chuditch by undertaking targeted surveys in poorly sampled areas, and on the margins of its known range.
- Undertake concurrent DNA sampling to improve understanding of the genetic structure across the entire species range and to identify source populations for translocations.
- Compile and interrogate all data to help identify potential processes influencing population change in chuditch.

Progress

- Sites were surveyed for chuditch within the Swan, Wheatbelt and South West regions.
- Chuditch captures continued to be significantly higher using chicken rather than universal bait.
- Chuditch were captured at Stene, Centaur, Catterick, Batalling and Avon Valley, with Centaur yielding the lowest captures and Batalling the highest. No chuditch were captured at Dragon Rocks and Jarrahdale.
- Genetic sequencing has been completed for 446 samples, with analyses underway to determine patterns in genetic structure, diversity and relatedness across remnant populations.
- A SNP array was developed to facilitate non-invasive genetic monitoring of chuditch from scats.
- A PhD study commenced to investigate the impacts of Eradicat baiting on chuditch populations, as well as fine scale habitat use, with a focus on the Northern Jarrah Forest.

Management Implications

- Ongoing collection of survey data will facilitate improvements in chuditch population estimates to inform the current conservation status of the species, as well as to better understand population trends. This is particularly important now that integrated fox and feral cat control has commenced in areas where chuditch persist.
- Results of genetic analyses will inform population management, including future translocations to ensure newly established populations are genetically diverse and representative of the species.

Future Directions

- Continue repeat surveys to robustly estimate population size at all sites and determine population trends across the state.
- Complete population genetic analyses.
- Engage in a collaborative project with the University of New South Wales to determine sustainable introduced predator thresholds for chuditch.



Conservation of the night parrot

SP-2017-36

A Burbidge

Context

The critically endangered night parrot has been confirmed breeding in only two locations, one in Queensland and one in Western Australia, although roost sites have now been identified in a number of other locations in WA, and these are likely also to be breeding sites. The night parrot has not been adequately surveyed across much of its potential habitat, and a lack of knowledge of foraging and roosting habits has hampered progress in understanding the ecology of the species. This constrains possible recovery actions and management relating to resource development proposals. Identifying the conservation requirements of the night parrot is essential for informed management of this poorly known species.

Aims

- Assess the spatial extent of the population in Matuwa Kurrara Kurrara National Park, surrounding areas, and the entire Lake Carnegie catchment.
- Determine where the birds are foraging by identifying vegetation types they are using and the spatial relationship between roosting and foraging habitat.

- Determine differences in the vegetation at occupied versus non-occupied roost and foraging sites to inform predictive models.
- Engage with Traditional Owners to encourage surveys for night parrots and culturally sensitive management of the species.

Progress

- A scientific paper describing population genetic structure and historical changes in effective population size is now in press in the journal *Molecular Ecology*.
- A workshop for practitioners (attended by >90 people) was held to improve understanding of regulatory and technical requirements of survey for environmental impact assessments and conservation management. The workshop was built around the guidelines for survey of night parrots published on the DBCA website. Presenters included regulators from the Department of Water and Environmental Regulation, Department of Climate Change, Energy, Environment and Water and DBCA, and detailed information on night parrot biology and survey techniques was provided by University of Queensland (UQ) and Adaptive NRM.

Management Implications

- The revised survey guidelines are assisting environmental consultants in conducting more rigorous surveys, and will result in improved knowledge to inform decisions by regulators.
- Genomic sequencing, provides a substantially improved understanding of population structure and variation, which will be used in future management planning, particularly in relation to suggestions to translocate some birds.

Future Directions

- As required, continue to provide sound technical advice in relation to appropriate survey methods and potential impacts of resource development proposals and/or management actions.
- Close the project.



Dirk Hartog Island National Park ecological restoration project – fauna reconstruction

SP-2016-30

L Gibson, K Ottewell, S Garretson, J Angus, K Rayner, C Sims, A Burbidge

Context

The Dirk Hartog Island National Park Ecological Restoration Project aims to restore the ecological condition of Western Australia's largest island to that seen by Dirk Hartog when he landed on the island in 1616. The establishment of populations of up to 10 mammal and one bird species on Dirk Hartog Island (DHI) over a 12-year period is a key part of this project. Of these species, one is listed as critically endangered, one as endangered and six as vulnerable under the *Biodiversity Conservation Act 2016*. The other three species are either conservation dependent or near threatened. Their successful re-establishment will contribute to improving the overall conservation status of these species. The translocation of up to 11 native species to an island 633 square km in area makes it the largest fauna reconstruction project in Australia and one of the largest in the world. For successful re-establishment to occur, sheep, feral goats, and feral cats have been removed. The eradication of feral cats represents the most extensive eradication program achieved globally. Genetic information on source populations is being used to inform founder selection, genetic monitoring of released animals and ongoing management practices.

Aims

- Identify the most suitable source populations to act as founders for new populations on DHI, using the criteria set out in the *Dirk Hartog Island National Park Ecological Restoration Strategic Plan*.
- Establish new populations of up to 10 mammal species and one bird species on DHI, using the species selection criteria set out in the Strategic Plan.
- Confirm that the translocations are successful and that all new populations on DHI are healthy and self-sustaining, using criteria set out in the Strategic Plan and approved translocation proposals.
- Promote scientific research associated with the translocations, monitoring and establishment of fauna, and publish scientific findings.

Progress

- In April 2025, 180 woylies were translocated to the island, sourced from Dryandra Woodland National Park (60), Kingston National Park and state forest blocks (60) and Tone-Perup Nature Reserve (60).
- Most of the short and medium-term success criteria for the brush-tailed mulgara have been met with seven founders and eight island born animals captured 4-6 km from the release area in June 2025. A manuscript on range-wide genetic analyses has been accepted for publication in *Journal of Biogeography*.
- Most of the short and medium-term success criteria for the western grasswren have now been met except for evidence of dispersal away from the release area. Evidence of nesting and reproduction indicate the species is establishing well on the island.
- The majority of all success criteria for greater stick-nest rats, Shark Bay mice, Shark Bay bandicoots, rufous and banded hare-wallabies have been met, with dispersal away from the release area and ongoing evidence of reproduction. All these species have also persisted through the drought conditions experienced in 2023. Evidence of retention of genetic diversity for all species is pending.
- Scat DNA monitoring has facilitated assessments of success criteria for greater stick-nest rats and the two hare wallabies.
- While the persistence and breeding of dibblers on the island has been confirmed (two females with pouch young captured in June 2025), many of the success criteria remain difficult to assess, such as evidence of dispersal.
- A manuscript describing the challenges of evaluating the success of conservation translocations was published in *Animal Conservation*.
- A manuscript describing genetic analysis of source populations of the brush-tailed mulgara has been accepted for publication in *Journal of Biogeography*.
- Monitoring of the remaining small vertebrates on the island revealed a decline in the total number of small mammals from 2022 to 2024, coinciding with drought conditions in 2023. The overall number of reptile individuals increased but some geckoes and dragons noticeably declined.
- Presentations on the progress of the project were given at the Island Arks Symposium, Ecological Society of Australia Conference, Genetics Society of Australia Conference and International Congress of Conservation Biology.

Management Implications

- The successful translocation and establishment of large self-sustaining populations of these nine species on DHI is likely to have beneficial outcomes for their conservation and for the ecosystems they inhabit.
- The development of innovative techniques to enhance translocation and post-release monitoring success will not only be beneficial to this project but may also improve translocation outcomes at other locations.
- The development of non-invasive approaches to monitor fauna species will provide an effective solution that can be implemented to reduce time in the field.
- Genomic analysis informs population management strategies and provides a suite of novel, affordable monitoring tools to support the ongoing adaptive management of these populations.

Future Directions

- A translocation of boodies is planned to be undertaken in 2026.
- Monitoring of all translocated species on DHI and source populations will continue to be undertaken.
- Population genomic analyses for translocated species will be progressed.
- Continued assessment of the utility of environmental DNA techniques to monitoring species such as dibblers.



Improving the use of remote cameras as a survey and monitoring tool

SP-2013-5

L Gibson, M Cowan

Context

The use of camera traps is often regarded as an effective tool for fauna survey and monitoring with the assumption that they provide high-quality, cost-effective data. Nevertheless, understanding of appropriate methods for general survey and species detection, particularly in the small-medium sized range of mammals, remains poor. Within the department, the use of camera traps to date has usually been restricted

to simple species inventories or behavioural studies, and beyond this, there has been little assessment of deployment methods or appropriate analytical techniques. This has sometimes limited the usefulness of data derived from captured images. Camera traps have the potential to offer a comparatively reliable and relatively unbiased method for monitoring medium to large native and introduced mammal species throughout the State, including several significant cryptic species that are currently not incorporated under the Western Shield fauna monitoring program. Further research is required to validate and assess the temporal and spatial components of different survey designs, methods of deploying camera traps and interpretation of results to determine how best to use remote cameras to provide rigorous data on species detectability and species richness and density.

Aims

- Investigate methodologies for the use of camera traps to examine the temporal and spatial occurrence of native and introduced mammal species in the south-west of Western Australia.
- Investigate and assess methods of data capture and data storage, including emerging automated species recognition technologies.
- Develop analytical tools and methodologies for the interrogation and interpretation of camera trap imagery data.
- Undertake comparative trials of new models of cameras and trapping array designs to assess effectiveness and suitability for monitoring and survey programs.
- Provide analysis of trends and occurrence of critical weight range mammals and introduced predators at landscape scales within targeted reserves.

Progress

- A project investigating the impact of repeated Eradicat® baiting, to control feral cats, on the activity levels of the red-tailed phascogale using tree-mounted cameras was completed, demonstrating a low risk to the phascogales, and a paper has been published in *Wildlife Research*.

Management Implications

- Integrating the application of Eradicat® to control feral cats with existing fox control in conservation reserves that support populations of red-tailed phascogales is likely to pose minimal risk to the species.

Future Directions

- The project has been completed.



Monitoring of threatened birds on Dirk Hartog Island

SP-2013-21

A Burbidge

Context

This project was designed to develop and implement a monitoring program for the three naturally remaining threatened bird species on Dirk Hartog Island (DHI): DHI southern emu-wren, DHI rufous field-wren, and DHI white-winged fairy-wren. This project is part of the broader Dirk Hartog Island National Park Ecological Restoration Project. The intent is to allow assessment of the distribution, status and population trends of the threatened bird species and enable monitoring of change in relation to management actions aimed at restoring plant and animal communities of the island to a state similar to that which existed before pastoralism and the introduction of exotic weeds, herbivores and carnivores.

Aims

- Determine historical and contemporary occurrence of threatened bird species across Dirk Hartog Island.
- Model and map the occurrence of each species across the island in relation to vegetation characteristics.
- Develop a robust monitoring program.
- Clarify the conservation status of each of the threatened bird taxa.

Progress

- A manuscript on modelled species distribution and population sizes on the island has been submitted for publication, and is currently being revised following reviewer comments.

Management Implications

- As all three threatened taxa are more abundant and widespread on the island than previously thought, localised management actions will have limited impacts and monitoring will not need to be undertaken as frequently or as intensively as previously anticipated.

Future Directions

- Finalise publication of accounts of species distribution modelling across the island and population estimates of the species.
- Finalise development of an optimal monitoring design for each species across the island.
- Clarify the conservation status of each of the island's threatened bird taxa.



Barrow Island threatened and priority fauna species translocation program

SP-2012-25

L Gibson, A Burbidge, J Angus, S Garretson, C Sims

Context

Barrow Island Nature Reserve is one of Australia's most important conservation reserves, particularly for mammal and marine turtle conservation. It has also been the site of a producing oil field since 1964. In 2003, the Western Australian Government approved the development of the Gorgon gas field off the north west of Barrow Island and associated LNG plant on Barrow Island subject to several environmental offset conditions. One of these offsets was the threatened and priority fauna translocation program that provided for the translocation of selected Barrow Island fauna species to other secure island and mainland sites. This will assist in improving the conservation status of these species and allow the reconstruction of the fauna in some areas. It also provides an opportunity to examine the factors affecting translocation success and improve these where necessary. Targeted species are the golden bandicoot, brushtail possum, spectacled hare-wallaby, boodie, black and white fairy-wren and spinifex bird.

Aims

- Translocate mammal and bird species from Barrow Island to other secure island and mainland sites.
- Reconstruct fauna in areas where these species have become locally extinct.
- Develop and refine protocols for fauna translocation and monitoring.

Progress

- In association with the Rangelands Restoration Project, boodies and golden bandicoots translocated from Barrow Island to Matuwa Kurrara Kurrara National Park (MKKNP) continued to be monitored inside an introduced predator free enclosure.
- Boodies are now "self-releasing" outside the enclosure via three pipes installed in the fence, which have been proven to be too small for feral cats. Ongoing camera monitoring has been installed. Boodies are using relic warrens for shelter and supplementary food and water have been provided.
- Introduced predator control and associated monitoring continued at MKKNP and Cape Range National Park.

Management Implications

- A novel approach that allows boodies to move freely in and out of a predator-proof closure has facilitated their return to relic warrens outside of the enclosure.
- Persistence of boodies outside the enclosure indicates introduced predator control has been effective.
- This project has contributed to an improvement in the conservation status of several threatened fauna taxa by establishing additional populations on islands and the mainland as the result of successful translocations.

Future Directions

- Continue the monitoring of translocated populations at MKKNP.
- Continue integrated introduced predator control control at Cape Range and MKKNP.
- Prepare final reports describing the monitoring of birds and mammals on the Montebello Islands.



Conservation and management of the bilby in the Pilbara

SP-2012-35

H Moore, T Harrison, D Bohorquez Fandino, L Gibson

Context

The bilby (*Macrotis lagotis*) is listed as vulnerable under the *Biodiversity Conservation Act 2016* and the Commonwealth EPBC Act. Increases in threats, including pressure from mining activities across the Pilbara mean that a greater understanding of the distribution, abundance and ecology of the bilby is necessary to ensure appropriate conservation and management measures are implemented. This project aims to increase our knowledge of the bilby in the Pilbara bioregion of Western Australia and develop a regional survey and monitoring program. The current focus is to determine the distribution of the bilby in the Pilbara and to establish appropriate survey and monitoring techniques, including genetic approaches.

Aims

- Improve understanding of the distribution and demographics of bilbies in the Pilbara.
- Provide information to environmental regulators, resource development companies and contractors that will allow appropriate management to ensure the long-term persistence of the greater bilby in the Pilbara.
- Design, establish and implement a long-term monitoring program for bilbies in the Pilbara.

Progress

- Annual abundance monitoring of bilbies near the Warralong community in the Pilbara continued, as well as a third year of Eradicat feral cat baiting. The current sampling design has not detected a change in feral cat occupancy following baiting but the bilby population remains relatively stable. A larger cell will be baited in 2026, in conjunction with increased monitoring efforts to help determine whether the baiting is effective at reducing feral cat activity and promoting bilby abundance.
- An analysis investigating the influence of fire attributes on bilby occurrence in the Pilbara was published in *Fire Ecology,* which showed that bilby occupancy decreased with increasing spatial extent of recently burnt habitat in the surrounding landscape and increased with diversity of fire ages.
- A summary of the findings from the first three years of baiting at Warralong is in preparation for submission to a scientific journal.

Management Implications

- Published findings highlight the importance of appropriately managing fire to benefit bilby populations, with a mosaic of vegetation ages beneficial.
- Improved understanding of the effectiveness of feral cat control will help inform ongoing conservation management of the bilby across its range.
- Ongoing surveys for bilbies across the Pilbara will improve our understanding of their conservation status in this region and assist assessments of development proposals.

Future Directions

- Continue long-term monitoring of feral cats and bilbies at Warralong to evaluate the effectiveness of threat management.
- Further investigate the role that fire can play in improving bilby habitat (for example in promoting the regeneration of food resources), as well as improving our understanding of the interaction between fire and other threatening processes (such as predation).
- Design a region-wide occupancy survey of bilbies to improve our understanding of their distribution and habitat use, and as a baseline for future monitoring.



Conservation of south coast threatened birds

SP-2012-22

A Burbidge, G McGrath

Context

Identifying the conservation requirements of threatened south coast birds, such as the critically endangered western ground parrot, endangered noisy scrub-bird, vulnerable western bristlebird, western subspecies of the western whipbird and the endangered Australasian bittern, will aid *in situ* management of these taxa. Understanding of responses to fire and hydrological changes, biological and behavioural characteristics, such as vulnerability to predation, and nesting site requirements is essential knowledge for the conservation of these birds, some of which are endemic to the south-west, and the development of management programs.

Aims

- Develop an understanding of the biological and ecological factors that limit the distribution and numbers of south coast threatened birds, including interactions with predators, habitat requirements and response to fire.
- Increase the survival chances of south coast threatened birds and increase their total population size through the creation of management prescriptions that will benefit all threatened south coast animals.
- Investigation of life history characteristics and ecological processes impacting recruitment in the Australasian bittern.
- Survey and monitor Australasian bittern population and habitat trends.

Progress

- Continued to collaborate with Perth Zoo and BirdLife Australia to improve the design and analysis of acoustic survey data for informing monitoring and management of kyloriny (western ground parrot).
- Continued investigation into the diet of the western ground parrot using innovative indirect methods in partnership with Perth Zoo.
- Continued to liaise with South Coast traditional owners in relation to kyloriny research and conservation management.
- Presentations were given at three international and three State conferences.
- Held a workshop on Structured Decision Making (SDM) for the western ground parrot.
- Published three papers on threatened birds at Two Peoples Bay Nature Reserve, in *Pacific Conservation Biology*.
- Collaborated in a Saving Native Species funded program with BirdLife Australia to improve understanding of Australasian bittern habitat requirements and movements, designed to underpin wetland management actions.
- A noisy scrub-bird translocation proposal and release site selection for translocations in 2025-2027 are being prepared.
- Advice was provided to the South Coast Threatened Birds Recovery Team and WA Australasian Bittern Recovery Team.

Management Implications

- Current analyses of genomic data will clarify the relationship between eastern and western ground parrots. Resolution of this will indicate the feasibility of genetic rescue for the critically endangered western birds.
- Improved acoustic monitoring methods and density estimates will allow timely management response to changes in population trend, and evaluation of translocation success.
- The SDM workshop outcomes will indicate the relative efficacy of different management options for the western ground parrot.
- Wetland surveys will improve understanding of habitat quality for the Australasian bittern and co-occurring species to assist with conservation planning.

Future Directions

- Finalise and publish genetic analyses for the ground parrot.
- Ongoing improvement of acoustic survey methods specifically for the western ground parrot.

- Finalise and report on future directions for recovery and management implications outcomes of the western ground parrot SDM workshop.
- Continue Australasian bittern/wetland surveys on the south coast in partnership with BirdLife Australia.
- Undertake noisy scrub bird translocations.



Genetic assessment for conservation of rare and threatened fauna

SP-2012-34

K Ottewell, L Umbrello, R Sun, M Millar

Context

Genetic analysis of threatened species can provide important information to support and guide conservation management. Genetic information can aid resolution of the taxonomic identity of species and sub-species to determine whether they have appropriate conservation listing. At a population level, analysis of the genetic diversity present and its distribution across extant populations, provides information on the genetic 'health' of threatened species. Concurrent analysis of some of the proximal drivers of genetic change can identify appropriate management responses for declining populations to improve conservation outcomes. Further, emerging genomic technologies enable novel monitoring approaches, expanding the available toolbox for threatened species monitoring.

Aims

- Assess the genetic diversity and genetic structure of target species.
- Use genetic approaches to assist in resolving taxonomic boundaries of target species.
- Undertake genetic monitoring of translocated and natural populations of target species.
- Use novel genetic technologies to assist and inform conservation management of target species.

Progress

- A SNP array for scat monitoring of black-flanked rock wallabies has been developed and validated across *Petrogale lateralis lateralis* and *Petrogale lateralis kimberleyensis* populations.
- Black-flanked rock wallaby samples from ongoing monitoring and newly identified northern populations have been submitted for genomic analysis.
- Bilby faecal DNA monitoring and reporting was undertaken on Pilbara and northern WA populations.
- Genetic analysis of non-invasive samples from malleefowl (scat, eggshell, feathers), quokka (scats) and Pilbara olive python (skin slough, scats) were trialed to develop novel monitoring approaches for these species.
- A phylogeographic analysis of brushtail possums was completed and published in *Zoological Journal of the Linnean Society.*
- Samples and genetic data were contributed for development of an eDNA detection assay for Margaret River hairy marron.

Management Implications

- Development of scat monitoring for the black-flanked rock wallaby provides an additional tool for monitoring remote populations to estimate abundance and survivorship to support ongoing conservation.
- Genomic assessment of black-flanked rock wallabies enables understanding of the genetic identity of newly-identified populations and their genetic diversity, informing management strategies.
- Bilby scat monitoring methods enable estimates of abundance and inter-annual survivorship, informing effectiveness of population and habitat management strategies, including fire and feral cat management.
- Current subspecies' classifications of *Trichosurus vulpecula* do not align with genetic structure, as Western Australian Pilbara and Midwest populations, currently defined as the subspecies *Trichosurus vulpecula hypoleucus*, are instead genetically similar to south-eastern and central *Trichosurus vulpecula vulpecula.*

Future Directions

- Analyse black-flanked rock wallaby tissue and scat samples from recent monitoring and translocation events. Further refine SNP array to improve performance for Kimberley populations.

- Provide bilby, black-flanked rock wallaby, malleefowl, olive python and quokka non-invasive genotyping as required for genetic monitoring projects.
- Develop SNP array for Margaret River hairy marron pedigree management if required by Perth Zoo. Contribute to development of hairy marron eDNA monitoring techniques.



Rangelands restoration: reintroduction of native mammals to Matuwa (Lorna Glen)

SP-2012-24

C Lohr, B Pittway, D Cummins, L Gibson

Context

Operation Rangelands Restoration commenced in 2000 with the acquisition of Lorna Glen (Matuwa) and Earaheedy (Kurrara Kurrara) ex-pastoral leases by the WA Government, which were made a National Park with an Indigenous Land Use Agreement (ILUA) in 2023. Working in collaboration with the Traditional Owners, Tarlka Matuwa Piarku Aboriginal Corporation (TMPAC), who were granted exclusive Native Title over the area in 2014, the project aims to restore ecosystem function and biodiversity in the rangelands. Matuwa once supported many mammal species that have suffered large declines. This project seeks to reintroduce 11 arid zone mammal species following the successful suppression of feral cats and foxes. Mammal reconstruction will also contribute to the restoration of rangeland ecosystems through re-establishment of ecosystem services such as digging, grazing/browsing of vegetation and seed dispersal. The first mammal reintroductions commenced in August 2007 with the release of bilby (*Macrotis lagotis*) and brushtail possums (*Trichosurus vulpecula*). Between 2010-2012, mala (*Lagorchestes hirsutus*), Shark Bay mice (*Pseudomys fieldi*), boodies (*Bettongia lesueur*) and golden bandicoots (*Isoodon auratus*) were translocated into a 1100 hectare introduced predator-free fenced enclosure. The enclosure is intended to provide species with an opportunity to acclimatise to the desert environment. The ultimate goal is to release animals outside the enclosure and establish free-ranging, self-sustaining populations of these species.

Aims

- Refine effective feral cat control and monitoring techniques in a rangeland environment.
- Continue to reintroduce native mammal species to Matuwa and contribute to an improved conservation status for these species.
- Re-establish ecosystem processes and improve the condition of a rangeland conservation reserve.
- Develop and refine protocols for fauna translocation and monitoring.
- Participate in two-way science with TMPAC and Wiluna Rangers.

Progress

- Feral cat control via aerial baiting with Eradicat continued with the track activity index indicating a suppressed but increasing activity of feral cats.
- Two-way dispersal tunnels for boodies/mitika were installed in the fence of the introduced predator-free enclosure. Boodies outside the enclosure have taken up residence in relic warrens with 190 burrows documented. So far, no feral cats have managed to enter the fenced reserve through the tunnels. Ground-penetrating radar was used to map the depth and complexity of boodie warrens.
- Monitoring of bilbies was undertaken with abundance from scat DNA pending.
- Abundance of mala from scat DNA confirmed a decline following drought conditions in 2019.
- Threatened Great Desert skink and grey falcon were rediscovered at Matuwa.
- The following manuscripts were published: genetic relationships among boodies, in *Australian Mammalogy*; threatened fauna behaviour near prescribed burns, in *Global Ecology and Conservation;* a continental synthesis of the use of camera-traps in Australia, in *Biological Reviews of the Cambridge Philosophical Society*; working with Traditional Owners on mammal translocations, in *Wildlife Research* and a paper on the susceptibility of golden bandicoots to the Eradicat bait has been submitted to *Wildlife Research*.

Management Implications

- A strategic approach to feral cat control using annual aerial baiting plus additional control activities to remove bait-shy individuals has proved to be effective in suppressing feral cat activity.
- Bilbies can thrive outside fenced enclosures in the presence of a sustained and effective feral cat control program.
- Two-way dispersal tunnels can allow boodies to disperse outside of fenced reserves without allowing feral cats inside the reserve.

- The use of cat urine lures has improved the effectiveness of camera trap monitoring and abundance estimation of feral cats.
- The capacity to monitor fauna on Matuwa has been improved by involvement of Traditional Owner rangers and associated training.
- Successful translocations to Matuwa have enabled this location to become a source site for other translocations.
- Non-invasive monitoring approaches such as scat DNA have improved the ability to monitor species that are difficult to detect using other methods, such as live trapping, thereby improving the ability to measure translocation outcomes.

Future Directions

- Continue to investigate new methods of re-establishing native mammals outside a fenced enclosure.
- Develop and refine management protocols for other introduced vertebrate pests.
- Verify potential malleefowl mounds identified by LiDAR analysis.
- Continue to improve monitoring techniques for cryptic species such as mala.
- Continue to participate in two-way science with TMPAC and Wiluna Rangers and provide training opportunities for Wiluna Rangers and community members.
- Complete publications on the ecology of boodies and the structure of boodie warrens.



Ecology and management of the northern quoll in the Pilbara

SP-2011-5

H Moore, T Harrison, D Bohorquez Fandino, L Gibson

Context

The northern quoll (*Dasyurus hallucatus*) is listed as an endangered species under the *Biodiversity Conservation Act 2016*. Funding from mining offset conditions is being used to gain a better understanding of quoll distribution, ecology, demographics and management requirements in the Pilbara. The two major components of the project are monitoring and ecological research. Survey and monitoring of Pilbara northern quoll populations over 10+ years will provide a regional context for understanding population dynamics. Researching northern quoll ecology will provide information related to impacts, such as loss of known or potential habitat critical to the survival of the species, loss of known or potential foraging/dispersal habitat, and barriers restricting dispersal opportunities and genetic flow.

Aims

- Develop appropriate and standardised survey and monitoring methods for northern quoll.
- Define areas of critical habitat and better understand how disturbance affects habitat quality.
- Improve understanding of population dynamics.
- Better understand the key threats and interactions between these threats.
- Determine whether the northern quoll will colonise restored/rehabilitated areas and artificial habitat.

Progress

- Region-wide annual monitoring of occupancy and abundance of northern quolls continued.
- A paper detailing best practice survey methodology and promoting consistency in survey methods was published in *Australian Mammalogy*.
- An analysis is underway to assess the efficacy of condition taste aversion baiting at a landscape scale to buffer northern quolls against cane toad invasion.
- A manuscript is in preparation describing the effect of bushfire on northern quolls, using Dolphin Island as a case study.
- A PhD project has been commenced that aims to explore the effect of fire age on the movement ecology of quolls, as well as how northern quolls and feral cats might interact in this context.

Management Implications

- Camera monitoring will effectively track trends in quoll occupancy and abundance, investigating drivers of population trends to allow for timely responses to significant declines or changes, as well as manipulation of management levers to promote persistence.

- Guidelines for consistent monitoring and engagement of local stakeholders, strengthens capacity for monitoring northern quolls effectively at scale in the Pilbara, standardises data to improve region-wide knowledge of the species and has increased the capacity of Aboriginal ranger groups to undertake their own monitoring of other culturally significant fauna.

Future Directions

- Further investigate how to promote northern quoll persistence in the face of a cane toad invasion.
- Continue the regional monitoring program, including additional strategic sites, and building capacity within Aboriginal Country managers and regional staff.
- Further develop research projects to continue to fill knowledge gaps as identified in the recent review of progress of the Pilbara Northern Quoll Research Program to inform conservation management.



Impact of cane toads on biodiversity in the Kimberley

SP-2006-4

D Pearson

Context

The invasion of cane toads is impacting the biodiversity of the Kimberley but no technique has been developed to prevent their spread across the landscape. Earlier research has identified that predators, such as northern quolls (*Dasyurus hallucatus*) and goannas, are especially vulnerable to poisoning by toads and that it is possible to train some native predators to avoid eating cane toads. A taste aversion bait to prevent quolls eating toads has been developed and is being trialled during this project. Monitoring of northern quoll and reptile populations on Adolphus Island and mainland sites is required to understand how these species are likely to respond to the arrival of toads on islands.

Aims

- Test taste aversion baits and the use of ‘teacher toads’ (metamorphs too small to be lethal) to induce an effective conditioned taste aversion (CTA) response by native species threatened by toads.
- Develop operational techniques to roll out taste aversion training across Kimberley landscapes.
- Monitor populations of susceptible species behind the toad front, including those where taste aversion training took place and at control sites.
- Investigate where and how toads survive in seasonally dry habitats to better understand their colonisation of islands and their potential to spread into the Pilbara region.

Progress

- Fieldwork is complete. Work is now focused on examining a large number of still and video images collected during trials of taste aversion sausages with northern quolls.
- Draft paper prepared on the impact of the arrival of cane toads on Adolphus Island on susceptible species (quolls and goannas).
- Advice provided to the Cane Toad Program and associates.

Management Implications

- Trials of DBCA conditioned taste aversion baits resulted in equivocal results, with small numbers of quolls persisting on both control and treatment sites after the arrival of cane toads. The differences are being carefully assessed using video and camera footage to understand how quolls interact with the baits.
- CTA baits were found to be effective at inducing quoll avoidance of the baits and toad legs. Results from this work and research by others suggests that quolls do not remember their taste aversion experience for a long period (weeks). Therefore, it is important that aerial drops of CTA baits occur both early, and at other times in the wet season, so that quolls have likely encountered a CTA bait a short time before they meet their first toad.

Future Directions

- Finalise data analysis and publication of conditioned taste aversion trials on wild and captive quoll populations with recommendations on how baits could be better employed to protect mainland and island northern quoll populations.
- Publication of information on the impact of cane toads on various other taxa.



Development of effective broad-scale aerial baiting strategies for the control of feral cats

SP-2003-5

D Algar, N Hamilton, M Onus

Context

The effective control of feral cats is one of the most important native fauna conservation issues in Australia. Development of an effective landscape-scale baiting technique and incorporation of a suitable toxin for feral cats, is cited as a high priority in the various iterations of the national *Threat abatement plan for predation by feral cats*, as it is most likely to yield a practical, effective and cost-efficient method to control feral cat numbers in strategic areas and promote the recovery of threatened fauna.

Aims

- Design and develop a bait medium that is readily consumed by feral cats.
- Examine baiting strategies to provide long-term and sustained effective control.
- Assess the potential impact of baiting programs on non-target species and devise methods to reduce potential risks where possible.
- Provide a technique for the reliable estimation of cat abundance.
- Refine the feral cat trapping technique to effectively collect information on population parameters relevant to control strategies, while minimising risk to non-target species. Assess the utility of trapping as a follow-up measure post-baiting where eradication of cats is required or to provide additional control effort.

Progress

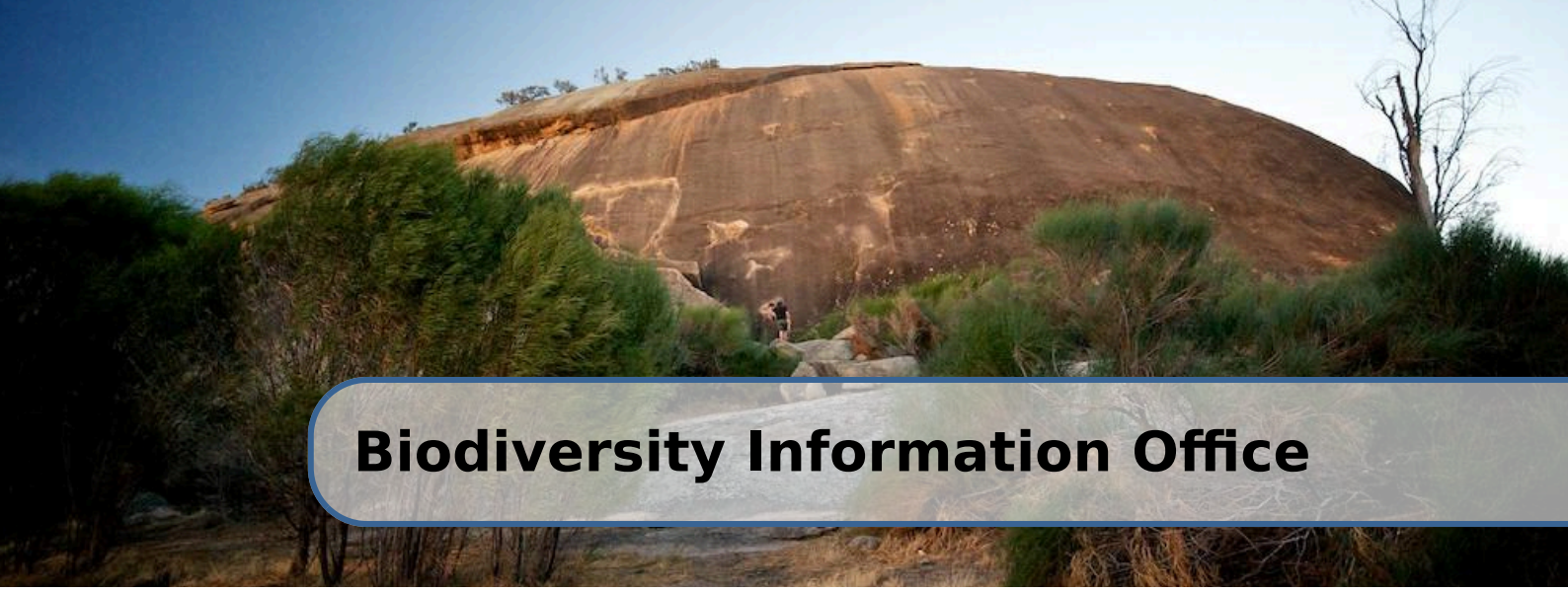
- A collaborative project with colleagues in New Zealand and Murdoch University has identified a further compound that elicits a gustatory response in cats. Pen trials of this compound in baits are about to commence to assess whether palatability improves. New methods of producing the bait medium to improve bait quality, longevity and integrity continued.
- Feral cat patterns of movement through the landscape are being investigated at several sites across differing climate gradients using GPS data-logger radio-collars, most recently in Millstream-Chichester National Park. The aim is to provide a more targeted and strategic deployment of baits to optimise the effectiveness of baiting programs and their cost-effectiveness.
- Field trials examining cat urine as an olfactory lure for camera traps have indicated its potential importance to monitoring methodology. Further trials are in progress to provide a reliable and accurate monitoring technique that has operational utility.
- Investigation of other potential control techniques continued. For example, Felixer grooming traps have been located at a site where a number of feral cats and foxes have been radio-collared to field test the control efficacy of these devices.

Management Implications

- Improvements to bait medium palatability will enhance baiting efficacy and cost-effectiveness.
- Effective landscape-scale baiting methods, based on cat activity and movement patterns, across climatic regions will assist in fine-tuning techniques to provide optimal control efficiency and effectiveness of field operations to target this pest species at strategic locations across mainland Western Australia and lead to significant conservation benefits.
- Development of an accurate, reliable and repeatable statewide feral cat monitoring technique will complement the control toolkit and improve ability to collect data relevant to management options.

Future Directions

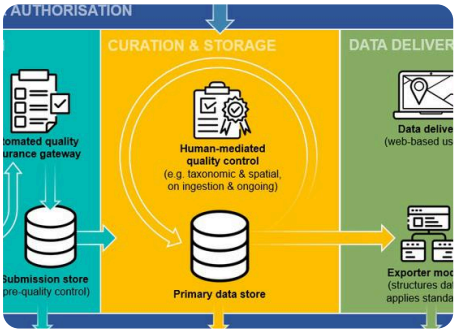
- Complete pen trials testing the efficacy of a new additive to the bait that may improve palatability.
- Commence analyses of feral cat activity and movement patterns to help inform more strategic targeted management of this pest species.
- Test various feral cat monitoring methodologies to improve accuracy and efficiency of techniques that enables a better understanding of the efficacy of feral cat management.
- Continue joint investigations into the efficacy of other potential control techniques complementary to *Eradicat* baiting.



Biodiversity Information Office

Program Leader: Trisha Moriarty

The Biodiversity Information Office (BIO) has been established as custodian and manager of the Biodiversity Data Repository for the biodiversity data collected and used by the Western Australian community. BIO will mobilise biodiversity data from all environment-related sectors, including government, industry and community organisations, promoting a culture of collaboration and seamless data sharing across government, industry, research and the community. Greater access to biodiversity data will increase knowledge of our biodiversity and support informed decision making. BIO enhances the capability of the WA public sector to deliver services to a diverse range of stakeholders, leading to the delivery of sound policy outcomes and evidence-based decision-making. BIO is a core component of the WA digital transformation initiative, delivering data services for digital transformation of environmental assessment and approvals system (Environment Online) that is led by the Department of Water and Environmental Regulation. BIO will provide seamless integration with Environment Online to ensure access to the best available information to inform decision making. BIO is part of the partnership between WA and the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) to deliver the Digital Environmental Assessment Program as an integrated digital environmental assessment system and biodiversity data repository.



BIO biodiversity data platform

CF-2021-44

T Moriarty, N Panine, D Murphy, Z Huq, A Barker, C Piper, K Grogan, S Marcus, H Pichette

Context

The Biodiversity Information Office (BIO) has developed Dandjoo, a central platform that makes Western Australian biodiversity data more easily discoverable, searchable and accessible. Dandjoo was launched in mid-2022 and has since been enhanced with a range of new features and refinements. Dandjoo is designed to mobilise biodiversity data from all environment-related sectors, including industry, government and community organisations, and to support seamless data sharing across the public, private and research sectors and the broader community.

This work will drive improved regulatory decision-making, providing data for the State government's Environment Online portal to support digital transformation of environmental assessment and approval and support other State agencies' evidence-based decision-making for better environmental outcomes. It also facilitates the automated exchange of biodiversity data between Western Australia and the Commonwealth to support decision-making at a national level.

Aims

- Allow users to easily discover, search and access a range of Western Australian biodiversity data via a single platform.
- Provide streamlined access to biodiversity data for government agencies, including regulators, to enhance the quality and timeliness of decision-making.
- Contribute to the ongoing work with the Commonwealth, State and Territory governments towards the harmonisation of biodiversity data and data management across Australia

Progress

- The data model was extended to handle systematic survey data, refining data ingestion processes to facilitate the curation and publication of systematic survey data, such as DBCA's aquatic projects and the Department of Water and Environmental Regulation's Index of Biodiversity Surveys for Assessments data.
- Continued to enhance and refine the Dandjoo data platform with various improvements and new features, including enhancements to unique species lists, management of conservation listed species, data exports and search buffer functions.
- Conducted a User Experience/User Interface review of Dandjoo's public interface with external stakeholders to inform and prioritise ongoing system improvements.
- Commenced publishing a regular newsletter to keep stakeholders informed of database updates and system changes.
- Collaborated with the Western Australian Museum, Western Australian Herbarium and DBCA experts to ensure the data in the platform remains up-to-date and robustly curated.

Management Implications

- Increased data availability for industry and government will support environmental impact assessments and facilitate transparent and evidence-based ecological decisions.
- Access to a broader range of high-quality biodiversity data will expand research opportunities and enhance the quality of research outputs.
- Biodiversity conservation outcomes will be enhanced by more information on the geographic distribution of species in Western Australia, supporting conservation programs' effectiveness and identifying knowledge gaps that will inform priorities for future data collection efforts.

Future Directions

- Ongoing development of Dandjoo to provide additional functionality, including improved search and filter functions. These changes will allow upload of polygons to define search areas, search by vernacular names and filtering for all taxonomic ranks.
- Ongoing development of Nomos taxonomic register module within Dandjoo, to replace the WA Census application when decommissioned.
- Development of an Extract, Transform, List process to handle data transfer and updates between State and Commonwealth biodiversity data repositories.
- Ongoing consultation with data users and data custodians across all sectors to prioritise future enhancements and refinements of the platform.



BIO data collation program

CF-2021-45

T Moriarty, R Cechner, N Panine, D Murphy, Z Huq, A Barker, C Piper, S Marcus, H Pichette, K Grogan

Context

The data collation program of the Biodiversity Information Office (BIO) brings together data from a range of data sources and providers across industry, government, the public, research sectors and community organisations. BIO is initially focusing on high volume, high quality datasets, particularly those that are not easily accessible at present, driving a step-change in the availability of biodiversity data in Western Australia. Data are ingested into the platform after passing automated quality assurance checks, where they are mapped to the Darwin Core biodiversity data standard and undergo human-mediated quality control before being released to users.

The initial datasets ingested into BIO's Dandjoo biodiversity data sharing platform have been sourced directly from industry, DBCA repositories, the Western Australian Museum, Department of Water and Environmental Regulation (DWER) and other regulators. New data will continually be ingested, through future automated delivery from regulators and BIO's rolling program to identify and source other valuable datasets. This data collation program will involve outreach to data custodians across all sectors, exploration of technologies to unlock data in pre-digital documents and ongoing monitoring of existing data to identify temporal and spatial gaps.

Aims

- Provide users with access to a rich collection of high-quality datasets.
- Ingest new and up-to-date data over time.
- Enable access to previously undiscoverable and inaccessible datasets held by government and other sectors.

Progress

- BIO curators have ingested approximately 3.4 million biodiversity records into Dandjoo. Curatorial work on these records is driving a State-wide uplift in data quality, as many have not undergone curation since they were first collected.
- Curated and published DBCA's Fauna Returns Survey dataset (447,956 records) and Western Shield Monitoring datasets (15,552 records). Reprocessed the WABSI Subterranean Fauna Research Program dataset, adding an additional 4200 records to the repository.
- Updated Nomos taxonomic name register with records from World Register of Marine Species, Codes for Aquatic Biota and Australian Fauna Directory.
- Began the ingestion and curation of biodiversity survey data held by DWER in the Index of Biodiversity Assessment portal with a licence that permits sharing and reuse into the Dandjoo repository.
- Progressed acquisition of Western Australian biodiversity records from a range of international, state and territory collections so they can be made available to Western Australian data users.
- Signed a data sharing agreement to make BirdLife Australia's data accessible via Dandjoo.

Management Implications

- Access to a greater range of high-quality biodiversity data, including datasets that have not been available in the past, will support better-informed research and decision-making.
- Availability of up-to-date environmental assessment data, mapped to common standards and validated via the curation process, will ensure that environmental decisions are based on current and accurate information.

Future Directions

- Continue to ingest high-quality datasets from across DBCA, the Western Australian Museum and DWER and connect with data providers across all sectors to secure new datasets.
- Implementation of systematic survey data visualisation and ingestion functionality and increasing scope of available data for use by government, industry and community.
- Seek to streamline data pipelines from data providers and taxonomic sources through API integration.
- Investigate the provisioning of vegetation association data.



Ecosystem Science

Program Leader: Adrian Pinder

Applied research undertaken by the Ecosystem Science Program seeks to understand the environmental, ecological and biogeographical processes that determine the conservation values, health and productivity of the lands and inland waters managed by the department. The program's research examines the spatial and temporal distribution of the State's biodiversity and how ecosystems function and respond to threatening processes and management.

Biogeographic studies provide information on the composition of communities and distribution of the State's flora and fauna at scales relevant to management questions. Survey data provide the foundation for a range of management activities, including conservation estate planning, assessing the conservation status of species and communities and predicting the impacts of other land uses and threats.

The program investigates how ecosystems function and respond to water and land resource management practices, including forest management, and to broadscale threats including salinity, altered hydrology, climate change and habitat fragmentation. Projects include investigations into the nature of threats and monitoring associated ecological responses and effectiveness of mitigation strategies. The program also investigates genetic diversity, evolutionary history and ecological plasticity of plant populations to guide vegetation management.

The program collaborates with other parts of the department, museums and herbaria, universities, cooperative research centres, natural resource management groups, CSIRO and other research providers. Partnerships also exist with Traditional Owners, resource companies and the environmental consulting industry.



Forest Health Monitoring Program

SP-2024-14

A Pinder, S Molloy, C Gosper, L Gibson, R Dayrell, T Harrison, L Hawkins, L Dugal, K Zdunic, R Hortin, K Ruthrof

Context

The *Forest Management Plan 2024-2033* (FMP) sets out how south-west native forests will be managed over its term. Strategic goals two and three of the FMP are: ‘to conserve biodiversity and support ecosystem resilience’, and ‘to maintain or improve forest health and enhance climate resilience’. The FMP will be informed by a suite of specialised monitoring programs designed to inform how forest management is progressing towards these strategic goals. This project will develop and implement a Forest Health Monitoring Program (FHMP) that will contribute to the evaluation of the targets and performance measures associated with the above-mentioned strategic goals.

The FHMP provides a contemporary, integrated and cost-effective framework for monitoring forest health, delivered through a multi-faceted program, with components ranging from whole of landscape scale using remote sensing, consistent monitoring at a network of representative fixed sites and targeted monitoring of particular species, communities, threats and management actions.

Aims

- Determine the status of key biodiversity and ecological components of major forest ecosystems.
- Detect and quantify changes in key forest biodiversity and ecological components to understand and predict patterns of drivers and change.

Progress

- Published the FHMP Implementation Plan and developed an Operations Plan describing all technologies to be used in the plot network and how data are to be gathered and analysed.
- Designed and established a network of 100 sites representative of forest ecosystem type, climate and topography across south-west forests.
- A project to inventory fauna projects in the FMP area commenced.
- A trial of malaise trap deployment times was carried out and data are being analysed.
- Trials examining ecoacoustic monitoring methodologies have been carried out and data are being analysed.
- Floristic surveys and vegetation structure assessments were conducted across 42 of the 100 sites during spring 2024 and autumn 2025. A total of 10,400 point-intercepts, 7120 flora observations and 3149 tree diameter measurements were recorded, along with over 580 unique plant species.
- Insect trapping using malaise traps, sampling for soil microbiome and deployment of eco-acoustics recorders were carried out at 85 sites. Analysis of insect sequence data has commenced. Soil samples have been processed in the lab and sequence data are pending.
- Baseline ecoacoustics surveys were carried out across spring 2024 at 85 permanent monitoring sites. Data processing has commenced, showing differences in acoustic signatures between forest types. Acoustic signatures have been recorded for some key species by recording species in captivity.
- A new method is being trialed using LiDAR built into handheld smart devices to improve the time-efficiency of measuring tree diameter during fieldwork.
- A selection of plots established in tingle forests 43 years ago were relocated, remarked and scored for tingle species.
- Capture of LiDAR, photogrammetry and multispectral data was undertaken over 38 of the 100 sites using remotely piloted aircraft. Standardised processing flows have been derived to produce analysis ready data.

Management Implications

- The FHMP will report on trends in multiple indicators of forest biodiversity and forest structure, in relation to key landscape-scale drivers including climate and fire, to inform adaptive management of the FMP area.
- Targeted research and monitoring projects developed under the FHMP will answer specific questions related to forest management.
- Methods for broadscale application of efficient monitoring technologies will be developed, tested and available for other monitoring and research applications.

Future Directions

- Complete the fauna data inventory to inform design and scope of future targeted monitoring projects.
- Continue annual monitoring of biodiversity at the fixed plot network for the life of the plan.
- In partnership with stakeholders, project staff will develop, facilitate and implement research and monitoring projects to answer specified knowledge gaps. Some of these may become standalone projects.



Forest ecosystem resilience and stand management

SP-2022-42

G McGrath, L Hawkins, J Ruscalleda Alvarez, A Wills, R Mazanec, M van Rooyen, R Van Dongen, L Hayles, T Bleby, A Rowe, K Ruthrof

Context

A warming and drying climate in south-western Australia has and increasingly will, put forest ecosystems under chronic and acute moisture and temperature stress. Concurrently, past management of the forest for timber production has produced legacies of altered stand structure. Portions of the forests are currently characterised by dense stands of regrowth, which may be increasingly vulnerable to warming and drying conditions because they use more water than a more mature forest. There may also be flow-on consequences of these changes in water availability and use for the biodiversity that the forest sustains, including for riparian ecosystems and habitats.

One of the main intervention techniques to help the forest adjust to a drying and warming climate is to alter forest stand structure via thinning to reduce competition for water, termed ecological thinning. A range of thinning trials were established as part of harvesting for timber production in south-western Australia in the past 50 years. These show that thinning can increase available water, increase protection of riparian zones and other habitats and increase growth rates of remaining trees. However, other ecological implications of thinning for conservation outcomes are less well known.

Aims

This project aims to provide a clearer understanding of the capacity of forest stand management, such as thinning, to maintain or improve forest ecosystem resilience to climate change and other disturbances. The project also aims to provide an understanding of community perceptions of forest thinning and contribute to enhanced public understanding.

Progress

- The subsurface structure at Yarragil 4L was determined through resistivity geophysics transects to determine the subsurface characteristics of the catchment and better inform hydrological responses to thinning. Groundwater and streamflow were monitored and two micrometeorological monitoring towers (including a nearby control) were installed to aid in quantifying changes to ecosystem water use and energy balance in response to thinning. Sapflow, soil moisture and cosmic ray neutron moisture monitoring sensors have been installed to measure specific components of the changes to plant water use and soil moisture available to plants due to thinning.
- At the Munro ecological thinning demonstration site sap flow and soil moisture monitoring sensors were installed and maintained along with weather stations, to measure individual tree water use under ecological thinning treatments. Permanent ecoacoustic monitoring sites have been established to examine faunal responses to changes in forest structure from thinning.
- A study to assess impact and phytotoxicity of herbicide use in ecological thinning was commenced.
- Standardisation of drone monitoring has commenced for quantification of changes to vegetation cover, species composition and forest structural metrics in response to ecological thinning.
- Permanent plots have been established at the Gordon North ecological thinning Forest Enhancement Area to examine changes in metrics of forest health over time in response to ecological thinning, using photo points, as well as data on canopy cover, coarse woody debris and leaf litter and compaction on primary and secondary snig tracks.

Management Implications

- Monitoring of changes to hydrology, tree water use and micrometeorology will help assess efficacy of ecological thinning design in the relief of water stress by overstorey and understorey forest plant species.
- Phytotoxicity studies will inform improved management of coppice and regrowth following ecological thinning as well as identify potential indirect impacts of herbicide use on understorey species.
- Remote sensing measurement methods will provide knowledge of forest health and efficacy of various approaches to ecological thinning.
- Quantifying responses of thinning on ecological variables such as forest structure, fuel loads, and compaction will provide a better indication of the benefits and tradeoffs of ecological thinning.
- Detecting changes in faunal use of ecological thinning sites using ecoacoustics, provides a means for developing thinning strategies that can enhance habitat to support a biodiverse fauna.

Future Directions

- New geophysics surveys (resistivity and passive seismic) will be conducted in existing catchments with assistance from the Department of Mines, Petroleum and Exploration.
- Hydrological monitoring will continue in research catchments and at three new sites in southern catchments.
- Micrometeorology, weather, soil moisture and sap flow monitoring equipment will be maintained at existing sites.
- Ongoing development of remote sensing methods and establishment of baseline measurements at long-term monitoring plots.
- Utilising the permanent plots at Gordon North, resprouting of cut stumps and damaged ground coppice will be quantified to estimate the efficacy of herbicide treatment. In addition, a tree and regeneration

survey and a floristics survey will be conducted.
- Continue to track the response of acoustic communities and specific fauna taxonomic groups to changes in forest structure from thinning over time at Munro.
- Remeasuring old thinning sites representative of forest ecosystems and old-thinning techniques.



