National Environmental Science Program

Marine and Coastal Hub research plan 2025 – Attachment B project plan

Contents

Project 5.1 – Mapping Sea Country and investigating conservation and restoration opportunities along the Kakadu coast and Garig Gunak Barlu National Park

Project summary

This project addresses the need for contemporary biodiversity and habitat data in the Garig Gunak Barlu National Park (Cobourg Peninsula) and coastal Kakadu National Park, essential for effective Sea Country planning and management. Successful co-management of protected areas requires strong support from the government to enable local communities to have autonomy in decision-making to benefit both the environment and livelihoods. The research focuses on a two-way knowledge transfer process to integrate Western science and Traditional Owners' knowledge to improve knowledge on the extent, condition, and biodiversity of coastal ecosystem habitats under current management and threats. This will empower Traditional Owners to make informed decisions on managing their coastal ecosystems, including restoration opportunities under emerging environmental markets, to improve the resilience of coastal communities and ecosystems under environmental changes while enhancing livelihoods.

To achieve this, researchers will collaborate with Traditional Owners to map coastal habitats, assess the biodiversity of coastal habitats, and evaluate environmental changes due to sea level rise and feral ungulate impacts. Outputs include co-authored publications, visually engaging materials, and a co-designed mapping project. Outcomes include better management of Kakadu National Park and Cobourg Peninsula by empowering Traditional Owners with enhanced knowledge that they can use to make on-ground decisions that benefit their communities and biodiversity conservation. This collaboration ensures that Traditional Owners' perspectives guide the management and preservation of culturally significant sites while exploring socio-economic opportunities in emerging environmental markets.

Project description

Project description

The coastal regions of the Garig Gunak Barlu NP and Kakadu NP face significant challenges in effective Sea Country planning and management due to inadequate biodiversity and habitat data and a rapidly changing climate. This lack of detailed baseline information hinders the ability to protect and restore these culturally significant areas, particularly in the face of environmental threats such as sea-level rise and the impact of feral ungulates. Additionally, past efforts have failed to fully integrate Traditional Owners' knowledge and perspectives into research activities and environmental management, further complicating sustainable practices. Therefore, with the potential expansion of the national park and future review of management practices, it is critical that Traditional Owners are well informed to be able to make decisions that improve the environmental and socio-economic outcomes of the co-managed protected area.

Project Objectives and Approach

This project seeks to address these challenges by collaborating with Traditional Owners to collect, map, and analyse biodiversity and habitat data in the region. The research aims to create a comprehensive and detailed dataset that will support effective Sea Country planning and the restoration of these critical ecosystems. The project will:

- Co-design a baseline intertidal and subtidal benthic habitat mapping survey using various methods such as helicopter aerial surveys, towed video, drop cameras and remote sensing approaches (high-resolution satellite imagery).

- Conduct surveys of faunal communities (indicator species) and assess the condition of coastal wetland ecosystems.

- Evaluate the impact of sea-level rise and feral ungulates on the environment using existing spatial data and models and using remote sensing and on-ground verification at accessible locations.

- Ground truth vegetation and assess biodiversity across key taxa, particularly in saltmarsh and supratidal zones.

- Produce outputs including co-authored publications, spatial data and visually engaging materials that will be accessible and useful to Traditional Owners.

Priority and Relevance

This project is a priority because it addresses the urgent need for detailed environmental data and the inclusion of Traditional Owners in the management of their ancestral lands. With the increasing threats posed by climate change and invasive species, accurate data and inclusive planning are crucial for preserving biodiversity and cultural heritage. The involvement of Traditional Owners is essential for cultural reasons and to ensure that management strategies are grounded in local knowledge and traditions. Kakadu Traditional Owners have stated that this project should set the foundation for developing a Sea Country Plan of Management.

Research Methodology and Scope

The research will be carried out through a combination of fieldwork, data analysis, and collaborative planning. It intentionally takes a landscape approach, consistent with Traditional

Owner perspectives, including the mosaic of coastal ecosystems present in Kakadu. In scope are activities such as:

- Field surveys using advanced technological methods (i.e. towed video, BRUVs) to map and assess coastal habitats. Inter-tidal helicopter surveys only for part of the Garig Gunal Barlu coast but all of the Kakadu coast.

- Biodiversity surveys of mangroves and supratidal forest, including established methods to assess vegetation and habitat condition, molluscs, and birds led by Dr Hagger, and measurements of culturally important species in consultation with Traditional Owners. We propose to undertake two field surveys either to encompass seasonal variation (e.g. early dry season and late dry season) or temporal variation (e.g. climate variability over two years). Indicators measured may include:
- Native tree species composition
- Tree (canopy) height, basal area, tree canopy cover, shrub cover, native shrub, grass, and forb/other species composition
- Seedling density
- Native vegetation ground cover and non-native vegetation ground cover
- Organic litter cover
- Epiphyte cover
- Pneumatophore density and height
- Crab burrow density
- Disturbance by hooved animals
- Gastropod and bivalve species diversity
- Bird species diversity – waterbirds, shorebirds, and terrestrial birds

- Physical ungulate disturbance assessments at mangroves and supratidal wetlands using established transect- or point-based methods. Porewater salinity measurements at select locations across intertidal, supratidal, and freshwater wetlands to determine saltwater intrusion.

- Collaborative planning and data analysis sessions with Traditional Owners to ensure their knowledge and perspectives are fully integrated.

- Production of accessible materials to communicate findings to a wider audience, particularly the Traditional Owners.

Out of scope are:

- Long-term monitoring beyond the project's timeframe.

- Areas outside the defined geographical focus of Cobourg Peninsula and coastal Kakadu.

- Creation of new hydrological models of the impacts of sea level rise.

- Economic assessments not directly related to the environmental or cultural impacts identified.

Case Studies and Trial Programs

This project involves case studies areas to measure the impacts of sea-level rise and feral ungulates on coastal ecosystems. These studies will offer insights into practical measures that can be implemented to mitigate these impacts and improve the physical environment.

Related Prior Research

This project builds on previous research conducted under the NESP project 3.8, which assessed the impacts of feral ungulates on wetland biodiversity and greenhouse gas emissions in the floodplain wetlands of Kakadu. The lessons learned from this earlier work, particularly the need for better data and greater inclusivity of Traditional Owners, have

directly informed the current project's approach. From the Gulf of Carpentaria to the Kimberley, several benthic habitat surveys have been conducted in partnership with Aboriginal ranger groups under the NESP program. The surveys proposed here adopt the same consistent method for comparability and robustness. While the impacts of sea level rise on Kakadu ecosystems have been studied since the early 2000s, research has been fragmented and difficult for the Traditional Owners to access. This project will seek to consolidate prior research and share effectively with Traditional Owners to aid decision making for management. Related prior research includes:

- *NESP MaC Project 1.15 – Coastal wetland restoration for Blue Carbon in northern Australia 2021-2022.* Led by Valerie Hagger and Cath Lovelock (UQ), this project developed a method that can be widely used across Australia to prioritise coastal wetland restoration sites for Blue Carbon projects based on a value-based framework that considers biophysical suitability, balancing of wetland values, condition, regulation and policy adequacy, and economic feasibility.

- *NESP MaC Project 3.8 – Carbon abatement and biodiversity enhancements through controlling feral ungulate disturbance in wetlands, 2023-2025.* Led by Cath Lovelock and Valerie Hagger (UQ), the project worked with Traditional Owners, academics and governments to characterise the benefits of feral ungulate control in wetlands, providing science to underpin the development of an Emission Reduction Fund method and/or Nature Repair Market, where payments for carbon credits and biodiversity enhancements would fund management of feral ungulates on Country.

- *NESP MaC Project 3.19 – Addressing Kakadu's Strategic Marine Research Needs 2023-2024.* Led by Rachel Groom (CDU), the project will be conducted in partnership with Bininj and Mungguy Traditional Owners to deliver a research strategy that will provide guidance on what marine research needs to be done and how it should be conducted in Kakadu. This is a cross-cutting initiative that will harmonise with the broader Kakadu Research Strategy led by Michael Douglas in the Resilient Landscapes Hub.

- *NESP TWQ Hub 3.1, 3.2.1, 5.4, NESP2 MAC Project 1.13: Seagrass mapping synthesis.* Led by Alex Carter, Rob Coles (JCU), Skye McKenna (JCU), Catherine Collier (JCU). Synthesis of the available seagrass spatial data in the Great Barrier Reef, Torres Strait and the Gulf of Carpentaria collected 1982-2022. This project was critical in identifying data gaps and priority areas for mapping and monitoring.

- *GBRF Healing Country Grant, 2022-2024:* Assessment of seagrass in a dugong hotspot in Girramay and Bandjin sea country in northern Hinchinbrook Island/ Girringun TUMRA/ IPA. Led by Girringun Aboriginal Corporation (Jade Pryor), Alex Carter and Chris Cleguer (JCU) and Rachel Groom (CDU). This project mapped seagrass and megafauna, including dugong and green turtle, equipped Girringun Rangers with subtidal monitoring equipment, trained Girringun Rangers in GIS mapping techniques, and provided essential information to Girringun Aboriginal Corporation for managing the Girringun TUMRA and IPA.

