Southwest Australia
Ecoregion Initiative

A STRATEGIC FRAMEWORK FOR BIODIVERSITY CONSERVATION

Report A: For decision-makers and practitioners

Southwest Australia
Ecoregion Initiative

Copyright text 2012 Southwest Australia Ecoregion Initiative.
All rights reserved.

Author: Danielle Witham, WWF-Australia

First published: 2012 by the Southwest Australia Ecoregion Initiative.

Any reproduction in full or in part of this publication must mention the title and credit the above-mentioned publisher as the copyright

Cover Image: © Henry Cook

Design: Three Blocks Left Design

Printed by: SOS Print & Media
Printed on Impact, a 100% post-consumer waste recycled paper.

For copies of this document, please contact SWAEI Secretariat, PO Box 4010, Wembley, Western Australia 6913. This document is also available from the SWAEI website at http://www.swaecoregion.org

Department of **Planning**
Department of **Agriculture and Food**
Department of **Environment and Conservation**

CARING
FOR
OUR
COUNTRY

CONTENTS

FOREWORD iii

EXECUTIVE SUMMARY iv

ACKNOWLEDGEMENTS vi

SETTING THE CONTEXT 01
The Southwest Australia Ecoregion Initiative 01
Rational for this report 02
What is biodiversity? 03
The boundaries of the Southwest Australia Ecoregion (SWAE) 03
The significance of the SWAE 05
Threats to the biodiversity of the SWAE 09
Responding to the threats 14

SYSTEMATIC CONSERVATION PLANNING PROCESS 16
What is systematic conservation planning? 16
Summary of the process for systematic conservation planning in the SWAE 16
Conservation planning software 18
How to interpret the results – allocating limited resources across the SWAE 22
How not to interpret these results 23
Future options 25

STATUTORY MECHANISMS TO ACHIEVE BIODIVERSITY CONSERVATION 27
International policies, treaties and conventions 27
Federal legislation, policies and strategies 27
State legislation, policies and strategies 28
Local planning strategies 31
The role of land-use planning to achieve biodiversity conservation outcomes 32

INCENTIVES TO ACHIEVE BIODIVERSITY CONSERVATION WITHIN THE SWAE 34
Local-scale biodiversity conservation 36

PARTNERING WITH REGIONAL-SCALE NON-GOVERNMENT ORGANISATIONS 37

DISCUSSION 40

GLOSSARY 41

ACRONYMS 43

REFERENCES 44

APPENDICES 49

Appendix 1. Results from Choice Modelling Survey 49

Appendix 2. Program and Project Planning within Areas of Conservation Action 51

Appendix 3. Example of how to apply the systematic conservation planning process to a local community group focus area at Lake Sway 54

Appendix 4. Implementation design principles and concepts 56

Appendix 5. Program logic example for projects contributing to achieving the SWAE conservation feature targets 60

Appendix 6. Additional mechanisms supporting biodiversity conservation in Western Australia 62

LIST OF TABLES

Table 1. Summary of the SWAE's natural assets 8

Table 2. Summary of biological and physical threats to the biodiversity of the SWAE 10

Table 3. Summary of conservation features used in the SWAEI systematic conservation planning process. 19

Table 4. Limitations on the use and interpretation of the SWAEI outputs 24

Table 5. Primary biodiversity conservation mechanisms for the SWAE 29

Table 6. Land-use planning mechanisms for biodiversity protection 33

Table 7. Examples of instruments to achieve biodiversity conservation 35

Table 8. Regional NGOs in the SWAE 37

Table 9. Dollar values derived from public base model (Rogers and Cleland, 2011) 49

Table 10. Willingness to pay for all possible interactions between endemic and threatened species 50

Table 11. Conservation features in Lake Sway that had 10–100% SWAE-wide representation 55

Table 12. Prioritise conservation features, identify rank and group threats and set condition targets 56

FOREWORD

It may surprise many West Australians – especially those in and around Perth – to discover that they are living in one of the most unique and fragile ecosystems on Earth.

The Southwest Ecoregion of Australia – a huge, triangular swathe of land stretching from Shark Bay to Eucla, on the South Australian border – is one of the most biologically diverse areas on the planet. It is unique, even within the context of Australia's huge array of weird and wonderful wildlife.

Often referred to as a "biodiversity hotspot" – one of only 34 in the world – the Southwest Australia Ecoregion (SWAE) is comparable to the Amazon rainforests, the jungles of Borneo, the Galapagos Islands or the Cape of Africa.

It is one of the world's oldest and most diverse regions. The SWAE's native flora, roughly half of which is endemic, is especially impressive. In fact, the ecoregion has the highest concentration of rare and threatened species on the Australian continent and one of the highest concentrations in the world.

Who would have thought that such a flat and featureless piece of mostly arid land could contain so much variety?

Many Southwest Australians already know they live in one of the most beautiful places on Earth. They take it for granted that the stunning coastlines, towering forests, scenic rivers and lush wetlands will always be there – along with all the colourful wildflowers and animals that make this corner of the world so unique.

What they may not know is that much of this area has already been damaged – some of it irreparably – and that it remains under constant threat from land-clearing, development and introduced pests and diseases, such as *Phytophthora* dieback.

More than 90 per cent of natural vegetation has already been lost in the Wheatbelt due to early agricultural clearing practices. Increasing areas are affected by soil erosion and salinity, meaning they cannot be used for farming and may never return to their natural state.

Many native species that have evolved over hundreds of millions of years now face the very real threat of extinction. Already, more than 80 per cent of wetlands on the Swan Coastal Plain have been all but destroyed, while bushland in Perth continues to be cleared at a rate of more than a football field each day!

Australia has some of the highest extinction rates in the world. Land-clearing, mining, urban development and introduced species have all taken a terrible toll. And, all the while, diminishing average annual rainfall in the Southwest over the past 30 years – a technical drought – has put even more pressure on the survival of native species.

So what can be done? Our own survival relies on the very biodiversity that we urgently need to protect, much like Aboriginal people have relied on it for thousands of years. While we cannot ignore the losses of the past, we now need to focus on preserving and restoring what remains.

Just as importantly, we need to address land-clearing, energy and water-use efficiency, power generation and population pressures in urban areas. We cannot keep sprawling out along the coast. Perth is already one of the most linear cities in the world and is beginning to feel the affect of transportation and infrastructure problems.

We all need to play our part by doing more with less. This does not mean sacrificing our quality of life; we simply need to change the way we think about the natural resources that we rely upon. In short, we must be smarter about the way we live. It is the essence of sustainability.

Resources are finite – once they are gone, they are gone. This includes our natural resources, such as our amazing native plants and animals. Ultimately, it also includes ourselves.

Dermot O'Gorman
CEO WWF-Australia

EXECUTIVE SUMMARY

The Southwest Australia Ecoregion (SWAE) is an internationally recognised biodiversity hotspot. Covering 700,000 square kilometres, it is high in biodiversity values and endemism; however, many of the ecoregion's natural values are subject to a variety of threats. The species and ecological communities that underpin the SWAE's biodiversity are threatened by historical and current land-use, *Phytophthora* dieback, salinity, feral animal predation and weed invasion. Over the past 30 years, a wide range of federal, state and local government, and community initiatives have sought to address these threats, yet biodiversity loss continues.

The Southwest Australia Ecoregion Initiative (SWAEI) is a consortium that includes representatives from local, state and federal governments, non-government environmental organisations and natural resource management (NRM) groups. Members are concerned about the ad hoc nature of biodiversity planning and management and have sought to identify new priority areas of national significance for conservation action using a data-rich, rigorous and defensible process. The consortium has undertaken an extensive systematic conservation planning project that aims to identify priority areas known as Areas for Conservation Action (ACA).

This systematic conservation planning project delivers a coordinated strategic framework for the conservation of biodiversity in the southwest of Australia. It is based on scientific principles, informed by experts, and has been developed using methods that are widely used and easy to interpret.

This report presents the culmination of the SWAEI's two-year systematic conservation planning project. It describes the systematic conservation planning process, provides guidance on how to interpret and implement the results, identifies a variety of statutory and incentive mechanisms that enable conservation action, and outlines some of the major stakeholders in the SWAE. Mechanisms for conservation encompass both management principles for the key threatening processes and the protection afforded through statutory means, such as land-use planning and policies specifically aimed at biodiversity conservation.

This report serves as a guide for conservation planning activities within identified ACAs by:

- Informing targeted investment for on-ground action by stakeholders operating at the local, state, national and international scale;
- Informing local and state government planning decisions;
- Guiding decision-making through community initiatives;
- Driving a range of strategies and actions that deliver the vision for the ecoregion; and
- Engaging the community and key stakeholders to build and strengthen partnerships necessary to conserving the values of the SWAE.

The results of this systematic conservation planning project demonstrate the need to make the current reserve system more strategic and extensive, and better supported by off-reserve conservation management. To achieve conservation goals identified by agencies, non-government organisations (NGOs) and communities, it will be necessary to consider biodiversity early in the land-use planning process.

© HELENA MILLS / WWF-AUS

Everlastings

ACKNOWLEDGEMENTS

This report recognises the valuable contribution that many committed individuals and organisations have made to the Southwest Australia Ecoregion Initiative (SWAEI) over many years. Their expertise, guidance, general assistance and advice has been critical to the systematic conservation planning process, however, this report may not fully reflect their particular views.

Members of the SWAEI Working Group: Dr Ken Atkins (Chair), Dr Geoff Barrett, Mr Paul Bowers, Mr Paul Gamblin (Chair), Mr Hamish Jolly, Mrs Katina Marchbank, Mr Neil Riches, Mr Rod Safstrom and Mrs Renata Zelinova.

Members of the Stakeholder Reference Group (in addition to the Working Group members): A/Prof John Bailey, Mr Mark Batty, Mr Justin Bellanger, Ms Danielle Berry, Ms Vanessa Bray, Mr Alan Briggs, Mr Leon Brouwer, Dr Allan Burbidge, Prof Michael Burton, Ms Jessica Chapman, Mr John Collins, Ms Sharon Colliss, Mr Mark Cowan, Mr Cameron Crowe, Dr Robert Davis, Ms Paula Deegan, Mr Phil Drayson, Dr Frances D'Souza, Mr Alex Errington, Dr Stuart Halse, Mr Charles Hammond, Mr Alan Hill, Prof Richard Hobbs, Dr Ric How, Ms Carol Innes, Mr Greg Keighrey, Mr Glen Kelly, Ms Annora Longhurst, Mr Mike Lyons, Prof Jonathan Majer, Ms Lisa Mazzella, Dr Abbie McCartney, Mr Ben Miller, Ms Hellene McTaggart, Ms Sue Middleton, Dr Melinda Moir, Ms Sophie Moller, A/Prof Sue Moore, Mrs Rebecca Palumbo, Ms Heather Percy, Mr Bob Pond, Dr Suzanne Prober, Mr Martin Rayner, Prof Dale Roberts, Dr Rom Stewart, Dr Kevin Thiele, Ms Lindy Twycross, Mr Deon Utber, Mr Martin Von Kaschke, Mr Ken Wallace, Ms Bronwyn Williams, Mrs Rachel Williams, Mr Ray Wilson and Dr Colin Yates.

Workshop participants and expert advisors: Dr Ken Atkins, Dr Mike Bamford, Mr Geoffrey Banks, Dr Geoff Barrett, Ms Alison Beard, Mr Brett Beecham, Mr Toumi Belouardi, Mr Karl Bossard, Ms Mieke Bourne, Mr Michael Braby, Ms Vanessa Bray, Mr Michael Brooker, Dr Allan Burbidge, Dr Andrew Burbidge, Ms Annabelle Bushell, Dr Margaret Byrne, Mr Matt Cavana, Ms Karen Clarke, Ms Sharon Colliss, A/Prof Arthur Conacher, Dr Michael Coote, Mr Mark Cowan, Dr Mike Craig, Mr Cameron Crowe, Mr Chris Curnow, Dr Stephen Davies, Dr Robert Davis, Mr Will De Milliano, Prof Kingsley Dixon, Mr Rob Doria, Dr Frances D'Souza, Dr Paul Doughty, Dr Chris Dunne, Dr Stefan Eberhard, Ms Val English, Mr Alex Errington, Dr Judith Fisher, Ms Vanessa Forbes, Dr Volker Framenau, Mrs Debora Freitas, Mr Paul Gamblin, Mr Paul Gioia, Mr Brett Glossop, Mrs Cheryl Gole, Mrs Cate Gustavsson, Dr Stuart Halse, Ms Judith Harvey, Dr Mark Harvey, Dr Brian Heterick, Mr Angus Hopkins, Dr Terry Houston, Ms Katherine Howard, Mr Ron Johnstone, Ms Anthea Jones, Ms Susan Jones, Mr John Kaye, Ms Amanda Keesing, Mr Greg Keighery, Mr David Knowles, Ms Alisa Krasnostein, Dr Rob Lambeck, Ms Justine Lawn, Dr Craig Lawrence, Ms Louise Leigh, Mr Mike Lyons, Prof Jonathan Majer, Mr Michael Manton, Mrs Katina Marchbank, Mrs Danielle Matthews, Dr Peter Mawson, Ms Cheryl-Anne McCann, Mr Norm McKenzie, Ms Helena Mills, Dr Melinda Moir, Ms Sophie Moller, Mr Rod Nowrojee, Dr Blair Parsons, Mrs Patricia Pedelty, Dr Adrian Pinder, Asst/Prof Pieter Poot, Dr Suzanne Prober, Mr Viv Read, Mr Jeff Richardson, Mr Neil Riches, Prof Dale Roberts, Dr Richard Robinson, Mr Rod Safstrom, Dr Erica Shedley, Mr Damian Shepherd, Mr Marcus Singor, Mr Simon Smale, Mrs Melanie Smith, Mr Dave Stapleton, Ms Bernadette Streppel, Prof Will Stock, Dr Tim Storer, Mr Bradley Tapping, Mr Deon Utber, Mrs Emma Van Looij, Dr Ryan Vogwill, Mr Ken Wallace, A/Prof Grant Wardell-Johnson, Mr Corey Whisson, Dr Matthew Williams, Mrs Rachel Williams, Dr Colin Yates and Mrs Renata Zelinova.

Members of the Conservation Planning Team: Dr Geoff Barrett (Chair), Prof Bob Pressey FAA, Dr Trevor Ward and Ms Danielle Witham.

Project manager: Ms Danielle Witham and Sue Eber

Technical Analysis: Gaia Resources

Maps: Michael Raykos

The author thanks the countless other professional people who provided occasional advice in their field of expertise and the data custodians who greatly assisted in supplying and interpreting the data.

Additional appreciation is extended to Dr Ken Atkins, Dr Geoff Barrett, Ms Amanda Burdon, Prof Bob Pressey FAA, Mrs Lucy Sands, Mr Neil Riches and Dr Trevor Ward for contributing to or editing this report.

Special thanks to Mrs Cheryl Gole, Ms Jane Madgwick and Mr Richard McLellan from WWF-Australia, who played a considerable role in establishing the SWAEI; Mr David McFarlane from WWF-Australia, who provided administrative support for the conservation planning project and to the Canberra-based Australian Government representatives for their interest in and support for this process. Funding support was provided by the Australian Government through Caring for Our Country, WWF-Australia, and the DEC.

SETTING THE CONTEXT

THE SOUTHWEST AUSTRALIA ECOREGION INITIATIVE

The Southwest Australia Ecoregion (SWAE) is internationally recognised for its biodiversity values. However, until now, there has not been a coordinated and integrated approach to mitigating the key threats it faces. A consortium of concerned conservation experts met informally in 2001 with the aim of developing a cooperative approach to biodiversity conservation in the southwest of Australia. This evolved into the Southwest Australia Ecoregion Initiative (SWAEI).

In 2002, the State Government response to the Salinity Taskforce report included two specific commitments relevant to the development of a vision for the southwest landscape that recognised the richness and vulnerability of biodiversity, and the threat of salinity and climate change. The response further recommended the establishment of a government-NGO working group, representing all major stakeholders to develop "a Nature Conservation, Native Vegetation and Biodiversity Strategy" for Southwest Western Australia – which directly supported the objects and structure of the SWAEI.

The SWAEI was formalised in 2002 with the inception of a Stakeholder Reference Group (SRG). The SRG is jointly chaired by the Department of Environment and Conservation (DEC) and WWF-Australia, and includes representation from NRM regional groups, Australian and State Government agencies, research and tertiary institutions and the community. A smaller Working Group (also jointly chaired by the DEC and WWF-Australia) met more frequently to progress SWAEI objectives and to report back to the SRG.

The SWAEI has relied upon the leadership and contributions of both the DEC and WWF-Australia to support activities such as the Conservation Planning Symposium. This symposium brought together over 260 participants, including internationally renowned conservation planning experts, NRM professionals and community representatives. The conservation planning experts who attended the symposium maintained ongoing dialogue and participated in subsequent workshops to help formulate the planning approach used here for the SWAE.

In 2008 and 2010, funding was received from the Australian Government's Caring for Our Country initiative to undertake a systematic conservation planning project for the SWAE. WWF-Australia has led the first two phases of this project on behalf of the SWAEI consortium. The first phase was completed in 2009 and used information from the Conservation Planning Symposium and subsequent consultation with experts to develop a draft spatial plan and process for prioritisation. The second phase commenced in 2010 to finalise the systematic conservation planning process and to demonstrate a means of on-ground implementation.

Aims and objectives of the SWAEI

The key SWAEI objective is to deliver a coordinated, strategic planning framework for the conservation of biodiversity in the southwest of Australia, starting with a biodiversity assessment and prioritisation process. The SWAEI consortium aims to act as a catalyst for addressing key threats to the values of the SWAE by raising the ecoregion's profile locally, nationally and internationally. The consortium also aims to guide decision-makers charged with the responsibility of land-use planning and on-ground implementation.

Vision for the SWAE

The SWAEI identified a set of guiding principles to protect, enhance and connect natural areas, which are underpinned by a landscape ecology approach to biodiversity conservation. These principles recognise the importance of people and their activities within the SWAE, as articulated in the following vision for the region:

"A diverse and continuous mosaic of natural landscape features distributed across the landscape, interspersed with a diversity of socially and economically productive land uses, which support the natural diversity and natural functioning of that landscape".

RATIONAL FOR THIS REPORT

This report presents a regional framework of priority areas across the SWAE, resulting from a rigorous systematic conservation planning process.

Much of the natural environment in the SWAE has been modified, primarily for commodity production and urban development. This consumption of natural resources (land, water and air) now threatens the SWAE, which is known for its biodiversity assets and high endemism.

While the reserve system (including nature reserves and national parks) exists to safeguard biodiversity and to provide additional benefits, such as protecting water supplies, we have relied too heavily on these protected areas to conserve biodiversity. The current reserve system does not adequately protect a number of species and highly valued natural assets (Hobbs *et al.*, 1992; Pressey and Logan, 1997; Gove *et al.*, 2008).

The world's existing reserve systems contain a biased sample of biodiversity, usually remote places and areas unsuitable for commercial activities (Margules and Pressey, 2000). Furthermore, the establishment of many popular national parks had little to do with their conservation or scientific values, or with the protection of flora and fauna habitat (Rundle, 1996). This inadequate reserve system, with its overstretched management budgets, has not effectively prevented continuing biodiversity loss.

According to Margules and Pressey (2000), the realisation of conservation goals requires strategies for managing whole landscapes, including areas allocated to production and protection. While the areas protected within the reserve system are inadequate for the protection of all biodiversity values, they are the cornerstone upon which large regional conservation frameworks are built.

Reserves have two main roles: they should sample or represent the biodiversity of each region and separate this biodiversity from processes that threaten it. A more systematic approach to identifying areas to be protected and managed, both within and outside the reserve system, has been evolving. This systematic approach will need to be implemented if a large proportion of today's biodiversity is to survive, especially given population growth and increasing demands on natural resources.

Systematic conservation planning involves finding the best set of potential areas for conservation that align with a number of principles, including comprehensiveness, representativeness, efficiency, flexibility, risk spreading and irreplaceability (Sarkar *et al.*, 2006). Conservation activities outside the conservation estate take account of wide-ranging species, such as migratory or nomadic animals, and increase the opportunity for landscape planning. This underpins the SWAEI's systematic conservation planning strategy and builds on the existing reserve system. It uses a cost-effective method and gives priority to biodiversity values located near existing reserves (Margules *et al.*, 1991; Game and Grantham, 2008).

Ecoregion conservation

Ecoregion conservation is an ambitious undertaking. It aims to conserve and, where necessary, restore the full range of biological diversity within an ecoregion through a rigorous analysis of biological information as well as an assessment of linkages between ecological, political, economic and socio-cultural factors. Fundamental goals of biodiversity conservation include:

- Representation of all distinct natural communities within conservation landscapes and protected area networks;
- Maintenance of ecological and evolutionary processes that create and sustain biodiversity;
- Maintenance of viable populations of species; and
- Conservation of blocks of natural habitat that are large enough to be resilient to large-scale stochastic disturbances (or unpredictable events, like fires, flooding and insect population explosions) and deterministic disturbances (or predictable events, such as predator/prey relationships or population cycles) as well as to long-term effects, such as climate change (WWF, 2004).

The SWAEI has produced a priority map of ACAs. This report discusses biodiversity values and threats, and provides a summary of the systematic conservation planning process for the ecoregion. Strategies for immediate investment, action and appropriate land-use planning are not included in this phase of the project. However, this report describes the prioritisation of areas for conservation, and proposes a process for translating regional-scale planning into on-ground implementation. The report also provides information on mechanisms that support biodiversity outcomes, such as legislation, policies and incentive instruments.

This report aims to facilitate the dissemination of scientific findings and allow uptake by decision-makers and practitioners at all levels, by:

- Informing targeted investment and acquisition strategies for on-ground action from a range of stakeholders who operate at different scales;
- Informing local and state government planning decisions;
- Guiding decision-making and support for community initiatives;
- Motivating a range of strategies and actions that deliver conservation outcomes at the ecoregional scale;
- Engaging the community and key stakeholders to build and strengthen the partnerships required to conserve the values of the ecoregion;
- Building knowledge and innovation, and providing a platform for sharing knowledge; and
- Tapping into new opportunities – for example, offsets and novel landscapes.

Expert engagement

Over the course of the systematic conservation planning project, which commenced officially in 2009, a series of workshops and one-on-one engagements have been conducted. Over 130 scientists and other experts have contributed to the process, providing advice on the analysis, selection of relevant conservation features, target-setting parameters, land classification, threats, data access and analysis, interpretation of results and translation to on-ground action. The Conservation Planning Team (CPT) that managed the analysis and data interpretation consisted of world-renowned experts such as Prof Bob Pressey FAA, Dr Trevor

Ward and the DEC's Regional Ecologist Dr Geoff Barrett. Gaia Resources ably supported the CPT in the collation and analysis of data.

Partnerships

WWF-Australia, as the lead organisation, has worked collaboratively with a range of key stakeholders, mainly through three pivotal groups. The Working Group provided strategic direction for the project; the Stakeholder Reference Group (SRG) advised on stakeholder engagement and future community engagement, and the CPT provided technical expertise and guidance. In addition, stakeholders and partners attended a series of workshops and one-on-one meetings. This project would not have been possible without the support, investment and contribution of partners that included the Australian Government, Western Australian Government, regional NRM groups, environmental NGOs, the Western Australian Local Government Association, tertiary institutions and various other interest groups.

WHAT IS BIODIVERSITY?

Biodiversity is the variety of all living things: the different plants, animals and micro-organisms, the genetic information they contain, and the ecosystems they form. Biodiversity is usually explored at three levels – the genetic, species and ecosystem levels, which work together to create the complexity of life on Earth (Noss, 1990).

The benefits of healthy ecosystems

The conservation features used in our analysis included functional measures associated with ecosystem condition. This is based on a broader definition of biodiversity that includes function as well as composition and structure (Noss, 1990). For example, the size and isolation of remnant patches of vegetation, as well as threats such as dieback and salinity, were included as surrogates for habitat condition and ecosystem services. Ecosystem services are a benefit that humans receive from healthy habitat. Such services are important because they influence human quality of life and the productivity of our landscapes, support air and waterway health, encourage tourism and recreation, provide important cultural values, and also protect and buffer resilience to climate change (Millennium Ecosystem Assessment, 2005).

THE BOUNDARIES OF THE SWAE

The SWAE (Map 1) comprises the Southwest Australian Floristic Region (SWAFR, sensu Hopper and Gioia, 2004), plus the adjacent semi-arid region (the "Transitional Zone"). After extensive consultation, it was also agreed to include a 100-kilometre buffer outside the Transitional Zone to provide spatial context for conservation planning, particularly to identify threats, conservation features and processes just outside the SWAE boundary that might influence decisions within its boundary.

Included within the boundary and scope of the project are both terrestrial and critical aquatic habitats, including coastal and estuarine areas. The significance of marine biodiversity is acknowledged, but excluded from the scope of the project. Initially, it was agreed that off-shore islands larger than 20 hectares be included. However, based on expert advice, it was decided to exclude all islands because they have quite distinct values that need to be evaluated using different criteria.

Planning at the ecoregion scale is important for a variety of reasons. Firstly, it provides broad spatial context for decision-making by different spheres of government, NRM bodies and other organisations involved with on-ground conservation delivery. Secondly, it provides decision-makers with an appreciation of regional variation in vegetation types and species in different habitats, thereby contributing to a more comprehensive assessment of the ecoregion's biodiversity.