Evaluating the application of eDNA and metabarcoding as biodiversity and monitoring tools

SP-2020-68

K Fernandes, A Wills, L Dugal, R Hortin

Context

Ecological monitoring is a key element of adaptive conservation management, but can be resource intensive. In recent years, techniques such as camera traps, audio recorders and satellite tracking have improved effectiveness of monitoring programs. Metabarcoding and environmental DNA (eDNA) are emerging technologies that may be used to enhance environmental monitoring. While no single tool can provide all the information necessary for monitoring, eDNA has some advantages over other methods in some situations. For example, significant taxonomic expertise is often required to identify taxa, especially invertebrates but such expertise can be difficult to obtain. Additionally, some existing methods are not ideal for detecting elusive or poorly known taxa and can be laborious. eDNA may overcome some of these limitations. This project examines how eDNA can be effectively used as a monitoring tool, complementing existing methods and projects for biodiversity conservation.

Aims

- Apply eDNA and metabarcoding methods to a range of survey and monitoring projects to evaluate whether they can effectively replace or complement traditional ecological sampling.

Progress

- Wetlands eDNA kits were tested at two Ramsar wetlands and barcoding of invertebrates has progressed, with Sanger sequencing completed for 75 specimens.
- Samples of zooplankton from the Pilbara were re-sequenced, and bioinformatic analyses have been completed. Results were presented at the eDNA Conference in Wellington, New Zealand. A manuscript is in preparation.
- Metabarcoding sequence data were analysed from soil microbial samples collected in the Yarragil catchment experimental thinning sites. A manuscript is in preparation.
- eDNA samples are being analysed on an ongoing basis to track the movement of cane toads in the Kimberley, as part of a collaboration with the Cane Toad Management Group.
- eDNA samples from fire dams in the Perth Hills have been sequenced, and analyses are being undertaken to assess the ability of eDNA metabarcoding to recover signatures of vertebrate taxa visiting the dams. A manuscript is in preparation.
- Two studies using eDNA have been undertaken to detect fish and amphibian diversity at Benger Swamp and detect threatened short-tongue bee species from clay pans around Perth. Data analyses are ongoing.

Management Implications

- Results of these projects will help inform how eDNA can be applied to enhance the efficiency and scope of ecological monitoring.
- Adoption of standard protocols for eDNA collection, extraction and sequencing will facilitate comparison of survey results from different projects and potentially other organisations.
- Generation and publication of barcode libraries is aiding the characterisation and identification of species of interest from molecular datasets, thereby improving the quality of information available for conservation management.
- eDNA has demonstrated that the composition of jarrah forest soil microbiomes is unaffected by the management practice of ecological thinning.
- eDNA is being used to monitor the ongoing cane toad invasion in WA and map invasion frontlines to inform management of affected areas.

Future Directions

- Continue to add to the barcode libraries as opportunities arise.

- Synthesise the results of the freshwater eDNA projects and produce guides and standard operating procedures for use in management.
- Submit the manuscript about the responses of soil microbiomes to ecological thinning at the Yarragil catchment.
- Contribute to a paper on the impacts of redclaw crayfish on zooplankton in Pilbara river pools.
- Analyse sequence data and commence a manuscript on the utility of soil eDNA as a forest vertebrate fauna monitoring tool.
- Prepare a manuscript on the eDNA results from the Perth Hills fire dams.
- Prepare results and summaries for the two regional projects.



Lifeplan: A planetary inventory of life

SP-2020-9

A Pinder, A Barrett, K Quinlan, R Glowicki

Context

Lifeplan is a global biodiversity survey project funded by the European Research Council and led by the University of Helsinki. As a fundamental data platform, Lifeplan will generate standardised, global data on a range of species groups, allowing quantification of variation in ecological communities at spatial scales from 0.1 km to 10,000 km across hundreds of thousands of species. This project is establishing 100 sites globally, with additional denser sampling in the Nordic countries and in Madagascar. Each of the 100+ global sites will consist of paired urban and natural locations. Perth has been selected as one of the global sites, with plots located in woodlands dominated by *Banksia* and *Casuarina* in Lowlands Nature Reserve and Kings Park. In addition to investigating global patterns in biodiversity, the project aims to scale up the use of efficient biodiversity monitoring tools (machine learning analysis of ecoacoustics and camera trapping data, and metabarcoding of aerial spores, soil fungi and flying insects). The project will be carried out over six years, with sampling alternating between the Lowlands and Kings Park locations.

Aims

- Gain an understanding of the application and effectiveness of novel biodiversity survey methods through participation in a global project.
- Survey and contrast the biodiversity values of a large semi-rural nature reserve and a large urban bushland with similar dominant overstorey vegetation.
- Improve understanding of the broader biodiversity values of a threatened ecological community (*Banksia* woodlands of the Swan Coastal Plain).

Progress

- The second and final year of sampling was completed at Kings Park.
- The third and final year of sampling at Lowlands Nature Reserve commenced.
- Samples of spores from the cyclone sampler and soil were sent to the Swedish University of Agricultural Sciences and insect samples to University of Guelph in Canada.
- Audio and camera trap imagery are being transferred to the project headquarters in Helsinki.
- The Perth project team contributed to a manuscript on filtering out humans in camera trap imagery.
- A paper using the Perth site data to examine global patterns in soundscapes was revised and resubmitted to *Nature Ecology and Evolution*.

Management Implications

- Involvement with this global project provides improved understanding of the potential of newer technologies to be employed for efficient survey and monitoring of biodiversity, leading to the incorporation of most of these methods into the Forest Health Monitoring Program (SP-2024-14).
- Monitoring will provide insights into threatening processes such as urbanisation, feral animals and fire. In particular, it will provide an understanding of how management of Kings Park has allowed retention of biodiversity inhabiting *Banksia*/*Casuarina* dominated woodlands on the Swan Coastal Plain.
- Information collected adds to an understanding of temporal patterns in biodiversity values of the *Banksia* woodlands of the Swan Coastal Plain threatened ecological community, which can be used to design monitoring programs and management actions.

Future Directions

- Continue monitoring at Lowlands Nature Reserve until October 2025.
- Compile reference libraries of faunal images and assist with providing training data for machine learning of bird call recognition.
- Contribute to journal articles analysing the global data for each methodology.
- Analyse the Perth site data to understand differences between the natural and urban *Banksia*/*Casuarina* woodlands.



Tracking the condition of Ramsar wetlands in Western Australia

SP-2020-7

M Venarsky, A Barrett, B Huntley, G McGrath, A Pinder

Context

The management of Ramsar wetlands on Western Australia's conservation estate is the responsibility of DBCA, in partnership with external organisations. The department coordinates documentation on the wetlands' condition and reports to the Commonwealth Government for reporting to the Ramsar Secretariat. Like many wetlands globally, Western Australia's Ramsar wetlands are threatened or currently being affected by various pressures. These include water resource development, agriculture and urban development, invasive species, mining, plant diseases, salinisation and climate change. This project aims to undertake monitoring of the State's Ramsar wetlands to improve reporting capabilities and determine efficient monitoring techniques for adaptive management programs.

Aims

- Undertake monitoring of Ramsar and other high priority wetlands to enable effective management and reporting on their condition.
- Understand spatial and temporal patterns in wetland hydrology, water quality and vegetation structure, as primary drivers of wetland biodiversity.

Progress

- Two papers were published the *Journal of Hydrology*, documenting salinity-water level relationships and how they can be used to inform lake management, based upon data from the Southwest Wetlands Monitoring Program, including lakes in the Muir-Byenup and Toolibin Ramsar sites.
- Processed vegetation monitoring data for the Muir-Byenup system collected using remotely piloted aircraft (RPA). Due to the time-consuming nature of RPA fieldwork and data processing, this approach has been assessed as logistically unfeasible for the purposes of monitoring vegetation structure at most Ramsar sites.
- Conducted waterbird surveys at Thompsons and Forrestdale Lakes, Ord River Floodplain (Parry Lagoon), Lake Argyle, Lake Kununurra, Lake Gore and Lake Warden Ramsar sites.
- Installed remote telemetry equipment in Lake Wheatfield within the Lake Warden system, allowing measurements of water chemistry and depth, plus photographs of the lake to be taken remotely.
- Secured funding from South Coast NRM to commence a new phase of ecological monitoring of the Lake Gore system.
- Started wetland palaeoecological coring project at multiple Ramsar sites to place contemporary trends in climate in a longer-term context.
- Provided data and advice into multiple Ramsar wetland management and reporting frameworks.
- Assisted with development of wetland monitoring programs for regional staff and Aboriginal Ranger groups.
- Began collaboration with Murdoch University to complete processing of the Peel-Yalgroup invertebrate dataset. This will provide the first baseline for future monitoring and contribute to studies of Western Australian estuarine biodiversity.
- Conducted trial run of a monitoring program for Lake Clifton thrombolites.

Management Implications

- Direct measurements of habitat quality and quantity as surrogate indicators of broader wetland health and biodiversity values will improve the ability to report on limits of acceptable change in Ramsar wetlands' Ecological Character Descriptions.

- Monitoring of waterbird populations will provide consistent data on which to base assessments of ecological character and limits of acceptable change.
- Site specific monitoring and research will provide local managers with information to assist with adaptive management of Ramsar wetlands.

Future Directions

- Analyse Muir-Byenup macroinvertebrate data and write a paper describing diversity and spatial patterning.
- Complete processing of Peel-Yalgorup aquatic invertebrate samples and write a paper describing diversity and spatial patterning.
- Conduct first year of monitoring program for Lake Clifton Thrombolites
- Complete fieldwork associated with the wetland coring project.
- Continue routine monitoring at other Ramsar wetlands.



Investigating the causes of change in forest condition

SP-2019-48

K Ruthrof, A Wills, R Van Dongen

Context

A decline in vegetation cover in the north-east of the Forest Management Plan area was noted in *Mid-term review of performance of the Forest Management Plan 2014-2023*. The decline is broadly consistent with climate change predictions, although other factors may be contributing. Previous research suggests that *Eucalyptus wandoo* has been undergoing a series of declines associated with drought and increasing temperatures and a buprestid beetle (*Cisseis fascigera*). *Eucalyptus marginata* and *Corymbia calophylla* have been reported to be vulnerable to acute drought and heatwave events at water-shedding sites with shallow soils, as well as to frost events.

More information is needed about the landscape, site and stand characteristics that predispose forests to decline. This project will build on available information and investigate the contributing factors. Project results will provide a greater understanding of the vulnerability of the forest to climate change to assist in developing evidence-based management interventions.

Aims

- Investigate the cause of decline in vegetation cover in south-west forests by understanding the interactions of contributing factors.

Progress

- Extensive drought and heat-induced vegetation die-off occurred across the south-west of Western Australia in autumn 2024. Incidences of die-off reported by regional staff and the wider community were collated. Remotely sensed imagery was used to detect vegetation cover and colour, before and following the die-off. The vegetation changes were mapped and categorised into multiple severity classes. These changes were calibrated with on-ground observations to correctly interpret remotely sensed findings and helped develop a model for each vegetation community.
- Extensive field work was carried out across the south-west from Walpole to Shark Bay to determine the extent and severity of impact of the vegetation die-off, types of vegetation communities affected, site characteristics and any influencing or predisposing factors.
- Outreach seminars on the vegetation die-off were given to help regional staff, local governments and the broader community understand what was occurring, noting the level of anxiety within the community across the south-west.
- Additional funding was secured through the Forest Enhancement Fund to assist with the die-off research and through the Natural Hazards Research Australia to investigate the implications of die-off on fuel loading and recovery of vegetation.

Management Implications

- Satellite mapping showing levels of vegetation die-off indicated which communities were severely affected across the south-west, which assisted fire managers in planning the spring 2024 and autumn 2025 prescribed burn programs. This information also assisted regional staff to quantify impacts on specific plant communities and develop responses, such as for those serotinous species affected by

drought and wildflower harvesting.
- Die-off impacts in vegetation communities in shallow soils over granite and limestone and single-aged cohorts of shrublands in coastal areas in the south-west, suggest that these communities are more vulnerable to extreme drought and heat events and may need specific management.

Future Directions

- Continue fieldwork to further validate satellite maps in areas that have been difficult to model, and report on the die-off event of 2024.
- Further refinement of models is needed for mapping of vegetation communities affected by drought and heat-induced die-off. Especially in forest ecosystems, this will help to plan management, and intervention techniques, where appropriate



Understanding the implications of a drying climate on forest ecosystem function to inform and improve climate change adaptation

SP-2019-68

K Ruthrof, G McGrath, R Van Dongen, W Veber

Context

Little is known about the effects of climate change on south-west forest ecosystems. A broader understanding of the range of effects that climate change has on forest ecology and functioning is required to predict how forest ecosystems will respond to a future climate and extreme weather events. By increasing our understanding, management intervention techniques may be explored that could reduce the severity of changes to forest ecosystems. The Forest Management Plan 2024-2033 specifies that research to address knowledge gaps related to forest conservation, forest health and forest management for climate adaptation will be prioritised. Responding to current impacts of climate change on forest biodiversity and resilience, and forecasting future impacts, will be underpinned by knowledge and understanding of mitigation and adaptation actions.

Aims

- Understand the impacts of climate change and extreme events on structure, composition, and functioning of forest ecosystems in south-western Australia.

Progress

- Electrical resistivity surveys were conducted at pine plantations and native forest between Nannup and Balingup to quantify the effect of soil thickness, stem density and age, on level of die-off.
- Remotely piloted aircraft imaging was conducted using multispectral cameras and LiDAR to characterise Normalised Difference Vegetation Index and other indices, canopy height and individual tree health. Basal area and tree health were measured, and cores were extracted from 36 trees for analysis of $\delta^{13}C$, which indicates how efficiently trees are using water.

Management Implications

- Geophysics work helped quantify the soil thickness beneath drought and heat-induced mortality in pine plantations and native forest, in the Nannup/ Bridgetown region. This information will help plan thinning operations in native forests and future pine planting locations.

Future Directions

- Finalise reporting of native forest and pine plantation geophysics work, quantify soil thickness in areas experiencing drought and heat-induced die-off. Publish findings.



Hydrological function of critical ecosystems

SP-2016-5

J Rutherford, B Huntley, G McGrath

Context

Biodiversity conservation requires an understanding of ecological processes that include balances and fluxes of water, energy and biogeochemistry. These processes are considered in a number of coarse scale ecological assessment and management frameworks but these are difficult to apply at finer or local scales, where an appreciation of hydrological variation is important. To increase confidence in applying coarse scale management frameworks at finer scales, they need to be verified by results from targeted, critical, local scale ecosystem investigations. Critical ecosystem sites are selected where dominant processes driving their behaviour are complex but not unique, so that frameworks for ecosystems with similar hydrological function and response to change can be assessed. The project will investigate the hydrological function of local scale critical water dependent ecosystems, determine and improve our understanding of dominant hydrological processes controlling their physico-chemical sensitivity and responses to change and feed the results back into coarser scale ecosystem management frameworks. Local scale sites will be selected where ecohydrological data can be collected and integrated with existing biophysical datasets and information to optimise the transferability of hydrological results and outcomes to other areas.

Aims

- Assess and determine the scales and dimensions of data required to map hydrological features being researched and measure change important for interpretation and management.
- Build suitable conceptual hydrological models within the bounds of available data and application requirements.
- Explore critical hydrological parameter and system sensitivities to resolve potential ecohydrological management zones.
- Construct conceptual hydrological models and review the need and uncertainties associated with numerical models.

Progress

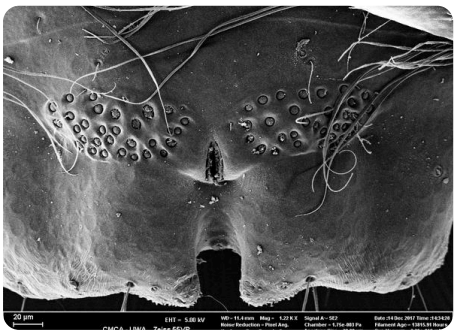
- Hydrological monitoring continued in and around Lake, Mammoth and Calgardup caves of the Leeuwin-Naturalist Ridge to evaluate hydrological response to the December 2021 Boranup bushfire. The project aims to monitor cave pool and groundwater water levels and water quality.
- The manuscript elucidating Walyarta spring sources in arid north-west Australia using geophysical and hydrochemical approaches has been revised to address reviewers' comments. The outcome is a framework to test multiple conceptual models of how groundwater supports perennial springs.

Management Implications

- Hydrological research at the Leeuwin-Naturalist Caves will reveal how water level and water quality data in the pools supporting the caves priority ecological community are impacted by forest regrowth following bushfire and climate, to inform management of these communities and their habitat.
- Publication of the framework for testing how groundwater supports perennial arid zone springs can be applied to other arid zone evaporite basins and most coastlines in northwestern Australia to map potential springs and groundwater dependent vegetation and assess their resilience to changed water availability.

Future Directions

- Hydrological monitoring of the caves will continue with the assistance of local DBCA staff and staff from the other caves managed by the Margaret River-Busselton Tourist Association.
- Publish the Walyarta organic springs paper.



Taxonomy, zoogeography and conservation status of aquatic invertebrates

SP-2014-25

A Pinder, K Quinlan, A Islam

Context

Taxonomic knowledge underpins effective management of aquatic invertebrate biodiversity, including spatial patterning and trends over time in relation to threats. Over half of the species are not formally described but they are consistently named across departmental projects through maintenance of a voucher specimen collection. As opportunities and skills allow, program staff undertake systematics studies (primarily species descriptions and genetic analyses), sometimes with specialist co-authors. This allows formal naming and description of Western Australian endemics that would not otherwise occur and allows species to be consistently identified by external research groups. Tools allowing consistent identification of aquatic invertebrates will also be produced.

Aims

- Undertake aquatic invertebrate systematics to improve the description of Western Australian aquatic invertebrate biodiversity and allow more consistent identification of specimens by departmental and external researchers.

Progress

- Collections of clam shrimp from DBCA survey projects in the Wheatbelt, Goldfields and Midwest Regions have resulted in the description of several new species. Genetic analyses are further contributing to understanding of the diversity within this group and assisting with consistent identification.
- Genetic analyses are revealing that each granite rock in the Midwest, Wheatbelt and Goldfields regions has a unique lineage of aquatic oligochaetes belonging to the Gondwanan family Phreodrilidae, resulting from long-term isolation and inability of these worms to disperse between rocks. The level of genetic divergence is of a level commensurate with species status for each lineage and indicating cryptic diversity within morphological species.

Management Implications

- The description of new species and the production of taxonomic tools, will allow more routine and consistent identification of this group, including in environmental impact assessment.
- For some invertebrates inhabiting moss beds, each granite outcrop may have a unique genetic lineage, suggesting that conservation of genetic diversity within these groups requires protection of a large number of outcrops and management of threats such as feral herbivores and access by two and four-wheel drive vehicles.

Future Directions

- Undertake similar taxonomic work as required.



Responses of terrestrial vertebrates to management in the jarrah forest

SP-2012-38

A Wayne, M Maxwell, T Doherty

Context

Understanding the impacts of management activities, such as timber harvesting and fire, on the terrestrial vertebrates of the jarrah forest is necessary for biodiversity conservation and development of ecologically sustainable forest management. This project began in 1994 and uses a before-after, control-impact study design to intensively investigate biodiversity responses to and ecological consequences of disturbance by forest management.

Aims

- Investigate the effects of management activities on terrestrial vertebrates in jarrah forest ecosystems.
- Provide information that helps improve ecologically sustainable management and biodiversity conservation in the jarrah forest.

Progress

- Vehicle based spotlight monitoring of mammals on three standardised transects was conducted in spring 2024 (3 repeat surveys per transect).

- Ngwayir (western ringtail possum) detection rate in 2024 was 10.8 per cent of the pre-decline peak of 1998. This constitutes the highest detection rate recorded since this decline. The detection rate of koomal (common brushtail possum) suggests a relatively stable trend over the last 10+ years but a modest increase over the last two years. The detection rates of ngwayir and koomal suggest that there have been no adverse effects detected so far from the gum leaf skeletoniser outbreak of 2022-23 and the pronounced dry conditions of 2023-24.
- Drafting of a scientific paper for publication is underway.
- Pre-burn camera trapping surveys were conducted for eight weeks in autumn 2024 and 2025 at 474 camera survey points split across a prescribed burn treatment area and two unburnt reference areas. Approximately four million images were captured in both 2024 and 2025. The data provide detailed information on the medium-sized mammal populations prior to a planned prescribed burn, including numbat, ngwayir, chuditch, woylie, quenda, koomal, wambenger, cat and fox.
- Pre-burn surveys using a pedestrian-based spotlight survey method were conducted in autumn 2025 along 280 km of transect. Density estimates for ngwayir and koomal are being developed using a distance sampling modelling approach.
- The prescribed burn of the treatment area is planned to be completed in spring 2025. Post burn sampling using the same camera trapping and spotlight methods are planned for autumn 2026.

Management Implications

- Monitoring of the critically endangered ngwayir population in the southern jarrah forest is fundamentally important to informing the conservation and management of the population and species.
- Information on the effects of management (including prescribed burning, introduced predator control and historic timber harvesting) and environmental factors (such as gum leaf skeletoniser outbreak and drought) on terrestrial vertebrates and the factors responsible for changes in populations will lead to improved ecologically sustainable forest management practices and conservation of biodiversity.

Future Directions

- Publication of the results from the long-term monitoring in a peer-reviewed paper.
- Post burn surveys in autumn 2026 of the first treatment site and associated unburnt reference sites. Pre- and post burn surveys of additional replicate sites to be included in successive years, starting in spring 2025.



Western Australian flora surveys

SP-2012-5

M Lyons, A Markey, M Langley, A Barrett

Context

Flora surveys of targeted areas provide knowledge of floristics and vegetation pattern and structure for a variety of purposes, including provision of baseline biodiversity data, monitoring of management effectiveness, understanding distributions of threatened taxa, defining threatened and priority ecological communities, determining suitability of vegetation for fauna translocation and conservation operations such as fencing and stock control. Recent surveys have included flora and vegetation surveys in the West and Central Kimberley and targeted flora surveys in Karijini National Park.

Aims

- Undertake targeted surveys to provide specific management advice, monitor long-term change in vegetation at specific sites and specific communities and fill specific knowledge gaps.

Progress

- A survey of wetlands on jointly managed Badimia lands was conducted to further sample wetland flora following limited rains. Collected specimens, including several priority flora species, are being identified. Further survey is dependent on there being substantial rains in the area.
- A paper on the compositional patterning and significance of aquatic plant communities of Pilbara wetlands and rivers was published in *Pacific Conservation Biology*.
- A new species of *Samolus* was described from material collected during a vegetation mapping project for Fortescue Marsh.

- A project to re-analyse floristic community data for the Swan Coastal Plain continued. Descriptions of each community type with diagnostic criteria have commenced.
- A survey for conservation dependent flora was undertaken in Karijini National Park as part of disturbance assessment associated with tourist infrastructure planning.
- Projects funded by Rio Tinto and Australian Premium Iron Management include improved mapping of vegetation, focused on Millstream-Chichester National Park and parts of the Hamersley Ranges including Karijini National Park.

Management Implications

- Identification of rainforest patches in Wunaamin Conservation Park will enable planning of fuel reduction burning operations to avoid impacting these fire sensitive plant communities.
- The updated analysis of the Swan Coastal Plain floristic data will provide a more comprehensive and robust suite of floristic community type definitions as a basis for ongoing conservation planning in the region.
- Wetland flora data will provide a baseline for future monitoring and contribute to prioritising conservation actions on jointly managed Badimia lands.

Future Directions

- Expand floristic sampling at Badimia wetlands depending on adequate rainfall.
- Complete floristic community type descriptions for the Swan Coastal Plain.



Management of invertebrate pests in forests of south-west Western Australia

SP-2011-19

A Wills, K Ruthrof

Context

Within the history of forest and natural landscape management in Western Australia, many invertebrates are known to utilise forest biomass for their survival and, in doing so, impart some form of damage to leaves, shoots, roots, stems or branches. There are 10 recognised invertebrate species with demonstrated significant impact on tree health, vitality and timber quality within our natural environment. Currently the most prevalent insect pests of concern in native forests are *Perthida glyphopa* (jarrah leafminer, JLM), *Phoracantha acanthocera* (bullseye borer, formerly known as *Tryphocaria acanthocera,* BEB) and *Uraba lugens* (gumleaf skeletoniser, GLS). Both JLM and GLS have documented population outbreak periods and BEB incidence appears to be responsive to drought stress and is likely to increase. However, Western Australian forests and woodlands also have a history of developing unexpected insect outbreaks with dramatic consequences for ecosystem health and vitality. The decline in mean annual rainfall in south-west Western Australia since the 1970s and global climate model predictions of a warmer and drier environment, mean conditions for invertebrate pests will alter significantly in the next decade as our environment shifts toward a new climatic regime. This project addresses both recognised and emerging and potential invertebrate forest pests and is designed to augment forest health surveillance and management requirements by providing knowledge on the biological aspects of forest health threats from invertebrates in the south-west of Western Australia.

Aims

- Investigate aspects of pest organism biology, host requirements, pathology and environmental conditions (including climatic conditions) that influence populations.
- Determine distribution of the invertebrate pests, including outbreak boundaries and advancing outbreak fronts, using aerial mapping, remote sensing and road surveys.
- Measure relative abundance of invertebrate pests, including quantitative population surveys and host/environmental impact studies where appropriate and/or possible.

Progress

- Incidence of gumleaf skeletoniser, was surveyed in the upper Warren in the summer of 2022-23 by visual inspection of established survey points to ground truth satellite imagery documenting a severe outbreak. A report was prepared and distributed detailing the extent of outbreak populations. Visual inspection has been carried out in 2024 and 2025. Outbreak was absent in both years.
- A project surveying eDNA in soils, jarrah leaves and on jarrah leaf surfaces commenced. Sampling is complete and eDNA data will be analysed in detail. Entomopathogens of GLS were recovered and are

stored in culture for future experimentation.
- A paper was prepared and submitted to *Pacific Conservation Biology* reanalysing historic data and showing a relationship between amount of leaf skeletonising and remobilisation of nitrogen in leaves.

Management Implications

- Integration of GLS population and impact data from two major outbreak events, indicates a strong relationship between GLS outbreak and periods of below-normal rainfall at seasonal or longer timescales. Further outbreaks are likely, given present declining trends in rainfall.
- Isolation of GLS entomopathogens is an important step into understanding the mechanism of how climate drives outbreaks. This may allow spatially based prediction of future outbreaks.
- GLS outbreaks affect other arboreal vertebrate populations such as those of possums and birds, which can require multi-species conservation responses.

Future Directions

- It is anticipated that projects based around GLS entomopathogens may be initiated in future.



Western Australian wetland fauna surveys

SP-2011-18

A Pinder, K Quinlan, M Venarsky, D Cale, A Barrett

Context

Regional biological surveys provide analyses of biodiversity patterning for conservation planning at broader scales but sites in these projects are usually too sparse for use at a more local scale, such as individual reserves, catchments or wetland complexes. This project is designed to fill gaps within and between regional surveys by providing aquatic invertebrate biodiversity data and analyses at finer scales. Recent examples of such projects are wetland surveys in the Upper Fortescue catchment in the Pilbara, Lake Carnegie and Kimberley Mound Springs.

Aims

- Provide an understanding of aquatic biodiversity patterning at the scale of individual wetlands to wetland complexes, catchments or regions to inform local conservation planning and as baselines for future monitoring.
- Provide better data on the distribution, ecological tolerances and conservation status of aquatic fauna species and communities.

Progress

- Aquatic invertebrates were identified from Dobaderry Swamp and Leulf Road wetland as part of a larger effort to understand diversity in the Wandoo woodlands.
- Analyses are underway to examine the responses of aquatic invertebrate communities to the presence of redclaw crayfish in the Pilbara, including comparisons of metabarcoding versus morphological identification of plankton.
- A survey for wetland biodiversity on Badimia lands in the Midwest was undertaken and samples are being processed.

Management Implications

- New knowledge of the biodiversity values of arid zone wetlands will assist with assessing the conservation status of species and communities and environmental impacts of mining and pastoralism.
- Species level invertebrate data can assist in understanding the conservation significance of individual species and in refining descriptions of threatened ecological communities.
- Wetland survey work is providing information to understand the threats posed by redclaw crayfish in the Pilbara and inform actions to minimise its spread.

Future Directions

- Publish analyses of invertebrate data to understand impacts of redclaw crayfish on Pilbara river pool communities.

- Analyse invertebrate data to understand resilience of Wheatbelt wetland communities to a prolonged decline in rainfall.
- Identify wetland invertebrates from Badimia lands and publish survey data. Expand this survey if the large salt lakes fill.
- Survey aquatic invertebrates on Ngadju country when sufficient rains occur to fill salt lakes.
- Publish a review of diversity and distribution of aquatic invertebrate communities within vegetated clay-based wetlands of south-western Australia.



FORESTCHECK: Integrated site-based monitoring of the effects of timber harvesting and silviculture in the jarrah forest

SP-2006-3

A Pinder, A Wills, G McGrath, J Hyde, K Ruthrof, L Dugal

Context

FORESTCHECK has been a long-term monitoring program and results have been used by forest managers to report against Montreal Process criteria and indicators for ecologically sustainable forest management. Initiated as a Ministerial condition on the Forest Management Plan 1994-2003, FORESTCHECK was incorporated in the Forest Management Plan 2014-2023 as a strategy for increasing knowledge on the maintenance of biodiversity and management effectiveness in Western Australian forests.

Aims

- Quantify the effects of timber harvesting and silvicultural practices in the jarrah forest (gap creation, shelterwood, post-harvest burning) on forest structural attributes, soil and foliar nutrients, soil compaction and the composition of the major biodiversity groups including: macrofungi, cryptogams, vascular plants, invertebrates, terrestrial vertebrates and birds.

Progress

- Sequencing has been completed for a second round of eDNA sampling from soil, burrow and hollow habitats, using three vertebrate-specific primer sets to detect vertebrate fauna.
- Data are being prepared for submission to Dandjoo and associated data papers are being prepared.
- Some FORESTCHECK sites have been included in the new Forest Health Monitoring Program and others have been used in fire research projects.

Management Implications

- FORESTCHECK has provided a systematic framework for evaluating the effects of silvicultural practices in jarrah forests and provided a sound basis for adaptive management.
- Findings from the project will continue to inform a variety of forest management policies and practices and contributed to development of the Forest Management Plan 2024-2033.
- The network of FORESTCHECK grids will remain in place and provide locations with known characteristics and history that will be useful for future forest research and monitoring, including the Forest Health Monitoring Program (SP-2024-14).

Future Directions

- Archive remaining FORESTCHECK project data in suitable repositories and ensure integrity of the grid sites. Publish data papers promoting the value and use of FORESTCHECK data and the site network.
- Investigate further analyses of FORESTCHECK data, such as for biogeographic patterning across the jarrah forest.
- Continue the analyses and prepare a manuscript on the soil microbiome of the jarrah forest.
- Complete current eDNA based monitoring projects, including soil microbiome and analysis of vertebrate sequence data originating from soil, hollow and burrow samples.



Hydrological response to timber harvesting and associated silviculture in the intermediate rainfall zone of the northern jarrah forest

SP-2000-3

G McGrath, B Huntley, R Van Dongen

Context

This long-term experiment was established in 1999 to address a Ministerial Condition attached to the *Forest Management Plan 1994-2003* to monitor and report on the status and effectiveness of silvicultural measures in the intermediate rainfall zone (900-1100mm/yr) of the jarrah forest to protect water quality. The project, focused on the Yarrigil thinning trial site near Dwellingup, evaluated groundwater and streamflow responses to a 1983 thinning trail and currently the responses to a re-thinning of the catchment in 2019.

Aims

- Investigate the hydrological impacts of timber harvesting and associated silvicultural treatments in the intermediate rainfall zone of the jarrah forest in a changing hydroclimate.

Progress

- Hydrological monitoring was maintained and telemetry system upgraded to ensure continuity of data collection.

Management Implications

- Re-thinning of Yarragil 4L provides an opportunity to examine the effects of silvicultural treatments on groundwater and surface water hydrology, biodiversity, vegetation structure and composition of the catchment. The experimental catchments at Yarragil provide the only continuous long-term record of the hydrological response of the headwaters of the jarrah forest to climate change and forest management practices, enabling managers to better assess how thinning impacts forest and riparian zone health.

Future Directions

- All data and ongoing work will be transferred to SP-2022-42.
- Two manuscripts are in preparation. One documents long term hydrological changes in all the Yarragil catchments from 1977 - 2019 and the second describes hydrological changes in Yarragil 4L following thinning of the catchment in 2019.
- This project is complete.



Fire Science

Program Leader: Ben Miller

The Fire Science Program seeks to inform fire management and biodiversity conservation on lands managed by the department, including state forests, national parks and other conservation reserves. The strategic goal of the program is to ensure that the best available scientific information is used for integrated fire management to protect communities and natural values. Key themes for the program include developing and validating decision support tools for fire management and understanding the effects of fire regimes on species, ecosystems and landscapes and how these interact with threatening processes including weeds, introduced predators and climate change. Monitoring and learning from the outcomes of prescribed burns and bushfire incidents is also an important activity of the program. Strong collaborative linkages exist with universities, cooperative research centres, CSIRO, the Bureau of Meteorology, other government agencies and private sector research providers.



Fine-scale burn mosaics in south-west Forests

SP-2021-13

I Radford, B Miller, S Samson, A Wills, J Hollis

Context

This study aims to provide biodiversity, habitat and fuel hazard data to assess prescribed patch mosaic burning treatments being trialed in an adaptive management experiment in Wellington and Blackwood Districts. Patchy, low severity fire outcomes often sought in prescribed burning, are more likely to result if fuels are not long unburned. Frequent application of targeted ignitions under mild conditions in a landscape that already contains low fuel patches, is likely to promote further patchy and low severity outcomes, potentially supporting a range of fuel age and recruitment cohorts in a fine-grained mosaic. Frequent and high severity fire can be a risk for obligate seeder plant species and habitat-dependent fauna such as forest cockatoos or western ringtail possums, which require intact forest canopy habitat including large trees and large hollows. This project will support management decisions regarding frequently applied fine-grain patch mosaic burning with an evidence base on fire behaviour, fuels, flora, fauna and bushfire risk.

Aims

- To assess the patch mosaic burning (PMB) fire regime, including its fuel consumption outcomes, spatial complexity, severity and fire return intervals, and compare it to standard cell-scale prescribed burning.
- To assess fuel treatment effectiveness from PMB, including patterns of fuel and fire risk that result from treatments, and how fire behaviour and spread is affected if unplanned ignitions would occur.
- To assess biodiversity consequences of PMB for plant species sensitive to short fire intervals (obligate seeder shrubs), fire sensitive fauna (threatened mammals and arboreal species), and vegetation community composition and structure.

Progress

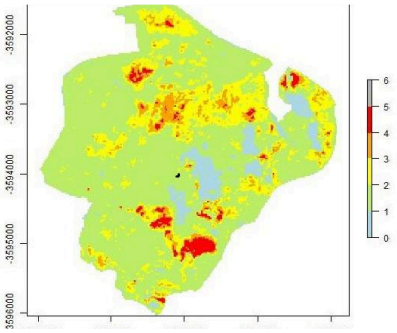
- Patch mosaic burning has now been applied in the south-west forest area for four years at Wellington and two years in Blackwood districts.
- 130 monitoring plots have been established to test for effects of patch mosaic burning on forest biodiversity, habitats and fuel hazard, half inside and half outside mosaic areas for comparisons with conventional prescribed burning.
- Baseline measurements of fuel hazard, tree canopy cover, diameter at breast height, basal area, shrub cover, herbaceous cover, litter cover and depth, course woody debris and tree hollows have been completed at all plots.
- Floristic and functional compositions have been compiled for all monitoring plots. More than 540 plant species have been recorded.
- Camera traps have been deployed at all plots, providing continuous fauna activity data. Seventeen native mammals, 49 birds, four reptiles and seven introduced species have been recorded.
- Baseline analysis of effects of existing fire mosaics is currently underway.

Management Implications

- This project informs on the management effectiveness of patch mosaic burning in the south-western forest in terms of fuel hazard reduction and its application for maintaining and improving biodiversity outcomes.
- Once fully established, the project will provide more specific management recommendations in future years, once outcomes of the mosaic are measurable.

Future Directions

- Analyse baseline datasets.
- Maintain the application of PMB.
- Assess fire and mosaic outcomes in future years.
- Resurvey monitoring plots after several years of PMB application.



Development of a systematic approach to monitoring and reporting on the outcomes of prescribed burns and bushfires

SP-2018-134

K Zdunic, V Densmore, R Van Dongen

Context

Fire severity describes the amount of biomass removed, reduced or substantially altered (for example, charred) by either unplanned bushfire or planned burning. Severity relates to fire intensity but extends consideration beyond fire behaviour to incorporate ecological effects and structural changes. Thus, fire severity represents a valuable approach to gauge how planned burning or unplanned fire has impacted future fire hazards and the persistence of habitat for flora and fauna. A systematic tool to assess fire severity supports the objective evaluation of the outcomes of decision making, the methods used to apply planned burns, and assists in meeting statutory reporting obligations including fire management performance indicators and potential impacts on listed flora and fauna.

Aims

- Develop a framework for a systematic approach to assessing and reporting the outcomes of prescribed burns and bushfires based on remote sensing and field surveys.
- Develop and test a variety of reporting tools and metrics related to environmental outcomes.

Progress

- The production of burn severity maps for prescribed burns is well established and ongoing.
- A paper relating key fauna habitat variables to burn severity classes has been submitted and is currently under review at *Australian Forestry*.
- Fauna habitat look-up tables have been drafted for severity classes within forested districts in south-western WA.
- Severity mapping is being utilised in a case study examining the effectiveness of prescribed burning to reduce the extent of multiple bushfires ignited in Perth Hills on a single day in November 2023.

- Consultations are ongoing with the National Severity Scoping Study to document the burn severity mapping approach undertaken by each jurisdiction.
- Maps and statistics from the burn severity data are being used routinely by regional staff to evaluate prescribed burn outcomes and assess burn histories of planned burns.

Management Implications

- Severity maps are being used to report actual area burned and impact of prescribed burns and bushfires to Government.
- Fire managers are adjusting burn objectives and success criteria within burn prescriptions to incorporate data provided by severity mapping. This represents a substantial change to specific and measurable metrics, such as percentage area within a target severity class, increasing accountability for decisions made regarding burn implementation, thus supporting adaptive fire management.
- Historical severity maps are being used to improve the accuracy of fire history records, helping to improve confidence in DBCA fire management.
- Historical severity maps assist in fire management planning by enabling comparison of consecutive fire events, evaluation of the role of prior severity in mitigating severity of subsequent fire events and monitoring changes to fire regimes as climate changes.

Future Directions

- Pending publication of the manuscript under review at *Australian Forestry*, which relates key fauna habitat variables to burn severity classes, the project is complete.
- Data availability and access will be a focus in the next 12 months.



Evaluation of synergies among fire and weed management in urban biodiversity and fire management

SP-2018-46

B Miller, R Miller

Context

The social and conservation values of remnant natural ecosystems in urban and peri-urban environments can be significant, particularly where they include threatened species and communities, such as the nationally listed 'Banksia woodlands of the Swan Coastal Plain ecological community'. Fire management of these systems is particularly complex as they are often: very close to homes, businesses and infrastructure; exposed to high ignition likelihoods; fragmented; subject to a wide range of other threats and disturbances; and susceptible to invasion or already supporting a number of pest plant and animal species. The spread of grassy weeds, in particular, can be enhanced by fire and promotes changes in fire regime. Knowledge of interactions between fire regimes and weed invasion will provide a basis for synergies in fire and weed management that may deliver beneficial outcomes. The study design and replication and fuel, plant species and community response data, provide valuable research infrastructure that associated student projects and other studies can use (for example, soil properties and invertebrate responses).

Aims

- Assess outcomes for prescribed and bushfire management, weed management and persistence of native plant species in urban and peri-urban areas by testing a range of fire and weed management approaches.

Progress

- Weed management was continued at the Kings Park, Bold Park and Yangebup sites.
- Site preparation, a Prescribed Fire Plan, approvals and communications are well progressed for a planned research burn at Bold Park in spring 2025.
- Analysis of fuels data is in the final stages and a manuscript is being prepared for submission to a scientific journal.
- Cleaning of floristic data is in the final stages and will soon be ready for final analyses.
- Presentations and site visits were held with a variety of internal and external stakeholders, including local councils and local community groups, to share findings and demonstrate management implications.

Management Implications

- Identification of optimal combinations of weed and fire management treatments will provide a basis for recommendations for the management of peri-urban and urban bushlands.
- Burning without weed management results in increased grass weed cover and poor recovery of native species.
- Post-burn weed management is effective in maintaining low levels of weed cover at pre-burn levels (or lower) and beneficial for native community regeneration.

Future Directions

- Ongoing implementation of weed management treatments and floristic and fuel surveys in all sites where required.
- Post-fire surveys at the Bold Park site following the planned research burn in spring 2025.
- Complete analyses of fire-grassy weeds interactions and submit manuscript for publication.
- Complete cleaning of floristics data and progress analyses of floristic response to burn and weed treatments across all sites.



Long term response of jarrah forest understorey and tree health to fire regimes

SP-2012-29

B Miller, V Densmore, S Samson

Context

This study is a long term strategic research project to better understand the effects of fire regimes, including prescribed fire, on the floristic composition of jarrah forests. This knowledge is essential for developing and implementing ecologically appropriate fire regimes and managing fire to reduce risk to the community, biodiversity and other environmental values.

Aims

- Understand and quantify the long-term effects of fire regimes on the floristic composition of jarrah forests.
- Determine the long-term effects of various fire regimes on tree health and growth rates.
- Utilise the established plots to compare fire behaviour outputs, drivers and ecological responses between prescribed burning and Aboriginal-led cultural burning approaches.
- Monitor potential interactions between climate change and fire regimes and their impacts on floristic composition and fire behaviour in jarrah forests.

Progress

- Burning regimes continued at sites with planned burn treatments at Perup (plots 2 and 10).
- Collected leaf litter samples and purchased equipment for undertaking leaf litter decomposition surveys.
- Undertook weather monitoring at plots during spring 2024 and summer and autumn 2025.
- Explored steps that may enable Aboriginal-led cultural burning to be included as treatments within plots at both the Perup and McCorkhill sites.

Management Implications

- Being one of the few long-term studies of its kind around the world, the findings of this study are important for guiding fire management policy and planning for community protection and biodiversity conservation.
- Knowledge and understanding gained from this long-term study have been incorporated into a fire ecology training program that is delivered to officers involved in fire management planning and operations.
- Within the fire frequency and intensity ranges investigated in this study, there was flexibility in the application of prescribed fire to achieve management goals without loss of plant diversity.

Future Directions

- Continue current burning regimes with the next burn treatments planned at McCorkhill (plots 6 & 10).

- Measure leaf litter decomposition rates and monitor weather conditions across treatments at the McCorkhill and Perup plots.
- Maintain the integrity of the study sites for ongoing monitoring in the longer term.
- Investigate potential for establishing new burning regime in 'burnt once only' plots (2 per site) and 2 'spare' plots at the McCorkhill site.
- Implement new monitoring and a review of floristic change data.



North Kimberley Landscape Conservation Initiative: monitoring and evaluation

SP-2012-27

I Radford

Context

This project is a biodiversity monitoring and evaluation program to inform adaptive management of fire and cattle in the north Kimberley. The adaptive management program that forms the Landscape Conservation Initiative of the *Kimberley Science and Conservation Strategy* commenced in 2011 in response to perceived threats by cattle and fire to biodiversity conservation in the North Kimberley. This initiative is based on the hypothesis that large numbers of introduced herbivores and the impacts of current fire regimes are associated with declines of critical weight range mammals, contraction and degradation of rainforest patches, and degradation of vegetation structure and habitat condition in savannas. This monitoring and evaluation program will provide a report card on performance of landscape management initiatives in the north Kimberley, particularly prescribed burning and cattle culling, in maintaining and improving biodiversity status.

Aims

- Inform management of biodiversity status in representative areas after prescribed burning and cattle control programs have been applied.
- Provide warning when landscape ecological thresholds have been reached, for example a decline of mammals to below two per cent capture rate or a decline in mean shrub ground cover to less than two per cent.
- Compare biodiversity outcomes in intensively managed and unmanaged areas to evaluate the effectiveness of management interventions in maintaining and improving conservation values.
- Investigate cane toad and predator interactions that may influence mammal abundance.
- Elucidate influence of different burning approaches to threatened plant taxa in the North Kimberley.
- Investigate interactions between fire and weed invasion.

Progress

- Analysis of obligate seeder population dynamics in the north Kimberley shows inter-fire interval is sufficient for emergence and reproduction despite annual patchy burning. New sites are planned to include more priority species
- Camera trapping confirms more Kimberley threatened mammal species occur in remote northern high rainfall regions. This work confirms Kimberley mammals prefer longer unburnt vegetation and are negatively associated with feral cats. Cats and cane toads were positively associated with feral cattle impacts.
- Analysis of trapping methods showed that arboreal camera traps were more effective at detecting arboreal species than other methods. The rarest arboreal species are those which prefer non-rocky tall open forests/woodlands. More targeted searches in remote areas are recommended to locate more populations of threatened arboreal mammals
- A third and final year of Grader Grass and vegetation survey and herbicide-burning treatment effectiveness trials was conducted at six experimental plots at Wunaamin Miliwundi Range Conservation Park (WMRCP). Data analysis is underway.

Management Implications

- The project continues to provide annual, real-time feedback into adaptive fire and feral herbivore management.
- Reduced extent of late dry season bushfire, increased effectiveness of herbivore management and resulting increase in grass cover (>10 per cent), has allowed threatened mammals at Orchid Creek in Drysdale River National Park (DRNP) to attain their highest abundance and species richness since 2013. This emphasises the importance of reducing bushfire extent via prescribed burning and feral herbivore

control.
- Extensive fires in previously long unburnt vegetation at Mount Hart in WMRCP during 2023 led to the lowest mammal abundance and species richness since 2011. Careful fire management is needed to compartmentalise highly flammable but preferred, long unburnt vegetation, to prevent this from happening in the future.
- More strategic application of burn mosaics to retain larger patches of long unburnt vegetation resulted in increases in mammal abundance and species richness as Cascade Creek in remote areas of Prince Regent National Park.

Future Directions

- Annual monitoring surveys and reporting will continue as part of the evidence-based evaluation of Kimberley adaptive management effectiveness.
- Survey newly established remote sites in DRNP, WMRCP, Fitzroy River National Park and Purnululu National Park.
- Resurvey sites to include additional priority flora and fire-sensitive obligate seeder species.



Fire regimes and impacts in transitional woodlands and shrublands

SP-2010-11

C Gosper

Context

The Great Western Woodlands (GWW) is an internationally significant area with great biological and cultural richness. This 16 million hectare region of south-western Australia contains the world's largest and most intact area of contiguous temperate woodland. The GWW Conservation Strategy and a review conducted by a wide range of scientific experts identified inappropriate fire regimes as a threat to the woodlands and emphasised the need for a science-based fire management regime for the area. Critical gaps in the knowledge of fire ecology for GWW ecosystems are a hindrance to ecological fire management in the region. The GWW supports eucalypt woodlands at very low mean annual rainfall (250-350 mm). Many of the woodland eucalypt species are killed by fire (obligate-seeders) and eucalypt recruitment is stimulated by fire but individuals are slow growing. In recent decades a large part of the GWW has been burnt and concern has been expressed over the ecological impacts of this. Fire ecology research already undertaken in eastern Wheatbelt nature reserves will help resolve ecological fire management issues for mallee and mallee-heath communities in the GWW but similar information for the dominant eucalypt woodlands is needed.

Aims

- Develop a method to robustly estimate stand time since fire in gimlet (*Eucalyptus salubris*) woodlands that have not been burnt during the period covered by remotely-sensed imagery, allowing the scale of recent extensive bushfires to be placed in a historical context.
- Investigate the effects of time since fire on the assembly and recovery of gimlet woodlands, including on plant and animal community composition, development of ecosystem structure and changes in carbon dynamics.
- Produce a spatially explicit representation of long-unburnt woodlands through linkage of plot data on vegetation structure with remotely-sensed imagery.

Progress

- Analysis of on-ground vegetation structure measurements of tree allometry in combination with landscape-scale medium-resolution airborne LiDAR has tracked the recovery trajectory of canopy 3D structural diversity over a ~450-year chronosequence, finding that as recovery followed a predictable pattern, stand age could be estimated from canopy structural metrics. A manuscript from this collaboration with CSIRO and the University of Bristol has been submitted for publication.
- Coincident high-resolution remotely piloted aircraft (RPA) LiDAR and landscape-scale medium-resolution airborne LiDAR was used to test scalability of 32 canopy structural metrics, finding that while there was high correlation between RPA- and airborne-derived metrics, only a small subset of metrics primarily calculated from canopy height models was consistent across platforms. This research has been published in *Remote Sensing in Ecology and Conservation*.
- Vegetation structure and biomass data from the *E. salubris* chronosequence was used to parameterise the Full Carbon Accounting Model (FullCAM) pools of live biomass, standing dead tree biomass and woody debris biomass for Eucalypt Woodland and Open Woodland vegetation - one of eight FullCAM

native vegetation types across the Australian continent. A paper from this CSIRO-led collaboration has been published in *Ecological Modelling*. With support from Woodside Energy, woodland biomass data was also used to calculate carbon stocks in eucalypt woodlands across the GWW, and how stocks respond to management scenarios and future fire regimes.

- Similarities in structure, function and threatening processes have allowed the development of a structured framework for generalised state-and-transition models to inform recovery planning for threatened eucalypt woodland communities across southern Australia. This work has been published in the *Journal of Applied Ecology*.
- Understanding of the fire response of Australian sandalwood (*Santalum spicatum*) and the vegetation in which it occurs was synthesised in a review of knowledge gaps and future research priorities to support sandalwood conservation. A manuscript has been submitted for publication.

Management Implications

- National-scale syntheses of temperate eucalypt woodland responses to disturbance revealed that many Western Australian woodlands are uniquely dominated by taxa that are obligate seeding, and have vegetation dynamics driven by rare, stand-replacing disturbances. These characteristics illustrate a putative vulnerability to decreases in intervals between bushfires and increases in bushfire extent, with large changes in vegetation composition and structure and losses of carbon stocks after woodlands are burnt and especially with short prior fire intervals. This knowledge allows land managers to prioritise fire management mitigation and suppression activities for improved woodland conservation.
- Post-fire succession in vegetation composition and structure, which in turn determines successional patterns in animals, occurs over multi-century timescales, demonstrating the value of avoiding fire in mature woodlands to optimise future fire management outcomes.
- A spatial map of multi-century GWW woodland age classes provides the basis for DBCA, Department of Fire and Emergency Services, local government and Indigenous fire managers to plan fire mitigation and suppression activities to minimise loss of mature woodlands in bushfires.
- Models of biomass carbon stocks in woodlands and their response to time since fire and prior fire interval, supports testing of the economic and implementation feasibility of a fire management carbon methodology for obligate-seeder eucalypt woodlands.

Future Directions

- Expand models of carbon stocks in eucalypt woodlands to be applicable across the geographic extent of the GWW through consideration of climate gradients and different woodland types and predict carbon stock responses to management interventions and climate-driven fire regime change.
- Continue development of using LiDAR metrics to track woodland structural characteristics over space and time.
- Develop a conceptual model of woodland response to likely future climate.



Kings Park Science

Program Leader: David Merritt

Kings Park Science undertakes research in native plant biology, underpinning the conservation and ecological restoration of Western Australia's unique biodiversity and biodiversity generally. Research focuses on the key areas of restoration ecology and ecophysiology, seed science, conservation genetics, conservation biotechnology, ecosystem ecology, fire ecology and systematics. Research is prioritised to enhance practical outcomes in conservation and management and sustainable development of the State’s unique natural resources. The Program delivers science capacity underpinning the State’s botanic garden and the lands managed by the Botanic Gardens and Parks Authority, and the horticultural development of the Western Australian flora. The Program has a long history of successful postgraduate student supervision in collaboration with Western Australian universities and contributes to undergraduate teaching, predominantly in conservation biology and restoration ecology.



Conservation biotechnology

CF-2018-48

B Funnekotter, K Elder

Context

Research into *in vitro* and cryogenic science streams is essential to progress and enhance the *ex situ* conservation and germplasm storage options for threatened plant species, where other forms of germplasm storage are not possible. The micropropagation of threatened taxa also provides a source of greenstock for plant translocation studies in cases where normal propagation is not possible. Germplasm of a range of species is kept in liquid nitrogen storage for conservation and research purposes, including many rare and threatened vascular plant taxa and the seeds and mycorrhizal fungi of hundreds of native orchid species.

Aims

- Develop micropropagation for plants requiring translocation and for living collections.
- Develop cryopreservation protocols for long-term *ex situ* conservation of germplasm of selected species.