Linkages with Other Research and Hubs

The project is closely linked to other NESP Marine and Coastal Hub research projects, particularly those focused on Indigenous engagement, environmental management, and threatened species. This project will also collaborate with other hubs working on climate change adaptation and biodiversity conservation, ensuring a coordinated and comprehensive approach to environmental management in Northern Australia. Coordination is aided by sharing of key personnel across multiple projects. This project links to other research including:

- *NESP MaC Project 3.5 Supporting regional planning in northern Australia: Building knowledge, skills and partnerships for understanding seagrass distribution.* Led by Alex

Carter, Catherine Collier (JCU), Rachel Groom (CDU) and Kathryn McMahon (ECU). This project is mapping seagrass habitats across northern Australia through targeted mapping expeditions in data-deficient regions across northern Australia, and modelling gaps. The project has strengthened relationships with coastal communities, built on existing knowledge and skills, trialled new technologies for monitoring, and synthesised historical and new seagrass data into an open-access resource.

- *Limmen Marine Park (Commonwealth) and Limmen Bight Marine Park (NT)*. Led by Catherine Collier and Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats were mapped in the southern Gulf of Carpentaria (NT) in collaboration with li-Anthawirriyarra rangers and NT Parks and monitored in 2023.

- *GBRF Seagrass and Blue Carbon in the Girringun TUMRA.* Led by Girringun Aboriginal Corporation (Jade Pryor), Alex Carter and Nathan Waltham (JCU), Rachel Groom (CDU), and Valerie Hagger and Catherine Lovelock (UQ). This project is implementing drone-based seagrass monitoring at six sea countries in the Girringun IPA/TUMRA and mapping carbon values and restoration opportunities.

- *NESP MaC Project 4.1 Coastal seagrass of the Gulf of Carpentaria: building knowledge and capacity as a foundation for long-term monitoring*. Led by Catherine Collier (JCU), Alex Carter (JCU) and Mark Hogno (CLCAC). This project is mapping intertidal seagrass habitats from the NT border to Karumba, QLD. New technologies for monitoring using drones will be collaboratively tested in key locations.

- *Yanyuwa IPA seagrass mapping and monitoring (NT).* Led by Mabunji Aboriginal Resource Indigenous Corporation, Rachel Groom (CDU), Catherine Collier and Alex Carter (JCU). Benthic habitats have been mapped and a monitoring program is under development using drones and drop cameras from ranger boats.

- *Yanyuwa Sea Country Planning and Management (NT).* Led by li-Anthawirriyarra sea ranger unit, Rachel Groom and Jackie Gould (CDU) and John Bradley (Monash University). This project takes a rights-based and risk-based approach to sea country planning to ensure Yanyuwa people's values are central to their sea country management.

- *Incorporating Aboriginal Peoples' Perspectives into Fisheries Management Review Processes (NT).* Led by Rachel Groom and Jackie Gould (CDU), NT Fisheries, Northern Land Council, Stephen Schnierer, NT Aboriginal communities in the Gulf of Carpentaria, Daly River, Maningrida and NE Arnhem Land. FRDC-funded.

- *South East Arnhem Land IPA seagrass mapping and monitoring (NT).* Led by Northern Land Council, Catherine Collier, Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats are being mapped (2022 – 2024) with funding from NESP MaC Project 3.5, a DCCEEW IPA grant, an NTG Aboriginal Ranger grant, and a monitoring program developed using drones and drop cameras from ranger boats.

- *Tiwi Islands IPA seagrass mapping and monitoring (NT).* Led by Tiwi Resources, Catherine Collier, Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats are being mapped (2023 – 2024) with funding from NESP MaC Project 3.5 and NTG Aboriginal Ranger Grant, and a monitoring program developed using drones and drop cameras from ranger boats.

- *NESP MaC Project 1.11 - OzSET: Integration and publication of the Australian Surface Elevation Table dataset.* Led by Neil Saintilan (Macquarie University) and Cath Lovelock

(UQ), this project synthesised data on Australian coastal floodplains and wetlands that are threatened by accelerating rates of sea-level rise. The assessment of the vulnerability of these environments requires measurements of rates of vertical accretion, subsidence and elevation gain across a range of coastal settings. Australia's network of Surface Elevation Tables is one of the most extensive in the world, consisting of over 200 benchmark monitoring stations from Westernport Bay, Victoria, to Darwin Harbour, NT. The project collated and made available through a national platform data on accretion, subsidence and elevation change in mangroves, saltmarshes, seagrasses and tidal freshwater forests, information vital to coastal risk assessment.

Application of Research to Decision-Making and On-Ground Action
The outcomes of this project will significantly enhance the ability of Traditional Owners and other research users to make informed decisions regarding the management of coastal ecosystems. The detailed data collected, along with the inclusive planning process, will provide a strong foundation for on-ground actions to protect and restore these areas. Additionally, the project's outputs, including the co-designed mapping project and visually engaging materials, will serve as vital tools for communicating and implementing effective management strategies. By integrating Traditional Owners' knowledge with scientific research, the project will contribute to sustainable and culturally respectful environmental stewardship.

By providing opportunities to enhance the capacity, knowledge, and visibility of Traditional Owners, they will be better equipped to engage in park management discussions and advocate for their perspectives. This positions them as critical voices in the management of culturally significant sites and in responding to environmental challenges. Over time, this increased influence can lead to more formalised roles, such as securing seats on the Kakadu or Cobourg Board of Management. Traditional Owners will be better positioned to directly inform and guide park management decisions, ensuring that cultural values and traditional knowledge are fully integrated into the management strategies.

Traditional Owners are actively involved in the Kakadu and Cobourg Boards of Management, and they can continuously contribute to the park's governance, ensuring that the management of Kakadu reflects both contemporary environmental needs and cultural priorities. This ongoing influence not only leads to more sustainable and culturally aligned management practices but also creates opportunities for Traditional Owners to explore socio-economic benefits, such as participation in environmental markets, further reinforcing their role in the stewardship of Kakadu's landscapes.

Project 5.2 – A toolkit for ranger-led seagrass monitoring in northern Australia Sea Country

Project summary

Monitoring of key habitats is increasingly being led by Indigenous Ranger groups. It is important that this information, across the whole of northern Australia, is collected in a reliable and consistent manner. Our project will develop a robust framework for monitoring seagrass habitats across northern Australia, ensuring consistent and reliable data collection to support conservation and management efforts. By partnering with Indigenous rangers, researchers, and local filmmakers, we will co-create visually engaging training materials and establish a monitoring decision-making framework tailored to diverse Sea Country environments, ranger resources, and monitoring questions. This research is crucial for managing culturally and economically significant species like dugongs and green turtles, aligning with national priorities and the NESP2 guidelines by promoting Indigenous-led conservation efforts and enhancing environmental data quality.

Project description

Project description

Seagrass habitats in northern Australia face pressures from climate change, floods, cyclones, land activities, and commercial and recreational fishing. These pressures threaten habitats critical for threatened and migratory species that depend on healthy seagrass meadows, including dugongs and green turtles. Consequently, seagrass mapping and monitoring have become priorities in Sea Country management plans. Significant progress has been made in consolidating historical data and mapping new areas since 2020 (funded by NESP, DCCEEW, TSRA, State and Territory Governments, GBRF). However, monitoring programs and understanding seagrass condition variability remain limited beyond Queensland's east coast and Torres Strait.

Indigenous ranger groups seek to understand seagrass health, provide opportunities for rangers on Sea Country, and build monitoring capabilities. Equipped with small vessels, drones, and trained staff, remote ranger groups are well-positioned to begin coastal monitoring using new approaches such as drones. Monitoring programs will have significant conservation and management impacts if a comprehensive and consistent approach is used. This includes appropriate indicators and methods, accessible and high-quality training materials, and empowering rangers to monitor confidently.

To achieve this, we will create a consistent monitoring framework for the diverse seagrass habitats of northern Australia. We will continue collaborating with Karajarri, Girringun, Torres Strait and li-Anthawirriyarra/Marranbala rangers. In Torres Strait, we will utilise recent seagrass mapping and the long-term monitoring partnership between JCU and TSRA. For ranger groups just beginning to monitor seagrass, we will co-design and implement monitoring programs. Leveraging other contracted research funding for 2025, we aim to include a filmmaker to create publicly available short films about the importance of seagrass and how to monitor it that can be used for monitoring training. These resources will aid community engagement, train new rangers, and serve as refresher courses. Training materials will complement Field Manuals for Marine Sampling to Monitor Australian Waters, Version 2 (Przeslawski and Foster 2020), which did not include intertidal (drone, helicopter, walking transect) or shallow subtidal (underwater video camera drop, van Veen grab) methods suited to ranger operations. We will promote this work to other ranger groups and research users through seminars, conferences, webinars, co-authored report and publication and presentations, and short films.

