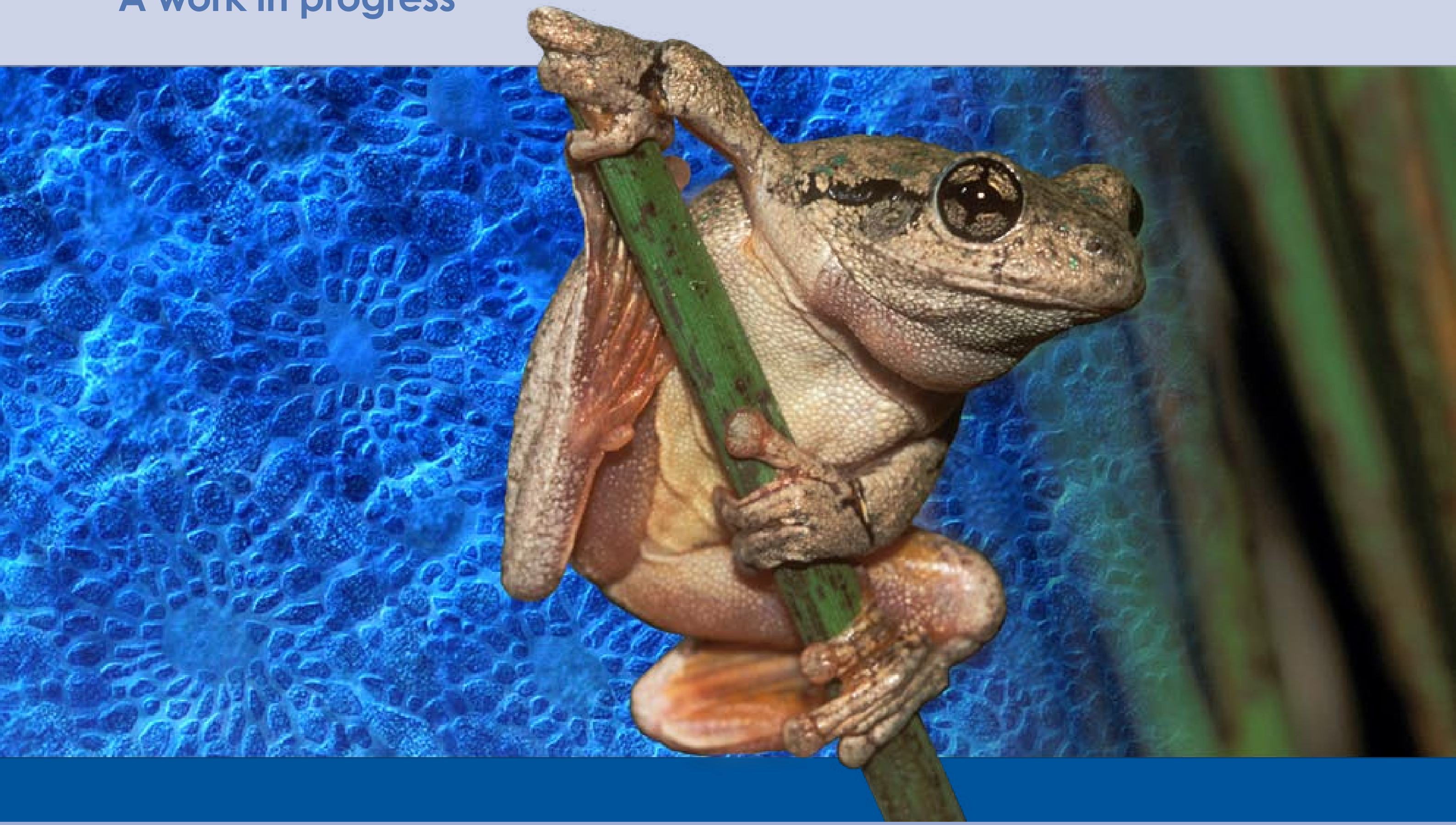
Science Directions 2010–2015

Strategic Directions in Science and Research for the South Australian Department of Environment and Natural Resources

A work in progress



Department of Environment and Natural Resources

Government of South Australia

www.environment.sa.gov.au

Foreword

The Department of Environment and Natural Resources has the privilege and responsibility of working with the scientific community for the future of South Australia's environment. Our aim is to nurture a society that values, conserves and invests in its natural environment.

Over many years, we have developed a huge scientific knowledge base across terrestrial, freshwater and marine environments. We will continue to build on this base, not only by conducting our own research, but also collaborating with others.

There is still a lot for us to learn about the complex challenges we face, such as our increasingly variable climate and the impacts of climate change.

In DENR, our scientific knowledge underpins our policies and informs our service delivery, ultimately providing better environmental outcomes. This document outlines a clear direction for our scientific efforts to fully reap the benefits of our research and knowledge.

Research partners contribute by adding to the store of information and assisting with the interpretation of science and data. Partnerships deliver better management decisions and results, enhance capabilities and make information more accessible to government and the public.

It is only by collaborating with researchers and other agencies that we can tackle the environmental challenges of the future.

Science Directions 2010–2015 describes our focus for science and research. It outlines our priorities and our drive. We're working to invest in science for the future; will you join us on this journey of discovery?

Allan Holmes
Chief Executive
Department of Environment and Natural Resources
Government of South Australia

Introduction

South Australia's social, ecological and economic systems need balance and resilience. Our biodiversity and natural environment are in need of new, broad approaches to their management and conservation.

The Department of Environment and Natural Resources (DENR) is the lead agency for taking up these challenges. *Science Directions 2010–2015* sets DENR's broad scientific direction. Our capability and record in research and delivery is strong but it is strengthened immeasurably when combined with the expertise of partners in seeking knowledge and understanding of our complex ecological, social and economic systems.

Contents

Setting our direction in science

A comprehensive forward looking direction for science in DENR guides our science investment and enhances the impact that science has on our management actions and policy advice.

DENR is responsible for South Australia's nature conservation, heritage conservation and animal welfare. We collect and provide information and knowledge about the state's environment. We manage the state's natural resources and public land including national parks, marine parks, important cultural sites and coastline. We oversee management of the Coorong, Lower Lakes and Murray Mouth, and manage cultural and scientific collections through the state's botanic gardens and herbarium. We advise on environmental policy.