Progress

- A focus for the tissue culture collection was to deaccession the historic cultures where sufficient material was cryopreserved. A total of 26 accessions from six species were deaccessioned, freeing up resources and space for new species, such as *Acacia volubilis* and *Tetratheca erubescens*, to be added to the collection.
- The tissue culture collection now has 159 accessions from 48 species successfully cryopreserved. The focus for the year was on the large *Philotheca basistyla* collection where an additional 10 accessions consisting of 162 vials were added to cryogenic storage.

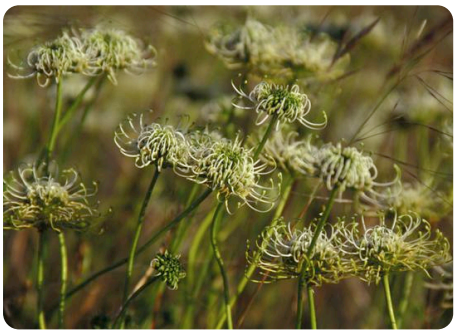
- A successful tissue culture protocol and cryopreservation protocol was developed for *Acacia volubilis* as part of a larger project collaborating with partners in DBCA and the Australian Seed Bank Partnership working on conservation of this species.
- An industry funded project with Alcoa provided improved tissue culture protocols for species of interest to their post-mining rehabilitation programs, with this project gaining additional funding to continue for another 12 months.

Management Implications

- *In vitro* propagation provides *ex situ* germplasm material for threatened species where propagation via seeds or cuttings is unavailable. This approach provides biosecure storage in culture collections or cool storage for selected genetic material of threatened plants. This material can be accessed to provide plants for future translocations if required.
- Cryopreservation provides very long-term, biosecure storage of shoot tips, protocorms, seeds and other material of threatened plant species, which can be revived and utilised to produce plants for restoration purposes.

Future Directions

- Continue development of tissue culture protocols to initiate new species of interest, including additional accessions of *Acacia volubilis* and species relevant to the continued industry partnership with Alcoa (*Lomandra, Lepidosperma, Netrostylis* and *Tetrarrhena* species).
- Explore new innovations to improve tissue culture performance of challenging species, with a focus on new technologies (including temporary immersion and bioreactor systems), reaching out to international experts to understand limitations and applications as part of a submitted ARC Linkage grant.
- Continue research to understand the effects of cryopreservation on the metabolism of plant germplasm in collaboration with Curtin University.
- Develop cryopreservation protocols for 'exceptional' species that may possess recalcitrant seeds and/or may be threatened by myrtle rust (*Syzygium* species) as part of a current ARC Linkage grant.



Conservation genetics

CF-2018-68

S Krauss, C Elliott, N Maher, J Anthony

Context

The conservation, restoration and horticultural development of Western Australia's unique biodiversity is informed by understanding of patterns of genetic diversity at multiple hierarchical levels (individuals, populations, species, communities), as well as the key ecological and evolutionary drivers of this genetic diversity, such as adaptation, mating and dispersal. Research into conservation genetics seeks to understand the impacts on genetic diversity and the key drivers of this diversity from environmental stressors, such as habitat fragmentation, mining, climate change and introduced species and to identify solutions based on genetic data and theory.

Aims

- Experimentally assess seed sourcing strategies for restored plant communities that are resilient to changing climate and altered substrates.
- Employ novel eDNA tools to assess the biological health of soils in restoration post-agriculture and mining.
- Assess reproductive functionality in restored and impacted plant communities.
- Conduct experimental molecular and ecological studies of pollination by birds and mammals and insects on banksias.
- Establish multi-species provenance trials in the northern jarrah forest and Pilbara as part of a national network for an assessment of climate adjusted seed sourcing strategies for ecological restoration.
- Commence a multi-year study on the genetic and biochemical basis for flower colour in kangaroo paws.
- Assess the population genomics, spatial and temporal variability in plant health and pollination biology of threatened plant species in the Pilbara.

Progress

- Ongoing assessment of survival and growth of 32,000 seedlings in multi-species provenance trials established at 32 sites across the Swan Coastal Plain are showing no consistent nor predictable provenance effect.
- Assessed soil health and innoculation success in post disturbance restoration through eDNA assessment of microbial communities.
- Identified the capacity of honeybees to learn and deliver effective pollination on the specialist flowers of *Haemodorum*.
- In addition to birds, non-flying mammals and bees, beetles were found to contribute to the nocturnal pollination of *Banksia*.
- Provenance trials across the national network are showing variable provenance effects.
- The kangaroo paw genome has been sequenced and a biochemical understanding of flower colour established.
- Mating system, plant health and pollination biology continue to be assessed across multiple populations of *Aluta quadrata* and *Quoya zonalis*.

Management Implications

- Provenance trial results to date suggest little to no predictable benefit in applying a climate adjusted seed sourcing strategy for restoration of key species of banksia woodland on the Swan Coastal Plain.
- Knowledge of the genetic and biochemical basis for flower colour is assisting efficient breeding of native plants for horticultural markets.
- When assessing potential impact on rare plant species that might require management intervention, long-term studies are critical in Pilbara systems that naturally show high spatial and temporal variability in key indicators of plant health.

Future Directions

- On-going assessment and extension of large-scale provenance trials, glasshouse trials and seed germination trials for key species from banksia woodlands to test seed sourcing strategies for restoration that is resilient to climate change.
- Assessment of genomic data and reciprocal transplant trials with polyploid and diploid seagrass in Shark Bay continues.
- Continue experimental molecular, chemical and ecological studies of pollination by birds and mammals and insects on banksias.
- Monitor multi-species provenance trials in the national network for an assessment of seed sourcing strategies for ecological restoration.
- Continue a multi-year study on the genetic and biochemical basis for flower colour in kangaroo paws.
- Continue a multi-year study on the pollination biology and mating systems of *Aluta quadrata.*
- Continue research on the pollination biology of banksia woodlands.
- Continue a study on the population genetics and pollination biology of *Quoya zonalis*.
- Commence a study on the pollination biology and breeding system of *Synostemon hamersleyensis*.



Orchid conservation and recovery

CF-2018-60

J Stevens, B Davis

Context

Western Australia is an orchid biodiversity hotspot of worldwide significance, with 413 named species of orchid, of which 95 per cent are endemic. There are 44 Western Australia orchid taxa listed as threatened, with the key threatening processes being habitat loss due to land clearance, fragmentation, pollinator loss, weed invasion, illegal collection and habitat degradation. Orchids represent a conservation challenge as they have complex and highly specific ecological interactions with pollinators above ground and their mycorrhizal partners below ground. Overlaying the immediate needs of the orchid are the independent requirements of the pollinator (nectar sources, brood sites) and the mycorrhizal partner (nutrient sources, soil attributes). *Ex situ* conservation of Western Australia's orchids is undertaken through maintaining a large living collection of orchids, seed banking and maintaining an orchid mycorrhizal library in long term cryostorage. Scientific research into pollination, orchid ecology, translocation, propagation and mycorrhizal function underpins successful species recovery in the Orchidaceae.

Aims

- Determine and prioritise those orchid species most at threat and undertake *ex situ* conservation actions leading to supplementation of natural populations, to ensure their ongoing persistence.
- Continue maintenance and growth of the *ex situ* living collection, seed and fungal collections.
- Conduct integrated conservation research to provide management solutions to improve the conservation status of threatened orchid taxa.
- Make collections of seed and fungi from threatened and priority listed species available to investigate the potential for supplementation of wild populations.
- Maintain and build *ex situ* seed and fungal banks of the orchid flora of Western Australia for conservation and research purposes.

Progress

- Continued orchid translocations, with the augmentation planting of 255 laboratory raised *Caladenia lodgeana* plants. This planting is the culmination of three years of pollination ecology and propagation research to select sites to optimise the establishment of a self sustaining secondary population for the species.
- Post-translocation monitoring for survival, flowering seed set and recruitment of *Caladenia busselliana* translocations shows successful recruitment events in plantings that are now three years old. The youngest plantings had successful seed set in their first-year post-translocation, showing that all translocations are on track to reach self-sustainability goals.
- Long term monitoring of tagged individuals of *Caladenia lodgeana, Caladenia leucochila* and *Caladenia busselliana* continued across natural populations.
- Propagative *ex situ* material (seed and fungi) was collected from all known populations of *Caladenia hopperiana* and placed in long term, secure cryostorage. Further, seedlings were propagated for incorporation into the *ex situ* living collection for seed and fungal harvest and to serve as a source of flowers for pollination ecology studies.
- Successful asymbiotic germination protocol established for the endangered, *Thelymitra variegata*.

Management Implications

- Development of germination protocols for threatened orchid species provides conservation support in the form of *ex situ* living collections, advances the possibility of translocations as a conservation tool and informs *ex situ* collection practices for functionally similar species.
- Growing *ex situ* collections of threatened orchids provides essential conservation support for species with critically low wild plant numbers or single populations. The provision of plant material to undertake pollinator research and site selection for translocations is critical to species recovery efforts.
- Collecting data on survival, reproduction and pollinator visitation in plants post-translocation is key to improving future orchid translocation efforts. Data also inform regional conservation management of remaining habitat, selection of future translocation sites and whether reproductive management of the orchid species may be necessary.
- Long term demographic monitoring data for orchids is rare but vital to perform population viability analysis and provide an understanding of orchid life stages, recruitment, reproduction and life span to inform species management and recovery.

Future Directions

- Undertake research and population viability analyses to inform regional planning and management of threatened and conservation listed orchid species.
- Make targeted seed and fungal collections available to supplement *ex situ* orchid collections in line with the *ex situ* conservation program.
- Investigate orchid, pollinator and mycorrhizal ecology as they relate to species recovery efforts and *in situ* management of populations.



Restoration science

CF-2018-77

J Stevens, S Krauss, W Lewandrowski, C Elliott

Context

Restoration science encompasses a multidisciplinary approach to provide a comprehensive scientific basis for ecological restoration actions across the State. The research includes seed science, provenance, ecohydrology, ecophysiology, soil science, community ecology and plant-enabling technologies. Restoration science projects are active across diverse systems including Pilbara grasslands and savannas, mid-west shrublands, Swan Coastal Plain banksia woodlands and shrublands, jarrah forest, marine seagrass meadows and arid coastal communities. Through collaboration with a variety of stakeholders, the restoration science program is well placed to provide the applied scientific solutions required for all plant community restoration activities.

Aims

- Establish targets and criteria for restoration success.
- Determine appropriate sourcing of biological materials for restoration.
- Optimise establishment of plants in restoration.
- Determine factors influencing growth and survival of plants in restoration.
- Determine factors influencing resilience, sustainability and landscape integration.

Progress

- Continued research to examine the species biology (pollination and reproduction biology) of rare Pilbara plant species including *Aluta quadrata* and *Quoya zonalis*. These projects continue to inform conservation decision making and management within the mining sector.
- Several strategic projects continued through the CRC Transformations in Mining Economies, connecting the department's climate research and seed science capability with Australia's mining sector.
- Continued to monitor tree health in managed parkland and bushland systems at Kings Park using novel whole tree ecophysiological monitoring tools linked to remote sensing data.
- Continued the collaborative program with DPIRD to understand biodiversity values of Kimberley grassland grazing systems. Small scale plots were established in Perth to collect seed to understand germination and harvesting challenges for priority grasses.
- Commenced studies in the Pilbara region for Rio Tinto Iron Ore, assessing dust impacts on keystone arid zone species and ecophysiological responses of keystone tree species to varying hydrological regimes in groundwater dependent ecosystems.
- Continued monitoring of the rare *Tetratheca butcheriana* on Mount Brockman Range to inform decision making for rare species conservation and management within the mining sector with funding from Rio Tinto Iron Ore. In addition, remote sensing approaches, as well as dust studies, were undertaken in recent survey efforts.
- Commenced a research project to guide conservation and management of the threatened *Synostemon hamersleyensis* using ecophysiological and molecular ecological approaches with Rio Tinto Iron Ore.
- Continued research partnership with Hanson Construction Materials, delivering banksia woodland restoration solutions for practitioners, focussing on assessing post-pine restoration activities and long-term banksia woodland restoration trajectories.
- Completed a guiding document on the restoration of *Melaleuca argentea* in the Pilbara.

Management Implications

- Critical insights into plant habitat, substrate and niche interactions underpinning species distribution, as well as environmental conditions driving persistence and ecophysiological functioning, will help monitoring approaches and management actions within the mining sector.
- Maximising seed usage will assist in creating resilient biodiverse systems and the sourcing of seeds for restoring mined lands under future climate scenarios.
- Monitoring and understanding tree health and decline in response to seasonal changes in rainfall and nutrient deficiencies informs changes in management of parkland and bushland (for example, irrigation practices, acidifying of bore water).

Future Directions

- Continue a multi-year study on the pollination and reproductive biology of the rare *Aluta quadrata* and *Quoya zonalis* and extend this research to other rare species in the Pilbara.
- Understand opportunities for science to inform approaches to monitor rare species that occur in isolated and difficult environments.
- Engage in restoration science partnerships that continue to explore Traditional Owner collaborations.



Seed science

CF-2018-85

D Merritt

Context

Seed science projects focus on supporting plant species conservation and ecosystem restoration. Research themes include seed storage behaviour, the physiology and ecology of seed dormancy and germination, the interactions of seeds and seedlings with the soil environment and the development of seed technologies to enhance seedling establishment in threatened species translocation and broad-scale restoration settings. Seed science is integrated with the conservation seed banking functions of DBCA to support and enhance the capacity for long-term storage of germplasm of Western Australia's flora.

Aims

- Support and enhance the curation of *ex situ* germplasm collections through characterising seed storage behaviour and longevity, developing methods for assessing seed viability and quality, and predicting seed storage life.
- Develop reliable methods for seed-based propagation through determining seed dormancy break and germination requirements.
- Develop seed enhancement technologies that improve seedling establishment for ecological restoration.
- Improve mechanised direct seeding systems to support biodiverse ecological restoration.
- Inform the management of Western Australia's flora through the study of seed ecology in the natural environment.

Progress

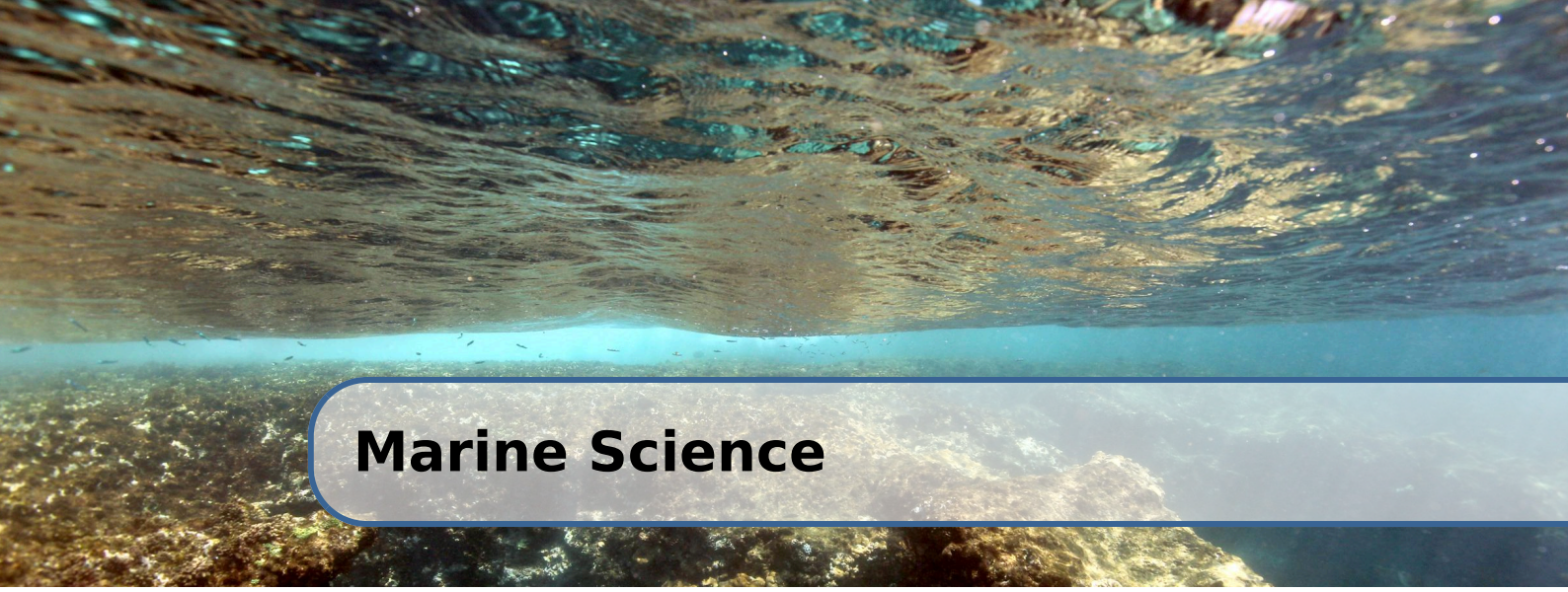
- Completed a study on the viability and longevity of 44 seed collections of Kings Park and Bold Park bushland species banked for up to 34 years.
- Completed and published a review of current germplasm collections of WA's myrtaceous flora at risk from myrtle rust and developed a prioritised list of genera and species for future collections.
- Commenced a research project to study seed biology and storage behaviour of WA's myrtaceous species at risk from myrtle rust.
- Completed a project examining seed propagation techniques for the threatened species *Quoya zonalis*.
- Completed a project studying the seed germination biology and storage behaviour of over 25 Kimberley species.
- Continued a five-year project to develop seed technologies and seeding machinery for mine site restoration.
- Continued a five-year research project studying the mechanisms of seed protection and release in serotinous species.
- Commenced a project studying seed dormancy and germination traits of annual species of the York Gum woodlands to improve ecological restoration of understorey plant communities.

Management Implications

- Research on seed longevity demonstrates the utility of experimental seed ageing techniques to assess the future storage potential of historical, banked seed collections and to differentiate between low and high-quality seed collections to inform collections management and re-collection priorities.
- A review of *ex situ* conservation needs for WA's myrtaceous species highlights the role of *ex situ* conservation in responding to biosecurity threats and provides guidance for future strategic and pro-active germplasm collection and conservation to respond to myrtle rust.
- Research and development of direct seeding machinery has supported the establishment of a spin-out company through UWA to deliver direct seeding services for mine site rehabilitation.

Future Directions

- Continue research to quantify the role of oxygen in seed longevity of diverse native species to inform seed banking practices.
- Continue to focus on resolving seed dormancy of problematic and high-priority species, including Hibbertia, to support seed-based propagation for restoration and bushland management.



Marine Science

Program Leader: Thomas Holmes

The broad goal of the Marine Science Program is to ensure the department's marine biodiversity conservation and management programs are based on best practice science. Specifically, the program promotes and undertakes marine research and monitoring to improve the scientific basis for the conservation and management of Western Australia's State-wide system of marine protected areas, threatened marine fauna and marine biodiversity generally. The program also coordinates and manages external marine research programs, such as the current investigation into the bio-physical, social and cultural values of the Kimberley that is undertaken as part of the Western Australian Marine Science Institution (WAMSI). The research and monitoring programs undertaken by the Marine Science Program are based around the research and monitoring strategies identified in protected area management plans and threatened species recovery and management plans, ensuring that all activities are linked to departmental priorities and programs.



Understanding the drivers of hypoxic events and impacts to the coral communities in Bill’s Bay, Ningaloo Marine Park

SP-2024-1

C Ross, M Cuttler, T Holmes

Context

Deoxygenation has been gaining increasing attention globally for its role in the degradation of tropical coral reefs. Multiple deoxygenation events have occurred at Bill’s Bay, a semi-enclosed lagoon within the UNESCO World Heritage-listed Ningaloo Marine Park and have been associated with significant ecosystem impacts, including fish kills and coral mortality. Although these events are thought to be linked to the entrapment and decomposition of coral spawn, the physical mechanisms that trigger these events remain poorly understood, making it difficult to predict when they may occur and to assess the capacity for reef recovery. This project will identify the physical conditions associated with known deoxygenation events and develop thresholds to support the prediction of future events. New data will be collected and collated with existing multi-decadal ecological data to examine the status of the coral communities and juvenile abundance as benchmark for coral recovery in Bill’s Bay.

Aims

- Investigate the physical drivers of acute hypoxic events in Bill’s Bay using calculations based on numerical modelling and develop threshold physical conditions to assist with the prediction of future hypoxic events.
- Quantify the impacts of the 2022 hypoxic event on coral communities compared to previous events and assess coral recovery through time, particularly coral recruitment and coral juvenile abundance as indicators of early-stage recovery.
- Determine how patterns in coral recruitment and juvenile abundance vary across a hydrodynamic gradient, specifically with respect to circulation and water residence time.

Progress

- Coral cover and juvenile abundance data spanning two decades has been cleaned and collated.
- Data on the physical conditions at Bill's Bay have been analysed and calculations based on numerical modelling have been used to develop physical condition thresholds for each of the historical hypoxic events.
- Field trips were undertaken in 2022 and 2024 to collect data on coral cover, community composition and juvenile coral abundance at the sites in Bill's Bay.
- A manuscript investigating the drivers of historical deoxygenation events and capacity for reef recovery in Bill's Bay is under review in the journal *Coral Reefs*.

Management Implications

- Predicting when and where deoxygenation events may occur is essential to enabling rapid management responses as the risk of deoxygenation in the tropics continues to increase.
- Understanding the physical drivers of these events will underpin any attempt to develop early warning systems to mitigate their impacts. Specifically, physical condition thresholds derived by the project could be applied to existing wind and wave forecast products to provide warnings of the likelihood of deoxygenation conditions.

Future Directions

- Fieldwork to re-survey coral cover and juvenile coral distributions at Bill’s Bay in 2025 and 2026.
- Analysis of coral recruitment data from 2009-2024 at sites in Bill's Bay.
- Preparation of a manuscript to understand spatial and temporal patterns in coral recruitment and to investigate early recovery dynamics in Bill's Bay following recent disturbances including the deoxygenation event in 2022 and a coral bleaching event in 2024-25.



Whale shark behavioural response to tourism interaction in Ningaloo Marine Park and implications for future management

SP-2023-11

H Raudino, J Tyne, K Waples

Context

Whale sharks migrate annually to Ningaloo Marine Park (NMP). A nature-based tourism industry has developed around the predictable presence of these animals, taking people to snorkel near the whale sharks in NMP, between March and June each year. This tourism activity is licensed and managed by DBCA, which is responsible for the species' conservation in Western Australian waters.

Wildlife Management Program no. 57: *Whale shark management with particular reference to Ningaloo Marine Park* was implemented in 2013 to ensure the sustainability of whale sharks through understanding and mitigating pressures in WA state waters and promoting education and community engagement. This program includes strategies to minimise the potential impacts from wildlife interaction tourism on whale shark behaviour in NMP. Regular evaluation of the effectiveness of management strategies within the program to minimise impacts to whale sharks from tourism interactions is used in an adaptive management approach. The management program underwent a full review in 2024-25.

Aims

- Assess the effectiveness of the current management program by determining whether there are any identifiable impacts of encounters between whale sharks and commercial tourism activities.
- Ensure that data collected by tour operators is suitable and accessible to assess the whale shark tourism industry and its interactions.
- Identify knowledge gaps that need to be filled to support ongoing conservation of whale sharks and a sustainable tourism industry.

Progress

- A literature review evaluated the efficacy of the current whale shark management program in the NMP, summarised the current state of knowledge about whale sharks and identified knowledge gaps.
- A Standard Operating Procedure (SOP) was drafted to improve the quality, flow and efficiency of data collected by whale shark tour operators using the on-board Electronic Management System (EMS).

- Whale shark encounter data from 2011-2023 were processed and analysed to assess the potential impacts from tourism interaction and evaluate the effectiveness of management strategies in the Whale Shark Management Program.
- The duration of encounters with whale sharks was used to assess short-term impacts on individual animals. A short-term behavioural impact was detected for whale sharks experiencing multiple encounters within one day.
- Encounters were found to be clustered in particular areas of NMP, leading to the potential for vessel congestion and increased swimmer risk.
- A paper was published in *Frontiers in Conservation Science*, which noted the overall management framework for whale shark tourism in NMP is suitable and that the potential short-term impacts should be further investigated.

Management Implications

- The literature review provided context and background for review and revision of the Whale Shark Management Program.
- Analysis of the whale shark encounter data highlighted the need to better understand and manage the potential pressure of protracted and cumulative encounters and the high density of encounters in some areas of NMP.

Future Directions

- The project is complete.



Conservation and management of humpback whales in the Pilbara region

SP-2022-25

H Raudino, K Waples, J Tyne

Context

Humpback whales undertake an annual migration from Antarctic feeding grounds to tropical breeding and calving grounds along the WA coastline. During their migration, humpback whales use different coastal areas for different purposes, including as migratory corridors and staging and resting areas used by mothers and calves.

As humpback whales migrate through the Pilbara region they encounter many pressures, including noise pollution from coastal construction, shipping traffic, seismic activities, recreational and commercial tour vessels. However, there is a paucity of knowledge on the contemporary abundance and distribution of humpback whales during their annual migration and important habitat across the Pilbara needs to be confirmed. This project will improve understanding of humpback whales' habitat use in the Pilbara region in relation to pressures, so that impact from potential pressures can be minimised, including management of the in-water interaction tourism industry in Ningaloo Marine Park, an important site for mothers and calves.

Aims

- Assess areas in which in-water humpback whale commercial tour operation interactions occur and investigate potential cumulative and total pressure of interactions in those areas.
- Determine the spatial and temporal characteristics of humpback whale habitats in the Pilbara, why these habitats are important (using existing datasets) and how these habitats potentially overlap with current and emerging pressures.

Progress

- Aerial surveys were conducted in 2022, 2023 and 2024, consisting of ten 17 line transect surveys across the humpback whale migration season in Ningaloo Marine Park (NMP). The aerial survey design followed that established in a previous aerial survey program undertaken in 2016 and 2017. Data from both sets of aerial surveys were analysed to assist in understanding the effectiveness of the Humpback Whale Management Program and potential for impacts to the humpback whale population.
- Humpback whale distribution across NMP was compared between 2016, 2017, 2022, 2023 and 2024, with no significant difference in distribution detected between years, suggesting humpback whales spatial use of NMP has not materially changed.
- Analysis of absolute abundance estimates of humpback whales in 2022, 2023 and 2024 found the number of whales in the study area during the migration period has increased.

- Humpback whale mothers and calves continue to predominately use the mother calf protection zone established under the Humpback Whale Management program and this area has also become popular for in-water interactions.
- A report on humpback whale distribution, absolute abundance estimates, and in-water interactions, including recommendations, was completed.

Management Implications

- Data from aerial surveys and the in-water interaction tourism industry can be used to evaluate the Humpback Whale Management Program to ensure it meets objectives for humpback whale conservation and sustainable tourism.
- The continued high use of the mother and calf protection zone for in-water interactions warrants further investigation to ensure impacts to mothers and calves are minimised.
- Assessment of the distribution of in-water interactions has identified hot spot areas that may lead to congestion of vessels and swimmers, raising concerns for swimmer safety and impacts to whales that should be considered in the management program.

Future Directions

- Undertake a regional-scale spatial risk assessment for humpback whales across the Pilbara.



Benefits of marine parks for marine fishes in a changing climate

SP-2021-40

J Goetze, T Holmes, C Ross, W Robbins

Context

To conserve WA's marine biodiversity, a network of marine parks has been established under the principles of being comprehensive, adequate and representative. These principles require knowledge of ecological assets over a statewide scale and are complicated by a changing environment. Finfish have been identified as a key ecological asset due to their high ecological and social values. Anthropogenic pressures are leading to shifts in the composition of fish assemblages, and it is unclear how well the current network of marine parks represents fish diversity. This project will combine DBCA finfish monitoring data with information collected by external collaborators to assess fish biodiversity inside and outside of WA marine parks over the last decade. This dataset will be used to describe statewide spatial and temporal patterns of finfish composition and distribution in relation to key pressures, to enable adaptive management and guide marine park planning.

Aims

- Collate a statewide finfish dataset with key collaborators to enable biodiversity assessments of fish inside and outside of marine parks, over the last decade.
- Develop conversion factors that will enable the synthesis of DBCA finfish data (diver operated video, DOV) with legacy datasets (underwater visual census, UVC) and emerging methods (remotely operated vehicle, ROV).
- Compare the composition, biodiversity and productivity of fish assemblages among marine parks relative to non-reserved locations.
- Assess if the composition, biodiversity and productivity of finfish assemblages within marine parks has changed over time and if any changes correspond with climatic events or are due to fishing pressure.
- Determine if these changes persist through time and whether patterns of change differ among parks located along the WA coast.

Progress

- A workshop involving DBCA research scientists and collaborators from Curtin University, The University of Western Australia, and the Australian Institute of Marine Science, conducted preliminary analyses of the statewide fish dataset and outlined plans for three manuscripts.
- One manuscript was drafted examining how commonly used metrics of fish abundance, size and diversity vary across transect-based survey methods. The study provides a guide to combining data across methods to enable broader spatial and temporal assessments of fish assemblages. The manuscript was accepted as an oral presentation for the 2025 Australian Society for Fish Biology Conference.

Management Implications

- Establishment of an inter-organisational working group and the synthesis of a statewide dataset have enabled broader evaluation of marine park effectiveness, supporting adaptive management across Western Australia's marine parks.
- By demonstrating how to integrate data from previously disparate fish sampling methods, more comprehensive spatial and temporal assessments of fish assemblages are possible, leading to increased confidence in research and monitoring programs' adoption of new technologies.

Future Directions

- Finalise manuscript providing a guide to combining data across multiple methods to enable broader spatial and temporal assessments of fish assemblages.
- Using a combined dataset, progress preparation of manuscripts on the effectiveness of marine parks on a statewide scale.



Primary productivity and energy transfer between marine ecosystems

SP-2020-2

M Moustaka, R Evans, K Murray

Context

Primary productivity provides energy that fuels food webs and is recognised as an important driver of local diversity and secondary production. Hence conservation planning often aims to identify where primary production is high; what systems, including their spatial arrangement, are most productive; and how efficiently productivity from these producers is transferred to other systems or consumers. While marine productivity is largely attributable to oceanic phytoplankton, productivity from benthic macrophytes becomes increasingly important in coastal food webs. The link between benthic productivity by vascular plants and algae and secondary production remains equivocal. Moreover, local variations in hydrology are likely to influence the supply of nutrients, temperature and light (caused by turbidity), all of which are fundamental determinants of primary productivity. This project will investigate rates of primary productivity and energy transfer in the shallow, turbid waters of the Dampier Archipelago.

Aims

- Develop an updated coarse benthic habitat map for the Dampier Archipelago and fine resolution benthic habitat maps for up to 16 sites.
- Develop fine scale oceanographic modelling of the Dampier Archipelago to provide water flow and retention data for interpreting spatial differences in productivity.
- Measure water quality parameters (total soluble solids, salinity, nutrients, Chlorophyll A) and assess how they vary spatially and temporally.
- Measure primary productivity in different marine habitats (mangroves, seagrass, seaweed and coral reef) and assess how rates vary among locations and between seasons in the Dampier Archipelago area.
- Measure abundance, diversity and growth rates of fish and benthic communities and assess how these relate to spatial variation in primary productivity.
- Measure abundandance and diversity of macroalgal epifauna and sediment infauna and assess how these relate to spatial variation in primary productivity.
- Measure stable isotopes of primary producers and secondary consumers, and use isotopic signatures to assess the extent of transfer from different primary producers to secondary consumer tissues and between different habitats.

Progress

- Completed one field trip to the Dampier Archipelago, including collection of data on water temperature and mangrove productivity.
- Laboratory work for coral skeletal density samples (from photogrammetry colonies) was completed.
- Compound-specific stable isotope analysis of bluespotted emperor (*Lethrinus punculatus*) otoliths and tissue was completed.
- Hydrodynamic modelling was finalised and outputs continue to be used in ecological studies.
- Three manuscripts on juvenile fish distributions, macroalgal nursery function and cross-habitat trophic subsidies for fish have been published. One conference paper on photogrammetry methods to measure coral growth was published.

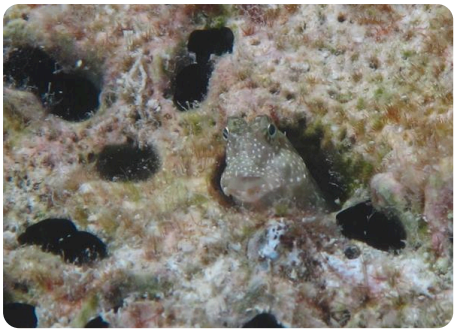
- Research findings were presented at two domestic confrerences and two international conferences.

Management Implications

- Identification of high productivity locations may be used in spatial planning within the Dampier Archipelago and to improve scientific advice relating to development projects in the area. Results will be transferable to planning in other locations with similar environmental conditions, by assessing which environmental factors correlate with high productivity.
- Primary drivers of community structure differed between adult (habitat composition and complexity) and juvenile fish (hydrodynamic conditions and seascape configuration). This information will inform environmental decision-making processes to improve management of fish communities throughout their life cycle.
- Consistently high abundance and diversity of juvenile fish (particularly species targeted by commercial and recreational fisheries) in macroalgal beds highlights the importance of this habitat type for fisheries sustainability and will inform future spatial planning.
- Planktonic productivity underpins the productivity of juvenile and adult fishes, increasing our understanding of ecosystem function in the region and underscoring the critical link between coastal habitats and surrounding waters.

Future Directions

- Finalise the 3D coral photogrammetry models (both individual colonies and reef-scale) and prepare resulting scientific publications.
- Complete one field trip to the Dampier Archipelago to quantify the impacts of the 2025 marine heatwave on coral communities.
- Continue preparing hydrodynamic model publications.
- Continue analysing epifauna, coral, productivity and eDNA data and writing scientific publications.



Do marine reserves adequately represent high diversity cryptobenthic fish assemblages in a changing climate?

SP-2019-31

O Luiz Junior, J Goetze

Context

Small-bodied fish (< 5cm) typically account for ~40 per cent of all described fish species on coral reefs and therefore are expected to represent a substantial proportion of fish diversity in the State's marine reserves. Short life spans of these small fish also suggest they are important conduits of energy transfer in marine food webs and will respond more rapidly to environmental change and stressors than larger-bodied counterparts. This is especially pertinent along the WA coastline, where marine heatwaves have dramatically impacted habitats and fishing may have reduced the abundance of small fish predators. Standard visual methods of surveying fish are not suitable for monitoring these small cryptobenthic fish (CRF). This project will investigate whether environmental DNA (eDNA) from water and sediment samples is a viable alternative to collecting with poison (clove oil) and visual approaches for assessing CRF assemblages. By collecting data from different habitats and management zones within marine parks, the project will also assess how effectively different techniques detect a change in CRF due to spatial variation in environment or management.

Aims

- Refine methods for measuring and monitoring CRF assemblages.
- Compare CRF assemblages collected inside and outside of no-take sanctuary zones and across gradients of reef (habitat) types from high coral cover and complexity to reefs dominated by macroalgae with low complexity.
- Examine how small, bottom-dwelling ("cryptobenthic") reef fishes harness and transfer carbon in two distinct tropical and temperate climatic zones.
- Improve understanding of the differences in community structure and composition and how these factors influence cryptobenthic fishes' role in energy transfer.

Progress

- Further surveys of cryptobenthic fishes were undertaken to improve knowledge of energy transfer through the marine food web.

Management Implications

- Better understanding of CRFs will support more holistic and effective management of marine protected areas (MPAs) by extending management focus beyond large, conspicuous species.
- Due to their low tolerance of environmental pressures and rapid generation times, CRFs can be effective indicators of broader environmental stress.
- Effective MPA management should consider CRFs critical role in cycling energy from microscopic food sources to larger consumers and ensure that the distinct habitats that support different energy channels are protected to maintain the overall productivity of the reef ecosystem.
- Robust data on CRF assemblages enables establishment of comprehensive biodiversity baselines and assessment of this otherwise hidden vertebrate biodiversity's conservation status.

Future Directions

- The project's original aims were completed in 2023-24 but the project has been reinstated due to the identification of further research questions.



Understanding the key ecosystem services provided by the seagrass meadows of Western Australia

SP-2018-136

S Strydom, I Leal, K Murray, M Moustaka, T Holmes

Context

Seagrasses are foundation species that support important ecosystem services and processes. Seagrass meadows are declining globally and anthropogenic pressures such as terrestrial run-off, anchor damage and dredging threaten the ecological, economic and social services that seagrass meadows provide. Some of the world's largest and most diverse seagrass meadows occur in Western Australia and support many commercially, recreationally and culturally important fauna. As the condition of seagrass meadows responds readily to pressures, they are used as indicators for the overall effectiveness of management across marine reserves managed by the department. Across-region comparisons and thorough temporal assessments of seagrass condition will provide a broader appreciation of seagrass health among the State’s network of marine reserves. Furthermore, a greater understanding of how climate change related pressures of increased seawater temperature and extreme events impact seagrass meadows and the ecosystem services they provide, is needed. This is particularly the case in vulnerable regions like Shark Bay, Western Australia’s largest World Heritage Area, where the full extent of seagrass loss since the 2010-11 marine heatwave was until recently, not well understood.

Aims

- Describe seagrass distribution and condition over time across the sub-tropical and temperate WA marine reserves.
- Establish appropriate methods for surveying and monitoring faunal communities in seagrass meadows.
- Assess faunal communities in different types of seagrass meadows across the seascape to inform how key ecosystem services are affected by pressures that impact seagrass condition.

Progress

- Seagrass condition differed across a latitudinal gradient across WA marine reserves, with increased mean summer temperatures being a strong driver of declines in Cockburn Sound and Marmion Marine Park.
- A paper published in *Ecological Indicators*, demonstrated that *Halophila* and *Halodule* seagrass meadows are critical habitat driving the presence of dugongs even at low cover (2-5 per cent).
- A manuscript quantifying how seagrass fish assemblage communities differed across meadows with varying degrees of seascape metrics, and invertebrate assemblages differed between *Posidonia* and *Amphibolis* is ready for publication.
- Concurrent fragmentation projects continued to progress, with one manuscript accepted into *Remote Sensing in Ecology and Conservation*.

Management Implications

- Assessing seagrass condition and drivers across marine reserves highlights the importance of tailoring management actions to specific stressors. For example, turbidity was found to be a driver of decline in Jurien Bay and Marmion Marine Parks and actions to reduce turbidity should be prioritised to maintain

seagrass condition at such locations. Ngari Capes Marine Park was identified as a climate change refuge area.
- Tropical seagrass meadows are important critical habitat driving the presence of dugongs even at low cover (2-5 per cent), highlighting the conservation priority of these meadows in the Pilbara.
- Understanding how seagrass meadow habitat quality is superior for fish and invertebrate communities within *Amphibolis* compared to *Posidonia* meadows, provides a basis for identifying areas to focus conservation efforts for enhancement of fishery nursery functions.
- Mapping products have been pivotal for site selection in externally led ecological restoration initiatives.

Future Directions

- Prepare papers on seagrass distribution and condition over time and submit for publication.
- Repeat Pilbara seagrass-dugong survey to establish a time-series for this work.
- Finalise manuscript on fragmentation of seagrass meadows and its influence on fish and invertebrate communities in Shark Bay.
- Finalise the updated Shark Bay seagrass habitat maps and quantify spatial and temporal shifts in seagrass extent between 2016 and 2023.
- Conduct additional field trip and analysis to assess impacts of the 2025 marine heatwave.



Distribution and abundance estimate of Australian snubfin dolphins at a key site in the Kimberley region, Western Australia

SP-2014-18

H Raudino, K Waples

Context

The conservation status of the Australian snubfin dolphin (*Orcaella heinsohni*) cannot be adequately assessed due to insufficient information on population dynamics and distribution. This species is known from tropical coastal waters of Australia and New Guinea, but individuals tend to be evasive and difficult to study. As there has been little locally based research on this species and the limited data collected remains unpublished, this project will compile existing data on snubfin dolphins across the Kimberley to better understand their habitat use and distribution. Collation of data into a single database will facilitate the study of population structure and demographics based on recognised individual animals.

Aims

- Provide a quantitative abundance estimate of snubfin dolphins for Roebuck Bay in Western Australia that will be used as a baseline for this population component and enable comparison with abundance estimates of the species from sites at Cleveland Bay (Queensland) and Port Essington (Northern Territory).
- Compare methods for abundance estimation (mark-recapture versus distance sampling) and assess the suitability of these methods for abundance estimation of this species.
- Map the extent of occurrence and area of occupancy of snubfin dolphins in the Kimberley by combining traditional knowledge and dolphin sightings from Aboriginal sea rangers and scientific survey.
- Refine and populate a purpose-built database and standardise data to support long term data collection and curation in Western Australia and facilitate data-sharing between jurisdictions.

Progress

- The triennial snubfin census for Yawuru Nagulagun Roebuck Bay Marine Park (YNRBMP) was completed in May 2025 in collaboration with Yawuru Rangers. All three species of dolphin were sighted during the survey and data are currently being analysed.
- The biennial dolphin survey for Malandoom Prince Regent River was undertaken with Traditional Owners. Both snubfin and humpback dolphins were seen on each day of the survey, including resights of individuals within the survey and from previous years. Data have been analysed and the survey report is being drafted.

Management Implications

- Collation of scientific and traditional knowledge of a poorly understood marine mammal of high conservation value will help to address the key performance indicators related to maintaining abundance and diversity of dolphin species in YYNRBMP.

- Standardisation of all dolphin research, monitoring, survey and photo-identification data improves the basis for assessing population abundance, distribution, population demographics and life history. These data were used to inform the Commonwealth Government's listing of Biologically Important Areas for snubfin dolphins in the Kimberley.
- Broad-scale collation of information and modelling has assisted in defining snubfin dolphins' area of occupancy and extent of occurrence, which were used to assess the species' conservation status, leading to its listing as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*.
- The research has established partnerships with Aboriginal sea ranger groups to develop survey methodologies, data storage and reporting structures consistent with Healthy Country and marine park management plans.
- The Marine Fauna Sighting app and Finbook photo-identification guide will support ongoing monitoring of the snubfin dolphin population in YNRBMP.
- An ongoing monitoring program for dolphins in YNRBMP will inform ongoing adaptive management of dolphins using the marine park and surrounds.
- Understanding the population structure and genetic connectivity of coastal dolphin populations will inform conservation management by identifying populations more vulnerable to anthropogenic impacts.

Future Directions

- Publish the results of the genetic analyses of snubfin dolphins in Malandoon Prince Regent River.
- Complete the report on the biennial snubfin survey in Lalang-gaddam Marine Park, Malandoon Prince Regent River.
- Complete the report on the three yearly snubfin census in YNRBMP and update the photo identification catalogue.
- Determine whether data from the three snubfin censuses to date can be used to estimate population abundance.



Habitat use, distribution and abundance of coastal dolphin species in the Pilbara

SP-2014-21

K Waples, H Raudino

Context

Australian snubfin (*Orcaella heinsohni*), Australian humpback (*Sousa sahulensis*) and Indo-Pacific bottlenose (*Tursiops aduncus*) dolphins inhabit Australia's north-western coastal waters but little is known about the population sizes, distribution and residency patterns of these species. Current knowledge of these dolphin species in the Pilbara is poor and is limited to a dedicated study of humpback dolphins in Ningaloo Marine Park and Exmouth Gulf, opportunistic surveys and anecdotal sightings throughout the region. Although the presence of several coastal dolphin species is expected in nearshore Pilbara waters (including humpback, snubfin and bottlenose dolphins), very little is currently known of their residency and habitat use patterns.

Human pressures on these species are increasing in the Pilbara through activities associated with expansion of the resources sector, including oil and gas exploration and production, coastal infrastructure development and shipping. While these are key factors that proponents are required to address to secure State and Commonwealth environmental approvals, impact assessments for these species are complicated by the lack of best practice protocols and standards for survey design and data collection, which limits the comparison of different studies and study sites. This project will provide a better understanding of these species and their spatial and temporal use of Pilbara coastal waters, leading to greater certainty in assessing and managing impacts related to industrial developments. This project was designed to meet this priority need under the Wheatstone Offset C program.

Aims

- Determine habitat use, distribution, abundance, residency and movement patterns of dolphins in coastal Pilbara waters.
- Identify the characteristics of habitats used by coastal dolphins, such as water depth, benthic substrate and a range of environmental variables.

Progress

- Research findings were shared with marine managers and the community to build awareness and appreciation of marine biodiversity. Communications included presentations to DBCA staff in Karratha, a

public presentation in Onslow, a booth at the Karratha Senior High School Science Fair, visits to primary schools in Onslow, Karratha and Dampier.

Management Implications

- Data depicting dolphin distribution and habitat use in the Pilbara were mapped to inform environmental impact assessments in Exmouth Gulf, Onslow, Thevenard Island and Dampier Archipelago.
- The information produced from this project directly informed the listing of the humpback dolphin as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*.
- Sighting data and associated behavioural data informed the listing of Biologically Important Areas by the Commonwealth Government. These areas will be important considerations in environmental impact assessments and have associated statutory requirements.

Future Directions

- Undertake genetic analyses of the two samples collected from humpback dolphins at Montebello Islands Marine Park.
- Develop a spatial risk assessment of pressures at a regional scale and assess how these overlap with dolphin distribution and abundance, using the data outputs from this project as the response variable in the model.



The influence of macroalgal fields on coral reef fish

SP-2013-6

T Holmes, J Goetze

Context

Macroalgae are a prominent component of tropical benthic communities along the north-west coast of Australia. Within Ningaloo Marine Park, large fields of macroalgae are a distinct feature of the lagoon, covering approximately 2000 hectares. These macroalgal fields are important habitats for fish targeted by recreational fishers and are a focal area for boating activity within the park. Moreover, large seasonal shifts in algal biomass on these and other tropical reefs, suggest macroalgae play an important role in nutrient fluxes in Ningaloo and similar systems. Work at Ningaloo has quantitatively assessed seasonal variation in biomass and diversity of macroalgal communities. This project will build on the information gained from those initial studies to improve understanding of how macroalgae are distributed across the Ningaloo lagoon and better define the role of macroalgal fields as habitat for fish recruits and adults.

Aims

- Quantify spatial variance in macroalgal fields at Ningaloo Marine Park and determine the relative importance of physical and biological drivers of algal abundance and diversity.
- Identify attributes of macroalgal fields favoured by juvenile fish and examine the relative importance of habitat quality and predation on juvenile abundance.
- Assess the influence of juvenile fish on replenishment and future adult abundance.

Progress

- Additional data on fish recruit abundance, adult lethrinid abundance and macroalgal dynamics and structure were collected.
- The spatial extent of sites within Ningaloo Marine Park has been reduced to reflect the project's greater focus on temporal trends in fish recruitment and macroalgal dynamics, rather than spatial dynamics.
- Two of the new sites established in the greater Exmouth Gulf area during 2024 were resurveyed.
- Opportunistic data on coral bleaching were collected across all sites in both Ningaloo Marine Park and Exmouth Gulf, following the onset of the 2024-25 marine heatwave event.
- Two manuscripts examining the characteristics of tropical algae and the role of sea water temperatures in driving changes in tropical algal structure are currently in preparation.

Management Implications

- As recruitment regulates recovery of fish stocks following climatic disturbance and recreational fishing, understanding of recruitment dynamics along the Ningaloo reef is important to consider in future recovery planning.

- Outcomes highlight the importance of considering macroalgal fields in the management of tropical reef ecosystems.
- Surveys of macroalgal and fish recruitment in Exmouth Gulf are providing key baseline information for marine park planning.
- Data on coral bleaching collected during 2025 survey provided important information on the extent and impacts of the 2024-25 marine heatwave event, which has been used for ministerial and public briefings.

Future Directions

- The project will continue to expand into Exmouth Gulf.
- Additional coral bleaching surveys will be conducted at the long-term study sites to provide invaluable information on heatwave impacts and any future recovery.
- The project will expand to examine the role of tropical macroalgae in carbon sequestration.



Understanding movements and identifying important habitats of sea turtles in Western Australia

SP-2013-2

S Whiting, S Fossette-Halot, T Tucker

Context

This project uses satellite telemetry to track rehabilitated turtles that are released to the wild with minimal and extensive rehabilitation. In addition, turtles are tracked to identify connectivity between different habitats in their life stages. Commonly, turtles are tracked from nesting beaches to identify habitat, migration routes and foraging grounds. The tracking results identify the geographic range and preferred habitats and provide insight into the viability and survivorship of healthy and rehabilitated turtles in the wild. The identification of preferred habitat allows pressures to be identified and prioritised for different size classes. Broadcasting live tracking data on the internet provides a direct link between the department's science activities and the community. The genetic information derived from samples collected routinely across a range of projects, will provide another layer of information that helps to describe the spatial range of sea turtles in Western Australia.

Aims

- Determine the distribution and movement of sea turtles and investigate how components of sea turtle biology (including genetics) influence turtle distribution, preferred sites, movement and foraging ranges.
- Investigate how environmental drivers, such as oceanographic factors, influence turtle distribution, preferred sites, movement and foraging ranges.
- Investigate the viability and survivorship of rehabilitated turtles.
- Investigate connectivity of turtles between habitats across their life stages.

Progress

- A paper was published in *Ecosphere* examining the tracks of over 280 turtles collated from multiple research partners. These data are now being reanalysed to answer more specific questions on male movements and detailed connections between rookeries and foraging grounds.
- Turtle tracks are published on www.seaturtle.org, where they can be viewed by the general public and stakeholders.
- Information gained from this project continues to improve understanding about sea turtle biology, distribution and behaviour, which assists in developing management strategies for this species.

Management Implications

- Results are informing the definition of boundaries of Biologically Important Areas for flatback turtles in Western Australia.
- Flatback turtle tracking data in Yawuru Nagulagun Roebuck Bay Marine Park is informing park management and port development planning.
- Identification of important flatback turtle foraging areas enables spatially targeted mitigation of threats and pressures.

Future Directions

- Investigate movements and distribution of male flatback turtles and describe mating areas.

- Investigate movements and distributions of juvenile flatback turtles in Roebuck Bay.
- Evaluate how seasonal environmental drivers influence flatback turtle distribution and foraging ecology.
- Determine connectivity of turtles between nesting beaches and foraging grounds using tracking and stable isotopes data.
- Continue to track other species of rehabilitated turtles to increase knowledge of their distribution and habitat.



Marine monitoring program

SP-2012-8

T Holmes, R Evans, T Shalders, C Ross, S Strydom, K Murray, W Robbins, J Goetze, K Crook, K Carter, I Leal, H Raudino

Context

A statewide system of marine protected areas has been established and periodically expanded in Western Australian State waters and contributes to Australia's National Representative System of Marine Protected Areas. Long-term monitoring of the condition of ecological and cultural values and the pressures acting on them is an integral aspect of adaptive management. The department's marine monitoring program is a long-term monitoring, evaluation and reporting program that is designed to increase the efficiency and effectiveness of marine reserve and threatened marine fauna conservation and management throughout Western Australian waters.

Aims

- Long-term monitoring of key ecological values and the pressures acting on them in Western Australia's marine parks and reserves.
- Long-term monitoring of threatened and protected marine fauna and the pressures acting on them in State waters.
- Report results and findings of the monitoring program to departmental managers, joint management partners, the Conservation and Parks Commission, public, peers and other stakeholders to facilitate effective management and conservation of Western Australia's marine values.
- Continually evaluate and review monitoring and reporting programs to ensure that best practice science is adopted and that communication methods are appropriate for the intended target audiences.

Progress

- Updated monitoring data were collected by DBCA and collaborators for fish, coral, seagrass, mangroves, macroalgae, subtidal invertebrates, little penguins, intertidal invertebrates, dugongs, seals, sea lions and water quality from 15 marine reserves from Walpole and Nornalup Inlets Marine Park in the south to North Kimberley Marine Park in the north.
- Updated results and findings from the monitoring program were communicated to managers via the annual Marine Park Performance Assessment process, written advice and opportunistic presentations. This information included more detailed management advice and data interpretation for Jurien Bay and Lalang Gaddam Marine Parks.
- Six scientific papers incorporating departmental monitoring data or examining developments in monitoring methodologies and indicators were published in *Science of the Total Environment*, *Landscape Ecology*, *Estuarine and Coastal Shelf Science* (x2), *Limnology and Oceanography: Methods* and *Marine Environmental Research*.
- Scientific advice was provided for planning of the South Coast, Marmion and Exmouth Gulf marine parks through internal planning discussions, risk assessments, management plan revisions and South Coast community engagement fora.
- Conducted marine monitoring prioritisation workshops with Yawuru, Bardi Jawi, Mayala, Balanggarra, Nyangumarta and Dambeemangarddee traditional owners.

