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| ATTACHMENT A  Research Plan 2 (Amended)  *Research Projects* |
|  |
| *2 December 2015 (v2b)* |

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# Project A1 – Northern Australian hotspots for the recovery of threatened euryhaline species

*Project length* – 24 months

*Project start date* – 01/07/2015

*Project end date* – 01/07/2017

*Project Leader* – Peter Kyne (FTE – 100%)

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*Lead Research Organisation* – Charles Darwin University

*Total NESP funding* - $819,665

*Total Recipient and Other Contributions (co-contributions)* - $819,665

|  |  |  |  |
| --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* |
| *NESP funding* | *$349,000* | *$403,581* | *$67,084* |
| *Cash co-con* | *$30,800* | *$29,800* | *$5,706* |
| *In-kind co-con* | *$318,200* | *$373,781* | *$61,378* |

**Project Summary**

Euryhaline elasmobranchs represent over half of the EPBC-listed threatened sharks and rays, with northern Australia of national importance for this threatened species community. Critical information gaps remain, limiting the implementation of Recovery Plan objectives. This project will fill many data gaps through the application of acoustic telemetry, traditional and advanced molecular research (population genetics and close-kin mark-recapture), life history studies and Indigenous knowledge and education. End-users, primarily the Department of the Environment, state and territory fisheries and wildlife agencies, and Indigenous organisations, will be provided with information necessary to improve management and facilitate recovery of these threatened species, focusing on three themes: (1) Monitoring and understanding euryhaline species; (2) Indigenous partnerships for management of euryhaline species, and; (3) Knowledge for the reassessment of river shark status.

**Problem Statements**

*Problem*

Euryhaline elasmobranchs represent over half of the EPBC-listed threatened sharks and rays, with northern Australia of national importance for this threatened species community. Critical information gaps remain, limiting the implementation of Recovery Plan objectives. New information demonstrates the value of northern estuaries and rivers to sustaining these data-poor species, and advancing technologies are allowing the discovery of data essential to the management and, ultimately, recovery of these species.

*How Research Addresses Problem*

This project will provide new knowledge on the status, distribution and management of species based on the application and development of an array of technologies and partnerships, with the aim of improving status and a re-evaluation of the EPBC listing of key species. The three project themes will each utilise a diverse array of methodologies, drawing on a broad collaborative approach. Indigenous partnerships will bring to the project unique knowledge on species and their habitats.

*What solution will this research provide?*

This research will provide the Department of the Environment with a vastly improved understanding of the status of several threatened species to inform and direct management and recovery decisions.

This project has a short-term focus with the bulk of activity in 2015 and 2016, concluding with the retrieval of the extensive acoustic receiver array deployed under NERP ($110,000 value) in early 2017, which will then be available for future NESP projects (2017-2020). Indigenous partnerships developed in this project will potentially form the basis of longer-term NESP projects.

*Alignment with NESP Research Priorities*

This project aligns with the following Departmental research priorities:

* Determine and trial practical and repeatable methods for monitoring the status and trends of key coastal and marine species and environments to underpin management of Commonwealth Marine Reserves.
* Improve our knowledge of key marine species and ecosystems to underpin their management and protection.
* Identify key opportunities to collaborate and build Indigenous participation and knowledge into the management and protection of marine species.

This project is addressing the following EPBC Recovery Plan for Sawfish and River Shark objectives:

* Improve the information base to allow the development of a quantitative framework to assess the recovery of, and inform management options for, sawfish and river shark species.
* Develop research programs to assist conservation of sawfish and river shark species.
* Improve community understanding and awareness in relation to sawfish and river shark conservation and management.
* Reduce and, where possible, eliminate adverse impacts of Indigenous fishing on sawfish and river shark species.