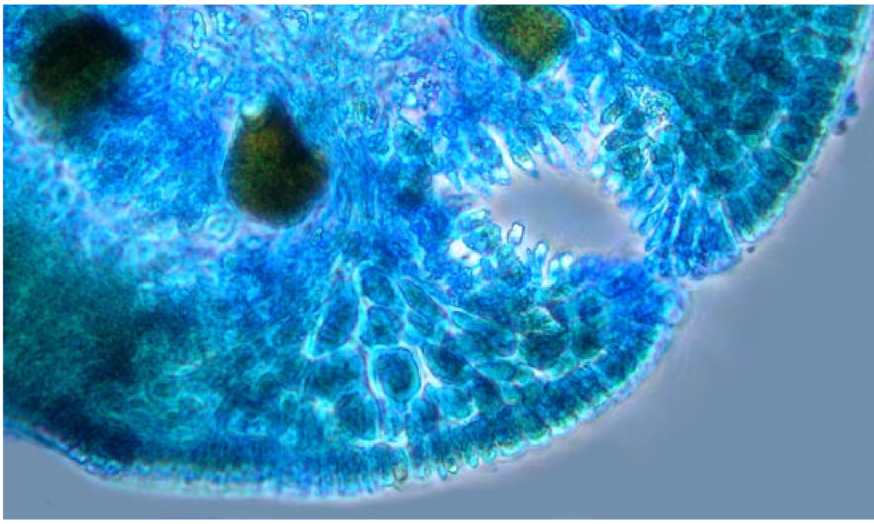
Our work is determined by our commitment to achieve targets in *South Australia's Strategic Plan*[1], to administer legislation dedicated to our Minister and to respond to the needs of South Australians.

DENR is part of the Environment and Conservation Portfolio and reports to the Minister for Environment and Conservation. We deliver the Government's environment policies directly and through partnerships with other government agencies, including the Department for Water, the Environment Protection Authority, Zero Waste SA, natural resources management boards, and Primary Industries and Resources SA, as well as a wide range of non-government environment organisations, industry bodies and the community. As a member of the NRM Research and Innovation Network we have unique opportunities to develop strategically targeted and multidisciplinary research collaborations.

DENR supports a number of key government policies and programs that guide our science such as *Tackling Climate Change: South Australia's Greenhouse Strategy 2007–2020*[2], *No Species Loss: A Nature Conservation Strategy for South Australia 2007-2017*[3] and the *State NRM Plan*[4]. We also administer a number of Acts[5] that promote science including the *Botanic Gardens and State Herbarium Act 1978*[6], which supports plant biodiversity research.

Science Directions 2010–2015 supports our responsibilities for protecting and restoring biodiversity and healthy ecological systems for future generations. Our policy directions and *Corporate Plan*[7] are underpinned by our six core scientific capabilities, five of which are highlighted in our synopsis of our scientific strengths and interests, *Realising Knowledge*[8]. The sixth, in the social and economic disciplines, is a capability that DENR is building to support environmental sustainability as an economic driver for South Australia.

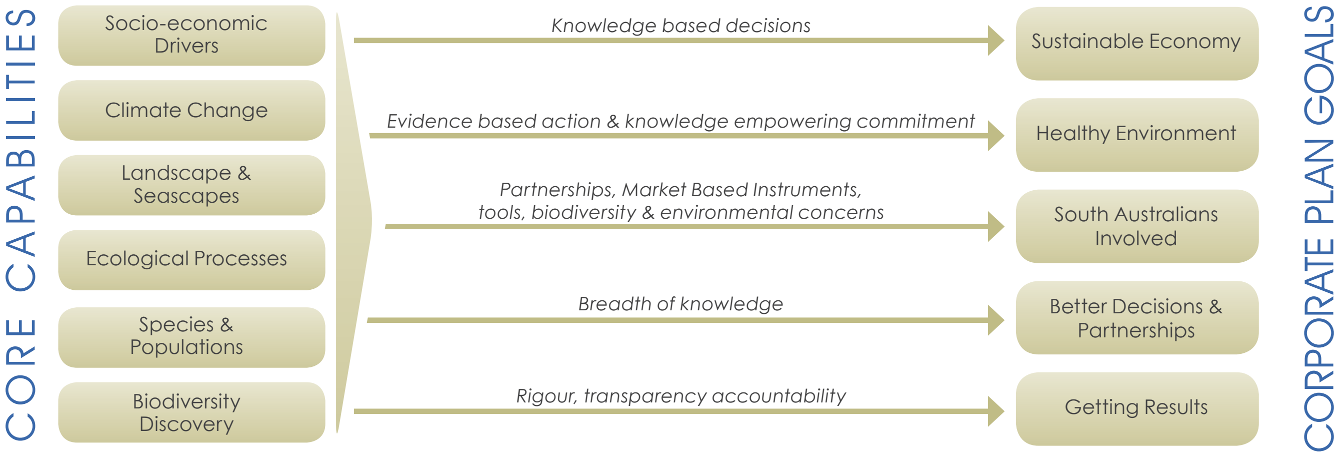
Our work is determined by our commitment to achieve targets in South Australia's Strategic Plan



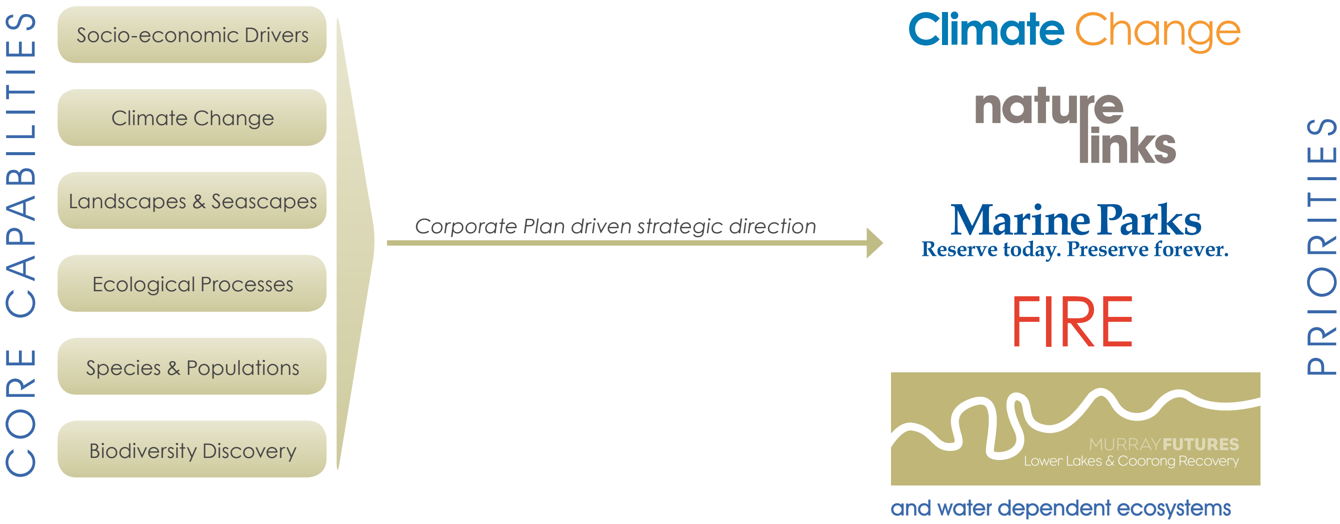
These scientific capabilities span terrestrial, freshwater and marine environments.