Management Implications

- The marine monitoring program provides data that inform evidence-based adaptive management of Western Australia's marine parks and reserves and threatened and specially protected marine fauna.
- Monitoring data describing key ecological values and the pressures acting on them guide adaptive marine park management responses. Performance assessment and adaptive management allow conservation managers to respond appropriately to changes as they become apparent and refine approaches to managing ecological values.

Future Directions

- Continue development of the online monitoring dashboard application.
- Continue and periodically review ecological value monitoring across the marine reserve system, including planning and prioritising of monitoring activities in the South Coast and proposed Exmouth Gulf marine reserves.
- Develop of new long-term monitoring programs in the Kimberley, including for seagrass and water quality.
- Continue science support and build capacity for Traditional Owner-led dugong monitoring in the Kimberley.



Northwest Shelf Flatback Turtle Conservation Program

CF-2011-118

S Whiting, S Fossette-Halot, T Tucker

Context

The Northwest Shelf Flatback Turtle Conservation Program (NWSFTCP) is one of four additional environmental undertakings for the Gorgon Gas project at Barrow Island. The purpose of the program is to increase the conservation and protection of the Northwest Shelf flatback turtle population through surveying, monitoring and research, reducing interference to key breeding and feeding locations and establishing information and education programs. This project coordinates the planning and implementation of works required for the NWSFTCP and coordinates general research and monitoring of marine turtles in Western Australia. The NWSFTCP has governance arrangements that include an advisory committee and a scientific panel.

Aims

- Implement the scientific management and communication strategies of the NWSFTCP Strategic Plan.

Progress

- Two meetings of the NWSFTCP Advisory Committee were held during the last 12 months to consider the annual report and next years' budget.
- Research continued on foraging and resident flatback turtles in Roebuck Bay in close collaboration with Yawuru Traditional Owners.
- Index nesting beaches continued to be monitored at Thevenard Island, Delambre Island, Eco Beach and Cape Domett.
- The NWSFTCP website was replaced, increasing accessibility to information and project material.
- Multiple education activities were completed across schools, AQWA and special events, increasing awareness about marine turtle conservation.
- Fox control actions were continued at Mundabullangana Station and progressed at Onslow, while actions on artificial light and coastal stability were continued at Port Hedland.
- Aboriginal engagement activities continued, including employment, community and school on-Country visits and research collaboration at several sites.

Management Implications

- Research results from this program helped to identify and define Biologically Important Areas for flatback turtles in Western Australia, which will assist in advice for development approvals and management decisions.
- Information from this program informs management decisions and actions relating to: artificial light and erosion issues at Port Hedland, fox control at Mundabullangana Station and Onslow and driving on beaches at Broome. Recent collaborations are helping to shape how light manufacturers design wildlife friendly lights and how coastal councils can adopt best practice solutions for turtle conservation.

Future Directions

- A new Strategic Conservation Plan will be finalised.
- A monitoring plan will be developed, taking into account the outcomes of analyses of long-term monitoring data.

- Research will focus on key fundamental knowledge gaps and projects to improve understanding of threats.
- On-ground actions to mitigate threats will be based on risk assessment.
- Communication and education will continue to influence better conservation outcomes and encourage local involvement in the program.



Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park

SP-2009-13

I Leal, O Luiz Junior

Context

Walpole and Nornalup Inlets Marine Park (WNIMP) was created in 2009 to include the entrance channel, Walpole and Nornalup inlet basins and the tidal extent of the Frankland, Deep and Walpole rivers. Invertebrates are recognised as a significant ecological value of the marine park and a key performance indicator (KPI) of management effectiveness. Additionally, benthic invertebrates are a key food source for a range of fish species in WNIMP. The benthic invertebrate community of the inlets was initially described from surveys conducted in 1984 and 1987. The fauna was relatively diverse compared with most estuaries in the south-west of Western Australia because of the predominantly marine conditions that are sustained in the inlets. Few subsequent studies have examined this fauna and knowledge of benthic invertebrates in the system was considered to be inadequate for marine reserve management. Furthermore, as there are strong recreational fishing values associated with the region, understanding trophic links between benthic invertebrates and fish in the estuary is important for management of the marine park.

Aims

- Determine spatial patterns and temporal variation in the WNIMP benthic invertebrate community.
- Develop long-term monitoring methods for benthic invertebrates in WNIMP and more broadly across temperate estuarine marine protected areas.
- Determine whether there are spatial and temporal differences in community structure (species composition, abundance and age class) in WNIMP.

Progress

- In collaboration with Edith Cowan University (ECU), benthic habitats were resurveyed in the inlets to produce a current habitat map of the marine park following a noticeable and significant expansion of seagrass meadows in the southern reaches of Nornalup Inlet. Imagery is currently being processed.
- The condition of bivalve communities was reported as part of the annual Marine Park Performance Assessment process.
- A paper describing the drivers of benthic invertebrate diversity in Walpole-Nornalup Estuary was published in *Biodiversity and Conservation*.

Management Implications

- This project aligns with the management plan strategic goal to monitor key ecological values at risk and human usage to provide a basis to adapt and improve management of the marine park.
- Project outputs contribute to annual marine park performance assessments by addressing one of the Key Performance Indicators for WNIMP, the condition of benthic invertebrate communities.
- Project outputs inform where areas of high diversity are located in the marine park, informing targeted management actions to reduce pressures on these communities (such as, fishing and anchoring).

Future Directions

- Two publications associated with the long-term dataset collected in collaboration with ECU will be progressed and finalised. The first of these will evaluate the effects of ephemeral seagrasses in the recovery of bivalve stocks and the second will describe the functional habitats in WNIMP.
- Future sampling of infaunal communities in the marine park will revert to every 2-3 years and become incorporated into DBCA's long-term monitoring program.



Spatial and temporal patterns in the structure of intertidal reef communities in the marine parks of south-western Australia

SP-2009-2

I Leal, O Luiz Junior, T Shalders

Context

Jurien Bay Marine Park (JBMP), Marmion Marine Park (MMP) and Shoalwater Islands Marine Park (SIMP) are located off the Turquoise and Perth metropolitan coasts, while Ngari Capes Marine Park (NCMP) is in Western Australia's south-west. These marine parks support a diverse range of marine conservation values ranging from various marine habitats to threatened marine fauna and are dominated by sub-tidal and emergent limestone reefs and shallow sandy embayments. The marine parks are subject to high levels of recreational and commercial human activity due to their proximity to population centres. Significant areas of intertidal reef platform occur on mainland and island shores and as isolated offshore patch reefs. While a number of local studies of intertidal communities provide a significant regional knowledge base, the broad spatial patterns of intertidal biodiversity across JBMP, MMP, SIMP and NCMP are not adequately understood. Particular gaps exist in our knowledge of the intertidal communities of offshore platform reefs. This study will determine spatial and temporal patterns in the distribution of intertidal reef organisms in Western Australia's temperate marine reserves. Relationships between the composition of these communities and the physical structure and location of the reefs will also be examined.

Aims

- Determine spatial and temporal patterns in the composition of intertidal reef communities in JBMP, MMP, SIMP and NCMP, including the proposed northern extension to MMP.
- Determine if the intertidal reef communities in management zones protected from extractive activities differ from the intertidal reef communities of otherwise comparable reefs.
- Develop methods for long-term monitoring of intertidal communities in temperate marine reserves.

Progress

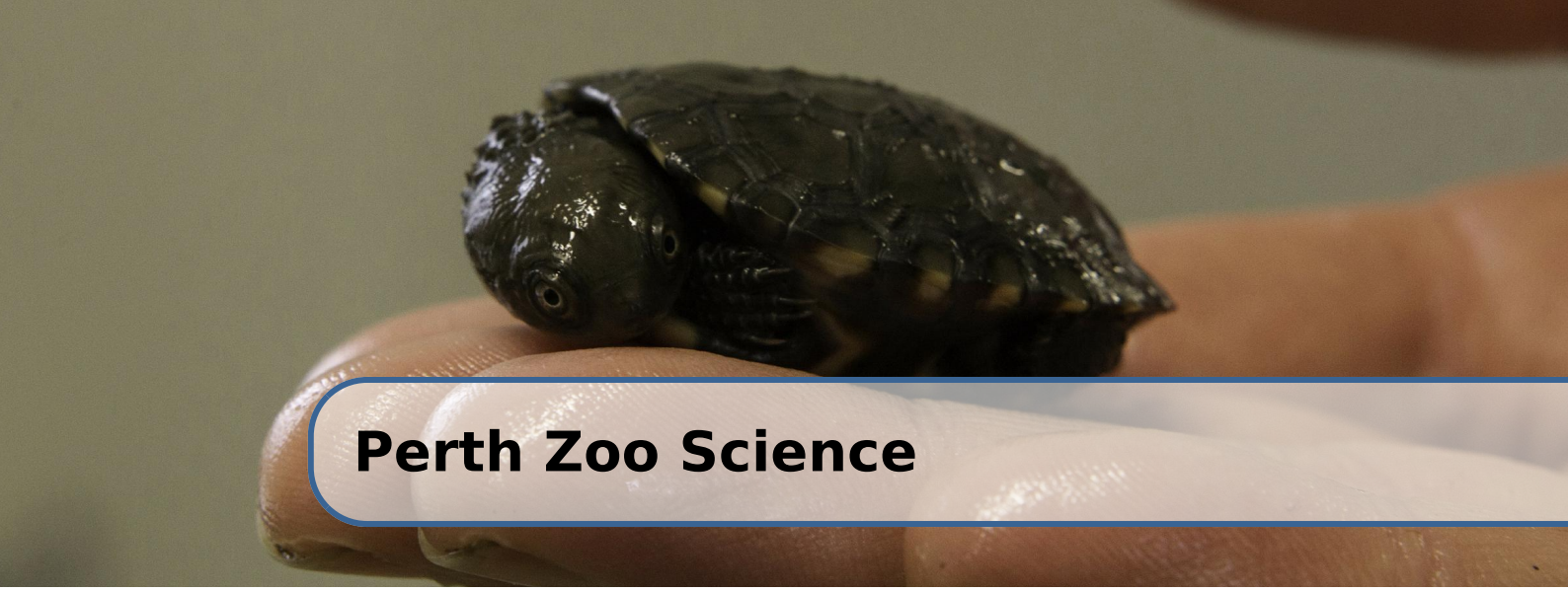
- Intertidal surveys were conducted in the Marmion Marine Park and Ngari Capes Marine Park in collaboration with volunteers and University of Western Australia researchers. Historical survey data from these marine parks have been analysed with contemporary data from this project.
- A Standard Operating Procedure for monitoring intertidal reef communities was finalised.
- Two Masters' students completed their theses relating to the spatial ecology and non-pelagic larval development of *Campanile symbolicum* in the intertidal reefs in Ngari Capes Marine Park. Two manuscripts from these theses are in preparation.

Management Implications

- This project aligns with the management plan strategic goal to monitor key ecological values at risk and human usage to provide a basis to adapt and improve management of the marine park.
- Project outputs contribute to annual Marine Park performance assessments by addressing one of the Key Performance Indicators for JBMP, MMP, SIMP and NCMP, the condition of intertidal reef communities.
- Project outputs inform where areas of high diversity are located, informing targeted management actions to reduce pressures on these communities (such as, fishing and trampling).

Future Directions

- Intertidal reef surveys are planned for Jurien Bay Marine Park and Shoalwater Islands Marine Park.
- Targeted project investigating how offshore reefs in marine parks are refuges to marine intertidal life is underway and will collate all data to date to inform on areas of high diversity within temperate marine parks.



Perth Zoo Science

Program Leader: Harriet Mills

Perth Zoo Science Program undertakes targeted research to support the breed-for-release of seven threatened species. It also addresses knowledge gaps in our understanding of behaviour, reproductive biology and conservation medicine for the species in the Zoo's collection and smaller number of species in the wild. The research program involves projects dealing with environmental communication and socio-ecology.



Anstisia frog breed and rear for release program

SP-2018-102

H Mills

Context

Two species of *Anstisia* (formerly *Geocrinia*) frogs, white-bellied frogs (*Anstisia alba)* and orange-bellied frogs (*A. vitellina)*, have restricted distributions in south-west Western Australia and are listed as critically endangered and vulnerable, respectively. Whilst these frogs lay large clutches of eggs, the survival rate to adult frogs is low. Captive rearing of eggs to metamorphs is an effective means of overcoming this constraint and providing supplementation of animals into the populations. Egg clutches of both species are collected from the wild and metamorphs are raised and subsequently released to the wild. Additionally, there is ongoing research and husbandry management to achieve regular and reliable captive breeding in both species.

Aims

- Breed and rear white-bellied and orange-bellied frogs for release to sites to maintain or increase the current extent and viability of populations of these species.

Progress

- 120 white-bellied frogs were reared and released into wild habitat south of Margaret River.
- The head-starting program for orange-bellied frogs is on hold while suitable new release sites are identified.
- Six egg nests from white-bellied frogs were collected from the wild and three nests were laid at Perth Zoo.
- Sixty-four juvenile frogs were produced and will be released in spring 2025.

Management Implications

- The husbandry protocols that have been developed over the last few years are working well, with another cohort of captive-bred frogs being produced. This gives confidence that Anstisia frogs can be bred at Perth Zoo to supplement wild populations in accordance with actions of the recovery plan.

Future Directions

- Continue to rear and breed juvenile frogs for release to supplement the threatened populations.
- Collect samples for genetic analysis of *in situ* and *ex situ* populations to inform future management.



Behavioural observations of Perth Zoo collection animals for animal welfare purposes and establishment of baseline data

CF-2018-115

E Polla

Context

Maintaining or improving animal welfare is a key consideration in operations at Perth Zoo and behavioural observations of collection animals ensures effective management approaches. Many observational studies conducted on Perth Zoo collection animals in the past have provided staff with insight into animal behaviour and generated recommendations on how to improve quality of life through specific enrichment, modifications to enclosures or husbandry practices, as well as data to allow comparisons to be made for individual animals over time.

Aims

- Determine what behaviours are exhibited by certain individuals or species of Perth Zoo's animal collection and at what frequency.
- Compare current data with past studies to see if animal behaviour has changed over time.
- Observe the effects of the current behavioural enrichment programs on behaviour in Perth Zoo's collection animals.
- Observe the effects of Perth Zoo visitors on the behaviour of Perth Zoo's collection animals.

Progress

- Social interactions of co-housed numbats were observed.
- Emus' behaviour was monitored during nearby construction.
- Feathertail glider observations improved understanding of their activity patterns.
- General behaviour and food choice in relation to beak growth of female Baudin’s cockatoos was monitored.
- A male Baudin’s cockatoo has been monitored in relation to his individual behaviours and social interactions.
- Lions' interactions with visitors through viewing windows was monitored.
- Animal interactions, including between turtles, lizards and fish, were monitored in the mixed species billabong exhibit.
- Review off CCTV footage of the estuarine crocodile provided an informed understanding of his diurnal and nocturnal behaviours.

Management Implications

- Baseline data and observations are necessary for monitoring the welfare outcomes for all species in Perth Zoo.
- Empirical behavioural data gathered through this project allow Perth Zoo staff to make informed decisions about animal welfare changes as animals age and respond to new or altered dietary regimes, monitor animals during introductions of new exhibit mates or breeding animals, validate the benefits of enrichment programs, quantify animal use of exhibits before and after redesign and measure visitor interaction with exhibited animals

Future Directions

- Use the data to recommend animal welfare improvements.
- Provide empirical data to support accreditation processes for a broader range of species.



Numbat breed for release program

CF-2018-98

H Mills

Context

Numbats (*Myrmecobius fasciatus*) are listed as endangered and occur in only two natural populations at very low densities. Establishing new populations entirely with wild caught numbats is not feasible and captive breeding provides a source of animals for supplementation of wild populations and establishment of new populations. A captive breeding program for numbats at Perth Zoo has been in place since 1992. Captive bred numbats have enabled new populations to be established at Boyagin Nature Reserve, Batalling Forest and fenced reserves at Dryandra National Park, Mount Gibson Sanctuary in Western Australia, Yookamurra Sanctuary and Secret Rocks Mallee Refuge (South Australia), and Scotia Sanctuary and Mallee Cliffs National Park (New South Wales).

Aims

- Produce yearling numbats in sufficient quantity to support proposed reintroductions to wild sites.

Progress

- A further thirteen numbats were transferred from Perth Zoo for release at Mallee Refuge (Secret Rocks) in South Australia.
- In the 2025 breeding season, seven pouch young were produced.
- Numbats at Perth Zoo were fitted with accelerometers and filmed as part of a University of NSW PhD research project to investigate the impacts of heat.
- Samples were provided to several researchers for eDNA testing (hair, air and substrate) and disease investigation.
- Contributed to a chapter on numbat biology and captive breeding in a major reference text on Australian mammals.

Management Implications

- The breeding program continues to produce numbats to supplement existing populations and to establish new populations across the former range.
- Numbats at Perth Zoo continue to provide opportunities for research to inform conservation management and recovery.

Future Directions

- Maintain the breeding colony at 5-6 pairs to provide numbats for translocations.
- Continue to engage with students and researchers on projects to improve the conservation status of the species.



Western ground parrot husbandry

SP-2018-137

H Mills

Context

The western ground parrot (*Pezoporus flaviventris*) is listed as critically endangered and is now restricted to a single population around Cape Arid. Less than 150 birds remain in the wild and these are threatened by foxes and feral cats. Habitat critical to the species' survival has been threatened by extensive bushfires in recent years. In July 2014, seven western ground parrots were transferred from departmental aviary

facilities near Albany to Perth Zoo in a successful attempt to establish a captive insurance population and to investigate the potential for future breeding for release.

Aims

- To determine if the western ground parrot can successfully breed in captivity.
- To develop and document captive breeding techniques that maximise reproductive output for western ground parrots, while also taking the opportunity to learn as much as possible about the biology and behaviour of the species.

Progress

- Perth Zoo continued attempts to breed western ground parrots.
- During the 2024 breeding season, two pairs produced clutches of eggs, but none hatched. Research into how to improve breeding outcomes for this species is continuing.

Management Implications

- Relatively little is known about this highly cryptic species and any information collected is valuable to those working with the species in the field and for recovery planning.

Future Directions

- Perth Zoo will continue to attempt to breed this species in captivity, building on information gathered from previous attempts and collaborating with experts for advice.
- Research will continue to better understand the fertility of the captive birds and to optimise their health through adjustments to factors such as diet and UV exposure.



Western swamp tortoise breed for release program

CF-2018-101

H Mills

Context

Western swamp tortoises (*Pseudemydura umbrina*) are listed as critically endangered and occur in only two natural populations at very low numbers. Establishing new populations entirely with wild caught tortoises is not feasible and captive breeding provides a source of animals for supplementation of wild populations and establishment of new populations. Captive bred tortoises have enabled new populations to be established at Moore River Nature Reserve and Mogumber Nature Reserve, with trial assisted colonisation sites on the south-west coast of Western Australia. Two additional captive insurance populations have been established at Adelaide Zoo and Monarto Zoo (South Australia).

Aims

- Produce a minimum of 30 hatchling tortoises (>30 days of age) each year for release into wild sites.

Progress

- 20 western swamp tortoises were released to Moore River National Park.
- 39 tortoise hatchlings were produced in the 2024-25 breeding season.
- Research continued to quantify the impact of incubation method (artificial incubation or ground nest incubation) on hatching success and locomotory performance.
- Student projects also investigated survival rates after translocation, temperature dependent sex determination and the prevalence of shell pyramiding.

Management Implications

- Research into incubation methods over the 2023 and 2024 breeding seasons suggested that there were no significant differences in hatching success or fitness of hatchlings between eggs incubated in the ground versus artificially. However, lower hatching success of ground nests in 2025 suggests that artificial incubation continues to be the best strategy.

Future Directions

- Depending on whether egg translocations occur in late 2025, breeding plans will be adjusted to manage the size of the captive population.
- Continued collaboration with DBCA staff on providing samples for genetic analysis and using the results to manage the studbook for maximum genetic diversity of offspring.
- Collaboration with students to investigate the feasibility of egg translocations.



Plant Science and Herbarium

Program Leader: Carl Gosper

Applied flora conservation research seeks to understand the factors and processes that are critical for the conservation of Western Australia's native plant diversity. Major objectives include ensuring the persistence of rare and threatened species, understanding key threats such as Phytophthora dieback and weeds, and improving the understanding of genetic and ecological factors that are vital for the long-term viability of plant species. Strong collaborative linkages exist with universities, cooperative research centres, CSIRO, other research providers such as the National Environmental Science Program and the corporate sector. The program includes the Western Australian Herbarium that houses the State collection of scientific specimens of plants, algae and fungi. Information in the collection underpins the conservation of Western Australian flora. The Herbarium is responsible for: documenting and understanding the diversity of Western Australia's plants, algae and fungi; maintaining a research and archive collection of specimens of all species in these groups from throughout their range in Western Australia; helping the community, industry and researchers understand and identify plants, algae and fungi; contributing to, supporting and servicing the research, conservation and decision-making activities of government; contributing to taxonomic research by the Australian and the international scientific community; providing authoritative information to government, industry and the community via the FloraBase website and the Herbarium's information management systems.



Dieback detector dogs

SP-2025-8

S Harshani, C Gosper, K Ireland

Context

Phytophthora dieback caused by the plant pathogen *Phytophthora cinnamomi* is the greatest disease threat to flora in the south-west of Western Australia. More than 40 per cent of the native species in the region are likely to be susceptible to the pathogen. Due to the permanent and irreversible damage that the disease causes, it is considered a key threatening process to Australian biodiversity. Currently, there is no cure for Phytophthora dieback and only the spread of the disease can be controlled. Accurate and early detection along with mapping the disease occurrence is essential for effective disease management. Existing mapping and diagnostic methods are costly, time-consuming and labour intensive. This project will evaluate the feasibility of using detector dogs to detect Phytophthora dieback. The primary aim is to assess the effectiveness of detector dogs under a range of laboratory and field conditions and determine their key applications in on-ground disease management.

Aims

- Assess the sensitivity and precision of detector dogs in detecting *P. cinnamomi* in laboratory soil samples and how the age of the soil samples from the date collected impacts a dog’s detection ability.

- Investigate the potential use of detector dogs for mapping disease fronts in dieback infested field sites.
- Evaluate whether detector dogs can assist in mapping areas that are 'uninterpretable' to dieback interpreters due to the lack of susceptible plants.
- Test the ability of detector dogs to identify the disease boundary in recently burnt forest sites affected by Phytophthora dieback.
- Assess the ability of detector dogs to detect Phytophthora dieback occurrence in threatened species translocation sites.
- Evaluate the potential use of detector dogs in minimising disease spread during mining activities by inspecting machinery and soil stockpiles.

Progress

- Detection dogs surveyed seven existing and two proposed *Grevillea calliantha* translocation sites near Cataby.
- The dogs made no indications in three translocation sites and two proposed translocation sites suggesting that they are Phytophthora dieback free.
- In the remaining sites, dogs made several indications and soil samples were collected from those locations.
- Laboratory testing of soil samples confirmed that *P. cinnamomi* is present in one translocation site.
- Two new WA dieback detector dogs are currently undergoing training with TATE Animal Training Enterprises in NSW.
- DBCA has selected two WA-based dog handlers through a competitive grant process.
- Training progress is promising, and the two dogs are expected to be handed over to the new handlers in next two months and will participate in upcoming science experiments.

Management Implications

Detector dogs have demonstrated the ability to detect *P. cinnamomi* in threatened flora translocation sites, indicating that they may provide an alternative approach to determining the dieback status of these locations.

Future Directions

- Using detector dogs to assess the dieback status of six translocation sites in the Fitz-Stirlings Threatened Species Action Plan Priority Place.
- Using detector dogs to inspect machinery and soil stockpiles at Premier Coal, Collie and Newmont Gold, Boddington mine sites.
- Laboratory experiments on detector dog sensitivity and precision, along with field experiments to map disease boundaries near Dwellingup.



Eco-physiological and ecological approaches to climate adaptation in threatened flora and ecological communities

SP-2024-34

L Xian, N Delnevo, J Picknoll, L Van Der Weyde, C Gosper

Context

There is a paucity of climate adaptation research specific to the unique environments and flora of Western Australia (WA). The Climate Adaptation Initiative is a program that aims to address WA-specific climate adaptation knowledge gaps, including better understanding the vulnerability of threatened species and ecological communities to climate change and their capacity to adapt to it. Strategies to build resilience to climate change and, accordingly, to inform on-ground management actions, will be investigated and trialed.

Impacts of climate change on plant species often occur through effects on the physiological function of plants, in particular, a plant’s ability to maintain normal function under drought stress. The physiological tolerances and differential capacities of species are one factor mediating species' persistence and competitive performance, which can be measured through analysis of leaf function and reflected in changes in plant health, mortality and distribution.

Aims

- Evaluate the effectiveness of strategies that lessen plant stress and improve survival such as water supplementation, reduction of evaporation and shade protection.

- Determine if resilience to climate stress can be increased through physiological improvements, with a focus on the availability of potassium and its role in drought tolerance.
- Determine threatened species distribution and plant performance in the context of climate and environment, such as on north and south facing aspects, by integrating remote sensing approaches and plant physiology.
- Quantify shifts in species distribution, patterns of community assembly and the extent and specificity of plant mortality in response to climate drivers.

Progress

- A glasshouse experiment was conducted, focusing on *Banksia attenuata, B. ilicifolia* and *B. prionotes*, subjecting plants to varying levels of potassium through soil and foliar applications. Detailed physiological assessments have been conducted to detect if and how tolerance to drought has improved, as well as identify potential adverse effects from elevated potassium levels.
- A field survey of *Banksia solandri* in Stirling Range National Park was conducted to collect comprehensive data on its occurrence on northern and southern slopes.
- Survey plots were established at three locations to monitor *Caladenia graniticola* populations. Individuals that emerged in 2024 were marked to track their reappearance and persistence over time.
- Data on drought-induced mortality in proteaceous shrublands have been included in a global database of high-resolution orthoimagery documenting canopy mortality, with a manuscript to launch this database under review.

Management Implications

- Improved understanding of flora physiological function under climate stress and ecological outcomes from extreme climate events will inform climate change threat mitigation actions and deliver improved climate resilience and adaptive capacity.

Future Directions

- Continue implementation of experimental manipulations of potassium and water availability.
- Establish field trials with potassium to evaluate effectiveness *in situ* and assess the impact on vegetation.
- Refine species distribution models for *Banksia solandri* to guide and select future survey locations.
- Identify and establish sites incorporating north and south facing aspects, for detailed physiological assessment of *Banksia solandri*.
- Implement supplemental watering of *Caladenia graniticola* and continue annual monitoring of emergence.



Molecular approaches to climate adaptation in threatened flora and ecological communities

SP-2024-35

N Delnevo, S Bailey, L Xian, L Van Der Weyde, R Binks

Context

There is a paucity of climate adaptation research specific to the unique environments and flora of Western Australia (WA). The Climate Adaptation Initiative is a program that aims to address WA-specific climate adaptation knowledge gaps, including better understanding the vulnerability of threatened species and ecological communities to climate change and their capacity to adapt to it. Strategies to build resilience to climate change and, accordingly, inform on-ground management actions will be investigated and trialled.

Recent advancements in sequencing technologies and computational and statistical power have enabled new research to generate critical insights for the future preservation of biodiversity, from fitness to gene expression and adaptation. This project aims to integrate molecular and experimental studies to inform climate mitigation strategies to maximise long-term persistence of populations, species, and ecological communities by enhancing their adaptive capacity to cope with future climatic conditions.

Aims

- Determine whether a carefully designed mixing of geographically isolated populations can boost standing genetic variation and enhance their capacity for long-term persistence.
- Evaluate whether the introduction of genes from populations separated by large geographic gaps and experiencing differing climatic conditions can introduce adaptive alleles from the drier end of species'

distribution.
- Assess the effectiveness of genetic strategies designed to facilitate adaptation to projected climatic conditions for populations expected to experience a steeper decline.

Progress

- Sampling across the entire distribution range of the two widespread keystone species *Banksia menziesii* and *B. ilicifolia* has been completed. Genomic DNA was extracted from the over 1000 samples collected.
- Seed of the threatened short-range endemic *Conospermum undulatum* collected after the 2024 flowering season were scored for viability and are now ready for germination.
- A field survey of *Banksia solandri* in Stirling Range National Park was conducted to collect comprehensive data on its distribution to examine the occurrence on both northern and southern aspects. Samples were collected from leaf tissue to conduct genomic investigations on fine-scale local adaptation to climate.
- Initial analysis of genomic data on disjunct populations of *Andersonia echinocephala* and *Gastrolobium crenulatum* were conducted.

Management Implications

- Improved understanding of local adaptation to climate, genetic clustering and diversity within threatened flora and ecological communities will directly inform the development of practical, science-based guidelines.
- These insights will support the implementation of genetic-based adaptation strategies, such as targeted population mixing and genetic rescue, to enhance the resilience and long-term viability of vulnerable species and communities under changing climatic conditions.

Future Directions

- Conduct detailed analyses of genotyping-by-sequencing (GBS) data, including Genotype–Environment Association (GEA) analyses, to identify genomic signatures of local adaptation.
- Complement genomic investigations with common garden and glasshouse experiments (where feasible) to assess plant responses to manipulated climate variables such as temperature and precipitation.
- Implement integrated genomic and experimental approaches to determine the climate tolerance thresholds and climate envelopes of selected threatened species.
- Undertake manual pollination experiments to assess heterosis or potential outbreeding depression in geographically isolated populations, enhancing understanding of reproductive compatibility and genetic rescue potential.
- Continue strategic sampling of selected threatened species to improve resolution of their genetic diversity and population structure across their distribution ranges.



A digital Flora of Western Australia – a guide to the State's botanical species diversity

SP-2023-17

J Wege, K Shepherd, C Wilkins, K Downes, B Richardson

Context

Western Australia has an evolutionarily remarkable flora that is not only the richest and most diverse of any Australian State but is of immense global scientific interest. There are more than 13,000 native and introduced plant species, many of which are threatened or otherwise significant for conservation management, and new species are regularly discovered through surveys, taxonomic assessment of herbarium collections and phylogenetic studies. Although new Western Australian plant species continue to be described at globally significant rates, the State lacks an overarching Flora with up-to-date descriptive, distributional and ecological data for all species and associated images and identification guides. Descriptive data and keys are currently held across disparate sources including historical literature, out-of-print field guides and a broad range of journals. For many species, no up-to-date or accessible description exists.

Aims

- Develop an approach for producing a digital Flora of Western Australia.
- Develop best-practice workflows for online delivery of high-quality taxonomic content through pilot projects on Myrtaceae and Stylidiaceae, groups for which taxonomic content is actively being prepared for the Flora of Australia and additional plant groups as capacity allows.

- Plan updates to IT infrastructure that will enable taxonomic content on the WA flora to be seamlessly delivered to stakeholders.

Progress

- Mobilisation of Myrtaceae knowledge continued apace. Nine novel taxa in *Thryptomene* were published in *Nuytsia* and a synthesis of the genus (54 species plus 3 phrase-named taxa) published in *Flora of Australia* along with treatments of *Malleostemon* (14 species) and *Micromyrtus* (50 species).
- A Flora treatment of Stylidiaceae was advanced, with a focus on taxa occurring in northern Australia and curation of associated specimens.
- Workflows established for the delivery of Flora content on Myrtaceae have been updated and adapted for a new project on Malvaceae tribe Lasiopetaleae. Taxonomic research on this tribe has been progressed, including clarification of generic boundaries.

Management Implications

By improving access to information on Western Australia's flora, this project will enhance the accuracy and efficiency of plant identifications, including rarities, novelties and environmental weeds, assist research projects across a broad range of disciplines and improve conservation outcomes.

Future Directions

- Compile taxonomic treatments of select genera for *Flora of Australia*, providing editorial assistance as required.
- Populate Imagebank with vouchered photographs.
- Document potential workflows and IT needs for a digital Flora of Western Australia.



Molecular characterisation of stinking passionflower (*Passiflora foetida*)

SP-2018-41

M Byrne

Context

Stinking passionflower (*Passiflora foetida*), a perennial vine native to South and Central America, is a highly invasive weed in the Pilbara and Kimberley regions of Western Australia and other parts of the world. In the Pilbara, the weed is rapidly expanding its abundance in areas with slightly higher moisture availability than the surrounding landscape, including coastal reserves and riparian habitats. Options for effective management of the weed in these areas are limited and biological control is being investigated as a potential management strategy in collaboration with CSIRO. Limited knowledge of the biology and life history of stinking passionflower is a significant impediment to implementing effective weed management strategies, including biological control. Ecological and genetic characterisation is required to understand the invasion ecology of the species and to guide the search for suitable biological control agents from the native range.

Aims

- Use molecular analysis of Australian collections in the context of samples from the native range and other regions and countries where *P. foetida* is introduced, to identify and characterise the genetic entity(ies) present in Australia.
- Elucidate whether there are multiple origins for the Pilbara invasions.
- Confirm the level of relatedness of the invasive *P. foetida* to *Passiflora* species native to Australia and to commercial varieties.
- Characterise Pilbara populations relative to less invasive populations to identify any signal of adaption.

Progress

- Genomic analysis of samples across the introduced range in Australia showed low diversity and confirmed the expansion of one of the introduced lineages from Ecuador across northern Australia from the location of introduction in Queensland.
- A manuscript on genetic diversity across the distribution has been prepared.
- Design of a whole genome sequence data approach to analysis of environmental adaptation has been undertaken with scientists from Monash University.

Management Implications

- Information on the potential taxonomic entities and origin of *P. foetida* in the Pilbara will inform the identification of, and guide the search for, putative control agents from the natural range.
- Information on local adaptation within invasive populations provides a basis for understanding the dynamics of invasion and determining the effectiveness of potential control agents.

Future Directions

- Finalise manuscript on the population genetic analysis of collections from the invaded range in Australia.
- Progress whole sequence analysis to determine environmental adaptation, considering the low diversity that has been found in populations in Australia.



Herbarium collections management

CF-2011-105

S James, J Huisman, S Coffey, M Hislop, K Sadgrove, C Parker, J Percy-Bower, S Sinha, R Gugiatti, S Patel, J Brown, K Benjamins

Context

The Western Australian Herbarium houses the State's botanical physical and digital collections, the core resource for knowledge of the State's plants, algae, fungi and slime moulds. The collection is growing constantly and consistently through accessions of specimens from internal and external sources. New taxa are documented as voucher specimens and digital records. The collections are maintained to the highest standard utilising international natural science collections and archival best practice and provide the department and the community with the fundamental resource that provides knowledge of the diversity, temporal and spatial distribution and abundance of the flora throughout Western Australia.

Aims

- Document and audit the diversity of Western Australia's plants, algae, fungi and slime moulds.
- Maintain in perpetuity, a comprehensive and representative research and reference collection of specimens of all taxa in groups occurring in and adjacent to, Western Australia.
- Contribute to, support and service the biodiversity research, conservation and decision-making activities of the department and stakeholders.
- Contribute to, support and service taxonomic and other research by the local, national and international scientific community.
- Provide digital resources enabling open access to the botanical collections (see CF-2011-110).

Progress

- The Western Australian Herbarium added 10,663 physical specimens to the collections, including 857 specimens of priority taxa, 153 specimens of threatened taxa and one specimen of presumed extinct taxa, increasing the size of the collection to 864,600 catalogued items representing more than 18,466 taxa. More than 60 new type specimens were added to the collection (9739 items).
- The Western Australian Herbarium shared specimens with five national and two international institutions and shipped 767 specimens in eight loans for scientific research. A total of 1176 exchange specimens were sent to collaborating institutions, and 18 requests for 235 tissue samples from herbarium specimens were processed for molecular and other scientific analyses.
- Major activities within the collections included a substantial and targeted reduction in unprocessed specimens, the incorporation of specimens returned to the Western Australian Herbarium from Manjimup DBCA (620 specimens), processing and incorporation of Herbarium Lowerianum (495 specimens), Bush Blitz expedition collections (552 specimens), M.D. Barrett collections (1111 specimens), and the TERN Ecosystem Research Infrastructure collections (362 specimens). The Herbarium also received specimens in the past year collected by ecologist David Goodall and students (est. 325 specimens, with a third processed to date), Curtin University Herbarium (formerly Western Australian Institute of Technology) (approx. 18,000 specimens), and the processing of dissected orchid flower cards collected by Western Australian Herbarium researchers (approx. 1200 cards with 524 processed to date).
- The rearrangement and expansion of the historical collection, containing specimens dating prior to 1896 (the year of the first official herbarium in the State) was initiated (currently 700 specimens).
- Specimens and their metadata were cited in more than 140 publications during the past year. The collection and associated data have been cited 3488 times since the early 1900s.

- A collection of Type photographs has been separated from the Type specimen collection (>2100 items) and data updated, providing greater capacity for the significant Type collection.
- Volunteer participation continues to be a significant and invaluable resource, totaling 5775 hours, equivalent to approximately 3.6 full time employees. The Herbarium was assisted by 23 regular volunteers and 28 Research Associates. With the assistance of volunteers, 5222 specimens were mounted on archival specimen sheets.
- The Reference Herbarium was accessed 2429 times by visitors, volunteers, students and industry consultants for plant identifications and other scientific purposes. Freezing services provided for the use of specimens in the Reference Herbarium by stakeholders increased by 13 per cent in the past year. The Research Collection was accessed 1286 times by visitors and stakeholders for the study and identification of botanical collections.
- The Herbarium Identification Service provided assistance to a range of clients, including departmental staff, other government agencies, environmental consultancies, regional herbaria and the public. More than 4176 specimen identifications in 484 transactions were completed. Verification of conservation listed populations for the Species and Communities Program and weeds for departmental management programs are also critical roles.
- Educational programs consisted of 18 herbarium tours and monthly induction sessions for departmental staff, tertiary institutions, environmental consultancies, community groups and the media (approx. 270 participants). The Herbarium also trained one University of Western Australia Work Integrated Learning intern in collections management skills.
- The Western Australian Herbarium Facebook page, with more than 7900 followers, shares a monthly 'Plant of the Month' and other interesting botanical announcements.
- The herbarium currently has an estimated 45,715 uncatalogued and unprocessed specimens dating back to 2015.
- Other herbarium collections activities include the creation and curation of digital data (CF-2011-110) and management of plant names (CF-2011-111).

Management Implications

- Maintenance and curation of the Western Australian Herbarium botanical collections provides an authoritative inventory of the biodiversity of Western Australia, which underpins flora conservation and State, national, and international biodiversity research programs.
- The collections are accessed continually by DBCA staff, consultants and policy makers to validate specimen records from biological surveys, environmental impact assessments, conservation status evaluation of native taxa, and for the documentation of of new and invasive species.
- Both the physical specimens and the curated data are heavily utilised resources for systematic and taxonomic research, collections management, environmental assessment, ecological and other scientific research, restoration and remediation projects, biosecurity management and planning, educational uses, cultural and historical studies, and citizen science.

Future Directions

- Continue to significantly reduce and make available the currently unprocessed and uncatalogued specimens in storage, particularly from the Pilbara region. Accept research quality specimens from DBCA, collaborating institutions, and stakeholder collection activities to continue to build a geographically and temporally diverse collection for Western Australia, and participate in federally funded Bush Blitz expeditions.
- Complete migration and training and implement the new collections management system (Specify), increasing the scope for the extended specimen initiative and improve efficiency in collections management and data delivery.
- Develop new workflows, including citizen science transcription projects, to process orphaned collections efficiently.



Taxonomy of selected families including legumes, grasses and lilies

SP-2011-1

T Macfarlane

Context

Successful conservation of flora requires that conservation units equate to properly defined, described and named taxa. There are numerous known and suspected unnamed taxa in the grass, legume and 'lily' (now

Asparagaceae and Hemerocallidaceae) families and numerous cases where keying problems or anomalous distributions indicate that taxonomic review is required. The main current focus is on *Thysanotus*, *Wurmbea*, *Caesia*, *Lomandra*, *Haemodorum*, *Amphipogon* and *Trithuria*, with collaborations in other groups.

Aims

- Identify plant groups for which taxonomic issues need to be resolved, including apparently new species to be described and unsatisfactory taxonomy that requires clarification.
- Carry out taxonomic revisions using field work, herbarium collections and laboratory work, resulting in published journal articles.

Progress

- A conservation genetics project on *Wurmbea dioica* is well advanced.
- *Thysanotus* fieldwork was undertaken, with one paper published and another manuscript (containing 2 new species) is in preparation.
- *Caesia* materials were collected from the field for future research.
- A paper on *Lomandra* was published in *Blumea*.
- A manuscript on *Haemodorum* with three new species was submitted.
- Two manuscripts on *Trithuria* with collaborators were submitted, contributing to understanding Angiosperm evolutionary relationships.
- Anarthriaceae: a revised Flora of Australia account is near submission; in the related Restionaceae a manuscript was submitted on understanding spikelet structure in *Leptocarpus*.
- Poaceae studies included published papers on *Cynodon* in WA (*Nuytsia)*, a multi-author international molecular phylogeny of the grass family and two conference presentations by collaborators on grass flower structure.
- Manuscripts in preparation include a new species of *Amphipogon* (drafted) and a collaborative paper on phosphorus nutrition in south-western native grasses.
- A review of genera in the *Pultenaea* group of legumes (Fabaceae) was published in *Australian Systematic Botany*.
- Collaborative papers on photosynthetic pathways in *Neurachne* (Poaceae) and *Tribulus* (Zygophyllaceae) were published in *Plant Physiology* and *Plant, Cell & Environment*, respectively.
- Contributed taxonomic, identification and scientific name advice on priority conservation species and surveyed poorly known species.

Management Implications

- Identification of species known or suspected to have restricted distributions enables re-assessment of conservation status and improved management effectiveness.
- Improved identification tools enable more effective and reliable identification of species and subsequent assessment of their conservation status.
- Better knowledge of plant relationships adds to the appreciation of the global significance of the Western Australian flora and facilitates its appropriate representation in a wide range of research.

Future Directions

- Finalise papers describing new species, especially in genera of Asparagaceae, Poaceae and Fabaceae.
- Continue revision of *Thysanotus* and *Wurmbea*.
- Finalise previous fieldwork on species or populations of insufficiently known species.
- Complete drafted Landscope articles about research on *Thysanotus* and *Wurmbea* for general audiences.



Taxonomy of undescribed taxa in the Ericaceae subfamily Styphelioideae, with an emphasis on those of conservation concern

SP-2011-15

M Hislop

Context

Recent phylogenetic studies have resulted in significant changes to the classification of the epacrids at the generic level. The circumscription of the genus *Styphelia* has now been expanded to include all taxa previously in *Astroloma*, *Coleanthera* and *Croninia*, and a large percentage of those in *Leucopogon.* A

recent publication formalising these changes has opened the way to the process of describing the many phrase name taxa of *Styphelia* (in the newly expanded sense) that are currently listed under *Leucopogon.* A significant number of these are short range endemics of conservation significance. In addition, there is still much taxonomic work remaining in *Leucopogon s. str.* and new taxa in all epacrid genera continue to come to light with some regularity.

Aims

- Publish new taxa from the tribes *Styphelieae* and *Oligarrheneae*, prioritising those of high conservation significance.
- Continue a taxonomic assessment of species boundaries across the tribe *Styphelieae* (mainly in *Leucopogon* and *Styphelia*) with a view to identifying previously unrecognised taxa, especially those that may be geographically restricted.

Progress

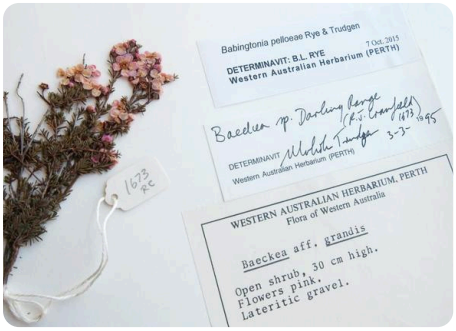
- Two papers were published in *Nuytsia.* One of these described six new species from the *Styphelia pendula* group (Ericaceae: Epacridoideae: Styphelieae), four of which are conservation-listed. The second short paper described a new, and probably rare species of *Leucopogon* (Ericaceae: Epacridoideae: Styphelieae) from the Great Southern Region of Western Australia.
- A short paper, in which a new species of *Brachyloma* and a new *Conostephium* are described, has been accepted by *Nuytsia*.

Management Implications

- Among the epacrids of Western Australia a high percentage of taxa have narrow and/or very sporadic distributions and are hence of conservation concern. Five of the seven new species described in the last year have a Priority flora classification.

Future Directions

The process of documenting the drupaceous epacrids continues with two further *Styphelia* papers nearing completion.



The Western Australian Herbarium specimen data and digitisation

CF-2011-110

S James, J Percy-Bower, S Coffey, S Sinha, R Gugiatti, R Gillen, S Patel, K Benjamins, R Craig, J Brown

Context

The Western Australian Herbarium collection management system (WAHerb) is critical to the management, maintenance, discovery and sharing of the Herbarium's botanical specimen metadata. It also allows for the transactional management of the collections (loans, exchange and sampling). WAHerb provides core data on the distribution, ecology, and other characteristics of taxa through time for the department and the community, through *Florabase* and other biodiversity data aggregators. Updated data from the collections database is provided to researchers, consultants and community members on request, and to the Australasian Virtual Herbarium (AVH), Atlas of Living Australia (ALA), Global Biodiversity Information Facility (GBIF) and Dandjoo (CF-2021-44) on a weekly basis. Digitisation of the herbarium collection also includes the systematic capture of images of the State botanical collections for use by the department and stakeholders.

Aims

- Capture, maintain and validate taxonomic, spatial, phenological, population and habitat data for the Herbarium botanical collections, enabling curation of the collection, and providing core data for biodiversity data providers and departmental decision support systems and science.
- Capture and maintain online images of botanical specimens, linked to the collection metadata.

Progress

- The Western Australian Herbarium added 10,663 specimen records in 2024-25.
- The metadata of more than 115,133 specimen records were edited ensuring the Herbarium collection and data are scientifically valid, accurate, up-to-date, and with current recognised and valid taxonomy. The data are aligned with the department's conservation designations.

- Through the AVH and ALA, 82.1 million herbarium data records were downloaded in more than 35,300 download events. The Western Australian Herbarium dataset is also available via GBIF (1.46 billion records in 40,600 download events) and through Dandjoo (numbers not recorded).
- The capture of high-resolution images of the entire research collection and online sharing with stakeholders (>110,000 images), with sensitive data redacted from relevant images, is ongoing. More than 78,100 high resolution images of Herbarium specimens were captured and a further 143 high resolution images of type specimens were delivered to the online JSTOR *Global Plants Initiative*. Specimen imaging also focused on the more than 3900 threatened and priority taxa in collections.
- Through an ALA Australian Biodiversity Data Mobilisation Program grant, more than 22,900 specimen images were captured, 620 specimens and metadata were added to the Herbarium collections and 23 naturalised taxa were added to the WA Plant Census (including nine new genera).
- Data cleaning and migration activities, including improving geocoordinates, identifying and linking agents (institutions, collectors and determiners), continues with the planned migration to the new collections management system (Specify) in spring-summer 2025-26.
- A collaboration with the Cambridge University Herbarium, supported through a Churchill Fellowship, has resulted in the online access of more than 3175 previously inaccessible historical specimens from Western Australia and more than 14,000 specimens valuable for Australian taxonomic research. A second collaboration with the California Botanic Garden Herbarium and Botanical Research Institute of Texas has linked the data of more than 500 Western Australian Herbarium collections objects (specimens, photographs, field notes).

Management Implications

- WAHerb is a comprehensive vouchered specimen database for Western Australian flora, providing a source of information that scientists, consultants, land managers and policy makers can use to update species distributions, conservation status, plant identification and to identify knowledge and collecting gaps. It ensures that research and management activities for the State are informed by up-to-date and valid botanical information.
- The curated herbarium collections data and images are a heavily utilised digital resource for systematic and taxonomic research, collections management, environmental assessment, ecological and other scientific research, conservation, restoration and remediation projects, biosecurity management and planning, educational uses, historical and cultural studies, and citizen science projects.

Future Directions

- Continue timely addition, editing and validation of specimens and specimen records to maintain currency and connectivity of the Herbarium collection, the Western Australian Plant Census and departmental and external biodiversity data providers, including Florabase, Dandjoo, AVH, ALA, and GBIF.
- Complete the migration of the collections management system to Specify.
- Continue to seek collaborations with national and international institutions to broaden the use of the specimen data for science.
- Focus on imaging of biosecurity-relevant specimens, algae (for specimen conservation purposes), conservation listed taxa and taxa not represented in the Reference Herbarium.
- Link specimen images to metadata delivered to biodiversity data aggregators, such as ALA and AVH for increased online accessibility of the collection.
- Collaborate with DBCA library to scan field notebooks to enable linking to specimens and enhance their associated digital biodiversity data.
- Develop protocols for management of culturally sensitive data and Indigenous knowledge and engage with the community to appropriately name the new collections management system.



The Western Australian Plant Census and Australian Plant Census

CF-2011-111

S James, C Parker, J Percy-Bower, T Macfarlane, S Sinha, R Gugiatti

Context

Botanical names and their status are critical to many departmental functions and stakeholder activities. The Western Australian Plant Census (WA Plant Census) is the authoritative database of the flora (vascular and non-vascular plants, algae, fungi and slime moulds) found in Western Australia, including nomenclatural synonyms created by taxonomic and systematic published research and concept changes. It is continually

updated to reflect changes in our taxonomic knowledge of the flora of the State. The census constitutes the fundamental master list for many departmental processes and datasets, including the Western Australian Herbarium's specimen database (WAHerb), the threatened and priority flora database maintained by the Species and Communities Program, the Herbarium's website Florabase, Nomos and Dandjoo (CF-2021-44).

At a national scale, the Western Australian Herbarium contributes to the Australian Plant Census (APC) and a Council of Heads of Australasian Herbaria project, part of the National Species List infrastructure designed to provide a consensus view of all Australian plant taxa. The APC delivers authoritative information on what species occur in Australia as a whole to obtain accurate national statistics and resolve differences in opinion and knowledge for taxa that cross jurisdictional boundaries. The APC process provides for updates as taxonomic changes or new findings are formally published and is the taxonomic backbone for the Atlas of Living Australia and the Australasian Virtual Herbarium. The WA Plant Census is updated to reflect the national consensus view, produced annually. The APC provides the taxonomic backbone for the Atlas of Living Australia and the Australasian Virtual Herbarium.

Aims

- Maintain an accurate and timely listing of all plants, algae, fungi and slime moulds in Western Australia, including current names and synonyms and harmonise this with the national taxonomic consensus.
- Provide taxonomic advice and updates for Nomos.

Progress

- The Western Australian Plant Census documents all of the known native and alien vascular plants for Western Australia. Cryptogams (fungi, lichens, slime moulds, algae and non-vascular plants) continue to be assessed and have not yet been comprehensively entered into the database.
- 216 plant names (187 formally published and 29 informal phrase names) were added to the WA Plant Census during 2024-25. The inclusion of cryptogams (particularly fungi, lichens and freshwater algae) in the WA Plant Census continues to be a focus. A further 528 name updates were made, keeping the taxonomic status current. Of particular note, *Pultenaea* (35 taxa, 1450 collection items) and *Thryptomene* (13 taxa, 175 collection items) underwent significant taxonomic curation.
- More than 1080 archived census forms, including descriptions of phrase name taxa, were scanned by volunteers and are now electronically available for departmental use.
- The State's contribution to maintenance of the Australian National Species List cooperative database continued with addition of 107 new vascular plant names and creation of 3288 new instances (data on synonymy, authors and publications) and 2266 data updates.
- Contributed to the International Code of Nomenclature at the International Botanical Congress in Madrid, Spain.

Management Implications

- The WA Plant Census provides an authoritative official list of the flora of Western Australia with their currently accepted classification, scientific name, correct spelling and authority. Delivery of this information is through Florabase, Dandjoo and other departmental linked databases and websites.
- Current information on names, taxonomic acceptance and occurrence in Western Australia provided by the WA Plant Census is used for conservation status lists, publications, signage, and legal requirements.
- The Herbarium's contributions to the Australian National Species List and the Australian Plant Census support national and international names databases used in biodiversity aggregators such as the Atlas of Living Australia, Australasian Virtual Herbarium, Global Biodiversity Information Facility and Catalogue of Life.