**Research**

*Description of research*

This project comprises three themes with the following research components:

Theme 1: Monitoring and understanding euryhaline species

1. Continue annual monitoring of euryhaline elasmobranchs currently tagged (212 individuals) in NT rivers for mortality estimates, movement patterns and critical habitat determination (regular downloading of 55 acoustic receivers (see Appendix I for tentative download schedule), plus tagging of 30 neonate *G. glyphis* in 2015 for mortality estimates)
2. Host a small-scale working group on prioritising recovery-directed research on threatened euryhaline elasmobranchs, and for considering ‘stopping-rules’ for investment in threatened euryhaline elasmobranchs
3. Investigate the optimal design of acoustic receiver arrays to measure long term movement and mortality of euryhaline elasmobranchs in NT, QLD and WA rivers
4. Develop statistical methods for estimating annual juvenile mortality accounting for movement and uneven coverage of acoustic arrays (due to the periodic loss of receivers)
5. Initiate a tagging program on large sub-adult *Glyphis glyphis* (1.5m +) to investigate adult distribution, reproductive philopatry & mortality (Adelaide River) (basis for future NESP proposal to investigate migratory corridors and critical habitat use of large marine species including river sharks)
6. Determine the age of *Glyphis glyphis* for demographic models and potentially testing DNA ageing, using existing specimens and collection of 10 medium to larger-sized animals from the Adelaide River
7. Synthesize and report on habitat use (including critical habitat), long-term movements and biologically important areas for euryhaline elasmobranchs (synthesising all NESP phase 1and NERP research)

Theme 2: Indigenous partnerships for management of euryhaline species

1. Develop partnerships to assess Indigenous cultural use and knowledge of sawfish, and develop a sawfish education package for communities (commence in 2-3 communities with scope to expand)
2. Develop protocols and methodologies for implementing annual Malak Malak (NT) sawfish survey (billabong fishing survey and relocation of trapped animals to main channel; I-Tracker application development; deploy small-scale acoustic receiver array for monitoring effectiveness of relocation program) (annual survey and monitoring to form the basis of future 2017-2021 NESP funding proposal if successful in 2015-2016)
3. Develop data collection, mapping and monitoring tools to support the above in collaboration with NAILSMA and utilising I-Tracker tools as appropriate

Theme 3: Knowledge for the reassessment of river shark status

1. Undertake field collection of *Glyphis garricki* tissue samples in unsurveyed NT habitat (primarily large rivers including Daly and Victoria Rivers) and WA distribution (Cambridge Gulf, King Sound) in partnership with Indigenous Ranger Groups
2. Examine population structure of *Glyphis garricki* (using existing and newly collected tissue samples)
3. Establish lower bound population size estimate (close-kin mark-recapture) for *Glyphis garricki*
4. Using data gained from the above research, undertake an updated assessment of the status of river sharks based on extent of occurrence, area of occupancy, population structure and population size calculations (synthesising all NESP phase 1and NERP research)

*Links with other projects and hubs*

This project links to other Hub projects on management of marine species, namely the project on White Shark status which shares some methodological approaches, and the project on prioritisation of research and management needs for threatened elasmobranch species. This project links to the Threatened Species Recovery Hub and the Northern Australia Environmental Resources Hub, with an additional link to the Threatened Species Commissioner.

*Related research*

This research expands on methodologies developed under NERP Marine Biodiversity Hub project 2.4 ‘Supporting Management of Listed and Rare Species’. That project was a proof of concept for close-kin mark-recapture as a tool to estimate population status in rare, poorly-known and difficult to sample marine species. The trial focal species for that project was *Glyphis glyphis*. The project also delivered additional research on three other threatened species, but these were not the prime focus of the close-kin mark-capture study.

Tools developed under the NERP project can now be extended to monitor other species through an existing NERP-funded acoustic receiver array, to apply the close-kin mark-recapture method to additional species (namely in this proposal, the Endangered *Glyphis garricki*) and to reassess the EPBC status of key species with this new information.

This project leverages off the extensive acoustic receiver array deployed under NERP in the Northern Territory.

**Expected Outcomes**

*Outcomes*

* 1. Improved knowledge of key marine species to underpin their management and protection
  2. Practical and repeatable monitoring of threatened euryhaline species
  3. Enhanced Indigenous participation in the management and protection of marine species
  4. Status determination for threatened river sharks
  5. Indigenous community education to improve the status and management of threatened euryhaline species
  6. Indigenous Ranger Group training in threatened species surveying and management

