



Australian Government

Department of the Environment and Energy

Celebrating Australia's wetland science

World class research for wetlands



2018

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Images:

Front cover: Yellow Water Wetlands, Kakadu National Park (Michael Douglas)

Back cover: Barmah wetlands, Victoria (Anthea Brecknell © Department of the Environment and Energy)

Celebrating Australia's wetland science

World class research for wetlands

This publication showcases research which will contribute to improved understanding and management of wetlands, both in Australia and internationally. It highlights work done by Australian scientists under the National Environmental Science Program, as well as important projects by other leading Australian wetland researchers.

Acknowledgement of Country

The Department of the Environment and Energy acknowledges the Traditional Owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.



Brush-tailed Mulgara (Oliver Tester © Department of the Environment and Energy)



Sunset (Michael Douglas)

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Introduction

Australian research is contributing to improved understanding and management of wetlands around the world.

The National Environmental Science Program

The National Environmental Science Program (NESP) is a long-term commitment by the Australian Government to environment and climate research.

It supports the integration of science into decision-making as a key principle of good environmental policy.

The program has six themed research hubs, each delivering world-class research to help ensure the management of Australia's biodiversity and environmental resources is based on the best available information.

The span of NESP research themes is a good match for the diversity of natural and human-made habitat types that are designated under the Ramsar Convention.

- The **Clean Air and Urban Landscapes Hub's** research is supporting environmental quality in urban areas and includes projects that consider the biodiversity and community benefits delivered by human-made wetlands in urban green spaces.
- The **Earth Systems and Climate Change Hub** is furthering our understanding of the drivers of Australia's climate. Researchers have provided coastal local governments with sea level projections data so they can better manage coastal ecosystems including estuaries and wetlands.
- The **Marine Biodiversity Hub** is providing research for understanding and managing Australian oceans and temperate marine environments. This includes projects on marine species, marine protected areas, and pressures on the marine environment, applied to habitats from the deep ocean to coastal ecosystems such as rocky marine shores and salt marshes.
- The **Northern Australia Environmental Resources Hub's** research is supporting the sustainable development of Australia's northern

environments, for example, by providing information and understanding about how water resource development will impact on the health and productivity of floodplains and wetlands.

- Research by the **Threatened Species Recovery Hub** to improve the recovery of threatened species includes projects on migratory shorebird habitat and wetland habitat for frogs threatened by chytrid fungus.
- The **Tropical Water Quality Hub** is supporting the management of the Great Barrier Reef by providing innovative research for practical solutions to maintain and improve tropical water quality from catchment to coast.

Each of the six hubs are delivering research that is being used by the Australian Government, by the states and territories, by local governments, by industry, by Indigenous people, and hands-on land and water managers, to support the wise use and management of Australia's wetlands.

The National Environmental Science Program proudly acknowledges that for Australia to be truly sustainable there is much we can learn from Indigenous knowledge and peoples. Indigenous research partnerships are a highly valued component of the program.

The way the program connects scientists, policy makers, Indigenous people and communities from research design to research use—is both innovative and effective.

The program's focus on collaborative, practical and applied research that informs on-ground action is the key to its success.

Australia's wetlands are benefiting from the hard work of hundreds of scientists funded by the National Environmental Science Program—doing research to protect and restore our environment.

Other research projects

A number of other important Australian research programs and projects are contributing to improved wetland conservation and management, both domestically and globally. A selection of these are highlighted in this publication.

They include work being done through a range of institutions including CSIRO, universities, state agencies and the Commonwealth Environmental Water Office. These projects include important work on assessing both risks to wetlands from climate change, as well as management actions to adapt to climate change, assessing the adequacy of information available to underpin management decisions, annual surveys over 35 years which track waterbird populations and wetlands in eastern Australia and use of satellite remote sensing to map the world's intertidal zone.



Top to bottom: Turtle, Green Island, Queensland (Catherine Collier); Dragonfly (Michael Douglas); New Holland Honeyeater (Luis Mata)

Charting a future for Australia's threatened shellfish reefs

Community education, protection and investment could restore Australia's shellfish reefs, a recent research study has found.

Shellfish reefs are vital to the health of Australia's bays and estuaries, supporting marine life and fish production, regulating water quality and curbing coastal erosion. These valuable nearshore ecosystems have long been known to be in serious decline due to historical overfishing, coastal development, and pollution from activities such as land clearing and intensive agriculture.

Now an extensive study led by the Marine Biodiversity Hub in partnership with The Nature Conservancy and including collaborators from every state has confirmed that shellfish reefs are one of Australia's most threatened ocean ecosystems, with 90–99 per cent of this once-widespread habitat having disappeared.

Knowledge of the loss that has occurred, and its severity, is increasingly motivating restoration projects through small to medium-scale on-ground works and research and development trials. A national network of practitioners, The Shellfish Reef Restoration Network, has been established to help support protection and restoration efforts.

The study identified three key actions that can help convert knowledge of loss into on-ground restoration and long-term recovery:

1. Raise the profile of shellfish ecosystems by increasing education and communication on their function and value.
2. Support protection of remaining shellfish ecosystems and eliminate current and future threats by determining eligibility for protection under Commonwealth and state government threatened ecological community, flora and fauna and fisheries policies and legislation.
3. Invest in the development of early restoration projects to build momentum, expertise and capacity in Australia's marine restoration community.

At the Victorian Shellfish Hatchery, native flat oysters are being reared to help repair Port Phillip Bay reefs that over the years have succumbed to overfishing, poor water quality, increased sediments and disease that has accompanied Melbourne's development. The pilot project was completed in 2016 and has improved the understanding of the function, status and value of repairing shellfish reefs, helping with prioritising and scoping repair investment opportunities, and devising data collection, analysis and reporting procedures. Restoration works are now going ahead, not only in Victoria, but other projects in Gulf St Vincent, South Australia and Oyster Harbour, Western Australia, with over five hectares of reefs re-constructed and many more to come.

The results are being communicated to natural resource and fisheries management agencies, recreational and commercial fishing groups, the aquaculture industry, the community and Traditional Owners to build momentum, expertise and capacity in Australia's marine restoration community.

The Marine Biodiversity Hub project has distilled knowledge of shellfish reefs, their distribution and ecology, to identify the environmental, social and economic benefits of conservation and repair, as well as to provide practical guidance for management activities. The project team also facilitated an Indigenous engagement workshop with 21 Traditional Owner groups to understand their interests and involvement in shellfish restoration. Workshop participants distilled the 'Seven Pearls of Wisdom': a collective view on how to engage Indigenous peoples in shellfish reef restoration.



Sydney Rock Oyster (*Saccostrea glomerata*) reef in the Hunter River, Stockton, New South Wales (Kylie Russell)



Experimental Blue Mussel (*Mytilus edulis*) bed with Eleven Arm Seastar (*Coscinasterias muricata*) Hobsons Bay, Port Phillip Bay, Victoria (Paul Hamer)



Wild oysters (*Ostrea angasi*), Hobsons Bay, Port Phillip Bay, Victoria (Paul Hamer)



National Environmental Science Programme

Project B4: Underpinning the repair and conservation of Australia's threatened coastal-marine habitats

www.nespmarine.edu.au

Delivering new coastal climate science for decision makers

Accessible climate science is being delivered to coastal local governments (councils) as they plan for the effects of climate change on our near-shore and coastal environments.

Rising sea levels pose a significant threat to coastal communities with millions of people living in Australia's coastal regions. Our coastal ecosystems including estuaries and wetlands, as well as billions of dollars of infrastructure are also at risk from the effects of climate change.

Coastal councils are on the front line of responding to these changes to ensure that planning and services will accommodate the impacts and disruptions caused by rising sea levels. Council planners and managers need to know how sea level rise will affect their particular council area.

Researchers are providing new data to 255 coastal councils around Australia to support their planning and management activities. The results of recent science are accessible to councils through the CoastAdapt web-based tool, including data for each decade from 2030 to 2100, for four emission scenarios.