The project boundary for the SWAE covers 686,870 square kilometres, which equates to approximately 27 percent of the total area of Western Australia, or 9 percent of the total area of Australia. It contains all or part of the following 14 (out of 85) Australian bioregions, which are described in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995). These include:

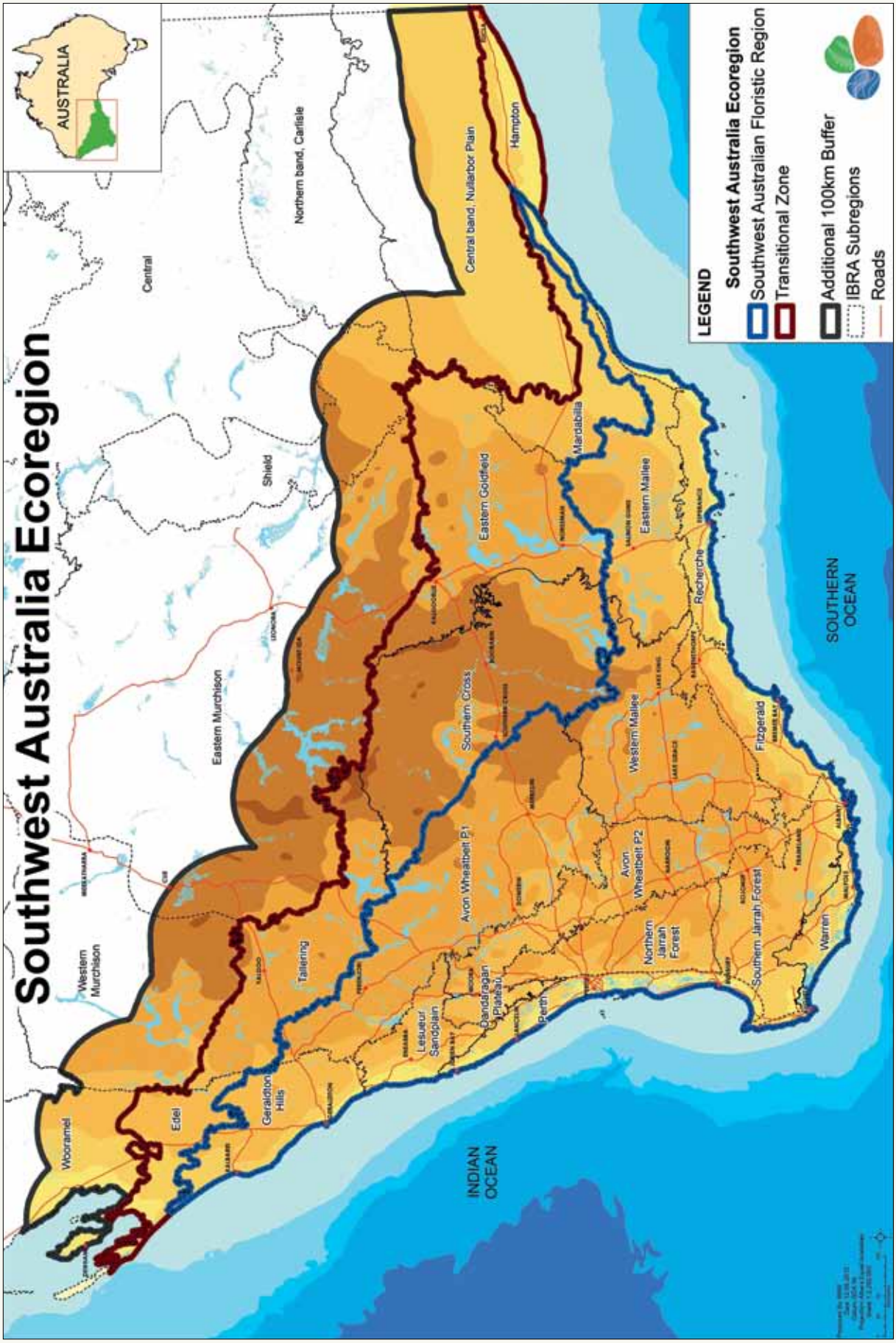
- Avon Wheatbelt
- Carnarvon*
- Coolgardie
- Esperance Plains
- Geraldton Sandplains
- Great Victoria Desert*
- Hampton
- Jarrah Forest
- Mallee
- Murchison*
- Nullarbor*
- Swan Coastal Plain
- Warren
- Yalgoo

*part of the 100 km buffer zone

Inclusive of the buffer zone, the Strategic Framework for Biodiversity Conservation includes part or all of 26 Interim Biogeographic Regionalisation for Australia (IBRA, DSEWPC, 2012) sub-regions.

Map 1 shows:

- The Southwest Australia Ecoregion (DSEWPC, 2012) demarcated by the Transitional Zone;
- The Southwest Australian Floristic Region (Hopper and Gioia, 2004); and
- A 100 km buffer.



Map 1. Southwest Australia Ecoregion

THE SIGNIFICANCE OF THE SWAE

The SWAE is an international asset and a jewel in the Australian continent. It is one of the most biologically diverse areas on Earth, containing approximately 15,000 taxa of higher plants and animals (including introduced species), and a high level of endemism. It also has the highest concentration of rare and endangered species in Australia (Hopper and Gioia, 2004; Gove *et al.*, 2008; Australian Government, 2011). For these reasons, the SWAE is valued socially, culturally, economically and ecologically, making it increasingly important to protect for future generations.

The SWAE has been listed by Conservation International as one of 34 Global Biodiversity Hotspots, by WWF as one of the Global 200 Ecoregions, and by BirdLife International as an Endemic Bird Area. Furthermore, it is one of only five globally significant Mediterranean-climate regions in the world and is considered a global Centre of Plant Diversity (WWF/IUCN) (WWF, 2010).

However, the ecoregion's global and national status has not always been matched by long-term protection. As a nation, we do not yet have a widely held culture of supporting those individuals and organisations that actively conserve biodiversity. Economic values have too often taken precedence over cultural, ecological and social values of biodiversity.

The ecoregion's biodiversity is likely to present future opportunities for Australians. Only by adopting precautionary approaches and informed decision-making to minimise the impacts of today's activities will these opportunities be realised. We have a moral and ethical responsibility to ensure that all indigenous species and the full range of ecosystems continue to exist (DEC, 2006).

Cultural values

The SWAE is also recognised for its important cultural values to Aboriginal people. Much of the ecoregion is the homeland of the Noongar (Nyoongar or Nyungar) people, the Yamadji people, and the Wongai people, who have maintained a close relationship with their land and natural environment for approximately 50,000 years (Nannup and Deeley, 2006).

Biodiversity is central to the identity and cultural heritage of Aboriginal people. This strong connection to the land is fundamental to their well-being and is expressed through ceremonies, art, dance and legends. Caring for country is an important part of Aboriginal culture and identity, so traditional knowledge and belief systems should be integrated into conservation planning and management.

Once viewed as harsh, weird and inhospitable, the Australian landscape is increasingly seen by non-Indigenous Australians as possessing unique beauty and value to our nation. The bush is iconically Australian, as reflected not only in our visual art but also in our ballads, writing, sculpture and other art forms (Lambert and Elix, 2000).

Economic values

Ecosystem services provide the basic materials for life, including livelihoods, food and water, shelter, clothing and access to goods (Millennium Ecosystem Assessment, 2005). Consequently, the economy of the ecoregion relies on the ecosystem services that biodiversity provides.

Natural resources are vital for land uses that generate income in the ecoregion. The long-term viability of agriculture, pastoralism, forestry, tourism and mining relies on the sustainable use of the region's natural resources. Agriculture can benefit considerably from biodiversity and ecological processes. Native vegetation and the animals it supports have economic benefits for adjacent crops, pasture growth, livestock production, timber harvesting, research/education, yields of honey and beeswax, carbon storage and sequestration, water supply and protection of water quality, and soil conservation (Gillespie, 2000; Economic Research Associates, 2011).

The SWAE provides some of the world's best and most distinctive nature-based tourism, contributing to one of the state's key economic drivers. The Western Australian tourism industry contributes $5.92 billion annually to the economy and employs around 73,000 people (Spur *et al.*, 2011), many of them in nature-based tourism. Carlson and Wood (2004) estimated that the value of tourism in the SWAE's southern forests and national parks, alone, was $61–70 million per annum in direct visitor expenditure and $6 million in substitute expenditure (Economic Research Associates, 2011). However, much of the ecoregion's nature-based tourism is outside national and conservation parks. Inadequate protection and management of our natural areas would, therefore, have serious consequences for this industry – from the tour operators to those who indirectly rely on this market, such as surrounding townships.

Very little information has been collected on the economic value of biodiversity in an urban context. The primary role of natural areas in an urban setting is more likely to be related to improving the aesthetic quality of a city and urban life. Urban communities place significant value on natural areas that are well managed and accessible to people. Pockets of remnant bushland that remain in Perth may fall into this category, namely Kings Park, Whiteman Park and Bold Park (including Reabold Hill). While the value that the community places on protecting these assets has not been studied, numerous reports have considered the land and house values within close proximity of quality parks and bushland. Proximity to natural bushland adds 10–15 percent to house and land values, demonstrating that a substantial capital value is connected to remnant bushland areas in Perth (Economic Research Associates, 2011).

Human health and well-being is inextricably linked to biodiversity and its delivery of a stream of services and products. Various studies on local temperature mitigation have shown that significant tracts of bushland and forests in urban areas can hold down the ambient temperature, thereby reducing air-conditioning costs. Again, these values have not yet been extensively studied in Western Australia, but overseas studies revealed significant value in this role (Economic Research Associates, 2011). Diminishing biodiversity will ultimately result in a general decline in the quality of life and well-being of current and future generations, affecting economic markets and social cohesion (DEC, 2006).

Social values

Biodiversity has social and amenity values. It can improve standards of living, engender pride, and help people to lead more fulfilled lives. A variety of medical issues are also influenced by biodiversity, including dietary health and nutrition, infectious diseases, science and medicinal resources, and social and psychological health (Takacs, 1996; Gaston *et al.*, 2007). Society is largely aware of these values, but it is difficult to quantify the social values of biodiversity in monetary terms. In recent years, however, natural resource managers, social scientists and economists have developed valuation techniques that assist in estimating the value of biodiversity assets.

Choice modelling is one technique used to estimate the non-market benefits and costs of biodiversity protection and management. It involves a sample of people who are expected to experience the benefits and costs being asked a series of questions about their preferences for future management.

Rogers and Cleland (2011) performed a choice modelling survey to determine public preferences for biodiversity in the SWAE. This survey involved 519 respondents, who had a number of different biodiversity attributes explained to them. These attributes were:

- Critical vegetation associations;
- Threatened species;
- Endemic species;
- Unique wetlands; and
- Largely unmodified estuaries.

The respondents were asked to choose between alternatives for protection of these biodiversity attributes, with one option being a "business-as-usual" approach. Respondents' preferred alternatives demonstrated their willingness to trade-off one attribute against another. So long as one of the biodiversity attributes used to describe the alternatives is monetary, it is possible to estimate respondents' willingness to pay to secure biodiversity attributes (Bennett, 2005).

The choice modelling survey found that:

The community values critical vegetation systems the most;

- People value endemic and threatened species more highly when both are being protected to some extent;
- Although people prefer to protect both threatened and endemic species together, threatened species appear to be the most important factor; and
- The values for wetlands and estuaries appear lower than for other attributes. However, some caution should be exercised in interpreting this result as it is possible that the description may have influenced these lower values.

Appendix 1. includes the results of this choice modelling survey. Further information on public preferences for biodiversity in the SWAE can be found at: http://www.crawford.anu.edu.au/research_units/eerh/publications/

Ecological values

The SWAE is one of the oldest and most diverse landscapes on the planet. Its soils are geologically ancient and nutrient deficient, resulting in species that have adapted to harsh conditions. The ecoregion's international importance is based primarily on the diversity and degree of endemism of its vascular plant species. In the Southwest Australian Floristic Region, alone, there are an estimated 6,759 plant species (7,380 taxa) and at least another 1,000 are estimated to remain unnamed, of which almost two-thirds (4,510 species) are endemic to the ecoregion. It is probable that a combination of ecological and evolutionary processes has operated over long periods of time to result in this diverse and species-rich flora in southwest Australia (Hopper and Gioia, 2004; Gove *et al.*, 2008).

Knowledge of southwest Australia's flora is recent (one-third of the recognised species have been described in the past 30–40 years) and still increasing, with new species being discovered each year (Hopper and Gioia, 2004). Table 1 contains a summary of the ecological assets of the SWAE.

Vegetation communities

The vegetation communities of the SWAE consist of unique assemblages that range from majestic forests to diverse heathlands. Examples include the jarrah-karri forests and shrublands, banksia and eucalypt woodlands, heathlands, mallee and arid savanna.

The jarrah forests are located on the western edge of the Darling Plateau and are home to some 150 species of birds, 29 mammals, 45 reptiles and 1,200 plant species, many of which are endemic to the ecoregion. Of the estimated 3.9 million hectares of jarrah forest that existed prior to European settlement, only half remains. However, the jarrah forest is largely intact compared to other ecosystems in the ecoregion.

The majestic karri forests around the Warren Region are a major tourist drawcard for Western Australia. Karri forests are found in the moderately wet climatic zone between Manjimup and Denmark, although some outlying populations are found around Margaret River, in the west, and the Porongorup Ranges in the east. As of 2007, the Warren Region was known to contain 1,865 indigenous vascular plant species. There is no accurate data on how much karri forest has been cleared for agriculture and logging. Estimates range from 13.2 percent (Shepherd *et al.*, 2002) to 31 percent (Beard *et al.*, 1984).

There are 11 broad types of banksia woodlands on the Swan Coastal Plain between Seabird, in the north, and Busselton in the south. These range from woodlands on the fringes of wetlands to those occupying the tops of sand ridges. Three of the 11 identified types of banksia woodlands in the Perth area are listed as threatened ecological communities. Four are priority ecological communities and one was found to contain up to 80 different plant species in 100 square metres, over 90 species of birds (including splendid fairy-wrens and western thornbills), other special fauna like honey possums, brush wallabies and quenda, nine frog species, over 20 species of skinks and burrowing snakes, and western jewel butterflies (Atkins, K., 2011, pers. comm.). Banksia woodlands are also habitat for a number of threatened species, including *Caladenia huegelii* (grand spider orchid) and *Drakaea elastica* (glossy-leaved hammer orchid) and provide essential sources of food for the endangered Carnaby's black cockatoo. These woodlands are threatened by urban and agricultural development, *Phytophthora* dieback, weed invasion and increased fire frequency. By 1986, only 45 percent of banksia

woodlands remained out of the original 281,000 hectares between Lancelin and Capel. In the case of the Bassendean Complex (Central and South on the coastal plain) only 14.5 percent of the banksia woodlands remain (Hopper and Burbidge, 1989).

Restricted to a 400 km band close to the southwest coast, tuart woodlands support a number of vulnerable and threatened species. Much of the remaining tuart woodland (67 percent) is located within privately-owned land, meaning that its conservation status is not secure (Gole, 2006). In addition, tuart woodlands face a multitude of stresses. These include declining rainfall; declining water tables; salinity; increased nutrient enrichment of soils and water-bodies; increased use of herbicides, fungicides and insecticides; long periods without fire; drought stress caused by understorey species being overstocked; and insect infestations and possible pathogens suspected of causing significant tuart decline south of Mandurah (Tuart Health Research Group, 2009). Approximately 65 percent of these woodlands have been cleared for urban development and agriculture.

The eucalypt woodlands, shrublands and mallee of the Wheatbelt, transition zone, and adjacent rangelands are floristically diverse, generally because of broad-scale variation in rainfall, landforms and soils. These vegetation communities generally appear in complex mosaics with heathland, mallee and salt lakes. Extensive woodlands of numerous types were once widespread throughout much of the agricultural area, with the most common being large eucalypts such as the York gum, marri, wandoo, salmon gum and gimlet. Other areas were dominated by various species of mallee eucalypts or Allocasuarina. These woodlands, shrublands and mallee areas are important habitat for many birds and other arboreal fauna. They harbour unusual wildlife – from rare marsupials to endangered reptiles. The eucalypt woodlands are important to a number of bird species within the SWAE that are obligate hollow nesters and others that use hollows as shelter and roosting sites. These include the endangered Carnaby's black cockatoo but also small insectivorous birds such as the rufous treecreeper, a declining species dependent on both standing and fallen hollows and logs. Hollows in old trees are increasingly scarce and may take up to 200 years to form. In poorly managed and degraded woodlands, trees are not regenerating fast enough to allow for their eventual replacement.

York gum-dominated woodlands originally covered more than 40,000 km^2 but it is estimated that only 3 percent of the pre-European extent remains. About 98 percent of wandoo woodlands have been cleared and less than 25 percent of other woodland types are left. In part of the central Wheatbelt, less than 5 percent of all native vegetation remains. However, there are areas of relatively undisturbed vegetation in the transitional zone between the Southwest Australian Floristic Region and arid zone. Understorey species in eucalypt woodlands differ between the arid and more humid zones (Birds Australia, 2005; Greuter, 1994; Yates and Hobbs, 2000).

Kwongan heaths and mallee of the northern and southern sandplains comprise floristically rich heath with dense thickets of sclerophyllous shrubs and isolated small trees. Kwongan is one of the most botanically diverse vegetation types world-wide. Favouring nutrient-poor sandy soils, frequent wildfire and a Mediterranean climate with winter rainfall and hot, dry summers, kwongan is characterised by a very high level of endemism and spectacular wildflower displays in spring (Pate and Beard, 1984). Most of the original "wheatbelt kwongan" has been cleared since European settlement but kwongan heath once covered approximately 30 percent of the SWAE. While most remnant kwongan now remains in some coastal and near-coastal areas, it is threatened by urban development and *Phytophthora* dieback. In addition, tens of thousands of flowers of the acorn and Hooker's banksias are harvested by wildflower pickers each year, further exacerbating the spread of plant killing pathogens such as *Phytophthora* dieback and aerial cankers (Northern Agricultural Catchment Council, 2011).

Fauna

While it is known primarily for its diversity of vascular plants, the ecoregion also boasts a rich and varied fauna, including a diverse array of jewel beetles. Invertebrates are poorly known (Moir *et al.*, 2009) but it is highly likely that narrow-range endemic invertebrates occur in many parts of the SWAE. Invertebrates account for 95–99 percent of all fauna found globally (Majer, 2008) and play a pivotal role in ecosystem function by aerating the soil, increasing rain infiltration, cycling nutrients, and aiding pollination and seed dispersal. They also constitute an important and specialized food source for many species of birds, mammals, reptiles and amphibians.

The SWAE has a rich frog fauna, with 28 species endemic to the region and a diversity of ground frogs (family Myobatrachidae), including unusual species such as the turtle frog (*Myobatrachus gouldii*) and sandhill frog (*Arenophryne rotunda*), which require no water to breed. Although some frogs, such as the sunset frog, have highly restricted ranges, making them vulnerable to threats such as habitat loss, in general the ecoregion frogs are faring better than those in eastern Australia, where catastrophic declines have resulted from the spread of the *Chytrid* fungus (Davis, 2006, unpublished).

There are approximately 77 species of terrestrial mammals, 14 of which are endemic to the ecoregion. The numbat (*Myrmecobius fasciatus*) is now considered endemic due to the massive contraction of its historical range. Other endemic species include the tiny honey possum (*Tarsipes rostratus*), weighing in at just 7–12 grams, the ash-gray mouse (*Pseudomys albocinereus*) and the quokka (*Setonix brachyurus*). The quokka is commonly seen on Rottnest Island, but is still found in densely vegetated areas around Harvey and Collie, Two Peoples Bay Nature Reserve, Torndirrup National Park and Walpole Nornalup National Park. There are 23 extinct mammal species from the ecoregion, eight of which are totally extinct (including two endemics) (Burbidge, A., 2011, pers. comm.).

A globally significant Endemic Bird Area, Southwest Australia is home to 13 endemic birds. Four of these species and two subspecies are listed as threatened (Gole, 2006). The Carnaby's black cockatoo, for example, was once numerous in Western Australia but is now listed as endangered, with populations declining dramatically due to historical land-clearing for agriculture and current land-clearing for urban development in Perth and elsewhere on the Swan Coastal Plain (Shah, 2006).

The ecoregion contains 14 species of native fish, 10 of which are endemic. This includes the extraordinary evolutionary anomaly, the salamander fish. This "living fossil" can survive seasonal

desiccation of its habitat by burrowing into bottom sand, where it has been recovered at depths of up to 60 centimetres (Berra and Allen, 1989). Little research has been undertaken on the status of native fish. However, the Department of Fisheries surveyed 114 lakes to find that only 50 contained native freshwater fish species. Half of the once permanent water bodies listed on maps in 2000 did not contain water throughout the year. This drying, coupled with the large number of introduced fish found during the survey, has threatened many native species. Only 9 percent of the lakes were populated exclusively with native freshwater fish, whereas introduced fish species were found in 66 percent of the lakes, while 12 percent contained no fish at all (Lawrence, C., 2011, pers. comm.).

There are approximately 260 reptile species in the SWAE. Of these, 34 are considered endemic to the region, including two freshwater turtles. The western swamp tortoise, now restricted to three seasonal swamps, is considered Australia's most endangered reptile. The ecoregion supports an array of geckos, worm lizards and legless lizards, dragons, thorny and bearded devils, skinks, bobtails and blue-tongue lizards, and non-venomous and venomous snakes (Bush *et al*., 2007).

Special habitats

The SWAE contains a variety of "special habitats", ranging from granite outcrops to wetlands, peat swamps, naturally saline and riverine systems. These support unique assemblages of flora and fauna.

Granite outcrops create a variety of microhabitats for plants and provide seasonal resources and refuge for a range of animals, ensuring rich assemblages of endemic species. They are also significant to Aboriginal and European cultural heritage. A number of animals are restricted to granite outcrops, including four species of reptile, a mygalomorph spider (*Teyl luculentus*), and the larvae of the chironomid fly (*Archaeochlus*). They also comprise an important habitat for rock-wallabies, such as the black-flanked rock-wallaby, and the ornate crevice-dragon (*Ctenophorus ornatus*). Rockpools, also known as gnammas, often form on the granite after winter rains and provide freshwater for at least 230 aquatic invertebrates, of which at least 50 are endemic. The variable rock surfaces and soil types create niches for many plants. At least 1,300 plant species occur on granite outcrops in Western Australia, many of them endemic (Bayly, 1999; Granite Outcrops Symposium, 1997).

Naturally saline wetlands are a result of salt accumulating in the soil profiles and groundwater over hundreds of thousands of years. These wetlands range from very large lakes to mosaics of small playas. Adaptation to these harsh conditions has resulted in complex vegetation systems and diverse fauna. The importance of the SWAE for aquatic invertebrates is less well documented than for plants but it appears to be a region of significant richness and endemism for groups with drought-resistant eggs, especially crustaceans. In most cases, whether on private or public land, these wetlands are threatened with increased inundation and salinisation due to rising groundwater levels. Salinisation increases salinities for at least part of the year, beyond the tolerance of the species that inhabit them. When it is the principal threat, rare species cannot usually be protected through small-scale management actions aimed at the organisms and their immediate habitat (Halse *et al*., 2004).

The SWAE contains 38 rivers, over 200 creeks and minor streams, a diverse range of wetlands, groundwater-dependent ecosystems and subterranean karst systems, all of which shape and influence the enormous aquatic diversity and ecosystems across the ecoregion (Gole, 2006). These aquatic assets are unique and also include eight Ramsar wetlands (wetlands of international importance) and 71 wetlands of national significance. Aquatic ecosystems in the ecoregion are highly threatened by the reduction in both surface and groundwater yields since the 1970s, rising saline water tables, and other degradation caused by human activities, such as landfill. It is estimated that more than 80 percent of wetlands on the Swan Coastal Plain have been lost or degraded (Environmental Protection Authority (EPA), 2007).

Table 1. Summary of the SWAE's natural assets

Features	Number of features	Endemic features	Threatened listings	
			State	Federal
Bird species	400	13	37	24
Fish species	14	10	3	2
Flora species * figure relates to the Southwest Australian Floristic Region only and is an under-estimation for the entire ecoregion	6,759*	4,510*	393	334
Frog species	39	28	3	3
Invertebrate species		likely high	18	6
Mammal species	77	14	20	17
Reptile species	260	34	7	8
Ramsar wetlands			n/a	8
Threatened ecological communities			53	16
Priority ecological communities			123	n/a
Nationally important wetlands			n/a	71

THREATS TO THE BIODIVERSITY OF THE SWAE

"Biodiversity loss is one of the world's most pressing crises and there is growing global concern about the status of the biological resources on which so much human life depends. It has been estimated that the current species extinction rate is between 1,000 and 10,000 times higher than it would naturally be"
– (International Union for Conservation of Nature and Natural Resources, 2009)

Since European settlement, human impacts have led to a rapid deterioration of biodiversity values in the SWAE, which is among the world's most heavily used landscapes (Judd *et al.*, 2008). The ecoregion's status as one of 34 biodiversity hotspots globally requires it to be an area where "*exceptional concentrations of endemic species are undergoing exceptional loss of habitat*" (Myers *et al.*, 2000). Expanding human populations and ever-increasing resource use and consumption have negatively impacted on biodiversity. These impacts include the clearing and fragmentation of natural habitats, dryland salinity resulting from broad-scale clearing, feral animal and weed invasions, exploitation and over-harvesting, and the spread of disease (Gole, 2006; EPA, 2007).

The Avon Wheatbelt bio-geographical region has been rated as the most stressed area for biodiversity in Western Australia, due to widespread loss of native vegetation, habitat fragmentation, land salinisation, and relatively small areas protected within the conservation estate (May and McKenzie, 2002). Biodiversity has been seriously impacted in other coastal parts of the South West and Mid West. Land development and associated clearing and fragmentation, *Phytophthora* dieback and weeds are examples of pressures in these regions (EPA, 2007).

Threats to biodiversity vary in nature, scale and origin and not all species and ecosystems respond to threats in the same way. It should be noted that our knowledge of the biodiversity of the SWAE is dominated by research undertaken in the western part of the ecoregion, which is more likely to be highly fragmented and has had much of its original vegetation removed or substantially altered (Hobbs and Atkins, 1991; Saunders and Ingram, 1995; Hobbs and O'Connor, 1999; Judd *et al.*, 2008). Less research has been undertaken in the eastern portion of the ecoregion, so these parts are less well known.

Biophysical threats to the ecoregion

Understanding the causes and impacts of threats and the vulnerability of different biodiversity assets is necessary to informing regional priorities and action. In 2007, the Environmental Protection Authority (EPA), in its *State of the Environment Report*, listed nine key threats to the environment in Western Australia, which are discussed in relation to the SWAE in Table 2.