*Specific management or policy outcomes*

* 1. This project will monitor and refine the status of key threatened species, leading to a reassessment of EPBC status with an evaluation of the appropriateness of down-listing key species
  2. The establishment of a long-term sawfish patrol on Malak Malak country in the Daly River region (with the possibility to expand this program elsewhere) will see any juvenile sawfish which have been stranded in drying waterholes be relocated to the main river, with the practical outcome of increased survivorship (relocated animals will be tagged to monitor survivorship and evaluate the program long-term) and increased capacity for monitoring
  3. The rolling out of an Indigenous education program on the status of key species (initial focus on sawfish, with extension to other species) will aim to decrease mortality of threatened species (through increased safe release following capture)

*Value*

Euryhaline elasmobranchs represent over half of the EPBC-listed threatened sharks and rays, and are subject to a multi-species Recovery Plan. This project will directly address several Recovery Plan objectives (listed above), and the project outcomes will be measured against meeting those objectives. The project will also lead to the reassessment of EPBC-status of key species (river sharks) which will demonstrate improvements in understanding since the first EPBC-listings (this may also lead to the demonstration of improved status). The project will aim to improve sustainability of threatened species through Indigenous education and stakeholder engagement with the commercial fishing industry.

**Planned Outputs**

* Updated assessment for river shark status
* Manuscripts on ecology and status relevant to the management of threatened euryhaline species
* Manuscripts on optimal design of acoustic receiver arrays and statistical methods for estimating mortality
* Threatened marine species education package for Indigenous communities
* Media releases around key field and engagement activities, such as the first threatened marine species survey of the western Northern Territory coastline
* Data and information outputs of this project will include distribution, extent of occurrence and area of occupancy estimates for key marine species, Indigenous knowledge on key species distribution and occurrence, mortality and survivorship data on key species, the first data on river shark age determination (an essential component of understanding demography), molecular data on population structure and population connectivity of key species, and lower population size estimate for *Glyphis garricki*. Data will be housed on appropriate explorable databases and made fully available to DOE
* Refining the identification of biologically important areas (BIAs) within the NT and WA for threatened euryhaline elasmobranchs (using published BIA protocols)

**Delivery of Project**

*Project leader’s track-record*

* The project leader has successfully delivered a large collaborative NERP project with substantial outputs, stakeholder engagement, Indigenous collaboration and delivery of products and expertise to DOE.

**Project Milestones**

Theme 1: Monitoring and understanding euryhaline species

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. Engagement with research end-users and stakeholders | Due 01 December 2015 |
| 1. Annual monitoring of tagged euryhaline elasmobranchs | Due 01 August 2016 |
| 1. Neonate river shark tagging for mortality estimates | Due 01 August 2016 |
| 1. Large river shark tagging for adult occurrence delineation and philopatry | Due 01 August 2016 |
| 1. Statistical methods for estimating annual juvenile mortality | Due 01 August 2016 |
| 1. Optimal design of receiver arrays | Due 01 December 2016 |
| 1. River shark ageing for demography | Due 01 December 2016 |
| 1. Working group on euryhaline elasmobranch species | Due 01 December 2016 |
| 1. Annual monitoring of tagged euryhaline elasmobranchs | Due 01 August 2017 |
| 1. Retrieval of acoustic receiver array (thereafter for future NESP projects) | Due 01 August 2017 |
| 1. Synthesize and report on habitat use, biologically important areas and long-term movements of euryhaline elasmobranchs | Due 01 August 2017 |
| 1. All project outputs and data will be made publically and freely accessible and available on the internet (see section Data and Information Management) | Due 01 August 2017 |

Theme 2: Indigenous partnerships for management of euryhaline species

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. Engagement with research end-users and stakeholders | Due 01 December 2015 |
| 1. Protocols for annual Daly River Indigenous sawfish survey | Due 01 December 2015 |
| 1. I-Tracker tool development for Daly River Indigenous sawfish survey and relocation | Due 01 December 2015 |
| 1. Daly River Indigenous sawfish survey and relocation | Due 01 December 2015 |
| 1. Develop Indigenous partnerships for sawfish knowledge assessment | Due 01 August 2016 |
| 1. Develop sawfish education package for Indigenous communities | Due 01 August 2016 |
| 1. Indigenous workshops for sawfish knowledge assessment | Due 01 August 2016 |
| 1. Daly River Indigenous sawfish survey and relocation | Due 01 December 2016 |
| 1. All project outputs and data will be made publically and freely accessible and available on the internet (see section Data and Information Management) | Due 01 December 2016 |