Related prior research includes:

- *NESP TWQ Hub 3.1, 3.2.1, 5.4, NESP2 MaC Project 1.13:* Seagrass mapping synthesis. Led by Alex Carter, Rob Coles (JCU), Skye McKenna (JCU), and Catherine Collier (JCU). Synthesis of the available seagrass spatial data in the GBR, Torres Strait and the Gulf of Carpentaria collected 1982-2022. Was critical in identifying data gaps and priority areas for mapping and monitoring, and results from monitoring in this project will contribute towards an update of those data.

- *GBRF Healing Country Grant:* Assessment of seagrass in a dugong hotspot in Girramay and Bandjin sea country in northern Hinchbrook Island/ Girringun TUMRA/ IPA. Led by Girringun Aboriginal Corporation (Jade Pryor), Alex Carter and Chris Cleguer (JCU) and Rachel Groom (CDU). This project mapped seagrass and megafauna, including dugong and green turtle, equipped Girringun rangers with

subtidal monitoring equipment, trained Girringun rangers in GIS mapping techniques, and provided essential information to Girringun Aboriginal Corporation for managing the Girringun TUMRA and IPA.

- *DBCA:* Conserving critical seagrass habitat for dugong: an integrated assessment across the Pilbara. Led by Kathryn McMahon, Paul Lavery and Amanda Hodgson (ECU) and Chris Cleuger (JCU). This project focused on three areas of known dugong use to understand the density and spatial distribution of dugong via drone surveys, and how this distribution is related to the benthic habitat. In addition, in these three areas seagrass abundance, condition and resilience were monitored over time.

- *WAMSI:* Defining thresholds and indicators of Primary Producer response to dredging related pressures. Led by Mat Vanderklift (CSIRO), Kathryn McMahon and Paul Lavery (ECU). There were two relevant sub-components in this project: the abundance, condition and resilience of seagrass in the Exmouth Gulf region over time, and the genetic diversity and connectivity in that region. In addition, there was a snapshot at 10 sites across the Pilbara on seagrass abundance and condition.

This project links to other research including:

- *NESP MaC Project 3.5.* Supporting regional planning in northern Australia: Building knowledge, skills and partnerships for understanding seagrass distribution. Led by Alex Carter, Catherine Collier (JCU), Rachel Groom (CDU) and Kathryn McMahon (ECU). This project maps seagrass habitats across northern Australia through targeted mapping expeditions in data deficient regions including Karajarri Sea Country. It will strengthen relationships with coastal communities, build-on existing knowledge and skills, co-design training resources with rangers to undertake monitoring, trial new technologies for monitoring, and synthesise historical and new seagrass data into an open access resource. This proposed project will provide an invaluable next step to further enhance capacity and add to the longevity of monitoring programs.

- *Torres Strait Seagrass Report Card and Monitoring Program.* Led by Torres Strait Regional Authority and Land and Sea Rangers and Alex Carter (JCU). For over 15 years TSRA and JCU have worked together to understand the health of seagrass meadows through a range of mapping and monitoring programs. Rangers lead intertidal transect walking and boat-based subtidal monitoring, while JCU lead reef-top helicopter-based monitoring. Results are incorporated with the Port of Thursday Island monitoring (JCU/ Ports North) into an annual seagrass report card covering 28 sites across islands, subtidal meadows and reefs. The proposed project will provide helicopter and transect training material developed with Torres Strait rangers.

- *Limmen Marine Park (Commonwealth) and Limmen Bight Marine Park (NT) (2021-2023).* Led by Catherine Collier (JCU), Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats were mapped in the southern Gulf of Carpentaria (NT) in collaboration with li-Anthawirriyarra rangers and NT Parks and monitored in 2023. The proposed project will provide a continuation of monitoring and camera drop-based training material developed with li-Anthawirriyarra rangers.

- *GBRF Seagrass and Blue Carbon in the Girringun TUMRA.* Led by Girringun Aboriginal Corporation (Jade Pryor), Alex Carter and Nathan Waltham (JCU), Rachel Groom (CDU), and Valerie Hagger and Catherine Lovelock (UQ). This project is implementing drone-based seagrass monitoring at six Sea Countries in the Girringun IPA/TUMRA and mapping carbon values and restoration opportunities. The proposed project will provide a continuation of monitoring at a few locations and drone-based training material developed with Girringun rangers.

- *NESP Mac Project 4.1.* Coastal seagrass of the Gulf of Carpentaria: building knowledge and capacity as a foundation for long-term monitoring. Led by Catherine Collier (JCU), Alex Carter (JCU) and Mark Hogno (CLCAC). This project is mapping

intertidal seagrass habitats from the NT border to Karumba. New technologies for monitoring using drones will be collaboratively tested in key locations. Training materials developed in this proposed project will be relevant for ongoing monitoring in the southern Gulf.

- *Yanyuwa IPA seagrass mapping and monitoring (NT).* Led by Mabunji Aboriginal Resource Indigenous Corporation, Catherine Collier (JCU), Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats have been mapped and a monitoring program using drones and drop cameras from ranger boats is under development. Training materials developed in this proposed project will be relevant for ongoing monitoring in the southern Gulf.

- *South East Arnhem Land IPA seagrass mapping and monitoring (NT).* Led by Northern Land Council, Catherine Collier (JCU), Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats are being mapped (2022 – 2024) with funding from NESP MaC project 3.5, DCCEEW IPA grant, and NT Ranger grant, and a monitoring program developed using drones and drop cameras from ranger boats. Training materials developed in this proposed project will be relevant for ongoing monitoring in the southern Gulf.

- *Tiwi Islands IPA seagrass mapping and monitoring (NT).* Led by Tiwi Resources, Catherine Collier (JCU), Alex Carter (JCU) and Rachel Groom (CDU). Benthic habitats are being mapped (2023 – 2024) with funding from NESP MaC project 3.5 and NT Ranger grant, and a monitoring program developed using drones and drop cameras from ranger boats. Training materials developed in this proposed project will be relevant for ongoing monitoring in the southern Gulf.

Our project aligns with national priorities and NESP2 guidelines by promoting sustainable marine ecosystem management, improving Indigenous futures, innovating monitoring and decision-making processes, and advancing Indigenous research and monitoring priorities for Sea Country. Outputs include (1) A publication co-authored by researchers and rangers on a monitoring decision-making framework for seagrass monitoring in northern Australia's diverse habitats; (2) Visually engaging and publicly available short films, posters, flyers, and manuals on the importance of seagrass, monitoring methods and species identification; (3) Co-designed monitoring programs and first-year monitoring in Karajarri and Girringun Sea Country following recent baseline surveys; (4) Presentations at conferences, seminars, and webinars, co-presented by researchers and rangers. Outcomes include:

• Enhanced Seagrass Management: Improved decision-making for seagrass monitoring, leading to better management and conservation of northern Australia's seagrass communities.

• Capacity Building: Increased skills of Indigenous rangers in seagrass monitoring and research.

• Public Engagement: Greater awareness of seagrass habitats through accessible materials.

• Collaborative Efforts: Strengthened collaboration between researchers and Indigenous communities for a more integrated approach to marine conservation.

• Influence Policy: Contributions to policy and practice through dissemination of findings, influencing future monitoring and conservation strategies.

• Sustainable Monitoring: Contribute to the establishment of sustainable, ranger-led monitoring.

• Scientific Contributions: Co-authored report and publication providing a framework for seagrass monitoring, guiding future research and initiatives.

Project 5.4 – Innovations To Support Crown-Of-Thorns Starfish Control and the Resilience of the Great Barrier Reef

Project summary

The Great Barrier Reef (GBR) faces increasing threats from climate-induced mass bleaching, cyclones, and Crown-Of-Thorns Starfish (COTS). To maximise the GBR's capacity to respond to these threats, it is vital to maintain coral cover and target management actions at the locations that best support the resilience of the GBR.

Of the major threats to the GBR, only COTS can currently be directly managed. Australia's COTS control program has already acted to reduce coral mortality at over 450 reefs. This project will develop innovations that increase the efficiency of COTS control, enabling protection of more reefs and more coral.

To maximise the resilience of the GBR, we must target protection to networks of reefs that can function together to rapidly recover from disturbance. This project will build our understanding of the factors and locations that support the resilience of the GBR.

The research will be closely partnered to deliver directly to research-users in the COTS Control Program and the Reef Authority. The innovations developed will progress the adaptive management of the resilience of Australia's marine ecosystems.

Project description

The Great Barrier Reef (GBR) faces increasing cumulative threats, due to the increasing incidence and severity of major acute disturbances (e.g., climate-induced mass bleaching, cyclones, and population outbreaks of Crown-of-Thorns Starfish (COTS)), compounded by chronic anthropogenic threats (e.g., declining water quality and fisheries exploitation) (Pratchett et al. 2014). To maximise the GBR's capacity to respond to these threats, it is vital to maintain coral cover and target management actions at the locations that best support the resilience of the GBR (Maynard et al. 2010, Mellin et al. 2019, Matthews et al. 2024). This project will provide innovations that maximise the amount of coral protected, through efficiency improvements to COTS control, and build our understanding of the factors and locations that are most important to the recovery and resilience of the GBR.