© PHIL LEWIS / WWF-AUS

Walker's Bencubbin

Table 2. Summary of biological and physical threats to the biodiversity of the SWAE

Loss and degradation of native vegetation

The removal of native vegetation, both historic and current, is a major threatening process affecting biodiversity. It includes the traditional concept of clearing, but also involves other substantial damage to native vegetation (e.g. burning, overgrazing and draining or flooding of land) that results in the removal of at least some native vegetation and can result in degradation or loss of whole ecosystems. Loss of habitat through clearing is currently the primary cause of declines in species and populations world-wide (Millennium Ecosystem Assessment, 2005; EPA, 2007).

The legacy of clearing, particularly in the Wheatbelt and coastal zones of the southwest, is a fragmented landscape prone to weeds, feral predators, changed hydrology (often resulting in salinity) and introduced disease. More recently, most clearing in the southwest occurs for urban development and, in other regional locations, for mining. The significant reduction in vegetation types has resulted in inadequate habitat or insufficient resources to support critical ecological processes (such as highly specialised insect pollination) for some species (EPA, 2007).

A snapshot of historical and current clearing practices:

- The agricultural Wheatbelt zone in the SWAE is the most highly cleared area in WA. Some local government areas have less than 5 percent of their original native vegetation cover remaining; and
- 42,285 hectares were approved to be cleared throughout WA by the Department of Environment and Conservation from 2007 to 2010 (DEC, 2008; 2009 and 2010). However, these figures do not represent the total extent of land-clearing in WA as the DEC does not record clearing that has occurred under exemptions to the *Environmental Protection Act 1986*.

Climate Change

WA is getting warmer, rainfall is decreasing in the southwest and ocean levels are rising. The implications of these changes are severe (EPA, 2007).

Almost all global climate models used by the Intergovernmental Panel on Climate Change Fourth Assessment Report predict that the climate in the region will get hotter and drier by 2030 relative to the historical period. There has been a significant climate change since the mid-1970s, which has affected yields of surface water and groundwater, and water-dependent ecosystems (CSIRO, 2009).

Climate plays a fundamental role in many of the primary processes of natural systems and is pivotal to the niche requirements of individual species. Changes in climatic factors, such as temperature and rainfall, can directly affect the distribution, life-cycles, habitat use, physiology and extinction rates of individual species. In turn, these changes can modify the structure and composition of certain ecosystems and communities by altering competition and other interactions between species. In altered ecosystems, invasive species are likely to thrive, while rare species may become extinct. Higher temperatures are expected to further raise sea levels by expanding ocean water. Rising sea levels inundate wetlands and other low-lying lands, erode beaches, intensify flooding, and increase the salinity of rivers, bays and groundwater tables (IPCC, 2007). More information on the impact that climate change may have on biodiversity can be found at www.dec.wa.gov.au.

Large areas of the SWAE have experienced significant climate change since the mid-1970s, which has impacted on surface water and groundwater yields, and water-dependent ecosystems. It is predicted that:

- A median future climate will decrease summer and winter run-off by 20–30 percent and especially affect water-dependent ecosystems that depend on high flows;
- Future yields in the region are likely to be, on average, 2 percent lower by 2030, according to groundwater modelling;
- Falling groundwater levels will affect groundwater-dependent ecosystems, such as wetlands; and
- Abstractions of water might need to be adjusted accordingly (CSIRO, 2009).

Change in fire regimes

Altered fire regimes are contributing to a decline in biodiversity across many areas of WA (EPA, 2007).

The role of fire is complex and inappropriate fire regimes could be a significant threatening process. We currently have limited knowledge of how the frequency, seasonality, intensity and extent of fires affects ecosystems, particularly those systems that have been fragmented, invaded by weeds and *Phytophthora* dieback, or have had natural processes severely altered because of land-use practices. These natural processes can include changes to ecosystem composition (e.g. removal of understorey due to grazing), diversion of hydrology, and the complete removal or decline in species. The effect of fire on species and ecosystems varies significantly, further complicating its effect on biodiversity (Gole, 2006).

Examples of ecosystems and species at serious risk from too frequent fire include:

- **Vegetation** – kwongan vegetation, other heathland vegetation types, Swan Coastal Plain communities, Goldfields woodlands and mulga woodlands;
- **Birds** – noisy scrub bird, western ground parrot, western bristlebird and Carnaby's black cockatoo;
- **Mammals** – honey possum, Gilbert's potoroo, heath rat, brush-tailed phascogale, golden bandicoot, scaly-tailed possum, monjon (rock wallaby); and
- **Invertebrates** – Stirling Range trapdoor spiders (EPA, 2007).

However, there are a number of ecosystems and species that require fire and, when fire as a natural ecological process is prevented, will be disadvantaged. Processes maintained by fire include:

- Vegetation structure and composition;
- Reduction/elimination of competition from other plants;
- Opening the vegetation canopy to increase sunlight and thus permit other species to grow;
- Nutrient supply from ash;
- Suitability for fast-growing but short-lived species such as ephemerals and some legumes;
- Release of seeds after fire; and
- Heat/smoke treatment to promote seed germination.

Population and consumption

Western Australians have among the largest ecological footprints in the world (EPA, 2007).

The Swan Coastal Plain (the coastal strip of land between Dunsborough and Jurien, including Perth) faces the most intensive environmental changes in WA. Many problems can be attributed to a large population, growing settlements and the use of land for production, including industry and agriculture. The southwest corner of WA has a considerable number of environmental problems, due mainly to widespread modification of the environment since European settlement. This worrying trend features:

- Population increases, which have pushed up the demand for housing, and a preference for larger houses and fewer people per household compared to other parts of the world;
- Urban expansion, which has increased dramatically around Perth and other major coastal regional centres in the southwest;
- The doubling in size of Perth's urban area since the 1970s, which has resulted in the clearing of large areas of native vegetation, fragmentation of remaining areas and loss of species and ecosystems (EPA, 2007);
- The clearing of 10,046 ha of native vegetation in the Perth metropolitan region, alone, from 2001–2009 (WALGA, 2010, unpublished);
- Rising consumptive water demand in the region, which is expected to increase by about 35 percent by 2030, with a range of increase of between 10 and 57 percent, depending on population and economic growth;
- Water shortages of about 250 GL/year under scenarios of dry extreme climate and high demand for water; and
- Significant gaps between water yields and demands anticipated by about 2020 for areas around Perth and where surface water resources are used for irrigation (CSIRO, 2009).

Phytophthora dieback

This pathogen, for which there is no cure, is affecting large areas of southwest bushland and continues to spread (EPA, 2007).

Phytophthora dieback (caused by *Phytophthora cinnamomi*) is an introduced soil-borne plant pathogen that can devastate forests, woodlands and heathlands. It is a key threat to biodiversity in southwest WA. More than one million hectares of native plant communities are infested and another one million hectares of susceptible native vegetation is under threat. With nearly 50 percent of all flora species directly affected, *Phytophthora* dieback can cause the complete collapse of some ecosystems as it removes the structural layers of vegetation. This collapse subsequently impacts many unsusceptible plant species and animals.

To date, there has been no effective threat abatement plan or coordinated response to prevent the spread of this pathogen. Similarly, there has been nothing done to prevent the introduction of new *Phytophthora* species, or an appropriately funded management program. Based on 2004 estimates, the cost of managing *Phytophthora* dieback by land managers and relevant industries is $160 million per annum. More information can be found at www.dwg.org.au

Introduced animals

Large numbers of introduced animals, both in terms of species and population densities, are present in WA. Attempts to prevent incursions and eradicate these animals have met with limited success (EPA, 2007).

A major threat to the biodiversity of our waterways is the introduction and spread of some exotic species, many of which are aggressive and can breed rapidly in the right conditions. Native species are displaced through competition for habitat and food, as well as direct predation. Introduced species indirectly deconstruct native freshwater ecologies by disrupting the food chain and creating physical conditions unfavourable for native aquatic life. Once introduced into natural waterways, invasive fish are almost impossible to completely eradicate, although controlling numbers may be possible. Such species include carp, goldfish, redfin perch, yabbies, mosquito fish, tilapia, guppies, swordtails and cichlids (Department of Fisheries, 2011).

Introduced animals causing significant impact to terrestrial biodiversity in the ecoregion include species that are direct predators on native fauna (foxes, feral cats and wild dogs), herbivores (rabbits and goats), species that disturb habitats (feral pigs), and species competing for habitat resources, such as nest hollows (feral honey bees, eastern long-billed corellas, rainbow lorikeets).

The highly populated areas of the Swan Coastal Plain have the most species and highest densities of introduced mammals, along with the forested areas of the southwest and the northern agricultural areas. There is evidence that native mammals have undergone significant range contractions in response to the increase in introduced species (especially in the Carnarvon Basin and Jarrah Forest bioregions). Another impact has been significantly reduced native mammal diversity in arid and semi-arid regions (especially the Yalgoo and Nullarbor bioregions).

Failure to control introduced animals is likely to result in further decline or extinction of native species or ecosystems. Introduced animals have been implicated in the extinction of 10 native mammal species in WA and the decline in population and range of many others. Introduced animals are also adversely affecting birds and many other groups for which detailed analysis has not been conducted. Introduced animal control needs to be consistent and sustained, and a proactive approach is required to prevent new introduced species becoming established. With a growing human population and associated travel, transport and trade, the risk of introducing new species is also likely to grow.

The potential cost of introduced animals is enormous, and includes the cost of control measures, loss of biodiversity, and damage to agricultural, forestry, pastoral and construction industries, in addition to effects on public health and amenity. For example, the environmental costs, alone (i.e. not including the economic costs), of foxes and cats across Australia are estimated to be about $190 million and $144 million, respectively (EPA, 2007).

Weeds

A large number of weed species are present across WA and management action is inadequate (EPA, 2007).

Many environmental weeds are invading WA's ecosystems and some are having significant impacts on native diversity at the genetic, species and community level. More investigation is required to understand the reasons for the recent rapid incursion of weeds and their impact at the ecosystem level. However, most ecosystems in WA are vulnerable to some extent to invasive plant species. It has been well observed that there is a strong relationship between the degree of invasion and disturbance to the ecosystem. Weed invasion can be seen as more of a symptom of disturbance and disruption than the primary cause of ecosystem disruption (Department of Conservation and Land Management (CALM), 1999).

With more than 800 species, the Swan Coastal Plain has the highest number of identified weed species. In general, however, most southwest bioregions have over 300 identified weed species. This could be associated with densely populated areas and highly disturbed environments (cleared and fragmented native vegetation), but could also be attributed to greater survey efforts (EPA, 2007).

Weeds

The gardening industry is by far the largest importer of exotic plants, accounting for 94 percent of new species brought into Australia (Groves *et al.*, 2005). About two-thirds of the weeds now established in Australia originated from gardens. Many garden plants known to be weeds continue to be imported and sold in nurseries (EPA, 2007).

It has been estimated that the cost of weeds to Australian agriculture, alone, is over $4 billion a year (Australian Weeds Committee, 2006 in EPA, 2007) and could account for as much as 20 percent of production costs (State Weed Plan Steering Group, 2001 in EPA, 2007). Aquatic weeds can also foul water supplies and clog irrigation and drainage systems, requiring extensive maintenance works. Loss of biodiversity (including extinctions and permanent changes to ecosystems) will continue with the further invasion and spread of weeds (EPA, 2007).

Land salinisation

The area of the southwest affected by salinisation is increasing. Active management is underway, but significant land-use changes are still required (EPA, 2007).

WA has the largest area of dryland salinity in Australia and the highest risk of increased salinity in the next 50 years. An estimated 4.3 million hectares (16 percent) of the southwest region has high potential for developing salinity from shallow water tables. This is predicted to rise to 8.8 million hectares (33 percent) by 2050.

In southwest WA:

- Groundwater level patterns are dominated by rising or stable trends;
- Of the 4.3 million hectares (16 percent) potentially at risk from shallow groundwater, 81 percent is agricultural land;
- Predictions based on current and perceived land uses indicate that approximately one-third of the agricultural areas could be affected by shallow water tables and salinity by 2050;
- Surface water resources are likely to become more saline;
- An estimated 1,500 plant species will be affected, with 450 at risk of extinction;
- Salinisation is likely to reduce fauna species by 30 percent in affected areas; and
- Species richness has already declined with the onset of salinity.

An interim assessment has put the annual cost of dryland salinity at $664 million. This is based on estimates of the impact on infrastructure and productivity losses, and does not include an assessment of the costs and benefits of strategies designed to combat salinity impacts on biodiversity (Australian Natural Resources Atlas (ANRA), 2011).

Salinisation of inland waters

Many waterways and wetlands in the SWAE are severely affected by salinisation (EPA, 2007).

Secondary salinisation is caused by human interventions, such as inappropriate irrigation practices, and poses a serious threat to the biodiversity and ecosystem processes occurring in many wetlands in the SWAE. Even relatively small increases in water levels, changes in the period of inundation, sedimentation and salinity can dramatically decrease the growth, reproductive capacity and survival of wetland plants and animals. In addition, if salinity levels cross critical thresholds in already stressed communities, irreversible losses of species and communities can occur (EPA, 2007).

In southwest WA:

- Twenty-one of the 54 wetland types located within the agricultural region are potentially at risk of rising water tables, which may affect wetland health (ANRA, 2011);
- There has been no comprehensive mapping of wetlands and other water bodies, so it is not possible to determine the percentage affected by salinity (Lawn, J., 2011, pers. comm.);
- Terrestrial animals will decline significantly (e.g. a 50 percent reduction in the number of waterbirds using Wheatbelt wetlands is anticipated due to the salinity-induced death of shrubs and trees) (ANRA, 2011);
- Despite some salt tolerance among invertebrate fauna, the salinity changes occurring with salinisation have been too rapid and too large for freshwater species to adjust. The current estimates suggest that 400 invertebrate species in the Wheatbelt are threatened with global or regional extinction (Keighery *et al.*, 2002); and
- There are several salinity thresholds at which rapid loss of the Wheatbelt invertebrate fauna occurs. The most sensitive species are rapidly lost from wetlands with even very mild salinisation, leading to changes in the composition of the invertebrate fauna inhabiting the wetlands (Pinder *et al.*, 2005).

Non-biophysical threats to the ecoregion

Biodiversity is also threatened by institutional issues. Foremost among these is the inability to adequately incorporate objectives for biodiversity conservation in decision-making processes, largely due to a general lack of public awareness and information, and poor appreciation of biodiversity. This is exacerbated by the lack of resources or capacity to manage ongoing threats. The growing demands of an expanding human population and growing global markets is placing additional pressure on our natural wealth, with long-lasting consequences (Gole, 2006; Western Australian Planning Commission (WAPC), 2011).

One such example of the failure to incorporate biodiversity conservation into the decision-making process occurred through the policies encouraging the clearing of land for agriculture between 1945 and 1982 (Hobbs and Hopkins, 1990). WA was developing rapidly, with half a million hectares of land being cleared and/or released each year with very little or no clearing guidelines. Almost 20 million hectares (54 percent) of native vegetation was replaced or modified for broad-scale agriculture in less than 40 years, significantly affecting biodiversity through fragmentation and lack of adequate habitat and/or ecological processes (Cody, 1986; Greuter, 1994; Yates and Hobbs, 2000; Hopper, 2003, 2004; EPA, 2007; Judd *et al.*, 2008).

Other significant threats to developing innovative solutions to biodiversity conservation are the complex legislative and bureaucratic structures that divide and fragment management responsibilities across a wide range of statutory authorities. Some legislation is outdated and unable to offer adequate protection in the modern-day social and economic environment.

Few people would argue for the loss of a species or an ecological community in isolation. However, the benefits of biodiversity, argued on the basis of ecological services, fundamental ethics or other reasons, are regularly overwhelmed by commercial imperatives.

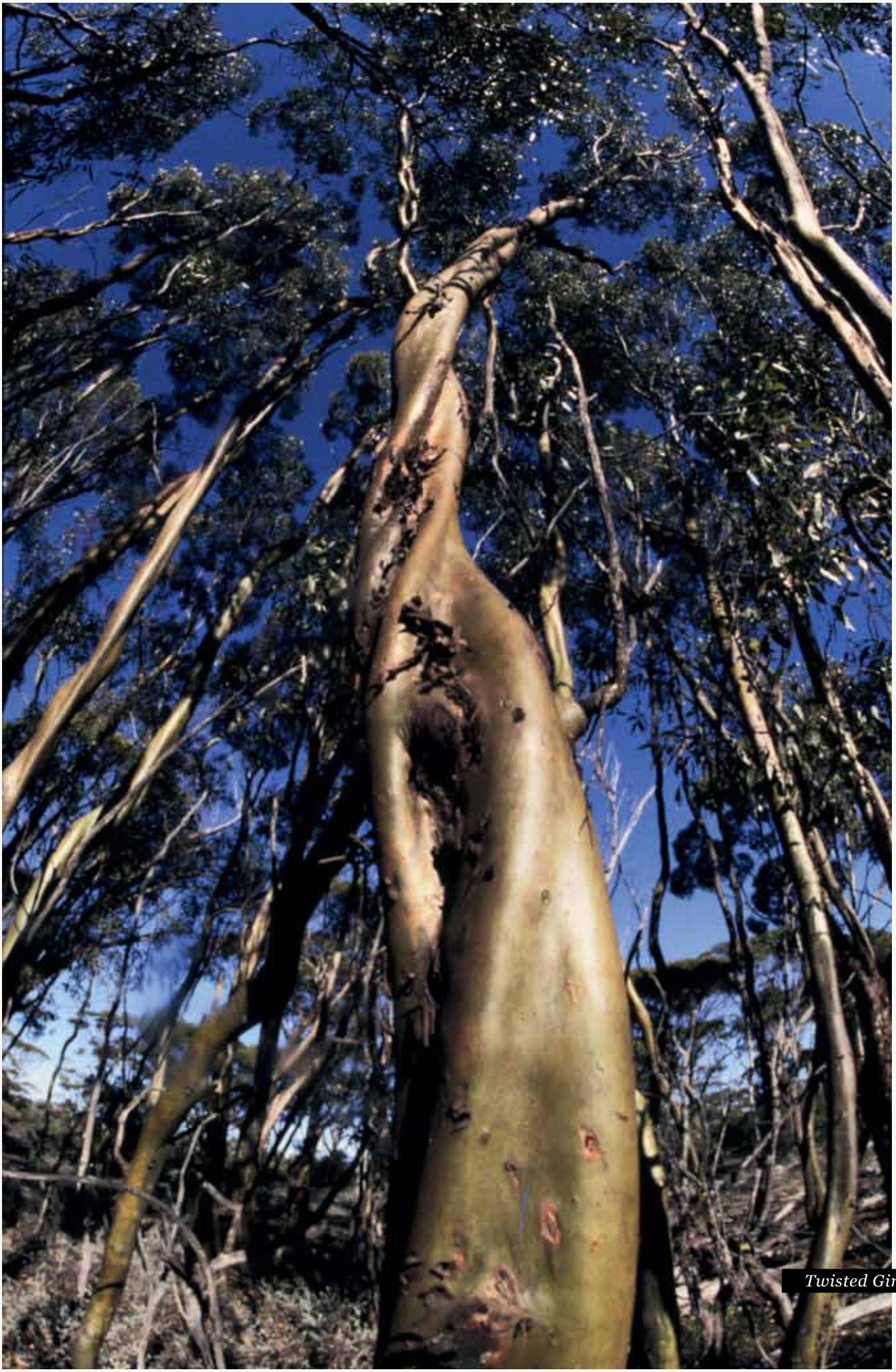
RESPONDING TO THE THREATS

Western Australians, in greater numbers, appear to realise the important roles that biodiversity and ecosystem services play in terms of our livelihoods, health and recreational pursuits. Consequently, there are a number of large-scale conservation programs and projects being implemented across the SWAE to systematically address the key threatening processes. One example is the multi-consortium approach of Gondwana Link, a landscape-scale vision involving many stakeholders to reconnect country across a southern swathe of the SWAE, in which ecosystems and the fundamental ecological processes that underpin them are restored and maintained. The main conservation groups involved include Bush Heritage Australia, the Fitzgerald Biosphere Group, Friends of Fitzgerald River National Park, Greening Australia, Green Skills, The Nature Conservancy and The Wilderness Society (Gondwana Link, 2011).

Many on-ground conservation projects have also been initiated by community groups, land owners, local governments and non-government environmental organisations across the ecoregion. These initiatives play a vital role in delivering actions to conserve biodiversity. There are many examples of local bush-care or "friends of" groups operating at the local level, such as Roleybushcare, a not-for-profit, volunteer-based environmental group focused on maintaining and protecting the bushland around the Roleystone and Karragullen areas. Regular tree planting and *Phytophthora* dieback treatment days are only made possible by the community's continuous participation (Roleybushcare, 2011).

The protection and conservation of biodiversity is multidisciplinary in nature and of local, regional, national and international importance. Consequently, the governing legislative and policy framework for biodiversity conservation in the ecoregion is cross-jurisdictional and addressed by a number of disciplines. This includes Acts of Parliament, statutory and non-statutory policies, and strategies that primarily target biodiversity conservation. The institutional and policy context for biodiversity conservation in the ecoregion is outlined in Statutory Mechanisms to Achieve Biodiversity Conservation.

Despite these efforts to address threats to biodiversity, species and functioning ecosystems are still being lost. Conservation efforts tend to be site or species-based and can often be makeshift in nature (Tabunakawai and Areki, 2007). With limited resources to conserve biodiversity, the SWAEI has responded by undertaking a rigorous strategic analysis of multiple conservation assets to inform a future systematic conservation plan. The results of this project identify key areas for immediate conservation action, whether this is on-ground implementation or protection through statutory mechanisms. It is important to note that this approach complements many other initiatives that are being undertaken within the SWAE, so should be seen as a support tool to aid decision-making and provide additional justification for the work being conducted.



© RICHARD MCLELLAN / WWF-AUS

Twisted Gimlet

SYSTEMATIC CONSERVATION PLANNING PROCESS

WHAT IS SYSTEMATIC CONSERVATION PLANNING?

Systematic conservation planning is a process that involves the collection of data, setting target objectives for the biodiversity features for which there is available data, and then using software to select areas that collectively meet the objectives. In the context of the SWAE, systematic conservation planning is a means of analysing biodiversity information about the region to objectively identify those areas where the most efficient and effective conservation activities can be implemented.

Systematic conservation planning has two characteristics. First is the use of explicit and quantifiable objectives. This means that planners and managers must be clear about what they intend to achieve and be accountable for decisions aimed at meeting their objectives. The second characteristic is the principle of complementarity, whereby conservation areas are identified that complement one another in terms of collectively achieving objectives. Areas identified in this way will contain different species or complementary portions of different habitat types (ANZECC, 1997; Pressey and Bottrill, 2008).

Furthermore, systematic conservation planning involves working through a structured, transparent and defensible process of decision-making. One of the key outcomes is an integrated system of conservation areas (referred to in this report as Areas for Conservation Action, or ACA). This approach is distinct from traditional conservation planning that results in a non-integrated collection of conservation areas produced by a series of ad hoc decisions, often made in isolation from one another. The integration resulting from systematic conservation planning is much more effective at achieving objectives for the persistence of biodiversity and other natural values. It provides a cost-effective plan that has both a spatial and taxonomic focus for the investment of effort, given that there are always limited conservation resources (Pressey and Bottrill, 2008).

SUMMARY OF THE PROCESS FOR SYSTEMATIC CONSERVATION PLANNING IN THE SWAE

Step 1: Identify biodiversity features and their information availability

Biodiversity conservation planning used the Marxan software package (see below) and involved a five-step data input process. The first step was to identify biodiversity assets that may be used as conservation features on which the planning will be based, and to assess the availability of suitable descriptive spatial data. Nearly 1,400 conservation features were identified and used in the SWAE analysis. Box 1 contains a description of a conservation feature. Table 3 summarises the conservation features used in the SWAEI analysis. A more detailed list is provided in *The Southwest Australia Ecoregion Initiative – Technical Report B: For conservation planning practitioners*. These conservation features were identified by eminent scientists and included common species, vegetation assemblages, environmental surrogates, and species and communities protected by state and federal legislation.

Step 2: Set "targets" for each conservation feature

The second step was to derive numerical objectives, or "targets", for each conservation feature. These specify the quantities/extent of each conservation feature that the experts considered should be included in the priority areas. The targets serve as estimates of the necessary levels of replication and abundance to ensure the persistence of each conservation feature. Targets are expressed as amounts of viable occurrences or extents within the SWAE and ranged from 15–100 percent of present distributions. The target for each conservation feature was derived using a set of specific rules that reflected the present conservation status, current threats, and any special circumstances that the experts felt needed to apply. *The Southwest Australia Ecoregion Initiative – Technical Report B: For conservation planning practitioners* contains the rules and logical construction of the targets.

Step 3: Stratify conservation features in the ecoregion

Thirdly, conservation features in the SWAE were stratified by IBRA regions to ensure a comprehensive and representative sample of the conservation features across the SWAE. This allowed for the priority areas to represent conservation features across the full range of environmental gradients (e.g. soil and climate)

© MIKE GRIFFITHS / WWF-AUS

New Holland Honeyeater

and geographical variation within the ecoregion (Thackway and Cresswell, 1995). It also allowed for replication of the features to increase the likelihood of persistence in the face of environmental change. Stratification of the ecoregion was also applied, if data was available, to conservation features that use different parts of the SWAE over different periods of their life-cycles. An example is the Carnaby's black cockatoo, which typically breeds in the Wheatbelt, but moves to coastal areas to feed and roost during the non-breeding season. To incorporate the high spatial turnover of the kwongan heath and mallee vegetation complexes, the IBRA regions were further stratified by sub-region.