Theme 3: Knowledge for the reassessment of river shark status

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| --- | --- |
| **Milestones** | **Due date** |
| 1. Engagement with research end-users and stakeholders | Due 01 December 2015 |
| 1. WA sampling | Due 01 August 2016 |
| 1. Western NT marine survey | Due 01 August 2016 |
| 1. *Glyphis garricki* population structure | Due 01 August 2016 |
| 1. *Glyphis garricki* lower bound population size | Due 01 December 2016 |
| 1. River shark status assessment | Due 01 December 2016 |
| 1. All project outputs and data will be made publically and freely accessible and available on the internet (see section Data and Information Management) | Due 01 December 2016 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE 2015** | **FTE 2016** | **FTE 2017** |
| Peter Kyne – Charles Darwin University | Project leader/Field ecology/telemetry/Indigenous partnerships | 1.0 | 1.0 | 0.2 |
| Christy Davies - NAILSMA | Indigenous partnerships | 0.5 | 0.5 | - |
| Pierre Feutry – CSIRO | Molecular research | 0.3 | 0.3 | - |
| Richard Pillans – CSIRO | Field ecology/telemetry | 0.3 | 0.2 | 0.2 |
| Toby Patterson – CSIRO | Mortality & movement models | 0.2 | 0.2 | - |
| Mark Bravington – CSIRO | Population assessment & modelling | 0.2 | 0.2 | - |
| Grant Johnson – NT Fisheries | Field ecology | 0.2 | 0.2 | 0.1 |
| David Morgan – Murdoch University | WA field ecology | 0.1 | - | - |
| Jeff Whitty – Murdoch University | WA field ecology | 0.1 | - | - |
| Michelle Heupel - AIMS | Life history/field ecology | 0.1 | 0.1 | - |

Note: 2015 is 1 July to 31 December; 2016 is 1 January to 31 December; 2017 is 1 January to 30 June (project length: 24 months).

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| Charles Darwin University | $331,529 | $66,306 | $265,223 |
| CSIRO | $281,285 | $0 | $281,285 |
| AIMS | $22,676 | $0 | $22,676 |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| NAILSMA | $123,000 |  | $123,000 |
| Murdoch University | $22,500 |  | $22,500 |
| Northern Territory Fisheries | $38,675 |  | $38,675 |
| Kakadu National Park | $0 |  |  |
| Malak Malak Ranger Group | $0 |  |  |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Department of the Environment | Lesley Gidding-Reeve, Ashley Leedman |
| Department of the Environment | Gregory Andrews |
| Department of the Environment | Parks Australia (Kakadu National Park) |
| Department of the Environment | SPRAT, Kasia Gabrs |
| Malak Malak Ranger Group | Rob Lindsay, Traditional Owners |
| Additional Indigenous ranger groups | TBD through consultation and engagement |
| Indigenous land councils | Northern Land Council; others TBD |
| NT Fisheries | Thor Saunders |
| WA Fisheries |  |
| WA Parks and Wildlife |  |
| NT Seafood Council | Lyn Lambeth |
| **Key Stakeholders (organisation/programme)** |  |
| Department of the Environment | Lesley Gidding-Reeve, Ashley Leedman |
| Department of the Environment | Gregory Andrews |
| Department of the Environment | Parks Australia (Kakadu National Park) |
| Department of the Environment | SPRAT, Kasia Gabrs |
| Malak Malak Ranger Group | Rob Lindsay, Traditional Owners |
| Additional Indigenous ranger groups | TBD through consultation and engagement |
| Indigenous land councils | Northern Land Council; others TBD |
| NT Fisheries | Thor Saunders |
| WA Fisheries |  |
| WA Parks and Wildlife |  |
| NT Seafood Council | Lyn Lambeth |

**Knowledge Brokering and communication**

Knowledge brokering and communications will be a core component of the project. Communications tools will include newsletter articles, short films, media releases and media packages (for example around the high-profile western NT threatened marine species survey) and website contributions, amongst other tools. The development of Indigenous education tools will be accompanied by communication activities to promote this widely. This will include Indigenous specific knowledge brokering through the partnership with NAILSMA and Indigenous communities.