Of the major acute disturbances that directly contribute to elevated rates of coral mortality, only COTS can currently be directly managed (Westcott et al. 2015). Protecting reefs from COTS maintains coral cover and diversity, fostering the resilience and adaptive capacity of the GBR to respond to cumulative threats. Since 2018, Australia's COTS Control Program has employed an Integrated Pest Management (IPM) approach to protect coral at over 450 reefs, based on research developed under the National Environmental Science Program Tropical Water Quality Hub (2015 – 2020), and the COTS Control Innovation Program (2020 – 2024). This is the largest and most successful coral protection program on the GBR, but it still only protects ~12% of the GBR's 3806 reefs (Matthews et al. 2024). Innovations that increase the efficiency of COTS control will allow more reefs and more coral to be protected with the resources available to the Control Program. This project will increase the efficiency of COTS control by: 1) developing adaptive refinements to the design of the day-to-day program to increase operational efficiency, allowing more coral and reefs to be protected for the same amount of on-water investment; and 2) developing better detection methods for low-density COTS populations in the area suspected to initiate new outbreaks, allowing early and efficient intervention, and building our understanding of the drivers of outbreak initiation.

Reef management efforts that protect coral at high-priority locations maintain coral cover and diversity at those locations. However, individual reefs both depend on and contribute to the long-term health and resilience of the reefs around them through processes such as larval dispersal. To maximise the long-term viability and resilience of the GBR, we must target protection to networks of reefs that can both maintain vital ecosystem functions, and support recovery from disturbance. This project will build our ability to target reef management to these networks, by building our understanding of the factors and locations that can support the resilience of the GBR under projected long-term exposure to key threats. It will also assess the performance of COTS control strategies that target these areas, or respond to acute events, like bleaching or cyclones, to support coral recovery and reef resilience.

The research will be closely partnered to deliver directly to end-users in the COTS Control Program and the Reef Authority. The innovations developed will progress the adaptive management of the resilience of Australia's marine ecosystems.

1. <u>Increasing COTS control efficiency with adaptive refinements of operational decisions</u>

The COTS Control Program, while effective and successful (e.g., Westcott and Fletcher 2019, Westcott et al. 2020, Matthews et al. 2024), has clear opportunities for increased operational efficiency, which this component of the work package will deliver. The COTS

Control Program makes extensive use of the data collected during control activities to guide effective ecologically-informed decision-making using advanced analysis and decision support systems (Fletcher et al. 2020, Fletcher et al. 2024a). This approach underpins the success of the Control Program, but as the Program has been implemented, opportunities have emerged to increase the efficiency of COTS control by supporting more effective data-informed decisions (Fletcher et al. 2024a). The project will engage directly with Control Program staff to identify areas where the greatest efficiency gains are likely to be available, to target analyses at the highest value areas for innovations to on-water operations.

The project will produce a number of outputs focused on areas where potential efficiency gains in the COTS Control Program have been identified. For instance, manta tow data is critical to effective decision-making in the Control Program, but it performs poorly when COTS densities are low, such as early in an outbreak, or at the end of control actions at a reef (Fletcher 2024a). This project will develop management-ready methods of implementing and processing existing and new data sources, including cull data, manta data and advanced analytics, to improve decision-making and increase efficiency around completing control at a reef. Control Program data will be analysed to refine key Control Program parameters, such as COTS density thresholds targeted for management, so that Control Program resource use can be reduced while effectiveness is maintained. The ways that reefs are prioritised for control will be refined to account for real-world conditions to reduce days lost to non-operational conditions. The outputs of these analyses will be integrated into existing digital decision support platforms utilised by managers and control program operators.

2. SALAD surveys for low-density COTS surveys

At the scale of the Control Program, the most significant determinant of regional COTS control success is a proactive approach to control early in the outbreak cycle within a region (Matthews et al. 2024). However, operationalising this insight is difficult, because early in an outbreak individual COTS are small and difficult to detect. Worse, current methods of large-scale surveillance, such as manta tow, exhibit particularly low detectability for small individuals (MacNeil et al. 2016). This effect is most significant for new Outbreak cycles, both because there is no upstream outbreak to indicate when new outbreaks may occur, and because missing the start of an outbreak constrains understanding of the putative causes of recurrent outbreaks.

Recent data suggest that renewed COTS outbreaks have recently commenced in the northern GBR, as evidenced by sustained increases in COTS densities around Lizard Island since 2021 (Chandler et al., 2023). To guide effective and rapid localised COTS control, better methods for detecting and responding to low-density aggregations of small COTS are required. Scooter Assisted Large Area Diver-based (SALAD) surveys have demonstrated capacity to both effectively resolve low densities and detect subtle changes in the abundance of COTS at individual reefs. The efficiency and efficacy of SALAD surveys for COTS surveillance may have similar utility for culling COTS in areas with low to moderate densities. The ability of SALAD to accurately resolve COTS densities at the beginning and end of outbreaks will be crucial to building our understanding of the ecological patterns and processes involved in the initiation of renewed outbreaks, which could provide the most efficient and effective long-term solution to COTS control.

This component of the work package will deliver:
1) Annual SALAD surveys in four regions (Cairns, Lizard Island, Princess Charlotte Bay, and Cape Grenville) to further assess changes in the size and abundance of COTS and,

     thereby, better understand patterns and processes involved in the initiation of renewed population irruptions on the GBR.

2) More extensive SALAD surveys on reefs in the vicinity of Lizard Island, to further refine the utility and application of this method, to not only detect broad changes in COTS densities, but inform and facilitate effective culling.

Together, these outputs will: 1) provide crucial data for guiding immediate COTS control response; 2) build an understanding of the drivers of COTS outbreak initiation; and 3) further develop the SALAD method for more widespread use as both a surveillance tool and a control tool, especially for low-density COTS populations.

3. <u>Understanding factors that drive the resilience of the Great Barrier Reef.</u>

Reef management efforts that protect coral at high-priority locations maintain coral cover and diversity at those locations. However, given the increasing frequency, severity and diversity of disturbances (including escalating climate impacts), simply protecting coral at locations we value will not be sufficient. Each reef we choose to protect will act as an important source of coral larvae to promote recovery of downstream reefs following future impacts. Those future impacts will vary across the GBR, exposing different reefs and regions to different levels of risk. To maximise the resilience of the GBR to future threats, we must target protection to networks, clusters or portfolios of reefs that can function together in a way that allows them to rapidly recover in the limited period between successive disturbances (Maynard et al. 2015, Mellin et al. 2019, Matthews et al. 2024).

This sub-project will progress three key research components to improve our understanding of the locations that are likely to support the resilience on the Great Barrier Reef. First, it will generate new coral larval dispersal matrices to identify how coral larvae from source reefs are transported to sink reefs to fuel recovery, and identify clusters of reefs that operate as larval sources or sinks. Second, it will identify likely thermal refugia based on hydrodynamic modelling of ocean currents and upwellings of cool water. It will integrate these thermal refugia into risk exposure estimates, including COTS distributions and other coral reef damage processes. It will combine the risk exposure maps with the larval connectivity clusters to identify areas likely to be important to fostering reef recovery to acute disturbance events, and long-term resilience to chronic threats. Finally, it will use GBR ecosystem models to understand how protecting these areas contributes to long-term reef resilience outcomes. It will test COTS control strategies that target these areas important to reef resilience and respond to acute events, like bleaching or cyclones, to identify strategies that can support coral recovery and reef resilience.

Project 5.5 – Assessing impacts of extreme events on inshore coastal habitats in the northern Great Barrier Reef

Project summary

This project aims to assess the impacts of Tropical Cyclone Jasper and associated flooding on inshore coastal habitats (i.e. mangroves, seagrass, coral) in the northern GBR. This project will provide a current consolidated asset assessment that will be compared against previous monitoring/assessment data to determine any impacts of TC Jasper. This will be achieved through high-resolution imagery, rapid on-ground aerial surveys, subtidal surveys using underwater camera systems, and consolidating other available information (i.e., anecdotal/private records). Understanding the impact of TC Jasper on inshore coastal habitats is essential as extreme climate events can cause significant and enduring changes to the condition and resilience of critical habitats of key species, such as dugongs and turtles.

Project description

Tropical Cyclone (TC) Jasper crossed the coast north of Port Douglas in mid-December 2023. TC Jasper was the wettest tropical cyclone in Australian history, breaking many rainfall records and causing significant and damaging flooding in the region. Since TC Jasper, there has been no regional on-ground assessment of adjacent coastal habitats (seagrass, mangroves, inshore reefs etc.) to assess the extent of impact that TC Jasper and its subsequent record flooding had on these habitats. Extensive physical impacts of the intense rainfall and flooding to hillsides, waterways and riparian zones are visually evident in the affected areas but impacts in the coastal/marine zone have not been assessed. This project will address this knowledge gap through on-ground assessments (i.e., low-level aerial surveys, subtidal surveys using underwater camera systems), imagery, synthesising other available information (i.e., anecdotal/private records/photos/drone footage) and comparing against recent historical available data.