Step 4: Lock in important areas

The fourth step recognises that there are some areas within the SWAE that are already afforded protection and management as part of the conservation estate. These areas were "locked" into the final set of priority areas so that they are always included. The "lock-ins" included any parcel of land that met IUCN I-IV criteria protected areas (classified as (Ia) Strict Nature Reserves, (Ib) Wilderness Areas, (II) National Parks, (III) Natural Monument or Feature and (IV) Habitat Species Management Area) (IUCN, 2011). This included Crown reserves classified for the purpose of conservation parks, national parks, nature reserves, or reserves with "land use" or purposes specified for "conservation". This means that the systematic conservation planning process aimed to meet the targets set for the conservation features in lock-in areas before selecting other areas within the priority area set. Using the existing conservation estate as the foundation for newly prioritised areas is important as it builds on current investment, increases the size and capacity, provides protection and buffering, and better connects those areas already protected through statutory means. Maps 1 and 2 demonstrate the importance of building on parts of the conservation estate and using it as the cornerstone for ACAs.

Step 5: Identify areas that are more suitable for conservation

Finally, a "suitability" component was included, where numerical values were identified through a matrix that included: three threatening processes (urbanisation, *Phytophthora* dieback and salinity), and land tenure, zoning and uses. These were grouped according to their suitability for conservation management, as a reflection of the potential to achieve conservation outcomes. Numerical values were assigned in the matrix to represent the degree of impediments to likely conservation success, essentially making less suitable areas more costly to protect and less likely to be selected. For more information, refer to *The Southwest Australia Ecoregion Initiative – Technical Report B: For conservation planning practitioners*. This process was used to distribute conservation priorities to locations amenable to effective management and long-term persistence of the conservation features. This step defines the current degree of landscape degradation and fragmentation and/or the probability of future degradation and fragmentation. It uses spatial data that represents current or future human infrastructure, activity and land use.

© MIKE GRIFFITHS / WWF-AUS

WT Eagle Chick

CONSERVATION PLANNING SOFTWARE

There are a variety of software tools available to assist with the systematic conservation planning process, all with their strengths and weaknesses. Marxan is a popular support tool, which identifies areas that efficiently conserve a user-specified amount and variety of conservation features. Marxan was used in the SWAEI project because it is the most widely used tool for planning marine and terrestrial reserve systems. An integrated open source Geographical Information System platform, called Zonae Cogito or ZC (version 1.21) was also used because it serves as an interface to Marxan software and allows results to be mapped. It is considered a simple and robust way to run Marxan analyses and to view the results. Both Marxan and ZC can be downloaded from http://www.uq.edu.au/marxan/index.html?page=77064&p=1.1.4

For more information on the technical analysis, refer to *The Southwest Australia Ecoregion Initiative – Technical Report B: For conservation planning practitioners.*

An important aspect of the systematic conservation planning process using Marxan is the concept of "selection frequency". Selection frequency is a measure of how important an area is for achieving the conservation targets. Areas with high selection frequency (ie selected in a greater number of run options of the software) have few or no potential replacements in the region. If they are not managed for conservation, then one or more targets might not be achieved. Areas with low selection frequency have many potential replacements in the region, so there is scope to explore other areas. This allows decision-makers to identify, for example, areas where there is less conflict with other land uses, with less threats or management issues, or greater likelihood of species persistence. Selection frequency is therefore a measure of the irreplaceability of specific areas for achieving the conservation targets. Any set of areas selected to achieve targets will contain areas with both high and low selection frequency. Most or all areas with high selection frequency are required to achieve targets, and smaller proportions of areas with lower selection frequencies are required.

Table 3. Summary of conservation features used in the SWAEI systematic conservation planning process.

Conservation feature	Total number included in analysis	Total % of conservation features
Bird species	100	7
Mammal species	31	2
Amphibian species	7	1
Inland water species	49	4
Invertebrate species	43	3
Flora species	137	10
Inland water bodies	82	6
Other surrogates (e.g. granite outcrops)	45	3
Vegetation types	862	62

Maps produced

After undertaking the technical analysis for the systematic conservation planning project, two standard maps are presented and it is important to consider both. The datum underpinning these maps is available as ArcGIS shapefiles and Best Solution maps have been produced for each ACA (available on request).

Map 2 illustrates the Priority Areas for Conservation Action. The ACAs align to the IBRA sub-regional boundaries and group similar subregions together to create 11 ACA. These ACA contain areas ranked from very high to very low biodiversity importance and very low to very high cost of threat (i.e., the threat of urbanisation, *Phytophthora* dieback and salinity) given the tenure of the land. These may be interpreted as "easy-win" areas – areas of high biodiversity importance and low cost of threat, where you are most likely to achieve your priority conservation goals.

Map 3 shows areas of further prioritisation indexing by identifying those areas that:

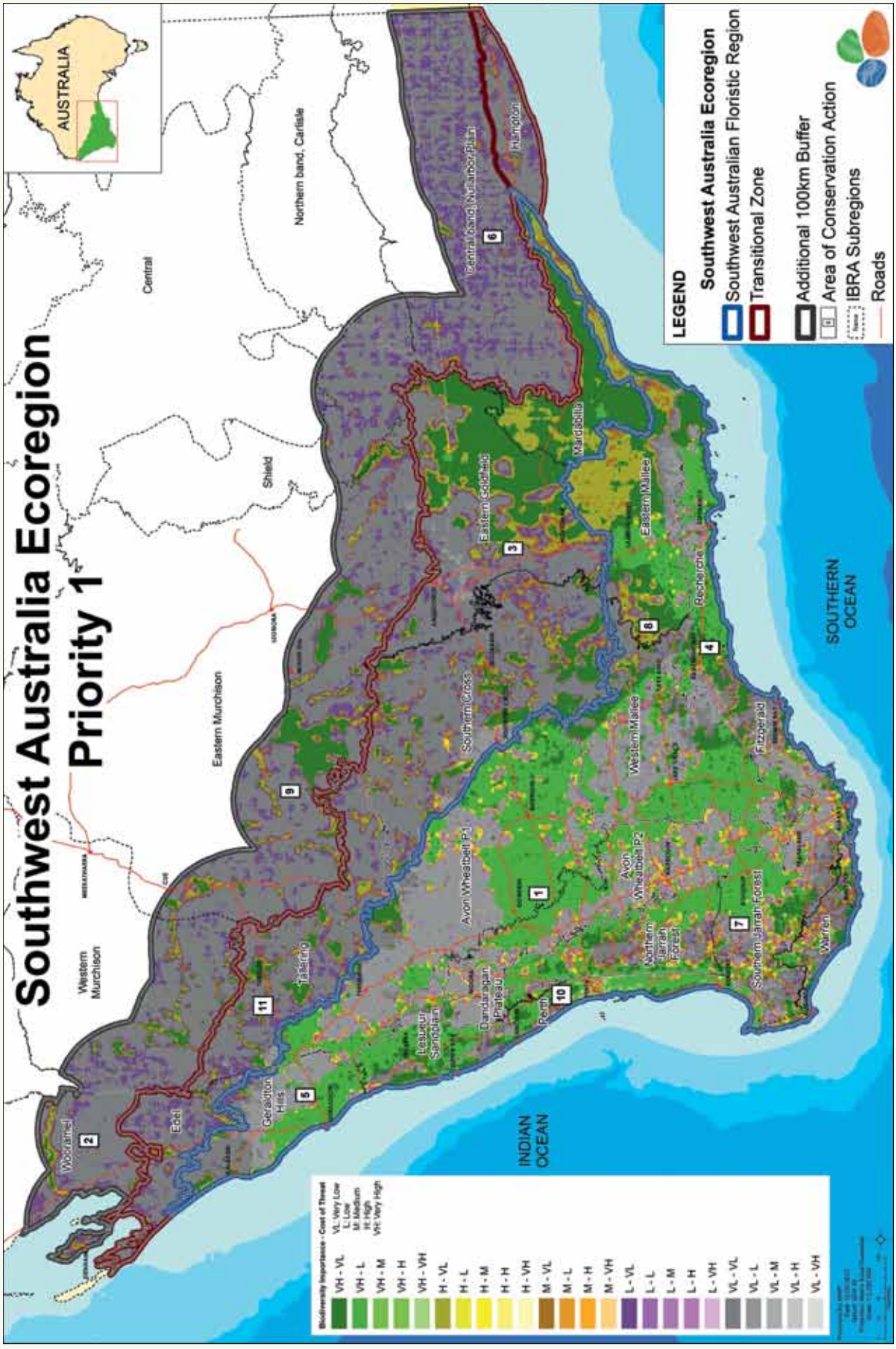
- Were most frequently selected; and
- Were most vulnerable to urbanisation, *Phytophthora* dieback and salinity.

By identifying those areas needing the most urgent action to meet conservation targets, the priority index produces a gradient of priorities based on importance and urgency. The darker the shade of mauve, the greater the importance and greater the urgency given multiple threats to the area. The lighter the shade of yellow to green, the lesser the threat and lower the importance.

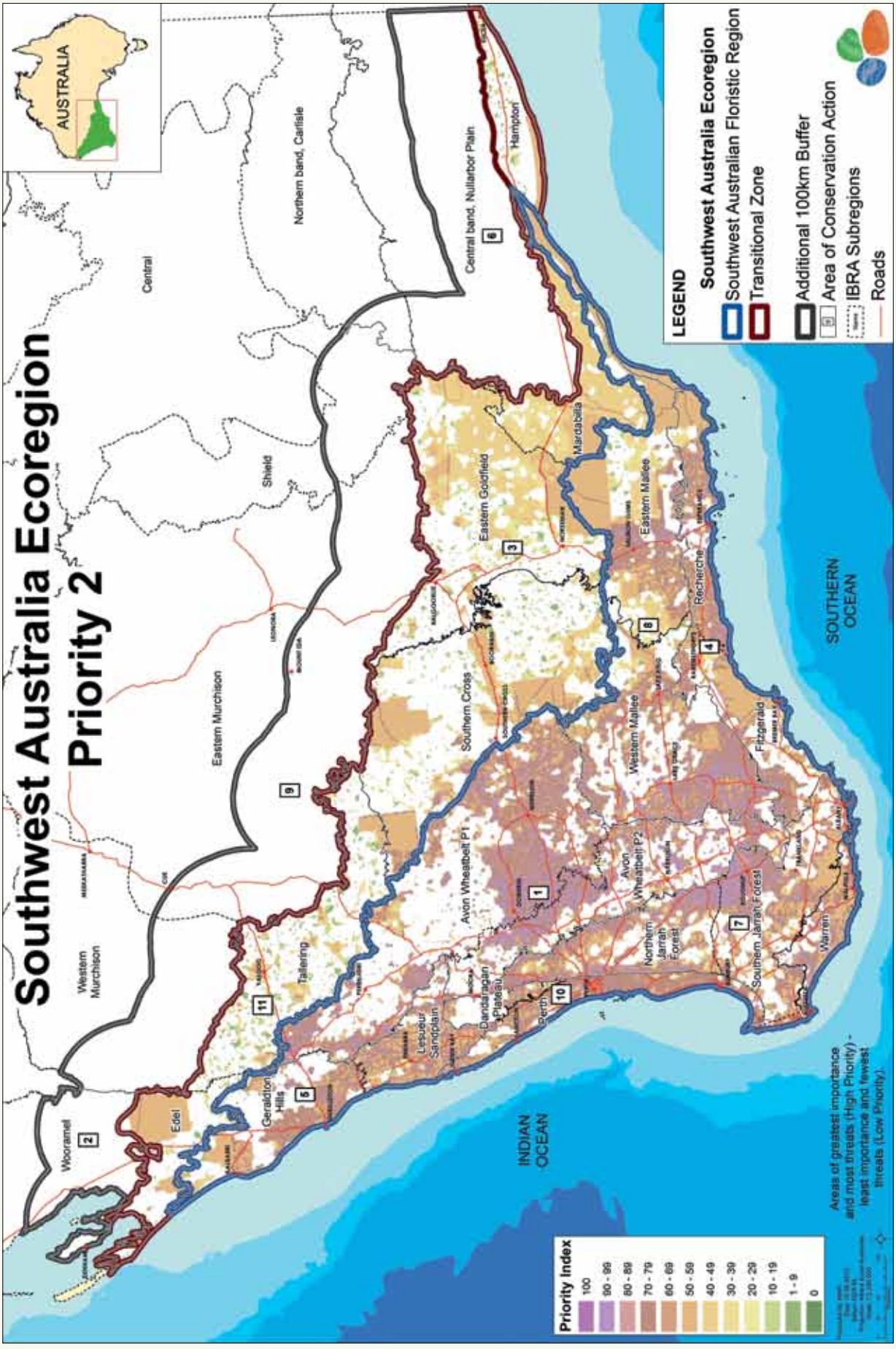
Box 1. What is a conservation feature?

Conservation features include:

- Any part of the environment, ecosystem or biodiversity for which a target is set to be achieved within the decision-making process;
- Vegetation types or ecological communities;
- Populations of individual species, or distributed meta-populations of a species; areas with high proportions of locally endemic species; areas of specific habitats; other identifiable features of an ecosystem (such as areas of congregation); important structural formations or processes (such as migration pathways);
- Features that have a specific supporting function or are a surrogate for biodiversity (for example, granite outcrops or south-facing slopes);
- Features that experts have advised be included; and
- Features listed under state or federal legislation.



Map 2. Priority Areas for Conservation Action



Map 3. Priority Index

HOW TO INTERPRET THE RESULTS – ALLOCATING LIMITED RESOURCES ACROSS THE SWAE

The priority areas identified through the systematic conservation planning project are broad areas that have been selected based on a wide, representative range of conservation features, identified by experts and listed under state and federal legislation. The priority areas within the ACA are highly recommended for on-ground implementation and protection through relevant statutory mechanisms. They are a set of places likely to return the highest conservation outcomes for investment.

The methods used in this systematic conservation planning process identified areas that, in sum total, have the highest representation of diversity. Using this complementarity method, priority areas could be selected that contain the most species between them, but not necessarily be the most species-rich areas individually.

Systematic conservation planning aims to distinguish higher from lower priority areas for urgent conservation. By nature, some areas will be given lower priority, but this is not to say that they have no conservation value. Rather, in relation to agreed goals for this analysis, the actions are not as urgent. Similarly, values of the SWAE not selected as a conservation feature for this analysis are still important and must be considered during local-scale conservation initiatives.

The results of this analysis should encourage and support planning and action across a range of scales and sectors. This project provides practitioners and decision-makers with the opportunity to undertake conservation action and to establish partnerships within a single framework. It focuses the allocation of limited resources on priority parts of an extensive landscape.

While the biodiversity vision and targets have been set at the scale of the SWAE, many ecological processes and socio-economic forces will extend beyond its boundaries, or only occur within part of it. This systematic conservation planning project responds to these realities by using targets set at the scale of the region and considering variation in threatening processes within the region. The project is a reference point for the development of responses, strategies, collaborations and actions at multiple scales.

In many instances, the development and implementation of initiatives nested within the SWAE might develop their own momentum. Pilot projects, campaigns and multi-disciplinary initiatives, designed to address threats, take advantage of opportunities, or respond to stakeholder interests at relevant and manageable scales, will always be integral to ecoregion conservation efforts. However, the success of these individual projects and programs will be measured by the contributions they make to the ecoregion conservation vision and targets.

The strategic framework for biodiversity conservation lays the groundwork for establishing relationships with stakeholders and partners that build confidence, trust, understanding, and a common sense of ambition and purpose, which are all essential to successful action and sustainable outcomes (WWF, 2004).

Planning and conservation action programs need to be developed that are sophisticated enough to address the interacting and sometimes competing needs of social, ecological and economic processes. Expertise from many disciplines needs to be called upon to make strategic linkages between local, state, national and international biodiversity policies, industry trends and consumer opportunities.

For lasting impacts, stakeholders ranging from private landholders to communities, corporations, governments and other institutions need to be appropriately engaged because their attitudes and behaviours will shape the landscape.

To improve the biodiversity status of the ecoregion, we recommend:

1. Undertaking further regional and local scale analysis of conservation features across the SWAE, setting targets and objectives for implementation;
2. Planning and implementing an acquisition program that considers the ACAs in its prioritisation process to further strengthen the ecoregion framework;
3. Further supporting conservation actions relevant to the conservation features in reserved areas within the conservation estate;
4. Ensuring that the implementation of the off-reserve programs on private land supports conservation actions that benefit the conservation status of the ecoregion's conservation features;
5. Ensuring that the priority areas and conservation features within ACAs are considered in development and planning decisions; and
6. Encouraging organisations delivering conservation management within the SWAEI to consider the framework's conservation features during planning, and implementing actions that improve their conservation status.

The following recommendations are made as a starting point for discussions to improve the biodiversity status within the prioritised areas.

- If necessary, revise biodiversity conservation targets for the conservation features across the SWAE and interpret these as targets to be achieved within each area;
- Develop a variety of conservation strategies (identifying roles and responsibilities for delivery) that are required to achieve the conservation goal for the SWAE, including:
  - Developing and implementing a land acquisition program that strengthens and further supports reserved areas already within the conservation estate;
  - Developing and implementing off-reserve programs on private land that strengthen and support the functions of reserved areas already contained within the conservation estate;
  - Establishing investment programs focused on on-ground implementation within the priority areas;
  - Maintaining and protecting the environmental processes of freshwater and naturally saline habitats in good condition and restoring those water bodies in poor condition;
  - Identifying the size, representativeness and connectivity of vegetation patches within and across the priority area that maximise the resilience of species and habitats, particularly in the face of climate change. This would form the basis for management and restoration activities;

© CHRISTINA MYKYTIUK / WWF-AUS

Moaning Frog / Heleioporus eyrei

  - Restoring native vegetation in all IBRA sub-regions that have fallen below 10 percent back to more than 10 percent and toward 30 percent of their original extent;
  - Undertaking strategic revegetation to prevent salinity from further affecting remnant vegetation and water bodies;
  - Protecting areas of high conservation value at risk of unsustainable grazing pressure;
  - Identifying and protecting relevant ecological stepping stones required by particular conservation features;
  - Encouraging land-use planning decisions and processes that are responsive to biodiversity needs;
  - Expanding partnerships and community engagement;
  - Using choice modelling survey results to further engage the community;
  - Developing, funding and implementing an integrated pest management strategy;
  - Developing, funding and implementing multi-stakeholder, integrated catchment management plans; and
  - Developing, funding and implementing a "Communication for Conservation" program that identifies the barriers to desired behaviour and addresses awareness-raising and gaps in knowledge and skills.
- Create a SWAE-wide funding plan that addresses current projects and programs as well as third-party investment, and considers the conservation impact of activities.

HOW NOT TO INTERPRET THESE RESULTS

The SWAEI process had the primary aim of identifying priority areas across the SWAE for conservation action. This has been achieved and a conservation planning tool has been produced that sets regional priorities and provides a framework for local planning.

There are two further important aspects to note:

1. Local planning priorities and legislative requirements for conserving listed species and ecological communities still apply and are separate to the SWAEI process; and
2. The limitations and broad scale of the systematic conservation planning process, summarized in Table 4.

The SWAEI process must thus be taken in context and treated as the first step in achieving a systematic approach to conservation in the region. While priority areas identify those of greater conservation potential in terms of effectiveness and efficiency in achieving goals, sub-region scale planning is required to put these opportunities into effect. This process must be regarded as a starting point for conservation planning, not the end point.

Table 4. Limitations on the use and interpretation of the SWAEI outputs

- The mapping output should not be used for local-scale land-use planning decisions. Rather, it provides an indication of broader areas that are particularly important for biodiversity and where conservation management is urgent.
- Some data provided for local planning schemes could not be used because of problems with:
  1. Data format;
  2. Data availability; and
  3. Data attribute standards.
- A pervasive limitation of conservation planning is access to appropriate data. While the project used the best data available, there are and always will be gaps in the comprehensiveness and consistency of data across the ecoregion. The absence of data should not preclude this type of analysis, although users should be conscious of the related constraints on conservation planning. Where planning units have not been selected, we are not suggesting that there are no biodiversity values in these areas. A part of the decision-making process is to ask the following questions:
  1. Are there conservation features in these unselected planning units that are of value, but not included in the SWAEI analysis?
  2. Is there a lack of data relating to these areas?
  3. Should targets for some conservation features be increased in percentage terms for specific areas?
  4. Approximately 6 percent of conservation features had very high targets that were not fully achieved. Have these been missed at the local level and is there scope for additional target achievement in local areas?
- The conservation features selected are a representation of biodiversity, not a complete inventory of all biodiversity assets and processes across the ecoregion. Hence, they do not represent all important aspects of biodiversity that might need to be managed in a particular area.
- Due to the vast number of plant species in the SWAE, not all listed conservation-status flora were included in the analysis. Rather, a subset of state-listed flora species was selected, which, in turn, represented different habitat types and species across the ecoregion. Therefore, it is important that when translating this analysis to the local scale, additional listed species are considered.
- The targets set for conservation features were determined at the scale of the region and, consequently, do not reflect local priorities. For example, some of the insectivorous woodland bird species that are fast disappearing in some of the landscapes across the SWAE, such as in the Perth Metropolitan Region, remain relatively common elsewhere. The ecoregion-scale targets were, therefore, lower in percentage terms than might be needed in the smaller region around Perth. In a local-scale planning process, these targets would be re-evaluated to make them more relevant to particular parts of the ecoregion.
- The analysis required data layers that were consistent across the whole ecoregion. Therefore, local datasets that may provide more detailed and accurate information have not been used as it may bias the result for the whole ecoregion. Decision-makers considering more local-scale issues than the ecoregion (eg NRM regions, DEC-managed conservation areas, local government areas) may be able to use more accurate or additional local datasets to improve local prioritisation.
- Targets for a small proportion of conservation features were not fully achieved. These features included a composite data layer for threatened ecological communities and 82 of the vegetation types. Nonetheless, targets for 1,307 of the 1,391 (94 percent) conservation features were met through this process, well within the bounds of acceptable outputs. All of the conservation feature targets that were not met were those that were set trying to achieve 100 percent of their existing occurrences or extent in the analysis. However, because of the threat layers included in the analysis and the associated high costs of some areas, the best solution was unable to meet all of these 100 percent targets. Many of these conservation features did achieve high proportions of their targets, and the group of targets that were not met also included some conservation features that are endemic but localised and subsequently only have a very small extent in the SWAE. Details of the targets that were met and those that were not are in *The Southwest Australia Ecoregion Initiative – Technical Report B: For conservation planning practitioners.*
- The systematic conservation planning process cannot define every source of threat to every identified conservation feature. More in-depth information on threats should be collected and analysed when working on specific conservation projects. The planning process used in this conservation planning project should be considered as an initial evaluation of the threats to biodiversity and not the ultimate one.

- Only threats with geographically defined data across the whole region were used. The threat data used was only predicting the likelihood of the threat being in a planning unit. It was not a literal representation that the threat was occurring, or how bad its effect was on our ability to manage biodiversity conservation. Also, other threats will occur within the priority areas selected by Marxan, so local knowledge of these is required to ensure feasible sites are selected where high quality conservation management action is most likely to be successful.
- Methods for incorporating climate change into the SWAEI systematic conservation planning project have not been included, although there are approaches to doing this. Most of these approaches are based on modelling the prediction of shifts in species ranges and were considered too general for this systematic conservation planning project. Overcoming differences among model predictions and discrepancies between predicted fundamental and actual realised niches usually requires detailed data on species migration rates, inter-species interactions and rates of adaptation (Iwamura *et al*., 2010). The value of conservation prioritisation based on future species ranges remains limited by our ability to compile and analyse this data for thousands of species over large spatial scales. Furthermore, there are no immediate and practical actions that can be taken that guarantee the security of the biodiversity in the SWAE from the impacts of climate change, and the impacts of climate change remain uncertain. While there are challenges inherent in including climate change in the analysis, we have addressed this to a certain extent by including a range of environmental gradients, a representation of processes and environmental surrogates in the analysis.

FUTURE OPTIONS

The systematic conservation planning process and data used in this analysis can be applied at a finer scale to achieve more targeted conservation planning outcomes. The selection of additional conservation features from the data, to augment those used in the current analysis, but which apply to a specific target area, will enable finer resolution for developing conservation actions that are more applicable to the target area.

Alternatively, other conservation planning approaches can be used to develop conservation actions within priority areas using this process, which target specific conservation features that have been identified by practitioners as priorities for conservation.

© DEJAN STOJANOVIC / BIRDS AUSTRALIA

Pair of Carnaby's Black Cockatoo

© MIKE GRIFFITHS / WWF-AUS

Varanus Rosenbergii

STATUTORY MECHANISMS TO ACHIEVE BIODIVERSITY CONSERVATION

INTERNATIONAL POLICIES, TREATIES AND CONVENTIONS

Several international treaties apply in the SWAE, including the Ramsar Convention on Wetlands of International Importance (Ramsar Wetlands), the China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

The bilateral agreements between the Australian Government and the governments of Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA) are meant to protect migratory birds in danger of extinction and their environments.

Australia is also a signatory to the Convention on Biological Diversity 1992 – an international, legally binding treaty that has the following main objectives:

- The conservation of biological diversity;
- The sustainable use of its components; and
- The fair and equitable sharing of benefits arising from the use of genetic resources.

Being a partner to these international treaties, conventions and agreements, Australia has given an undertaking to ensure that its internationally important areas are conserved. These obligations are met through Commonwealth and state/territory legislation and administrative arrangements that are made within the state/territory governments (Australian Government, 2011).

More information on international policies, treaties or conventions can be found at:

- http://www.environment.gov.au/water/topics/wetlands/ramsar-convention/index.html
- http://www.environment.gov.au/biodiversity/migratory/waterbirds/bilateral.html
- http://www.cbd.int/

FEDERAL LEGISLATION, POLICIES AND STRATEGIES

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key piece of environmental legislation and is administered by the Department of Sustainability, Environment, Water, Population and Communities.

The EPBC Act aims to:

- Provide for the protection of the environment, especially matters of national environmental significance;
- Conserve Australian biodiversity;
- Provide a streamlined national environmental assessment and approvals process;
- Enhance the protection and management of important natural and cultural places;
- Control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife; and
- Promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.

Under the EPBC Act, a person who proposes to take an action that will or is likely to have a significant impact on a matter of national environmental significance is responsible for referring the action to the Minister for Environment for a decision as to whether further assessment and approval under the Act is required before they can proceed (Australian Government, 2011).