Future Directions

- Continue to provide a comprehensive and up to date State and national census across all plant, algae and fungal groups.
- Continue to ensure the collections of the Western Australian Herbarium remain taxonomically correct for biodiversity and conservation research, and departmental needs.
- Continue to assist with the implementation of a new, more efficient online database forum for APC.
- Provide taxonomic support for the new Western Australian Herbarium collection management system (Specify) and assist with replacement of the obsolete WA Plant Census system and associated tools.



Systematics of the triggerplant genus *Stylidium*

SP-2010-1

J Wege

Context

With more than 300 known taxa, the triggerplant genus *Stylidium* is one of Australia's most abundant and diversified genera. While substantial progress has been made over the past 20 years in documenting Australia's *Stylidium* diversity, our knowledge of the genus remains insufficient for scientific and conservation needs. There are new taxa awaiting formal description, species complexes that remain poorly understood and a number of nomenclature and typification issues that require resolution. The most significant issue at this point is the lack of an overarching flora treatment for the family Stylidiaceae, which hinders survey and accurate identification by conservation personnel, botanical consultants and other stakeholders.

Aims

- Improve the underlying taxonomic knowledge necessary for effective biodiversity management of the triggerplant family Stylidiaceae and make this information readily accessible to stakeholders.
- Investigate phylogenetic relationships within *Stylidium* and use these data to inform taxonomic research and conservation management.

Progress

- 15 novel species from northern Australia (including eight from WA) were published in *Nuytsia* along with an annotated key to the species found in the Northern Territory (NT).
- Research describing novel taxa in WA and Queensland, updating species circumscriptions and resolving typification issues has been substantially advanced.
- Approximately 400 specimens at the WA Herbarium were annotated to correct or confirm their identity, with additional material at the NT Herbarium in Alice Springs and Darwin similarly updated in accordance with recent research.
- The treatment of *Stylidium* for *Flora of Australia* was progressed, with a focus on species from northern Australia.
- Approximately 1900 photographic records were identified on iNaturalist, some of which represent new populations of poorly known species and a voucher specimen was subsequently obtained for a significant new population of *S. glabrifolium*. The results of an iNaturalist expert identification blitz for three biodiverse regions in WA (which included *Stylidium* identifications) were summarised in a collaborative paper published in *Plants People Planet*.

Management Implications

- Herbarium-based taxonomic research and targeted field work continues to improve our understanding of the *Stylidium* species that occur in WA and other jurisdictions and their distribution, habitat requirements and conservation status.

Future Directions

- Continue preparing species profiles for the *Flora of Australia* and associated research papers, visiting select Australian herbaria as required.
- Progress phylogenetic research and identification guides.



Taxonomic resolution and description of new plant species, particularly priority flora from those areas subject to mining in Western Australia

SP-2009-6

K Shepherd, M Hislop, T Macfarlane, P Baleeiro Souza, S Dillon, C Wilkins, J Wege, B Anderson

Context

Our State boasts a rich and diverse flora that is far from fully documented, with more than 1000 putative new taxa listed on Western Australia's vascular plant census. This taxonomic backlog has remained fairly consistent in recent years despite a sustained research effort to document new species across the State (1840 native species have been added to the census between 2004 and 2024). This continued high rate of species discovery has occurred through ongoing assessment of herbarium collections, floristic surveys and botanical evaluations of mineral leases. Notably, around 50 per cent of these undescribed taxa are either poorly known, geographically restricted and/or under threat. A lack of detailed information about these 'known unknowns' hampers identification, which in turn delays their accurate conservation assessment. It therefore remains an ongoing priority to resolve their taxonomic status through research and associated publications.

Aims

- Resolve the taxonomy and expedite the description of phrase-named plant taxa, particularly those vulnerable to future mining activities or otherwise listed as being of conservation concern.

Progress

- 34 new taxa were recognised for Western Australia, of which 27 are conservation-listed. These include new species of *Goodenia*, *Leucopogon*, *Styphelia*, and *Thryptomene*, as well as five novel conservation listed species of *Stylidium* and two species of *Tecticornia* that are only known from a single salt lake.
- Taxonomic research on *Lasiopetalum* and allied genera has progressed along with associated manuscripts.
- A preliminary assessment of select undescribed taxa in the Pilbara region has been conducted in preparation for targeted field work, and updates for Version 2 of the Threatened and Priority Plants of the Pilbara App were completed
- Five new records of conservation-listed species in *Convolvulus*, *Minuria* and *Stylidium* were added to the State's vascular plant census, while the priority listed *Minuria tridens* was removed, as this species was found to only occur in the Northern Territory.

Management Implications

- The provision of names, scientific descriptions, illustrations and associated data will enhance the capacity of conservation and industry personnel to identify these new species, thereby improving conservation assessments and effective management.

Future Directions

- Identify and formally describe new taxa of conservation significance.



Taxonomic review and floristic studies of the benthic marine algae of north-western Australian and floristic surveys of Western Australian marine benthic algae

SP-2009-9

J Huisman, C Parker, R Binks, K Lazar

Context

This project involves systematic research into a poorly known group of Western Australian plants and is directly relevant to the department's biodiversity conservation programs. It includes floristic studies of the marine plants of several existing and proposed marine parks and areas of commercial interest, to provide baseline information that will enable a more comprehensive assessment of the Western Australian marine biodiversity. These include Shoalwater, Marmion, Ningaloo, Dampier Archipelago, Barrow Island, Montebello Islands, Rowley Shoals, Scott Reef and the Maret Islands.

Aims

- Collect, curate and establish a collection of marine plants representative of the Western Australian marine flora, supplementing the existing Western Australian Herbarium collection.
- Assess the biodiversity of the marine flora of Western Australia, concentrating initially on the poorly-known flora of the tropics.
- Prepare a marine flora guide for north-western Australia, documenting this biodiversity.

Progress

- A paper describing two new Western Australian species in the genus *Hypnea* (*Hypnea decipiens*, *Hypnea subramentacea*) was published in *Phycologia*, clarifying the identity of a species previously regarded as a pest internationally.
- 281 specimens of marine algae were added to the WA Herbarium collection.
- Seven algal species were added to the Western Australian census.
- A green seaweed of the genus *Pseudobryopsis* has been recognised as new and will be described in a forthcoming paper.
- A manuscript clarifying the identities of poorly known red algal species described in 1855 has been submitted to *Australian Systematic Botany*, including generic reassignments of seven species and two species newly described.

Management Implications

- Easier identification of marine plant species leads to a more comprehensive understanding of their conservation status, recognition of regions with high biodiversity and/or rare species, recognition of rare species, recognition of potentially introduced species and discrimination of closely-related native species.
- Enhanced knowledge of marine plant species allows a more accurate assessment of management needs and potential impacts of environmental change, including change conferred by resource developments, biosecurity breaches and climate change.

Future Directions

- Publication of papers describing new and existing genera, species and other categories, including several new species in the *Hypnea pannosa* complex.
- Undertake taxonomic studies of Western Australian species of the red algal genus *Prionitis*.
- Undertake taxonomic studies of marine algae occurring in the Swan-Canning Estuary, including the description of a new species of *Callithamniella*.
- Undertake taxonomic assessments of turf algae, including descriptions of potentially new species of filamentous red algae.
- Use molecular methods to clarify the identities of Western Australian species of the ubiquitous green algal genus *Ulva*.



The Western Australian marine benthic algae online and an interactive key to the genera of Australian marine benthic algae

SP-2009-8

J Huisman, C Parker, M Chalmers

Context

This project is a direct successor to the *Western Australian Marine Plants Online* and will provide descriptions of the entire currently known Western Australian marine flora through *Florabase*. Interactive keys enable positive identification of specimens and provide a user-friendly resource that enables the identification of marine plants by non-experts. It will be of great value in systematic research, teaching, environmental and ecological research, environmental monitoring and quarantine procedures.

Aims

- Prepare an interactive key to the approximately 600 genera of Australian marine macroalgae.
- Provide online descriptions of the Western Australian marine flora, including morphological and reproductive features, to enable easy comparison between species.
- Provide online descriptions of higher taxa (genus and above).
- Incorporate descriptions and images of newly described or recorded taxa of marine flora into *Florabase*.

Progress

- Data for 281 algal specimens, newly added to the Western Australia Herbarium collection, are now available via *Florabase*, improving taxonomic and distribution knowledge concerning the Western Australian marine flora.
- Seven new algal names have been added to the census of Western Australian flora.

- 1371 existing WA Herbarium records of marine flora have been edited to update synonymy, cited specimens and family changes.
- Scoring of character states for the interactive key is ongoing.
- Additional fact sheets describing morphological and reproductive features have been prepared for inclusion in the interactive key, to assist in character recognition. Existing fact sheets have been edited for consistency.
- Numerous additional *in situ* (particularly from the Perth region, including the Swan-Canning Estuary, and Coral Bay) and microscopic images of marine algae have been taken.
- Over 60 images have been added to the WA Herbarium's ImageBank.

Management Implications

- Easier identification of marine plant species will lead to a more accurate understanding of their conservation status and enhanced knowledge of marine biodiversity that will permit a more accurate assessment of management proposals and practices and threats to biodiversity.
- Provision of a readily available web-based information system will facilitate easy access by managers, researchers, community and other stakeholders to marine plant species inventories and up-to-date names.

Future Directions

- Finalise the interactive key and distribute a test version to garner feedback.
- Continue collating existing species descriptions and write new descriptions for uploading to *Florabase*.
- Upload additional marine plant images to ImageBank/*Florabase*.



Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of conservation importance

SP-2001-1

R Binks, M Byrne, J Kestel, A Brunton, K Lazar, R Dillon, A Crawford, L Monks

Context

Understanding the interaction between mating systems, levels of inbreeding and patterns of genetic variation within populations of species is a key element in assessing the viability of plant populations, particularly rare and threatened taxa, and the development of management strategies that reduce the likelihood of local extinction and increase the probability of successful establishment of restored populations.

Aims

- Assess the relationship between effective population size and levels of genetic diversity and the minimum effective population size for maintaining genetic diversity in natural and restored populations.
- Assess the effects of population size and habitat degradation on mating system parameters that indicate inbreeding or the potential for inbreeding.
- Assess whether reduction in population size, increased inbreeding and reduced genetic variation are associated with any reduction in fitness.
- Assess whether there are differences in the levels of genetic diversity and mating system parameters between rare and common congeners, which will provide a more general understanding of rarity in this flora and how it can be managed.
- Assess patterns of genetic diversity and population differentiation in rare species to assess previous management actions and inform future actions.

Progress

- Genetic diversity was assessed in translocated and natural populations of *Acacia cochlocarpa* subsp. *cochlocarpa,* and genetic structure was assessed across the range of *A. cochlocarpa* subsp. *cochlocarpa* and its sister taxa *A. cochlocarpa* subsp. *velutinosa*. Levels of genetic diversity in two translocated populations were found to be equivalent to the wild source population and two other wild populations, and across the two subspecies patterns of genetic structure generally indicate significant differentiation between them. A manuscript describing this study is in preparation.
- Genetic analysis of *Chorizema humile* is underway to assess genetic diversity and population differentiation across wild and translocated populations. Preliminary findings have shown moderate population structuring that is consistent with the species' geographically disjunct distribution and supports previous decision-making to establish separate translocations each sourced from these

disjunct geographic areas.
- Genetic analysis of *Banksia cuneata* is complete. The major findings have clarified species boundaries, appropriate management units and the species' 40 year translocation history. A manuscript summarising this work has been accepted for publication in the Plant Conservation Genetics special issue of *Annals of Botany*.
- A newly identified population of *Grevillea acropogon* has been incorporated into the existing genetic study of *G. acropogon* and a manuscript summarising this work is in preparation.
- Genetic analysis of *Tetratheca butcheriana* is complete. The results showed moderate levels of genetic diversity but highly limited gene flow across the species' very narrow range that coincided with gaps in plant distribution greater than 350m, such that the species will be vulnerable to threats that increase fragmentation. A manuscript detailing these results is near completion.
- Genetic analysis of *Acacia volubilis* is near completion, finding strong population structuring among geographically structured populations and varied levels of clonality within populations. A manuscript is in preparation.
- Genetic analysis of *Synostemon hamersleyensis* showed a signal of isolation by distance across the species' narrow range, indicating that stepping stone connectivity and large population size have maintained genetic diversity in this rare species. A manuscript is in preparation.

Management Implications

- Assessment of genetic variation and mating system parameters will inform prescriptions for the prevention of inbreeding and maintenance of genetic variation in small fragmented populations of rare and threatened plants, and will facilitate strategies for managing inbreeding and loss of genetic diversity during translocation programs.
- For species in resource-rich areas, information on genetic diversity and gene flow patterns will also inform impact assessments for future mining activities.

Future Directions

- Finalise mating system and genetic diversity studies on translocated and natural populations of *A. cochlocarpa* and publish findings.
- Complete genetic analyses for *C. humile* and *G. acropogon* and publish findings.
- Finalise manuscripts on *T. butcheriana*, *A. volubilis* and *S. hamersleyensis* for publication.



Translocation of critically endangered plants

SP-2001-4

L Monks, R Dillon, M Byrne

Context

The contribution of translocations (augmentation, introductions, reintroductions) of threatened flora to the successful recovery of species requires the development of best-practice techniques and a clear understanding of how to assess and predict translocation success.

Aims

- Develop appropriate translocation techniques for a range of critically endangered and other threatened flora considered priorities for translocation.
- Develop detailed protocols for assessing and predicting translocation success.
- Establish a translocation database for all threatened plant translocations in Western Australia.

Progress

- Infill planting at two multi-species seed orchard sites for threatened Stirling Range plant species was undertaken and previously established plants were monitored at the two sites.
- A population of *Banksia montana* on Bluff Knoll was restocked with a small number of seedlings.
- Analysis of monitoring data from a translocated population of *Banksia cuneata* commenced to assess medium-term (five-year) success.
- Monitoring of one translocated and two wild populations of G*revillea maxwellii* was undertaken as part of a multi-year data collection plan in order to develop a population viability model for the species to inform future management options. Analysis of data collected in the previous year for these populations has commenced to assess medium-term translocation success.

- The only population of the recently described *Grevillea kulikup* was augmented with seedlings. Measurements of plant dimensions and counts of flowers and fruit were undertaken for wild and translocated populations of *G. acropogon* and *G. kulikup.* These data will be compared between translocated and wild populations within each species to assess whether translocated populations have similar demographic characteristics to wild populations, a milestone that is used to predict successful translocation establishment.
- A new translocation was developed for the critically endangered *Grevillea calliantha*. Surveys for new sites involved the trial use of dieback detector dogs (SP-2025-8) to assess for the presence of *Phytophthora* species at wild and established translocated populations, as well at three potential translocation sites. Translocation planning has been completed and approved for one new translocation site. Site infrastructure has been installed and seedlings have been planted at the new site.
- A new translocation was developed for *Banksia ionthocarpa* subsp. *ionthocarpa*. The new site will function as a seed production area for this critically endangered species. Translocation planning has been completed and is pending approval.
- New translocations for restocking the East Bluff populations of *Andersonia axilliflora* and *Persoonia micranthera* were developed. Translocation planning and approval documents were completed and submitted.
- A new one hectare kangaroo and rabbit proof fence was constructed around an existing translocated population of *Grevillea maxwellii.*

Management Implications

- Successful translocations lead to the improved probability of threatened flora persistence, particularly for critically endangered species. Ongoing monitoring of translocations is providing information on the success of methods used and the probability of long-term success and informs other flora translocation projects.
- Further development of success criteria and methods for analysing long-term success, such as the use of population viability analysis (PVA), mating system analysis and genetic variability analysis, will ensure completion criteria are adequately addressed and resources can confidently be allocated to new translocation projects.
- Improved awareness of best-practice translocation methods by departmental staff and others undertaking such work leads to greater translocation success.

Future Directions

- Develop a PVA model for translocated and natural populations of *Acacia cochlocarpa* subsp. *cochlocarpa* using previously collected demographic data.
- Continue to monitor plant survival, growth and seed production at *Grevillea calliantha*, *G. acropogon, G. kulikup* and threatened Stirling Range flora translocation sites.
- Analyse monitoring of vegetation plots at one *Banksia cuneata* translocation site, to assess impacts of translocation activities on associated vegetation. Draft a manuscript describing translocation and vegetation monitoring results.
- Continue to undertake annual monitoring of the *Grevillea maxwellii* translocation and natural populations in order to develop a PVA model. Analyse monitoring data collected from nine-year-old translocated plants and compare to equivalent data collected from wild populations.
- Implement the translocation proposal for *Grevillea calliantha* to establish a new population. Undertake genetic analysis of wild and previously established translocations of this species to inform future management actions.
- Implement the translocation proposals for *Banksia ionthocarpa* subsp. *ionthocarpa*, *Andersonia axilliflora* and *Persoonia micranthera.*
- Develop and implement new translocation for *Gastrolobium humile*.
- Investigate potential new seed orchard sites for Stirling Range species in order to increase overall plant capacity and seed production.
- Continue to support the dieback detector dogs project (SP-2025-8) through providing translocated plant populations for use as trial sites for training for the dogs.



The population ecology of critically endangered flora

SP-2000-15

C Gosper, R Dillon, C Elliott, M Chick, B Miller, K Ruthrof, R Tangney, J Overton

Context

South-west Western Australia is a global hotspot of plant diversity. Understanding the patterns of occurrence and traits of threatened and Priority flora and the relative importance of multiple threatening processes, including the interactions between fragmentation and small population processes, fire regimes, weed invasion, climate change, disease and grazing, is critical for the conservation and management of threatened flora and threatened ecological communities (TECs).

Aims

- Determine the critical biological factors and relative importance of contemporary ecological interactions and processes in limiting population viability and persistence, particularly for critically endangered species and key plant species occurring in TECs.
- Improve understanding of patterns of distribution of threatened and priority flora, their ecological, evolutionary and genetic traits, and how these traits mediate susceptibility to key threats.

Progress

- Long-term vegetation monitoring of threatened flora and ecological communities in the Stirling Range impacted by bushfires, disease and browsing continued. Data on post-fire recovery were contributed to a national synthesis of responses of Australian biodiversity to the unprecedented 2019-20 bushfires, which was published in *Nature*.
- A manuscript on the effectiveness of the herbicide flupropanate in controlling invasive African lovegrass (*Eragrostis curvula*) and investigating off-target effects on native species, including the endangered *Grevillea curviloba*, has been submitted for publication.
- Testing of temperature germination thresholds of the critically endangered *Commersonia apella* was undertaken, with findings presented at the 2024 Ecological Society of Australia Conference.
- Monitoring of the effects of kangaroo exclusion fencing on the composition and vigour of threatened *Banksia* woodland ecological communities on the Swan Coastal Plain continued, with a focus on exploring the interaction with vegetation die-off due to the prolonged hot and dry 2023-24 summer. Monitoring protocols were demonstrated to Regional Parks staff.
- A paper on the relative effects of pollination and abiotic environment on evolution of flower size and colour in eucalypts has been published in *Ecology and Evolution*. Flower size and colour evolved in tandem in eucalypts, with larger and more colourful flowers, which are more frequent in south-western Australia, possibly reflecting the role of birds as pollinators in regions where flower-visiting bats are absent.
- Vegetation recovery after fire and drought in the biodiversity hotspot of Lesueur National Park was assessed through monitoring of long-term plots, in collaboration with Midwest Region and Murdoch University.
- A partnership between the Binalup Rangers commenced to quantify biodiversity values of the Tambellup Water Reserve, the largest vegetation remnant in the Broomehill-Tambellup Shire and an important occurrence of the Eucalypt woodlands of the Western Australian wheatbelt TEC.

Management Implications

- Studies of the effects of fire interval, *Phytophthora* dieback, browsing and threat mitigation actions on population trends for 26 threatened and priority flora in Stirling Range National Park provided critical information on impacts of 2018 and 2019 bushfires and priorities for species recovery through *in situ* threat management and translocation.
- Studies investigating the impact of disease, fire regimes, climate change, grazing and environmental weeds on threatened flora and threatened ecological communities is providing critical information for supporting species recovery and enhancing community condition.
- Partnerships with Aboriginal ranger teams are building ranger skills and capacity in flora and fauna sampling and providing baseline information on the threatened species and ecological communities of areas under Indigenous management.

Future Directions

- Continue demographic studies of key threatened flora species and quantify the condition of key threatened ecological communities in the context of prevailing threatening processes and threat mitigation programs.
- Complete the assessment of population trends in *Ptilotus pyramidatus* and the impacts of bulbous weed invasion.
- Complete the analysis of spatial patterns of threat intensity in the Southwest Australian Floristic Region to define hotspots and priority areas for flora recovery and management.
- Develop a model of vegetation condition in Fitzgerald River National Park so that temporal and spatial trends in *Banksia* decline can be assessed and monitored.
- Analyse data on flora persistence in fragmented landscapes to identify plant trait, landscape context and land management correlates of population persistence.



Seed biology, seedbank dynamics and collection and storage of seed of rare and threatened Western Australian taxa

SP-1999-10

A Crawford, S Dudley, A Monaghan

Context

Seed conservation is a specific and targeted action to conserve biodiversity and entails banking genetic material in the form of seed. Seed banking provides an important opportunity for assessing and utilising genetic material for *in situ* recovery actions and seed research. Understanding the seed biology and ecology of plant species is important for the conservation and management of conservation significant Western Australian taxa and for developing and implementing recovery plans for rare and threatened flora.

Aims

- Provide a cost effective and efficient interim solution to the loss of plant genetic diversity by collecting and storing seed of rare and threatened Western Australian plant species, thereby providing a focus for flora recovery.
- Increase knowledge of seed biology, ecology and longevity.
- Incorporate all information into a corporate database and provide relevant information on seed availability, seed biology, storage requirements and viability of seed of rare and threatened taxa to assist the development of management prescriptions and preparation of recovery plans and translocation plans.

Progress

- A total of 129 seed collections (68 species) were banked at the Western Australia Seed Centre, Kensington. 99 collections (49 species) were from species listed as critically endangered, endangered or vulnerable (threatened flora). 28 of these collections (18 species) were priority flora and two were collections of a species not conservation listed.
- The seed bank now contains 6366 collections (1943 taxa), representing 357 threatened flora, 747 priority flora and 839 species for ecological restoration.
- 314 germination tests were conducted.
- 28 accessions were used to produce seedlings of 13 threatened species and one priority species for use in translocation.
- An assessment of the moisture content of seed collections in long-term storage was undertaken and found a major issue was identified with the moisture integrity of bags for collections stored prior to ca. 2003. Many collections stored prior to this date have moisture contents higher than the level considered suitable for long-term storage.

Management Implications

- Seed moisture content is one of the major factors that can affect the longevity of seed. The large number of collections found to have moisture contents higher than the suitable range for long-term seed storage threatens to significantly decrease their lifespan. This presents a risk of premature loss of significant genetic diversity represented by the collections.
- Seed conservation supports the survival of species in the wild by providing the genetic material for reintroduction. Seed is provided for translocations of threatened flora and for departmental restoration projects.
- Provision of seed biology and ecology data increases the success of threatened flora recovery actions, particularly through knowledge of how pre-treatments may stimulate seed germination.

Future Directions

- Prioritise the repackaging of seed collections stored prior to 2003 to ensure their seed moisture content is at a level suitable for long-term storage.
- Undertake re-testing of collections that have not been tested in at least 10 years to check for viability loss.
- Develop infrastructure to facilitate the regeneration of seed collections that have lost a significant amount of viability (less than 85 per cent of initial), which may potentially result in the loss of genetic diversity that cannot be replaced.
- Ongoing collection of seed of conservation significant flora, focusing on species either not represented in the seed bank or with low quantities of banked seed, for long-term conservation and use in translocations.

- Commence seed conservation of plant species of Aboriginal cultural significance in collaboration with the Binalup Aboriginal Corporation in the Wagyl Kaip region.
- Complete a review of the long-term (>10 years) storage performance of seed collections held in the Western Australian Seed Centre.



Genetics and biosystematics for the conservation, circumscription and management of the Western Australian flora

SP-1998-3

R Binks, M Byrne, B Anderson, J Kestel, K Lazar, D Bradbury, C Gosper

Context

The flora of Western Australia is complex due to the antiquity of the landscape, and this can lead to obscurity in taxonomic identity, which impacts the conservation status of rare and threatened taxa. Genetic analysis can inform the biosystematics and conservation of these taxa.

Aims

- Use genetic data to support plant taxonomic research, particularly in groups that involve species of conservation concern.
- Clarify species boundaries in morphologically challenging groups, such as species complexes and cryptic species.
- Assess the taxonomic validity of phrase-named taxa.
- Identify cases of suspected hybridisation.

Progress

- Genetic analysis and morphological assessment of *Verticordia spicata* have demonstrated a lack of evidence to support the continued recognition of *V. spicata* subsp. *squamosa* as a subspecies distinct from *V. spicata* subsp. *spicata*. A paper has been published in *Conservation Genetics* and taxonomic revision is underway.
- Genetic analysis of a *Wurmbea* species complex is now complete and morphological analysis is underway, with a draft manuscript in preparation.
- Genetic analysis of a *Synaphea* species complex is progressing, noting particular complexities around hybridisation and clonality.
- A paper summarising the Genomics for Australian Plants Initiative has been published in *Australian Systematic Botany*.
- Genetic analysis for the *Grevillea brachystylis* species complex is now complete. Results support the distinction of existing taxa in this group (*G. bronweniae*, *G. brachystylis* subsp. *brachystylis*, subsp. *grandis*, subsp. *australis* and subsp. Yelverton) but also an additional entity in the Blackwood Plateau region. A paper detailing the genetic results has been published in the *Botanical Journal of the Linnean Society* and taxonomic revision is underway.
- Genetic analysis of three Midwest threatened eucalypt species (*E. leprophloia*, *E. pruiniramis*, *E. crispata*) is now complete. Results confirmed that both *E. leprophloia* and *E. crispata* do represent hybrid entities but *E. pruiniramis* is not of hybrid origin. A manuscript is near completion.
- Genetic analysis of *Rhagodia* sp. Hamersley is now complete. Results show that it is a distinct species from *R. eremaea* and warrants formal description as a species. A manuscript is in preparation.
- Genetic analysis for the pilot study of the *Acacia aneura* complex is now complete. Results showed high levels of clonality that was consistent with apomixis, as well as high levels of hybridisation. The data had sufficient resolution to delimit 10 of the 12 current mulga species. Morphological assessment of these samples is progressing.
- Genetic analysis for Western Australian *Minuria tridens* is now complete. Results confirmed that the two Western Australian populations do not represent *M. tridens* and instead represent two separate species that have now been raised as phrase-name taxa until suitable type material can be obtained for formal description. A manuscript is in preparation.
- Genetic analysis for *Adenanthos eyrei* is now complete. Results confirmed that *A. eyrei* represents an *A. cuneatus* x *forrestii* hybrid and is not a valid species. A manuscript is in preparation.

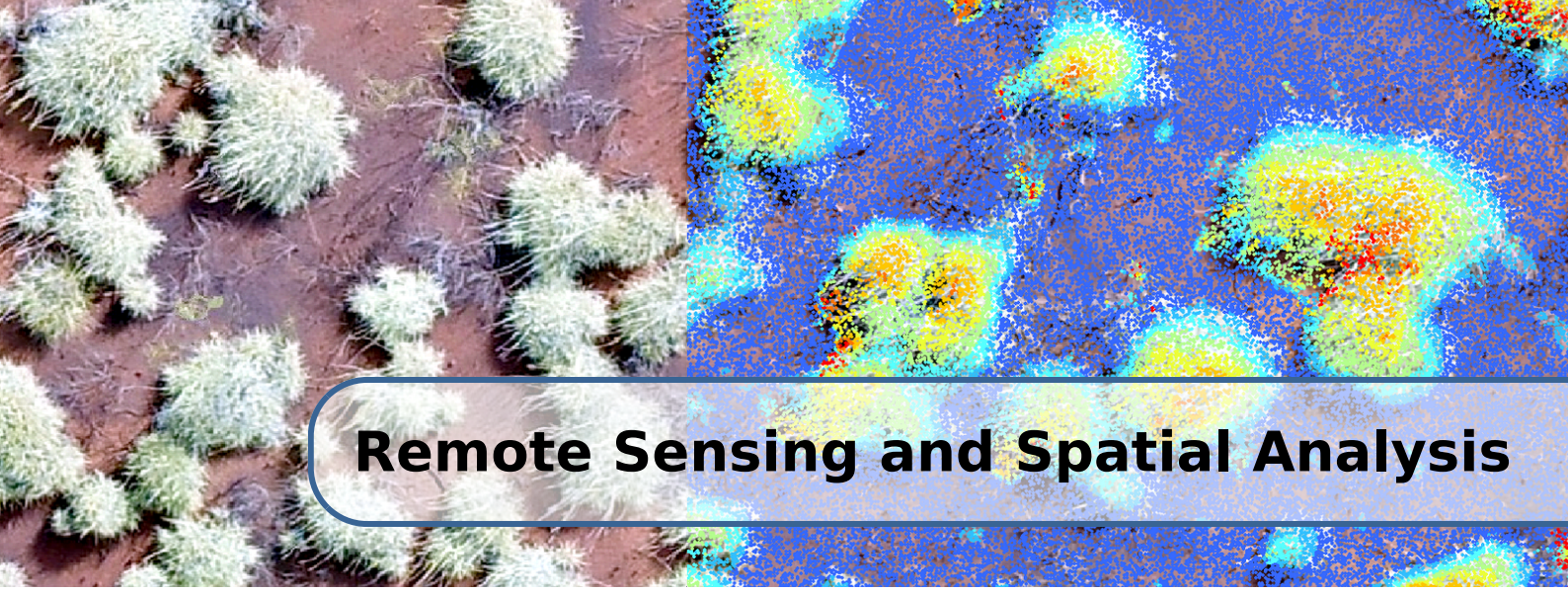
Management Implications

- Use of genetic data to resolve species boundaries, identify hybrids and assess phrase named taxa provides: clarity on taxonomically important morphological characters to improve species identification for conservation officers in the field, clear delineation of geographic distributions to inform recovery

action decision-making and on-ground management actions and enables assessment of conservation listings and the appropriate allocation of resources to priority taxa.

Future Directions

- Complete genetic analyses for the *Synaphea* species complex.
- Complete morphological assessments for *A. aneura, G. brachystylis* and *Wurmbea*.
- Finalise draft manuscripts for the *Eucalyptus*, *Minuria*, *Rhagodia*, and *Adenanthos* studies for publication.



Remote Sensing and Spatial Analysis

Program Leader: Katherine Zdunic

The Remote Sensing and Spatial Analysis Program seeks to integrate the science and application of remote sensing and spatial analysis into departmental programs. For a department that manages large tracts of terrestrial and marine conservation parks and reserves, the efficient use and analysis of spatial data is crucial for understanding natural processes and informing management actions.

In recent times the availability of spatial data has increased dramatically. With this increase in data, the Program is continuing to develop sophisticated statistical analysis, interpretative and automation techniques to synthesise data into a form where they directly assist departmental staff.

The program undertakes fire mapping over extensive areas of the State. Utilising time series satellite imagery and ground information, monitoring programs have been established in the forest, wetland, marine, coastal, rangeland and tropical savanna environments. Species and habitat modelling and spatially explicit assessments, such as risk assessments, allow managers to identify areas of concern and efficiently utilise resources. Program scientists collaborate with other parts of the department, universities, CSIRO, natural resource management groups, resource companies and other research providers.



Species Distribution Modelling under Climate Change

SP-2024-11

L Van Der Weyde

Context

The Climate Adaptation Initiative (CAI) is undertaking research that aims to address WA-specific climate adaptation knowledge gaps, including developing a better understanding of the vulnerability of terrestrial threatened species and ecological communities to climate change and their capacity to adapt to it. One component of the initiative involves spatial and ecological modelling, which can provide a useful tool for increasing scientific knowledge, project planning and actions to protect ecosystems under future climate change scenarios. Incorporating knowledge of species-specific habitat requirements, as well as predicted changes in rainfall and temperature, can provide information on potential shifts in distribution and ranges of species in the near future. This knowledge can add to the existing ecological needs of threatened species and is necessary for informed decision making by conservation managers.

Aims

- Undertake research to address key knowledge gaps for WA threatened species, including climate vulnerability and adaptation linked with genetics and ecology, to inform the most impactful on-ground actions to support climate resilience and adaptation.

- Develop distribution maps for key species and assemblages providing information on projected changes in distribution under several global climate models.
- Identify areas of low and high risk for species under future climate scenarios.

Progress

- Species distribution modelling was used to assist in site selection for the potential translocation of the noisy scrub bird (*Atrichornis clamosus*) along the South Coast. Modelling was conducted across several proposed sites with the species' distribution assessed under several climate scenarios over coming decades. Additional information such as invertebrate availability, management and cultural values of preferred sites was also considered in potential site selection.
- Stream site selection using fine-scale aerial imagery and remote sensing metrics is being used to help identify suitable translocation sites for the white-bellied frog (*Anstisia alba*) in the south-west.
- Species distribution modelling using spatially varying climate layers is underway to complement population genetic analysis of the chuditch (*Dasyurus geoffroii*) to inform species management.
- Micro- and macro habitat comparisons have been used to assess differences in spatial distribution following fire in *Banksia brownii* in the Stirling Ranges.
- Micro-habitat and tree characteristics data are being collected to aid in monitoring and understanding of the ecology and distribution of the threatened pygmy trapdoor spiders *Bertmainius tingle* and *B. mysticus* in the Frankland District.

Management Implications

- Modelling can inform monitoring of species that have undergone significant distribution changes and range contractions by focusing specifically on the key habitat requirements, allowing research to be directed to fine-scale targeted areas, making effective use of time and resources.
- Species distribution models that inform where species are likely to be able to persist under future climate scenarios are available for identifying potential translocation sites, key habitats where species are at risk or are secure and potential dispersal corridors.
- Spatial models can incorporate existing threats to identify areas requiring increased management actions to further secure habitat for threatened species, both now and under future climate change scenarios.

Future Directions

- Develop spatially explicit models of species and ecological community distributions under different climate scenarios and spatially represent threats for selected species.
- Expand monitoring sites of pygmy trapdoor spiders (*Bertmainius* species) and investigate micro-habitat modelling opportunities.
- Update previous modelling of the white-bellied frog using high resolution mapping of identified streams and micro-habitat modelling of soil characteristics. Expand on similar modelling and population genetics for the orange-bellied frog *Anstisia vitellina*.
- Finalise chuditch distribution modelling combined with population genetic information for publication and provide support for ongoing management.
- Provide support for flora spatial modelling for several *Banksia* species, orchids and *Petrophile* species across the south-west.



Novel methods combining ground-based monitoring and remotely sensed observations to inform management and measurement of ecosystem condition in the rangelands

SP-2021-11

K Zdunic, J Ruscalleda Alvarez

Context

The mulga rangelands of the mid-west have experienced long-term degradation from the cumulative impact of 150 years of pastoral activity. Changing precipitation regimes and increasing temperatures threaten to further modify the trajectory of ecological condition of these ecosystems, with the impact of vegetation mortality and invasive species both likely to become more pronounced in future decades. However, while the extent of degradation is widely acknowledged, it is not known whether these ecosystems have the ecological capacity to naturally recover when agricultural grazing pressures are removed or how resilient they might be to future climatic extremes.

Aims

- Deliver new insights into the functioning of rangeland ecosystems in WA and tools to undertake future monitoring and evaluation of these ecosystems.
- Develop a method to relate remote-sensing based measurement of ecosystem condition to on-ground monitoring datasets.
- Integrate new remote sensing technologies into assessments of rangeland condition and change detection.
- Determine the recovery potential of degraded rangeland ecosystems in Western Australia.

Progress

- Finalised two different woody vegetation cover (WVC) models that predict WVC using Landsat imagery. The first model is based on a segmented linear regression of a vegetation index (STVI) and the second model is a random forest model that uses a handful of different vegetation indices (including STVI). Both models performed similarly when compared to remotely piloted aircraft derived WVC measures in three different years in Thundelarra ex-pastoral station. Similarly, when the models were tested outside of the training area at Boolardy ex-pastoral station (~150 km north of Thundelarra), the predictions had a very similar error, providing confidence that the models can be used in the broader area of the southern mulga rangelands of WA. This work was published in *Ecological Indicators*.
- Finalised the analysis of an aerial LiDAR dataset through a c-means unsupervised classification which resulted in a one hectare pixel map of the Badimia block (the area covered by the LiDAR survey) in which eight different vegetation structural types are identified. A manuscript has been drafted and is currently under review by co-authors.
- Trained a model based on time series of optical and radar satellite imagery to predict the eight structural types mentioned above. Analysis is currently being finalised and a manuscript will be prepared for peer-review publication.

Management Implications

- Identifying the recovery potential of particular areas of the landscape allows land managers to design targeted interventions in areas either most at risk of further degradation or in places with the greatest potential to recover.
- Developing new remote-sensing based monitoring methods will allow more spatially comprehensive assessments of changes in vegetation condition than are currently practicable.

Future Directions

- Publish papers describing the vegetation structural map generated through the LiDAR dataset and the model to predict vegetation structure using optical and satellite imagery.
- Generate a vegetation potential map that can be used to compare with the current status of vegetation, with the final goal of identifying areas that have the potential to host more vegetation than they currently do.
- Share the results of the project with stakeholders in the rangelands and test these products in different properties across the mid-west.



Dirk Hartog Island vegetation monitoring

SP-2018-9

R Van Dongen

Context

In 2009, Dirk Hartog Island (DHI) was gazetted as a national park and the process to remove introduced animals and reintroduce native mammals and a bird began. A vegetation monitoring program was developed that integrates detailed floristic surveys, repeated site photography and Landsat satellite imagery to provide a comprehensive picture of vegetation condition and how the island's ecology has changed since destocking.

Aims

- Monitor changes in native vegetation cover following destocking of introduced herbivores.
- Monitor native vegetation cover changes with the recent reintroduction of native fauna.

Progress

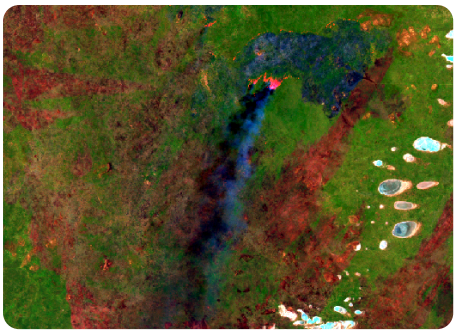
- The 2023-24 vegetation cover monitoring report was completed, showing that 15 per cent of DHI has experienced a significant increase in vegetation cover above pre-destocking levels. Vegetation across the island was impacted by hot and dry conditions in early 2024.
- Remotely piloted aircraft (RPA) data and records of the location and species of dominant shrubs were collected. Processing and analysis of imagery captured by RPA to date is ongoing with cover measures and, where possible, species identification being recorded. Results from this work show, for example, that at site AGWA657 the median shrub diameter increased from 1.8 m in 2015 to 2.7 m in 2022.
- Vegetation characteristics were assessed at several locations. These data will be used to create a vegetation map of DHI via statistical modelling.

Management Implications

- Results from the program demonstrate the ecological benefits of the eradication of introduced herbivores and provide evidence that, with the improvement in vegetation condition, the mammal reintroduction program has a high likelihood of success.

Future Directions

- Update vegetation monitoring and sand dune area movement using Landsat imagery and carry out field validation of vegetation change.
- Continue assessment of changes to buffel grass extent over the period 2015 to 2025 and further investigate buffel grass detectability.
- Carry out field identification of plants that have significantly changed in extent between 2015 and 2025 and provide growth and cover statistics.
- Draft a manuscript investigating the combined effects of climate and destocking on vegetation cover on DHI.
- Produce a draft vegetation map of DHI.



Remote sensing and spatial analysis for fire management

CF-2018-74

K Zdunic, B Huntley, J Chapman, P Rampant, R Van Dongen, J Ruscalleda Alvarez

Context

The department's fire management, monitoring and reporting functions require knowledge of fire events that are derived through fire scar mapping. The imagery used for this analysis is predominantly satellite imagery and includes optical and thermal imagery from airborne platforms. Research includes historical mapping that utilises the extensive archive record of satellite imagery and occasionally aerial imagery to build a fire history (or fuel age) for a location or to reconstruct the spread of major bushfires. These activities include monthly mapping during the prescribed burn season. The project plays a key role in fire research and development, through research into fuel growth, fire spread, fire risk and development of fire severity models. Internal and collaborative activities are carried out to further streamline and automate mapping techniques. General imagery support is also provided to Fire Management Services Branch and regional staff, including incident mapping and prediction and advice about imagery and systems development.

Aims

- Improve processes for fire scar identification to enable understanding of historical fire regimes for safety and ecological applications.
- Improve burn safety through development of methodology to detect and communicate hotspot locations.
- Develop techniques to provide inputs for fire behaviour models to enable desktop assessments.
- Carry out operational processing of fire severity maps for prescribed burning and expand the historical archive.
- Provide remotely sensed spatial and temporal data to assist with bushfire investigations and reporting.
- Develop protocols for airborne thermal capture of going fire for measuring fire rate of spread from prescribed burns and mapping bushfires.

Progress

- Fire scar information for the Pilbara and Goldfields regions, Kanyirninpa Jukurrpa, Desert Support Services and Tarlka Matuwa Piarku was supplied to inform and report on prescribed burning activities in the Western Desert and Pilbara regions.
- Provided fire metrics for the Pilbara Conservation Project using fire scar information from 1987 – 2024.
- Updated and continued the development of R scripts to automate the analysis of the fire scar information required for the Pilbara Conservation Project.
- Updating and editing the Pilbara fire scar information to enable more advanced analysis, including seasonal fire regime queries.
- Supported the operational use of airborne thermal cameras to detect hotspots for burn safety.
- Supported the use of thermal sensors on remotely piloted aircraft (RPA) for monitoring fire behaviour during studies in prescribed burns.
- Continued investigation into RPA-based LiDAR for fuel accumulation modelling and fire behaviour response.
- Supported regional and district fire managers in interpreting satellite derived burn severity products.
- Fire severity mapping continued with severity maps of all prescribed burns in the 2024-25 season created and delivered. Severity maps for bushfires that occurred in the south-west were also created.
- Historical burn severity mapping was completed for Perth Hills and Wellington districts and much of the South West and Swan Coastal district. Automated reports of key fire metrics were routinely delivered to the Swan region. Analysis is ongoing into the effect of the time and severity of previous prescribed burns and the spread of wildfires in the Perth Hills district.
- Continued development of the FireHistory R software package to enable fast querying and analysis of DBCA fire history data, especially focusing on working with big data queries (spatial and temporal).
- Provided data to Fire Management Services Branch to inform fire recovery, fire chronology and emerging satellite technology and availability.
- Continued integration of a satellite derived spinifex fuel cover model for the Pilbara region.
- Thermal mapping of hotspots has advanced with staff trained to operate the sensor and analyse the resulting data from aircraft.
- Trials have commenced for capturing thermography of going fire to better understand rates of spread in prescribed burn situations and the potential to map bushfires when other sources of information are not available.

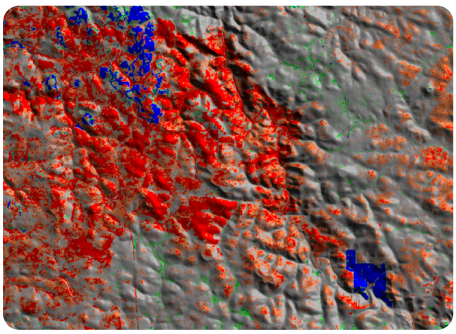
Management Implications

- The information provided for fire management is designed to significantly increase the accuracy of reporting and decrease the risks of fire management activities. Delivering fire scar mapping and information allows practitioners to make informed decisions that lead to more efficient fuel reduction activities and successful completion of burn prescriptions.
- Fire severity mapping is providing quantitative measures of prescribed burn and bushfire outcomes and provision of detailed statistics at reserve scale describing historical fire patterns is informing the impact of time since fire and burn severity on bushfire spread, helping management of nature conservation and bushfire suppression.
- Consistent production and attribution of seasonal fire scar mapping have resulted in the compilation of an annual fire scar mapping product with improved date, area and cause attribution. This product is suitable for analysing and providing spatial metrics that will aid in assessing the effectiveness of fire management in Millstream Chichester and Karijini National Parks.
- Delivery of aircraft-based thermal imagery hotspot data to on-ground staff improves burn safety.
- Development of a new cost-effective method for ground staff to assess burn safety by detecting boundary hotspots from RPA can be more efficient in more remote areas or when visibility is limited from piloted aircraft.
- Using RPA-based LiDAR for fuel height and density measurement will lead to a more accurate model of fuel accumulation for better management of fuel levels in the forest and safer bushfire management.
- Satellite derived spinifex fuel cover maps enable regional fire activities to be more targeted, efficient and safe in undertaking fuel reduction.
- The initial trial of mapping and monitoring prescribed burns from incendiary aircraft is providing valuable information for understanding rates of fire spread in different fuels and locations across the landscape aiding fire ecology research into the fuel and fire behaviour relationship.

Future Directions

- Continue development and automation of fire scar detection methodology.
- Investigation and development of new data sources including emerging satellite sensors and aerial capture.
- Fire severity mapping across the south-west will continue with a focus on expanding analysis techniques and building more sophisticated automated, reserve and district scale reporting. Research will also target improvements in the severity model for heath type vegetation and examining the degree to which cool, understory burns can be detected in karri forest.
- Continue testing and operationalise fire severity models in south-west forests.

- Implementation and development of spatial analysis of fire patterns and fuel loads.
- Assist in implementing safe use of RPAs with thermal sensors for studies onfire behaviour and for burn safety.
- Further RPAtrials to create flight parameter protocols for effective data collection.



Remote sensing monitoring

CF-2018-72

K Zdunic, R Van Dongen, K Murray, B Huntley, J Chapman, G Loewenthal, G Pitt, P Rampant

Context

The measurement and analysis of change across terrestrial, wetland and marine environments using remote sensing provides essential historical and current information that can be used to understand the effects of management actions and natural events. Imagery used is predominantly satellite imagery, optical imagery from handheld and airborne remotely piloted aircraft (RPA) and manned aircraft platforms, and LiDAR data. Field observations provide essential ground truth and calibration of remotely sensed data. Analysis techniques include an increasing number of sophisticated time series analysis tools and object orientated image classification. This work is underpinned by efficient and statistically rigorous analysis and batch processing techniques in the R programming environment and Python through the Geoscience Australia (Digital Earth Australia) Sandbox. Remote sensing monitoring relies on repeatable and consistent source imagery and developing methods to produce reliable spatial and statistical products that the department can use for reporting, managing the conservation estate and assessing threats to biodiversity.

Aims

- Undertake remote sensing monitoring and research at a range of temporal and spatial scales using technologies that include satellite imagery, digital cameras, RPAs and LiDAR data.

Progress

- Time series mosaics using collection of analysis ready satellite data have been improved, updated and processed for mangrove vegetation cover and products for Lalang-garram, Bardi Jawi Gaarra, Mayala, Ningaloo and Montebello Islands marine parks using automated processing from in house developed R package groveR for marine park reporting. The calibration determined from Lalang-garram ground truthing has been applied to Lalang-garram, Bardi Jawi Gaarra and Mayala marine parks to improve the representation of mangrove vegetation densities, while reef masks, a potential error, have been considerably improved to provide more accurate reporting.
- Investigations are underway to understand potential false positives in the mangroves time series in Shark Bay at the Big Lagoon site. Initial RPA capture has been completed and processed and will be analysed for the impact to time series data and reporting.
- High resolution RPA capture of important mangrove sites on the Houtman Abrolhos Islands was conducted and processing of the capture is underway. The data will form the vegetation cover baseline for five yearly time series monitoring.
- Millstream Chichester National Park riparian vegetation monitoring was continued.
- Contributed to the design process for the wider Fortescue Marsh Feral Herbivore Management Program. Conducted workshops including with the Nyiyaparli Joint Management Partners.
- Wetland inundation and hydroperiod analysis for various wetlands throughout the State was undertaken utilising satellite imagery.
- Technical knowledge of and protocols were developed for site surveying and GNSS post-processing of geolocated data.
- Forest Health Monitoring Program fixed monitoring sites were captured using RPA photogrammetric, LiDAR and multispectral sensors. Captured data were analysed to produce analysis ready data products and protocols developed.
- Continued RPA capture testing using a variety of sensors at Benger Swamps in order to develop appropriate measures to manage bittern habitat.
- Continued development of cover and structure measures from close range and satellite remote sensing of the Badimia reserves to support carbon projects.
- Commenced geospatial data reports summarising changes in rainfall, vegetation cover trends and fire history metrics across the Leeuwin-Naturaliste National Park Management Plan area and Albany Coast Parks and Reserves.

- A project to map vegetation types relevant to fire management and reporting across the Great Western Woodland is nearing completion with final consultation and documentation remaining.
- An analysis of drought and die-off across the south-west for the 2023-24 summer was completed. The analysis uses field observation of drought impact across a range of vegetation types and regions to build a predictive drought impact model with satellite imagery.
- ~~Completed~~ field data and high-resolution satellite imagery ~~collection~~ for 2023 Swan and Canning River seagrass extent detection at shallow depths. The product has been completed and a manuscript showing Shark Bay seagrass mapping for 2020 and 2023 is being prepared. Advice has been provided on potential seagrass restoration sites from classified data and current imagery.
- Advice was provided to the WA Vegetation Extent project on native vegetation mapping using Artificial Intelligence.
- Participated in the UN FAO Global Forest Resources Assessment Remote Sensing Survey (FRA RSS) undertaking assessment of forest change for plots across Western Australia.

Management Implications

- Wetland inundation and hydroperiod analysis provides information to understand the status and conservation significance of wetlands, especially those in remote locations.
- Evaluation of wetland characteristics is informing locations of suitable habitat for threatened species.
- Real-time kinematic RPA multispectral sensor processing workflows will enable repeatable analysis and the development of a framework for vegetation and wetland monitoring.
- Protocols for site survey and GNSS post-processing of geolocated data will ensure best practice for data capture from the real-time kinematic RPA.
- Monitoring program design and the development of consistent monitoring protocols will assist the coordination of data collection by DBCA and joint management partner ranger groups and thereby the effectiveness of conservation actions on the Fortescue Marsh.
- Mangrove monitoring information provides quantitative locational changes of mangrove canopy, informing management actions and Conservation and Parks Commission reporting.
- Improved landscape mapping resolution aids management at scales relevant to parks and reserves.
- Vegetation monitoring across various environments including mangroves, riparian zones, rangelands and forests provides quantitative information for assessing vegetation changes and informs management actions.
- Management plan evaluations for several national parks and nature reserves are supported by satellite imagery analysis and spatial data analytics.
- The Wheatbelt senescence analysis provided managers with an indication of the reserves in which senescence may be significantly impacting vegetation condition. This was used in conjunction with ground observations to plan prescribed burning.
- Vegetation mapping in the Great Western Woodland will be used to plan prescribed burns and in post burn reporting.
- The Kwinana Freeway vegetation cover assessment provides a statistical assessment of vegetation change in 12 management zones, which can be used to assess the effectiveness of revegetation activities.
- Draft versions of drought mapping are informing potential fire risk, highlighting areas where potential vegetation hazards may occur and assisting the Department of Water and Environmental Regulation to investigate interactions with water drawdown.
- Through measurements and classification of imagery captured using RPAs, the size and density of trees in drought impacted areas in the jarrah forest is informing forest management strategies to mitigate drought impacts.
- Seagrass extent mapping of the Swan and Canning River will assist in management, reporting and modelling of river dynamics.
- Multiple sources of ground truthing and validation improve seagrass mapping time series and provide managers with trusted data for informed decision making. Mapping of the locational changes of seagrass will be used in reporting to the Conservation and Parks Commission.
- Maintaining the currency of native vegetation mapping is important for identifying critical habitat of species and for informing land planning processes.
- The participation of WA experts in the FAO FRA RSS ensures that local knowledge of forest types and land use is incorporated into the WA plots assessed for global forest status.

Future Directions

- Undertake research and develop inputs to Forest Management Plan reporting including forest health monitoring and program development.
- Continue research into forest condition with a focus on resilience.
- Continue to explore and develop cloud processing options with Geoscience Australia.
- Develop and refine the use of RPA imagery and LiDAR for vegetation monitoring and mapping, including development of capture specification and analysis pathways to determine vegetation structure and cover attributes.
- Update Roebuck Bay/Yawuru, 80 Mile Beach, Mayala and Maiyalam and Bardi Jawi Gaarra marine parks mangrove monitoring timeseries and test the accuracy of the products developed for Lalang-garram

Marine Park.
- Finalise methods for seagrass classification and complete the Swan and Canning River 2023 seagrass extent map.
- Continue seagrass mapping for 2020 and 2023 in Shark Bay with better sources of ground truthing and validation.
- Expand vegetation mapping in the Great Western Woodland.