- **Socio-economic drivers:**
  Humans shape the outcomes that DENR is delivering for South Australia. The outcomes will be better if we have a better understanding of the community's aspirations and what motivates the community and key stakeholders to make environmentally sustainable choices. South Australia can secure the health of the natural infrastructure that underlies the state's prosperity through strong community involvement in sustainable land management. DENR is focusing effort to building core capability in the social, economic and human behaviour disciplines to this end.
- **Climate change:**
  With key partners, DENR is using innovative modelling and research to understand more about the impacts of climate change on species and ecosystems, and thus develop effective landscape-scale management strategies.
- **Landscapes and seascapes:**
  DENR plays a lead role in determining those ecological systems that require protection and is working with others to restore large areas of degraded habitats in programs underpinned by sound ecological knowledge combined with social and economic considerations.
- **Ecological processes:**
  DENR scientists assess the ecological processes that influence the distribution and survival of plants and animals and the health of ecosystems.
- **Species and populations:**
  Survey, monitoring, research and adaptive management programs help us understand the status and trends in species and populations, and to recover threatened species, populations and ecological communities.
- **Biodiversity discovery:**
  DENR actively surveys the distribution of plants and animals across South Australia, from the common to the critically endangered, the local to the invasive. Plants, their identification and classification, and their evolutionary relationships, are a major focus for DENR.

Our core scientific capabilities directly interface and support our ability to effectivley act in response to directions set by our Corporate Plan.



Our current Corporate Plan 2009/2010 outlines the challenges we face and our priorities for response. Our core scientific capabilities facilitate response to these priorities.



***Science Directions 2010–2015* confronts these five priorities for action.**

Climate change

DENR's primary climate-change role lies with adaptation. Adaptation provides a mechanism that allows species populations and ecological systems to respond to changes in their environment. It enables species to manage risks, reduce vulnerability and increase resilience.

Climate change increasingly presents a major challenge for managers of key natural assets such as protected areas. It adds to ever present risks such as habitat loss and degradation, invasive species and changes to fire regimes. South Australia's protected area system is crucial for enabling species to respond to climate change.

Rigorous predictive modelling and long-term monitoring data will help us identify the likely risks, impacts and opportunities that underpin effective adaptation and risk management strategies, and high level adaptation policy at the state level.

NatureLinks and landscape scale conservation

South Australia's NatureLinks[9] initiative frames a new approach to the conservation of South Australia's biodiversity in a climate change world already declining from the effects of past and current land use practices. It aims to conserve the ecological systems and processes that underpin the survival, evolution and adaptation of ecosystems and species.

NatureLinks is connectivity conservation in action. It urgently needs applied research to guide on-ground management priorities and understand their effectiveness.

The NatureLinks initiative also encompasses social, economic and ecological research, towards long-term nature conservation outcomes and environmental stewardship based on sound, evidence-based planning and policy.

South Australia's protected areas system is a key mechanism for protecting biodiversity. Priorities for adding to our conservation estate are given to high value contributions to NatureLinks and No Species Loss[3], and to building a comprehensive, adequate and representative National Reserve System. The value and contribution of our protected area system for protecting and enhancing ecosystem function and resilience requires further knowledge and research.

Marine parks

Establishing a network of marine parks across our state waters is an important strategic target for the South Australian Government. A rigorous monitoring and evaluation framework is required to understand the effectiveness of the marine park network. In particular we need to better understand the patterns in marine biodiversity within state waters, and the ecological and geophysical responses to the marine parks network and to different park zones in a variety of locations.

Fire management

South-eastern Australia is recognised as one of the most fire prone areas in the world. An increase in the number and intensity of extreme fire weather days is expected as the consequence of a hotter, drier climate. This is likely to increase the size and extent of severe bushfires, extend the season when bushfires occur, and reduce the periods of mild weather suitable for conducting mitigation activities. Recent significant bushfires have highlighted the impact bushfire can have on human and environmental values. Little is known about the effects of altered fire regimes on biodiversity or of the consequences of managed regimes, particularly in fragmented, densely populated landscapes.

Coorong, Lower Lakes and Murray Mouth

The long-term plan being developed for management of the Coorong, Lower Lakes and Murray Mouth region aims to secure a future for the region as a healthy, productive and resilient wetland of international importance that supports a vibrant regional community.

DENR is developing an environmental management plan for Lake Albert that includes structural, ecological and community management components. We need to define and implement an effective ecological monitoring program for adaptive management of the lake and surrounds.

The researchable questions for the Coorong, Lower Lakes and Murray Mouth take a high level focus on future research directions[10]. They also address critical issues facing water dependent ecosystems more broadly in acknowledgement of the diversity of our aquatic ecosystems and the urgent need to gain knowledge for managing them. The pressures on these systems are increasing disproportionately to those on terrestrial systems.

Key questions and our approach

We strive for science and research partnerships that are intimately connected with policy, management, on-ground implementation and human livelihoods.

Science Directions 2010–2015 sets DENR's broad scientific direction. The appendix to this document defines in more detail our short–medium term direction (3–5 years).

DENR recognises the critical importance of long-term research and monitoring to understand how ecological systems function. Some questions in this document will require longer-term investment to reveal meaningful information.

It is counterproductive to view social and ecological systems separately; their intimate links demand integration. Participatory research, adaptive management, and active partnerships with academia, community and industry are the key to building a sustainable future for South Australia.

An iterative approach to research – with research questions reframed as knowledge gaps are filled – best informs policy and management. This is a dynamic document, which will be reviewed and updated regularly.