Understanding the impact of TC Jasper on coastal habitats is essential because these extreme climate events may be more common in the future and can cause significant and potentially long-lasting changes to the habitats of key species, such as dugongs and turtles, which rely on healthy seagrass meadows and coral reefs for feeding and shelter. This project will provide an opportunity to evaluate any potential 'downstream' or longer-term impacts of habitat change on key species such as dugongs and turtles and will provide recommendations where possible for restoration, rehabilitation, accelerated recovery and reducing further loss to key habitats.

On-ground activities will occur between Kurrimine Beach (Cassowary Coast region) and the Endeavour River (Cooktown Shire), extending from the mangrove line to the GBR Waterbodies "Open Coastal" zone; ~6km off the coast (also including the Low Isles and Green Island) – the Area Of Interest (Figure 1). This is the area of coastline that was 'activated' by DESI under the Disaster Recovery Funding Arrangements (DRFA) as the Local Government Areas (LGAs) which were impacted during the cyclone and subsequent flooding.

Inshore habitats (mangroves, seagrass, reefs, oyster beds etc.) and coastal reefs will be assessed by:

- Low-level helicopter surveys – Surveys conducted at spring low tide when extensive intertidal areas are exposed to the air.
  - Helicopter surveys allow for extensive areas to be assessed relatively quickly and cost effectively for the amount of area surveyed.
  - Helicopter surveys allow for ground truthing and closer inspection of habitat as the helicopter can land or hover within 1m of the substrate.
  - Remote imagery - to inform any before/after TC Jasper changes.
    - Also allows for identification of long-term changes i.e., mangrove canopy extent and coverage.
    - UAV/drone imagery of inshore reefs in the Area of Interest collected before and after TC Jasper.

Subtidal habitats (i.e., seagrass, coral, algae) will be assessed by:

- Identifying priority areas/blocks with Traditional Owners and researchers to concentrate on-ground efforts.
- Vessels using underwater camera equipment and potentially underwater drones.

Key Information collected will include (but not limited to):

Mangroves: Change in canopy extent & coverage, species composition, structure, condition, and potential threats. For established methods see (Canning and Duke 2022; Duke et al. 2024; Duke et al. 2022)

Seagrass: presence/absence of seagrass, biomass, % cover and extent loss, sediment movement/deposition, dominant species, signs of disease (i.e., necrosis). For established methods see Carter et al. 2014; McKenzie et al. 2022; McKenzie et al. 2024; Reason et al. 2024.

Project 5.5 Impacts of extreme events on inshore coastal habitats in the northern GBR.

Coral: % cover hard & soft coral, functional/structural groups, evidence of bleaching, disease, smothering, death, sediment deposition (adapted Reef Health Impact Survey methodology to suit aerial techniques & limited inshore visibility from underwater camera systems).

Other habitat: i.e., algae presence/absence, % cover categorised into five functional groups (erect macrophytes, erect calcareous, filamentous, turf mat), sponges, oysters.

This project links to the threatened and migratory species and threatened ecological communities Initiative. The project links to and will help inform various research and monitoring initiatives conducted by JCU, the Reef Authority Marine Monitoring Program, Cape York Water Partnership, Ports North and Traditional Owners. This project will provide recommendations to the State Disaster Recovery Program. The survey methods will be consistent with those used in previous NESP seagrass and mangrove surveys across northern Australia, including recent mangrove dieback surveys. This will allow data to be integrated into these projects in the future and enable historical data comparison. The surveys will be targeted in areas where data is available to enable an assessment of impacts due to TC Jasper.

Subject to approvals by Traditional Owners as appropriate, the data collected and produced by this project will be available to Commonwealth, State, and regional management agencies, as well as on-ground researchers and Traditional Owners and can guide environmental decision-making and on-ground action by:

- Providing a current consolidated asset assessment of coastal intertidal and subtidal habitats for the Area of Interest to help inform management actions.
- A current consolidated asset assessment that can be compared against previous data (where available) to determine any impacts of TC Jasper.
  - A documented register of the impacts of an extreme weather event on coastal habitats in the northern GBR.
- Providing recommendations where possible for habitat restoration, rehabilitation, accelerated recovery or to reduce further loss.
- On-ground data can help inform/validate models (i.e., models on climate change and impacts on habitat, habitat suitability and predictability models) and remote sensing work that is being carried out on coastal habitats in this region.
- Inform expectations for any downstream impacts to threatened and migratory species such as dugongs and turtles.
- The project supports Reef 2050 Plan goals/objectives through:
  - Ecosystem health: thorough assessment of the current condition of coastal habitats after TC Jasper. Our project contributes to maintaining and enhancing the ecosystem's resilience. This is crucial for sustaining the ecological functions that support species such as dugongs and turtles.
  - Biodiversity: Our project aligns with the Plan's emphasis on protecting and conserving biodiversity by assessing the health of habitats critical to the survival of culturally and environmentally significant species. Understanding the impact of extreme weather events on these habitats helps inform strategies for their protection and recovery.
  - Adaptive management: The data and insights gained from our project will inform adaptive management strategies, aligning with the Reef 2050 Plan's commitment to responsive and informed decision-making. Our project provides a benchmark and the foundation for targeted actions that align with the plan's adaptive management framework.

What is out of scope as the budget stands

Additional funding will be required to cover costs of:

- Subtidal habitat surveys—without additional funding, the extent of subtidal surveys will be limited to areas covered by in-kind contributions (i.e., from Mandubarra, GMY, Ports North & Jabalbina).

- Support a re-survey of areas/habitats in 2025 to track longer term recovery/lack of recovery from impacts associated with TC Jasper.

- Deeper engagement with Traditional Owners including more survey work to answer questions of interest to each group.

Project 5.5 Impacts of extreme events on inshore coastal habitats in the northern GBR.

References:

Canning, A., and Duke, N. 2022. Monitoring mangrove threats across the Torres Straits using remote-sensing. James Cook University, Townsville, Australia.

Carter, Alexandra & Rasheed, Michael. (2014). Critical Marine Habitats in High Risk Areas, South Warden Reef to Howick Group - 2013 Atlas. Centre for Tropical Water & Aquatic Ecosystem Research Publication 13/56.

Duke, N., Canning, A., and MacKenzie, J. 2024. More intense severe tropical cyclones in recent decades cause greater impacts on mangroves bordering Australia's Great Barrier Reef. In Oceanographic Processes of Coral Reefs. Edited by E. Wolanksi and M. Kingsford. CRC Press, London, England.

Duke, N., Mackenzie, J., Canning, A., Hutley, L., Bourke, A., Kovacs, J., Cormier, R., Staben, G., Lymburner, L., and Ai, E. 2022. ENSO-driven extreme oscillations in mean sea level destabilise critical shoreline mangroves - an emerging threat. In review at PLOS Climate.

McKenzie, L.J., Langlois, L.A., Roelfsema, C.M. 2022, Improving Approaches to Mapping Seagrass within the Great Barrier Reef: From Field to Spaceborne Earth Observation. Remote Sensing, 14(11): 2604. doi: doi:10.3390/rs14112604

McKenzie, L.J., Collier, C.J., Langlois, L.A., Brien, H., Yoshida, R.L. 2024, Marine Monitoring Program: Annual Report for Inshore Seagrass Monitoring 2022–23. Report for the Great Barrier Reef Marine Park Authority. 179pp.

Reason C, Hoffmann L, McKenna S & Rasheed M. 2024. Seagrass habitat of Cairns Harbour and Trinity Inlet: Annual Monitoring Report 2023, Centre for Tropical Water & Aquatic Ecosystem Research, Publication Number 24/20, James Cook University, Cairns, 44 pp.

Is this a cross-hub project?

Yes. The Resilient Landscapes Hub is presently developing a comparative project to look at the impact of TC Jasper flooding on freshwater species in the rivers and streams of the affected area. Being focused on freshwaters, the locations and methods are different from those of the current study, but combined, our work will provide a comprehensive picture of the status of key ecosystems affected by TC Jasper. Both NESP Hub projects are reporting to the same Qld Govt-DESI Disaster Recovery Team, and we are in contact with the RL Hub research team and their developing NESP proposal.

Does this project contribute to a cross-cutting initiative?

Yes, the Threatened and migratory species and threatened ecological communities in the Resilient Landscapes Hub.

This project will examine the status of seagrass and other important coastal habitats that support populations of key species (dugong, turtle, fish) and ecological communities (seagrass) after extreme weather (cyclones, floods, marine heat waves) and in relation to prioritising recovery of these habitats.