Coastal councils can now easily access sea-level projections that are specific to their local area, to feed into awareness raising, risk assessment, planning and policy-making.

The CoastAdapt tool can be accessed at:
<https://coastadapt.com.au/>



**Earth Systems and
Climate Change
Hub**

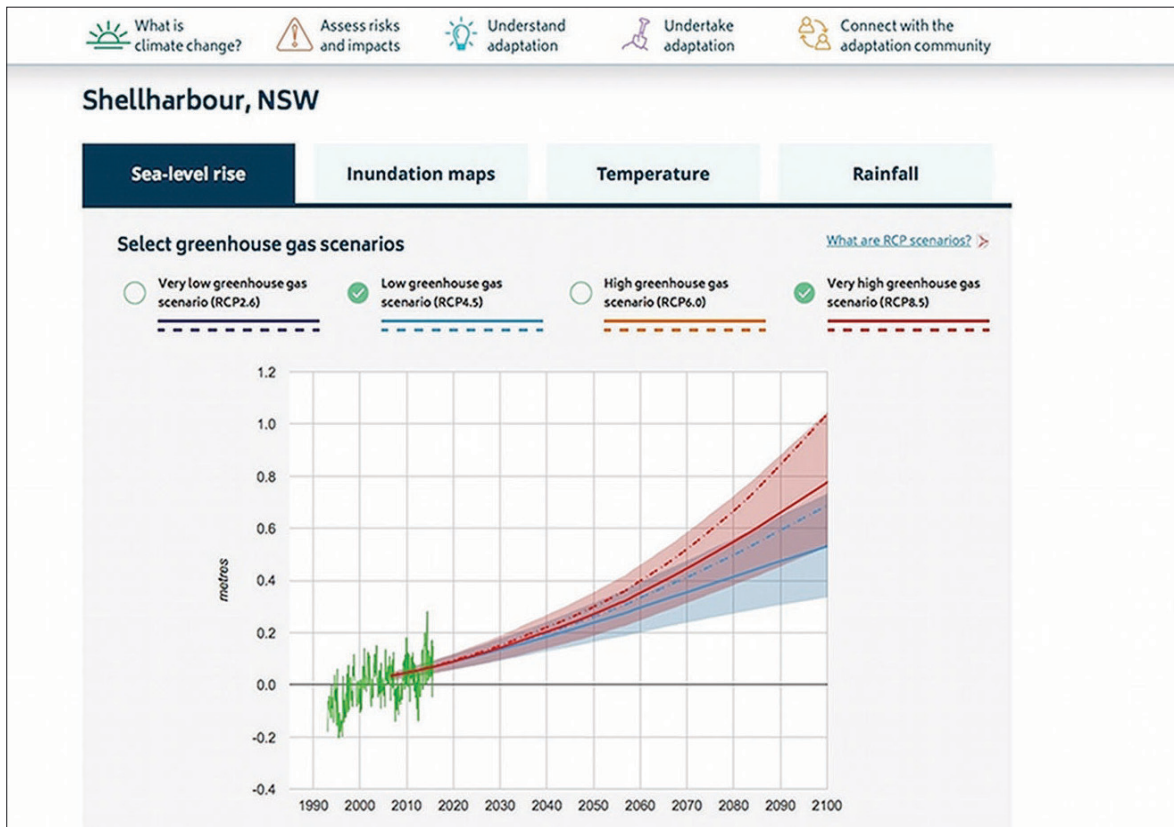
National Environmental Science Programme

Project 2.12 Developing local government
sea-level projections

www.nesclimate.com.au



Bondi Beach (Michelle McAulay © Department of the Environment and Energy)



CoastAdapt sea level rise example



Storm surge on Queensland's Gold Coast (Bruce Miller, www.scienceimage.csiro.au CC BY 3.0)

Understanding and managing feral animal impacts on waterholes

In partnership with local Indigenous groups, this project is finding effective monitoring and management methods to assess and address feral animal damage to waterholes and rivers in far north Queensland.

Feral animals are a major threat to the ecological and economic values of northern Australia. Feral herbivores, particularly pigs, as well as cattle, horses and buffalo wreak havoc on the natural environment, displace native species and can threaten agricultural production.

Indigenous groups are also concerned about the damage feral herbivores inflict on rivers, wetlands and coastal areas, with turtles, water lilies and crocodile eggs among the traditional resources being affected. However the issue is complex since Indigenous groups are also interested in preserving populations of feral pigs and buffalo as a source of potential income and food for remote communities.

In this project researchers are working with Indigenous ranger groups, local communities and agencies to help local communities make informed decisions about managing feral animals. Teams are exploring the extent of the damage being caused by feral pigs to aquatic ecosystems in Cape York's Archer River Basin and how to best limit this damage. For example, rangers have installed exclusion fencing around key wetlands and are comparing the results to unfenced sites. Teams are also working to understand how different waterhole types affect the movement of feral pigs across the landscape with the onset of the wet season.

These investigations are helping research partners design effective monitoring, management and reporting methods that can be shared with other land managers across northern Australia.

Ensuring that all key groups are involved in the project fosters a shared understanding of the most effective and efficient ways to manage feral animals to deliver joint social, economic, environmental and cultural benefits.

The project builds on and works alongside state and Australian Government funding programs that have been awarded to Indigenous groups Balkanu, Aak Puul Ngangtam (APN) and Kalan Enterprises over the past five years to control feral animals in the Archer River Basin.



**Northern Australia
Environmental
Resources
Hub**

National **Environmental Science** Programme

Project 2.5: Defining metrics of success for feral animal management in Northern Australia

www.nespnorthern.edu.au



Bank erosion caused by feral pigs at a northern Australia wetland (Steve Wray © Department of the Environment and Energy)



Feral pigs in a northern Australia wetland (Sam Setterfield)

Informed management actions for alpine bogs

Priority management actions for Australia's unique south eastern alpine wetlands and bogs are now easily determined as a result of new knowledge delivered through a science and state government partnership.

The Australian alps of New South Wales and Victoria are known for their rich biodiversity, with internationally significant wetlands and many plants and animals found nowhere else – including several threatened species – Northern and Southern Corroboree Frogs, the Baw Baw Frog, the Booroolong Frog and the Alpine Water Skink.

Land use, riparian vegetation condition and other catchment influences contribute to the health status of aquatic biodiversity and the function of ecosystems such as bogs. In collaboration with parks staff, researchers took a whole of landscape approach to identify priority areas for conservation in the region.

Using a decision support tool (MCAS-S) that integrates spatial data, the project was able to identify where threats such as fire, feral animals and the impact of climate change might coincide, signalling the need for priority management action. The research mapped threats for over 11,000 alpine wetlands and bogs and these data were consolidated into a data-pack for use by parks managers.

The project has developed a range of tools, techniques and policy pathways to help planners and environmental managers make decisions. The Australian Alps Liaison Committee has endorsed the use of MCAS-S for guiding the management of natural values in the Australian alps and this approach has since been adopted by Parks Victoria.

MCAS-S (Multi-Criteria Analysis Shell for Spatial Decision Support) is available from the Australian Bureau of Agricultural and Resource Economics and Sciences <http://www.agriculture.gov.au/abares/aclump/multi-criteria-analysis>



Alpine peat bog, Mount Baw Baw, Victoria (Robert Kerton, CSIRO scienceimage CC BY 3.0)



The Australian Alps in summer (CSIRO, www.scienceimage.csiro.au CC BY 3.0)



National Environmental
Research Program

<http://www.lifeatlarge.edu.au/>

Shining a light on Great Barrier Reef seagrass meadows

Research has identified the light requirements of seagrass species in the Great Barrier Reef World Heritage Area which can now inform water quality improvement actions and targets.

Seagrass meadows are the habitat most likely to be directly affected by coastal and port developments due to their proximity inshore and along sheltered parts of the coast.