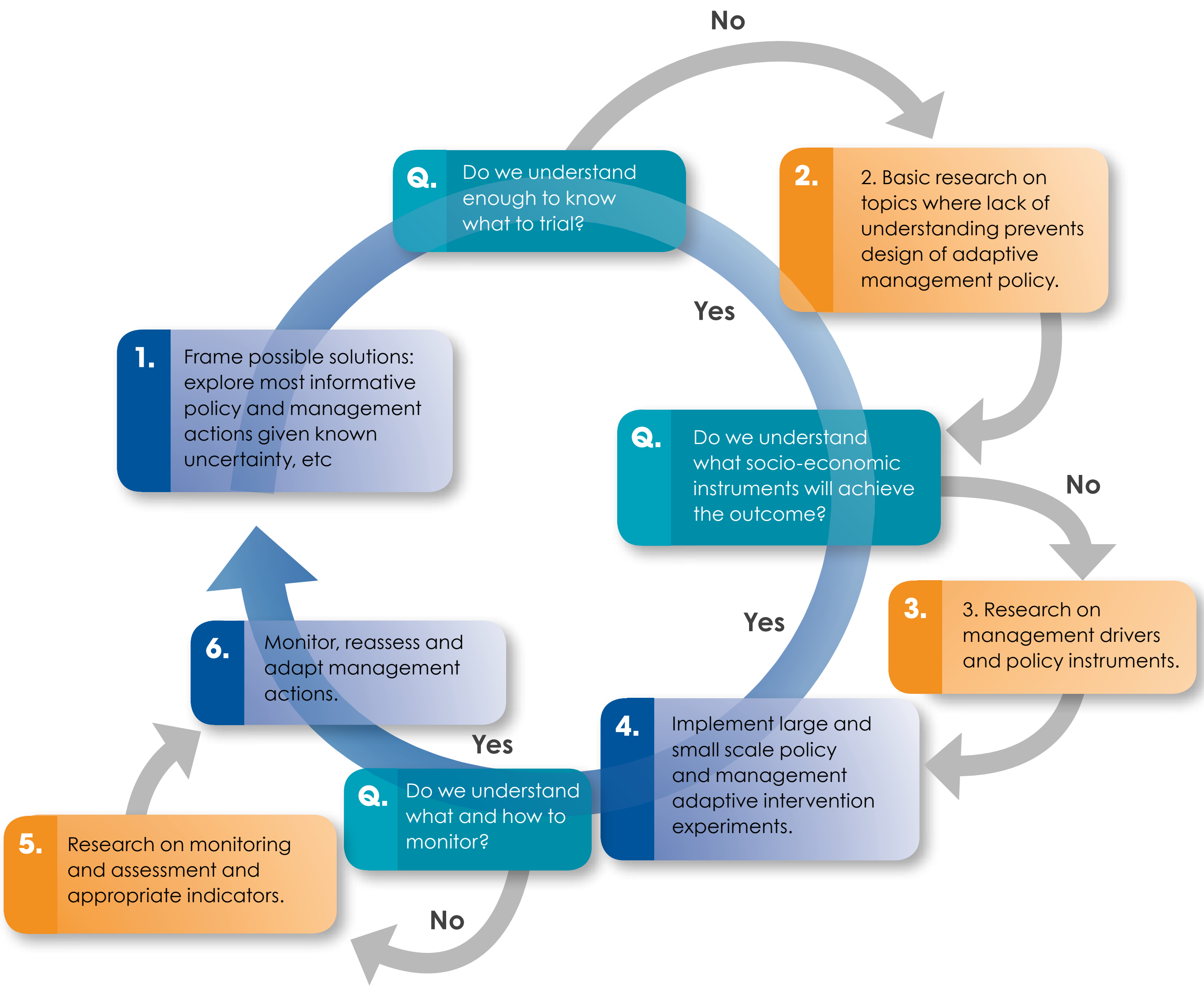
Science Directions 2010–2015 was developed in consultation with key scientific staff in DENR. Targeted scientists, policy-makers and managers from other NRM agencies and scientific institutions contributed through a series of workshops and other feedback mechanisms. An external peer review process will refine the document further.

In identifying directions in science for 2010–2015, DENR considered:

- What knowledge is needed to inform South Australian environmental policy and management decisions?
- Which researchable questions should we be asking?
- What knowledge is needed to underpin these five corporate priorities?
- How can we make ecosystems resilient to social, economic and environmental changes?
- Which foundational science capabilities do we need to be able to respond to the broader conservation issues we face?

We need to manage in the face of limited knowledge and uncertainty about future changes

Adaptive Management Cycle



Adapted from Hughes et al 2009[13]

Priority research questions 2010–2015

Our priority research questions provide broad context and targeted direction for DENR's future research investment. Grouped questions are listed in a logical order within each corporate priority.

Climate change

OBJECTIVE 1: To lead in delivering a statewide biodiversity climate change adaptation program that maximises the resilience of South Australia's terrestrial, marine, coastal and freshwater ecosystems and human settlements to the impacts of climate change.

1.1 How do ecological systems operate?:

- Which conditions/characteristics confer resilience to any particular ecological system and what is the role of refugia?
- What are the important ecological drivers?
- Which altered ecological processes threaten biodiversity?
- Which components of ecological systems can be manipulated to reduce impacts or negatively altered processes?
  - What are the relationships between species (marine and terrestrial), habitats/ environments and threats (including climate change)?
- What opportunities to enhance adaptation are opened by this knowledge?

1.2 What are the likely environmental changes (including geomorphological and sea level rise) and their potential impacts (both positive and negative) and what are the likelihood and consequences of these impacts?

What are the likely synergistic interactions?

1.3 What are the priority/key species at risk from climate change in any particular ecosystem or ecological community?

Which are the most important species/abiotic components/ processes for supporting and maintaining ecological processes?

1.3 *(cont)*

- What are the adaptation capacities of these species? Which life history stages of species are most at risk? What are the ecological thresholds that put species and life stages at risk?
- Which interactions among species might be affected by climate induced environmental change and what impact might this have on ecological processes?
- Which species are likely to incur adaptation risks in the face of climate change? What are the risks to these species?

Which are the most robust species/ communities with respect to climate change, including those that will benefit from climate change?

Which ecosystems have obvious climate change risks?

1.4 How will climate change interact with other key stressors and what are the implications for ecosystem structure and function, both cumulatively and individually?

How do species and ecosystems respond to climate change impacts (including extreme events)?

How should we implement systematic monitoring programs to determine this?

Which baseline data are essential?

Which parameters do we need to be monitoring and feeding back into management and policy?

How do we meaningfully manage the uncertainty of climate projections and of how species and ecosystems will respond?

Climate change continued:

1.5 What and where are the critical environmental refugia (including genetic refugia) in the landscape and what are their biotic and abiotic characteristics?

What are the dispersal barriers to species and populations in different landscapes?

Is it feasible to remove dispersal barriers?

1.6 How can we better manage existing development activity and planning in the context of climate change?

How do we influence development decisions to incorporate climate change adaptation planning?

In which areas will development have the least impact on the environment, and vice versa?

1.6 *(cont)*

Which opportunities can we create for conservation outcomes from future developments and benign technologies?

What changes can be made to agricultural practices and what opportunities can be created to gain better biodiversity conservation outcomes?

How do we apply the knowledge of trophic dynamics to help us assess the impacts of resource use and climate change on ecosystems?

NatureLinks and landscape scale conservation

OBJECTIVE 2: To lead in establishing five biodiversity corridors aimed at maximising ecological outcomes, particularly in the face of climate change. To develop a rigorous approach for documenting conservation priorities at landscape scales, including identification of ecological communities, and their status and trend.

2.1 How do ecological systems operate?:

- What are the altered ecological processes that threaten biodiversity?
- How can ecological systems be manipulated to reduce impacts or negatively altered processes?
    - What are the relationships between species (marine and terrestrial), habitats/ environments and threats (including climate change)?
    - Which species are likely to incur adaptation risks in the face of climate change?
    - Which ecosystems have clear climate change risks? What are the likely environmental changes and their potential impacts (likelihood/ consequences)?