Project 5.6 – Synthesis of environmental values information to support review of Australian Marine Park Management Plans

Project summary

The statutory review of the Management Plans for Australian Marine Parks (AMPs), including the Coral Sea, is scheduled for 2028. To support this, data synthesis from the Marine and Coastal (MAC) Hub and other external work must be completed by 2026. This synthesis will integrate research findings from 2017 onwards into Parks Australia's processes in 2027. The MAC Hub has focused on understanding the status and trends of natural values within AMPs and improving socio-economic value estimates. Key NESP-funded projects, such as 4.20 and 4.21, are developing monitoring protocols and data frameworks for sentinel parks, which will receive more frequent monitoring. This project will consolidate park-level data to support the review process at the network level. National marine data platforms like SQUIDLE+, GlobalArchive, AODN, and Seamap Australia will provide essential summaries for user-friendly reports. These synthesis reports will offer network-level assessments, science outputs, and summaries of natural and socio-economic values, contributing to the AMP management plan reviews and potentially informing national State of the Environment and State of Parks reports.

Project description

Project description

The statuary review of the Management Plans for the North, North-West, South-West, Temperate-East AMP networks and the Coral Sea AMP will occur 2028 to meet requirements under the EPBC Act 1999. Information, data and synthesis of MAC Hub and broader NESP products for this process need to be complete by the end of 2026 to allow integration into Parks processes in 2027. This will include all information from 2017 onwards which could not be considered when the plans were established.

The MAC Hub has made significant investments in understanding the status and trend of natural values within Australian Marine Parks Networks (through projects such as 1.3, 2.1, 2.2, 2.3, 4.20, 4.21). In collaboration with NESP researchers, Parks Australia has developed a management effectiveness system, which relies on the collection of relevant monitoring data on assets and pressures occurring in Australian Marine Parks (AMPs) to support decision-making. Currently, two NESP projects, 4.20 and 4.21, are feeding directly into this system focusing on developing monitoring protocols for natural assets and establishing data reporting frameworks for sentinel parks. Sentinel parks, a subset of AMPs, will be monitored more intensely and frequently. A crucial component of this overall management effectiveness system is the development and provision of synthesis reporting capability that can consolidate zone and park-level data outputs to the network level (Figure 1).

The collation and synthesis of information will be based on MAC and previous hub projects and appropriate other contracted work that is essential for Parks Australia to meet the reporting requirements associated with the review of management plans for the remaining five networks in 2028 (southeast review was completed in 2023/24) and State of Parks reporting. This will include a data scan, to be delivered at the first Research-user workshop, that will form the catalogue for the primary data products to be used in the synthesis.

Portals such as Seamap Australia, eAtlas and AODN can provide information and reports that summarise the location, frequency and content of seafloor sampling platforms for natural values and pressures. The transfer of knowledge from research and monitoring datasets to Parks Australia is hampered by the lack of user-friendly tools to summarise research and monitoring outputs in a management-ready format.

MAC Hub project 2.3 provided a list of natural value indicators and metrics recommended to inform management and Project 2.2 provided a workflow template to generate some of these metrics for fish assemblages, from stereo-BRUV data, and benthic assemblage data, from BOSS and BRUV data. Project 4.20 will also deliver workflows and a reporting template for values and pressures assessments to enhance understanding of the status of AMPs, combining the development of monitoring protocols from survey design to data analysis. Parks Australia has also contributed to the maintenance of the GlobalArchive, with a planned output of syndicating synthesis and reporting ready fish assemblage summaries, including composition and size-based indicators to Seamap Australia. Similarly, the IMOS Understanding of Marine Imagery Facility has machine learning capabilities to detect overabundant native benthic species (such as Long-spine Sea urchins) and classify the cover of broad-level indicators (such as canopy-forming macroalgae, hard corals and sponges) and size-based indicators that can be flexibly exported to platforms such as Seamap Australia.
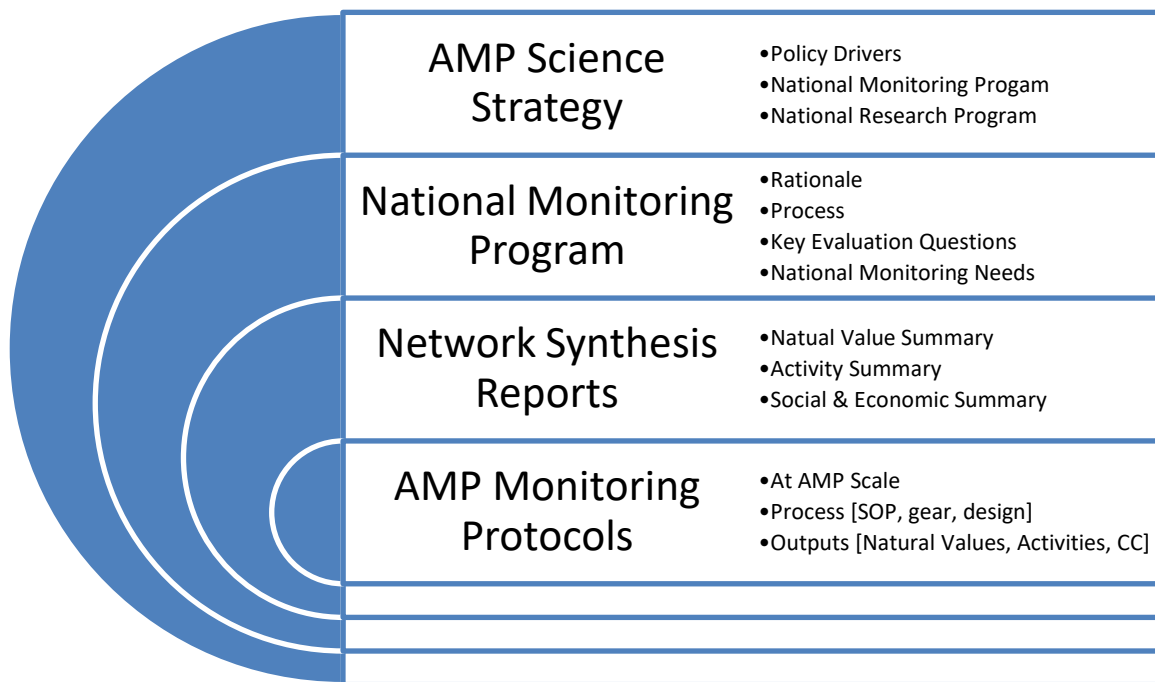
Figure 1. National AMP monitoring and assessment initiatives

Another important aspect of the management plan review is to track how socio-economic benchmarks of the AMPs have changed over time. This project will link to 'Update of socio-economic values information to support review of Australian Marine Park Management Plans' (proposed MAC project 5.10), as these data provide important information for park and network scales estimates of recreational fishing pressure, which can be an important pressure to inform the natural values condition and trends across various AMPs, via redesign and update of the D6 Socio-economic benchmark boat-ramp surveys – and national recreational use patterns hosted on Seamap Australia.

This project will produce network-scale synthesis reports for all AMP networks and the Coral Sea (not including the SE AMP network) to provide foundational knowledge inputs to the statutory review of AMPs. We will also review the data summaries, workflows and reporting tools (i.e., that formed the building blocks of the synthesis) and provide recommendations for how these can better fit together to future regional and national environmental impact and assessment reporting. It is envisaged that developing data summaries will enhance currently available functionality with other nationally recognised platforms, such as Seamap Australia, to inform the 10-yearly statutory review processes for AMP management plans in 2028 as well as potentially the upcoming national State of the Environment reporting.

Specifically, this project will provide:

1. A catalogue of available data for each network and the Coral Sea AMP (not including the SE) for discussion in the early stages of the project (milestone 2)

2. A synthesis report for each network and the Coral Sea AMP (not including the SE) that includes:

   - A science outputs for the network

   - A summary of science activity since 2017 for the network

- A summary of natural values status for the network - aggregated to ecosystem component, ecosystem depth contour, zone and AMP where possible

- A summary of activity and pressures since 2017

3. A concise report providing a review of data summaries, workflows and reporting tools used to develop the synthesis reports and detailed recommendations on how such infrastructure can work together better in the future to support AMP and national environmental impact and assessment reporting

Project 5.7 - Updating knowledge of Australian white sharks

Project summary

Project A3 (Bruce et al. 2018) funded in the previous NESP Marine Biodiversity Hub provided an important update of the knowledge of Australian white shark populations in providing estimates of breeding population size and trend. However, the results were based on modest data sets and were limited by some critical knowledge gaps, particularly in relation to pupping and juvenile nursery areas. Additionally, recent work has noted that southern hemisphere white shark populations comprise a single lineage. However, the population structure within this is subject to uncertainty. Recent unpublished work has raised the prospect of a single Australian population. This project addresses a key objective of the White Shark Recovery Plan 2013 which identifies the need to provide a quantitative assessment of population trends and evidence of any recovery of the white shark in Australian waters. More specifically it will focus efforts to identify critical habitats and biologically important areas for white sharks and improve the understanding of population status including structure, abundance and potential trends through advancing close-kin mark recapture research.