Water quality affects light reaching seagrass meadows, and light in turn controls the productivity, abundance and distribution of seagrasses. When light levels become too low, seagrass loss occurs with considerable flow-on effects for marine ecosystems such as dugong and turtle mortality. Therefore, guidelines for light are recommended as a management trigger for seagrass meadows at risk from declining water quality.

Until recently, there has been little biologically relevant information available to set appropriate light level thresholds. This research will ensure seagrasses at highest risk from direct anthropogenic impacts have adequate protection from activities that affect water quality and the light environment over the short-term, such as coastal and port developments, and assist in the establishment of long-term light thresholds.

Researchers working on a Tropical Water Quality Hub project have investigated the impact of light levels on different species of seagrasses on the Great Barrier Reef and developed a practical guide to implementing seagrass light thresholds for management of activities, such as dredging, that cause light reductions.

Light management thresholds for acute impacts were developed for twelve species of seagrass, with the team finding that fast-growing 'colonising' species are the most sensitive to reduction of light levels, while larger, more persistent species have higher light thresholds and are more resilient to changes.

The light thresholds are a key reference for managers, regulators and modellers to use in generating relevant water quality guidelines. The Hub has identified the values of light required to maintain functioning healthy seagrass meadows in the Great Barrier Reef and a practical framework for implementing compliance monitoring programs on seagrass condition during coastal developments.



Determining light thresholds for seagrass meadows is critical for development impact planning (© NESP Tropical Water Quality Hub)



National Environmental Science Programme

Project 3.3: Light thresholds for seagrasses of the GBR:
a synthesis and guiding document for managing seagrass

www.nesptropical.edu.au

Mapping seagrass habitat for turtles and dugongs

A Tropical Water Quality Hub mapping project has provided current seagrass spatial information at the local scale to inform community-based approaches to managing turtles and dugongs.

Seagrass meadows in north-west Torres Strait play a vital role in supporting local dugong and turtle populations. Assessing and managing these seagrass resources required baseline information on seagrass presence/absence, seagrass biomass, species composition, and meadow area.

Dugong and green turtle populations are considered cultural keystone species in Torres Strait. Torres Strait Islanders have the right to hunt dugong and turtle in their sea country. Community-based Turtle and Dugong Management Plans have been implemented for dugong and turtle fisheries that include restrictions on hunting vessel size and hunting equipment, and area closures for dugong hunting such as the Dugong Sanctuary in western Torres Strait.

The sampling methods used to study, describe and monitor seagrass meadows were developed by James Cook University's TropWATER Seagrass Group and tailored to the location and habitat surveyed. They included video transects using an underwater CCTV camera system towed from a vessel at drift speed, and helicopter surveys. Torres Strait Regional Authority (TSRA) Land and Sea Management Unit (LSMU) Rangers from Boigu Island and Saibai Island were essential to the success of boat-based surveys.

The researchers documented over 60,000 hectares of a wide variety of seagrass species across more than 850 sites. The vast area of highly diverse seagrasses in Torres Strait provides a consistent source of primary production supporting the region's marine ecosystems including turtle and dugong.

Understanding seagrass resources at the community scale is important because seagrass biomass, distribution, and species composition varies significantly at small spatial scales. Potential management responses (e.g. temporal or spatial closures, dugong and sea turtle catch reductions) triggered by seagrass or dugong/green turtle declines will be most successful if implemented at the community level.

The mapping provides a baseline against which future change in seagrass can be assessed in this region. Any change in the distribution, biomass and community structure of Torres Strait seagrasses may have implications for dugong and turtle populations.

Mapping results are available online through the e-Atlas information service at:
www.eatlas.org.au



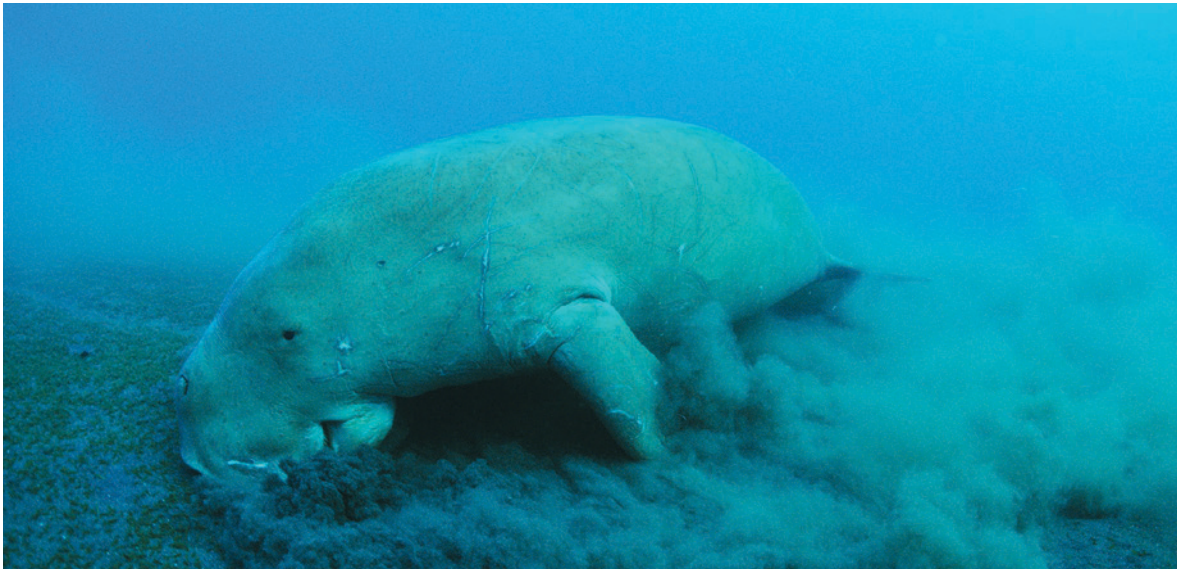
National Environmental Science Programme

Project 3.5 Assessment of key dugong and turtle seagrass resources in the northern Torres Strait

www.nesptropical.edu.au



The skills of Indigenous Rangers are critical to discovering the true size and extent of seagrass meadows in the Torres Strait (TropWATER, James Cook University)



Dugong feeding (© GBRMPA)



Green turtle (Tony Howard © Department of the Environment and Energy)

Novel approaches to conserving frogs

Researchers, zoos and government are partnering to overcome the key causes of declining threatened frog populations in habitats including urban wetlands.

Many of Australia's frog species have been badly affected by the global amphibian disease caused by chytrid fungus. As there is no way to control the disease, Australian researchers are embracing novel techniques to help support threatened frog species to persist in the wild.

Captive breeding programs have been established for the frog species most susceptible to chytrid fungus. A key purpose of these programs is to release frogs to boost wild populations. However due to chytrid fungus, frogs are not thriving in many areas which were once considered prime habitat, so new strategies are being explored to identify refuge sites, leveraging all factors that can give frogs an advantage.

In particular, researchers are investigating the environmental conditions that do and don't favour the disease in order to identify potential refuges where chytrid levels are naturally lower. They are also collecting, collating and mapping fungus samples to better understand the disease and to inform threat abatement plans.

The Spotted Tree Frog is highly susceptible to chytrid fungus and non-native fish predate heavily on eggs, tadpoles and young frogs. The combination is driving significant population declines – this species has already disappeared from 50 per cent of historic sites and is now rare at remaining sites.

Knowledge from recreational fishing groups is contributing to the identification of refuge sites where non-native fish densities are low or could be managed. By reducing the impact of non-native predatory fish, researchers and conservation partners hope to establish stable wild populations of Spotted Tree Frogs at these refuges.

In the case of the Northern Corroboree Frog, researchers are investigating introducing the sub-alpine frogs to lower elevation sites in order to help frogs

reach sexual maturity sooner. This is expected to allow frogs to breed before they are killed by the disease. Researchers are also identifying sites with few other frog species that act as hosts of chytrid fungus.