2.2 How do we evaluate different landscape scale planning frameworks?

How do we organise our knowledge in a management context to set priorities at a landscape scale?

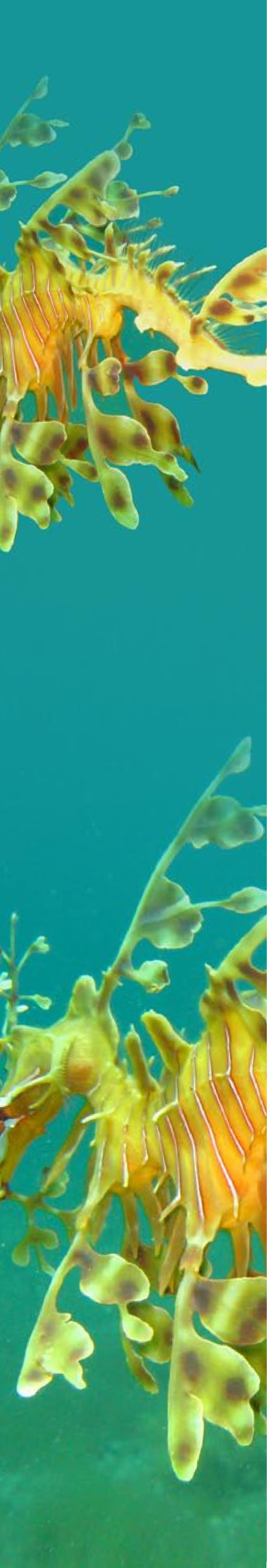
How do we incorporate real world issues (social, economic and feasibility) into delivery?

2.3 Which restoration techniques are most effective in constructing robust, sustainable systems?

2.4 What are the socio-economic processes we need to influence in order to implement NatureLinks successfully?

What are the impediments/ opportunities to engaging the community/stakeholders?

Which mechanisms are best placed to influence the socio-economic drivers needed to engage stakeholders in priority activities for NatureLinks?



Marine parks

OBJECTIVE 3: To protect and conserve biological diversity and marine habitats by declaring and providing for the management of a comprehensive, adequate and representative system of marine parks; and to help maintain ecological processes and adaptation to the impacts of climate change in the marine environment.

3.1 How do marine ecological systems operate?:

- What are the processes that underpin marine habitats?
- Which conditions/characteristics confer resilience to any particular ecological system and what is the role of refugia?
- What are the important ecological drivers?
- How do marine systems function at the habitat level?
- Which components of marine systems can be manipulated to reduce impacts or negatively altered processes?

3.2 What is the diversity and extent of our mapped/unmapped marine habitats in South Australia's marine parks network?

Which physical/spatial parameters reflect species diversity/richness and ecological function?

Which threats/stressors are likely to impact on key ecological drivers and marine habitats and what synergistic effects might compound or mitigate impacts?

3.3 Is existing connectivity sufficient to maintain species, populations, meta-populations and communities in established marine parks in the short and long term? Is our knowledge of connectivity at all levels and spatial scales sufficient to appropriately inform the design and management of SA's marine network?

3.4 What are the design criteria for a robust monitoring and evaluation framework for South Australia's marine parks?

Which taxa and attributes are effective as indicators of the condition and trend in each element of the marine parks network?

3.5 How accurately do the existing surrogates for marine biodiversity (including habitats and physical features) represent the range and features of South Australia's marine biodiversity (including genetic, species and habitat/ecosystem levels of biodiversity)?

3.6 How is South Australia's marine protected area network likely to perform subject to direct and indirect threat at different scales?

Is the intent for connectivity criteria within SA's marine park network likely to be compromised by the scale at which threats interact with park boundaries?

Fire management

OBJECTIVE 4: To manage fire on public lands for reduced impact on infrastructure, life and communities and to maximise environmental outcomes, increase engagement and collaboration with key stakeholders, and enhance staff skills, knowledge and resources for managing fire.

4.1 What are the ecological thresholds associated with all components of fire regimes in our landscapes?

How do we determine which thresholds are most important for meeting biodiversity objectives?

How well does the threshold concept deliver biodiversity objectives?

Can these thresholds be applied in fragmented landscapes?

4.2 What is the effectiveness of prescribed burning in minimising the risk to property/life?

What is the risk to biodiversity from prescribed burning to protect life/property? What is the effectiveness of prescribed burning in minimising the risk to biodiversity assets?

What is the risk to biodiversity as a whole as a result of prescribed burning to protect a particular biodiversity asset?

What is the mix of prescribed burning in the landscape to get the best outcome for both biodiversity and life/property?

How can we use modelling to produce multiple scenarios that will aid decision making?

4.3 What is the most appropriate ecological framework to guide fire management policy in different South Australian ecosystems under different climatic variables/conditions?

What are the relationships between fauna requirements, habitat and fire?

4.4 What are the social attitudes, values and drivers that are impacting on or having the greatest influence on decision making? Does fire management policy actually reflect these attitudes?

How do we influence the community, based on science, toward better fire and biodiversity decisions?

4.5 How can aboriginal uses of fire meet community and cultural values while maximising biodiversity outcomes?

Coorong, Lower Lakes and Murray Mouth

OBJECTIVE 5: To reduce the rate of ecological degradation and prevent immediate and permanent ecological collapse in the Coorong, Lower Lakes and Murray Mouth (CLLMM) region while building a resilient ecology that can adapt and respond to a drier future climate.

5.1 How are water-dependent ecosystems responding to environmental change?

5.2 How do water-dependent ecological systems operate?:

- Which conditions/characteristics confer resilience to any particular ecological system?
- What are the important ecological drivers?
- How do we define/detect thresholds that might lead to an alternative state?
- What are the key drivers and how do they interact?

5.3 How do we use species as surrogates to understand change?

Which are the most important species we need to focus on to maintain ecological processes?

5.4 What is the response at the ecosystem level to proposed medium- and longer-term management actions?

How can ecological systems be manipulated to reduce impacts or negatively altered processes?

5.5 What are the interactions between social, economic and ecological systems?

How does the community influence our management of the ecosystem?

What are the implications of degraded ecosystems for social systems?

5.6 How does the hydrological cycle operate?

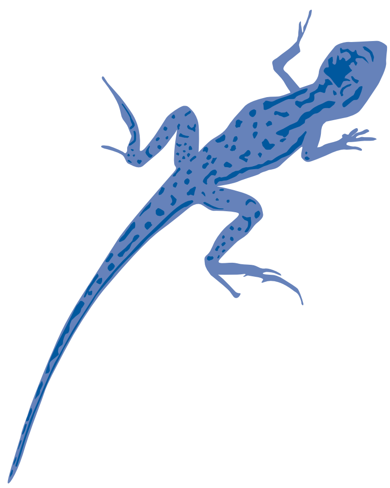
What are the interactions between the hydrological cycle, geomorphology and the ecology of terrestrial and aquatic systems?