Project description

Project description

There are a number of continuing key knowledge gaps for white sharks across southern Australia that will be important to understand population recovery and continuing threats. These are required to implement priority actions in White Shark Recovery Plan 2013. A project was proposed in RP 2024, with DCCEEW confirming a need to revisit the project and scope in RP 2025. The key areas for white shark research are identifying critical habitats and biologically important areas, as well as understanding population abundance and trends by advancing close-kin mark-recapture research. The previous NESP A3 project demonstrated that the close-kin mark-recapture approach can detect trends in adult abundance. However, given how long it takes animals to mature (12 – 13 years and above), recent possible trends in the juvenile population, specifically increases in survival and overall numbers post-protection of the species, are only likely to be detectable in the adult population in the future years. This project seeks to examine new data and determine if there is evidence of recovery trends in the adult population using CKMR. A key gap also remains in understanding the movement and habitat usage of large adults in both the eastern and southern-western populations.

This project proposes 3 subcomponents that will update our knowledge of population structure throughout the southern hemisphere for white sharks in Australia:

1. Investigate the feasibility of filling knowledge gaps around juvenile and pupping areas in WA/SA waters. This component would have significant Traditional Owner (TO) engagement, input and participation.

2. Investigate population structure to resolve mixing/connectivity questions.

3. Update population estimates based on significant new data collected by NESP hub partners and affiliates

1 A pilot study on filling key knowledge gaps for conservation of Australian white sharks

Data collection in NSW, SA, and WA has vastly increased our knowledge of white shark populations. However, a key gap remains in understanding the movement and habitat usage of large adults in both the eastern and southern-western populations.

The NESP A3 (2018) estimation of population size in the south-west is hampered by the challenge of sampling small juveniles for tagging and genetic analyses. This is in stark contrast to the Eastern population where access to known juvenile nursery areas has supported the collection of a large data set. Additionally, there are no definitively known pupping areas for either white shark population in Australian waters. A comprehensive study on this aspect is beyond the scope (in both funding and time) of the current NESP MaC hub. However, the project team believe that useful preliminary work can be conducted to advance this area, particularly with the additional information contained in the NESP A14 (2020) report on identification of nearshore habitats of juvenile white sharks in the southern western population. Specifically, we propose a pilot study to assess the effectiveness of tagging where the focus would be on tagging adult females (>4.5 m TL) and YOY/1+ animals (<2.0m TL).

This project will aim to deploy tags on YOY/1+ white sharks (<2.0m TL) and on adult female white sharks (>4.5m TL) throughout the southern-western white shark range. Genetic analyses will incorporate all available samples regardless of total length.

a. In SA, large females can be accessed across different aggregations and when overlapping with human activities. YOY/1+ are fewer but have been increasingly sighted and interacted with across SA. The increased knowledge of the occurrence of these two life stages provides new opportunities to access and tag them, and collect biological samples (see point 2 and 3).

b. In WA, there is an established route for tagging white sharks but most individuals tagged are within the 3.0m and 4.5m TL size classes with limited numbers of large adult females > 4.5m TL. YOY/1+ requires further stakeholder engagement, particularly with Traditional Owner (TO) groups in southern WA where fieldwork is required. WA DPIRD have ongoing relationships with key figures and would continue engaging with TO's on identifying potential juvenile/YOY nurseries to focus fieldwork.

2. Investigate southern hemisphere population structure

The project would gather samples from around Australia and also seek access to samples from South Africa and New Zealand to conduct a comprehensive update of white shark stock structure. Understanding population structure is of high importance for ongoing management and conservation planning.

Since the work by Blower et al. (2012), white sharks around Australian waters were considered to be split into two separate sub-populations. The kin-based analysis in Bruce et al. (2018- NESP A3) supported this result based on the distribution of kin pairs between nominal eastern and southern-western populations. More recent work from Deakin/University of Queensland, NSW DPIRD, and Flinders University, based on many more recent samples (though without samples from WA), suggests one mixed population. It is possible that limited gene-flow between eastern and southern-western populations would lead to this conclusion and yet the sub-populations still be demographically separate (i.e. within a generation only a few breeders from one population breed in their non-natal population). Alternatively, the increased sample size may be shedding light on a higher degree of mixing than previously thought.

3. Updated population estimates

The project would utilise the vastly updated tissue sample set from NSW (~1000 samples) to update and refine estimates of adult population size and population trend for the eastern population. Data from the NSW shark management program would also be used to estimate juvenile numbers. There are also ~2-300 additional samples from SA/WA that would be combined with previous samples in the southern-western population to refine estimates of population size. Given the population is likely to change slowly, the project would use updated estimates of population size and growth to determine an appropriate and cost-effective assessment cycle for ongoing monitoring and assessment of Australia's white shark populations.

The NESP A3 (2018) report detailed estimates of adult population size in both eastern and southern-western populations. A whole of population estimate was calculated for the eastern population by combining estimates of juvenile survival and population demographics. At that stage, no direct data suitable for juvenile abundance was available from the eastern population. This has now changed with intensive sampling by NSW DPIRD. The NESP A3

(2018) study could not provide a whole population size estimate for the southern-western population as limited access to small juveniles prevents sample collection or tagging data which could be used to estimate survival rates (hence the need for component 1, listed above).

Key outputs from this project will include final reporting that will document:

- close-kin mark-recapture estimates of adult abundance and trend
- a comprehensive update of white shark southern hemisphere stock structure using samples from around Australia and overseas
- an improved understanding of the movement and habitat usage of large adults in both the eastern and southern-western populations
- review of information, including Traditional Ecological Knowledge (TEK), related to the identification of critical white shark habitat for the SW population
- development of a recommended research program to assist in the identification of additional critical habitat for the SW population of white sharks

This project addresses a key objective of the White Shark Recovery Plan 2013 which identifies the need to provide a quantitative assessment of population trends and evidence of any recovery of the white shark in Australian waters. Given the population is likely to change slowly, the project would use updated estimates of population size and growth to determine an appropriate and cost-effective assessment cycle for ongoing monitoring and assessment of Australia's white shark populations.

Project 5.9 – Making marine environmental data more assessment ready

Project summary

The 2020 Independent Review of the EPBC Act (the Samuel Review) states that "Decision-makers, proponents and the community <u>do not have access to the best available data, information and science</u>. This results in sub-optimal decision-making, inefficiency and additional cost for business, and poor transparency for the community. Immediate investment in the information supply chain is needed to support reform. We can't wait until perfect data is available. What is missing at the moment, is the step required to routinely turn well-managed marine research data into marine environmental data and products, that can be consumed by the EIA national environmental data supply chain and made available for use in SOE reports, Environmental Economic Accounts, environmental assessments, and tracking of environmental trends and outcomes.

This project will address that gap by (a) identifying priority datasets currently managed as research data and (b) building the additional information infrastructure required to (c) routinely deliver marine environmental data and products that are assessment ready, in line with the Nature Positive Plan.

Project description

Project description

What is the problem?

As noted in the 2020 Independent Review of the EPBC Act (the Samuel Review) "Decision-makers, proponents and the community do not have access to the best available data, information and science". It goes on to say that "A national supply chain of information will deliver the right information at the right time to those who need it. This supply chain should be an easily accessible, authoritative source that the public, proponents and governments can rely on. A clear strategy to deliver an efficient supply chain is needed so that each investment made contributes to building and improving the system". This is a complex problem with multiple dimensions, including access to industry data. One dimension that is, however, tractable in the near term is improved access to research data.

Australia is fortunate to have world-class marine research facilities and institutions. These include the multi-institutional Integrated Marine Observing System (IMOS), which has operated a wide range of observing equipment throughout Australia's marine estate since 2007. Within IMOS, the Australian Ocean Data Network (AODN) is a critical marine data management capability, which makes all IMOS data available and incorporates other data contributions from universities and government research agencies. The Australian marine data landscape also includes mapping tools, principally Seamap Australia (UTAS/IMAS) and eAtlas (AIMS), that are built on institutional repositories and are supported by NESP. The NESP MaC Hub data strategy requires all Hub research data to be held in the appropriate repository and aggregated through the AODN to enable discovery and access through a central location.

Marine environmental research data in Australia is comparatively well-managed in part due to sustained investment by the Australian Government in systemic observing (IMOS), open data access (AODN), and applied environmental research programs focused on the marine environment (NESP). The marine environmental data and products produced from these investments are available for use by policy and decision-makers in assessment processes that require information on status and trend of marine habitats, species, and other measures. In practice, however, the use of the best available marine environmental research data in regular assessment processes is impeded by a lack of investment in additional analysis required to make research data 'assessment ready'. The aim of this project is to address the 'assessment ready' marine data gap.

Why is the project a priority?

The December 2022 Nature Positive Plan is the Australian Government's response to the Samuel Review. A key aspect of the Nature Positive Plan is the establishment of Environment Information Australia (EIA) to provide, clear authoritative sources of high-quality environmental information through establishment of a national environmental data supply chain. EIA environmental data and information will come from across governments, projects, scientists, and the broader community and be publicly available. Marine environmental research data is, therefore, very much in scope.