Threatened bell frogs in eastern Australia are susceptible to chytrid fungus and also face sustained pressure due to increasing urbanisation. Long term data on the threatened Green and Golden Bell Frog is being compiled and analysed to assess the population status and threats across seven regions, contributing new information to government management actions.



Chytrid fungus under the microscope (AJC1, Flickr CC BY-SA 2.0)



Green and Golden Bell Frog (Will Brown, Flickr CC BY 2.0)

Researchers are also investigating the effects of local wetland characteristics – habitat loss, fragmentation and isolation – on the persistence of bell frogs in city and urban environments. They are assessing alternative management scenarios for water body characteristics, increasing habitat connectivity, and quantifying the importance of preserving off-stream wetlands in new residential developments.

This project is playing an important role in providing new knowledge that supports sustainable urban planning practices and management decisions for threatened frog species, and raising awareness through citizen science activities.

Chytrid fungus has wrought a terrible toll on Australia's unique frogs. Through new partnerships, conservation efforts to help recover threatened frog species – targeting both chytrid fungus and other threats – are providing hope for species recovery.



**Threatened
Species
Recovery
Hub**

National **Environmental Science** Programme

Project 1.4: Disease and faunal declines

www.nespthreatenedspecies.edu.au



**Clean Air and
Urban Landscapes
Hub**

National **Environmental Science** Programme

Project 5: The Shared Urban Habitat

www.nespurban.edu.au

Understanding Indigenous water needs

Scientists and Traditional Owners have partnered on a project that is improving ways of eliciting Indigenous water values to inform plans for future developments in Western Australia's Fitzroy River catchment.

Aboriginal people have a long-standing and strong connection to the Fitzroy River which is integral to their way of life and the foundation of social activities, ceremonies, hunting and gathering. Such values underpin the river's National Heritage Listing and Traditional Owners from along the river have recently committed to a renewed effort to work together to protect them. It is hoped that by understanding the potential effects of increased development in the region and reflecting this information in planning rules and processes, the risks to valued places and relationships can be reduced.

This project addresses the acknowledged need for socio-ecological research to improve the capacity of water managers, planners, Indigenous communities and others to determine Indigenous water requirements and plan for future water use in the catchment. In partnership with Indigenous groups, the project is identifying customary uses of water and waterways using methods that integrate with regional water and catchment management planning.

The research is revealing links between Indigenous values, practices and water regimes, and is eliciting knowledge, as well as objectives for the future management of land and water resources. Emphasis is being placed on advancing the field of Indigenous water planning by trialling social assessment methods and showing the value of community participation in environmental flow assessments.

Research teams are working with communities to determine water requirements of environmental assets and cultural features valued by Indigenous people such as fish, pools in the river and riverside vegetation. The project is developing conceptual models that link the social and ecological needs and goals of Indigenous people with the potential impacts of water resource

development. Research recommendations are being made on ways of meeting and monitoring Indigenous water requirements in water management plans, and in natural resource management plans and programs.

The participatory nature of this research aims to increase the capacity of Indigenous organisations to influence water policy and allocation decisions. Research outcomes will support improved understanding of the value of Indigenous knowledge to conservation and environmental management, and the environmental, social and heritage consequences of proposed water resource development in the catchment. Importantly the research underpins evidence-based water allocation planning in the catchment.



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National **Environmental Science** Programme

Project 1.5: Indigenous water needs for the Fitzroy River

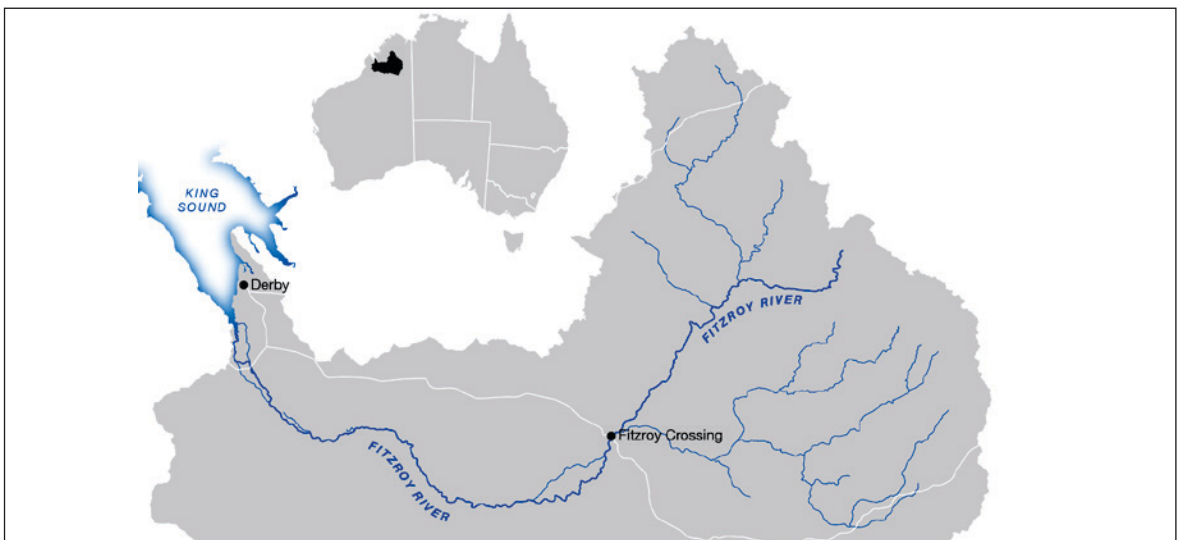
www.nespnorthern.edu.au



Waterhole on the Fitzroy River (Nick Rains)



Rangers collect fish in the pools and shallow run habitats of the lower Fitzroy River (Leah Beesley)



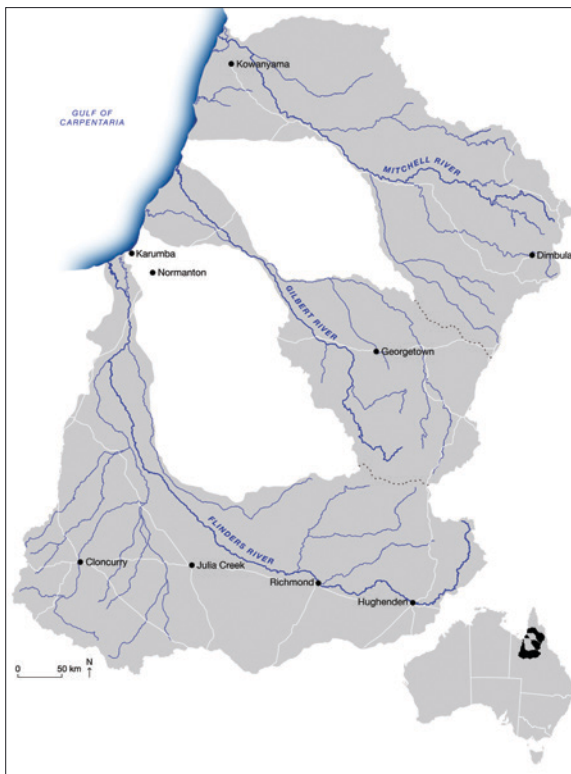
Location of the Fitzroy River catchment

Linking Gulf rivers and coastal productivity

A better understanding of the downstream impacts of water resource development in the Gulf of Carpentaria, in Australia's north, will help in prioritising and planning for sustainable development.

The Flinders, Gilbert and Mitchell Rivers in Queensland flow into the Gulf of Carpentaria, supporting healthy ecosystems and nationally significant wetlands as well as important recreational and commercial fisheries.

With increasing interest in developing water resources in northern Australia, further information is needed to understand how such developments will impact on the health and productivity of floodplains and coastal areas. Specifically, we need to know which flow characteristics of the rivers earmarked for future development are most important for the region's ecosystems and associated ecosystem services. Using this information we can better predict the consequences of changes in flow regimes, as well as better understand the consequences of other risks to flow such as climate change.