How do CLLMM ecosystems fit into broader regional contexts?

5.7 What is the rate of acid generation, how quickly is it transported and what are the transport pathways?

What role do microbial processes play in bioremediation of acid sulphate soils?

5.8 How can we learn more about CLLMM ecology from the results of management actions?



Building additional core capability

DENR's science priorities for building core capability in the social and economic disciplines have not yet been rigorously determined but a number of researchable questions were identified as critical to the delivery of our five corporate priorities. Those not already identified as urgent priorities in the Priority research questions 2010–2015 section are listed below as an interim set of research needs:

- How can natural systems be valued, so that financial incentives encourage their maintenance and the external environmental costs of primary production and other land uses are incorporated into the prices of goods?
- What are the 'community's' current priorities, values and perceptions of nature conservation and climate change impacts? What can we expect the community to do (including socio-economic constraints)? What are the best mechanisms to influence community (assuming we know what needs to be done)?
- How do we build social capital and stewardship for parks and the environment? What do people care about, what are their perceptions and which social trends might drive environmental decisions in the future? What is the current capacity for community and industry involvement? What are the barriers to community and industry involvement?
- How can we improve the community's (including industry) understanding of the short- and long-term consequences of their actions/decisions for natural systems and the implications for the broader community's health and well-being?
- Which biodiversity-related market-based drivers (including biosequestration) are needed for integration of environmental, social and economic values and how can we monitor these? Which market-based drivers currently exacerbate the problem?
- Which models can be developed to assess the social and economic value of healthy ecosystems/biodiversity?
- How do we market 'landcare' issues to develop a common and more accurate understanding by the community?
- Which aspects of our monitoring programs can the community take part in? How do we incorporate this into their design? What education/training/engagement could we provide?
- Which specific land uses are likely to be unviable in the future? What is the potential for land abandonment to provide new opportunities for restoration?

The considerable synergies and connections between Science Directions' research priorities are illustrated in the Appendix.

Working together

Our science and research capability needs you. Together, we can achieve much more.

DENR wants to build on existing relationships within and outside of government, and develop new partnerships, to address the knowledge gaps defined in this document.

Effective partnerships and alliances can find new solutions to complex problems, and achieve specific targets, apply research and use fundamental principles to deliver outcomes.

Complex problems also need an integrated understanding of the environment, society and the economy. Industries such as tourism rely on the sustainable use of South Australia's natural resources. Some tourism activities already make a major contribution to science. For example, Great White Shark behavioural research has been made possible through contributions and observations by shark cage diving tourism businesses operating in South Australian waters at the Neptune Islands. Research partnerships with industry and the community as a whole are needed to underpin sustainability: environmental, social and economic.

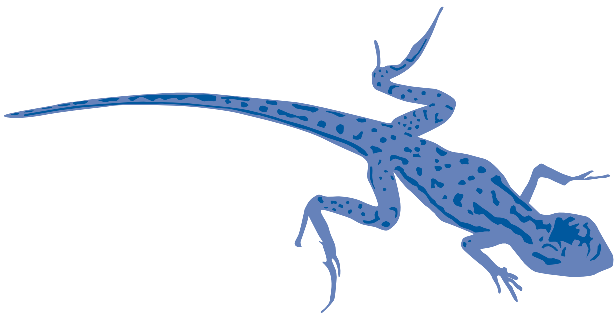
DENR wishes to collaborate and participate actively throughout the research cycle: design, conduct, analyse, interpret and adopt into practice. This enhances our knowledge and capacity to apply knowledge.

Pooled resources can tackle larger, more complex projects, and have a better chance of success.

Already, DENR has many Australian partners and global partners include the New York Botanical Garden and the Royal Botanic Gardens in Edinburgh. Working together at a local, state, national or international level allows integration of the breadth of resources, skills and expertise essential in delivering research needs. We will foster collaboration and co-investment with universities, government agencies, the NRM Research and Innovation Network, industry, research and development organisations, and the community.

Working together adds value to investment and creates larger opportunities and outcomes. Collaborations attract more funding and fulfil common needs of partners. To date DENR's Research Partnerships Fund has successfully leveraged significant investment through Commonwealth research grants by enabling DENR to become an industry partner. In the future such funding will be targeted to filling the knowledge needs identified in *Science Directions 2010–2015.*

The management of our natural environment requires a whole of system approach integrating the socio-economic and ecological sciences. DENR will endeavour to support projects that address multiple and complementary research questions in its implementation of *Science Directions 2010–2015*.



People and knowledge

Science supports DENR. DENR supports science that helps us deliver environmental outcomes for South Australia.

We value the insights and knowledge of the communities we work in, and facilitate the capture and sharing of this knowledge to inform management direction. DENR contributes to the research efforts of others through our research skills, ecological knowledge, and expertise in the application of exploratory science to real situations. As an active partner, DENR can add significant value to scientific discovery.

DENR continues to invest in data collection, coordination, interpretation and analysis. Our data and information resources span decades, and make a powerful and valuable resource for exploring new areas of scientific endeavour that build our understanding of the natural environment. We are proud of our expertise in setting standards and creating quality data, and our spatial and temporal analytical capabilities.

Our specialist scientists can co-supervise Honours, Masters or PhD students, provide in-kind support, help develop research grants and contribute to research project management.

DENR's diverse research expertise lies in a variety of fields such as biosystematics, species and population ecology, ecological processes, seascapes, landscapes and communities, and climate change. Our science infrastructure is situated both centrally and in protected areas across South Australia.

Our Science Resource Centre[11] supports DENR with foundational knowledge on species and populations, and helps to coordinate DENR's science and partnerships. It also helps to facilitate the transfer of our knowledge and build linkages between scientific partnerships and South Australian Government goals. DENR's record of scientific endeavour[12] contributes to current knowledge and our scientific achievements and research interests are summarised in *Realising Knowledge*[8].

Science principles

Underpinning DENR's scientific endeavours are principles that guide how we undertake our work:

- Inclusiveness
- Responsiveness
- Credibility
- Rigour
- Relevance
- Accessibility
- Timely input into effective decision making
- Accountability
- Ethics
- Integration of environmental, social and economic disciplines

Communicating science

Healthy ecological systems support healthy economies and societies.

The effective delivery and uptake of our science is crucial. We have a critical need to synthesise the science, knowledge and information we have in our priority areas of responsibility, and to translate it so it is relevant to decision makers. We need to communicate outcomes to a wide audience outside the research community, and improve public appreciation of the benefits of investment in science and research.

Our science must improve the community's understanding of our ecological systems and society must benefit from scientific research. By actively sharing the knowledge gained from science, we can enable South Australians to become more fully engaged in conservation and natural resource management decisions.