Spatial analysis and modelling

CF-2018-73

K Zdunic, G Loewenthal, B Huntley, J Kinloch

Context

The spatial analysis and modelling project develops and utilises tools to assist in the evaluation, interpretation and prediction of conservation values, threatening processes and management actions. These tools generally integrate spatial datasets, expert knowledge and GIS modelling techniques to produce spatially explicit products that can be used to inform decision making. Projects can be focused on species occurrence (species distribution models or habitat suitability modelling), animal movement (for example, identification of home range or habitat linkages), landscape scale processes (including assessment of habitat fragmentation) or assessments such as quantifying risk (for example risk presented by feral cattle to biodiversity values). Identification of areas of high conservation value for protection is also undertaken by combining numerous conservation value datasets and using software to evaluate possible conservation scenarios.

Aims

- Develop spatial models to describe ecological processes, thereby increasing the understanding and protection of biodiversity.
- Develop and utilise spatial analysis tools to inform management and support decision making.
- Collate and summarise spatial information using statistical and documented methods to inform monitoring and management practices.

Progress

- Climate suitability spatial modelling for the invasive plant pathogen myrtle rust was undertaken for current climate conditions and projected future climates.
- Regional conservation planning processes were supported with spatial analysis, including updating the base datasets with fauna data and preparation of flora data for South Coast region.
- Key spatial datasets to identify conservation values and threats were developed to inform land use planning across the Perth and Peel regions.
- Ongoing spatial analysis to support the investigation of climate impacts on threatened flora populations across Stirling Range National Park.
- Production of fire spatial metrics for Kimberley mammal monitoring sites commenced. Advice and feedback were provided to the Department of Water and Environmental Regulation in support of the production of remnant vegetation mapping and statistics for the Swan Coastal Plain and wider Perth and Peel metropolitan areas.
- Initiated improvement to vegetation mapping of the Swan Coastal Plain from 1:250,000 to 1:50,000 scale.

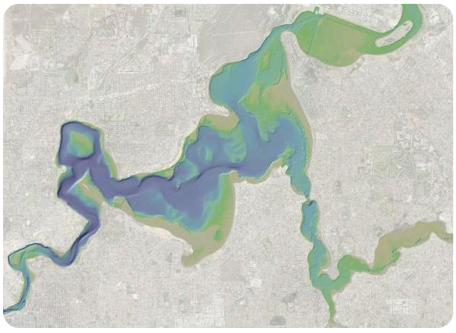
Management Implications

- Spatial information on areas of higher climatic suitability for establishment of myrtle rust will enable prioritisation of conservation efforts to the highest risk areas.
- Species distribution models provide information on the likelihood of conservation priority species' habitat, helping to determine species conservation and management priorities and actions.
- Information on the conservation values and threats present in each conservation management unit, contributes to the identification of management priorities during DBCA’s regional conservation planning process and wider land use planning.
- Identification of refugia for threatened flora populations can be used to inform management actions to mitigate the impacts of climate change.

- Evaluation of whether changed fire regimes are impacting Kimberley mammal populations will inform fire management in Kimberley conservation areas.
- Maintaining the currency of remnant vegetation mapping and statistics is important for identifying critical habitat and ensuring sufficient retention and protection of all vegetation types during land planning processes.
- Improving the scale of vegetation mapping of the Swan Coastal Plain will inform on the extent of threatened ecological communities. This project will provide a level of mapping that differentiates vegetation structures and types essential for planning and to streamline environmental approval processes.

Future Directions

- Further develop landscape scale spatial metrics of conservation values and threats that can be used for monitoring and management interventions.
- Finalise the report on modelling of areas at high risk of myrtle rust establishment under current and future climate scenarios.
- Develop spatial resources and tools to support South Coast strategic planning.
- Develop further functionality of the DBCA fire history analysis software to include additional metrics.
- Complete the fire spatial metrics for Kimberley mammal monitoring sites and contribute to any reports or papers.
- Using Urban Monitor data, extend the vegetation cover and connectivity assessment for the Swan Canning Riverpark to 2024.



Spatial data management

CF-2018-75

K Zdunic, K Murray, B Huntley, J Kinloch, G Loewenthal, R Van Dongen, P Rampant, J Chapman

Context

This core function manages spatial datasets by creating metadata, cleaning data to a corporate standard and saving or migrating data in a secure and accessible corporate data repository, the Spatial Data Library. Many of the datasets in the Spatial Data Library are identified through departmental project requirements. Large datasets include imagery and digital elevation models captured for general use across the department or for specific projects and have multiple uses such as time series analysis, spatial analysis, modelling and decision making for management, monitoring, planning and policy. Departmental collaborations also produce key datasets that are important but may not be ready to use or need a licence to be used. Making fundamental datasets accessible to all staff through corporate GIS software is an effective way of communicating what science is being undertaken and assists with determining management priorities and actions.

Aims

- Identify and manage fundamental datasets created internally and externally that have value to the department and multiple uses.
- Collate, clean and create metadata for final spatial datasets developed by departmental activities and science collaborations, and migrate these data into corporate GIS applications and the Spatial Data Library.

Progress

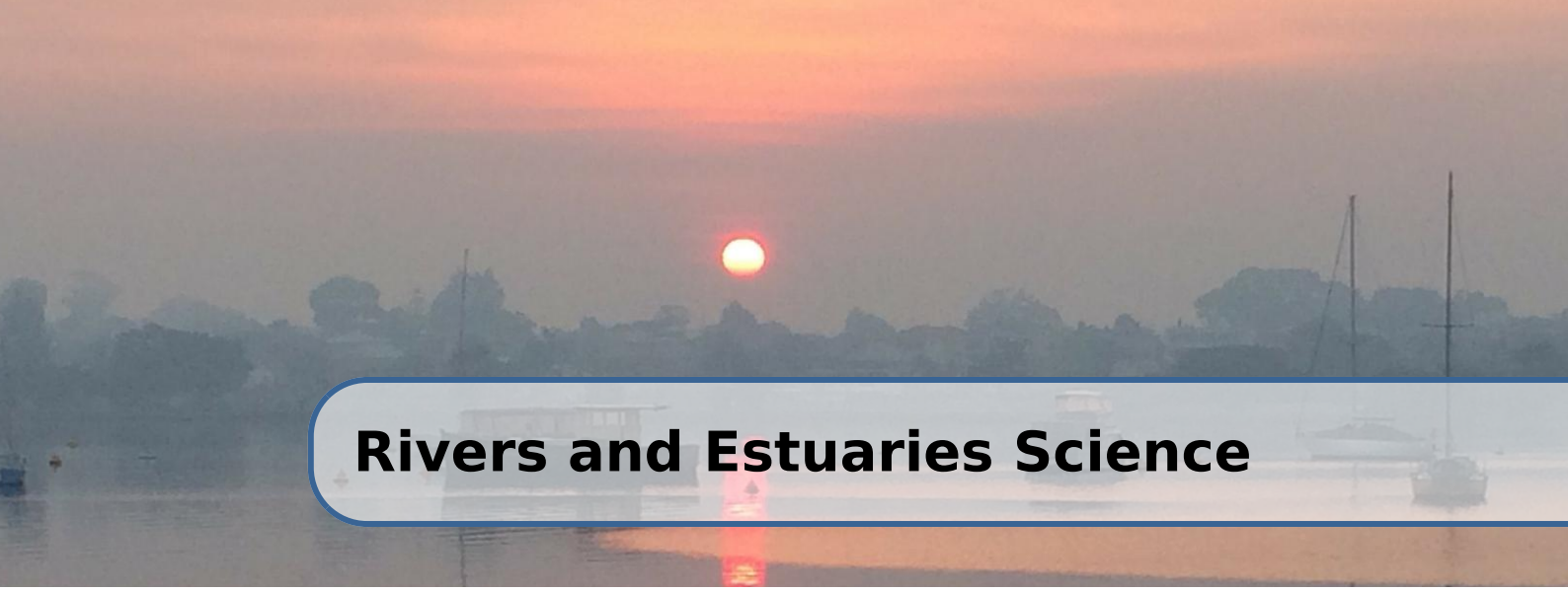
- Continued to make spatial data discoverable and accessible as the department moves data storage to a cloud environment.
- LiDAR datasets purchased by other State Government agencies were obtained and made available for corporate use.
- Made current and historical bathymetry data for the Swan and Canning Rivers more accessible and discoverable.
- Coordinated departmental bathymetry data needs and requested data from AusSeabed (Geoscience Australia) and the Western Australia Marine and Coastal Data Group.
- Developed and implemented an archiving system for remotely piloted aircraft image frames.
- Undertook development and training in access and application of scripts to enable processing of satellite imagery maintained on the national computing infrastructure.

Management Implications

- By making terrestrial and marine spatial data internally accessible from cloud-based platforms and on portals such as DataWA, data are available for conservation planning.
- Making updated state-owned LiDAR and other data available increases land managers' ability to spatially model soils, vegetation and habitats for more effective on-ground management.
- Better resolution bathymetry data assists department staff in navigation, management, research and monitoring operations in State marine parks.
- Continued development and migration of user-friendly spatial datasets contributes to the department’s obligation to improve the discoverability and accessibility of science data.

Future Directions

- Identify terrestrial and marine spatial datasets to be migrated to the corporate data menu.
- Continue to update satellite imagery, LiDAR and digital elevation model catalogues.
- Continue to develop scripts and functions to utilise satellite imagery on national computing infrastructure.



Rivers and Estuaries Science

Program Leader: Kerry Trayler

The Rivers and Estuaries Science Program undertakes and supports research across a wide range of disciplines to address knowledge gaps and inform management of the Swan Canning Riverpark. Research is aligned with the Swan Canning Research Strategy and WAMSI estuarine research priorities. Strong collaborative linkages exist with universities, research institutes and other government departments. Scientific advice and support is provided to the Swan Canning Waterways Branch in relation to waterway condition, management and incident response including algal blooms, fish-kills, sewage overflows and dolphin deaths.



Derbal Yiragan Djarlgarro (Swan Canning) Estuary and Bindjareb Djilba (Peel Harvey) Estuary shoreline plastic contamination study

SP-2025-7

P Novak, T Crutchett

Context

Plastic pollution has been identified as a ubiquitous and well known pollutant in urban waterways worldwide. The Western Australian Government through the Department of Water and Environmental Regulation (DWER) introduced regulations in 2018 to reduce impacts of single-use plastics by banning lightweight plastic shopping bags and a comprehensive range of other single use plastics through the WA Plan for Plastics in 2022.

This project will investigate the impact of the plastic regulations on the prevalence of plastic within the Swan Canning Estuary. The project will draw on a baseline assessment of plastic pollution on the shorelines and surface water of the Swan Canning Estuary completed in 2021 (EXT 2020-032), prior to these bans coming into effect. The project will extend into the Peel Harvey Estuary providing a critical baseline for this system. The nature and prevalence of plastic fishing gear litter will also be investigated.

Aims

- Investigate the type, extent and distribution of plastic pollution in the Swan Canning and Peel Harvey estuaries.
- Determine the distribution, extent and type of plastic pollution found on the shorelines of the Peel Harvey Estuary.
- Establish if the distribution, extent and type of plastic found in the Peel Harvey Estuary varies throughout the seasons.
- Determine the extent of fishing related debris in both the Swan Canning Estuary and Peel Harvey Estuary.

Progress

- 24 shoreline sites were surveyed in the Peel Harvey Estuary.

- 18 shoreline sites were surveyed in the Swan Canning Estuary.

Management Implications

- The project will provide an evidence base to inform policy development to reduce single use plastics and mitigate the impact of plastics in the environment.
- Updated understanding of plastic pollution in the Swan Canning Estuary will reveal how effective the existing WA Plan for Plastics and the DBCA Plastic Free River Park project have been.
- Determining the prevalence, source and potential impact of plastic pollution on estuary ecosystems will provide the basis for recommendations on how to mitigate these pressures.

Future Directions

- Complete final three surveys.
- Prepare a technical report.



Ecological values of river pools and evaluation of interventions to improve in-stream habitat

SP-2024-4

S Thompson, M Van Compernolle, K Trayler, M Donnelly, T Ryan

Context

This project will study the ecological condition and values of 10 river pools in the Canning, Southern and Wungong rivers and assess how sediment accumulation and quality, water quality and habitat might affect those values. Based on those results, one pool will be selected for a pilot study to test the effect of removing sediment and enhancing habitat on ecological condition and values. This project forms part of a broader program, "Cleaning up the Canning", funded through the Australian Government's Urban Rivers and Catchment Program.

Aims

- Identify areas of the Canning, Southern and Wungong rivers where intervention to improve habitat and ecological function might be appropriate.
- Investigate the ecological values and condition of 10 river pools, to produce a baseline dataset.
- Identify the river pool most appropriate to trial intervention actions and determine an appropriate intervention approach.
- Evaluate the effect of the trial intervention on river functions and values against available baseline data.

Progress

- Preliminary desktop investigation of >30 potential pool sites identified 10 pools for ecological survey.
- A 12-month baseline survey of the 10 sites is near completion. For each site, surveys involved: fyke netting and box trapping for fish, crayfish and turtles; water quality surveys for nutrient chemistry and physical parameters; hydrology surveys to quantify river discharge; a mussel survey to characterise the populations of the threatened Carter's mussel (*Westralunio carteri);* in-river habitat assessment; and sediment chemistry at 3-4 sites within each pool.
- Criteria were developed to inform the selection of the top five sites for potential intervention activities. These will be the focus the next phase of investigations.

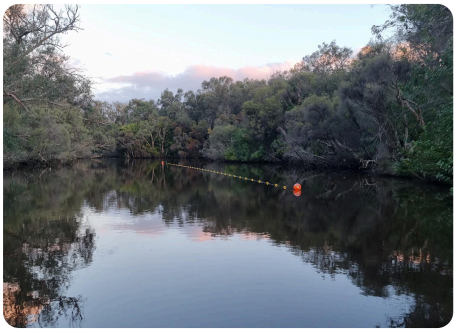
Management Implications

- The baseline dataset created by this project will provide valuable insight into the ecological values that the rivers support and the factors affecting them. Threats will be identified to inform management intervention to protect existing values.
- Improved knowledge of the river's ecology will inform the selection of a trial management intervention, such as removal of accumulated sediment, or introduction of more complex habitat.

Future Directions

- Remaining baseline surveys will be completed.
- Data from the ecological and hydrological surveys will be analysed to: 1) characterise the flora and fauna communities of the pools; 2) investigate how biotic and abiotic factors might influence the species assemblage and health in the pools; and 3) identify the key factors affecting the ecological values of the

pools.
- Results and conclusions of the ecological surveys will be documented in a report provided to key stakeholders.
- Identification of a trial intervention site in consultation with Whadjuk advisors and other stakeholders.
- Ecological surveys will be repeated at the intervention site and reference sites to evaluate the effect of the intervention on river functions and values.



Kent St Weir Pool - A case study in maximising environmental outcomes through better adaptive management

SP-2024-5

P Novak, S Thompson, T Ryan, A Gillies, K Trayler

Context

The Kent Street Weir Pool (KSWP) of the Canning River is one of the largest freshwater ecosystems in the Perth metropolitan area. It is affected by a range of anthropogenic stressors and as a result, has suffered poor water quality and low native fish abundance and diversity. This project aims to ascertain the current environmental values of the KSWP and develop and implement a range of interventions to improve biodiversity values within this important freshwater system. This project forms part of a broader program, "Cleaning up the Canning ", with funding from the Australian Government's Urban Rivers and Catchments Program

Aims

- Build contemporary understanding of biodiversity values and ecosystem function and trial agreed management approaches that will improve water quality and in-stream connectivity to the benefit of native species, including (where present) threatened species.
- Conduct a baseline assessment of water quality, biodiversity values, ecosystem function and connectivity of the KSWP (including fish, crustaceans and macro invertebrates).
- Review existing water quality and biotic data in response to management approaches to inform choice of management interventions for optimal environmental outcomes.
- Undertake experimental trials of management approaches to promote re-establishment of the submerged macrophyte community, better water quality and improved biodiversity.
- Evaluate the outcome of these trials relative to baseline conditions.

Progress

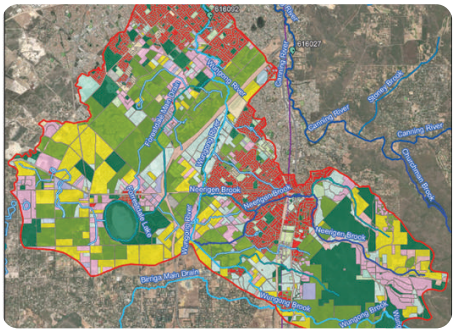
- Completed fish, crustacean and Carter’s freshwater mussel (*Westralunio carteri)* surveys.

Management Implications

- The project is expected to result in improvement of the biodiversity and environmental condition of the Canning River KSWP.
- In addition, significant knowledge of biodiversity in the KSWP and its response to environmental changes will be generated, for the ongoing management of this important freshwater habitat.
- The project will review management approaches and the impact they may have on water quality and biodiversity values, allowing informed and effective management of the KSWP into the future.

Future Directions

- Complete final macroinvertebrate, sediment and habitat surveys.
- Prepare technical report and manuscripts on the results from the baseline surveys.
- Develop and implement a water level management plan to create conditions likely to facilitate germination of any existing submerged macrophyte seed bank.
- Direct planting of native submerged macrophytes into the KSWP.
- Feral fish removal and/or exclusion trials.
- Detailed review of long-term water quality data in the KSWP.



Southern River Catchment nutrient export modelling

SP-2024-6

S Adiyanti, K Trayler, E Sydney, A Gillies

Context

Southern River Catchment (150km^2) is the second largest nutrient contributor to the Swan Canning Estuary. The catchment is intersected by the Darling Fault. On the east of the fault, 25 per cent of the area is at high elevation (~350m) of the Darling Scarp including the Wungong Dam upstream. In the west, the elevation varies between 2.6m and 40m. The catchment's water quality is influenced by this unique topography and by a mixture of land uses, affecting both surface and groundwater inputs particularly in the shallow groundwater regime on the western side. Previous attempts have been made to model nutrient exports from Southern River, but there remain uncertainties in the groundwater and land use type contributions to the overall nutrient export to the estuary. Refinement of the nutrient model with a distributed (2D) hydrological model and inclusion of groundwater-surface water interaction is essential to reduce these uncertainties in a changing climate.

Aims

- Estimate the surface water flux (discharge), baseflow and regional groundwater contribution to the Southern River Catchment nutrient export.
- Identification of active and legacy source contributions to stream nutrient load.
- Estimate the relationship between nutrient export and change in land use and land cover.
- Estimate the land use-specific nutrient export rate (with uncertainty estimates).
- Predict climate change impact and catchment management scenarios on Southern River nutrient export.

Progress

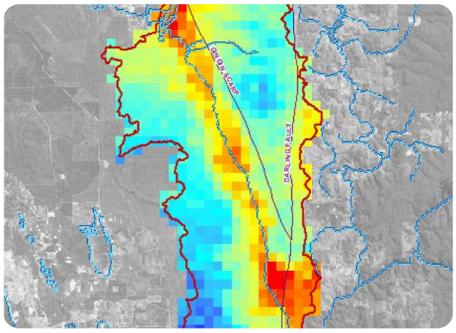
- Calibration and validation of the distributed (2D) hydrological model 1998-2024 has been completed with satisfactory performance metrics for both daily and monthly outputs.
- Preliminary hydrological model results were presented to and positively received by stakeholders, including the Cities of Armadale and Gosnells and the Commonwealth Department of Climate Change, Energy, the Environment and Water.
- Pressure loggers were installed in the waterway and are being used to improve flow validation.
- Water quality data collected since November 2024 and Forrestdale groundwater monitoring data (2017-2024), provided by the City of Armadale, have been processed.
- The model has been updated with climate prediction outputs from the WA Government's Climate Science Initiative for south-western Western Australia (CMIP6 at 4km grids) for air temperature, evaporation and rainfall.

Management Implications

- Knowledge of daily discharge at any given point (within the 500m grid domain) at any given time in the ungauged sub-catchment is important for identifying and managing the possible transport of active and legacy nutrients to the downstream environment.
- Understanding the seasonal variation of flow and water quality monitoring sites and their relationship will give an indication of whether nutrients are from active or legacy sources. This information is critical to determine the most appropriate water quality improvement measures within the catchment and their effect on water quality targets.

Future Directions

- Investigate the relationship between flow and nutrient concentration at monitoring sites.
- Apply predicted future rainfall, air temperature and potential evaporation (2025-2100) into the calibrated and validated model to forecast the future hydrology and nutrient export under different climate scenarios.



Ellen Brook Catchment nutrient export: sources and pathways

SP-2022-33

S Adiyanti, K Trayler, A Basnett

Context

Ellen Brook is a tributary to the Swan Canning Estuary and is identified as the major contributor of nutrient loads to the system. Water quality in Ellen Brook Catchment and its sub-catchments is influenced by a mixture of land uses and activities affecting both surface and groundwater inputs. Previous attempts have been made to model nutrient exports from the catchment but there remain uncertainties in the groundwater and land use type contributions to the overall nutrient export to the estuary. Refinement of nutrient modelling with inclusion of groundwater-surface water interactions is essential to reduce these uncertainties. To better inform land management policy and support decision making for nutrient interventions, a distributed 2D processed-based hydrological and nutrient model for Ellen Brook is being developed. The model will be used to quantify nutrient export from specific land use types, differentiate active and legacy sources and illustrate spatial and temporal variability. Climate change influence will also be investigated.

Aims

- Generate a hydrological and nutrient export model for Ellen Brook Catchment to estimate the surface flux (discharge), baseflow and regional groundwater contribution to nutrient export.
- Identify active and legacy sources contributing to stream nutrient load.
- Estimate the relationship between nutrient export and change in land use and land cover.
- Estimate land use-specific nutrient export rates.
- Predict climate change (2025-2100) impact and catchment management scenarios for Ellen Brook nutrient export.

Progress

- Calibration and validation of the Ellen Brook mesoscale hydrological model 2010-2024 has been completed, with the inclusion of estimated daily flows of Lennard Brook, Yalyal Brook and Breera Brook significantly improving validation of the model.
- Identification of active and legacy sources of nutrients and development of the relationship between nutrient export and changes in land use/land cover has been completed, utilising total nitrogen and total phosphorus concentration 2006-2024, collected by Ellen Brockman Integrated Catchment Group.
- The model framework and results were presented at the Sub-Regional Chairs and Coordinators Meeting and well-received.
- The latest Climate Science Initiative model outputs (at 4km grids) for the period 1951-2100 have been re-gridded to suit the Ellen Brook domain (100m grids).

Management Implications

- Understanding the seasonal variations of nutrient concentrations at each monitoring station and their relationship with flow will give an indication of whether nutrients are from active or legacy sources, which is critical to assess the influence of water quality improvement measures within the catchment on water quality targets.
- Development of the nutrient export model provides an opportunity to evaluate how land use change affects water quality and whether intervention options are effective in achieving water quality targets.
- Once complete, the model will be able to forecast hydrology under different climate scenarios and work as a tool for management to understand how nutrient export will change with these scenarios and landuse change.

Future Directions

- Progress development of a Bayesian nutrient model utilising 1km gridded simulated flow and nutrient monitoring data collected at 34 monitoring sites between 2010 and 2024.
- Apply future rainfall, air temperature and potential evaporation predictions (2025-2100) into the calibrated and validated model to forecast the future hydrology and nutrient export under different climate scenarios



Habitat enhancement approaches within the Swan-Canning Estuary.

SP-2022-29

L Arrowsmith, K Trayler, J Baker

Context

The Swan Canning Estuary is a microtidal system that has become subject to increasing urbanisation and development along its shorelines. As a result, river walls and rock revetments have been used to modify the shoreline and provide protection against erosion, often resulting in reduced natural habitats and species abundance. Eco-engineered habitats are an alternative method to aid in protecting shorelines and reducing erosion, whilst promoting biodiversity and alleviating declines in habitats. As existing modifications in the estuary reach the end of their intended lifespans and new structures are built to reduce erosion, there is potential to integrate eco-engineered technological and nature-based solutions in the estuary.

Aims

- Evaluate and incorporate the use of living seawalls (LSW) habitat panels along three sections of river wall within the lower Swan Canning Estuary to assess their effectiveness in enhancing habitats.
- Provide baseline information on the effectiveness of two commonly used erosion control techniques for enhancing habitat.
- Determine the effectiveness of LSW panels for enhancing habitat percentage cover and richness along river walls compared to unmodified walls.
- Investigate the influence of each habitat panel design on colonisation rates and species diversity on all panels.

Progress

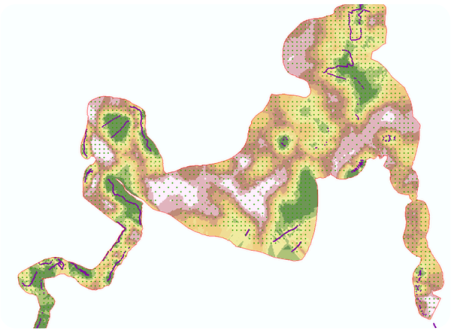
- Sampling of the habitat panels was finalised.
- Modified seawalls had a higher percentage cover of macroalgae species and abundance of bivalve species than the unmodified seawalls. In contrast, the unmodified seawalls had a greater abundance of snail species.
- Macroalgae growth and invertebrate settlement fluctuated seasonally. In winter, the modified seawalls had higher percentage cover and species counts in comparison to the unmodified seawalls. During the summer months growth and settlement decreased on the modified seawalls due to exposure to higher temperatures and low tides.
- The rockpool habitat panels were the most effective at promoting biodiversity with a 60 per cent increase in species coverage compared to the control panels.
- Preliminary results were presented at the 2024 Australian Marine Sciences Association conference in Hobart.
- A best management practice guideline and journal manuscripts are in preparation.

Management Implications

- The project is continuing to provide guidance to local governments on how to improve conservation of estuarine biodiversity by incorporating eco-engineering solutions to shoreline infrastructures.
- The increasingly extreme Australian summer has implications for the type and application of habitat panels. Panels that can retain water are more effective at promoting biodiversity.
- A best management practice guideline is being produced for local government and other organisations. This will guide the application of habitat panels along seawalls and will specify the position and type of panels that would be most suitable for areas along the Swan Canning Estuary. Additionally, it will provide a cost breakdown of the work, and how to monitor the installation of artificial habitat panels to promote macroalgae and invertebrate species growth.
- The methods developed during the project, such as panel installation and suitability, as well as biodiversity assessment protocols, will be used to inform other projects aimed at improving habitats along Swan Canning Estuary shorelines.

Future Directions

- Finalise and submit manuscript for publication.
- Finalise the best practice management guideline for distribution to local governments and natural resource management organisations.
- Support the development of promotional material for local government.



Mapping habitat in the Swan-Canning Estuary.

SP-2022-30

L Arrowsmith, K Trayler, C Phelps, J Cosgrove, S Adiyanti, P Howie, J Baker

Context

Disturbance in the Swan Canning Estuary over long periods has influenced habitats and potentially diminished species richness and abundance but there is limited information available that documents the distribution of habitat. Using remote image collection methods (remote operated vehicle, drop-cameras and tow-cameras) in conjunction with habitat classification systems, benthic surveys can be conducted across areas of importance to assist in assessing species abundance and extent of species reduction over time. As the estuary is an important ecosystem for a range of species and habitats, as well as recreational users, collecting data to establish distribution maps of key habitats is important for understanding the influences this system.

Aims

- Produce broad scale maps of the benthic habitat in the Swan Canning Estuary to inform understanding of habitat type, distribution and extent.
- Develop and consolidate maps of key species and communities and identify areas of ecological significance in the estuary.

Progress

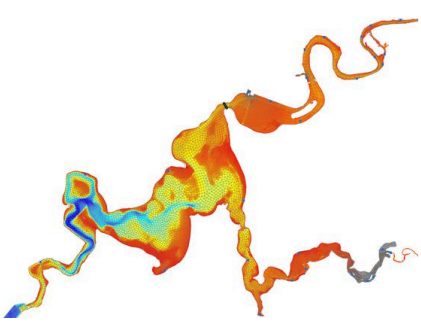
- Habitat images from the 2019-2020, 2023 and 2024 mapping surveys have been analysed in ReefCloud to provide species identification.
- Benthic habitat maps for 2019-2020 have been produced showing seagrass, macroalgae, sand, shell and rock distributions through the lower and middle Swan Estuary and the lower Canning.
- Image and benthic habitat data processing in the R package has been completed for 2023 and 2024.
- Raster processing for the 2023 and 2024 benthic habitat maps is underway with the aim of building on existing maps showing the distribution of seagrass, macroalgae and other substrates in the estuary.

Management Implications

- Benthic habitat maps identifying areas of ecological importance and coverage through the Swan Canning Estuary will inform development decision making and habitat enhancement projects.
- The methods and analyses used to develop these maps provide a framework for future mapping to assist in informing river managers about trends in benthic habitats.

Future Directions

- Continue to classify benthic habitat images that are collected through the Swan Canning Estuary.
- Finalise the 2023 and 2024 benthic habitat maps to assist with ecological modelling of important areas through the estuary.
- Continue to consolidate benthic imagery to update the distribution of species and habitats in the estuary.
- Use the 2019-2020 and the 2023, 2024 maps to assist with habitat suitability modelling for future projects, including collaboration with The Nature Conservancy project to develop nature-based solutions for remediating foreshores (EXT-2025-19), which is supported by the Australian Government's Urban Rivers and Catchment Program.



Using Swan Canning Estuarine Response Model to optimise oxygenation plant efficiency

SP-2022-34

S Adiyanti, K Trayler

Context

Understanding spatiotemporal variability in hydrodynamic and biogeochemical conditions of the Swan Canning Estuary is essential to improve the distribution of oxygen-saturated water injected via side-stream supersaturation oxygenation plants at Guildford and Caversham. Information on dissolved oxygen distribution and likelihood of benthic water experiencing hypoxia in each season are needed to ensure the plants are operating optimally under current and future climate conditions. This project will contribute to improved oxygenation approaches in the estuary by developing better understanding of variability and drivers of oxygen conditions and enabling predictive support for decisions in relation to oxygenation effectiveness.

Aims

- Refine the application of the 3D hydrodynamic oxygen predictive Swan Canning Estuarine Response Model (SCERM44).
- Understand the impact of seasonal variations in estuary conditions on the extent of the oxygenation plant generated plumes.
- Understand how salt wedge dynamics influence oxygen distribution.
- Understand the influence of catchment inflow water quantity and quality.
- Assess approaches to improve oxygenation plant efficiency.
- Assess the potential impact of 2030 climate change predictions and oxygenation adaptation requirements.

Progress

- Model validations were performed for both SCERM44 and SCERM29 using simulated, time series data compared against actual field data [hydrodynamic and dissolved oxygen concentrations (DOx)].
- In April, cross-sectional discharge measurements were taken at 21 locations in the Swan Estuary using an acoustic doppler current profiler and timeseries of DOx and current were recorded. Loggers were also set to record fine-scale temperature and salinity data. Data are currently being processed to undertake discharge model validation.
- Automated processing scripts have been prepared to compare simulated and field data efficiently.
- Data from the WA Government's Climate Science Initiative, Coupled Model Intercomparison Project - Phase 6 (CMIP6) datasets for south-west Western Australia, comprising 4km grids of hourly data (near surface: air temperature, relative humidity, precipitation, shortwave and longwave radiation, eastward and northward wind) and 3-hourly data (sea level pressure) have been processed to suit SCERM meteorological forcing/boundary conditions.

Management Implications

- The refined model will provide key understanding of hydrodynamics and oxygen dynamics of the Swan Canning Estuary, in particular for the upper reaches of the Swan Estuary, which are influenced by the oxygenation plants. This will assist oxygenation plant managers to optimise operations under present day conditions and adapt to predicted future climate conditions.
- Understanding future climate impacts on the effectiveness of the oxygenation plants is important to assess any required mitigation actions.

Future Directions

- Apply CMIP6 future climate outputs as meteorological forcing (2025-2030) into the calibrated and validated SCERM to gain insights on the required mitigation actions.



Apply acoustic technologies to investigate fish communities and movement

SP-2020-29

S Hoeksema, K Trayler, J Watsham, P Howie, J Chapman, R Karker

Context

How fish utilise the Swan Canning Estuary, including distances moved on a daily or seasonal basis and movements in response to changes in environmental condition, remains a key knowledge gap despite a number of detailed studies on fish biology and ecology over the past three decades. This is particularly

relevant for juvenile bull sharks (*Carcharhinus leucas*) in the estuary for which little is currently known about how they use and how long they reside within the system.

Acoustic telemetry can be utilised to provide valuable information on fish movements relative to water quality parameters, such as salinity and temperature. It can also be employed to understand how fish utilise habitats of differing complexity, particularly those that are not suited to traditional sampling methods. An acoustic receiver array was established in the Swan Canning Estuary in 2016.

Aims

- Utilise acoustic technology to assess fish communities and movement relative to water quality and habitat.

Progress

- Annual fish community monitoring (SP-2018-033) was completed in the Swan Canning Estuary with no juvenile (<1m) bull sharks tagged.
- The number of juvenile sharks tagged since February 2022 remained at 15, with 11 sharks active in the array during the year.
- Annual maintenance of the acoustic array was undertaken and analysis of downloaded data is underway.
- Data on juvenile and adult bull sharks were shared between DBCA and Department of Primary Industries and Regional Development (DPIRD) under a collaborative arrangement to help inform risk mitigation in the Swan Canning Estuary.
- Genetic samples obtained from the juvenile bull sharks have been added to DPIRD's statewide genetic database for this species.

Management Implications

- Tagging juvenile bull sharks within the Swan Canning Estuary will elucidate their movements within the system and improve our understanding of residency time, distribution and habitat use to identify whether important nursery areas exist that require protection or enhancement.
- Data from the three real-time receivers deployed at priority areas in the estuary, the Swan Canning Acoustic Array and DPIRD receivers at metropolitan coastal locations, will help to inform shark hazard risk mitigation in the estuary and nearshore coastal environment.

Future Directions

- Progress analysis of bream movement data relative to water quality in the Swan Canning Estuary and publish in a peer-reviewed journal.
- Undertake further tagging of juvenile bull sharks during the 2025-26 pupping season during annual fish community monitoring and analyse movement data.
- Continue to collaborate and share information with DPIRD to inform shark hazard risk mitigation in the estuary and nearshore coastal environment.



Investigations of contaminants in the Swan Canning

SP-2020-26

P Novak, K Trayler, K Bornt, S Hoeksema

Context

The Swan Canning Estuary is home to diverse faunal assemblages, productive seagrass and macroalgal communities and is a focus for many water-based activities, including recreational fishing. The estuary is situated wholly in the Perth metropolitan region and drains a large agricultural catchment. It faces many anthropogenic stressors, including flow reduction, excessive nutrient input, and contaminant loading associated with a range of contemporary and historical land uses. Ensuring environmental and social values are maintained requires an understanding of threats. In particular, it is important to understand the extent, distribution and potential impact of both novel and legacy contaminants, evaluate risks to the ecosystem and human health and improve approaches to management.

Aims

- Determine the distribution, extent and types of contaminants in the surface waters and sediments of the Swan Canning Estuary and its catchment.

- Determine the uptake of contaminants in key estuarine biota.
- Understand potential risks to human health through consumption of estuarine species.
- Explore potential control mechanisms for contaminants.

Progress

- A paper investigating plastic infrastructure, such as jetties and boardwalks, as a potential source of plastic pollution in the Swan Canning Estuary has been published in *Marine Pollution Bulletin*.
- Contributed to a manuscript in collaboration with CSIRO and the Department of Water and Environmental Regulation, investigating the presence of heavy metals and per- and polyfluoroalkyl substances (PFAS) in frogs in the Perth metropolitan area, which is under review in *Environmental Pollution*.
- A collaborative paper with The University of Western Australia and Department of Primary Industries and Regional Development, investigating the presence of plastic contamination and plasticisers in estuarine and marine decapods has been prepared for submission.

Management Implications

- Information on the distribution and concentration of contaminants in the Swan Canning river system is used to identify potential environmental risks.
- Findings from study of PFAS and heavy metals in frogs highlighted the need to assess essential metal(loid)s alongside pollutants like PFAS to refine ecotoxicological risk assessment.
- Results and recommendations of the plastic infrastructure survey are being used to guide installation of infrastructure in the Swan Canning Riverpark through development of a Guidance Note on Use of Plastic in Riverpark Infrastructure. The work has influenced revision of Corporate Policy Statements relating to planning for jetties, miscellaneous structures and facilities in the Swan Canning development control area.

Future Directions

- Develop a monitoring plan for contaminants within the Swan Canning River system.
- Where appropriate, continue to collaborate with external parties to advance investigation of the extent and potential impacts of contaminants in the Swan Canning Estuary



Swan Canning water quality monitoring

SP-2020-27

S Hoeksema, K Trayler, J Cosgrove, S Thompson, J Watsham, P Howie, J Chapman, R Karker, J Gregory, A Gillies, P Novak

Context

Water quality in the Swan Canning Estuary and its catchment has been routinely monitored over the past 25 years, producing one of the longest continuous datasets for any estuarine system in Australia. Data produced through the monitoring program provide essential information to assess system response to management actions, changes in estuary condition over time and to report against estuary water quality targets, catchment nutrient reduction targets and phytoplankton trigger levels. Data have also been used to progress the development of estuarine and catchment models that contribute to decision support.

Aims

- Undertake weekly monitoring of physical water quality parameters and fortnightly collection of phytoplankton and nutrient samples at routine estuarine monitoring sites.
- Undertake fortnightly monitoring of physical water quality parameters and collection of nutrient samples at routine catchment monitoring sites.
- Use the water quality and biological data collected from the Swan Canning Estuary and its catchment to provide weekly water quality and annual data reports on the condition of the river system to inform management actions.

Progress

- Water quality profiles were taken weekly at 36 sites and phytoplankton and nutrient samples were collected fortnightly at 21 sites throughout the Swan Canning Estuary and at up to 33 sites in the Swan Canning catchment.

- Water quality reports and phytoplankton information were updated weekly on the DBCA website and key stakeholders were provided information directly.
- An online data dashboard intended to make monitoring information more accessible was trialed as a beta version, with testing informing further improvement.
- Oxygen data informed on performance and management of oxygenation plants.
- A technical report on the condition of the Swan Canning waterway (2015-2020) is nearing completion. Information from this report was used in development of a revised draft of the River Protection Strategy.

Management Implications

- The online data dashboard is intended to make monitoring information available to the public and stakeholders in a more interactive and timely manner, which supports understanding of the waterway's condition, evaluation of change over time and performance assessment of management action.
- Information on potential public health risks, such as harmful algal blooms, black-water events and fish-kills, are provided to Department of Health, Department of Primary Industries and Regional Development and DBCA incident management teams, as required.

Future Directions

- Continue routine water quality monitoring in the Swan Canning river system and catchment and utilise data to inform management and research.
- Finalise and deploy the beta-version of the online data dashboard to publicly present water quality data and work towards the development of further functionality and updates.
- Finalise the production of the technical report on the condition of the Swan Canning river system (2015-2020).
- Make data reports on the estuary and catchment accessible on the DBCA data catalogue and via the library.



Algal blooms: investigations and control

SP-2018-35

C Phelps, K Trayler, J Cosgrove, S Thompson, S Hoeksema

Context

Depending on environmental conditions, algal blooms can proliferate within the Swan and Canning rivers and are exacerbated by anthropogenic activity. While most algal blooms are harmless, on occasion toxic blooms occur that can be harmful to wildlife and humans. The impact of these blooms on environmental and social values will depend on the type and severity of the bloom. Understanding the dynamics of algal blooms and their toxicity is important in determining their impact and approaches to their control. Regular monitoring of the Swan Canning waterway informs analyses of these events and adaptive management responses to them. Finding useful and applicable methods for managing blooms in the Swan Canning waterway requires an understanding of environmental triggers, the species involved, their toxic profile and laboratory and field-based trials. It is also important to consider the potential impact of control products on waterway values.

Aims

- Investigate harmful algal blooms and understand factors influencing their presence and toxicity.
- Test products suitable for controlling algae in laboratory and field settings.
- Understand the risks associated with blooms and bloom control products.
- Refine tools that contribute to understanding algal blooms.

Progress

- Multiple harmful algal species were detected in the Swan Canning waterway over summer and autumn periods. One potentially ichthyotoxic alga, *Karlodinium* cf. *armiger* was present at high densities and impacted a 25km reach of the upper Swan River for long periods. Two significant fish kill events were recorded.
- The exact identity and toxic profile of *Karlodinium* cf. *armiger* are unknown and samples were supplied to the University of Technology Sydney for isolation and culture with the aim of genetically identifying specific taxa affecting the river system.

- Laboratory trials have shown low application rate of a modified clay (kaolinite-polyaluminium chloride) slurry may be effective in controlling harmful algae like *Karlodinium* species and *Alexandrium minutum*. Subsequent evaluation of the literature suggests that there would be minimal impacts on the benthic environment of a low application rate (≤0.1 g/L).

Management Implications

- Routine water quality monitoring continues to provide early detection of algal blooms, with additional targeted response sampling providing enhanced spatial and temporal data for improved incident management.
- Favourable clay trials with the additive of poly-alum chloride and low risk to the environment suggest the viability of progressing with larger scale, potentially *in situ* trials to control toxic algal blooms.

Future Directions

- Investigate the long-term algal bloom dataset and historical management actions in the Kent Street Weir Pool to understand key drivers influencing bloom intensity and frequency.
- Continue the collaboration with University of Technology Sydney which can potentially lead to the design of specific primer sets, allowing for efficient and rapid future identification of toxic *Karlodinium* species using qPCR.
- Explore opportunities for *in situ* trials to control toxic blooms.



Incident investigations, response and advice

CF-2018-95

K Trayler, J Cosgrove, S Hoeksema

Context

Rivers and Estuaries Science plays an essential role in investigating issues as they arise in the Swan Canning Riverpark. This involves investigating events (such as harmful algal blooms, fish kills and pollution discharge), examining causes, implications and response actions.

Aims

- Monitor toxic algal blooms as they arise and report to an incident response team.
- Investigate fish kills as they arise and inform the incident response team.
- Investigate dolphin deaths as they arise, collate information and advise river managers and operational personnel when required.
- Investigate and provide advice to river managers on contaminant spills.
- Provide information and advice to support river management and planning.

Progress

- An ichthyotoxic dinoflagellate bloom of *Karlodinium* cf. *armiger* began in December 2024 and intensified through most of autumn, peaking at 170,100 cells /mL and affecting a 25km stretch of the upper Swan. The Canning River was affected to a lesser extent.
- Two fish kills were associated with the presence of this alga: one in the Swan River (~500 fish) and one in the Canning River (~100 fish).
- Samples of the bloom were sent to the University of Technology Sydney for culture, pending genetic identification.
- Necropsy and pathology tests followed the deaths of a dolphin and her calf in May 2025. These were due to natural causes.
- Saline intrusion threatened freshwater values in the Kent St Weir Pool in February 2025 and was monitored and managed through flushing.
- Sewerage spills into the lower Swan River occurred in June 2025, with water samples provided to the Water Corporation and Department of Health for evaluation of contact risk.

Management Implications

- Monitoring results and scientific advice effectively supports response management actions.
- An Incident Management Team was activated in early December 2024 with weekly reporting on blooms and implications for estuarine health and management through to the end of bloom conditions in May

2025.
- This is the second year in a row where significant and long-lasting blooms of the harmful *Karlodinium* have been encountered in the upper Swan.
- Extremes in water temperatures and high tides in 2025 exacerbated river incidents, indicating a need to adapt management responses to future changing climatic conditions.
- Better identification of *Karlodinium*, its toxic profile and control approaches are needed to improve management response and protocols.

Future Directions

- Respond to river incidents and involve key stakeholders and other management agencies where necessary.
- Provide advice to Swan Canning Waterways Branch incident management teams and statutory assessments unit.
- Work with the university sector to improve understanding of harmful algal species and control approaches.



Investigating fish communities as an indicator of estuarine condition

SP-2018-33

K Trayler, J Watsham

Context

Fish communities exhibit predictable responses to ecosystem degradation and stress, and thus may be used as sensitive indicators of the ecological condition of these systems. Biotic indices, based on fish and other biological communities, are now used worldwide to quantify the ecological health of rivers, lakes, estuaries and many other environments. This project applies a Fish Community Index developed by Murdoch University in collaboration with government agencies between 2007-2012 as a measure of the condition of the Swan Canning Estuary. This has been part of regular monitoring and reporting on the waterway since 2012 and a report on fish communities in the Swan Canning Riverpark is published annually.

Aims

- Undertake evaluation of the fish communities in the Swan Canning Riverpark for the purposes of applying the Fish Community Index (FCI) of estuarine condition and contribute to understanding waterway health.

Progress

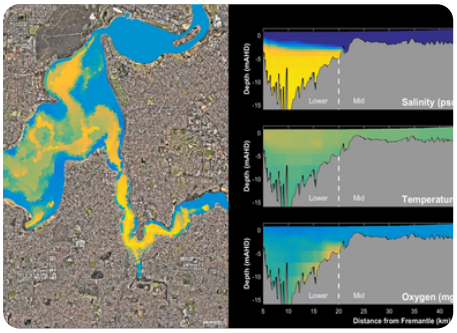
- The 2024 fish community index report was released. This reported that the combined FCI scores for nearshore and offshore waters were the fourth-highest recorded since monitoring began in 2012.
- The number of species and individuals recorded from the offshore waters in 2024 were amongst the greatest of any monitoring year.
- Fish communities in nearshore waters of the lower Swan Canning and Canning estuary were negatively impacted by extreme low tides and hot water conditions.
- The offshore waters of the Canning Estuary exhibited the lowest FCI scores of any zone.
- Catches of some marine species (including Hawaiian giant herring, southern eagle ray, yellowtail grunter and sea mullet) were relatively high in 2024.
- Summer and autumn sampling for 2025 has been completed and an annual report is being prepared.
- No juvenile bull sharks (*Carcharhinus leucas*) were caught.

Management Implications

- The high FCI in 2024, particularly in offshore waters, was influenced by the movement of marine species into the waterway and supported by marine-like conditions in the waterway through summer-autumn.
- Good riverine flow in the previous winter is also thought to have positively influenced juvenile recruitment in all zones.
- Extreme low tides were a negative pressure on fish communities in nearshore areas and particularly the mudflats of the lower Swan and lower Canning Rivers.
- The Canning River has exhibited consistently low FCI scores in offshore areas since 2012 and this is thought to be influenced by a combination of water quality issues (salinity dynamics and night-time hypoxia), the lack of complex habitat and reduced food resources.

Future Directions

- Complete the 2025 fish communities index report.
- Undertake fish community monitoring in late summer and autumn 2026.
- Continue to support the capture, tagging and release of juvenile bull sharks in order to build understanding of movement patterns of that species.
- Compile video information to improve understanding of this project in context of water health reporting.



Model frameworks for estuarine reporting

SP-2018-27

S Adiyanti, K Trayler, S Hoeksema

Context

Between 2011 and 2016, the department and project partners at The University of Western Australia and Department of Water and Environmental Regulation developed a spatially resolved coupled hydrodynamic-biogeochemical model, the Swan Canning Estuarine Response Model (SCERM). The model is a useful tool that can be used for predictive purposes as well as display. SCERM has the ability to complement but not replace, regular water quality monitoring and to simulate and display information on a wider spatial scale and over finer temporal resolution than the existing weekly water quality reporting. This project explores the capacity of a predictive model framework to rationalise water quality monitoring data, display information in a near real-time format and enhance understanding of the waterway.

Aims

- Evaluate optimal water quality data requirements for predictive modelling of estuarine conditions.
- Develop a display showing near real-time data.
- Validate model forecasts and hindcasts.
- Enhance understanding of estuarine dynamics.

Progress

- The model framework has been extended over a longer timeframe (2007-2025), with the 2017-2025 model framework incorporating the latest bathymetry datasets of the upper Swan River (surveyed in 2023 and 2024) and weekly estuarine monitoring datasets.
- The most recent climate predictions from the WA Government's Climate Science Initiative - Coupled Model Intercomparison Project Phase 6 (CMIP6) for south-west Western Australia have been incorporated to facilitate assessment of the Swan Canning Estuary under future climate scenarios.
- Data frameworks established for the model were used to inform a beta-version of an online data dashboard that is designed to provide water quality monitoring data to stakeholders and the public.

Management Implications

- The Swan Canning Estuarine Response Model (SCERM44) is an important tool that can be adapted to inform new management questions.

Future Directions

- Refine the model for application to habitat suitability assessments and assessments of the potential impacts of various climate scenarios.
- Model outputs will be made publicly available when the beta-version of the data dashboard is released.



Seagrass monitoring and evaluation

SP-2018-39

C Phelps, J Cosgrove, K Trayler, P Howie, J Watsham, A Gillies, J Chapman

Context

Seagrasses are a highly valued component of estuary ecosystems as they improve water quality by preventing sedimentation, removing excess nutrients and oxygenating the water. They also provide habitat to various aquatic organisms and are a food source for waterbirds. Seagrasses are recognised as being a bioindicator of ecosystem health, as they respond to changes in their physical and chemical environment, with loss of seagrass representing degraded conditions. An essential component of effective estuary management is ensuring that seagrass communities remain viable and resilient. DBCA continues to monitor seagrass throughout the Swan Canning Estuary to inform management decisions, in particular on new development proposals and to track the condition of estuarine health.

Aims

- Describe the variability of several seagrass characteristics including seagrass cover, species composition and seagrass reproduction in response to possible changes in key environmental and climatic conditions.
- Understand the sensitivity of seagrass responses to anthropogenic stressors, such as water quality, sediment stress, drift macroalgae load and invasive species.
- Integrate benthic assessment and habitat mapping data to produce a benthic habitat map of the estuary, which includes seagrass population distribution.

Progress

- Annual seagrass sampling of the Swan Canning Estuary was conducted during the spring-autumn growth season.
- Additional drop camera images were taken at the ‘deep edge’ of sampling sites to better understand the extent of meadows at varying depths and water quality.
- The overall performance index identified all sites in the estuary as ‘good’ this season, although seagrass at the Milyu and Canning sites displayed three 'fair’ performance scores out of the four possible metrics this year.
- This season was characterised by some of the highest spring maximum temperatures over the last 79 years. Rainfall was low, with spring rainfall being just over a third of the long-term average. Tides were at the highest level observed in the last 10 years, in contrast to the extreme low tides of the previous summer. Macroalgae were present in high abundances.

Management Implications

- Seagrasses are important habitats and can be sensitive to environmental change. As such, identifying and regularly monitoring potential pressures supports evidence-based management and, where necessary, action to reduce adverse impacts on seagrass communities.
- Heat stress, likely driven by climate change, is exacerbated by abundant macroalgae, highlighting the need to manage nutrient loads to the waterway.
- Seagrass monitoring at the Milyu and Canning sites informs on waterway management performance. Further reduction in seagrass health at these sites will necessitate extended effort to identify causal factors and potential management responses.
- Available information was compiled to produce an updated seagrass distribution map that was provided to waterway planners as a tool for assessing development applications in the Swan Canning Riverpark.

Future Directions

- Finalise the 2024-25 seagrass report and promote findings to inform and educate on seagrass health in the Swan-Canning Estuary.
- Continue implementing, reviewing and validating seagrass monitoring as stipulated in the five-year reporting cycle.
- Liaise with stakeholders regarding developments in the Swan-Canning estuary to mitigate potential impacts on seagrass communities.



Species and Communities

Program Leader: Ruth Harvey

Species and Communities Program supports the delivery of the Conserving Habitats, Species and Ecological Communities Service through the provision of biodiversity knowledge with consistent and reliable products, and information and advice regarding: legislation and policy development and interpretation, planning and priority setting, implementing biodiversity conservation programs, maintenance of data and other information, and community engagement. The program supports the department's operations in the areas of conservation of threatened fauna, flora and ecological communities; fauna and flora management; wetlands and off-reserve conservation. It administers the departmental Animal Ethics Committee and provides support to the Threatened Species Scientific Committee and the Threatened Ecological Communities Scientific Committee.