Location of the Flinders, Gilbert and Mitchell Rivers in Queensland

Information from the research is contributing to planning and managing water allocations, protecting regional biodiversity and managing Gulf commercial and recreational fisheries.

This will help ensure that aquatic production in coastal and floodplain areas of the southern Gulf is maintained to support migratory birds, fish, fisheries and other assets that depend on river flows.



Wetlands at Kowanyama, Cape York Peninsula, Queensland, (Feral Arts, Flickr CC BY 2.0)



**Northern Australia
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National Environmental Science Programme

Project 1.4: Links between Gulf rivers and
coastal productivity

www.nesppnorthern.edu.au



Mitchell River delta (Feral Arts, Flickr CC BY 2.0)



The Flinders River in Queensland (Stephen Faggotter)

Partnerships to protect sea country

Partnerships between wetland scientists, Traditional Owners, local citizens and natural resource management agencies are leading to better management of tidal wetlands in the southern Great Barrier Reef region.

Estuarine wetlands are an integral component of sea country, with sites of immense cultural heritage significance including middens, fish traps, and traditional fishery resources. Estuarine wetlands also provide essential ecosystem services that protect the Great Barrier Reef, including water quality improvement.

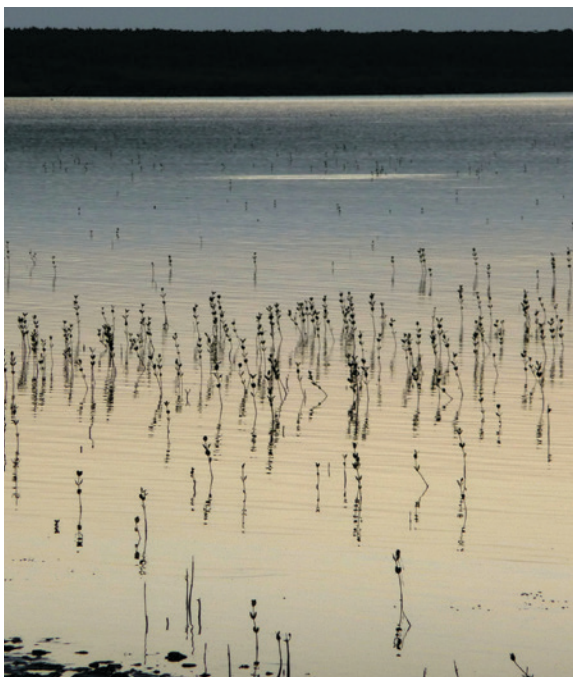
Shoreline habitats within estuaries of the southern Great Barrier Reef have been badly damaged by repeated, recent extreme flood events and continuing anthropogenic stressors. This reduces ecosystem resilience to future climatic stress events.

This project is building capacity of Indigenous rangers, natural resource management groups and the local community to monitor, manage and rehabilitate estuarine wetlands. Traditional knowledge and cultural heritage values are being incorporated into broad ecological assessments to give holistic and pragmatic views of

estuarine wetland condition, values and threats. In one area, these data are forming the basis of a Mangrove Management Plan that provides strategic guidance for estuarine repair activity and maximises water quality outcomes for the southern Great Barrier Reef.

Rangers have already identified mangrove damage and tree poisoning in an urban area. This vandalism was brought to the attention of local government and the community. Local citizens have been invited to help create an accurate list of saltmarsh plants through using a species checklist and submitting photos. Indigenous rangers and citizen scientists are carrying out detailed surveys of shorelines using the MangroveWatch Shoreline Video Assessment Method (SVAM) in southern Great Barrier Reef catchments.

This project provides a blueprint for how citizen science partnerships and Traditional Owner values can contribute to robust environmental monitoring. This provides a cost-effective and socially beneficial way of undertaking long-term monitoring required for the immense challenge of maintaining shoreline habitat health throughout the entire Great Barrier Reef region.



Mangrove shoots (Christine Painter, CSIRO scienceimage CC BY 3.0)



National Environmental Science Programme

Project 2.3.4 Working with Traditional Owners and local citizens to better manage Great Barrier Reef estuarine wetlands

www.nesptropical.edu.au



Flood damaged mangroves (© NESP Tropical Water Quality Hub)



Carrying out a shoreline survey using the MangroveWatch Shoreline Video Assessment Method (© NESP Tropical Water Quality Hub)

Social and biodiversity benefits from stormwater channel rehabilitation

A concreted drainage channel in one of Australia's largest cities is being transformed back into a semi-natural waterway bounded by earth, trees and vegetation.

Scientists are working to determine the benefits for biodiversity as well as the health and wellbeing of residents from a major urban greening project. The Upper Stony Creek Transformation Project involves the reclamation and rehabilitation of a 1.2 km section of Upper Stony Creek in Melbourne's western suburbs to a revegetated creek bed with wetlands, and improved surrounds including walking paths and parkland. Adjacent to the parkland will be a new residential development. The project is expected to improve both the environmental values of the space and the social amenity of the community.

The research area is located in Melbourne's west which is lacking in quality green spaces, and is vulnerable to heat which contributes to lower community health and wellbeing. This provides researchers with an opportunity to compare the baseline with short, medium, and long-term outcomes of the transformation project based on interviews and social and ecological surveys.

The transformation project is being undertaken throughout 2018 and into 2019, and the study will continue beyond that. First interviews with residents showed overall impressions of the site were negative, with many commenting on its undesirable features. However, they were excited about the change, believing it will improve the liveability of their neighbourhood and attract wildlife.

So far, ecological surveys have assessed the plants, insects, frogs, birds and bats currently present in the project area. As the project progresses, scientists will monitor changes in wildlife and air quality, and after its completion they will detail the way the new area is used. By the time the Upper Stony Creek study is complete, this will be one of the most integrated studies of an urban development anywhere in the world.

The importance of the ecological and biodiversity characteristics of cities go hand in hand with their social and psychological aspects. Rehabilitating waterways and establishing semi-natural environments such as wetlands within urban areas can deliver a range of benefits to both communities and biodiversity. This project represents an opportunity to quantify these benefits and assess the mechanisms for doing so.

To complete this project, the Clean Air and Urban Landscapes Hub is working with local and state government partners, water utilities and businesses. The partnership group includes Brimbank City Council, City West Water, Victoria's Department of Environment, Land, Water and Planning (DELWP), Greenfleet, Melbourne Water and Development Victoria. The partnership group has funded this project in addition to the National Environmental Science Programme.



**Clean Air and
Urban Landscapes
Hub**

National Environmental Science Programme

Project 6: Social and Biodiversity Benefits of Urban
Greening – A network of integrated study sites

www.nesurban.edu.au



Images clockwise from top left: A native Little Blue Butterfly on non-native white clover at Upper Stony Creek (Louis Mata); White-plumed Honeyeater – another native species found at Upper Stony Creek (Ashley Olson); the concrete drainage channel that is being transformed through the Upper Stony Creek project (Leila Farahani)

Understanding mangrove dieback

Researchers and Indigenous rangers are partnering to understand and monitor mangrove dieback along more than 1000 km of remote coastline in Australia's north.

Australia's tropical and subtropical regions are home to seven percent of the world's mangroves. These unique ecosystems are breeding and nursery grounds for many marine and estuarine species, and provide important habitat for a range of birds and other biodiversity.

In a brief period during the summer of 2015–16, one of the worst mangrove dieback events ever recorded devastated mangrove forests along more than 1000 km of Gulf of Carpentaria coastline. This dieback event has serious implications for biodiversity, fisheries and shoreline processes as well as affected local and Indigenous communities and relevant management agencies.