Refining the focus

Research priorities need to evolve with the growing knowledge base, and with new and emerging issues and environmental pressures.

We must understand how our environmental systems are tracking and determine whether management actions are effective. We will make sure our science priorities are the right ones by monitoring our performance and building the capacity to anticipate and detect ecological 'surprises'.

This document sets DENR's strategic direction for science during the next five years but is a living document to be reviewed regularly as our knowledge grows. Achievements in implementing *Science Directions 2010–2015* will be reported annually and the document will be substantially reviewed every five years based on achievements and lessons learned along the way.

How to get involved

To discuss partnership, sponsorship or research project opportunities contact us at:

DENRScience@sa.gov.au
or visit our website,
www.environment.sa.gov.au/science

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Appendix

Background and rationale for DENR's research priorities

Science Directions 2010–2015 establishes the broad policy context for our research priorities. The additional context set out in this appendix should help collaborators understand the rationale for this research and, thus, facilitate the establishment of partnerships to fill our knowledge gaps. There are dependencies between research areas and synergies among research questions in and across research areas (Figure 1).

RESEARCH AREA 1

Improving our understanding of the way ecological systems operate

This theme relates to research questions 1.1, 1.3, 2.1, 3.1, 3.2, 3.3, 3.5, 4.1, 5.2, 5.6 and 5.8

Description and purpose of research:
Much of our landscapes and seascapes are managed at the scale of communities and ecosystems. An improved understanding of ecological dynamics will contribute to our ability to make more accurate predictions about the way ecological systems will respond to change, thereby providing a basis for informed adaptive management. The protection of ecosystem function is likely to assist individual species to adapt to change.

Predicting the effects of change on biodiversity is complex. Responses to change are reflected in population dynamics of individual species. Component species or functional groups within an ecosystem will, therefore, not respond as a single unit. Interactions among species will have the potential to modify outcomes, sometimes in unpredictable ways. In addition, properties of biological and ecological systems are complex and hard to measure. Basic knowledge about limiting factors, genetics, dispersal rates and interactions amongst species comprising ecological communities and ecosystems is generally lacking. Actions taken to mitigate impacts of change on human systems (such as water management policy) can impose additional pressures on biodiversity.[13]

Addressing the questions related to this research area will vastly improve DENR's ability to address the other priorities outlined in *Science Directions 2010–2015*.

RESEARCH AREA 2

Improving our understanding of how systems are changing and the interactions of change with other ecological stressors

This theme relates to research questions 1.2, 1.4, 3.6, 5.1 and 5.7

Description and purpose of research:
Many of the most significant direct and indirect impacts on species and ecosystems are predicted to be a result of interactions of climate change with other threatening processes and synergistic changes including ocean acidification, coastal inundation, invasive species distribution and abundance, salinity, disease, hydrology, additional alteration of fire regimes, and changes in linkages between ecological and socio-economic systems. Understanding the negative and positive implications of these changes will help managers to decide which actions are needed to mitigate threats and when new adaptive approaches are needed to specifically incorporate climate change as a factor[14].

If negative impacts on ecosystem and community function and distribution of species are to be effectively managed, then we not only need to understand environmental changes and their interactions but also the drivers of ecosystems (Research Area 1) and the trends in distribution of species and ecological function (Research Area 3)

RESEARCH AREA 3

Understanding how systems and species are responding to change

This theme relates to research questions 1.3, 1.4, 3.2, 3.3, 3.4, 3.6, 4.1, 4.3, 5.1, 5.3, 5.4 and 5.8

Description and purpose of research:

Changes in the physical environment affect physiological processes in plants and animals. All organisms can cope with some environmental variability but all organisms have a physical threshold beyond which they cannot cope. We do not understand those thresholds for most species.

We also have a limited understanding of how species and populations are responding to environmental change and this leads to shortcomings in our knowledge of ecological community responses.

Some species and populations will benefit from change and others will not. Effective management of species requires objective prioritisation based on assessment of relative vulnerability to ensure resources are allocated to species that are unlikely to be able to adapt on their own.

Individualistic responses of species to change are highly likely to result in changes to both the structure and composition of many communities and ecosystems. Ecological communities are unlikely to move as units across the landscape in the face of change and novel combinations of species will appear in the future. Many of the changes are expected to be non-linear and there may be thresholds where rates of change alter or jump to different levels[13]. We need to understand the nature of trends to inform what to manage and when action is needed.

Current conservation management is based on restoring or maintaining species, populations or ecological systems in a 'pre-European' state. This may not be achievable or even appropriate in the face of rapid environmental changes. Determining appropriate conservation goals is thus a major challenge when we have such a poor understanding of the effects that human-induced declines in species, populations and communities have had, or will have, on broader ecosystem function. Understanding the current status and health of terrestrial and marine systems and the pressures and trends in these systems is critical knowledge for developing management strategies to confer ecological resilience[15].

A sound understanding of ecosystem dynamics is also a critical factor for developing effective conservation and adaptation measures. Effectively measuring and managing trends requires experimental designs that can provide a clearer understanding of thresholds beyond which regime-shifts are likely (before those thresholds are crossed) and that can determine the capacity of ecosystems to sustain key functions and processes in a changing environment. Monitoring just the current state or past trajectories of ecological systems is likely to have a more limited value[15]. Given the limited knowledge of future climatic condition, species dependencies and thresholds, and climate-ecosystem interactions, we will need to manage in the face of uncertainty, actively manage risk and employ responsive and iterative management approaches and policy frameworks.

The knowledge gained from this research area will help managers decide which early adaptation actions will maximise biodiversity conservation opportunities and which investments are likely to be futile or counter-productive as climatic changes continue.

RESEARCH AREA 4

Understanding how landscapes and seascapes can be protected and managed to maximise opportunities for species, populations, communities and ecosystems to adapt to change

This theme relates to research questions 1.5, 2.2, 2.3, 3.2, 3.3, 3.6, 4.1 4.3, 5.4, 5.6 and 5.8

Description and purpose of research:

Landscapes and seascapes are increasingly recognised for the multiple benefits they provide (such as biodiversity, carbon storage and production) and are starting to be managed accordingly. This can yield positive synergies or perverse outcomes as climate change and other socio-economic changes alter the distributions and types of resource use, with poorly understood consequences for conservation management[13].

An improved understanding of how to modify and manage landscape and seascape configuration to optimise conservation while providing for other productive land uses is urgently needed.

A better understanding of the role of refugia in maintaining biodiversity during climate changes in the past, could inform current and future landscape management under rapidly changing environmental conditions. There may also be generalised approaches for identifying refugia and landscapes, estimating their buffering capacity and planning protective management for multiple species[13].