Assessment and advice for conservation significant species and ecological communities

CF-2023-14

C Bourke, T Sonneman, A Connell, R Rees, K Griffiths, T Johnston, R Harvey

Context

The *Biodiversity Conservation Act 2016* (BC Act), the *Environmental Protection Act 1986* (EP Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* provide legislative mechanisms for the protection of threatened species and ecological communities. Decisions for Ministerial authorisation to take or disturb threatened species or modify an occurrence of an ecological community require detailed understanding of the risks posed to the conservation of threatened biodiversity by these actions and cumulatively across all sources of impact. Assessing these risks requires the application of specialist technical knowledge and consideration of up-to-date scientific information.

Aims

- Effectively translate and communicate scientific knowledge and information to decision makers and managers through appropriate processes.
- Develop and maintain digital processes for administering authorisations under sections 40 and 45 of the BC Act.
- Evaluate applications to take threatened species and modify threatened ecological communities under sections 40 and 45 of the BC Act.
- Provide advice to the Department of Water and Environmental Regulation (DWER) and the Department of Mines, Petroleum and Exploration (DMPE) for decisions under Part V of the EP Act. This includes ensuring conditions and offsets are appropriate, aligned and based on best available scientific knowledge.
- Provide advice on threatened species and ecological communities for departmental submissions to external regulators under the EP Act, *Mining Act 1978*, and *Planning and Development Act 2005*.

- Publish and maintain public-facing guidelines, procedures and compliance documents to inform proponents regarding application processes

Progress

- A total of 452 authorisations to take or disturb threatened species were issued under section 40 of the BC Act, consisting of 295 for threatened fauna and 157 for threatened flora.
- Four authorisations to modify occurrences of threatened ecological communities were issued under section 45 of the BC Act.
- Advice was provided on risks to the conservation of threatened species, and ecological communities to inform regulatory processes for key State Government initiatives and developments of economic importance to WA, including green energy development, the Ord Irrigation Area, lithium and rare earth mineral proposals, bauxite mining expansion, oil and gas projects and major infrastructure projects.
- Responded to 102 internal formal requests for advice.
- Provided advice on 47 clearing permits to DWER and DMPE.
- Continued collaboration with other departments on Streamline WA initatives, such as parallel processing.
- Improved and published new guidance on the department's website.

Management Implications

- Improvements in the advice provided by the assessment team gives greater transparency, consistency and clarity for proponents and regulators with the continued use of standardised methods to assess risks to conservation of threatened species and threatened ecological communities (TECs). By better identifying key risks to biodiversity, more effective avoidance, mitigation, authorisation conditions and offset requirements can be implemented.
- The program contributes to the delivery of Streamline WA initiatives and ongoing approvals reform by providing advice to decision making authorities that is targeted, effective and timely.
- Increased awareness and understanding of the legal requirements for taking and disturbing threatened species and modifying threatened ecological communities, has resulted in a decrease in enquiries and an increase in applications.

Future Directions

- Further guidance for proponents and other decision makers will continue to be developed and published on the website. This improves decision making for key species and ecological communities that are frequently impacted by proposals such as black cockatoos.
- Continue to engage with other government agencies and stakeholders to assist in communicating standard risk assessment methods and changes to regulatory requirements since BC Act implementation.
- Improvements to internal processes and systems will be supported by digital technologies to assist in a more streamlined authorisation application experience.



Biodiversity knowledge management

CF-2023-41

K Griffiths, J Donaldson, C Sands, C Jackson, H Miller, F Patmore, Y Skinner, J Chick, S Williamson, A Cooke, B Meagher, M Greenwell, R Harvey

Context

The *Biodiversity Conservation Act 2016* (BC Act) provides the statutory basis for listing species that are at risk of extinction and ecological communities that are at risk of collapse as threatened. Processes for listing threatened species and threatened ecological communities depend on accurate and comprehensive biodiversity knowledge. Threatened species and ecological community knowledge is required by external stakeholders, including government agencies, industry, universities and research organisations, to inform conservation and management planning and decision making.

Aims

- Ensure the lists of threatened species and ecological communities under the BC Act remain up-to-date as threats change and scientific understanding improves.
- Ensure that listing processes are robust and involve scientific, operational, community, stakeholder and government consultation in a manner consistent with contemporary expectations and administer the

Threatened Species and Threatened Ecological Communities Scientific Committees and the Common Assessment Method framework.
- Maintain relevant departmental policies for the administration of the legislative process for maintaining conservation lists.
- Maintain contemporary, integrated and accessible databases and data management systems, with appropriate data standards.
- Collect and curate data for conservation listed species and ecological communities and make available as appropriate.

Progress
- As of 30 June 2025, there were 444 threatened flora species (174 critically endangered, 151 endangered and 119 vulnerable) and 16 presumed extinct flora species.
- As of 30 June 2025, there were 250 threatened fauna species (59 critically endangered, 59 endangered and 132 vulnerable), 23 presumed extinct fauna species and 114 specially protected fauna species.
- As of 30 June 2025, there were 65 threatened ecological communities (45 critically endangered, nine endangered and 11 vulnerable).
- Priority lists were maintained. As of 30 June 2025, there were 3507 species of priority flora, 225 species of priority fauna, and 390 priority ecological communities.
- Work on development of the new threatened species and ecological communities database, Boranga, continued to ensure integration and functionality with other corporate systems.
- Curation of data for conservation listed species and ecological communities continued, with 55,529 occurrence records of threatened and priority species (53,590 fauna and 1878 flora) and 61 ecological communities added or modified.
- The data provision service managed 1886 data search requests for threatened and priority flora (683), fauna (624) and ecological communities (579).

Management Implications
- High quality curated and effectively maintained data support decision making for management of conservation significant species, ecological communities and wetlands. Improvements in data sharing led to improved efficiency of conservation and approvals service delivery.
- Maintaining updated lists of threatened and priority species and ecological communities ensures that conservation and protection measures are appropriately targeted.

Future Directions
- The Boranga database will be launched and ongoing work to increase functionality and integration with Dandjoo, the State's biodiversity data repository, will ensure that it continues to deliver benefits for conservation decision making.
- Ongoing updates to the threatened species and threatened ecological communities lists will be made to ensure that the lists continue to be based on best available knowledge and is reflective of current biodiversity risk.



Conservation and recovery of threatened ecological communities

CF-2023-16

K Schell, R Luu, A Wisolith, R Harvey

Context

Ecological communities are listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) when they are at risk of collapse and the BC Act provides a number of statutory mechanisms to conserve and recover threatened ecological communities. Provision of expert scientific advice to guide the application of statutory conservation and management planning, regulation and on-ground implementation, improves conservation outcomes for ecological communities around the State.

Aims
- Develop, test and review threatened ecological community (TEC) identification and monitoring techniques to ensure methods are kept up to date with current scientific knowledge and environmental impact assessments are based on correct identification of TECs.

- Document and describe ecological communities eligible for listing as priority ecological communities (PECs) and TECs.
- Coordinate the preparation and implementation of recovery plans for TECs.
- Contribute to combined listing and preparation of conservation advice led by the Commonwealth government.
- Provide scientific knowledge to guide development of effective mitigation strategies for management of threats acting on terrestrial, aquatic, estuarine and marine ecosystems, and contribute to regional conservation planning with scientific knowledge.
- Leverage opportunities for stakeholder involvement in TEC recovery planning and recovery teams.
- Provide advice to land managers on appropriate fire management strategies.

Progress

- Specialist advice and support was provided to internal and external stakeholders on recovery actions and land management activities to support conservation of ecological communities.
- Expert technical advice was provided to the Commonwealth government to inform listing decisions for TECs under the *Environment Protection and Biodiversity Conservation Act 1999*.
- Technical and scientific advice was provided on environmental impact assessments, including section 45 authorisations to modify TECs under the BC Act.
- Advice was coordinated for a draft listing assessment and conservation advice for a potential ecological community under consideration by the Commonwealth.
- TEC occurrences associated with floristic community types were identified through undertaking analysis using the statistical package PATN.
- A number of anomalies within corporate records concerning TECs and PECs are progressively being investigated and resolved.
- Nominations were drafted and presented to the TEC Scientific Committee for three priority ecological communities for listing as threatened.
- Support was provided to Recovery Teams for the Albany and Esperance Districts, Swan and Kimberley Regions.
- Advice was provided to Office of the Auditor General to assist with the performance audit of the conservation of TECs.

Management Implications

- Provision of accurate and up to date scientific information helps to guide TEC recovery plans and recovery teams, improves the effectiveness of conservation actions and maximises recovery outcomes.
- Listing of TECs and PECs means they are given priority consideration when planning and carrying out activities including the management of weeds, pests, diseases, fire, hydrology and visitor access, with the aim of protecting them, restoring their values and decreasing their vulnerability to threatening processes.

Future Directions

- Pursue improvements in ecological community knowledge and ensure this is adequately captured into corporate systems.
- Continue to provide scientific knowledge and advice for the protection, conservation and management of TECs and PECs.
- Continue to provide advice for legislative processes related to ecological communities and continually improve processes and guidelines based on feedback from users.
- Updated analysis of the Swan Coastal Plain floristic data will be refined and any implications for ecological community descriptions will be assessed.



Fauna conservation and recovery

CF-2023-18

J Richards, K Schell, M Sheehan, A Robey, F Carpenter, A Raycraft, R Harvey

Context

Fauna is listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) when it is at risk of extinction in the wild and the BC Act provides a number of statutory mechanisms to conserve and recover threatened, specially protected and other native animal species. The department has obligations

under the *Animal Welfare Act 2002* (AW Act) to ensure requirements for ethical consideration of animals in departmental research and management activities, which are achieved through the administration of an Animal Ethics Committee (AEC) and associated reporting. Provision of expert scientific advice to guide the application of statutory conservation and management planning, regulation and on-ground implementation, improves conservation outcomes for the State's fauna.

Aims

- Provide up to date scientific advice for the management, protection and recovery of threatened and priority fauna.
- Ensure that recovery programs for threatened fauna species, including translocations, are evidence-based and effective.
- Inform policy and strategic direction relating to fauna using up-to-date science.
- Ensure that management requirements for harvest quotas and reporting of the commercial harvest of kangaroos in WA are met.
- Ensure that animals used for scientific purposes are cared for and used in an ethical and humane manner and that the department meets its commitments under the AW Act and the Australian Code for the Care and Use of Animals for Scientific Purposes.

Progress

- Advice and support were provided to internal and external stakeholders on recovery actions for threatened fauna species, land management activities to support conservation and national recovery plans.
- Advice and support were provided to 15 State fauna Recovery Teams to ensure continued conservation and recovery of threatened species and to national Recovery Teams for mala, malleefowl, albatross and petrel, ghost bat and bilby.
- Provided expert technical advice on applications for fauna licences under the *Biodiversity Conservation Regulations 2018*, section 40 authorisations to take threatened flora under the BC Act and environmental impact assessments under the *Environment Protection Act 1984*.
- Reviewed and provided recommendations on eight proposals for intra- and interstate translocations involving six threatened and one priority fauna species, and including one species into, and one trial release from, captive-breeding programs.
- Provided the 2025 annual quota submission for the commercial harvest of kangaroos in WA in 2025 to the Commonwealth Government and drafted the 2024 annual report on the WA commercial kangaroo harvest in accordance with the *Management Plan for the Commercial Harvest of Kangaroos in Western Australia 2024-2028*.
- The AEC met six times, conducted a total of 331 assessments, approved 17 new projects and approved the renewal of 52 projects. There are 118 active AEC approved projects for fauna monitoring, general fauna research, translocations, fauna surveys, education, feral animal control research and marine and aquatic research.

Management Implications

- Provision of accurate and up to date scientific information helps to guide threatened fauna recovery plans and recovery teams, improves the effectiveness of conservation actions and maximises recovery outcomes.
- Expert assessment of fauna translocation plans and provision of technical and management advice on translocations, minimises animal welfare risks and optimises translocation success.
- Assessment of kangaroo population dynamics ensures that commercial harvesting continues at a sustainable level.
- Ensuring that fauna management activities are formally assessed by the departmental AEC and conducted in accordance with Standard Operating Procedures, fulfills legislative requirements of the AW Act.

Future Directions

- Continue to deliver strategic direction and coordination of the conservation, management, protection and recovery of fauna in an efficient and effective manner.
- Continue to ensure that the correct processes and advice are in place for the department to meet its requirements under the AW Act.
- Continue to implement BC Act requirements related to native fauna and ensure processes and guidelines are in place as required.



Flora conservation and recovery

CF-2023-19

K Schell, T Llorens, R Harvey

Context

Flora is listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) when it is at risk of extinction in the wild and the BC Act provides a number of statutory mechanisms to conserve and recover threatened and other native plant taxa. Provision of expert scientific advice to guide the application of statutory conservation and management planning, regulation and on-ground implementation, improves conservation outcomes for the State's flora.

Aims

- Provide up to date scientific advice for management, protection and recovery of threatened and priority flora.
- Ensure that recovery programs for threatened flora, including translocations, are evidence-based and effective.
- Inform policy and strategic direction relating to flora using up-to-date science.
- Leverage stakeholder involvement in recovery teams.
- Provide advice to land managers on appropriate fire management strategies.
- Provide scientific advice to prioritise and develop IUCN assessments for priority and threatened species.
- Use best-available scientific information to ensure licensing and harvesting decisions are evidence based.

Progress

- Provided expert technical advice towards combined assessments and conservation advices led by the Commonwealth Government for three flora species.
- Provided expert technical advice on nominations to alter the list of threatened flora species in Western Australia for six flora species and reviewed the listing status of two threatened flora species.
- Conservation status assessments resulted in 55 additions to the priority flora list, changes in category of 32 taxa and delisting of 28 taxa after survey and taxonomic review.
- Provided advice and support to internal and external stakeholders on recovery actions and land management activities to support conservation of threatened flora.
- Issued approvals for eight proposals to translocate six threatened and two conservation-significant flora species. Assessed 10 translocation proposals and provided advice to potential proponents.
- Provided support to threatened flora Recovery Teams.
- Provided technical and scientific advice on environmental impact assessments, section 40 authorisations to take threatened flora under the BC Act, applications for flora licences under the *Biodiversity Conservation Regulations 2018* and on issues relating to the management of the Western Australian flora industry.
- Provided support to volunteers for survey of 42 poorly-known priority flora species to contribute towards conservation status assessment.

Management Implications

- Accurate, contemporary and comprehensive lists of threatened and priority flora facilitate improved environmental impact assessments and development of more effective conservation and recovery actions.
- Provision of accurate and up to date scientific information helps to guide threatened flora recovery plans and recovery teams, improves the effectiveness of conservation activities and maximises recovery outcomes.
- Expert assessment of flora translocation proposals and provision of technical and management advice on translocations, minimises biodiversity risks and optimises translocation success.
- Provision of expert technical and management advice on applications to take threatened or priority flora and for environmental impact assessment, assists the department and other land managers to conserve threatened and priority flora and maximises the potential for positive conservation outcomes.

Future Directions

- Continue to deliver strategic direction and coordination for conservation, management, protection and recovery of flora in an efficient and effective manner.
- Continue to assess the conservation status of native flora species and prepare nominations for listing and recovery plans where necessary.
- Continue to provide high quality technical flora advice to stakeholders as required.
- Continue to implement BC Act requirements related to native flora and ensure processes and guidelines are in place as required.



Wetland mapping

CF-2023-13

F Felton, K Griffiths, J Donaldson, R Harvey

Context

Western Australia is home to many different varieties of wetlands, from tidal mangroves and billabongs, to salt lakes and fresh water springs. Access to accurate geospatial and ecological information about wetlands improves the basis for informed decisions on their management and conservation. The department coordinates mapping of Western Australia's wetlands and maintains digital datasets containing spatial data and associated attribution. The mapping identifies the presence of wetlands, delineates boundaries, classifies and assigns wetlands to management categories on the basis of their values. Mapping ensures accurate information about wetlands is available to land managers and decision makers, improving the basis for informed decision making about wetland management and conservation.

Aims

- Maintain current datasets and, where opportunities arise, expand the extent of wetland mapping for Western Australia.
- Maintain and improve documentation to standardise wetland mapping procedures.
- Use contemporary ecological and hydrological scientific information to continually improve policies and methods supporting wetlands datasets.
- Provide input to and assist with development of national wetland mapping guidelines and the Australian Wetland Inventory.
- Assist in the development of strategic policy for conservation of high ecological value wetlands.
- Provide advice on wetland mapping and values to stakeholders in a timely manner.

Progress

- Assessed seven requests to modify wetland evaluation and two requests to modify wetland delineation in the *Geomorphic Wetland Swan Coastal Plain* dataset.
- Provided technical advice for 51 requests relating to wetland mapping, land use planning and general wetlands matters to departmental staff, other State and Commonwealth agencies, landowners and consultants.

Management Implications

- Accurate wetland mapping facilitates better conservation, protection and management outcomes for wetlands and wetland ecosystems by improving the evidence base for environmental impact assessment, prioritising management actions and land acquisition, and assisting with identifying suitable habitat for conservation significant species.

Future Directions

- Continue to review and maintain wetland mapping datasets and provide technical advice on wetlands values to internal and external stakeholders.
- Continue to review wetland mapping methods to incorporate new technologies and support the development of contemporary wetlands policy.
- Undertake wetland mapping for the Badimia conservation reserves.



Wetlands conservation

CF-2023-20

H Oswald, K Schell, A Pinder, R Harvey

Context

Wetlands provide essential habitats for many native fauna and flora species and migratory birds, as well as providing essential ecological services, such as reducing the severity of floods, providing refuge for wildlife during drought, carbon sequestration and filtration of sediments, nutrients and pathogens. The Ramsar Convention on Wetlands is an international treaty that provides the framework for conservation and wise use of representative, rare and unique wetlands and wetlands that are important for biodiversity conservation. Being a signatory to the Ramsar Convention, Australia has undertaken to ensure our internationally important wetlands are conserved. There are 12 Ramsar wetland sites in Western Australia.

Aims

- Provide input to policy development for wetlands of high conservation value in accordance with the Ramsar principles and promote the wise use of wetlands.
- Provide scientific and technical guidance to site managers for conservation of wetland values.
- Contribute expertise to adaptive management and climate change adaptation measures.
- Collaborate with the Commonwealth government and with key stakeholders to deliver responsibilities under the Ramsar Convention.

Progress

- Ongoing assessments are being undertaken and communicated to site managers, science staff, Conservation and Parks Commission, stakeholders, other states and the Commonwealth to inform management, monitoring and reporting of ecological condition of Ramsar listed wetlands in WA.
- Six-monthly reports were provided to the Commonwealth. A strategic approach to managing and reporting on Ramsar wetlands in Australia is being developed.
- Four Ramsar Information Sheets (RIS) were finalised and approved by the Ramsar Secretariat. A further two RIS revisions are underway.
- Ramsar wetland projects were co-designed with natural resource management (NRM) groups for Commonwealth funding under National Heritage Trust and Urban Rivers and Catchments Grants to improve knowledge, management and restoration of wetlands with community involvement.
- In celebration of World Wetlands Day, the department collaborated with the Cockburn Wetlands Centre to host the 2025 WA Wetlands Conference.
- Technical support and guidance was provided for joint management of high value conservation wetlands in collaboration with Traditional Owners.

Management Implications

- Implementing a collaborative and strategic approach to managing and reporting on Ramsar wetlands will improve delivery of wetland conservation and clarify roles and responsibilities for monitoring, managing and reporting on Ramsar wetlands in WA.
- Updating Ramsar Information Sheets and condition reporting, assists in meeting national obligations under the Ramsar Convention and provides guidance to on-ground managers.
- Working with on-ground managers and NRM groups builds capacity to deliver collaborative management and restoration projects for Ramsar wetlands.

Future Directions

- Continue to implement a strategic framework for monitoring, managing and reporting on Ramsar wetlands in WA.
- Develop collaborative projects and continue to work with NRM groups, the Commonwealth and stakeholders to provide leadership in adaptive management and climate change mitigation for high conservation value wetlands and Ramsar sites.
- Continue to work with scientists and on-ground managers to collate information on the status of Ramsar wetlands and report to the Commonwealth.

External Partnerships

Project Title	Partners	External Funding	Departmental Involvement
A morphological and molecular investigation to resolve the taxonomic status of *Rhagodia* sp. Hamersley from the Pilbara bioregion	Rio Tinto; GHD	$59,000	K Lazar, B Anderson, R Binks
A partnership approach to filling key knowledge gaps on dugongs in northern Australia using novel technologies	National Environmental Science Program - Marine and Coastal Hub; Reef and Rainforest Research Centre	$379,366	K Waples, K Crook, H Raudino
A population management plan for the Wheatbelt black-flanked rock wallaby	WWF Australia; WA NRM Program	$10,450	L Povh, K Ottewell, A Raycraft, M Dziminski
A taxonomic synthesis of tribe Lasiopetaleae (Malvaceae)	Australian Biological Resources Study; Department of Industry Science and Resources	$195,000	K Shepherd
Advancing observations and predictions of WA marine heatwaves	Department of Jobs, Tourism, Science and Innovation; Marine Heatwaves Group	$500,000	C Ross
Aluta quadrata plant water use and niche characteristics	Rio Tinto Iron Ore	$306,382	W Lewandrowski, J Stevens
Aquatic microinvertebrate identification and systematics	R.J. Shiel and Associates	$5000	D Cale, K Quinlan, A Pinder
Australian Grasslands Initiative: *Triodia*	Bioplatforms Australia	Nil	B Anderson, M Barrett
Australian sea lions in the Perth metropolitan area: abundance, movement and habitat use.	Edith Cowan University; Australian National University; Department of Primary Industries and Regional Development; The University of Western Australia	$264,803	H Raudino, K Waples
Australian wide synthesis of baited video data to answer broad-scale ecological questions	Curtin University; Australian Institute of Marine Science; The University of Western Australia; Department of Primary Industry and Regional Development; Flinders University; Department of Environment and Water (SA); Deakin University; Department of Primary Industries (NSW); University of Tasmania; CSIRO;	Nil	T Holmes, J Goetze

Project Title	Partners	External Funding	Departmental Involvement
	FinPrint		
Automated Groundwater Dependent Vegetation Detection and Monitoring Tool	Atlas Iron; Fortescue; BHP Iron Ore Pty Ltd; Rio Tinto; Roy Hill; Minres; Digital Earth Australia; Geoscience Australia; Frontier SI; Department of Water and Environmental Regulation	Nil	B Huntley
Beyond fire frequency: understanding seasonal timing of fire for ecosystem management	Australian Research Council	$453,000	B Miller, K Ruthrof
Building resilience to change for mammals in a multi-use landscape	Australian Research Council; Murdoch University; Western Australian Museum; Roy Hill	$536,000	L Gibson, M Byrne, K Ottewell
Characterising organic carbon sources supporting cave pool communities in the Leeuwin Naturaliste Ridge	Margaret River Busselton Tourist Association Inc; Curtin University	$10,000	G McGrath, M Venarsky
Cleaning up the Canning - catchment modelling and habitat enhancment	Swan Canning Waterways Branch; South East Corridor Catchment Alliance; Department of Climate Change, Energy, the Environment and Water	$2,680,275	K Trayler, S Adiyanti, P Novak, S Thompson, M Van Compernolle, A Gillies
Collation of historic data for Shark Bay, Marmion and Shoalwater Islands Marine Parks.	Murdoch University	$20,000	J Goetze
Conservation and management of the bilby (*Macrotis lagotis*) on the Dampier Peninsula, Kimberley	Main Roads Western Australia; Kimberley Land Council; Nyamba Buru Yawuru Ltd; Walalakoo Aboriginal Corporation; Bardi Jawi Aboriginal Corporation; Rangelands NRM	$600,000	F Carpenter, M Dziminski
Derbal Yiragan Djarlgarro (Swan Canning) Estuary and Bindjareb Djilba (Peel Harvey) Estuary shoreline plastic contamination study	Department of Water and Environmental Regulation	90,000	T Crutchett, P Novak
Detection and identification of dugong through seawater eDNA	Curtin University	$40,000	W Robbins
Developing a non-invasive monitoring approach for Barrow Island boodies (*Bettongia lesueur*)	Astron Environmental Services	$27,204	K Ottewell
Developing a non-invasive monitoring approach for northern quoll	API Management Pty Limited	$20,000	K Ottewell, M Millar, R Sun
Development of tissue culture protocols	Alcoa Mining	$59,962	B Funnekotter, K Elder
Digitisation of the Curtin University orphaned herbarium collection	Atlas of Living Australia	$20,000	S James
Digitisation of weeds and invasive plants at the Western Australian Herbarium	CSIRO; Atlas of Living Australia	$20,000	S James, J Percy-Bower

Project Title	Partners	External Funding	Departmental Involvement
Diversity of infaunal polychaete assemblages in Walpole and Nornalup Inlets Marine Park	Edith Cowan University; Australian Museum Research Institute	Nil	I Leal, S Wilson
Dugong population and habitat survey - Shark Bay and Ningaloo	CSIRO; National Environmental Science Program - Marine Biodiversity Hub	$123,622	H Raudino, K Murray, K Waples
Ecology and management of the bilby in the Pilbara	Fortescue Metals Group; Millennium Minerals; Roy Hill	$2,005,000	F Carpenter, M Dziminski
Ecology and management of the northern quoll in the Pilbara	Atlas Iron; Fortescue Metals Group; Iron Ore Holdings; Roy Hill; Main Roads Western Australia	$195,000	L Gibson
Ecology and management of the Pilbara leaf-nosed bat	Atlas Iron; Rio Tinto; BHP; Kanyirninpa Jukurrpa; BatCall WA	$320,000	K Ottewell, L Gibson, L Umbrello
Ecology of the living fossil *Campanile symbolicum*	The University of Western Australia	Nil	I Leal, O Luiz Junior
eDNA detection of cane toads in the West Kimberley and Koolan Island	Mount Gibson Iron Limited	$16,500	L Dugal, K Fernandes
Enhancing the resilience of urban rivers: informing the regional restoration of the Djarlgaroo Beeliar (Canning River)	The University of Western Australia; National Environmental Science Program - Resilient Landscapes Hub; Perth NRM; Armadale Gosnells Landcare Group	Nil	K Trayler
Facilitating collaborations between AusSeabed and Kimberley Region marine operations by crowd sourcing bathymetry to improve national bathymetry data	Geoscience Australia	Nil	K Murray, W Robbins, K Zdunic
Fire severity and dense forest stands	Department of Fire and Emergency Services	$50,000	R Van Dongen, V Densmore, K Ruthrof
Fitzgerald Biosphere vegetation research for appropriate fire regimes	Friends of the Fitzgerald River National Park Inc; University of Notre Dame; Bush Heritage Australia	$374,000	C Gosper, B Miller
Forest Management Plan - Fire Research Collaboration, Phase 1: Fauna plus	Edith Cowan University	$1,600,000	B Miller, T Doherty
Forest Management Plan - Fire Research Collaboration, phase 1: Flora plus	Murdoch University; Edith Cowan University	$1,600,000	B Miller, R Tangney
Foundations for leading the nature positive ecosystem conservation agenda	University of New South Wales; IUCN; Department of Climate Change, Energy, the Environment and Water; Department of Energy Environment and Climate Action (Vic); Department of Environment and Water (SA); Department of Natural Resources and Environment Tasmania	$2,550,000	C Gosper, A Pinder, R Luu, R Harvey, K Zdunic
Fremantle Marine Quality Monitoring Program	Fremantle Ports	$30,659	R Karker, J Watsham, S Hoeksema, P Howie, J Chapman, J

Project Title	Partners	External Funding	Departmental Involvement
			Gregory, K Trayler
Genetic assessment of *Synostemon hamersleyensis*	Rio Tinto	$90,000	R Binks, A Brunton, K Lazar
Genetic assessment of *Xanthorrhoea nana*	Western Botanical	$16,000	R Binks, T Macfarlane, K Lazar
Genetic diversity and population structuring of *Tetratheca butcheriana* in the Pilbara bioregion of Western Australia	Rio Tinto	$97,000	R Binks, M Byrne, J Filipe
Genetic studies of Pilbara EPBC Act listed threatened vertebrate fauna	Murdoch University	$235,000	D Pearson
Geographe Bay seagrass satellite mapping	Department of Water and Environment Regulation	$60,000	B Huntley, K Zdunic, K Murray, S Bell
Global FinPrint	Florida International University; Australian Institute of Marine Science; James Cook University	$120,000	J Goetze
Great Western Woodlands carbon methodology	CSIRO; Woodside	$315,000	C Gosper, K Zdunic
Great Western Woodlands SuperSite	CSIRO; Australian SuperSite Network; Terrestrial Ecosystem Research Network; National Research Infrastructure for Australia	Nil	C Gosper
GYPWORLD a global initiative focused on understanding the ecology of gypsum ecosystems.	Multiple international organisations	NIL	M Lyons, M Langley
Hydrogeochemistry of Walyarta Springs	BHP; CyMod Systems; Australian Nuclear Science and Technology Organisation	$120,000	J Rutherford
Identification botanist position at the Western Australian Herbarium	Rio Tinto	$120,000	S Dillon, J Huisman
Impact of prescribed fire on desert fire regimes	Indigenous Desert Alliance	Nil	J Chapman, V Densmore
Integrated conservation and translocation of the threatened banded ironstone species *Tetratheca erubescens* (Elaeocarpaceae)	Mineral Resources Ltd; The University of Western Australia	$997,000	C Elliott, W Lewandrowski, B Miller, S Krauss, D Merritt, J Stevens
Integrating ecological, social and cultural values of the coastal waters of Roebuck Bay	Murdoch University; Rio Tinto; Nyamba Buru Yawuru; Edith Cowan University; University of Notre Dame; James Cook University; The University of Western Australia	$980,000	S Fossette-Halot, K Crook, K Waples, H Raudino, S Whiting
Karri forest fuel dynamics	Department of Fire and Emergency Services; Bushfire Front	Nil	J Hollis, A Wills, S Samson, V Densmore
Lifeplan: A Planetary Inventory of Life	Duke University; Swedish University of Agricultural Sciences; University of Helsinki	$30,000	K Quinlan, A Pinder
Lifespan estimation in	CSIRO	$310,000	T Tucker, S Whiting

Project Title	Partners	External Funding	Departmental Involvement
marine turtles using genomic promoter CpG density			
Long-term monitoring of intertidal communities at limestone and granite reefs in Ngari Capes Marine Park	The University of Western Australia	$5,000	I Leal, S Bell
Millstream riparian vegetation monitoring	Department of Water and Environmental Regulation; Water Corporation	$2000	B Huntley
Mirnong Maat (whale journeys) – Southern Right Whale research project	Macquarie University; University of Auckland; The University of Western Australia	Nil	H Raudino, K Waples, S Bell
Molecular characterisation of stinking passionflower (*Passiflora foetida*)	Net Conservation Benefits; CSIRO	$913,000	M Byrne
Morphological and molecular assessment of *Minuria tridens*	Curtin University; Leichhardt	$94,700	R Binks, B Anderson
Nature-based solutions for remediating foreshores	The Nature Conservancy; The University of Western Australia; Department of Climate Change, Energy, the Environment and Water	$280,644	K Trayler, L Arrowsmith, S Adiyanti
Optimising fire regimes for fire risk and conservation outcomes in *Banksia* woodlands in the Perth area	Australian Research Council; Murdoch University	$455,000	K Ruthrof, R Miller, B Miller
Optimising seed sourcing for effective ecological restoration	Australian Research Council; Flinders University; CSIRO; The University of Western Australia	$460,000	D Merritt, S Krauss
PEAT | Protecting peatland ecosystems and addressing threats in Southwestern Australia	The University of Western Australia; Edith Cowan University; Walpole-Nornalup National Park Association; Western Australian Museum; Biologic Environmental Survey	$2,500,000	B Miller, G McGrath, R Tangney
Peatland resilience - Global Peat Microbiome Project	Global Peat Microbiome Project (GPMP); Multiple international organisations; University of Michigan	Nil	J Rutherford
Phylogenetics and floral symmetry development of the core Goodeniaceae	Colorado College (USA); St John University (USA)	Nil	K Shepherd
Phylogenomics of the Western Australian flora	Genomics for Australian Plants; Bioplatforms Australia	Nil	B Anderson
Population genomics of the critically endangered Gilbert's potoroo	Gilbert's Potoroo Action Group; NRM WA	$35,000	M Millar, R Sun, T Friend, K Ottewell
Predicting the ecological impact of cane toads on native fauna of north western Australia	Australian Research Council; University of Sydney; Department of the Environment and Energy; Australian Reptile Park	$503,000	D Pearson
Prioritising on-ground actions for the endangered Australian sea lion	Landscape SA; South Australian Research and Development Institute	$32,600	K Waples, H Raudino

Project Title	Partners	External Funding	Departmental Involvement
Quantifying responses of forest thinning and developing social licence to build adaptive capacity in forest management	Alcoa	$166,600	G McGrath, R Van Dongen, K Ruthrof
Radio frequency identification devices as a new method to estimate little penguins population size: Penguin Island as case-study	Murdoch University	Nil	K Crook, H Raudino, T Holmes, I Leal
Reconstructing historic changes in the hydrology and biodiversity of wetlands in Western Australia	Australian National University; Edith Cowan University; The University of Western Australia; Curtin University; The University of Adelaide	Nil	M Venarsky, G McGrath
Redclaw crayfish impact assessment and eDNA detection tool	BHP; Department of Primary Industries and Regional Development; Department of Water and Environmental Regulation; Fortescue Metals Group; Precision Biomonitoring; Rio Tinto; Stantec	$475,000	A Pinder
Restoring *Banksia* woodland communities after mining	Hanson Construction Materials	$25,000 pa	W Lewandrowski, J Stevens
Seagrass adaptation and acclimation responses to extreme climatic events	Australian Research Council; The University of Western Australia; The University of Adelaide; Australian Genome Research Facility	$525,000	S Krauss
Securing the future for bilby in the Fitzroy Catchment / West Kimberley	National Environmental Science Program - Northern Australia Environmental Resources Hub; Environs Kimberley; Kimberley Land Council	$540,000	F Carpenter, M Dziminski
Seed collection, storage and biology	Millennium Seed Bank; Australian Seed Bank Partnership; Department of the Environment and Energy	$12,000	A Crawford
Skeletochronology and stable isotope analyses of flatback turtles	The University of Western Australia; National Marine Fisheries Service (USA); Northern Territory Museum; Western Australian Museum; Queensland Department of Environment and Science; Pendoley Environmental; Commonwealth Department of Agriculture	$400,000	T Tucker, S Whiting
Spatial and temporal analysis of ghost bat populations in the Pilbara using non-invasive sampling methodologies: Towards a robust genetic monitoring protocol	BHP Iron Ore Pty Ltd	$190,000	S McArthur, R Sun, K Ottewell
Spatio-temporal variability of coral reefs at the global scale: causalities, idiosyncrasies and implications for ecological indicators	SCORE-REEF	Nil	J Goetze, T Holmes, C Ross

Project Title	Partners	External Funding	Departmental Involvement
Surveying wetland biodiversity on Ngadju lands	Ngadju Aboriginal Corporation	$27,000	M Lyons, M Venarsky, K Quinlan, A Pinder
Systematics and biogeography of the Inocybaceae	National Science Foundation (USA)	$19,000	N Bougher
Targeted taxonomy of poorly known Pilbara flora	Fortescue	$692,000	C Gosper, J Huisman, R Binks, P Baleeiro Souza
Taxonomic resolution of a Hibiscus species complex	Rio Tinto	$85,000	R Binks, B Anderson, S Dillon, K Lazar
Testing the efficiency and efficacy of Felixer feral cat grooming traps	Ecological Horizons; Fortescue Metals Group; Roy Hill	$85,000	L Gibson
The long-term monitoring of seagrass communities in Geographe Bay	Geocatch; Edith Cowan University; Department of Primary Industries and Regional Development	$10,000	B French
The *Stylidium* phylogeny and pollination project	Royal Botanic Gardens - Kew; University of Portsmouth (UK)	Nil	J Wege
Threatened Species Initiative	BioPlatforms Australia: Threatened Species Initiative	Nil	R Binks, A Crawford, L Monks, K Ottewell
Towards an eFlora treatment of *Tephrosia* (Pers.) in Australia: taxonomic revision of the genus in Western Australia and the Northern Territory	Australian Biological Resources Study; Queensland Herbarium; Northern Territory Herbarium; University of the Western Cape	$515,000	T Macfarlane
Translocations of mammals from Barrow Island: offset program	Chevron	$9,500,000	J Angus, S Garretson, C Sims, L Gibson
Understanding sources of feral cats in Dryandra Woodland through DNA analysis	Peel Harvey Catchment Council	$20,000	K Ottewell
Upgrading fire history datasets using fire severity dynamics	Department of Fire and Emergency Services; National Emergency Management Agency; Interagency Bushfire Operations Committee	$1,294,000	B Miller, K Zdunic, R Van Dongen, J Hollis, C Rumenos
Use of biomineralising organisms to accelerate mineral carbonation and long-term carbon storage in engineered microbialites (*ex situ*)	CSIRO	Nil	M Venarsky
Using ecophysiology and remote sensing approaches to monitor *Tetratheca butcheriana* population dynamics in the Brockman Range	Rio Tinto	$434,000	W Lewandrowski, J Stevens
WAMSI-Westport seagrass project	Edith Cowan University	$1,200,000	S Strydom

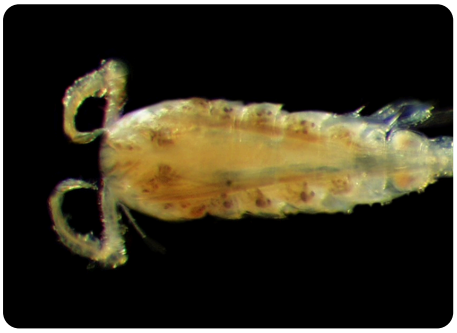
Student Projects

Project Title	Student	Duration	Academic/s	DBCA Officer/s	Page
Assessing congruence between morphological and molecular data in cyclopoid copepods from inland waters in southern Western Australia	Dylan Macgregor (BSc Honours)	2024 - 2025	N None	A Pinder	143
Southern River - Upper Canning River Catchment Distributed Hydrological Model	Eleanor Sydney (MSc)	2024 - 2025	S Thompson	S Adiyanti	143
Spore trapping for detection of airborne *Quambalaria coyrecup*, causal agent of Marri canker: An epidemiological study to aid forest management	Jasmine Leighton (MSc)	2025 - 2028	M Hanson, Dr A Hopkins	K Fernandes, L Dugal	144
Assessing pressure on coral communities from snorkellers at high visitation sites in Ningaloo Marine Park	Chloe Deakin (PhD)	2024 - 2025	Dr M O'Leary	T Holmes, C Ross	144
Assessing the structure of boodie warrens using geophysics	Eloise Oakley (MSc)	2024 - 2024	A/Prof M Leopold	G McGrath, C Lohr	145
Chemical indicators of groundwater disconnection from forested streams	Kunzang Rinchen (MSc)	2024 - 2025	A/Prof A Rate	G McGrath	145
Exploring the impacts of boat wakes and wind waves on Point Walter spit and their impacts on fairy tern nesting	Shanal Rathnayake (MSc)	2023 - 2024	Dr C Pattiaratchi	S Adiyanti	145
Geophysical characterisation of peat	Jarrad Mckercher (MSc)	2023 - 2024	Dr D Blake	G McGrath	146
How has the invertebrate fauna of the Swan-Canning Estuary changed over the last 40 years	Ruth Lim (MSc)	2023 - 2024	Dr J Tweedley	K Trayler	146
How marine parks affect benthic communities in the Swan River estuary	Emily Stout (PhD)	2023 - 2024	Dr J Tweedley	K Trayler	147
Molecular assessment of a recently discovered peatland	Charlotte Nelson (BSc	2023 - 2024	Prof S Hopper, Dr A Lullfitz	R Binks	147

Project Title	Student	Duration	Academic/s	DBCA Officer/s	Page
endemic, *Haemodorum* sp. East Northcliffe	Honours)				
Radar remote sensing of lake hydrology	Wangchuk Namgay (MSc)	2024 - 2025	Prof J Awange	G McGrath	147
Investigating the mechanics of native seedling emergence	Stephanie Lye (PhD)	2023 - 2027	Dr A Guzzomi, Dr M Masarei	D Merritt	148
Understanding the hydrology of freshwater pools at Murujuga: Implications for freshwater refugia under a changing climate	Diego da Silva Turollo (PhD)	2022 - 2025	A/Prof M Leopold	G McGrath	148
Alexandrium spp. in Western Australia: characterisation, toxin mobility and control options	Sheilah Kwambai (PhD)	2021 - 2024	Dr D Laird, Prof A Lymbery, Prof N Moheimani	J Cosgrove	149
Chasing flamingos - tracking synthetic eDNA in a river network using passive sampling methods	Suzanne Thompson (MSc)	2022 - 2025	Dr A Hopkins, Dr A Koenders	J Hyde, G McGrath	149
Ecophysiology of seed dormancy of *Hibbertia*	Savuti Henningsen (PhD)	2022 - 2025	Dr T Erickson	D Merritt	149
Microplastic distribution, sources, ingestion and health impacts in urban estuarine environments	Thomas Crutchett (PhD)	2021 - 2024	Dr R Hovey	P Novak	150
The influence of mining on the movement ecology and behaviour of the endangered northern quoll (*Dasyurus hallucatus*)	Mitchell Cowan (PhD)	2022 - 2025	Prof D Nimmo, Prof S Setterfield	L Gibson	150
Dirk Hartog Island fauna reintroductions disease risk analysis	Fiona Knox (PhD)	2019 - 2022	Dr R Vaughan-Higgins, Prof K Warren	S Cowen, C Sims	151
Environmental DNA as a tool to monitor fish movement in the Canning River	Emma Stevens (MSc)	2021 - 2021	Dr L Beesley, Dr D Gleeson	S Thompson, J Hyde	151
Understanding patterns of phenotypic and genetic divergence in island mammals to improve conservation outcomes	Kate Rick (PhD)	2020 - 2023	A/Prof N Mitchell	K Ottewell	152
Assisted colonisation of the western swamp tortoise (*Pseudemydura umbrina*): the role of energy requirements in translocation decisions	Bethany Nordstrom (PhD)	2020 - 2024	Prof S Jarman, A/Prof N Mitchell	M Byrne	152
Characterisation of mitochondrial function in the cryopreservation of threatened flora	Lily Whelehan (PhD)	2019 - 2025	Prof R Mancera	B Funnekotter	152
Development of cryopreservation for the recalcitrant seeded Australian plants *Syzygium australe* and *S. paniculatum*	Lei Hou (MSc)	2020 - 2020	Prof R Mancera	B Funnekotter, E Bunn	153

Project Title	Student	Duration	Academic/s	DBCA Officer/s	Page
Role of redox homeostasis in recovery from cryopreservation in *Arabidopsis thaliana*	Milana Lukic (PhD)	2020 - 2023	Prof R Mancera	B Funnekotter, E Bunn	153
Survey methods and population estimates of the chuditch across its range	Melissa Taylor (PhD)	2020 - 2023	Dr N Armstrong, Dr K Bryant, Dr M Calver	A Wayne	154
Taxonomy and evolutionary history of *Australocypris* giant ostracods from Australian salt lakes	Mahabubur Rahman (PhD)	2019 - 2022	Dr J Chaplin	A Pinder	154
Taxonomy and evolutionary history of *Parartemia* brine shrimp from Australian salt lakes	Aminul Islam (PhD)	2020 - 2023	Dr J Chaplin	A Pinder	154
Assessing ecological resilience of post-mining restoration: testing fire recovery across a restoration chronosequence	Ebony Cowan (PhD)	2019 - 2022	Dr J Fontaine, Dr R Standish	B Miller	155
Influence of fire history and seed distribution on the movements of granivorous finches in the East Kimberley	Sydney Collett (PhD)	2018 - 2021	Dr H Campbell	I Radford	155
Shifting soil fungal communities in response to fire and weed management in urban banksia woodlands	Aaron Brace (PhD)	2019 - 2023	Dr J Fontaine, Dr A Hopkins	K Ruthrof, B Miller	156
Ecologically tolerable fire regimes for key banksia woodland plant species	Russell Miller (PhD)	2015 - 2019	Prof N Enright, Dr J Fontaine	D Merritt, B Miller	156
Evaluating flowcam and machine learning approaches in water sciences	Bianca Owen (PhD)	2017 - 2025	Prof N Moheimani, Dr J Tweedley	J Cosgrove	157
Factors affecting the success of threatened flora translocations	Leonie Monks (PhD)	2016 - 2020	Dr R Standish	M Byrne	157

Student Project Reports



Assessing congruence between morphological and molecular data in cyclopoid copepods from inland waters in southern Western Australia

Student: Dylan Macgregor

Academic(s): N None

Scientist(s): A Pinder

Progress Report

Cyclopoid copepods are abundant and diverse in freshwater, with dozens of species known from Western Australia. In WA their taxonomy is largely based on morphological studies and there is uncertainty about diversity and phylogenetic relationships in some groups. This project aims to develop methods for undertaking genetic analyses of species diversity and relationships and apply these to freshly collected specimens, focusing on the genera *Pescecyclops*, *Metacyclops* and *Meridiecyclops*.

Analyses of CO1 and 18S sequence data suggests that morphological species delimitation is largely accurate but assignation of multiple undescribed species to the single genus *Pescecyclops*, based on morphology, does not entirely reflect phylogeny based on genetics. One of the traditional morphological characters (morphology of the fifth leg) may not be a reliable indicator of generic affiliation in some of the identified lineages.



Southern River - Upper Canning River Catchment Distributed Hydrological Model

Student: Eleanor Sydney

Academic(s): S Thompson

Scientist(s): S Adiyanti

Progress Report

- The distributed (2D) hydrological model setup for a simulation period 1997-2024 has been completed.
- The model has been calibrated and validated using gauged daily flow data and the results will be improved with the inclusion of flow data recorded at nearby river pools since November 2024.
- Future climate data (2025-2100) for air temperature, evaporation and precipitation have been clipped and tailored for this project. Data for 2025-2030 is being applied to the calibrated and validated hydrological model to assess climate change scenarios.



Spore trapping for detection of airborne *Quambalaria coyrecup*, causal agent of Marri canker: An epidemiological study to aid forest management

Student: Jasmine Leighton

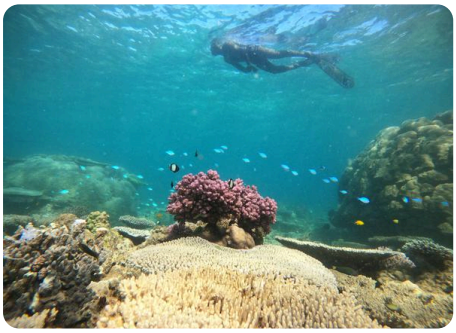
Academic(s): Dr A Hopkins, M Hanson

Scientist(s): K Fernandes, L Dugal

Progress Report

Marri, *Corymbia calophylla,* is a keystone species in our native forest ecosystems in Western Australia, existing as one of the dominant canopy species of the Jarrah (*Eucalyptus marginata*) Forest Ecosystem. There are several tree declines in south-western Australia that have progressively affected dominant canopy species in which plant pathogens have been implicated as contributing factors, including *Quambalaria coryecup,* a fungal pathogen that causes marri canker. Understanding a pathogen's interactions with its host and environment informs best-practice disease management in our forests. This project aims to bridge the current knowledge gaps surrounding the epidemiology and detection of *Q. coyrecup.* Firstly, the project aims to test the use of airborne spore trapping to detect *Q. coryrecup* using quantitative PCR (qPCR) based approaches. Secondly, this project will investigate if there are temporal differences in the dispersal of *Q. coyrecup*. Thirdly, the airborne fungal community will be characterised to determine other ecologically significant fungal taxa that can be detected using airborne sampling methods using a metabarcoding approach. This project will contribute vital epidemiological knowledge of marri canker disease to inform surveillance and monitoring techniques for *Q. coyrecup* – improving decision-making and outcomes for marri conservation and overall forest management.

Five different aerial spore monitoring techniques have been chosen, and sampling equipment is being purchased. A site at Kings Park has been identified as a study trial area, with trees visibly impacted by marri canker disease. The first trial of sampling is set to begin in June 2025, and weekly sampling will be carried out until November 2025 at this site.



Assessing pressure on coral communities from snorkellers at high visitation sites in Ningaloo Marine Park

Student: Chloe Deakin

Academic(s): Dr M O'Leary

Scientist(s): T Holmes, C Ross

Progress Report

Oyster Stacks is listed in the current Ningaloo Marine Park management plan as an area of concern due to coral damage resulting from snorkelling activities, particularly at low tide when corals are shallow and more vulnerable. This project aimed to 1) quantify spatial and temporal patterns in snorkeller activities at Oyster Stacks during peak-season, 2) explore relationships between snorkeller use and site visitation, environmental variables, and existing management and 3) assess the impacts of visitor pressure and snorkeller damage to the coral communities. Data collection methods included GPS tracking of snorkellers, snorkeller counts, deployment of a tilt drift meter to obtain real-time environmental information, deployment of a MetroCounter to record carpark traffic and in-water surveys of coral colony damage and benthic photo-transects.

Vehicle counts were found to be a reliable proxy for snorkeller numbers, demonstrating a strong correlation that underscores the challenges of managing visitor impact in remote areas. This study also revealed significant temporal patterns in snorkelling activity, with peak visitation during school holidays and mid-mornings. Spatial analyses indicated that snorkeller distribution was concentrated around key features due to accessibility and convenience. Snorkeller induced coral damage is significantly higher in high-use areas and particularly affects plate corals, emphasising the need for targeted management strategies. The study highlights the importance of effective management practices, including parking limitations, clear signage, visitor education and environmental protection to mitigate coral damage and enhance recovery in high-use zones. Future research should focus on long-term monitoring exploring visitation seasonality and coral community change. This work contributes to understanding the dynamics between recreational activity and coral ecosystems, informing conservation efforts in marine protected areas. The findings are now being prepared for scientific publication in a peer-reviewed journal.



Assessing the structure of boodie warrens using geophysics

Student: Eloise Oakley

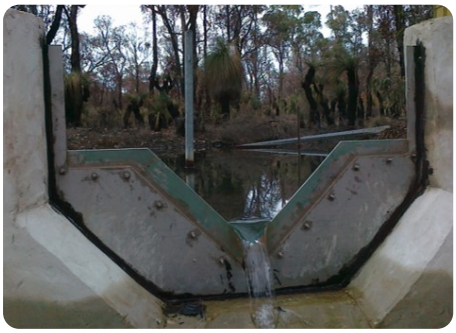
Academic(s): A/Prof M Leopold

Scientist(s): G McGrath, C Lohr

Progress Report

Boodies (*Bettongia lesueur*) are unique among macropods for their construction of complex warren systems, which have been observed to extend in diameter up to 70m and have as many as 90 unique entrances. This project seeks to improve understanding of the below ground life of boodies by quantifying warren structure using two geophysics techniques, ground penetrating radar and electrical resistivity tomography,

Analysis of the trial data and modelling different measurement methods is complete. Field data were collected from the Matuwa Kurrara Kurrara National Park in 2024. The data have been analysed and the thesis has been accepted. A manuscript will be drafted. The geophysics methods both revealed the depth of warrens is limited to depths of 2 to 2.5 m below the ground surface. They further indicate the warren depths may be limited by the presence of shallow groundwater. Calcrete warrens displayed deeper and more extensive warrens than those in softer, sandy soils, which were shallower and structurally simpler. Legacy warrens, known to occur along calcrete outcrops outside the enclosure, are therefore likely to be areas where boodies may establish larger communities were reintroductions outside the enclosure to occur.



Chemical indicators of groundwater disconnection from forested streams

Student: Kunzang Rinchen

Academic(s): A/Prof A Rate

Scientist(s): G McGrath

Progress Report

The gradual drying of south-west Australia over the last 50 years has led to changing hydrology, particularly of forested streams. The disconnection of groundwater from stream zones has been recognised as a driver of declining streamflow in certain headwater catchments. There remains little understanding as to the extent of groundwater disconnection across the jarrah and karri forests. As groundwater supports and is a component of streamflow, it is hypothesised that as streams begin to flow less, they will freshen. This, in turn, will have consequences for freshwater ecology. This Master's project sought to analyse existing streamflow and water quality data to assess this hypothesis.

The accepted thesis for this project documents an analysis of several long-term stream monitoring sites, including the Yarragil catchments. The results support the hypothesis that stream freshening accompanies a decline in streamflow and the transition of streams from permanent to ephemeral. It further documents the role of historical forest harvesting in modifying these trends. A manuscript is being prepared for this project.