It is important for the marine and coastal research community to engage early with EIA in development of the national environmental data supply chain to ensure that other relevant

Australian Government investments are fully leveraged, providing greater return on investment to the community. With the next SOE report due in 2026, there remains a narrow window available for making more marine environmental research data assessment ready. The fact that the frequency of SOE reports will increase from every five years to every two years (from 2028) suggests that routine delivery of assessment-ready data and products will be even more important in the future. Preparation of Environmental Economic Accounts (EEA), significant environmental approval processes (including for offshore renewable energy development), tracking of environmental trends and outcomes, development of the Sustainable Ocean Plan, and Australia's commitment to the Global Biodiversity Framework (including the "30 by 30" target) all provide further impetus for this work.

How will the research be undertaken, including what is in and out of scope?

This project will be undertaken by (a) identifying priority datasets currently managed as research data and (b) building the additional information infrastructure required to (c) routinely deliver marine environmental data and products that are assessment-ready, in line with the Nature Positive Plan. Priority datasets will be selected through consultation with research-users at early stages of the project (potentially the first week of February 2025). This workshop will produce a list of prioritised dataset to be incorporated in the workflow based on specific criteria and documented rationale. Discussions to date, however, provide a high degree of confidence that we will identify priorities for which sufficient data exists to meet the project objectives. For example, SOE 2026 is likely to require data on the status and trend of the following habitats, species, and measures that the NESP MaC Hub is working on and/or IMOS/AODN is collecting data:

- Seagrass
- Seabirds and shorebirds
- Marine Mammals (Dugong, Cetaceans, Sea Lions)
- Sharks (White, Grey Nurse, Sawfish, Maugean Skate)
- Fish (Black Cod)
- Other useful measures (physical and chemical time series, plankton, microbes, pressures, contaminants)

A second workshop will showcase the data and services provided by the project. A key participant will be DCCEEW along with other identified key stakeholders. The project team will produce examples on different use cases identified by the stakeholders.

Data will be delivered using standard Open Geospatial Consortium protocols (OGC) and will be stored in cloud-optimised formats. Metadata will be discoverable through the AODN portal, which uses ISO19155 schema to ensure the interoperability of the records.

Details of related research

The project will build on relevant projects undertaken by the NESP MaC Hub (and predecessor Hubs). Recent presentations to the Hub Steering Committee on dugong, sea lion, and seagrass projects provide evidence of valuable new data being available that can contribute to future assessment processes if we format it appropriately through this project.

IMOS/AODN is continuing to attract additional investment via the Australian Government's National Collaborative Research Infrastructure (NCRIS) program. This project will build on the IMOS 2019 Status and Trends of Australia's Oceans Report (STAR), which provided a

proof of concept for this project and had some uptake in SOE 2021. Since then, IMOS/AODN has developed the Biological Ocean Observer (BOO) and, more recently, has been funded for a data uplift to make more non-IMOS data available via AODN, with emphasis on biological data. Leader of the current project – Eduardo Klein-Salas - is also the project leader for that data uplift project.

The existing relationships between NESP and IMOS with Seamap Australia (UTAS/IMAS) and eAtlas (AIMS) will be strengthened. Seamap Australia is the data repository for the NESP MaC Hub southern node, and eAtlas is the data repository for the northern node.

The Australian Research Data Commons (ARDC) is investing in a Trusted Environmental Data and Information Supply Chains project on offshore renewable energy development in the Gippsland region, facilitated by Hamish Holewa. This project is complementary in that it is focused on enabling access to potentially sensitive data (e.g., industry data that may have commercial implications), whereas MaC Hub project 5.9 is focused on making openly accessible research data assessment ready.

How will the research be applied to inform decision-making and on-ground action?

Project outputs will contribute to the EIA national environmental data supply chain, which will be used for SOE 2026 (then 2028, etc.), preparation of Environmental Economic Accounts (EEA), environmental approval processes, and tracking of environmental trends and outcomes. These assessment processes will inform future policy and management responses, including Species and habitat recovery programs, Ecosystem restoration programs, and Climate mitigation and adaption programs, which may be Government funded, industry-regulated, or incentivised through the Nature Positive Plan.

This project is expected to also be useful in identifying gaps where there is currently insufficient data to inform the required policy and management responses.

How will the information infrastructure continue to be supported?

This is a key consideration for the project. The data products associated with this project will be built by and integrated into IMOS national research infrastructure, and thus sustained over time. Too often these types of activities are funded as short-term, time-bounded projects with no clear plan for observational and data management sustainability. This will not be the case for this project.

Project 5.10 – Improving socio-ecological understanding of natural values of the Australian Marine Parks

Project summary

This project aims to progress the use of socio-economic information to support the management of and contribute to the review of the Australian Marine Parks (AMPs). This work will build upon a previous NESP project (D6 Socio-economic Baselines) and redevelop existing socio-economic benchmarks to reflect Parks Australia's new Sentinel Park approach and network scale reporting. It will estimate changes in public awareness, attitudes, and usage patterns since a 2019/20 benchmark. This information is crucial for the upcoming AMP management plan review in 2028 and will contribute to the overall management effectiveness system by integrating socio-economic and natural values data, and improved socio-ecological understanding, complementing NESP led projects (SS2, D7, 1.3, 4.20 and 4.21) on data synthesis at both Sentinel Park and network scales.

Project description

Project description

This project will progress and refine the use of socio-economic values and use information of the Australian Marine Parks (AMPs), providing trends in public awareness and support for management plans and provide essential information on use and benefits to support the statutory review of AMPs required under the EPBC Act 1999, with a focus on sentinel park locations and complementing current and proposed projects to synthesise information on natural values.

A review of Management Plans for the North, North-West, South-West, Temperate-East AMP networks and Coral Sea MP will occur in 2028. Information, data and synthesis of MaC Hub outputs for this process needs to be complete by end of 2026 to allow integration into the AMP review and link together this project outputs with those synthesising natural values information.

The NESP Hubs have made considerable progress into understanding the status and trend of natural values (through projects such as MaC Project SS2, D7, 1.3, 2.1, 2.2 and 2.3) and socio-economic values and benchmarks (through previous MBH Project D6 and MaC Project 2.5) across the AMP Networks.

In collaboration with NESP researchers, Parks Australia has developed a management effectiveness system, which relies on the collection of relevant monitoring data on values, uses and pressures occurring in AMPs with a focus on sentinel parks: a subset of locations that will be monitored more intensely and frequently.

The integration of natural and socio-economic values is a critical component of management effectiveness reviews. Currently, two NESP projects, 4.20 and 4.21, are feeding directly into this system focusing on developing monitoring protocols and reporting frameworks for natural values within Sentinel Parks.

The redesigned socio-economic monitoring design will be critical in assessing the effectiveness of AMP management by tracking changes in key metrics and informing the upcoming management plan reviews. It will also provide essential covariates on use and pressures within AMPs, complementing natural values data for a comprehensive understanding of the parks.

Changes in socio-economic values of the AMPs and linking park usage to natural values

An important aspect of the management plan review is to track how socio-economic metrics of the AMPs have changed over time and to ensure alignment with strategies for monitoring natural values of the Australian Marine Parks. This project will provide a synthesis of the social and economic metrics of the AMPs, established through redesigned surveys of general public, and both recreational fishers and non-fishing recreational users. The redesigned survey will include components used by AMP zoning, and outputs will be generated showing metrics linked to natural values present in AMPs by zone. This project

will also explore changes since these 2019/2020 surveys to evaluate management effectiveness for the AMPs at both network and individual Park scales whilst redesigning surveys to better represent sentinel parks and network scale reporting.

This project will see the delivery of socio-economic knowledge, attitudes and practice (KAP) surveys, building on the approaches developed through the previous NESP MBH D6 and NESP MCH 2.2 Field Manuals projects, and drawing on insights from NESP MCH 2.5 on Recreational Fisher Compliance with zoning, to support analysis of trends to inform management reviews of the AMPs. This will include a redesign of a repeatable national KAP boat ramp survey targeting recreational fishers and non-fishers who use the AMPS at 9 key locations around Australia, including sentinel parks regularly accessed by recreational users. These locations will be selected through further co-design with Parks Australia in the early stages of the project. It will also involve a redesigned national general public survey to understand broader community views towards the AMP network. Both surveys will enable changes since 2019/2020 to be assessed and address key questions for the AMP management plan review in 2028.

The proposed survey methodology has been demonstrated to provide trends in public awareness and attitudes towards the AMPs, providing an important assessment for the management effectiveness system. In addition, these surveys provide essential information for park and network scale estimates of recreational fishing use, which can be an important covariate to inform the natural values condition and trends across various AMPs, sentinel parks and at network scales. Furthermore, gathering additional data on park usage by zone will allow for the representation of recreational/social usage of the parks to be analysed against the natural values present. This will allow researchers to represent the value of park zones by usage and highlight the level of understanding, support, and value by the public based on zoning category. There is currently no other source of this information to inform the management framework and review.

The draft budget has been designed based on adequate survey locations to characterise the Coral Sea, North, North-west, South-west, South-east and Temperate East Networks, with consideration given to sentinel parks. The selection of final AMPs, survey locations and spread across the networks should be co-designed with Parks Australia and other collaborators.