Connectivity within land and seascapes is an important concept for conserving biodiversity in a changing environment. Although connectivity can allow adaptive movement of species and help conserve meta-populations, it may also assist the movement of non-native species, diseases and fire. An understanding of the benefits and risks of constructing connective matrices in land and seascapes is needed, particularly as this will vary amongst species and communities in time and space.

RESEARCH AREA 5

Understanding how to maximise conservation outcomes through integration of biodiversity with socio-economic trends

This theme relates to research questions 1.6, 2.2, 2.3, 2.4, 3.3, 3.4,3.6, 4.4, 4.5 and 5.5

Description and purpose of research: Although conservation management is usually focused on native species or habitats, there is an increased recognition that humans are an integral component of dynamic ecosystems and that people depend on ecological processes for social and economic prosperity. How agricultural and other productive uses of ecosystems can be managed to retain and enhance biodiversity, particularly in a changing climate, is fundamental to building resilience.

Climate change is highly likely to exacerbate the effects of many human-induced environmental changes and we will need to change conventional management practice and governance arrangements to accommodate these increased impacts. Integrating ecological management with socio-economic trends, policy and frameworks requires effective measurement of ecological condition, trend and environmental performance to provide feedback to policy-makers about management action and environmental response. This is a critical issue for South Australia.

The ability to integrate conservation and climate change adaptation actions into policy and planning is likely to result in the most successful climate change response strategies[16]. This requires an understanding of the degree to which current policy and planning frameworks help or hinder the inclusion or integration of biodiversity conservation and climate change adaptation considerations and priorities.

Particularly in relation to the researchable questions related to fire, this research area will help provide decision makers with a clearer view of what the community wants and expects. This science will assist policy makers to have a more balanced discussion between the community and government and will provide a better understanding of how to better inform partners and the community. It will also help us understand barriers (knowledge, perception and reasoning) that impede individual actions towards more sustainable behaviours and how to instil a commitment to environmental stewardship. Without this research we risk not meeting the community's objectives and may find difficulty gaining public support for critically important biodiversity policies.

Figure 1. Dependencies and synergies among policy priorities and research areas

Examples of dependencies between research areas: an understanding of how ecological systems operate (Research Area 1) informs the other four research areas and an understanding of how systems are changing (Research Area 2) informs how systems and species are responding to change (Research Area 3). Examples of synergies among research questions in different areas: question 1.3 informs Research Area 3 and also informs other highlighted questions in Research Area 3.

POLICY PRIORITIES	PRIORITY RESEARCH QUESTIONS	RESEARCH AREA 1 Ecological systems	RESEARCH AREA 2 Changing systems and interactions of change	RESEARCH AREA 3 Systems and species response to change	RESEARCH AREA 4 Protection and management to enhance adaptation	RESEARCH AREA 5 Integrating biodiversity with socio-economic trends
Climate Change	1.1	■				
	1.2		■			
	1.3	■		■		
	1.4		■	■		
	1.5				■	
	1.6					■
NatureLinks & Landscape Scale Conservation	2.1	■				
	2.2				■	■
	2.3				■	■
	2.4					■
Marine Parks	3.1	■				
	3.2	■		■	■	
	3.3	■		■	■	■
	3.4			■		■
	3.5	■				
	3.6		■	■	■	
Fire Management	4.1	■		■	■	
	4.2					
	4.3			■	■	
	4.4					■
	4.5					■
Coorong, Lower Lakes & Murray Mouth	5.1		■	■		
	5.2	■				
	5.3			■		
	5.4			■	■	
	5.5					■
	5.6	■			■	
	5.7		■			
	5.8	■		■	■	

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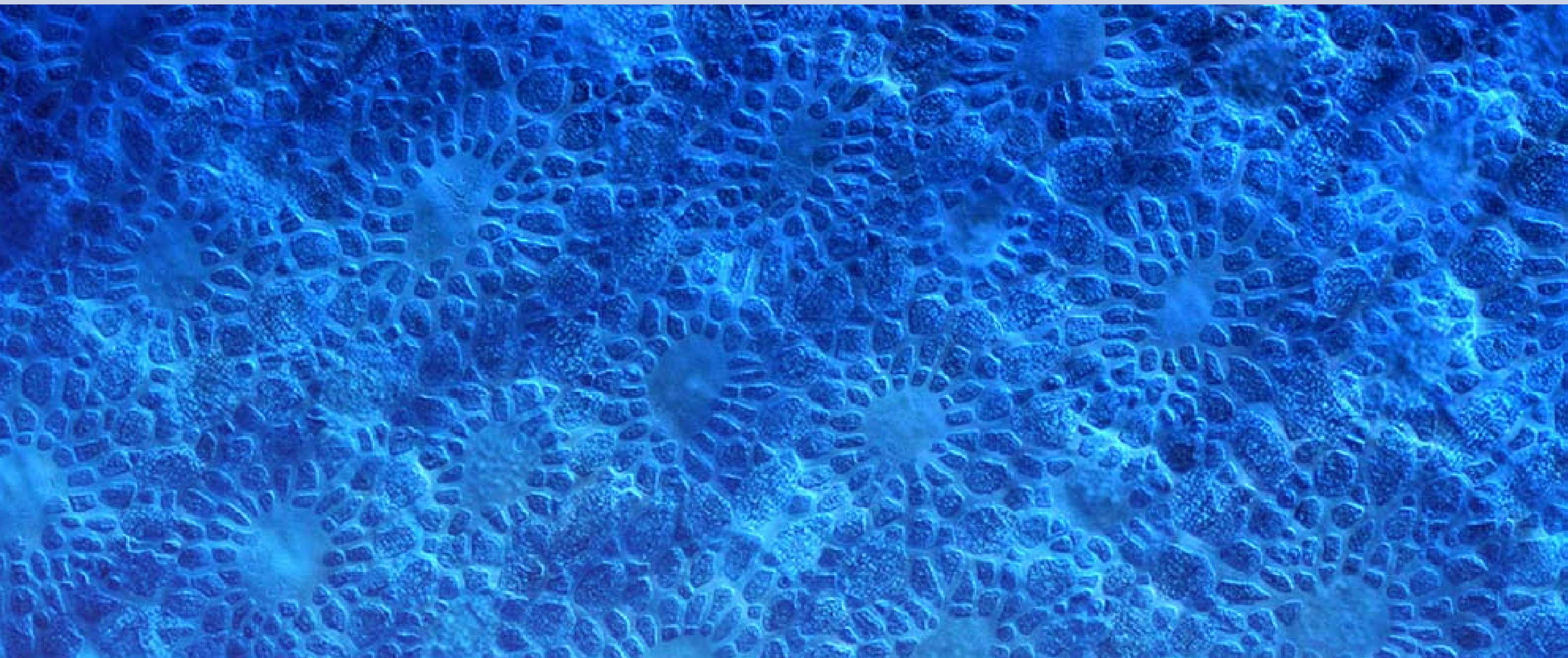

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