Australia's Biodiversity Conservation Strategy 2010–2030 (ABCS) is a guiding framework for conserving our nation's biodiversity over the coming decades. The ABCS vision is that Australia's biodiversity is healthy and resilient to threats, and valued both in its own right and for its essential contribution to our existence. It identifies three national priorities for action to help stop the decline in Australia's biodiversity (Natural Resource Management Ministerial Council (NRMMC), 2010).

These are:

1. Engaging all Australians in biodiversity conservation through:
   - > Mainstreaming biodiversity;
   - > Increasing Indigenous engagement; and
   - > Enhancing strategic investments and partnerships.
2. Building ecosystem resilience in a changing climate by:
   - > Protecting diversity;
   - > Maintaining and re-establishing ecosystem functions; and
   - > Reducing threats to biodiversity.
3. Getting measurable results through:
   - > Improving and sharing knowledge;
   - > Delivering conservation initiatives efficiently; and
   - > Implementing robust national monitoring, reporting and evaluation.

These priorities for action are supported by sub-priorities, outcomes, measurable targets and actions. The ABCS functions as a policy umbrella over other more specific national frameworks, including the:

- National Framework for the Management and Monitoring of Australia's Native Vegetation (currently being revised) (NRMMC), 2001);
- Australian Weeds Strategy (NRMMC, 2006);
- Australian Pest Animal Strategy (NRMMC, 2007); and
- Australia's Strategy for the National Reserve System 2009–2030 (National Reserve System Task Group, 2009).

More information on federal policies, strategies and legislation can be found at:

- http://www.environment.gov.au/epbc/about/index.html
- http://www.environment.gov.au/biodiversity/publications/strategy-2010-30/index.html

STATE LEGISLATION, POLICIES AND STRATEGIES

Western Australia has a range of legislation, policies and strategies that relate to the management and conservation of biodiversity in the SWAE. These include the *Wildlife Conservation Act 1950, Conservation and Land Management Act 1984, Environmental Protection Act 1986*, Environmental Protection Policies and the draft 100-year Biodiversity Conservation Strategy (DEC, 2006). However, other mechanisms support biodiversity conservation, including land-use planning legislation, policies and strategies.

A brief outline of the primary biodiversity conservation mechanisms is provided in Table 5. A full list of mechanisms that indirectly support biodiversity conservation can be found in Appendix 6.

A more comprehensive review of most of these instruments can be found in Part II, Section 7.4 of *Directions Paper on the Integration of NRM into Land Use Planning* (WAPC, 2011) and Part A, Section 3 of the *Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region* (Del Marco *et al.*, 2004).

Table 5. Primary biodiversity conservation mechanisms for the SWAE

Primary mechanisms aimed at biodiversity conservation in Western Australia		
Relevant legislation, policy or strategy	**Purpose**	**Comments**
Legislation		
Wildlife Conservation Act 1950 **(administered by the Department of Environment and Conservation(DEC))**	Provides for the protection of native flora and fauna, including: • Protection against the "taking" of native flora and fauna; • Control of "dealings" in native flora and fauna; and • Specific licensing requirements for flora and fauna.	• The Act covers species-level protection but does not provide protection for ecological communities, species habitat, or genetic diversity within species; • The Act does not provide protection from threatening processes; and • There is a government commitment to the repeal and replacement of this act with a modern biodiversity conservation act.
Conservation and Land Management Act 1984 **(administered by the DEC)**	• The Act establishes the Conservation Commission, whose primary role is to oversee the management of lands vested in it, and to prepare management plans for those lands; • The Act applies to all land vested in the Conservation Commission (including nature reserves, national parks, conservation parks, State Forest and marine parks and reserves) and other defined lands; • Under this Act, the DEC is also responsible for research into the conservation and protection of flora and fauna, and the taxonomy of flora and introduced plants; and • The DEC is also required to promote and encourage rehabilitation of land and conservation of biodiversity throughout the state.	
Environmental Protection Act 1986 **(administered by the DEC and the Environmental Protection Authority (EPA))**	The main purposes of the Act are to: • Establish the EPA; • Provide for the conservation, preservation, protection, enhancement and management of the environment; • Deal with the prevention, control and abatement of pollution and environmental harm; and • Regulate vegetation clearing.	

Primary mechanisms aimed at biodiversity conservation in Western Australia		
Relevant legislation, policy or strategy	**Purpose**	**Comments**
Environmental Protection (Clearing of Native Vegetation) Regulations 2004	Established under Part V Division 2 of the *Environmental Protection Act 1986* for the regulation of clearing native vegetation in Western Australia. The regulations specify clearing exemptions where a clearing permit is not required unless within defined environmentally-sensitive areas.	A review of the state's native vegetation clearing legislation (the *Environmental Protection Act 1986 and Environmental Protection (Clearing of Native Vegetation) Regulations 2004*) is currently being undertaken, with the aim of improving processes and environmental outcomes.
Policies		
Wetlands Conservation Policy for Western Australia (1997)	Provides broad objectives for wetlands, waterways, estuaries and shallow marine areas. It also provides an implementation strategy specifically for the management of wetlands in WA.	This policy is being revised in light of legislative and policy changes since its release.
EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia	Provides an overview of the EPA's position on the clearing of native vegetation in Western Australia, with particular reference to clearing in the agricultural area.	
EPA Guidance Statement No. 10: Level of Assessment for Proposals Affecting Natural Areas in the System 6 Region and Swan Coastal Plain Portion of the System 1 Region	Provides guidance for schemes and proposals potentially impacting on regionally significant natural areas in the System 6 region and Swan Coastal Plain portion of the System 1 region. Guidance Statement No. 10 is concerned with proposals to clear or significantly impact on native vegetation or natural areas of regional significance, where this cannot be addressed under other processes, such as applications for clearing of native vegetation managed under the *Environmental Protection Act 1986*.	
Part B of EPA Guidance Statement No. 33 Environmental Guidance for Planning and Development	Provides guidance for biodiversity conservation through land-use planning. Guidance Statement No. 33 lists the natural areas that the EPA considers are of high conservation significance, including critical environmental assets and high-value environmental assets that require a high level of protection in Western Australia.	
Bush Forever (Government of Western Australia, 2000a, 2000b and 2000c)	Provides a 10-year strategic plan to protect regionally significant bushland in the Perth Metropolitan area. This includes approximately 51,000 hectares of bushland across 287 Bush Forever sites.	This policy set 10-year objectives and is due to be reviewed.
Strategies		
Draft 100-year Biodiversity Conservation Strategy for Western Australia: Blueprint to the Bicentenary in 2029 (DEC, 2006)	Prepared in response to the continuing decline in indigenous biodiversity in Western Australia, with the aim of ensuring continued protection and restoration of biodiversity within the state over the next 100 years. This draft strategy provides a framework to guide biodiversity conservation action through a number of key strategic directions and associated objectives and actions.	This draft strategy has not been finalised. A copy can be found at http://www.dec.wa.gov.au/component/option,com_docman/task,doc_details/gid,319/Itemid,7

Primary mechanisms aimed at biodiversity conservation in Western Australia		
Relevant legislation, policy or strategy	**Purpose**	**Comments**
A Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands (DEC, 2010)	Provides a strategic framework to integrate the planning and management of the various uses of the Great Western Woodlands, which is the largest remaining area of intact Mediterranean-climate woodland on the planet.	A commitment of $3.8 million from the State Government will support the implementation of this strategy.
Western Australia's State Weed Plan (2001)	Prepared to provide coordinated, collaborative and effective weed management throughout Western Australia.	
Environmental Weeds Strategy for Western Australia (1999)	Provides direction for the control and management of environmental weeds, including criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity.	This strategy did not specify a timeframe for its revision. The strategy does highlight that there is no specific legislation in WA that addresses environmental weeds and that this issue should be addressed when revising the *Wildlife Conservation Act*.
Natural Resource Management (NRM) strategies	Each of the six regional groups in Western Australia prepared a regional strategy in response to a shift in NRM delivery in Australia, from a state delivery model to a regional delivery approach. These regional strategies outline strategic priorities and action for NRM in each region, all of which include biodiversity. The strategies also form the basis of rolling investment plans that guide the delivery of funds within the region.	A number of regional groups have either reviewed or are undergoing a review of their regional strategies. Please refer to individual NRM regional group websites for additional information.

LOCAL PLANNING STRATEGIES

Local government has a clear role to play in the retention, protection and management of Western Australia's biodiversity because it represents the level of government closest to the community, is responsible for the management of local reserves and other local government land, and is a key decision-maker in the land-use planning system (WAPC, 2011).

A Local Planning Strategy (LPS) is a strong mechanism for integrating conservation into the decision-making process for land-use planning. A LPS is prepared by the relevant local government, with final endorsement by the Western Australian Planning Commission (WAPC). These strategies guide long-term planning directions for local government, mechanisms for applying state and regional planning policies at the local level, and the rationale for proposed land zoning and other provisions of the local planning scheme (WAPC, 2011).

All councils within Western Australia are required to prepare a LPS when reviewing or preparing a Local Planning Scheme. The Local Planning Scheme is the statutory implementation component of the LPS, which guides local government decision-making in relation to applications for development approval and the WAPC's decision-making in relation to applications for land subdivisions (WAPC, 2011). Through the *Planning and Development Act 2005*, local governments are responsible for the preparation and implementation of LPSs.

Box 2. Local biodiversity conservation planning in the SWAE – A case study

Local governments have a dual role in biodiversity conservation, as key decision-makers in land-use planning and as land managers. However, their capacity to tackle biodiversity conservation issues varies greatly.

Since 2001, the Perth Biodiversity Project has worked to develop a framework and support mechanisms that enable a strategic and consistent approach to conservation planning at the local level. The methodology developed initially for the Perth Metropolitan Region and, in 2006, extended by the South West Biodiversity Project to other local governments experiencing development pressure in the southwest, was recognised by the state government.

Local biodiversity conservation planning is a process for identifying the ecological values of natural areas outside the current conservation estate, and prioritising them for conservation using a set of criteria that address legislative and policy requirements, and best practice management. The next step includes consideration of known opportunities and constraints to natural area retention and protection, and identifying feasible and effective local conservation mechanisms. Implementation tools include improved provisions in a local planning framework, the development of local planning policies, private landholder incentive strategies, and the adoption of a strategic approach to local reserve management. The process is finalised by the adoption of a Local Biodiversity Strategy (LBS).

Seventeen local governments are at various stages of developing or implementing a LBS. Many are demonstrating the effectiveness of local biodiversity conservation planning as a mechanism for achieving increased retention and protection of natural areas through land-use planning.

More information on a range of capacity-building tools and services developed through the Perth Biodiversity Project and the South West Biodiversity Project are available through the project website *www.pbp.walga.asn.au and at www.walga.asn.au/about/policy/swbp*

THE ROLE OF LAND-USE PLANNING TO ACHIEVE BIODIVERSITY CONSERVATION OUTCOMES

Land use planning has an important role in achieving biodiversity conservation outcomes through:

- Identifying and protecting natural areas with significant biodiversity values, in conservation reserves and zones;
- Directing development away from these areas, via appropriate zoning and subdivision design; and
- Controlling the impacts of land uses on these areas, in accordance with the development requirements of planning schemes.

It is important that conservation is integrated, considered early and reflected in each stage in the land-use planning process. Strategic planning at a regional to subregional scale is particularly important as it allows the consideration of biodiversity early in the land-use planning process, at a scale that is consistent with the natural extent of biodiversity assets, and is more effective in dealing with cumulative impacts of individual planning proposals (WAPC, 2011).

Land-use planning is potentially a powerful tool to support the achievement of a number of priority NRM outcomes, including the protection and sustainable management of water resources, biodiversity, agricultural land and basic raw materials. State and local government land-use planning processes (summarised in Table 6.), in the broad context of sustainable development, can be used to identify and protect natural resources from incompatible land uses, direct development away from sensitive environments, and require sustainable use and management of natural resource areas (WAPC, 2011).

However, while land-use planning mechanisms can regulate land development, local-scale planning cannot be relied upon to protect biodiversity at the regional scale. This is because jurisdictional boundaries do not correspond with the scientific imperatives of habitat protection. Additionally, policy and regulations can make it complex and complicated for both local government and developers to protect the environment. Local-scale land-use planning decisions will be more valuable if they consider regional significance and context.

© RICHARD MCLELLAN / WWF-AUS

Stirling Ranges

Table 6. Land-use planning mechanisms for biodiversity protection

Protective land zonings	• Special Rural Zones – provisions within Town Planning Schemes can prevent the clearing of natural areas outside the prescribed building envelopes; • Conservation Zones – designed specifically to protect and manage natural areas on private land; • Special Control Areas – define an area of land where a planning issue needs to be addressed; and • Town Planning Scheme Provisions – Local governments are legally bound to review their Town Planning Schemes at regular intervals and new provisions are an opportunity to introduce Conservation Zones or to set Special Control Areas.
Reservation and acquisition	• This can be done to retain the minimum 10 percent Public Open Space (POS) required in residential areas/developments to protect natural areas and is best done at the structure planning phase or prior to Town Planning Scheme amendments; • Reservation through subdivision is most effective when supported by a rezoning guide plan or structure plan or local planning policy – created under Section 20A of the *Town Planning and Development Act*; and • Rural Zoned Land.
Conditions on approval of applications	• Subdivision conditions; • Conditions on development; and • Restoration conditions.
Subdivision for conservation	• Subdivision and zoning; • Strata title subdivisions; • Cluster developments; and • Subdivision concessions.

INCENTIVES TO ACHIEVE BIODIVERSITY CONSERVATION WITHIN THE SWAE

Throughout Western Australia, biodiversity conservation has historically been delivered through the conservation estate, managed by the state government, and local conservation reserves managed by local government.

However, this approach does not protect the outstanding biodiversity assets located on privately-owned land. Therefore, there has been an increasing emphasis placed on biodiversity protection in these areas through the application of incentives, such as policy instruments and voluntary mechanisms.

These instruments and mechanisms fall broadly into three main categories (adapted from Collins and Scoccimarro, 2008):

1. **Motivational/non-financial** – tools and mechanisms that encourage changes in behaviour through the provision of information or incentives, such as via general education programs, training, awards and prizes, voluntary management agreements, and research and development.
2. **Market-based/financial** – policy tools that encourage behavioural change by using financial incentives to promote biodiversity protection. There are a range of market-based instruments, including subsidies and grants, rate rebates and land purchases.
3. **Regulatory** – require changes in behaviour by introducing penalties for parties who do not comply with the regulatory provisions. Types of regulatory instruments include standards (including planning instruments), licensing, mandatory management plans, covenants and offsets.

There has been a tendency in the past to rely solely on regulatory approaches to achieve biodiversity protection. This can promote inefficiency, inhibit innovation and impose unnecessary costs because regulation usually imposes uniform requirements on all businesses or land managers. Motivational approaches have been widely used in WA, but in recent years many programs have ceased or had funding significantly reduced. This may be because many of these programs focus on building the long-term capacity of land managers, which can take many years to translate into on-ground action, and many funding bodies prefer to see short-term results.

Projects that target private landholders make an important contribution, however there are increased risks associated with programs involving private property. These include potential interference, greater risk of non-compliance and much higher transaction costs.

Market-based instruments (MBI) that adopt economic principles of supply and demand to natural resources provide a relatively new approach to biodiversity protection. MBI are generally quite flexible and less expensive to implement. These instruments recognise that land managers and other businesses may have different capacities to undertake activities in NRM (Collins and Scoccimarro, 2008). They can also be designed to recognise differences in expected biodiversity benefits across regions. To ensure the effectiveness of MBI, they often require some regulatory underpinning. In addition, the level of biodiversity protection being targeted needs to be proportionate with the value of the biodiversity asset being protected.

Table 7 provides a list of the types of instruments and mechanisms that can be employed in the prioritised areas identified in the systematic conservation planning process. It is important to note that there is no "one-size-fits-all" approach to biodiversity protection and conservation at this level. The most suitable instrument or mechanism will depend on specific biodiversity values, threats to those values, and motivations (i.e. financial, intrinsic) for protection.

In many cases, two or more instruments and/or mechanisms might be more effective in managing biodiversity assets than one. For example, an extension program offering technical support could be effective in complementing a MBI (such as a rate rebate) or a MBI could be more effective if underpinned by a regulatory tool.

Durante *et al.* (undated) found that it was critical to consider a number of issues when designing an incentive program for a particular area or landholder. These include:

1. Providing landholders and land managers with an adequate incentive to participate;
2. Being flexible in the application process and program requirements;
3. Providing opportunities to negotiate outcomes;
4. Keeping monitoring to an achievable level; and
5. Considering that voluntary involvement might be more self-supportive in the long-term.

If there is uncertainty over the most appropriate mechanisms to use and the receptiveness of landholders and organisations, then programs being considered should be trialled. The lessons learnt should then be published for other landholders and natural resource managers to consider.

Additional information on biodiversity incentives can be found at:

- http://www.dec.wa.gov.au/
- http://www.amrsc.wa.gov.au/library/file/1Council/Meetings/CouncilCommittees/SAC/100218_AMR%20incentives%20strategy_Attach.pdf

MBI:

- *http://www.marketbasedinstruments.gov.au/*
- *http://lwa.gov.au/taxonomy/term/3399*
- *http://www.environment.gov.au/biodiversity/publications/scoping-paper/index.html*

Overview of MBI and environmental policy in Australia:

- *http://www.ecosystemservicesproject.org/html/publications/docs/MBIs_overview.pdf*

Further information on how to encourage participation in incentives and MBI:

- *http://www.csu.edu.au/research/ilws/research/docs/WP30-MBI_Expert-Interviews.pdf*

Table 7. Examples of instruments to achieve biodiversity conservation

	Instrument	Intention	Examples
Policy market-based/ financial	**Grants**	Grants or funding programs for the undertaking of conservation activities.	• Minister for the Environment – Environmental Community Grants; • Healthy Wetland Habitats (DEC); and • NRM regional devolved grant programs
	Subsidies	Subsidies support part of the cost of on-ground activities.	Subsidised plants for revegetation, or fencing material for fencing programs.
	Rate rebates	Rate rebates are given to landholders in return for undertaking conservation planning and/or activities.	• Shire of Busselton Biodiversity Incentives Strategy; and • Shire of Serpentine-Jarrahdale Local Government Conservation Scheme.
	Land purchase/ donation	Landholders who have bushland of high conservation value may not always be interested or able to manage that land. These landholders may be interested in selling or donating it by way of subdivision to government and non-government organisations that can actively protect and manage the land.	• Bush Bank (National Trust of Australia (WA); • Bush Heritage Australia; • Gondwana Link; and • Government Land Purchase Program (DEC).
	Accreditation systems	Usually a voluntary form of sustainability assessment, which indicates that the market producer (eg. vineyard, potato farmer) has met some form of sustainability criteria, so that their product may be labelled accordingly and be more attractive to "green consumers".	Eco-labelling, for example the Marine Stewardship Council and the Forest Stewardship Council.

Regulatory	**Covenants**	Although covenants are often entered into voluntarily, they are legally binding to the land title upon which the caveat is lodged. Most are perpetual, although some can be lodged for a specified period of time. Covenants are negotiated with the existing landholder and can be tailored to meet the needs of the landholder so long as the conservation needs of the land are not compromised. Covenants are often accompanied by specialist advice and support. Entering into a covenant also makes the landholder/s eligible for potential local government rate rebates or tax concessions, as well as (potentially) funding under public biodiversity funding schemes.	• National Trust of Australia (WA)'s Natural Heritage Covenanting Program; • WA Department of Environment and Conservation's Nature Conservation Covenant Program; and • WA Department of Agriculture and Food's Soil and Land Conservation covenants.
	Offsets	Offsets are off-site actions taken in an attempt to compensate for the negative environmental impacts of developments. Sometimes this is associated with an aspiration to achieve no net environmental loss or even a net environmental gain. Many conservation organisations and scientists contest the effectiveness of such policy responses.	• Additional protection for off-site habitat; • Creation of new off-site habitat; or • Funding for other conservation activities or research. There may be a requirement for "like-for-like" habitat protection or creation and/or a requirement that the off-site offsets are no more than a desired distance from the impact site. There may be time lags between the negative impact and the implementation of the compensatory offset.
	Waiving development fees	Development fees and charges could be waived in conservation areas for beneficial activities, such as rehabilitation, or landholders can be exempt from requiring development approval for carrying out conservation activities in accordance with an approved management plan.	
	Compensatory habitat	Negotiation to exchange land for conservation at the strategic planning stage.	
	Developer contributions	Contributions or levies required by councils that can help provide the community with possible funding.	
	Developer incentives	Additional subdivision and development rights in return for conservation of certain areas.	
	Management plans	Often required as a development condition, to ensure the protection of local or regional natural assets.	Management plans for Conservation Category Wetlands on private property being developed or subdivided.

LOCAL-SCALE BIODIVERSITY CONSERVATION

Biodiversity conservation at the local level is often undertaken by state and local governments, community groups, landholders, regional groups and NGOs, and it is where on-ground management is usually evident. Federal, state and local governments offer a number of funding programs that aim to achieve biodiversity conservation outcomes.

Information on some of the grants available can be found at:

- *http://www.grantsdirectory.dlg.wa.gov.au/* and
- *http://australia.gov.au/topics/environment-and-natural-resources/environment-grants.*

Historically, grant programs request information on the number of hectares fenced, or the number of people participating in vegetation improvement activities. Measures such as these would be appropriate if the goal of management is to increase the amount of fencing in the region, or to increase the number of people engaged in native vegetation management. However, such measures provide scant indication of progress towards a stated goal, such as increasing the amount or quality of native vegetation (Duncan and Wintle, in press).

PARTNERING WITH REGIONAL-SCALE NON-GOVERNMENT ORGANISATIONS

A number of NGOs operate throughout the SWAE and partnerships with regional NGOs help to improve the coordination of biodiversity outcomes. These organisations are involved in a variety of projects and work, such as acquiring land for conservation, advocating for sustainable management of resources, through to providing land management training and coordinating revegetation projects with landholders.

Although these organisations may have their own visions and objectives, they often work in collaboration to achieve mutually beneficial outcomes. Many also work with government organisations, the community and the private sector, particularly on larger-scale projects that require significant investment.

Table 8 provides a list of some of the regional NGOs operating throughout the SWAE. Many other sub-regional and localised environmental groups, catchment groups, community groups and "friends of" groups contribute significantly to the conservation of biodiversity within the SWAE.

Table 8. Regional NGOs in the SWAE

Organisation	Activity in biodiversity conservation
Aboriginal land and sea councils *http://www.glc.com.au/* *http://www.noongar.org.au/* *http://www.yamatji.org.au/*	There are three Aboriginal land and sea councils located within the SWAE. Each has a primary role to play as native title representatives for Traditional Owners. Increasingly, they also have interest and a role in NRM and land-use negotiation. • **The Goldfields Land and Sea Council (GLSC)** is the principal voice for Aboriginal people from the Goldfields-Esperance region on matters to do with land and waters, governance, social and economic development, heritage and justice. The GLSC is the Federal Government-appointed native title representative body for the region. • **The South West Aboriginal Land and Sea Council (SWALSC)** is a native title representative body that works in the interests of the Noongar people. The SWALSC has experience in NRM projects through the Caring for Our Country programs, where it works in close cooperation with catchment councils and community groups. • **Yamatji Marlpa Aboriginal Corporation (YMAC)** is the native title representative body for the Traditional Owners of the Pilbara, Murchison and Gascoyne regions.
Australian Wildlife Conservancy	The AWC acquires land and works with other landholders to establish sanctuaries for the conservation of threatened wildlife and ecosystems in south-western Australia. It undertakes practical, on-ground conservation programs including feral animal control, weed eradication, fire management and translocation of threatened species. The AWC works in partnership with universities, museums, the CSIRO and a range of other science organisations to conduct strategic research on key issues affecting wildlife. It hosts visitor programs at some of its sanctuaries to promote public awareness of the plight of Australia's threatened wildlife. This includes a program of school visits to the Yookamurra and Karakamia sanctuaries.

Organisation	Activity in biodiversity conservation
Birds Australia (BA) *http://www.birdsaustralia.com.au/*	BA is dedicated to the conservation and study of Australia's native birds and habitats. The group purchases land of high conservation significance, and conducts surveys and research on relevant conservation issues.
Bush Heritage Australia (BHA) *http://www.bushheritage.org.au/*	BHA acquires land and water of outstanding ecological significance to preserve the nation's heritage, then manages it to protect and enhance natural values. Funds are raised by tax-deductible public donations and through funding organisations, and land is acquired through purchases, gifts and bequests.
Conservation Council of WA (CCWA) *http://ccwa.org.au/*	The CCWA facilitates advocacy and action on conservation and environmental issues on behalf of the wider community and acts as an umbrella group for over 100 member organisations. The council works with community, government and industry towards a more sustainable future for WA. With professional staff and volunteers, it works on policy development and legislative change, consultation, campaigning, submission writing and environmental education.
Conservation Volunteers Australia (CVA) *http://www.conservationvolunteers.com.au/*	A national, not-for-profit, community-based organisation, CVA is dedicated to involving the community in practical conservation NRM programs. CVA works in partnership with catchment management authorities, local councils, community groups, conservation agencies, tourism organisations and operators, state governments and departments, the Federal Government, NGOs and individual land owners.
Gondwana Link Inc. *http://www.gondwanalink.org/*	Gondwana Link coordinates the work of a number of NGOs to reconnect natural habitats from the southwest corner of WA to the Nullarbor Plain. On-ground work has started in the Stirling Ranges to Fitzgerald section, with planning underway for other areas. The primary functions of Gondwana Link include: • Lobbying for stronger protection of public land; • Providing incentives for better land management, such as fencing and restoring bushland; • Purchasing bushland to protect and manage it; • Revegetating large tracts of cleared land; • Developing ecologically supportive industries, such as commercial plantings of local species; and • Improving the science behind the planning.
Greening Australia WA (GAWA) *http://www.greeningaustralia.org.au/*	GAWA works in partnership with landholders, the community, government and business to tackle environmental degradation in a practical, political and scientific way. GAWA is committed to large-scale revegetation with native species and the trial of native species for ecologically sensitive industries.
Green Skills *http://www.greenskills.org.au/*	Green Skills is committed to supporting the creation of ecologically sustainable employment, by providing quality training, employment services and management of projects. Green Skills focuses on biodiversity conservation, new farming systems and sustainable living.
Natural resource management (NRM) regional groups *http://www.nrm.wa.gov.au/waRegionlNrmGroups.htm*	The SWAE encompasses all six of WA's NRM regional groups. These groups work in partnership with federal, state and local governments, environment groups, community, industry, research institutions and land owners to address priority NRM issues. Each region has programs and projects that address biodiversity issues. Collectively, the six regional groups have prioritised almost $22 million for biodiversity and natural icons in the SWAE.
Men of the Trees (MOTT) *http://www.menofthetrees.com.au/*	A not-for-profit, incorporated association, founded in 1979, MOTT has planted more than 11 million seedlings to prevent the spread of deserts, erosion and salinity. MOTT uses its resources to combat salinity and soil erosion, and to strengthen biodiversity. In 2011, the group started acquiring degraded sub-catchment land in the Wheatbelt and relies heavily on businesses, volunteers and members for its operation and funding.