This project is providing a better understanding of mangrove dieback patterns and trends in the Gulf region to inform management options and help recovery intervention decisions. Researchers are using imagery, site visits and other techniques to examine the dieback to better understand what species in what locations and in what tidal elevations are most affected by the event. This assessment will provide a basis for deciding whether recovery or management actions should be pursued and if so, where and how. It will also provide a baseline dataset to underpin evaluations of future recovery of the mangrove forests and of associated impacts and environmental changes that occur.

A number of Indigenous ranger groups in the affected Gulf region have partnered with researchers to share traditional ecological knowledge and build capacity through Indigenous participation in fieldwork and training in specialised monitoring techniques. Mangrove systems are both culturally significant and support food-species for local Indigenous communities, and a meeting of all interested stakeholders will be held in 2018 to share information and knowledge.

Importantly, the project links local, national and international communities through understanding this unprecedented event in Australia's remote north.



Mangroves at Karumba, Queensland (Geoff Crane, Flickr CC BY-NC 2.0)



**Northern Australia
Environmental
Resources
Hub**

National Environmental Science Programme

Project 4.4: Assessing mangrove dieback in the
Gulf of Carpentaria

www.nespnorthern.edu.au



Aerial views of mangrove fringes showing sections of minor damage (left) and extreme damage (right) along the Gulf of Carpentaria (Norm Duke)



Map showing the Gulf of Carpentaria coastline affected by the mangrove dieback in 2015-16

Evaluating the effectiveness of coastal wetland restoration methods

On-ground restoration efforts have probably improved wetlands, yet no scientific data to evaluate and examine success has been available to date.

Protecting and repairing wetlands in Great Barrier Reef catchments is a high priority for Australian and state governments which have jointly invested millions into on-ground restoration works, including weed removal, fish barrier upgrades, improvements to agricultural land management practices and community education.

The Tropical Water Quality Hub is undertaking a scientific evaluation of wetland restoration sites, to capture data and assist with future planned restoration projects.

The project team, led by Dr Nathan Waltham at James Cook University's TropWATER facility, in collaboration with local landholders and Indigenous groups, has used the 2017-2018 wet season for a range of evaluative research activities. These include establishing a water balance model at a constructed wetland near Cairns, surveying the biochemistry of soils and vegetation in a wetland north of Townsville, monitoring Barramundi and Salmon Catfish after removing aquatic weeds, and using aerial drones to survey feral pig exclusion fencing in a wetland reserve.

At another wetland site in far north Queensland, the research has already yielded results. The degradation of the Mungalla wetland complex began more than a hundred years ago when an earth bund was constructed in the early 1900s to exclude seawater and create a ponded pasture for grazing.

The wetlands have undergone restoration actions including removing the bund wall to allow saltwater to again connect with the wetland area, as well as fire management, weed spraying, and fencing of stock. Removing the bund wall has been an important natural control on invasive plant species.

The wetlands are showing measurable ecological improvement. A survey of the fish occupying the wetlands in 2008 recorded three freshwater fish species, including two invasive species – gambusia (*Gambusia holbrooki*) and tilapia (*Oreochromis mossambicus*). In a survey in 2017 nine species of fish were found, including three fish species that have an estuary life phase, including the Barramundi, which has probably not been recorded in these wetlands in over a hundred years, before the bund wall was built.



**Tropical
Water
Quality
Hub**

National Environmental Science Programme

Project 3.3.2 Science Evaluation of coastal wetland systems repair projects across Great Barrier Reef catchments

www.nesptropical.edu.au



Plenty of effort has been invested in restoring wetlands, but how do we know if it has made a difference? (© NESP Tropical Water Quality Hub)



Barramundi (Charlene N Simmons, Flickr CC BY-NC 2.0)

Recovering the Far Eastern Curlew

A research project to find out more about the habitat requirements of the Far Eastern Curlew, the world's largest migratory shorebird, will be used to develop guidelines for the bird's conservation that will be of benefit in Australia and in other parts of the flyway.

About three quarters of the world's Far Eastern Curlew population winters in Australia. While the curlew is listed as critically endangered in Australia, it is impossible to conserve the species without international collaboration along the East Asian-Australasian Flyway (EAAF) from Siberia to Australia and New Zealand.

Far Eastern Curlews are facing significant threats in Australia through disturbance. Far Eastern Curlews occur almost exclusively in Australia's coastal strip, and share their habitat with recreating humans and their dogs. Coastal development also results in the loss of critical 'roosting' habitat, the places that curlews rest in during high tide periods when their mudflat feeding grounds are covered with seawater.

To address some of the conservation concerns and knowledge gaps facing Far Eastern Curlew in Australia, a Threatened Species Recovery Hub project, based in Darwin, is enhancing knowledge on how the shorebirds use different habitats in order to assess how these can most strategically be conserved.

Working in partnership with the Darwin Port, where significant numbers of Far Eastern Curlew use the East Arm Wharf as a roosting area, the project is analysing feeding and roosting habitats. The East Arm Wharf is just one of the artificially created habitats that shorebirds make use of in the EAAF; other examples include commercial salt works and aquaculture ponds.

Analysing the relationship between these habitats in the Darwin region will support development of strategic guidelines for conservation that will provide greater certainty to developers, planners and regulators. Improved management of 'accidental' habitats like East Arm Wharf, alongside conservation of intertidal mudflat habitat, could help species like the Far Eastern Curlew recover.



**Threatened
Species
Recovery
Hub**

National **Environmental Science** Programme

Project 5.11 Strategic Planning for the Far eastern Curlew

www.nespthreatenedspecies.edu.au



Eastern Curlew (Neil Saunders, Flickr CC BY-NC-ND 2.0)



Eastern Curlew (Brian Furby Collection)

Risks to floodplain wetlands in Kakadu National Park under a changing climate

As a result of sea level rise the coastal wetlands in Kakadu National Park in northern Australia will be very different in the future.

Research funded by the Department of the Environment and Energy and CSIRO shows that by 2100 the freshwater wetlands are projected to be replaced by marine-dominated ecosystems. Management of Kakadu's wetlands will need to be adaptive and backed by specific monitoring and research.

Following social-ecological investigations over several decades, an integrated risk-assessment framework was used to assess the threats to the wetlands from feral animals and aquatic weeds under sea-level-rise scenarios over time (present-day, 2070 and 2100). The over-riding 'big-picture' conclusion was that Kakadu's wetlands by 2100 will essentially be an environment with novel ecosystem states that may render traditional management goals unachievable.

Under the climate scenarios, the risk from existing invasive species would decrease as the freshwater habitats decreased. The loss of freshwater habitats also indicates the importance of securing refuges for the survival of iconic freshwater species, and highlights the need to maintain them in good condition now and into the future.

Although the risk assessment framework allowed a careful and relatively quick assessment of the risks, it is only a first step. To benefit the future management of wetland sites susceptible to climate change, there will be a need for 'user-friendly' simulation tools to evaluate management strategies and support decision-making. Long-term management strategies will need triggers for new actions, including potentially high-risk options (e.g. species translocations to refuges).

The main policy option may be to accommodate change rather than attempt to prevent change. A multidisciplinary approach is being recommended, for future research and monitoring in the Park, as well as effective partnerships with park managers

and traditional owners. A socio-economic and cultural program is needed to provide a context for the biophysical change and to help identify adaptation measures, and reappraisal, including whether changes are cyclic, such as may be the case for mangroves, or completely novel in response to new pressures.

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Bayliss P, Finlayson CM, Innes J, Norman-Lopez A, Bartolo R, Harford A, Petite NE, Humphrey CL, van Dam R, Dutra LXC, Woodward E, Ligtermoet E, Steven A, Chariton A & Williams DK 2018. An integrated risk-assessment framework for multiple threats to floodplain values in the Kakadu Region, Australia, under a changing climate. *Marine and Freshwater Research* <https://doi.org/10.1071/MF17043>



Mangroves, Kakadu (Sergio Cabral)

Evidence based decision-making – how confident are you?

Investment in environmental outcomes requires confidence that the intended environmental outcomes will be achieved; but how do we build confidence in an inherently uncertain operating environment?