Exploring the impacts of boat wakes and wind waves on Point Walter spit and their impacts on fairy tern nesting

Student: Shanal Rathnayake

Academic(s): Dr C Pattiaratchi

Scientist(s): S Adiyanti

Progress Report

Nearmap aerial images (2008-2020) were analysed to determine relative changes in morphology of the Point Walter Spit over time. These showed the spit as a continuous sand bar in early 2008, then splitting in 2010, 2017, 2019. The area of the sand bar known to be used by fairy terns for nesting remained undivided but the width of that zone was gradually reduced by approximately 0.5 m per year between 2008 and 2020. In an effort to understand the drivers of erosion, this study compared the magnitude of wave energy of a 4-hour storm event (average wind speed 16 km/h) with the individual energy generated by 100 high energy boat wakes using high-resolution pressure loggers deployed between December 2023 and July 2024. The results suggest the storm event produced wave energy equivalent to ~2700 instances of 5-minute high-energy boat wakes.

Further comparison with the energy generated during a 4-hour period of heavy vessel traffic on Australia Day 2024, revealed that even during this high-traffic event, the total energy exerted from boat wakes was only ~2 per cent of the total energy generated by a significant storm event. The results suggest that decreased vessel speed limits around the spit would be unlikely to significantly reduce the Point Walter Spit erosion, particularly on the eastern side.



Geophysical characterisation of peat

Student: Jarrad Mckercher

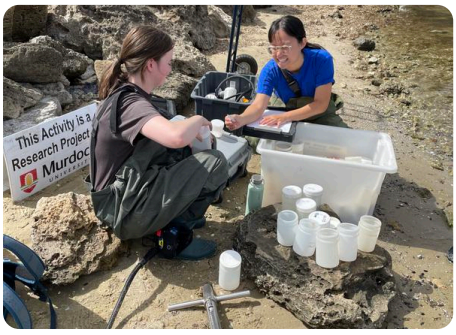
Academic(s): Dr D Blake

Scientist(s): G McGrath

Progress Report

The peatlands of Walpole-Nornalup National Park are at threat from a drying climate and altered fire regimes. To better protect these biodiverse systems, they need to be mapped and the hydrological conditions which support them characterised. Part of that characterisation requires measuring their lateral and vertical extent at sites where groundwater levels and water quality are monitored. This project looked to assess the potential of the geophysics techniques, resistivity and induced polarisation, to map the subsurface distribution of peat. This will involve collection of peat samples, measurement of their electrical properties in the laboratory and measuring peat depths at a field site.

Geophysics transects were conducted at three sites in Walpole-Nornalup National Park and peat samples were collected for laboratory measurement of their electrical properties. Laboratory measurements of the chargeability and phase shift of the peat samples found only weak chargeability and no significant phase shifts that provided distinct signals of the presence of peat in comparison to clay and saturated sand samples. Despite this, resistivity geophysics still provides useful information about the subsurface structure at peat sites. A short report was prepared and the project is complete.



How has the invertebrate fauna of the Swan-Canning Estuary changed over the last 40 years

Student: Ruth Lim

Academic(s): Dr J Tweedley

Scientist(s): K Trayler

Progress Report

This study investigated changes in the benthic invertebrate communities of the lower reaches of the highly-urbanised Swan-Canning Estuary in1986-7, 2003-4 and 2023-4. The number of species increased, likely due to sustained higher salinities. There was also a marked decline in crustaceans, an increase in stress-tolerant taxa (e.g. polychaetes) and contraction in estuarine species. Project findings highlight the importance of long-term datasets and regular monitoring in understanding ecological shifts under climate change.



How marine parks affect benthic communities in the Swan River estuary

Student: Emily Stout

Academic(s): Dr J Tweedley

Scientist(s): K Trayler

Progress Report

This project focused on invertebrate communities of Swan Estuary Marine Park and compared species richness, diversity, abundance and composition of the benthic macroinvertebrate fauna in different habitats within the three zones and evaluated these relative to areas outside the park.

The project provided contemporary information on the benthic macroinvertebrate communities within the marine park and found that between 2005 and 2023, macroinvertebrate fauna species richness and abundance both increased, demonstrating the importance of protected areas and conservation of seagrass habitat to maintain species richness and abundance.



Molecular assessment of a recently discovered peatland endemic, *Haemodorum* sp. East Northcliffe

Student: Charlotte Nelson

Academic(s): Prof S Hopper, Dr A Lullfitz

Scientist(s): R Binks

Progress Report

This project aims to generate molecular data for a recently discovered peatland endemic species in south-western Australia, *Haemodorum* sp. East Northcliffe. These data will cover two primary aims: (1) phylogenetic analysis to determine the taxon's placement in the context of the wider genus to confirm its species status and facilitate formal naming and (2) population genetic analysis to assess genetic diversity within populations and the extent of gene flow occurring among populations. These data will formalise the species' taxonomy and provide much needed demographic knowledge to inform its management within the context of being a key component of the south-western Australian *Empodisma* peatlands, which are listed as a Threatened Ecological Community.

The phylogenetic dataset confirmed that *Haemodorum* sp. East Northcliffe is a distinct species that warrants taxonomic recognition. This species has now been formally described and named *H. sandifordiae* in a manuscript that is currently under review in *Nuytsia*. The population genetic dataset found that connectivity among peat swamps is very low, with strong genetic differentiation among populations, even at relatively short distances. These findings provide critical knowledge for decision-making regarding the appropriate source material to be used in future restoration activities. The project is now complete.



Radar remote sensing of lake hydrology

Student: Wangchuk Namgay

Academic(s): Prof J Awange

Scientist(s): G McGrath

Progress Report

Radar remote sensing has demonstrated capabilities to measure surface water areas and even water levels to accuracies of centimeters from space. These interferometric methods have not been assessed on Western

Australian lakes. This project sought to modify existing methodologies and to test them at Lake Clifton, where DBCA empirically measured surface water data were used to calibrate and validate the methods assessed.

Data analysis focused on a "Persistent Scatterer" technique to constrain water level change estimates from the satellite data. The results presented in a Master's thesis suggested that seasonal rather than short-term water level changes could be estimated better by this technique, although several limitations will likely restrict the application of the technique more widely. A manuscript is in revision for the journal *Water*.



Investigating the mechanics of native seedling emergence

Student: Stephanie Lye

Academic(s): Dr M Masarei, Dr A Guzzomi

Scientist(s): D Merritt

Progress Report

A challenge to successful seed-based rehabilitation is the high mortality rate of emergent seedlings. The pre-emergence phase, where seeds have germinated but seedlings are yet to emerge from the soil, is a primary bottleneck for seedling survival.

Laboratory experiments to determine the relationship between maximum pre-emergent shoot length and incubation temperature for seedlings of *Acacia inaequilatera* and *Corymbia calophylla* have been completed, demonstrating the maximum length of pre-emergent seedlings is not affected by temperature for *C. calophylla* but varies at least twofold with temperature for *A. inaequilatera*. Experiments measuring the emergence forces of seedlings using electronic force sensors are focused on *A. inaequilatera,* with early results showing seedlings can exert between 1.3-1.8N of force before breaking. Current experiments are investigating the relationships between emergence forces and seed burial depth in different soil substrates to quantify the effects of overburden pressure on seedling growth and maximum emergence depth, along with the mechanisms by which seedlings navigate rocky substrates to emerge.



Understanding the hydrology of freshwater pools at Murujuga: Implications for freshwater refugia under a changing climate

Student: Diego da Silva Turollo

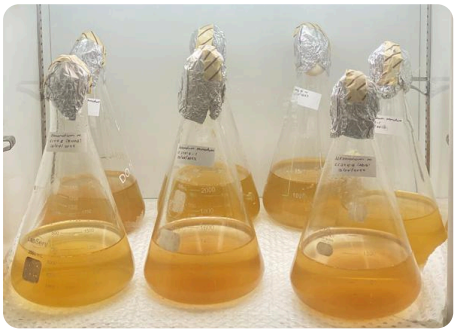
Academic(s): A/Prof M Leopold

Scientist(s): G McGrath

Progress Report

Isolated pools in Murujuga National Park including the peninsula and nearby islands are culturally and ecologically significant, particularly as freshwater refugia. Little is known about the hydrology of these pools, such as how often they are filled, how long they retain water and the quality of that water to support their ecology. This study aims to better understand the ephemeral hydrology of these pools through a monitoring program on Enderby Island and a wider landscape scale characterisation of the adjacent islands and the Burrup.

Beginning in 2023 and concluding in May 2025, weather, soil moisture, pool and stream water levels and water quality data were logged continuously at a selection of ephemeral streams and pools. Several site visits were conducted to measure soil hydraulic properties and resistivity geophysics to characterise the subsurface structure of hillslopes adjacent ephemeral streams so as to better understand runoff generation mechanisms. Statistical models for the frequency and magnitude of pool filling events have been developed. Development of physically based numerical models of runoff generation and pool water levels has commenced using the software Hydrus 2D/3D.



Alexandrium spp. in Western Australia: characterisation, toxin mobility and control options

Student: Sheilah Kwambai

Academic(s): Dr D Laird, Prof N Moheimani, Prof A Lymbery

Scientist(s): J Cosgrove

Progress Report

Globally, harmful algal blooms represent a major and growing threat due to their undesirable ecological, economic and health impacts. Since 2019 the Swan Canning Estuary has suffered repeated blooms of *Alexandrium, a* species that produces toxins that can cause potentially fatal paralytic shellfish poisoning in humans via consumption of affected seafood. This project is investigating the toxicity and genetics of local *Alexandrium*, while also investigating a potential control method. Risk of exposure to toxins when eating crabs is also being investigated by measuring toxin mobilisation when crabs are cooked.

All major experimental components of this project are complete. Final analyses and preparation of results are underway, and progress was presented to the project technical advisory group, including representatives from the Department of Primary Industries and Regional Development and Department of Health. A manuscript documenting the results of a trial of modified clays to control *Alexandrium* has recently been submitted.



Chasing flamingos - tracking synthetic eDNA in a river network using passive sampling methods

Student: Suzanne Thompson

Academic(s): Dr A Hopkins, Dr A Koenders

Scientist(s): J Hyde, G McGrath

Progress Report

While eDNA is developing as a powerful tool to quantify biodiversity of aquatic systems, there remains uncertainties regarding the movement and fate of eDNA, particularly in streams and rivers. This study seeks to quantify the movement of artificial eDNA in an urban stream from a tracer experiment. This experiment will provide an improved understanding of the advection, adsorption and degradation processes eDNA experiences during its movement from the source to the sampler. These results will help provide a spatial context as to the distribution of sources relative to a sampling location for future eDNA measurements.

Using two hydrological tracers, salt and a synthetic DNA, to measure changes in concentration with distance downstream from the point of injection, the experiment, conducted in late-2023 in Southern River, generated salinity data and >100 water samples for six sites. Water samples have been filtered and the eDNA extracted from >50 samples. DNA extracts have been analysed using qPCR to quantify the tracer DNA they contained and calculate the concentration of tracer DNA in river water samples. Results have undergone preliminary analysis to compare changes in tracer concentration at each site. Results were presented at the 2025 eDNA Conference and will be more thoroughly interrogated using a one-dimensional solute transport model. The student project is now complete.



Ecophysiology of seed dormancy of *Hibbertia*

Student: Savuti Henningsen

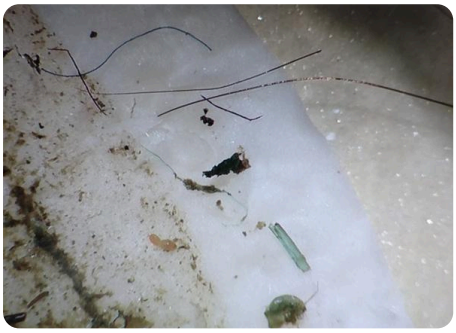
Academic(s): Dr T Erickson

Scientist(s): D Merritt

Progress Report

Restoration of jarrah forest species can be challenging due to complex seed dormancy mechanisms limiting seedling establishment. Reliable methods of propagation are yet to be established for most species. Seeds of *Hibbertia* possess complex dormancy and germination requirements. Within the jarrah forest of south-west WA, *Hibbertia* are common, and the inability to propagate their seeds precludes their use in mine site rehabilitation. This project will focus on the germination ecology of *Hibbertia* seeds through field trials studying the intra- and inter-specific variation in seed dormancy and germination timing of a range of *Hibbertia* species differing in collection year and location. Through linked laboratory studies, seed pre-treatments applicable to nursery settings will be developed to allow for the large-scale production of *Hibbertia* seedlings for planting in mine site rehabilitation.

Laboratory experiments on 10species collected in 2022 and 2023 demonstrate that most species germinate preferentially at cool temperatures of 5°C/15°C (day/night), with a strong requirement for smoke-derived karrikin, no influence of light or darkness and a significant variation in dormancy depth amongst species. Seeds stratified at cold (5°C) or warm (35°C) temperatures did not germinate to a greater degree than seeds incubated at 5°C/15°C. Studies on seeds of multiple species sourced from different populations show no variation in dormancy or germination traits within species. A multi-year field experiment established in the summer of 2024 to study how seed embryo growth rates influence the timing of germination and seedling emergence amongst three co-occurring species is continuing, with data showing seedlings emerge within three weeks of the onset of embryo growth for all species.



Microplastic distribution, sources, ingestion and health impacts in urban estuarine environments

Student: Thomas Crutchett

Academic(s): Dr R Hovey

Scientist(s): P Novak

Progress Report

This project extends a DBCA report on plastic contamination in the Swan Canning Estuary by determining the presence of microplastics (plastics <1mm diameter) in surface waters and beaches of the estuary. This project undertook a critical review of methodologies for assessing microplastics in estuarine environments and adopted the most applicable approaches to evaluate microplastic contamination in the surface water and sediment of the Swan Canning Estuary and determined seasonal changes in microplastic contamination in the Canning River Kent Street Weir Pool. Due to the complexity of quantifying and identifying microplastics in environmental samples, plastics accumulation in fish digestive tracts was not progressed.

The project has made a significant contribution to the microplastic literature and greatly enhanced our understanding of microplastic pollution in estuary environments. It was found that microplastic abundance in surface water of the estuary changes significantly with season, where a much higher concentration of microplastics were found during the winter months, a finding consistent with previous surface water work within the estuary. However, shoreline microplastic data did not follow the same pattern, with no significant difference between microplastic accumulation on shorelines in winter or summer, suggesting atmospheric contributions may also be significant. The Canning River upstream of the Kent Street Weir had the highest concentration of microplastics of any site surveyed in this study. A methods paper was published in MethodsX, in which a novel density separation technique for environmental microplastic samples was described. Additionally, a review of microplastic measurement was published in the *Journal of Environmental Management* and two further manuscripts from the study are in preparation.



The influence of mining on the movement ecology and behaviour of the endangered northern quoll (*Dasyurus hallucatus*)

Student: Mitchell Cowan

Academic(s): Prof D Nimmo, Prof S Setterfield

Scientist(s): L Gibson

Progress Report

The northern quoll (*Dasyurus hallucatus*) is threatened by habitat loss due to mining in the Pilbara region of Western Australia. This project seeks to identify the movement patterns of northern quolls living in mining landscapes. Quolls prefer rocky habitats and creeklines, which likely serve as high-resource areas providing dens, food and safer travel than simpler habitats like spinifex sandplain. When quolls have larger amounts of spinifex sandplain in their home ranges, this leads to longer movements and larger areas required to survive. In mining landscapes, quolls avoided mining habitats during breeding season, likely due to a lack of mates and resources in these habitats. While quolls did den in these habitats, they don't provide the food and breeding opportunities that natural habitats do. Quolls used more energy in mining habitats compared to natural ones, supporting the suggestion that these areas contain less resources and likely a higher predation risk.

Results from this study demonstrated the complex impacts of human disturbance on animal communities and ecosystems and the need to consider community-wide approaches when undertaking fauna management in modified landscapes. This PhD project is now complete with a final paper published in *Biological Conservation* that describes the influence of mining camps on species composition and diversity, ecosystem function, predator-prey networks and temporal activity.



Dirk Hartog Island fauna reintroductions disease risk analysis

Student: Fiona Knox

Academic(s): Dr R Vaughan-Higgins, Prof K Warren

Scientist(s): S Cowen, C Sims

Progress Report

This project aims to develop disease risk analyses (DRAs) for several species in the fauna translocations to Dirk Hartog Island. By identifying key disease risks related to these translocations, mitigation measures such as screening for specific pathogens can be put in place.

A paper on chlamydia in wild Australian rodents, documenting a cross-sectional study to inform disease risks for conservation translocations, has been published in Wildlife Research and a second paper detailing novel host-parasite records in a sandy inland mouse (*Pseudomys hermannsburgensis*) has been published in the International Journal for Parasitology: Parasites and Wildlife. A further three manuscripts on disease risk analysis for rodent translocations to Dirk Hartog Island, assessment of baseline health of extant rodents on Dirk Hartog Island and a literature review of infectious disease in Australian rodents are being prepared for submission to peer-reviewed journals.



Environmental DNA as a tool to monitor fish movement in the Canning River

Student: Emma Stevens

Academic(s): Dr D Gleeson, Dr L Beesley

Scientist(s): S Thompson, J Hyde

Progress Report

This project investigated the capacity of eDNA survey techniques to characterise the freshwater fish assemblage in the Canning River and the role that barriers play in limiting distribution of invasive fish. Sites in the Canning River were surveyed using three methods, 1) fyke netting, 2) active filtration of water for eDNA, and 3) passive collection of eDNA.

The study demonstrated that active eDNA sampling more consistently describes fish assemblage at any given site in this river and required less replicates than the other methods. A subset of the data was used to compare methods for monitoring the invasion front of pearl cichlid and found that pearl cichlids were already present upstream of an existing weir. A further paper was published in *Environmental DNA*, which showed that combined eDNA methodologies detected one more fish species than fyke netting and that active eDNA

sampling produced the highest capture probabilities. The project is now complete.



Understanding patterns of phenotypic and genetic divergence in island mammals to improve conservation outcomes

Student: Kate Rick

Academic(s): A/Prof N Mitchell

Scientist(s): K Ottewell

Progress Report

This project focused on quantifying phenotypic and genetic divergence amongst island and mainland populations of several threatened mammals including the burrowing bettong (*Bettongia lesueur*), golden bandicoot (*Isoodon auratus*) and the dibbler (*Parantechinus apicalis*) to determine whether genetic and morphological differentiation between remnant populations reflects divergent adaptation or are artefacts of genetic drift, and the consequences for mixing populations of each species.

Population genomic assessment for island and mainland golden bandicoots has been completed and published in *Heredity*. Morphological measurements of museum specimens of dibbler and the burrowing bettong have been completed to investigate broad patterns of adaptation in each species, including an assessment of whether morphological differentiation in dibbler is associated with drift or divergent selection. Genomic analyses of island and mainland dibblers have been completed and the PhD thesis has been accepted.



Assisted colonisation of the western swamp tortoise (*Pseudemydura umbrina*): the role of energy requirements in translocation decisions

Student: Bethany Nordstrom

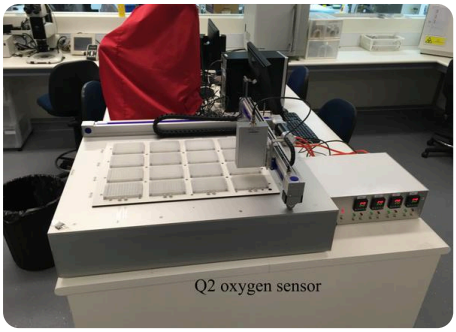
Academic(s): Prof S Jarman, A/Prof N Mitchell

Scientist(s): M Byrne

Progress Report

The western swamp tortoise (*Pseudemydura umbrina*) is endemic to south-west Australia and occupies seasonal wetlands where hydroperiods are shortening due to declining rainfall. Trial assisted colonisation translocations south of their current habitat will test whether tortoises can grow in cooler climates where hydroperiods are likely to be more suitable in the future. The aims are to 1) develop novel environmental DNA methods to understand diet in new habitats; 2) document foraging behaviour in relation to water temperatures and prey availability; 3) link metabolic processes and food intake to predict long-term growth rates and reproduction in new environments.

This PhD project is now complete. Based on the results of this study, further translocations are being considered to supplement this assisted colonisation trial with improved monitoring methods being investigated.



Characterisation of mitochondrial function in the cryopreservation of threatened flora

Student: Lily Whelehan

Academic(s): Prof R Mancera

Scientist(s): B Funnekotter

Progress Report

This project examined the effects of cryopreservation on the metabolism of plant tissues, with emphasis on mitochondrial function as these organelles are the primary sources of energy molecules that drive all cellular processes including the ability to recover from injury sustained to cells and tissues during the various steps of cryopreservation. A better understanding of the effects of cryogenic injury will assist in optimising cryopreservation for sensitive species, including many threatened taxa for which *ex situ* storage remains a problem.

The key findings from this research identified the significant impact cryopreservation has on mitochondrial function, especially during the early recovery phase once samples are rewarmed after exposure to liquid nitrogen, with high levels of mitochondrial dysfunction observed. Novel protocols were developed to gain this insight into mitochondrial function in plants after cryopreservation, assessing respiration and changes in extracellular flux during key stages in the cryopreservation process. In addition to improving mitochondrial function during the early recovery period, it was identified that some of the cryoprotective agents commonly used were detrimental to normal mitochondrial function. These findings have highlighted the need for future research to develop cryopreservation protocols that limit damage to mitochondria. This project is now complete.



Development of cryopreservation for the recalcitrant seeded Australian plants *Syzygium australe* and *S. paniculatum*

Student: Lei Hou

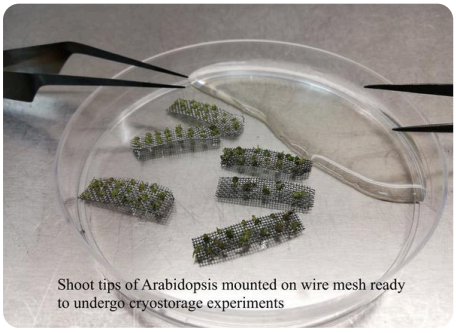
Academic(s): Prof R Mancera

Scientist(s): B Funnekotter, E Bunn

Progress Report

Syzygium paniculatum and *Syzygium australe* are two rainforest species with recalcitrant seeds that are not storable by seed banking, with *S. paniculatum* currently threatened in its native habitat. The objective of this project is to develop a viable cryopreservation protocol for these species.

This project identified key bottlenecks in cryopreservation of *Syzygium* species. These species were found to have a strong tolerance to long incubation times in cryoprotective agents (CPA) but exhibit a complete lack of survival following liquid nitrogen exposure, which could indicate that post-cryogenic failure is primarily due to either insufficient vitrification promotion and/or insufficient suppression of ice formation. Thermo-analytical assessments (differential scanning calorimetry) measured the extent of ice formation in shoot tissues, permitting differentiation between cell death by actual ice damage and other stress factors such as CPA toxicity and reactive oxygen species damage. This project is now complete.



Role of redox homeostasis in recovery from cryopreservation in *Arabidopsis thaliana*

Student: Milana Lukic

Academic(s): Prof R Mancera

Scientist(s): B Funnekotter, E Bunn

Progress Report

This project examined the effects of oxidative stress on cryopreserved plant material, using the model species *Arabidopsis thaliana*, including mutant variants with reduced antioxidant contents. Oxidative stress is a primary impediment to successful cryopreservation of plant material and a better understanding of this will be a crucial step forward in designing more efficient cryopreservation protocols for *ex situ* conservation of threatened plant species.

An optimised cryopreservation method for wild type *A. thaliana* has been developed using vitamin C- and GSH-deficient mutant plants (vtc2-1, vtc2-4, pad2-1 and cad2), to assess changes in transcriptome using RNA-sequencing. Assessments of the transcriptome, gene expression by RT-qPCR, oxidised DNA damage and antioxidant contents have been completed to understand the stresses imposed by cryopreservation. This

project is now complete.



Survey methods and population estimates of the chuditch across its range

Student: Melissa Taylor

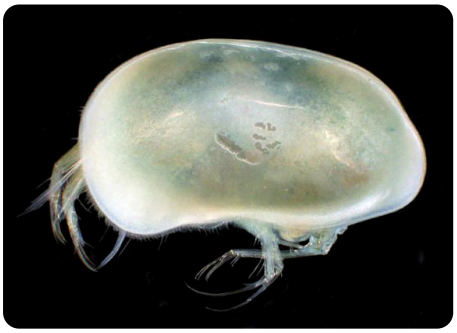
Academic(s): Dr N Armstrong, Dr K Bryant, Dr M Calver

Scientist(s): A Wayne

Progress Report

Robust population estimates are fundamental to species conservation and management. This project aims to use lured remote sensor cameras and spatially-explicit capture-recapture (SECR) modelling to improve the reliability of density estimates for chuditch populations.

Data from this project were reanalysed to determine the potential utility of spatial mark-resight (SMR) modelling for a naturally marked species. Results suggest that SMR likely overestimates population density due to uncertainty of marked status (if an individual is known or not). The magnitude of the potential bias appears to vary with overall identification success, total detections and number of recaptures. As such, SECR is currently still preferred when marked status is unknown. This project is complete pending assessment of the thesis.



Taxonomy and evolutionary history of *Australocypris* giant ostracods from Australian salt lakes

Student: Mahabubur Rahman

Academic(s): Dr J Chaplin

Scientist(s): A Pinder

Progress Report

Salt lakes are a distinctive feature of WA's arid zones, supporting several invertebrate groups that are more diverse in WA than elsewhere. Their biota are threatened by lakebed disturbance and by altered hydrology and water quality. This project aimed to use molecular data to assess the morpho-taxonomy of *Australocypris* ostracods and mytilocypridine systematics generally and to test hypotheses about species radiations in *Australocypris*. Another goal was to develop a protocol for hatching and raising ostracods from eggs in sediment of dry lake beds.

A paper on ostracod egg hatching has been published in the journal *Hydrobiologia*, suggesting that egg hatching from dry wetland sediments may be an effective tool for survey and monitoring of ostracods. A manuscript on mytilocypridine systematics has been accepted for publication in the *Zoological Journal of the Linnean Society*, providing evidence for nine new species and for paraphyly among mytilocypridine genera. A manuscript on the phylogeography and evolutionary history of *Australocypris* has been drafted and is currently being prepared for submission. It suggests that three *Australocypris* species exhibit high levels of genetic diversity and negligible gene flow among sites.



Taxonomy and evolutionary history of *Parartemia* brine shrimp from Australian salt lakes

Student: Aminul Islam

Academic(s): Dr J Chaplin

Scientist(s): A Pinder

Progress Report

Australia is home to numerous salt lakes that support a diverse range of endemic invertebrates largely restricted to these environments. The brine shrimp genus *Parartemia* is a good example, being one of the most diverse groups of invertebrates that only occurs in Australian salt lakes. This project focused on brine shrimp in Australia, with three aims: 1) to use molecular data to evaluate the taxonomy of *Parartemia*, which is currently based primarily on morphology, 2) to understand the evolutionary history and phylogeography of *Parartemia* and 3) to investigate the distribution of the exotic brine shrimp *Artemia* in Australian natural salt lakes and investigate the genetic composition of *Artemia* using molecular data.

A paper addressing the taxonomy of *Parartemia* was published in *Invertebrate Systematics*, suggesting that the morphotaxonomy is largely valid, although many morphospecies contained significant molecular divergence. Another manuscript, nearing submission, explores the evolutionary history and phylogeography of *Parartemia*, revealing that long-term aridification played a major role in speciation, while glacial-interglacial oscillations primarily influenced intraspecific variation. A manuscript currently under revision examines the distribution, identity and spread of exotic *Artemia* in Australian natural salt lakes, showing that *A. franciscana* and parthenogenetic *Artemia* have been spreading, raising concerns about their impact on native biodiversity. This project is now complete.



Assessing ecological resilience of post-mining restoration: testing fire recovery across a restoration chronosequence

Student: Ebony Cowan

Academic(s): Dr R Standish, Dr J Fontaine

Scientist(s): B Miller

Progress Report

This project investigated the fire resilience of banksia woodlands restored after sand mining, specifically seeking to determine an age when restoration is resilient to fire. Investigations assessed resprouting capacity, soil seedbank dynamics and floristic compositon across a chronosequence of ages between three and 27 years since restoration.

Experimental fire was introduced to sites across the chronosquence with post-fire regeneration monitored for 1.5 years. Regeneration from soil seedbanks and resprouting were monitored. Sites returned to a similar pre-fire state following fire, with some differences in perennial vegetation composition remaining between restored and intact sites. Three papers have been published and a fourth is in review. One paper developed a framework for measuring the effects of disturbance in restoration projects and was published in *Restoration Ecology. A*nother paper that identified drivers of post-fire resprouting success in restored banksia woodlands was published in *Austral Ecology.* A third paper on soil seedbank development of smoke responsive plant species in a 23-year restoration chronosequence was published in *Applied Vegetation Science*. The final paper assessing overall resilience of the restored community to fire is in review in *Ecology and Evolution*. This project is now complete.



Influence of fire history and seed distribution on the movements of granivorous finches in the East Kimberley

Student: Sydney Collett

Academic(s): Dr H Campbell

Scientist(s): I Radford

Progress Report

According to ecological niche theory, sympatric species cannot occupy the same niche space. Yet in the tropical savannas of northern Australia, three sympatric grass finches co-exist, presumably due to partitioning of resources, habitat or both. Fire regimes leading to increased movement to locate specialist food resources may increase risks to Gouldian finches of starvation or lost body condition. This study uses stable isotope analysis and novel radio telemetry methods to test hypotheses on diet specialisation and foraging behaviour through the Kimberley savanna dry season.

Research from this project reinforces the importance of fine-grain patchy prescribed burning mosaics for the benefit of Gouldian finches. A paper describing how finch movement patterns showed they preferred to forage where prescribed burning has occurred during the previous year due to higher seed density and greater grass diversity, was published in *International Journal of Wildland Fire*. Gouldian finches showed no selection of unburnt or bushfire burnt savanna. Another paper published in E*mu - Austral Ornithology*, showed that finches were found to decrease their time foraging within individual patches and increase the number of patches they visited, when seeds became increasingly scarce during the late dry season. A paper demonstrating that Gouldian finches partition their foraging niches from co-occurring species including long-tailed and masked finches by specialising exclusively on grass seeds and foraging more widely across savannas while the other species change their diets to include non-grass seeds and invertebrates and become more sedentary in their movements, was published in *Functional Ecology*. A final paper showed that Gouldian finches were found to move in flocks of closely related individuals, suggesting family associations are maintained in this species was published in *Animal Behaviour*. The project is now complete.



Shifting soil fungal communities in response to fire and weed management in urban banksia woodlands

Student: Aaron Brace

Academic(s): Dr A Hopkins, Dr J Fontaine

Scientist(s): K Ruthrof, B Miller

Progress Report

The project aimed to answer four key questions regarding the responses of soil fungal communities to 1) time since fire over a 50-year chronosequence, 2) time since fire within the first year, 3) fire and herbicide under field conditions, and 4) a range of herbicides under glasshouse conditions.

Three of the chapters have been published, with the fourth soon to follow. Overall, it was observed that in the post fire environment, the soil fungal community is very dynamic in the early months of recovery, but throughout time it increases in diversity but decreases in relative abundance before plateauing approximately 30 years post-fire. Herbicide application has complex effects on the fungal community under field conditions and *ex situ* application of herbicide increased abundance and richness, especially of pathogenic species, but effects were lessened with the addition of prescribed burns.



Ecologically tolerable fire regimes for key banksia woodland plant species

Student: Russell Miller

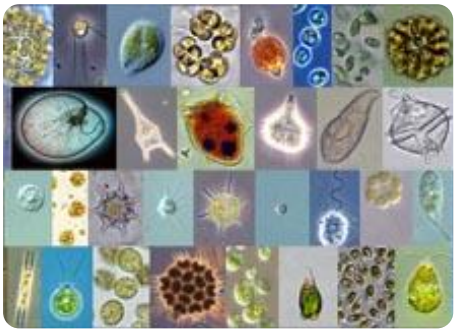
Academic(s): Dr J Fontaine, Prof N Enright

Scientist(s): D Merritt, B Miller

Progress Report

Fire is a dominant disturbance that shapes species and ecosystems. Many plant species have developed strategies and adaptations to cope with certain fire regimes. If fire occurs too frequently, too intensely or otherwise outside of the limits of a species' tolerance, populations are likely to decline or disappear. This project aims to determine the impact of varying fire regimes on the demographics of key banksia woodland plant species.

In addition to two previously published papers, two final papers from this project were published, one in *Australian Journal of Botany* and one in *Austral Ecology*. These papers focused on analysing plant demographic data and fire-related plant trait data for six co-occurring species of banksia woodlands to quantify historical fire regime associations and post-fire juvenile periods, respectively. This project is now complete.



Evaluating flowcam and machine learning approaches in water sciences

Student: Bianca Owen

Academic(s): Dr J Tweedley, Prof N Moheimani

Scientist(s): J Cosgrove

Progress Report

Phytoplankton are key biological components of the Swan-Canning Estuary and have been monitored using taxonomic approaches and species counts since 1994. Improved technologies for monitoring such as, flow cytometry (FlowCam®) and machine learning have evolved, providing opportunities to enhance and streamline phytoplankton monitoring efforts. However, adoption of these approaches is hindered by confusing and contradictory reports on the accuracy and performance of these technologies.

The project has focused on image evaluation using FlowCam® and species counts using machine learning to enhance future plankton monitoring. The project has explored the complexity of classifier performance metrics for species count data, to clearly show how these characteristics heavily skew metric outputs. The project is working to develop recommendations for appropriate performance metric selection and usage for future ecological classifier assessments.



Factors affecting the success of threatened flora translocations

Student: Leonie Monks

Academic(s): Dr R Standish

Scientist(s): M Byrne

Progress Report

The aim of this study is to investigate factors affecting success of plant translocations, to inform future translocations and help prevent the extinction of plant species.

Ecological and genetic factors in translocations of *Lambertia orbifolia, Acacia cochlocarpa* subsp. *cochlocarpa* and *Schoenia filifolia* were analysed to provide information to support management of these threatened species. The soil seedbank and response to prescribed fire were assessed for *Acacia cochlocarpa* subsp. *cochlocarpa* and the use of prescribed fire was shown to be an effective approach to stimulate regeneration of translocated populations of this subspecies. A meta-analysis investigating factors influencing plant translocations success showed excluding vertebrate herbivores and summer watering were important factors in translocation success. The thesis describing this work has been examined and the PhD degree conferred. Three papers, describing the studies on *Lambertia orbifolia, Schoenia filifolia,* and the meta-analysis of factors influencing translocation outcomes, have been published and a fourth paper, describing the *A. cochlocarpa* subsp. *cochlocarpa* work, has been written.

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Summary of Research Projects

Animal Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Adapting across climate gradients: enhancing connectivity and resilience in south-west Australia's fauna	South Coast, South West, Swan, Warren			2
Developing management strategies for south-west short-range endemic (SRE) invertebrates to build climate resilience	South Coast, South West, Swan, Warren, Wheatbelt			4
Improving the conservation management of range-restricted, endemic south-west vertebrates under climate change	South Coast, South West, Swan, Warren, Wheatbelt			5
Investigating the interactive impacts of fire and climate change on threatened fauna in south-west Australia	South West, Swan			6
Managing connectivity, refuge availability and genetic variation of freshwater species in drying south-west catchments	South Coast, South West, Swan, Warren, Wheatbelt			7
Better understanding the status of the greater bilby in Western Australia	Midwest	Carnarvon, Shark Bay	Rangelands	8
Securing the critically endangered Margaret River hairy marron in the wild	South Coast, South West, Warren	Jarrah Forest, Warren	South Coast, South West	9
Building resilience to change for mammals in a multi-use landscape: identifying refugia and landscape connectivity for small mammals in the Pilbara	Pilbara	Pilbara	Rangelands	10
Distribution and conservation status of the heath mouse (*Pseudomys shortridgei*) in Western Australia	South Coast, Wheatbelt	Avon Wheatbelt, Coolgardie, Esperance Plains, Mallee	South Coast	11
Genetics of Pilbara threatened bats	Pilbara	Pilbara	Rangelands	12
Ecology, threats and monitoring of the Pilbara olive python (*Liasis olivacea barroni*)	Midwest, Pilbara	Gascoyne, Pilbara	Rangelands	13
Felixer grooming trap trial: Feral cat control	Warren	Jarrah Forest	South West	14

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
for threatened fauna conservation in the southern forests				
Investigation into the decline of chuditch (*Dasyurus geoffroii*) in the south-west of Western Australia	Midwest, South Coast, South West, Swan, Wheatbelt	Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren	Avon, Swan, South Coast, South West, Wheatbelt	15
Conservation of the night parrot	Goldfields, Kimberley, Midwest, Pilbara	Carnarvon, Gascoyne, Gibson Desert, Great Sandy Desert, Great Victoria Desert, Little Sandy Desert, Murchison, Pilbara, Tanami	Rangelands	16
Dirk Hartog Island National Park ecological restoration project – fauna reconstruction	Midwest	Yalgoo, Shark Bay	Rangelands	17
Improving the use of remote cameras as a survey and monitoring tool	All DBCA Regions	Gascoyne	All NRM Regions	18
Monitoring of threatened birds on Dirk Hartog Island	Midwest	Geraldton Sandplains	Rangelands	19
Barrow Island threatened and priority fauna species translocation program	Goldfields, Pilbara	Gascoyne, Murchison, Pilbara	Rangelands	20
Conservation and management of the bilby in the Pilbara	Pilbara	Pilbara	Rangelands	21
Conservation of south coast threatened birds	South Coast, Warren	Esperance Plains, Jarrah Forest, Warren	South Coast, South West	22
Genetic assessment for conservation of rare and threatened fauna	Kimberley, Pilbara	Central Kimberley, Dampierland, Northern Kimberley, Pilbara	Rangelands	23
Rangelands restoration: reintroduction of native mammals to Matuwa (Lorna Glen)	Goldfields	Gascoyne, Murchison	Rangelands	24
Ecology and management of the northern quoll in the Pilbara	Pilbara	Pilbara	Rangelands	25
Impact of cane toads on biodiversity in the Kimberley	Kimberley	Central Kimberley, Northern Kimberley, Ord Victoria Plain, Victoria Bonaparte	Rangelands	26
Development of effective broad-scale aerial baiting strategies for the control of feral cats	Midwest, Pilbara, South Coast	Carnarvon, Gascoyne, Gibson Desert, Murchison	Swan, Rangelands	27

Biodiversity Information Office

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
BIO biodiversity data platform	All DBCA Regions	All IBRA Regions	All NRM Regions	28
BIO data collation program	All DBCA Regions	All IBRA Regions	All NRM Regions	29

Ecosystem Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Forest Health Monitoring Program	South Coast, South West, Swan, Warren			31
Forest ecosystem resilience and stand management	South West, Swan, Warren	Jarrah Forest, Swan Coastal Plain, Warren	Avon, Swan, South Coast, South West	32
Evaluating the application of eDNA and metabarcoding as biodiversity and monitoring tools	All DBCA Regions	All IBRA Regions	All NRM Regions	34
Lifeplan: A planetary inventory of life	Swan	Swan Coastal Plain	Swan	35
Tracking the condition of Ramsar wetlands in Western Australia	Kimberley, South Coast, South West, Swan, Warren, Wheatbelt	All IBRA Regions	Avon, Northern Agricultural, Swan, Rangelands, South Coast, South West, Wheatbelt	36
Investigating the causes of change in forest condition	South West	Jarrah Forest	South West	37
Understanding the implications of a drying climate on forest ecosystem function to inform and improve climate change adaptation	South West, Swan, Warren	Jarrah Forest	Swan, South West	38
Hydrological function of critical ecosystems	South West	Jarrah Forest, Swan Coastal Plain	South West	38
Taxonomy, zoogeography and conservation status of aquatic invertebrates	All DBCA Regions	All IBRA Regions	All NRM Regions	39
Responses of terrestrial vertebrates to management in the jarrah forest	Warren	Jarrah Forest, Warren	South West	40
Western Australian flora surveys	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	41
Management of invertebrate pests in forests of south-west Western Australia	South West	Esperance Plains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren	Swan, South Coast, South West	42
Western Australian wetland fauna surveys	All DBCA	All IBRA	All NRM	43

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
	Regions	Regions, All IMCRA Regions	Regions	
FORESTCHECK: Integrated site-based monitoring of the effects of timber harvesting and silviculture in the jarrah forest	South West, Swan, Warren	Jarrah Forest, Warren	Swan, South West	44
Hydrological response to timber harvesting and associated silviculture in the intermediate rainfall zone of the northern jarrah forest	Swan	Jarrah Forest	Swan, South West	45

Fire Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Fine-scale burn mosaics in south-west Forests	South West			46
Development of a systematic approach to monitoring and reporting on the outcomes of prescribed burns and bushfires	All DBCA Regions	All IBRA Regions	All NRM Regions	47
Evaluation of synergies among fire and weed management in urban biodiversity and fire management	Swan	Geraldton Sandplains, Swan Coastal Plain	Northern Agricultural, Swan	48
Long term response of jarrah forest understorey and tree health to fire regimes	South West, Swan, Warren	Jarrah Forest	South West	49
North Kimberley Landscape Conservation Initiative: monitoring and evaluation	Kimberley	Northern Kimberley	Rangelands	50
Fire regimes and impacts in transitional woodlands and shrublands	Goldfields, South Coast, Wheatbelt	Avon Wheatbelt, Coolgardie, Mallee, Yalgoo	Rangelands, Wheatbelt	51

Kings Park Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Conservation biotechnology	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	53
Conservation genetics	All DBCA Regions	All IBRA Regions	All NRM Regions	54
Orchid conservation and recovery	South Coast, South West, Swan, Warren, Wheatbelt	Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren	Avon, Northern Agricultural, Swan, South Coast, South West	55
Restoration science	All DBCA Regions	All IBRA Regions, All	All NRM Regions	56

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
		IMCRA Regions		
Seed science	All DBCA Regions	All IBRA Regions	All NRM Regions	58

Marine Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Understanding the drivers of hypoxic events and impacts to the coral communities in Bill's Bay, Ningaloo Marine Park	Pilbara	Pilbara, Ningaloo		59
Whale shark behavioural response to tourism interaction in Ningaloo Marine Park and implications for future management	Pilbara			60
Conservation and management of humpback whales in the Pilbara region	Pilbara	Ningaloo		61
Benefits of marine parks for marine fishes in a changing climate	All DBCA Regions	All IMCRA Regions	All NRM Regions	62
Primary productivity and energy transfer between marine ecosystems	Pilbara	Pilbara, Pilbara (Nearshore)	Rangelands	63
Do marine reserves adequately represent high diversity cryptobenthic fish assemblages in a changing climate?	Pilbara	Ningaloo	Rangelands	64
Understanding the key ecosystem services provided by the seagrass meadows of Western Australia	Kimberley, Midwest, South West, Swan	Carnarvon, Geraldton Sandplains, Pilbara, Swan Coastal Plain, Warren, Yalgoo	Northern Agricultural, Swan, Rangelands	65
Distribution and abundance estimate of Australian snubfin dolphins at a key site in the Kimberley region, Western Australia	Kimberley	Bonaparte Gulf, Kimberley, Northwest Shelf, Cambridge-Bonaparte, Canning, King Sound	Rangelands	66
Habitat use, distribution and abundance of coastal dolphin species in the Pilbara	Pilbara	Pilbara, Pilbara (Offshore)	Rangelands	67
The influence of macroalgal fields on coral reef fish	Pilbara	Carnarvon, Pilbara (Nearshore)	Rangelands	68
Understanding movements and identifying important habitats of sea turtles in Western Australia	Kimberley	All IMCRA Regions	Cocos Keeling Islands, Rangelands	69
Marine monitoring program	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	70
Northwest Shelf Flatback Turtle Conservation Program	Kimberley, Pilbara	Northwest Shelf	Rangelands	71
Spatial and temporal patterns in benthic invertebrate communities of the Walpole and Nornalup Inlets Marine Park	Warren	WA South Coast	South Coast	72

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Spatial and temporal patterns in the structure of intertidal reef communities in the marine parks of south-western Australia	Swan	Central West Coast	Swan	73

Perth Zoo Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Anstisia frog breed and rear for release program	South West, Swan	Jarrah Forest, Swan Coastal Plain	Swan, South West	74
Behavioural observations of Perth Zoo collection animals for animal welfare purposes and establishment of baseline data	Swan	Swan Coastal Plain	Swan	75
Numbat breed for release program	Swan, Warren, Wheatbelt	Avon Wheatbelt, Jarrah Forest, Swan Coastal Plain, Warren	Northern Agricultural, Swan, South West	76
Western ground parrot husbandry	South Coast, Swan	Esperance Plains, Mallee, Swan Coastal Plain	Swan, South Coast	76
Western swamp tortoise breed for release program	Swan, Warren	Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, Warren	Swan, South West	77

Plant Science and Herbarium

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Dieback detector dogs	Midwest, South Coast, South West, Swan, Warren			79
Eco-physiological and ecological approaches to climate adaptation in threatened flora and ecological communities	Goldfields, Midwest, South Coast, South West, Swan, Warren, Wheatbelt	Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan Coastal Plain, Warren	Avon, Northern Agricultural, Swan, South Coast, South West, Wheatbelt	80
Molecular approaches to climate adaptation in threatened flora and ecological communities	Goldfields, Midwest, South Coast, South West, Swan, Warren, Wheatbelt	Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Mallee, Swan	Avon, Northern Agricultural, Swan, South Coast, South West, Wheatbelt	81

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
		Coastal Plain, Warren		
A digital Flora of Western Australia – a guide to the State's botanical species diversity	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	82
Molecular characterisation of stinking passionflower (*Passiflora foetida*)	Pilbara	Pilbara	Rangelands	83
Herbarium collections management	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	84
Taxonomy of selected families including legumes, grasses and lilies	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	85
Taxonomy of undescribed taxa in the Ericaceae subfamily Styphelioideae, with an emphasis on those of conservation concern	All DBCA Regions	All IBRA Regions	All NRM Regions	86
The Western Australian Herbarium specimen data and digitisation	All DBCA Regions	All IBRA Regions	All NRM Regions	87
The Western Australian Plant Census and Australian Plant Census	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	88
Systematics of the triggerplant genus *Stylidium*	All DBCA Regions	All IBRA Regions	All NRM Regions	90
Taxonomic resolution and description of new plant species, particularly priority flora from those areas subject to mining in Western Australia	All DBCA Regions	All IBRA Regions	All NRM Regions	90
Taxonomic review and floristic studies of the benthic marine algae of north-western Australian and floristic surveys of Western Australian marine benthic algae	Kimberley, Pilbara, South Coast, South West, Swan, Warren	Central Kimberley, Dampierland, Esperance Plains, Gascoyne, Geraldton Sandplains, Jarrah Forest, Northern Kimberley, Swan Coastal Plain, Victoria Bonaparte, Warren	Northern Agricultural, Swan, Rangelands, South Coast, South West	91
The Western Australian marine benthic algae online and an interactive key to the genera of Australian marine benthic algae	Kimberley, Midwest, Pilbara, South Coast, South West, Swan, Warren	Central Kimberley, Dampierland, Esperance Plains, Geraldton Sandplains, Jarrah Forest, Northern Kimberley, Swan Coastal Plain, Victoria Bonaparte, Warren	Northern Agricultural, Swan, Rangelands, South Coast, South West	92
Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of	Midwest, South Coast, South West,	Avon Wheatbelt, Esperance	Avon, Northern Agricultural,	93

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
conservation importance	Swan, Warren, Wheatbelt	Plains, Jarrah Forest, Mallee, Swan Coastal Plain	Swan, Rangelands, South Coast, South West	
Translocation of critically endangered plants	Midwest, South Coast, South West, Wheatbelt	Avon Wheatbelt, Coolgardie, Esperance Plains, Gascoyne, Jarrah Forest, Mallee, Murchison, Swan Coastal Plain, Warren	Avon, Northern Agricultural, Swan, South Coast, South West	94
The population ecology of critically endangered flora	All DBCA Regions	Avon Wheatbelt, Central Kimberley, Esperance Plains, Gascoyne, Geraldton Sandplains, Jarrah Forest, Mallee, Northern Kimberley, Swan Coastal Plain, Warren	Avon, Northern Agricultural, Swan, Rangelands, South Coast, South West, Wheatbelt	95
Seed biology, seedbank dynamics and collection and storage of seed of rare and threatened Western Australian taxa	All DBCA Regions	All IBRA Regions	All NRM Regions	97
Genetics and biosystematics for the conservation, circumscription and management of the Western Australian flora	Goldfields, Midwest, South Coast, Swan, Wheatbelt	Avon Wheatbelt, Coolgardie, Esperance Plains, Geraldton Sandplains, Mallee, Murchison, Swan Coastal Plain, Yalgoo	Avon, Northern Agricultural, Swan, Rangelands, South Coast, South West	98

Remote Sensing and Spatial Analysis

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Species Distribution Modelling under Climate Change	South Coast, South West, Swan, Warren			100
Novel methods combining ground-based monitoring and remotely sensed observations to inform management and measurement of ecosystem condition in the rangelands	Midwest	Geraldton Sandplains	Northern Agricultural	101
Dirk Hartog Island vegetation monitoring	Midwest	Yalgoo, Shark Bay	Rangelands	102
Remote sensing and spatial analysis for fire	All DBCA	All IBRA	Avon,	103

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
management	Regions	Regions	Northern Agricultural, Swan, Rangelands, South Coast, South West	
Remote sensing monitoring	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	105
Spatial analysis and modelling	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	107
Spatial data management	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	108

Rivers and Estuaries Science

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Derbal Yiragan Djarlgarro (Swan Canning) Estuary and Bindjareb Djilba (Peel Harvey) Estuary shoreline plastic contamination study	Swan	Swan Coastal Plain	Swan	110
Ecological values of river pools and evaluation of interventions to improve in-stream habitat	Swan	Swan Coastal Plain	Swan	111
Kent St Weir Pool - A case study in maximising environmental outcomes through better adaptive management	Swan	Swan Coastal Plain		112
Southern River Catchment nutrient export modelling	Swan	Swan Coastal Plain	Swan	113
Ellen Brook Catchment nutrient export: sources and pathways	Swan	Swan Coastal Plain	Swan	114
Habitat enhancement approaches within the Swan-Canning Estuary.	Swan	Swan Coastal Plain	Swan	115
Mapping habitat in the Swan-Canning Estuary.	Swan	Swan Coastal Plain	Swan	116
Using Swan Canning Estuarine Response Model to optimise oxygenation plant efficiency	Swan	Swan Coastal Plain	Swan	116
Apply acoustic technologies to investigate fish communities and movement	Swan	Swan Coastal Plain	Swan	117
Investigations of contaminants in the Swan Canning	Swan	Swan Coastal Plain	Swan	118
Swan Canning water quality monitoring	Swan	Swan Coastal Plain	Swan	119
Algal blooms: investigations and control	Swan	Swan Coastal Plain	Swan	120
Incident investigations, response and advice	Swan	Swan Coastal Plain	Swan	121
Investigating fish communities as an indicator of estuarine condition	Swan	Swan Coastal Plain	Swan	122

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Model frameworks for estuarine reporting	Swan	Swan Coastal Plain	Swan	123
Seagrass monitoring and evaluation	Swan	Swan Coastal Plain	Swan	124

Species and Communities

Project Title	DBCA Region	IBRA/IMCRA	NRM Region	Page
Assessment and advice for conservation significant species and ecological communities	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	125
Biodiversity knowledge management	All DBCA Regions	All IBRA Regions	All NRM Regions	126
Conservation and recovery of threatened ecological communities	All DBCA Regions	All IBRA Regions	All NRM Regions	127
Fauna conservation and recovery	All DBCA Regions	All IBRA Regions, All IMCRA Regions	All NRM Regions	128
Flora conservation and recovery	All DBCA Regions	All IBRA Regions	All NRM Regions	130
Wetland mapping	All DBCA Regions	All IBRA Regions	All NRM Regions	131
Wetlands conservation	All DBCA Regions	Eighty Mile Beach, All IBRA Regions	All NRM Regions	132



Ground-truthing spatial modelling for soil and vegetation mapping in Karijini National Park as part of the Pilbara Conservation Project. *Photo – Paul Rampant/DBCA.*



Monitoring water quality in the Mandoon Bilya (Helena River). *Photo – DBCA*