Organisation	Activity in biodiversity conservation
Pew Environment Group *http://www.protectourcoralsea.com.au/*	A global environmental advocacy organisation that actively promotes strong conservation policies, Pew applies a range of tools – including applied science, public education, media and communications, and policy advocacy. Their Wild Australia Program is an ambitious effort to protect millions of hectares of the country's most important wilderness and tens of thousands of square kilometres of our oceans that hold globally significant biodiversity. It does so by developing projects or supporting existing organisations to pursue significant conservation outcomes. In the SWAE, Pew currently focuses on the Great Western Woodlands Collaboration.
The Nature Conservancy (TNC) *http://www.nature.org/*	TNC's mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. Science guides the organisation's work by identifying Earth's most important natural places, which it then seeks to protect and restore. The organisation works with communities and partners around the world.
The Wilderness Society (TWS) *http://www.wilderness.org.au/*	TWS is Australia's largest national, community-based conservation organisation working solely for the protection of Australia's wilderness and other high conservation value areas. TWS's work is guided by the science and philosophy of WildCountry – a long-term, national vision for the conservation of Australian ecosystems. It recognises that biodiversity conservation requires the protection and restoration not only of small patches of country but entire ecosystems and ecological processes.
Urban Bushland Council (UBC) *http://members.iinet.net.au/~ubc/*	The UBC is the peak community organisation for the recognition and protection of urban bushland in WA. It comprises approximately 60 community conservation groups concerned about urban bushland. The UBC is involved in local action and networking, policy development, lobbying and raising public awareness.
Western Australian Naturalists' Club (WANC) *http://www.wanats.iinet.net.au/*	The WANC is one of the oldest conservation groups in Australia. Founded in Perth in 1924, it provides for amateurs and professionals with an interest in natural history through a full program of meetings, excursions, workshops and occasional social events. These include bird-watching, botany, spotlighting, fossicking for fossils and fungi, observing habitats, as well as learning more about WA's environmental issues, such as soil salinity, introduced flora and fauna, and land degradation. The club's conservation committee responds to issues and makes submissions on development proposals.
Wildflower Society *http://members.ozemail.com.au/~wildflowers/*	With more than1,000 members, this society aims to understand our plants, share information about them, protect the bushland in which they grow and to propagate them. Members from all sections of the community work with government departments such as the Department of Environment and Conservation, especially the WA Herbarium and the Kings Park and Botanic Garden Authority. The society has branches in Perth and country areas, each offering a host of different activities.
WWF-Australia *http://www.wwf.org.au/*	WWF-Australia works closely with private landholders, industry, various spheres of government and other NGOs to deliver on-ground outcomes as well as advocating for best practice, policy and legislative reforms that improve biodiversity conservation. It aims to drive effective conservation action to protect the animals and plants of the highest priority parts of southwest Australia by identifying priority ecosystems, species and ecosystem processes, and protecting them through on-reserve and off-reserve measures.

DISCUSSION

This report summarises the results of the SWAEI's region-wide spatial prioritisation process and represents a major pathway for identifying and representing the biodiversity values of the SWAE.

Conservation initiatives are underway and ongoing in many areas within the SWAE. This report recognises the value of these initiatives and their contribution to conservation. However, these initiatives are not sufficient to achieve conservation at the ecoregional scale.

The basic foundation of this planning process is to identify representative biodiversity in the ecoregion (i.e. the minimum amount of land required while avoiding threats and land-use conflict). Focusing conservation efforts on these areas will deliver the highest return on investment.

The analysis has been undertaken at the ecoregion scale and the priority areas should not be considered as stand-alone areas. Rather, they each make a contribution to the persistence and representation of biodiversity across the ecoregion and need to be considered in this context. The only exception is where unique conservation features are entirely contained within a priority area.

More than 100 experts helped to identify the representative priority areas. This approach will not ensure that all biodiversity assets in the SWAE are protected, due to data and knowledge gaps, but the priority areas represent a good starting point for prioritising biodiversity conservation action, especially given limited resources.

While a broad and comprehensive range of decision variables have been used, it is impossible to capture all variables within the scope of this analysis. In particular, the analysis does not consider all threats to biodiversity in the ecoregion or additional conflicts, such as land that should be protected for primary production.

This strategic framework is a decision support tool, not a decision-making tool, and the results presented are a snapshot based on current data. As patterns of biodiversity change, either in response to changes in climate or other threatening processes, or as new and additional data comes to light, it will be necessary to reconsider the boundaries of the prioritised areas and the likely success of implementing projects.

The results of this rigorous analysis should provide a basis for allocating resources for management initiatives that respond to region-wide threats and that require a national, state and local response. The results should inform a coordinated response from those organisations involved in on-ground implementation activities. They should also inform policy and decision-making processes, including land-use planning and funding objectives, and strengthen stakeholder capacity by increasing the autonomy of decision-making and program implementation.

It is recommended that implementation strategies are developed based on the results of this framework. These strategies should be managed in such a way as to foster cooperation and coordination, in order to ensure a synchronised and cost-effective approach. This will require the refinement of the boundaries at the local scale and verification of data based on local knowledge.

Management actions at the ecoregion scale that can be incorporated into international, regional, national and local programs should be identified so that all conservation efforts within the SWAE can be integrated.

Importantly, this process should provide a basis for monitoring and evaluation that will enable stakeholders to track their progress toward biodiversity conservation in the ecoregion. The measurement of incremental impacts should be fed back into the systematic conservation planning process, so that stakeholders continue to build on past accomplishments. This will encourage efficient solutions to be explored and provide stability and investment as funding sources and policy changes.

GLOSSARY

Area for Conservation Action (ACA): an area defined by the IBRA boundaries (where some have been amalgamated for a reduced number of ACAs) for the achievement of conservation goals specific to the conservation features used in this systematic conservation planning exercise.

Biodiversity hotspot: a biogeographic region with a significant number of endemic species that is under threat from humans. The concept of biodiversity hotspots originated with Norman Myers and was revised in H*otspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions* (Mittermeier, *et al.*, 1999). To qualify, a region must contain at least 0.5 percent, or 1,500 species of vascular plants as endemics, and it has to have lost at least 70 percent of its primary vegetation. Internationally, 34 sites qualify under this definition. These sites support nearly 60 percent of the world's plant, bird, mammal, reptile and amphibian species, with a very high number of endemic species.

Centre of Plant Diversity: established in 1998 as a joint classification initiative between WWF and the International Union for the Conservation of Nature (IUCN). It intended to identify the areas in the world of the highest conservation value in terms of protecting plant species. As at 1998, there were 234 Centres of Plant Diversity registered across the globe, each having a rich diversity of endemic plant species that are of great value to humans and their native ecosystems. These species tend to occur in unique edaphic conditions likely to have a high number of highly vulnerable, irreplaceable plant species.

Conservation Action Plan: a plan of action composed of different implementation strategies that aims to achieve conservation targets in a local area.

Conservation Category Wetlands: those afforded the highest priority for protection and conservation in Western Australia (Water and Rivers Commission, 1994). Conservation Category Wetlands are generally those with important ecological attributes and functions, such as hydrology, soil types and surrounding vegetation, and may include Declared Rare Flora, be located within a Bush Forever Site, considered part of a threatened or priority ecological community, or be the last remaining "good" representation of a particular type (Krasnostein, A., 2011, pers. comm.).

Ecological communities: naturally occurring biological assemblages in a particular type of habitat. They are the sum of species within an ecosystem and, as a whole, provide many of the processes that support specific ecosystems and provide "ecological services". Ecosystems are much more than the sum of their parts. The myriad of interactions between their component species provides an important third level of biological diversity in addition to those of genes and species. http://www.dec.wa.gov.au

Ecoregion: an ecologically and geographically defined area that is smaller than an ecozone and larger than an ecosystem. Ecoregions cover relatively large areas of land or water, and contain geographically distinct assemblages of natural communities and species.

Endemic Bird Area: defined by BirdLife International as a region that contains two or more restricted-range species. BirdLife International has defined the term "restricted-range endemic" as any species whose historical range is less than 50,000 square kilometres. For more information go to http://www.birdlife.org/

Endemic species: a species that is unique to a defined geographic location, such as an island or other defined zone, or habitat type. Organisms that are indigenous to a place are not endemic to it if they are also found elsewhere.

Global 200 Ecoregions: WWF's first attempt to identify a set of ecoregions whose conservation would achieve the goal of saving a broad diversity of the Earth's ecosystems. These ecoregions include those with exceptional levels of biodiversity, such as high species richness or endemism, or those with unusual ecological or evolutionary phenomena. For more information go to http://www.worldwildlife.org/science/ecoregions/global200.html

Gnammas: rock holes created by weathering, capable of holding water, and highly valued for sustaining life in arid times and places.

IBRA: Interim Biogeographic Regionalisation for Australia. IBRA is the National Reserve System's planning framework and the fundamental tool for identifying land for conservation. IBRA is a more refined and detailed subset of the global ecoregions. The identification and requirements of a Comprehensive, Adequate and Representative (CAR) reserve system is undertaken by the Department of Sustainability, Environment, Water, Population and Community, based on IBRA 6.1.

Planning units: the uniform spatial unit of analysis used in most approaches to systematic conservation planning. Planning units are cells that form a continuous grid over the project area and are the building blocks of an expanded system of conservation areas.

Priority ecological communities: potentially threatened ecological communities that do not meet survey criteria or that are not adequately defined and subsequently ranked 1, 2 or 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status , so that consideration can be given to their declaration as threatened ecological communities. In addition, communities that have been proposed as threatened ecological communities by the WA Threatened Ecological Community Scientific

Committee (WATECSC) and that have not yet been classified as threatened in Western Australia are listed as Priority 1 ecological communities as an interim measure. Ecological communities that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation-dependent ecological communities are placed in Priority 5. For more information go to www.dec.wa.gov.au

Priority species: species of flora or fauna that are either poorly known or known only from a few occurrences. They, therefore, could be at risk and require further survey to determine if they should be considered for listing as threatened species, or are rare but not currently threatened and require ongoing monitoring.

Ramsar wetlands: sites that contain representative, rare or unique wetlands, or that are important for conserving biological diversity. Sites are nominated to be recognised on the List of Wetlands of International Importance (Ramsar sites) for their international significance in terms of ecology, botany, zoology, limnology or hydrology.

Threatened ecological communities: those endorsed by the Minister for Environment, and listed by the DEC, that fit into the critically endangered, endangered or vulnerable categories.

Threatened species: those flora and fauna species determined by the Minister for Environment to be adequately searched for and deemed to be either rare, in danger of extinction or otherwise in need of special protection in the wild, and listed as such under the *Wildlife Conservation Act 1950*. Also known as declared rare flora and threatened fauna, threatened species are ranked by the DEC using IUCN criteria as critically endangered, endangered or vulnerable.

© KATHERINE HOWARD / WWF-AUS

Quokka

ACRONYMS

ACA	Areas for Conservation Action
CALM	Conservation and Land Management (Department of)
CAP	Conservation Action Planning
CCWA	Conservation Council of Western Australia
CF	Conservation Feature
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVA	Conservation Volunteers Australia
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
ENGO	Environmental Non-Government Organisation
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation Act 1999
GLSC	Goldfields Land and Sea Council
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
MOTT (WA)	Men of the Trees Western Australia
NRM	Natural Resource Management
NRMMC	Natural Resource Management Ministerial Council
PRNRM	Perth Region Natural Resource Management Inc.
SWAE	Southwest Australia Ecoregion
SWAEI	Southwest Australia Ecoregion Initiative
SWALSC	South West Aboriginal Land and Sea Council
TEC	Threatened Ecological Community
TWS	The Wilderness Society
WALGA	Western Australian Local Government Association
WAPC	Western Australian Planning Commission

REFERENCES

Australian and New Zealand Environment Conservation Council (ANZECC) (1997). *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*. A Report by the Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee, Canberra ACT 2601.

Australian Government, viewed 25th March 2011, http://environment.gov.au

Australian Government, viewed 9th April, 2011, http://www.environment.gov.au/water/topics/wetlands/ramsar-convention/index.html

Australian Government, viewed 9th April, 2011, http://www.environment.gov.au/biodiversity/migratory/waterbirds/bilateral.html

Australian Government, viewed 15th August 2011, http://www.nrm.gov.au/publications/frameworks/meri-framework.html

Australian Government, viewed 27th August 2011, http://www.environment.gov.au/epbc/about/index.html

Australian Natural Resources Atlas, viewed 20th March 2011, http://www.anra.gov.au

Bayly, I.A.E. (1999). *Rock of ages: human use and natural history of Australian granites*. Nedlands, WA: Tuart House.

Beard J.S. (1980). *A new phytogeographic map of Western Australia. Research Notes of the Western Australian Herbarium* 3:36–58.

Beard, J.S. and Sprenger, B.S. (1984). *Geographical Data from the Vegetation Survey of Western Australia*. Occasional Paper No. 2.

Bennett, J. (2005). *Choice modelling: A step-by-step guide, Economics Techniques Series: Fact sheet No.1*. Environmental Protection Authority, Queensland.

Berra, T.M. and Allen, G.R. (1989). Burrowing, emergence, behaviour, and functional morphology of the Australian salamanderfish, *Lepidogalaxias salamandroides*. *Fisheries* 14(5): 2–10.

Birds Australia, viewed 15th March, 2011, http://www.birdsaustralia.com.au/

Birds Australia (2005). *The Status of Australia's Birds 2005 – Woodlands and Birds*. Compiled by P. Olsen, M. Weston, C. Tzaros and A. Silcocks. Supplement to *Wingspan,* vol. 15, no. 4.

Bush, B., Maryan, B., Brown-Cooper, R. and Robinson, D. (2007). *Reptiles and Frogs in the Bush: Southwestern Australia*. University of Western Australia Press.

Carlson, J. and Wood, T. (2004). *Assessment of the Economic Value of Tourism in Western Australia's National Parks, Marine Parks and Forests*. CRC for Sustainable Tourism, Brisbane.

Cody, M.L. (1986). *Diversity, rarity and conservation in Mediterranean-climate regions* in M. E. Soulé, (ed.), *Conservation Biology*. Sinauer Associates, pp: 122–152.

Coggan, A. and Whitten, S.M. (2008). *Best practice mechanism design: Concepts and case studies for biodiversity. Final report for the Australian Government, Department of Environment, Water, Heritage and the Arts*. CSIRO Sustainable Ecosystems.

Collins, D. and Scoccimarro, M. (2008). *Market-based Instruments Decision Support Tool*. Market Based Instruments Capacity Building Program (part of Market Based Instruments Pilot Program and the National Action Plan for Salinity and Water Quality). Department of Natural Resources and Water, Brisbane.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2009). *Water yields and demands in south-west Western Australia – Summary of a report to the Australian Government from the CSIRO South-West Western Australia Sustainable Yields Project*.

Conservation Council of Western Australia (CCWA), viewed 10th March 2011, http://ccwa.org.au/content/what-we-do

Conservation Volunteers Australia (CVA), capability statement, viewed 10th March 2011, http://www.conservationvolunteers.com.au/capabilitystatement.htm

Convention of Biological Diversity, viewed 15th April 2011, http://www.cbd.int/

Davis, R.A. (2006). *Frogs in the Southwest Australia Ecoregion* (unpublished).

Davis, R.A. (2008). *Ecological Linkages and Urban Fauna at Risk on the Swan Coastal Plain, Perth, WA*. Report for the Swan Catchment Council.

Davis, R.A. (2008). *Designing Ecological Linkages*. (unpublished) Presentation made at the Ecological Linkages Guidelines Workshop. Swan Catchment Council, Perth, Western Australia.

Del Marco, A., Taylor, R., Clarke, K., Savage, K., Cullity, J. and Miles, C. (2004). *Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region*. Western Australian Local Government Association, Perth.

Department of Conservation and Land Management (CALM) (1999). *Environmental Weed Strategy* for WA. Government of Western Australia.

Department of Environment and Conservation (DEC) (2006). *Draft – A 100-year Biodiversity Conservation Strategy for Western Australia: Blueprint to the Bicentenary in 2029*. Government of Western Australia.

Department of Environment and Conservation (DEC) (2008). *Department of Environment and Conservation 2007–2008 Annual Report*. Government of Western Australia.

Department of Environment and Conservation (DEC) (2009). *Department of Environment and Conservation 2008–2009 Annual Report*. Government of Western Australia.

Department of Environment and Conservation (DEC) (2009). *Biodiversity Incentive Programs in Western Australia*. Government of Western Australia.

Department of Environment and Conservation (DEC) (2010). *A Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands*. Government of Western Australia.

Department of Environment and Conservation (DEC) (2010). *Department of Environment and Conservation 2009–2010 Annual Report*. Government of Western Australia.

Department of Fisheries, viewed 15th February 2011, http://www.fish.wa.gov.au

- Department of Sustainability, Environment, Water, Population and Community, viewed 18th May 2012,
- Ecoregions at http://www.environment.gov.au/parks/nrs/science/bioregion-framework/terrestrial-habitats.html
- Intermin Bio-regionalisation of Australia (IBRA) at http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

Duncan, D. and Wintle, B. (in press). *Towards Adaptive Management of Native Vegetation in Regional Landscapes* in Pettit,C., Cartwright, W., Bishop, I., Lowell, K., Pullar, D., Duncan, D. (eds.) *Landscape Analysis and Visualisation: Spatial Models for Natural Resource Management and Planning*. Springer Verlag, Berlin.

Durante, J., Morrison, M., Greig, J. and Ward, J. (undated). *Encouraging Participation in Market Based Instruments and Incentives: Insights from the Expert Interviews,* Working Paper No. 3 from the Project "Impediments to the Uptake of Market Based Instruments".

Economic Research Associates (2011). Business Case for *Phytophthora Research Funding*. Report to the Dieback Consultative Council.

Environmental Protection Authority (EPA) (2007). State of the *Environment Report Western Australia*. Government of Western Australia.

Etienne, R.S. and Heesterbeek, J.A.P. (2000). On optimal size and number of reserves for metapopulation persistence. *J. theor. Biol.* 203, 33–50, doi:10.1006/ jtbi.1999.1060.

Game, E.T. and Grantham, H.S. (2008). *Marxan User Manual: For Marxan version 1.8.10*. University of

Queensland, St. Lucia, Queensland, Australia, and Pacific Marine Analysis and Research Association,

Vancouver, British Columbia, Canada.

Gaston, K.J., Warren, P.H., Devine-Wright, P., Irvine, K.N. and Fuller, R. (2007). Psychological benefits of greenspace increase with biodiversity. *Biology Letters* 3 (4): 390–394. doi:10.101098/rsbl.2007.0149. PMC 2390667. PMID 17504734.

Gawler, M. (2005). *Project Design in the context of Project Cycle Management: Sourcebook*. WWF Introductory Course.

Gillespie, R. (2000). *Economic Values of the Native Vegetation of NSW*. Department of Land and Water Conservation, Background paper No 4, NSW.

Goldfields Land and Sea Council, viewed 12th March 2011, http://www.glc.com.au/

Gole. C. (ed.) (2006). *Southwest Australia Ecoregion: Jewel of the Australian Continent*. World Wildlife Fund Australia, Perth.

Gondwana Link, viewed 10th March 2011, http://www.gondwanalink.org/

Gove, A.D., Dunn, R.R. and Majer, J.D. (2008). The importance of species range attributes and reserve configuration for the conservation of angiosperm diversity in Western Australia. *Biodiversity Conservation* 17, 817–831.

Granite Outcrops Symposium, September 14–15, 1996. p.87–237. *Journal of the Royal Society of Western Australia,* vol.80, pt.3 (September 1997).

Greening Australia, viewed 16th March 2011, http://www.greeningaustralia.org.au/

Greuter, W. (1994). Extinction in Mediterranean areas. *Philos*. Trans. R. Soc. London. B 344: 41–46.

Groves, R.H., Boden, R. and Lonsdale, W.M. (2005). *Jumping the Garden Fence: Invasive Garden Plants in Australia and their Environmental and Agricultural Impacts – A CSIRO report for WWF-Australia*. WWF-Australia.

Halse, S.A., Lyons, M.N., Pinder, A.M. and Shiel, R.J. (2004). *Biodiversity patterns and their conservation in wetlands of the Western Australian wheatbelt*. Department of Conservation and Land Management, Science Division.

Hobbs, R.J. and Atkins L. (1991). Interactions between annuals and woody perennials in a Western Australian nature reserve. *J. Veg. Sci.* 2: 643–654.

Hobbs, R.J. and Hopkins, A.J.M. (1990). From frontier to fragments: European impact on Australia's vegetation. *Proc. Ecol.Soc.Aust*. 16:93–114.

Hobbs, R.J. and O'Connor, M.H. (1999). Designing mimics from incomplete data sets: salmon gum woodland and heathland ecosystems in southwest Australia. *J. Agroforest*. Syst. 45: 365–394.

Hobbs, R.J., Saunders, D.A. and Main, A.R. (1992). Conservation Management in fragmented systems in R.J. Hobbs, D.A. Saunders (eds.) *Reintegrating fragmented landscapes: Towards sustainable production and nature conservation,* pp. Ch.10, pp 279–296. Springer-Verlag, New York.

Hopper, S.D. (2003). Southwestern Australia, Cinderella of the world's temperate floristic regions, 1. *Curtis's Bot. Mag*. 20: 101–126.

Hopper, S.D. (2004). Southwestern Australia, Cinderella of the world's temperate floristic regions, 2. *Curtis's Bot. Mag*. 21: 132–180.

Hopper, S.D. and Burbidge, A.H. (1989). Conservation status of Banksia woodlands on the Swan Coastal Plain. *Journal of the Royal Society of Western Australia*. 71(4): 115–116.

Hopper, S.D. and Gioia, P. (2004). The southwest Australian floristic region: evolution and conservation of a global biodiversity hotspot. *Annu. Rev. Ecol. Syst*. 35: 623–650.

Intergovernmental Panel on Climate Change (IPCC). Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. (eds.) (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the IPCC. Cambridge University Press, Cambridge, United Kingdom.

International Union for the Conservation of Nature and Natural Resources (IUCN), Protected Area Products, viewed 14th March 2011, http://www.iucn.org/about/work/programmes/pa/pa_products/

Iwamura, T., Wilson, K.A., Venter, O. and Possingham, H.P. (2010). A Climatic Stability Approach to Prioritising Global Conservation Investments. *PLoS One* (11):e15103.doi:10.1371/journal.pone.0015103).

Judd, S., Watson, J.E.M. and Watson, A.W.T. (2008). Diversity of a semi-arid, intact Mediterranean ecosystem in southwest Australia. *Web Ecol*. 8: 84–93.

Keighery, G., Halse, S. and McKenzie, N. (2002). Why wheatbelt valleys are valuable and vulnerable: the ecology of wheatbelt valleys and threats to their survival in V.A. Read (ed.) *Dealing with Salinity in Wheatbelt Valleys: Processes, Prospects and Practical Options,* pp. 1–8. Water and Rivers Commission, Perth.

Kutt, A., Eyre, T., Fisher, A., Hunt, L., (2009). *A Biodiversity Monitoring Program for Australian Rangelands*. ACRIS Biodiversity Monitoring Program report to the Australian Government.

Lambert, J. and Elix, J. (2000). *The Social Values of the Native Vegetation of New South Wales: A background paper of the Native Vegetation Advisory Council of New South Wales*. Department of Land and Water Conservation, Background Paper No. 3, Sydney, NSW.

Land insight (2010). *Incentives Strategy for Conservation of Private Land within the Shire of Augusta-Margaret River*. Report prepared for the Shire of Augusta-Margaret River.

Lindenmayer, D.B. and Hunter, M. (2010). Some Guiding Concepts for Conservation Biology. *Conservation Biology,* 24: 1459–1468. doi: 10.1111/j.1523–1739.2010.01544.

Majer, J. (2008). The Invertebrates in A. Watson, S. Judd, J. Watson, A. Lam and D. Mackenzie (eds.) *Extraordinary Nature of The Great Western Woodlands*. The Wilderness Society of WA Inc.

Margules, C.R., Pressey, R.L. and Nichols, A.O. (1991). Selecting nature reserves, in Nature Conservation: Cost Effective Biological Surveys and Data Analysis in C.R. Margules and M.P. Austin (eds.) *Nature Conservation: Cost Effective Biological Surveys and Data Analysis,* pp. 90–97. CSIRO, Australia.

Margules, C.R. and Pressey, R.L. (2000). Systematic Conservation Planning. *Nature* 405, 243–253.

May, J.E. and McKenzie, N.L. (2002). *A Biodiversity Audit of Western Australia's Biogeographical Subregions in 2002*. Department of Conservation and Land Management.

Men of the Trees Western Australia, about us, viewed 10th March, 2011, http://www.menofthetrees.com.au/about.html.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

Mittermeier, R.A., Myers, N., Robles Gill, P., Mittermeier, C.G. (1999). *Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions*. Conservation International.

Moir, M., Brennan K.E. and Harvey, M. (2009). Diversity, endemism and species turnover of millipedes within south-western Australian global biodiversity hotspot. *Journal of Biogeography*. 36:10 pp. 1958–1971.