Watering for the environment is an investment in the future. With increasing public and political scrutiny of the value of resource trade-offs, there is heightened pressure to ensure that decisions to commit resources to landscape management realise the long term expected outcomes. The processes of planning, implementation, evaluation and improvement, rely on information to support decision-making that is current and reliable.

The assumption that environmental responses are based on ‘just add water’ is being challenged and superseded with a focus on addressing the core stressors rather than the perceived ecological needs (based on long term modelled natural conditions).

The Commonwealth Environmental Water Office recently concluded a program of work in collaboration with scientists and site managers reviewing the conceptual model for Black Box floodplain vegetation communities, to develop a framework for reversing the long-term decline in their health. This investigation was initiated following successive years of poor vegetation response despite natural flooding and environmental watering activities.

The outcome of the investigation highlighted that floodplain vegetation vulnerable to groundwater and salinity stress, such as Black Box, is unlikely to respond to environmental watering without other complementary land management activities. Calperum Station, within Australia’s Riverland Ramsar wetland, was selected as the pilot for testing and refining the information assessment and planning process that provides the foundation for the Black Box Management Framework.

The development of a framework for the management of Black Box vegetation aims to provide a structured approach to management planning which focuses on the drivers of ecosystem decline, as the basis for resource prioritisation and investment.

The Framework also provides a means for conducting a confidence assessment based on a minimum level/standard of information required for decision-making, relative to the scale of resource investment. This assessment is underpinned by an information hierarchy that establishes clear expectations for all parties in the evidence base required to support management decisions.

The Framework will provide practical guidance to assist land and water managers to assess the information available to support management decisions. In so doing, it will provide greater assurance of the outcome for decision-makers wishing to invest in landscape management, and build public confidence and on-going resource/political commitment.



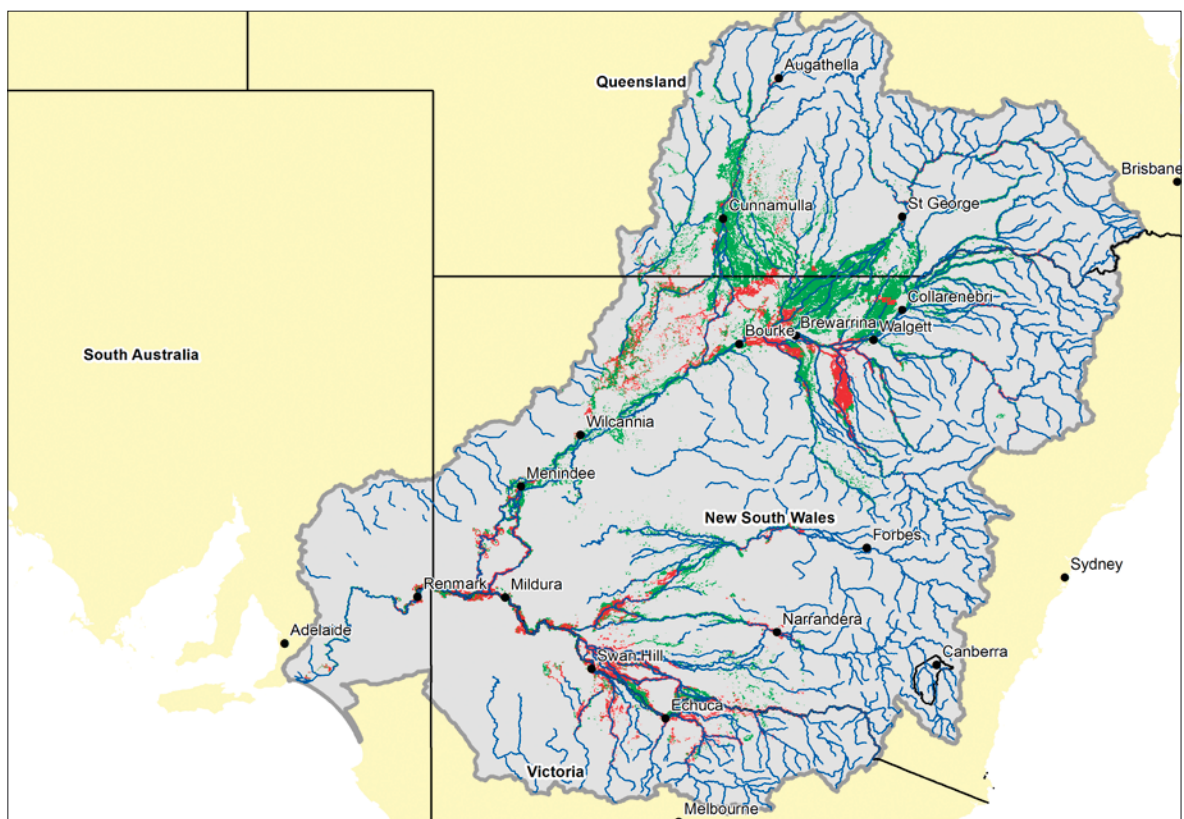
Commonwealth Environmental Water Office

The Black Box Management Framework is available at:

<https://www.environment.gov.au/water/cewo/publications/black-box-management-framework>



Black Box community (John Baker © Department of the Environment and Energy)



Map of vulnerability of Black Box across the Murray-Darling Basin to support prioritisation of NRM investment (red=vulnerable to combination of flooding frequency, groundwater depth and salinity) (© Department of the Environment and Energy)

Taking the pulse of wetlands

– waterbird surveys over three decades

Annual aerial surveys of more than 50 waterbird species, over 35 years (1983-2017), have covered almost a third of Australia, visiting up to two thousand wetlands each year.

Large areas of wetlands can be without water in a dry period, contrasting with extensive expanses during wet periods. The survey represents one of the more extensive and long-term wildlife surveys in the world, measuring changes in the freshwater realm, encompassing the world's most threatened environments. The aerial surveys data is used for state of environment reporting, management of recreational waterfowl shooting, tracking ecological character of Ramsar sites, assessing conservation values of wetlands for gazettal as protected areas and information to assist in assessing potential impacts of developments.

The survey tracks across ten survey bands, every two degrees of latitude, extending from the east coast of Australia to the middle of the continent. Each survey band is thirty kilometres wide, with every river, lake, swamp and estuary in the band surveyed for waterbirds each year. In addition, small farm dams are also counted on an ad hoc basis. This survey has been funded by the eastern states, University of New South Wales, Sydney and the Australian Government.

There are also more intensive surveys of all of the major wetland systems in the Murray-Darling Basin, funded by the Murray-Darling Basin Authority (see map). These surveys focus on Ramsar-listed sites and include surveillance of breeding colonies of waterbirds.

Aerial surveys are done from a single engine aircraft. One person counts the waterbirds around the edge of the wetland while the other observer on the other side of the aircraft, counts waterbirds towards the middle of the wetland, producing a total estimate for the wetland. Those data are used in long-term trend analyses and assessment of drivers of change at the wetland, river and even major river basin scale.

The surveys also track the status of more than 50 individual species, providing one of the few data sets on a large suite of freshwater species across a significant part of Australia. Importantly, data on the community of waterbirds for a particular wetland can be analysed separately as functional response groups (e.g. fish-eating waterbirds) to determine ecosystem changes. The data have allowed long-term assessment of the deleterious impacts of water resource developments on wetlands, including the building of dams and diversion of water. They have also provided a powerful source of evidence for major policy decisions relating to environmental flows to rivers and wetlands, including Ramsar-listed sites.

Measuring long-term changes to wetlands is challenging but necessary to track changes in ecological character and inform management aimed at mitigating threatening processes. Such data are difficult to collect, particularly over extensive areas, but are essential to separating out anthropogenic impacts from natural drivers. Waterbird surveys across eastern Australia have proved very effective at delivering such information.

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Kingsford, R. T., and J. L. Porter. 2009. Monitoring waterbird populations with aerial surveys - what have we learnt? *Wildlife Research* 36:29-40.