Morrison, R. (undated). *Salamander Fish – The last of its tribe*, viewed 10th May 2011, http://homepage.mac.com/gregalchin/rm/pdfs/salamander%20fish.pdf

Morrison, J.D., Greig, M. and Ward, J. (undated). *Encouraging Participation in Market Based Instruments and Incentives: Insights from the Expert Interviews*, Working Paper No. 3 from the Project "Impediments to the Uptake of Market Based Instruments".

Myers, N., Mittermeier, R.A., Mittermeier, C.G., de Fonseca, G.A.B. and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* (Lond) 403:853:858.

Nannup, N. and Deeley D. (2006). *Rainfall and Water as Cultural Drivers*, abstract presented at the 1st National Hydropolis Conference, Perth, Western Australia, 8–11 October.

National Reserve System Task Group (2009). *Australia's Strategy for the National Reserve System* 2009–2030. Report to Natural Resource Management Ministerial Council (NRMMC). Australian Government Department of the Environment and Water Resources, Canberra ACT.

Natural Resource Management Ministerial Council (NRMMC) (2001). *National Framework for the Management and Monitoring of Australia's Native Vegetation*. Australian Government Department of the Environment and Water Resources, Canberra ACT.

Natural Resource Management Ministerial Council (NRMMC) (2006). *Australian Weeds Strategy – A national strategy for weed management in Australia*. Australian Government Department of the Environment and Water Resources, Canberra ACT.

Natural Resource Management Ministerial Council (NRMMC) (2007). *Australian Pest Animal Strategy*. Australian Government Department of the Environment and Water Resources, Canberra ACT.

Natural Resource Management Ministerial Council (NRMMC) (2010). *Australia's Biodiversity Conservation Strategy 2010–2030*. Australian Government. Department of Sustainability, Environment, Water, Population and Communities, Canberra ACT.

Northern Agricultural Catchment Council (2011). *Kwongan heath*, viewed 14th March 2011, http://kwongan.nacc.com.au

Noss, R.F. (1990). Indicators for monitoring biodiversity: a hierarchical approach. *Conserv. Biol.* 4, 355-364.

Ovaskainen, O. and Hanski, I. (2001). Spatially structured metapopulation models: metapopulation capacity and threshold conditions for persistence. *Theor. Popul. Biol.* 60, 281–304, doi:10.1006/tpbi.2001.1548.

Ovaskainen, O. and Hanski, I. (2002). Transient dynamics in metapopulation response to perturbation. *Theor. Popul. Biol.* 61, 285–295. doi:10.1006/tpbi.2002.1586.

Pate, J.S. and Beard, J.S. (eds) (1984). *Kwongan: Plant Life of the Sandplain in Biology of a south-west Australian shrubland ecosystem*. University of Western Australia Press, Perth.

Pew Environment Group, viewed 16th March, http://www.protectourcoralsea.com.au/

Pinder, A.M., Halse, S.A., McRae, J.M. and Shiel, R.J. (2005). Occurrence of aquatic invertebrates of the wheatbelt region of Western Australia in relation to salinity. *Hydrobiologia* 543, pp.1–24.

Platt, S.J. (2002). *How to Plan Wildlife Landscapes: a guide for community organisations*. Department of Natural Resources and Environment, Melbourne.

Possingham, H.P. and Field, S.A. (2000). Regional bird extinctions and their implications for vegetation clearing policy. *Lifelines* 7:15–16.

Pressey, R.L. and Bottrill, M.C. (2008). Opportunism, threats and the evolution of systematic conservation planning. *Conservation Biology* 22: 1340–1345.

Pressey, R.L. and Logan, V.S. (1997). Inside looking out: Findings of research on reserve selection relevant to "off-reserve" nature conservation in P. Hale and D. Lamb (eds.) *Conservation outside nature reserves*. The Centre for Conservation Biology, University of Queensland.

Rogers, A. and Cleland, J. (2011). *Conserving biodiversity in the Southwest Australia Ecoregion: the policy implications of scientist and community values. Environmental Economics Research Hub*. Research Report No. 91, Canberra (report in progress).

Roleybushcare, viewed 1st April, 2011, http://www.roleybushcare.com

Rundle, G.E. (1996). History of conservation reserves in the south-west of Western Australia. *Journal of the Royal Society of Western Australia*, 79(4).

Sarkar, S., Pressey, R.L., Faith, D.P., Margules, C.R., Fuller, T., Stoms, D.M., Moffett, A., Wilson, K.A., Williams, K.J., Williams, P.H. and Andelmans, S. (2006). Biodiversity Conservation Planning Tools: Present Status and Challenges for the Future. *Annual Review of Environment and Resources*, 31, 123–159.

Saunders, D.A. and Ingram, J.A. (1995). *Birds of Southwestern Australia: An Atlas of Changes in the Distribution and Abundance of the Wheatbelt Avifauna*. Surrey Beatty and Sons, Chipping Norton.

Shah, B. (2006). *Conservation of Carnaby's Black Cockatoo on the Swan Coastal Plain, Western Australia*.

Shepherd, D.P., Beeston, G.R. and Hopkins, A.J.M. (2002). *Native vegetation in Western Australia: Extent, Type and Status. Resource Management Technical Report No. 249*. Department of Agriculture and Food, Government of Western Australia.

South West Aboriginal Land and Sea Council (SWALSC), project page, viewed 10th March, 2011 http://www.noongar.org.au/projects-people.php

Spur, R., Pambudi, D., Duc Pham, T., Forsyth, P., Dwyer, L. and Hogue, S. (2011). *Tourism Satellite Accounts 2008–09: Summary Spreadsheets. The Economic Contribution of Tourism to Australian States and Territories*. Tourism Research Australia, Australian Government.

State NRM Office, viewed 16th March 2011, http://www.nrm.wa.gov.au/waRegionlNrmGroups.htm

Tabunakawai, K. and Areki, F. (2007). *Ecoregion Planning and Conservation in Fiji for a Sustainable Ocean*. WWF South Pacific Program.

Takacs, D. (1996). *Philosophies of Paradise*, abstract viewed 29th March 2011, http://www.dhushara.com/book/diversit/restor/takacs.htm

Thackway, R. and Cresswell I.D. (eds) (1995). *An Interim Biogeographic Regionalisation for Australia*. Australian Nature Conservation Agency, Canberra.

The Nature Conservancy, viewed 16th March 2011, http://www.nature.org/

The Wilderness Society, viewed 16th March, 2011, http://www.wilderness.org.au/

The World Bank (1998). *Guidelines for Monitoring and Evaluation for Biodiversity Projects*. Report by the Global Environment Division, The World Bank.

Tuart Health Research Group (2009). *Research into the cause and management of Tuart decline*. Tuart Health Research Group, Murdoch University, Perth.

University of Queensland, Marxan – *Informing Conservation Decisions Globally*, last viewed 19th February 2011, http://www.uq.edu.au

© HELENA MILLS / WWF-AUS

Monitor in pigface / Quaalup

Urban Bushland Council, viewed 25th April 2011, http://members.iinet.net.au/~ubc/

Western Australia Local Government Association (WALGA) (2004). *Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region*. Western Australian Local Government Association, Perth.

Western Australia Local Government Association (WALGA) (2010). *Remnant vegetation extent statistics based on 2010 remnant vegetation mapping* (unpublished). Western Australian Local Government Association, Perth.

Western Australian Naturalist's Club, viewed 16th March 2011, http://www.wanats.iinet.net.au/

Western Australian Planning Commission (WAPC) (2011). *Directions Paper on the Integration of NRM into Land Use Planning*. Western Australian Planning Commission, Perth.

Wikipedia, *Warren Biogeographic region*, viewed 18th March 2011, http://en.wikipedia.org/wiki/Warren_(biogeographic_region)

Wikipedia (2012), "FloraBase - the Western Australian Flora". Department of Environment and Conservation. Retrieved 25th October 2010, http://en.wikipedia.org/wiki/Southwest_Australia

WWF-Australia, viewed 16th March 2011, http://www.wwf.org.au/

WWF-Australia (2003). *Impacts of Land Clearing on Australian Wildlife in Queensland*.

WWF (2004). *Ecoregion Action Programmes – A Guide for Practitioners*. WWF, Washington DC, USA.

WWF-Australia (2010). *A Strategic Regional Conservation Plan for Australia's Global Biodiversity Hotspot Phase 1 Report*.

Yamatji Land and Sea Council, viewed 12th March 2011, http://www.yamatji.org.au/

Yates, C.J. and Hobbs, R.J. (eds.) (2000). *Temperate eucalypt woodlands in Australia: biology, conservation, management and restoration*. Surrey Beatty and Sons.

APPENDICES

APPENDIX 1. RESULTS FROM CHOICE MODELLING SURVEY

The general dollar values for incremental improvements in conservation (or levels) of each biodiversity attribute are reported in Table 9. Rogers and Cleland (2011) found that all biodiversity attributes are valued positively, suggesting that the WA population is willing to pay for additional biodiversity conservation measures for the SWAE. It was also noted that respondents were generally willing to pay more as the level of protection and management increases for biodiversity attributes.

Table 9. Dollar values derived from public base model (Rogers and Cleland, 2011)

	Willingness To Pay $/year/individual
Critical vegetation associations *(status quo: 10% contained within reserves)*	
30% contained within reserves	$103***
50% contained within reserves	$164***
Wetlands *(status quo: 20 nationally important wetlands fully contained within reserves)*	
30 nationally important wetlands fully contained within reserves	$23***
40 nationally important wetlands fully contained within reserves	$63***
Estuaries *(status quo: five largely unmodified estuaries fully contained within reserves)*	
Six largely unmodified estuaries fully contained within reserves	$20***
Seven largely unmodified estuaries fully contained within reserves	$35***
Threatened species *(status quo: 50% of populations contained within reserves)*	
60% of populations contained within reserves	no significant value
70% of populations contained within reserves	$54***
Endemic species *(status quo: 50% of populations contained within reserves)*	
60% of populations contained within reserves	no significant value
70% of populations contained within reserves	$12

***, **, * denotes significance at the 99%, 95% and 90% level of confidence respectively.

© HENRY COOK

Turtle Frog

Table 10. Willingness to pay for all possible interactions between endemic and threatened species

		Endemic species: % of populations contained within reserves		
		50%	**60%**	**70%**
Threatened species: % of populations contained within reserves	**50%**	*Status quo*	No significant value	No significant value
	60%	No significant value	$40***	$54***
	70%	$54***	$86***	$76***

***, **, * denotes significance at the 99%, 95% and 90% level of confidence respectively.

Table 10. reports some additional results for the threatened and endemic species attributes. It was hypothesised that individuals may have assumed that endemic species and threatened species are related (given that many endemic species are threatened), and as such they may have assumed that by valuing one of the attributes they are valuing both. Or, alternatively, they may consider that it is worth protecting both attributes, rather than just concentrating on one. As such, Table 10. indicates the dollar values for the interactions between these two attributes, i.e. how individuals value threatened species, depending on the level of endemic species protected, and vice-versa.

APPENDIX 2. PROGRAM AND PROJECT PLANNING WITHIN AREAS OF CONSERVATION ACTION

Many organisations are delivering on-ground biodiversity conservation management within the SWAE. The strength of the SWAEI partnerships has demonstrated that these organisations are keen to contribute to the implementation of this framework.

This framework aims to provide a program and project planning structure that allows these organisations to combine geographically-specific conservation objectives and actions with ecoregional goals and targets as new projects are developed and implemented within the priority areas. The success of implementing the systematic conservation planning outcomes will be determined by the focus, quality, effectiveness and cumulative effort of the on-ground biodiversity conservation activities within the ecoregion.

Using a program and project planning structure consistent with this framework will benefit both the SWAE and organisations undertaking biodiversity conservation management by:

- Ensuring the efforts of individual organisations to improve biodiversity conservation collaboratively contribute to the recognised biodiversity values of the ecoregion;
- Building on the expert opinion built into the systematic conservation planning approach to assist and underpin prioritisation processes and decision-making;
- Identifying areas in which organisations can work that will provide the best biodiversity conservation return on investment;
- Allowing organisations to identify environmental values that are important and aligning these with local priorities and management efforts;
- Providing a catalyst for organisations to build partnerships with other like-minded organisations and to develop projects that make a greater collective contribution to biodiversity conservation; and
- Assisting organisations and partnerships to justify the ecoregion-wide importance of geographically-specific conservation work.

Program and project planning for on-ground action within the ecoregion

Conservation efforts that complement and contribute towards the SWAE strategic framework for biodiversity conservation should be developed using a consistent project planning methodology that considers the objectives of both the ecoregion and the organisations. By undertaking the proposed program and project planning process – the process of managing several related projects – key stakeholders will be delivering their stated conservation objectives and contributing to the ecoregion's conservation.

The suggested program and project planning methodology aims to move strategically from the extensive scale of the SWAE to the scale relevant to on-ground management or policy responses to particular threats. Development of a project plan should also consider the ecoregion's conservation features within the project area, conduct a situation analysis, and build on local knowledge of relevant threats, opportunities, existing activities, policies, information gaps, stakeholder interests, capacity and attitudes, including social, economic and cultural values. All project plans should be developed considering species and habitat protection (including those not included as conservation species in the SWAE analysis), sustainable land-use and management, advocacy, communication, education and collaboration. Flexibility in defining priority areas at the local level is recommended to allow for the input of local stakeholders. Ideally these project plans will strengthen existing frameworks and processes, as well as stimulate new initiatives.

The suggested program and project planning process will help create a clear agenda for action and the achievement of objectives that will inspire and shape partnerships and the collaborative effort needed to realise the SWAE vision (WWF, 2004). Different methodologies can be employed to translate the maps produced from the systematic conservation planning project into on-ground action. However, the following program and project planning methodology is suggested (Figure 1.).

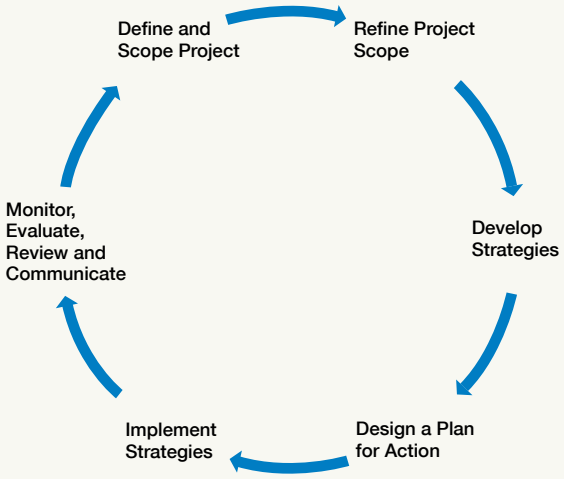


Figure 1. Summary of the program and project planning process

1. Define and scope project

Set clear conservation objectives

- Consider the vision for the SWAE as determined by the SWAEI
- Consider how your local objectives contribute to this vision
  - > An objective is a specific statement detailing the desired outcome or future state. It should be ambitious but realistic.
  - > Consider the environmental thresholds in this area.
  - > Are you protecting and maintaining what is currently in the ZCA? Are you enhancing ecosystem function? Are you connecting and restoring fragmented populations?

Consider your (organisation's) capacity

- What skills do you have access to?
- What funds, tools and time could be available?
- What level of commitment could be available (areas to be covered, period that your group maintains the focus/effort)?

Identify assumptions

- What assumptions have you made about the current situation, for example about biological interactions, threats, data, social interactions and stakeholders?

Identify an area within the priority area

- Consider your resources and the feasibility of working in an area
- Consider the area of interest of your organisation and land managers, local community
- Select the area where the most effective conservation outcomes will be achieved

2. Refine project scope

Consider the scale of your project

- What scale are you working at within the ACA? Is it a subset of the ACA that becomes your group's "Area for Conservation Action" (ACA)?

Identify targeted conservation features

- Which conservation features from the SWAEI conservation planning project occur in your area of interest?
- How important is your area to those conservation features? Check the area rating on the priority index for your area of interest, and the extent to which the conservation feature of interest is restricted to your area
- List possible conservation features for local-scale management (not restricted to those used in the SWAE analysis) and select a limited number that reflect the ecoregion conservation goals and the biodiversity of the area

Identify those conservation features that can be grouped (but note that not all should be grouped)

- What are the likely responses of the conservation features (independent or grouped) to types of interventions that are within your group's interest/capability?
- Those that are highly responsive could be considered a high priority for your conservation action.
- Are there conservation features that have similar requirements for habitat and management (e.g. woodland birds) that can be considered together and would respond to the same types of intervention?

Obtain local-scale data

- Is there additional data on the conservation features?
- Are there additional aspects of biodiversity in your area that are not included in the SWAEI project that should be considered?
- Confirm that the data used in the conservation planning project has accurately mapped the distributions for the conservation features of interest
- What is the spatial distribution of the conservation features?
- Is there a relationship between conservation features that may allow them to be grouped? (e.g. similar habitat requirements or similar management issues)
- Is there additional data on local-scale threats, for example weeds?

Conduct a situation analysis

- What other local conservation actions are already occurring? (e.g. activities by environmental NGOs, the DEC, NRM groups, local groups etc.)
- What critical political, economic, social and cultural circumstances are connected to the state of biodiversity?
- What are the barriers to achieving your goal?
- What incentives or disincentives can be developed to influence these barriers?
- Who are the key stakeholders and how will you engage with them?
- Consider how your actions can integrate with or complement the work already being undertaken
- Consider international, national, state and local biodiversity conservation legislation and policy
- Are there local or state government statutory planning strategies that inform land use in your Area for Conservation Action (ACA)?
- Are there conservation features already identified, protected and managed through legal agreements?
- What land tenure and zoning constraints exist?

Test assumptions

- Now you have more refined information, are your previous assumptions correct? Do you need to review these assumptions? How will this inform your strategies to ensure success?
- Do you need to re-draw the boundary of your priority area in response to improved data, local-scale understanding and local management objectives?

3. Develop strategies

Prioritise conservation features (either grouped or ungrouped)

- Which conservation features are viable to protect or can be restored?
- Which conservation features are highly threatened and not protected or managed?
- What is the extent or abundance of the conservation features?
- What is the current condition of the conservation features?
- What is the landscape-scale context? (e.g. are there conservation features important to the functionality and processes of the ecosystem?)

Identify and prioritise threats

- Identify key threats to the conservation features and consider whether these threats can be grouped

- How do these threats affect the conservation feature throughout its life-cycle?
- Are the threats manageable within the priority area or is there a requirement for broader coordination of management actions?
- Is there a key threat that affects multiple conservation features, irrespective of whether they are grouped? For example, does a changed fire regime affect vegetation types, ground-nesting birds and invertebrates?
- Set targets for threat management. For example, we will reduce the fox population to 10 percent in the next two years, or we will increase the number of nesting hollows by 20 percent in the next five years.

Re-evaluate conservation features

- Are the prioritised conservation features you initially identified viable for conservation action?
- Will your project/activities make a difference to that population or the functionality of that ecosystem?
- Do you have the resources (human, technical, financial, time) to undertake meaningful work?
- Do you need to choose different conservation features?

Set targets for management, population, functionality etc.

- What is the current and desired status of the prioritised conservation features?
- What targets need to be set for conservation features in your priority area and within the context of the SWAE? For example, some conservation features may be locally significant or declining although widely represented elsewhere in the ecoregion (e.g. wrens in the Perth Metropolitan Region are declining, so you may set very high population management targets). This step also helps reference how your local-scale activities contribute to ecoregion-wide conservation.
- What are the management thresholds? For example, some threats are pervasive and the likelihood of 100 percent eradication may not be possible. Is there a threshold at which the threat has little or no impact on the prioritised conservation feature and that might be an easier and more realistic target?
- How will you measure progress through time towards your target achievement for prioritised conservation features? For example, an improvement in the condition of vegetation or wetland, an increase in recruitment rate or age class size, etc.

4. Design a plan for action

- What management actions need to happen based on their impact on conservation features? This also includes changes in land use and protection of areas through statutory mechanisms or acquisition.
- Are there perverse outcomes of management actions?
- Have you determined what will be the most cost-effective management actions to achieve your conservation objectives?
- For how long is this intervention required or maintenance programs to be implemented?
- If this intervention is long-term, how will it be funded?
- Whose role and responsibility is this management intervention?
- How can you work with other stakeholders? For example, is there a local community group or an external niche project that has additional funding and can assist in management actions or that may be able to take over longer-term project maintenance?
- Have you set an appropriate hypothesis about the contribution of management actions to your targets? If you do a particular action, what do you expect the outcome to be? If your outcomes aren't met, have you considered adaptive management techniques and adjusting management actions on the basis of what you have learnt?
- Have you considered which management actions will benefit which conservation features and whether there are multiple benefits?

5. Implement actions

- Marshall the resources
- Establish the timetable for activities
- Conduct a pilot activity to test the effectiveness of tools and logistical arrangements
- Conduct the activity in time/resource blocks
- Review the on-ground success of the activity
- Conduct repeat blocks of the activity

6. Monitor, evaluate and review

Establish a monitoring and evaluation program based on scientific principles

- What are your objectives?
- What are your information needs?
- What are your indicators and success criteria?
- How does this relate to your Plan for Action?
- What methods will you use to measure and report on achievement of objectives?
- Who is responsible for data collection?
- Will the data be collected in a standardised manner to enable integration and analysis with other data sets?
- Who will analyse the data?
- What is the cost of monitoring?
- What baseline data do you have? Do you need to establish the current condition benchmark before implementing the activity?
- What is your final desired reporting process? To whom will you report, how often, how will the reports be presented, is there a need to provide media briefings, reports to funders/supporters, etc?
- How will the results of monitoring and evaluation be used to change the approach to management interventions?
- How will you record, store, process, analyse and then archive the data in a way that will be accessible to follow-up groups in 20 years' time?

Review results

- Integrate results into the formal reporting cycles of your organisation

Adapt for future management

- In conjunction with the (annual) reporting, establish a formal point of review and revision for the following (annual) cycle of activity

Share information with relevant stakeholders

- This could include local government, environmental NGOs, NRM groups

Guiding points

1. The process should be adaptive;
2. It should comprise steps that can occur at the same time; and
3. The process should be iterative and contain feedback loops that help you to reconsider and refine your priorities.

Program logic

Program logic is an approach to program planning. It captures the rationale behind a program, probing and outlining the anticipated cause-and-effect relationships between program activities, outputs, intermediate outcomes and longer-term desired outcomes. Program logic is usually represented as a diagram or matrix that shows a series of expected consequences, not just a sequence of events, and expresses how change is expected to occur. How the program logic is translated into operational plans will vary across programs and organisations. See Appendix 5 for a program logic example for the SWAE.

More information can be found at:
http://www.nrm.gov.au/publications/books/meri-program-logic.html

APPENDIX 3: EXAMPLE OF HOW TO APPLY THE SYSTEMATIC CONSERVATION PLANNING PROCESS TO A LOCAL COMMUNITY GROUP FOCUS AREA AT LAKE SWAY

1. Define and scope project

A local community group is interested in undertaking conservation work within one of the prioritised areas. However, this area is too large for the group to manage with its resources, so the decision has been made to work in a subset of the zone called Lake Sway, an imaginary area made up for the purposes of this example.

Objective

To retain, in perpetuity, vegetation communities and other ecological communities that have greater than 10 percent of their SWAE occurrences within the identified ACA.

Organisation capacity

- Two full-time employees
- $300,000 over two years

Assumptions

- Grazing pressure from cattle, kangaroos and rabbits is the greatest cause of biodiversity decline;
- Changes to fire regimes are the second most important cause of decline;
- Once habitat has been affected by grazing and changed fire regimes, weeds are the third most important threatening process;
- Grazing pressure and changes to fire regimes are the same in all land tenures;
- Initial areas of interest are on both private and public land; and
- Private landholders run productive farms and might not have a lot of time for conservation activities.

2. Refine project scope

Table 11. Conservation features in Lake Sway that had 10–100% SWAE-wide representation

Conservation feature name	Other details	Known population or hectares found in Lake Sway	Known population or hectares found in SWAE	The % found in Lake Sway compared to SWAE
Succulent steppe with open low woodland F Murchison		0.05	0.05	100
Hummock grasslands G Murchison		0.94	0.94	100
Succulent steppe with open scrub G Murchison		305.37	318.72	95.8
Succulent steppe A Murchison		30.49	34.84	87.5
Succulent steppe with open scrub K Murchison		273.9	320.29	85.5
Medium woodland J Yalgoo		49.41	92.59	53.4
Succulent steppe with open scrub G Yalgoo		62.37	121.64	51.3
Hummock grasslands M Yalgoo		30.06	59.77	50.3
Wetlands		1833.5	4123.41	44.5
Succulent steppe with open scrub J Murchison		90.34	210.9	42.8
Low woodland U Murchison		18.27	43.74	41.8
Shrublands Mulga E Murchison		374.29	1723.91	21.7
Climacteris affinis	White-browed treecreeper (WBTC)	7	37	18.9
Low woodland B Murchison		171.59	957.49	17.9
Granite outcrops Yalgoo		36	211	17.1
Granite outcrops Murchison		77	705	10.9

Group conservation features

- Group granite outcrops;
- Group woodlands;
- Group grasslands;
- Group succulent steppes; and
- White-browed treecreeper (WBTC).

Extra information required

- Grazing pressure on water points;
- Baseline for each vegetation community for monitoring and evaluation (check with Department of Agriculture and Food WA, as this might already be done);
- Impact of different fire regimes on vegetation communities and white-browed treecreeper;
- Main weeds for granite outcrops;
- Baseline data and population density for a resilient population of white-browed treecreepers that can be supported in the priority area; and
- Identify the impact of rabbit grazing on conservation features.

Situation analysis

- Mixed tenure of privately-owned farm land and areas protected within the reserve system;
- Some voluntary management agreements exist with private landholders;
- NRM regional group has good relationship with many landholders and offers training activities through a landholder engagement program; and
- Succulent steppes are already protected and managed within the conservation estate.

Table 12. Prioritise conservation features, identify rank and group threats and set condition targets

Asset	Threat 1	Threat 2	Threat 3	% Improved condition target in two years*
Group 1 granite outcrops	Grazing stock, kangaroos, rabbits	Fire		50%
Group 2 woodlands	Grazing stock, kangaroos, rabbits	Fire	Weeds	25%
Group 3 grasslands	Grazing stock, kangaroos, rabbits	Fire	Weeds	10%
Group 4 Woodland birds – focal species WBTC	Fire	Weeds		Needs baseline data

*This could be measured by recruitment rates, changes in extent, increases in age range, less weed species present, etc.

3. Develop strategies

Targets for threats to conservation features

- No new water points are installed;
- 100 percent of introduced pastoral stock removed from public land;
- Condition of major vegetation communities is improved by 20 percent so that their state returns to the baseline vegetation condition one year after the next significant rainfall event;
- Areas affected by weeds reduced by 20 percent; and
- No new weeds are introduced.

4. Design a plan for action

Identify a range of activities and rank in order of effectiveness and cost

- Working with NRM regional group, support landholder engagement program to encourage further uptake of voluntary management agreements and provide extension and education activities for key messages;
- Identify those parts of each vegetation community in good condition (using grazing gradient);
- Reduce grazing pressure in those areas most sensitive to grazing;
- Remove stock from Crown land;
- Undertake weed management actions and restoration in areas where grazing has been reduced;
- Survey for weeds on the granite outcrops and prioritise weeds and granite outcrops for control as/if required; and
- Control rabbit populations in concert with private landholders and manage to threshold numbers.

Responsibility

- Project manager; and
- Land managers (pastoralists and the DEC).

5. Implement actions

- Undertaken as above, considering seasonal requirements.

6. Monitor, evaluate and review

- Monitor vegetation response to rainfall (this could use the Normalised Difference Vegetation Index – a simple numerical indicator for analysing and assessing the productivity of areas);
- Establish monitoring plots where management controls have been undertaken; and
- Evaluate and report on success and lessons learnt.

APPENDIX 4. IMPLEMENTATION DESIGN PRINCIPLES AND CONCEPTS

A number of concepts and principles should be considered when designing the on-ground actions required for project implementation. Experts generally agree that prevention is the key to the conservation of biodiversity. It costs far more to repair damage to biodiversity than it does to avoid this damage by incorporating biodiversity conservation into planning and development. The key to prevention is to understand the ecological concepts and principles of biodiversity management and how to apply them.

The following section describes general landscape design principles and concepts. These do not stand alone; rather they come together in varying degrees to create a heterogeneous environment.

Ecological principles

The following ecological principles underpin actions for conserving biodiversity:

- The protection of species will support biodiversity;
- Maintaining habitat is fundamental to conserving species;
- Large areas usually contain more species than smaller areas with similar habitat;
- "All things are connected" but the nature and strength of connections varies;
- Disturbances shape the characteristics of populations, communities and ecosystems; and
- Climate change will increasingly influence all types of ecosystems.

Lindenmayer and Hunter (2010) further suggest:

- Successful conservation management requires consensus on explicit objectives;
- The overall goal of biodiversity management will usually be to maintain or restore biodiversity, not to maximise species richness;
- A holistic approach is needed to solve conservation problems;
- Diverse approaches to management can provide diverse environmental conditions and mitigate risk;
- Using Nature's template is important for guiding conservation management (but it is not a panacea);
- Focusing on causes, not symptoms, enhances efficacy and efficiency;
- Every species and ecosystem is unique (to some degree);
- Threshold responses are important, but not ubiquitous;
- Multiple stressors often have critical effects on species and ecosystems; and
- Human values are diverse and dynamic, and significantly shape conservation efforts.

Concepts for designing conservation management actions

Conventional wisdom states that the following concepts are important design considerations when undertaking conservation management actions:

- Patches (or Areas for Conservation Action)
  - > Quality – Protect the best native vegetation first;
  - > Size and number – Include more types of habitat; and
  - > Shape and edge – The more compact the better, consider edge effects, include buffers, include all land classes.
- Sites
  - > Local significance – Include specific habitat features, such as wetlands, waterways and outcrops, provide for threatened species (rare, vulnerable and endangered).
- Linkages
  - > Connectivity and corridor – Include corridors (the more connected the better), provide stepping stones.
- Matrix
  - > Mosaics – Integrate nature conservation areas with surrounding land uses.

Box 3. Landscape design considerations

To survive, a species must find the resources it needs for all stages of its life-cycle. This includes the ability to withstand the test of time and catastrophic events such as fire (Platt, 2002).

It is important to maintain viable populations of all native species in natural patterns of abundance and distribution. The conventional wisdom in population viability studies is that any species that has fallen below a total population size of 500 is more than likely to become extinct if their decline cannot be quickly reversed. Species with populations that are isolated and species that depend more heavily on natural habitat are more likely to disappear (Possingham and Field, 2000).

Rare landscape elements, critical habitats and features and their associated species should be preserved and might require specialised intervention. It is important to seek the necessary scientific expertise and advice on any legal requirements.

Modern ecological science reliably informs us that the retention of large contiguous or connected areas that sustain natural ecological processes is important. Small areas of habitat may support fewer species and have less persistence of species than large areas of the same habitat. The Single Large or Several Small (SLOSS) theory is where reserve designs can either include a single large area, or a number of small areas to achieve biodiversity conservation, depending on the spatial distribution and home range of the biota (Etienne and Heesterbeek, 2000; Ovaskainen and Hanski, 2001, 2002).

Mammals are particularly sensitive to the effects of habitat reduction and fragmentation. They typically occur at low population densities and individuals may require large areas of habitat for survival. A study of mammal communities in woodland habitat in Victoria showed that macropods, possums and gliders were generally absent from woodland patches of less than 10 hectares, and that the number of species in a woodland patch declined after isolation of that patch by clearing of the surrounding vegetation (WWF-Australia, 2003). Consequently, if you are targeting mammals for management, remnant patches of vegetation must be large if they are to support viable populations of most mammal species. Moreover, for the majority of species that depend on vegetation cover for survival, movement through the landscape is severely curtailed by land-clearing. This means that populations in isolated fragments of habitat cannot be replenished by dispersal from other areas.

Many on-ground works increasingly focus on creating ecological linkages or stepping stones across the landscape. It is important to note that ecological linkage guidelines should be focused on the species that you most want to conserve or those that you think are representative of the needs of all others. The design of linkages is generally better with a number of different foci. An example of how to design ecological linkages for birds is provided in Box 4.

Box 4. Designing ecological linkages for birds (Davis, 2008, unpublished)

Try to place corridors near to or in a vegetated matrix and/or complex landscapes with minimal disturbance

- Complex landscapes are good for the diversity and abundance of smaller bird species.
- Landscape heterogeneity is good for all species, and land-use intensification is a threat to small species as it homogenises landscape texture.

Corridors are proven to be effective but their appeal to sedentary and bushland-dependent species is dependent on their size, shape and composition

- Corridors permit colonisation of new sites, allow wildlife to move out of sites as they become unsuitable, permit recolonisation of extinct populations, allow species to move between different areas as required in their life-cycle and increase the overall extent of habitat within an area.
- Linear strips of vegetation have a number of negative aspects, such as higher rates of nest predation and lower abundance and density of birds.
- Linear corridors may be used extensively by bushland-dependent migrants.
- Corridors provide habitat for resident birds as well as a conduit for movement. Few studies have proven that corridors are necessary for dispersal as opposed to being used as habitat.

It is preferable to design large regional linkages rather than localised corridors

- Corridors can function as regional level landscape linkages or smaller local-scale connections and, if properly designed, can allow a complete range of community and ecosystem processes and the movement of organisms between areas over generations.
- The role and function of a corridor needs to be decided prior to its design. Narrow corridors may only be suitable for rapid movements, whereas a wide corridor allows for a complete range of community and ecosystem processes and provides greater regional connectivity.

Regional corridors should be 500 metres in width, wherever possible, and a minimum of 300 m

- Incorrect design can lead to corridors acting as sinks and decreasing the viability of local populations.
- High edge effects lead to increased predation, competition and altered habitats, such as through weed invasion. Adding a low-quality corridor connected to a low-quality patch can have a negative impact on a larger source population.
- Corridors less than 100 m wide have been found to mostly contain disturbance capitalising species. Most forest species only occur in vegetation corridors more than 100 m wide and some sensitive species require corridors greater than 300 m wide.
- Bird occurrence and abundance increases with corridor width. A study reported that widths of 75–175 m were required to include 90 percent of bird species.

Expand the size of existing remnant bushland patches wherever possible and plant a diverse understorey of a range of local native species (maximise density, structure and composition)

- Revegetation can support most birds in the region but rarer species are generally absent from revegetated sites. Insectivore abundance is highest where there is canopy or perching sites within 1 m of the ground.
- A mix of overstorey and understorey is best for birds, but understorey is critical.
- Larger patches and those that are closer to native remnants or other patches are more likely to support populations of declining, woodland-dependent species. Landscapes should have revegetated areas with mean patch sizes of 780–4,010 ha and be close to existing remnant vegetation.
- Expanding the size of existing remnants may be more beneficial in creating overall landscape connectivity than a corridor per se, although corridors are required when remnants are isolated by more than 500 m.

Aim for continuous linkages, without gaps, and revegetate up to the edges of roads to soften their barrier effect

- Roads can be major barriers to birds, depending on their behaviour and guild.
- Some species will not cross gaps greater than 80 m, especially forest species.
- Roads cause direct mortality; furthermore noise and high traffic volume have a suppressive effect on breeding and bird abundance up to 1 kilometre away.

Native vegetation retention should be favoured over leaving remnant pine or plantation stands

- Bird diversity and abundance is reduced in plantations.
- Generalist species are favoured.
- Food resources are limited for most bird species.
- Plantations may be as ineffective as cleared land in providing habitat.

Box 5. Implementing the systematic conservation planning outputs – A case study

An area north-east of Perth (see map) has been chosen as a demonstration Area for Conservation Action (ACA) to explore mechanisms for progressing from the ecoregion-wide systematic conservation planning process to achieving on-ground conservation outcomes.

This area was chosen based on a number of factors, including preliminary results of the systematic conservation planning process. Additional research on opportunities and constraints within the ACA was undertaken to further prioritise within the ACA and to define a targeted Area for Conservation Action (ACA).

The demonstration ACA has, as its core, significant areas of well-managed native bushland – Julimar Conservation Park and the Bindoon Defence Training Area (purple area). Together, they cover almost 50,000 ha. While generally supporting the managers of these areas, the corridors and buffers of native bushland surrounding them are the areas that the planning shows are particularly important targets for protection and management. A loose boundary of 15 km (green area) from these areas was applied to focus the on-ground work.

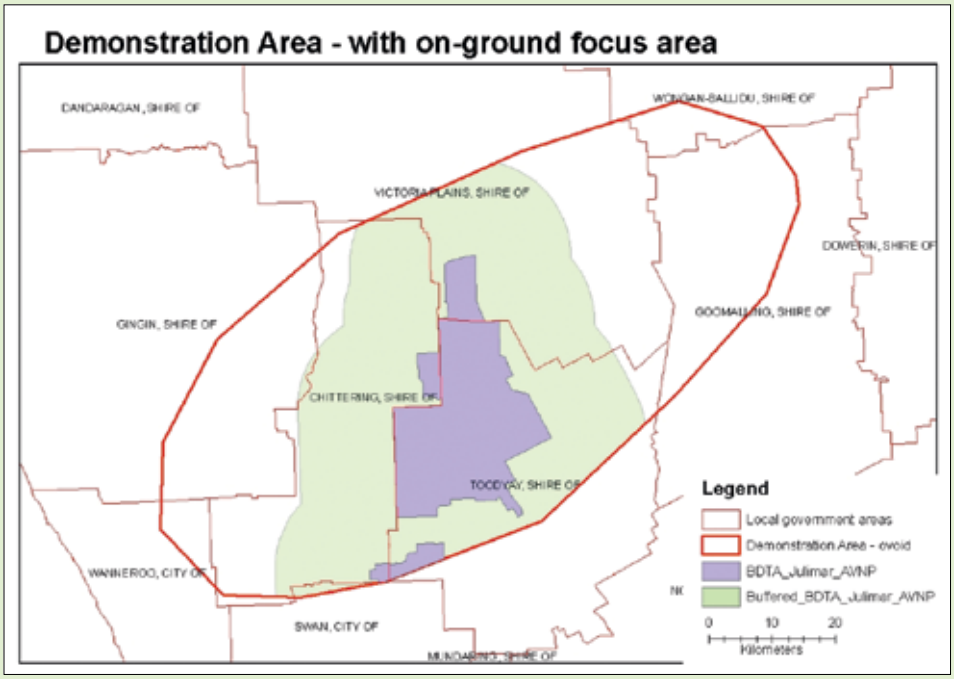
There are two interconnected areas of work associated with the demonstration area project. One is ensuring that funds are delivered on-ground swiftly to achieve lasting biophysical results; the other is to build a legacy of community action and interest to ensure that conservation planning priorities remain in decision-making and public awareness after the limited timeframe of the project.

The systematic conservation planning identified a suite of conservation features (such as vegetation types, threatened species and wetlands). For a number of these conservation features, this demonstration area contributes significantly to securing their long-term future across the whole of southwest Australia.

Swift but lasting on-ground outcomes

The demonstration area project aims to work in partnership with stakeholders across all tenures – private land, reserves, public land, and roadsides – to improve the conservation and management of priority areas of native habitat in this landscape. Stakeholders include private landholders, the Chittering Landcare Centre, the Toodyay Naturalist's Club, the shires of Chittering and Toodyay, Perth Region NRM, Wheatbelt NRM, the Australian Government Department of Defence, and the Western Australian Department of Environment and Conservation. In order to do this, the project will not only be funding on-ground conservation management activities, but will further support the needs of land managers through information, expertise and supporting local networks.

With a great deal of on-ground conservation wins already, the project continues to enthuse many land managers. There is still much to do, and a great deal more to learn about how to translate a low-resolution, broad-scale plan into a local-scale conservation effort but the lessons learnt already have been very informative indeed.



Monitoring and evaluation

Biodiversity projects are designed on the assumption that project interventions will lead to the conservation of targeted biological assets. Monitoring and evaluation are the primary mechanisms to assess whether a project is meeting its targets and objectives (The World Bank, 1998; Gawler, 2005) and are integral to project design.

A monitoring and evaluation plan needs to be considered early in the process. It should detail what monitoring activities will take place, when and by whom, and how that information will feed back into management decisions. The plan should include an estimate of the costs of implementation, and identify training and capacity-building needs among the staff and institutions responsible for the plan. It should also spell out how activities undertaken will contribute to broader strategic regional targets.

Adequate resources need to be allocated to monitoring and evaluation, including budget and institutional capacity, clear institutional responsibilities and reporting mechanisms. It is important to build incentives and capacity to collect, use and maintain data for monitoring and evaluation. Consideration needs to be given to appropriately resourcing the additional capacity, work and budget beyond the lifetime of the plan (The World Bank, 1998; Kutt *et al.*, 2009).

The information gathered through monitoring and evaluation activities is useful both for assessing the impacts of the individual project and for providing input into the design and implementation of future biodiversity projects and ongoing biodiversity management programs (Kutt *et.al.*,2009; Coggan and Whitten, 2008). Ideally, the data collected through this process should feed back into an ecoregion conservation plan to inform any future systematic conservation planning activities and to assess the status of key conservation features.

As a general guide, a monitoring and evaluation plan should:

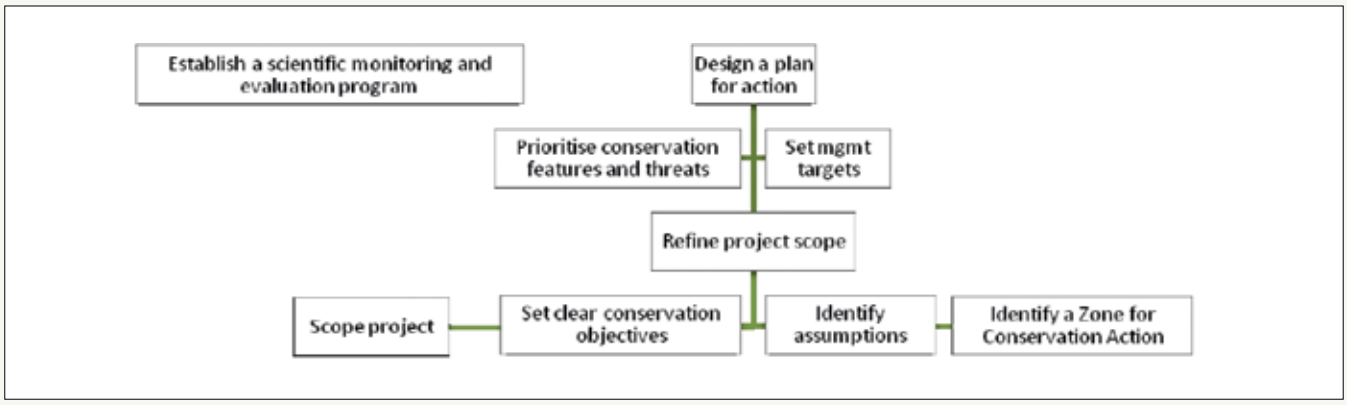
- Clearly answer a stated set of questions based on the conservation objectives;
- Seek expert statistical advice and peer review at all stages of the monitoring planning process;
- State clearly what indicators will be chosen;
- Select assessment methodologies that are objectively repeatable and informative;
- Specify how often monitoring and evaluation will be done, and by whom;
- Outline any necessary training or financial inputs that are required;
- State the intended audience for the evaluations;
- Specify how information will feed back into management decisions;
- State clearly the decision points at which action must be taken to address negative trends; and
- Ensure adaptive mechanisms to allow the review and refinement of the monitoring program.

The Australian Government has designed a Monitoring, Evaluation, Reporting and Improvement (MERI) framework that aims to assess program performance and the state of change in biodiversity assets over time. More information on this framework can be found at: *http://www.nrm.gov.au/publications/frameworks/meri-framework.html*

Finally, at the end of the project the monitoring and evaluation plan should provide information on what systematic conservation objectives have been met. This information can be used in future analysis of the systematic conservation plan to determine the success of its implementation and to identify a new suite of irreplaceable areas that may be targeted in future conservation works. Such an outcome is part of the higher level adaptive management approach for conservation planning in the SWAE.

APPENDIX 5. PROGRAM LOGIC EXAMPLE FOR PROJECTS CONTRIBUTING TO ACHIEVING THE SWAE CONSERVATION FEATURE TARGETS

Using this approach, each project should develop a program logic that uses the vision, outcomes by 2030 and relevant project contribution to the SWAE. However, it is recommended that stakeholders develop their implementation plans for action using the foundational processes outlined in the section Program and Project Planning within Areas for Conservation Action. The development of the plan for action will define what activities are undertaken as part of the project and this will replace the generic activities listed in the program logic above. The SWAEI recognises that each project will contribute to the overall SWAE outcomes.



Vision

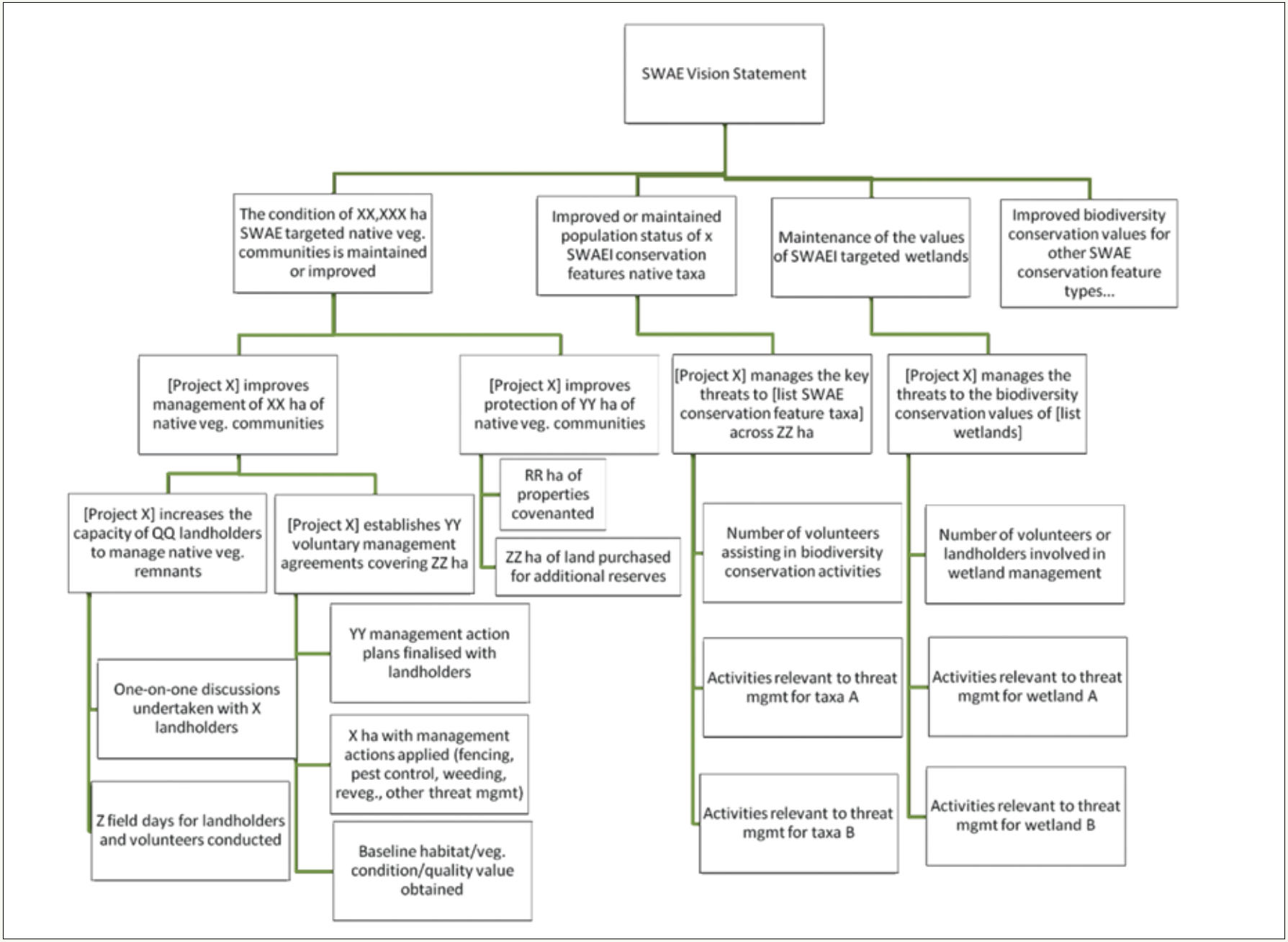
Outcomes by 2030

Project contribution to SWAE

Outputs

Activities (to be amended according to project plan)

Foundational activities



APPENDIX 6. ADDITIONAL MECHANISMS SUPPORTING BIODIVERSITY CONSERVATION IN WA

National legislation and strategies	State legislation, policies and strategies	Regional and local strategies and plans
Environment Protection and Biodiversity Conservation Act 1999	*Wildlife Conservation Act 1950*	A Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands (2010)
Australia's Biodiversity Conservation Strategy (2010–2030)	*Conservation and Land Management Act 1984*	Local Government Guidelines for Bushland Management in the Perth and Coastal South-West NRM Regions of Western Australia (2009)
National Framework for the Management and Monitoring of Australia's Native Vegetation (2001)	*Environmental Protection Act 1986*	Local government biodiversity strategies
National Strategy for the Conservation of Australia's Biological Diversity (1996–currently being revised)	*Environmental Protection (Clearing of Native Vegetation) Regulations 2004*	Regional NRM strategies
The Australian Weeds Strategy (2007)	Wetlands Conservation Policy for Western Australia	Regional Forest Agreement for the South West Forest Region of Western Australia
Australian Pest Animal Strategy (2007)	EPA Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia	Local water quality improvement plans (local application of the National Water Quality Management Strategy)
Australia's Strategy for the National Reserve System 2009–2030 (National Reserve System Task Group 2009)	EPA Guidance Statement No. 10 Level of Assessment for Proposals Affecting Natural Areas in the System 6 Region and Swan Coastal Plain Portion of the System 1 Region	Draft Perth-Peel Regional Water Plan (2009)
National Framework for Environmental Management Systems in Australian Agriculture (2002)	Part B of EPA Guidance Statement No. 33 Environmental Guidance for Planning and Development	South West Regional Water Plan (2010)
National Forest Policy Statement (1992)	Bush Forever (2000)	Local planning strategies
Principles for Sustainable Resource Management in the Rangelands (2010)	Draft 100-year Biodiversity Conservation Strategy for Western Australia: Blueprint to the Bicentenary in 2029 (2006)	WA Planning Commission regional strategies and regional planning and infrastructure frameworks
Commonwealth Coastal Policy (1995)	Environmental Weeds	
Strategy for Western Australia (1999)	Regional Development Commission strategies	
Natural Heritage Trust of Australia Act 1997	Better Urban Water Management (2008)	Healthy Rivers Action Plan (2007)
Water for the Future (2010) and National Water Quality Management Strategy (1998)	*Waterways Conservation Act 1976*	
National Strategy for Ecologically Sustainable Development (1992)	State Waterways Initiative (2008)	

National legislation and strategies	State legislation, policies and strategies	Regional and local strategies and plans
National Greenhouse and Energy Reporting Act 2007	State Water Plan (2007)	
	Stormwater Management Manual for WA (2004–2007)	
	Directions 2031 and Beyond (2010)	
	Planning and Development Act 2005 and Statements of Planning Policy	
	State Planning Strategy (1997)	
	State Coastal Planning Policy (2003)	
	Forest Management Plan (2004–2013)	
	WA Greenhouse Strategy (2004)	
	Hope for the Future: The WA State Sustainability Strategy (2003)	
	A Weed Plan for Western Australia (2001)	
	Nature Based Tourism Strategy for Western Australia (2004)	
	Swan and Canning Rivers Management Act 2006	
	Biosecurity and Agriculture Management Act 2007	
	Sandalwood Act 1929	
	Aboriginal Heritage Act 1972	
	Museum Act 1969	

Source: DEC, 2006