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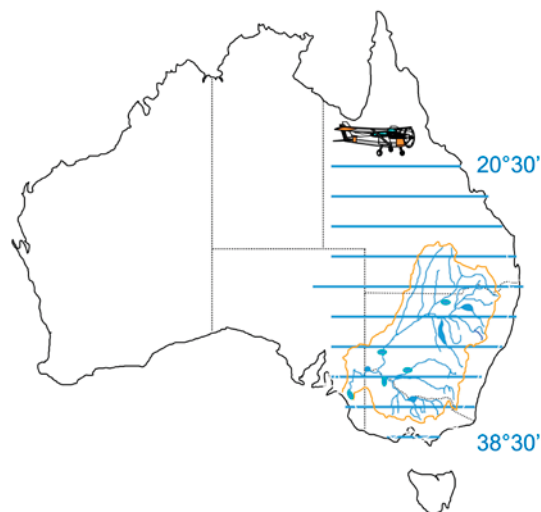
Website - <https://www.ecosystem.unsw.edu.au/content/rivers-and-wetlands/waterbirds/eastern-australian-waterbird-survey>



Cape Barren Geese and Australian Pelicans congregate on the Ramsar-listed Coorong, Lower Lakes and Murray Mouth wetland at the end of the Murray-Darling Basin, one of Australia's most important sites for waterbirds and regularly counted each year during aerial surveys (© R.T. Kingsford)



All waterbird species on a wetland are counted from a single engine plane flown about 50 m above the water (© R.T. Kingsford)



More than 50 species of waterbirds are counted each year within ten surveys bands each 30 km wide, within which all wetlands and rivers are marked and surveyed. In addition, waterbirds on all major wetlands (blue filled) in the Murray-Darling Basin in the southeast of the continent are also counted. (© R.T. Kingsford)

No magic bullets for conservation in a changing climate

Conservation actions aimed at addressing existing ecological degradation can be used as a suite of complementary building blocks for a low-risk climate change adaptation strategy.

The management of aquatic ecosystems is complex and challenging. Now climate change adds to the uncertainty of management outcomes and encourages a re-think of management for conservation as management for adaptation. This is particularly important for aquatic ecosystems, as they struggle with past degradation and face mounting pressure from generally hotter conditions and changes to water flows into the future.

In a project funded by the National Climate Change Adaptation Research Facility, we looked at how managers can incorporate adaptation (and avoid mal-adaptation) into their routine management actions. We first developed a [Climate Change Adaptation Catchment Assessment Framework](#) and then used it to assess nine common management actions in three catchments in NSW and Victoria. The table lists management actions that were assessed, outlining their conservation benefits and contributions to climate change adaptation.

In our assessments, we considered various aspects of adaptation, including the potential for maladaptation (perverse outcomes) and how an action performs under different climate change scenarios (such as extreme wet and extreme dry conditions). We also considered the economic and social consequences of the actions as well as its risk factors.

Our research indicates that a suite of complementary management actions is needed. For example, one impact of climate change will be rising temperatures and changing rainfall patterns leading to higher evaporation and increasing water temperatures. The restoration of riparian vegetation can directly lower stream temperatures, while the conservation of gaining reaches (where groundwater flows into a river channel) provides a source of cooler

ground water feeding into streams that can further ameliorate high temperatures and provide a drought refuge for native fish.

Geomorphic restoration provides new habitats for native fish, however to be fully utilised, habitat connectivity must be ensured so that aquatic species can make their way to the restored habitats. The management of exotic species is also needed to ensure that the restored sites are not colonized by pests.

Our research found that any of the current conservation actions could deliver significant adaptation benefits if they were better linked and extended. However, their potential climate adaptation benefits have not been properly assessed. The upscaling of many of these options is constrained by institutional complexity and socio-economic considerations that should be included in assessments of management approaches. This aspect of our research is further explained in the paper listed below.

Key messages and recommendations are:

- Go for multi-benefit, low-risk options.
- A suite of complementary management actions is better than any one single 'magic bullet'.
- Reducing vulnerability of the past builds resilience for the future.
- Social and economic impacts and benefits of management actions need to be considered.

Actions	What it means	Biodiversity conservation	Climate change adaptation
Environmental flows	water released for environmental purposes	assists in species breeding events	helps to restore natural wetting and drying patterns
Environmental works and measures	regulators, weirs to spread water on floodplains	mimics natural flows	allows environmental watering with less available water
Thermal pollution control	retrofit of large dams to release water from the top, not the bottom	helps counteract cold water pollution	increases ecosystem resilience
Riparian revegetation	restoration (planting & fencing off) of riparian vegetation.	increases freshwater habitat quality	lowers water temperatures
Freshwater habitat connectivity	fishways and ladders, removal of redundant barriers	enables colonisation of restored sites	enables species migration
Conservation of resilient habitats	protection of intact habitats, free flowing rivers and rivers with favourable features	protects high biodiversity areas	habitats remain cooler and retain natural variability
Conservation of gaining reaches	protection of places where groundwater flows into the stream	protects high biodiversity areas	habitats remain cooler and retain natural variability
Geomorphic restoration	restoration of river bed and banks	provides suitable habitat for aquatic biota	provides drought refugia
Management of exotic species	removal and control of non-native species – plants and animals	prevents domination by invasive pests	prevents dormant pests from spreading

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Full report at:

https://www.nccarf.edu.au/sites/default/files/attached_files_publications/Lukaszewicz_2013_Low_risk_climate_change.pdf

Lukaszewicz, A., Pittock, J. & Finlayson, M. (2016). Institutional challenges of adopting ecosystem-based adaptation to climate change. *Reg Environ Change* 16: 487
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One of the options we assessed, Habitat Connectivity, includes the building of artificial fishways, like this one at the Glenore Weir on the Norman River, Queensland (© Tim Marsden)

A new map of the global intertidal zone

How much of the world is intertidal? Where does the intertidal zone occur? How are intertidal ecosystems faring with sea level rise and other threats?

To help answer these questions we have developed new satellite remote sensing methods to finally put mudflats on the map.

Around the world, intertidal ecosystems are being lost and destroyed at an unprecedented rate. But because the intertidal zone is regularly inundated throughout the tidal cycle, mapping, monitoring and protecting intertidal areas remains a difficult remote sensing challenge.

We teamed up with developers from the Google Earth Engine to make a new map of the world's intertidal zone. To be published later this year, this new map details the areas of the world's coastline that are regularly inundated throughout the tidal cycle.

Developing the global intertidal map required a new approach to solving the difficult problem of mapping a system that is largely underwater. Our new approach relies on the incredible computing capacity that Google can provide.

We took every single Landsat satellite image available to us—more than 700,000 in total—and developed a cutting-edge machine learning approach for classifying every pixel that occurs in the coastal zone. The result is a global map time-series depicting intertidal ecosystems at 30m resolution over a 30+ year period.

Achieving an analysis of this immense scale was only made possible through the use of Google's computing infrastructure. We ran millions of analyses in parallel, and completed in only a few weeks what would have taken nearly three decades to run on a single computer.

Our new intertidal map time series reveals remarkable patterns of intertidal change driven by both natural processes, such as sediment deposition, and threats driven by humans, like coastal development.

Researchers, managers and policy makers will be able use the data to help understand the status of intertidal ecosystems, manage coastal resources and monitor their character over time.

Our datasets and remote sensing analysis pipeline, which will be made available in late 2018, provides the means to measure and analyse change of the global coastal environment and support conservation activities worldwide.

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Images from top: Landsat image showing intertidal mudflats (grey) impacted by coastal aquaculture development in Shandong province, China (Landsat images courtesy of the USGS); Intertidal mudflats exposed at low tide in Patagonia, Argentina (© Nicholas Murray); Searching for Spoon-billed Sandpiper on the vast intertidal sand flats of Rudong, China (© Nicholas Murray)