As this project has a substantial number of milestones, the outcomes and outputs of these will be regularly reported to DOE, by maintaining frequent contact with the Wildlife, Heritage and Marine Division. Any activities in Kakadu National Park are reported to Parks Australia upon their completion (for example within a day of the completion of a field trip), a practice which was successfully implemented during NERP. All activities will be regularly reported to the Threatened Species Commissioner.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species movement and population datasets and Indigenous knowledge and produce reports that include species distribution maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Project data management includes the specific recognition of the need to manage any sensitive data in consultation and agreement with Indigenous groups and organisations.

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Project funding will be used for salaries, to purchase acoustic tags for telemetry, maintain acoustic receiver arrays, undertake field sampling and surveys, engage and employ Indigenous Ranger Groups and communities, develop Indigenous data recording and education tools, host workshops, and sequence DNA for molecular analyses.

**Location of Research**

Northern Australian marine, estuarine and riverine systems, particularly in the Northern Territory and Kimberley, Western Australia.

**Indigenous Consultation and Engagement**

Key components of this project will be undertaken in partnership with Indigenous organisations, communities and Ranger Groups. Ranger Groups will be partnered to undertake field work, and a central theme of the project is the development of key Indigenous partnerships to enhance the management and protection of marine species. The North Australian Indigenous Land and Sea Management Alliance (NAILSMA) is a core project partner, and will use its extensive knowledge and relationships across northern Australia to lead key project components including assessing cultural use and developing Indigenous data-recording and education tools. Indigenous Land Councils will be consulted during the development of research to evaluate engagement and partnership opportunities. The Malak Malak rangers (NT) and Dambimangari rangers (WA), amongst other ranger groups will be undertaking project field components. A long-term vision is the adaptive management of threatened sawfishes on country by the Malak Malak Ranger Group. Indigenous participants will have opportunities to co-author research outputs, attend workshops and be acknowledged in all research outcomes.

**Inclusions (in scope)**

This project focuses on EPBC-listed threatened euryhaline elasmobranchs of northern Australia, encompassing acoustic telemetry, molecular research and Indigenous knowledge.

**Exclusions (out of scope)**

Non-threatened marine fauna; geographic regions outside of northern Australia.

**Risks**

Extreme monsoonal weather conditions have the potential to constrain field research and the remote location of Indigenous communities may constrain ability to work in these areas during the wet season.

NERP demonstrated the functionality of molecular approaches underlying the use of close-kin mark-recapture to estimate population status, and any initial risks around the development of this novel methodology have been nullified. As this project focuses on rare and threatened marine species, a central risk is the possibility of not being able to locate these species in the field, particularly in areas which have never been surveyed before. There was a risk around not being granted approval from relevant authorities to lethally sample a small number of *Glyphis glyphis* for essential ageing, but all approvals have now been received.

**Project Keywords**

Threatened species, marine conservation, population status, recovery planning, close-kin mark-recapture

**Appendix I. Tentative NT acoustic receiver array download schedule 2015-2017**

|  |  |  |  |
| --- | --- | --- | --- |
|  | South Alligator | Adelaide | Other Alligators\* |
| Download 1 | Jun-15 | Jun-15 | May-15 |
| Download 2 | Feb-16 | Feb-16 | May-16 |
| Download 3 | Jun-16 | Jun-16 |  |
| Download 4 | Sep-16 | Sep-16 |  |
| Download 5 | Dec-16 | Dec-16 |  |
| Retrieval# | May-17 | May-17 | May-17 |

\*Wildman, West Alligator, East Alligator

#Retrieval may occur earlier for a variety of reasons, such as: sufficient data has been collected to answer research questions, all tagged fish have left the array area, tag batteries have expired etc.

**Appendix II. Tentative sampling field work schedule (excluding NT acoustic receiver array downloads – see Appendix I)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Field activity** | **Date** | **Location** | **Partners** |
| Wildman River sampling | Sep 15 | Wildman River | CDU, NT Fisheries |
| WA shark sampling | Oct 15 | King Sound | Murdoch, CDU |
| Daly River shark sampling | Oct 15 | Daly River | CDU, Malak Malak, NT Fisheries |
| Western NT survey | Nov 15 | Western NT | CDU, NT Fisheries |
| Floodplain sawfish survey | Nov 15 | Daly River | CDU, Malak Malak, NAILSMA |
| *Glyphis glyphis* juvenile & sub-adult tagging | Nov 15 | Adelaide River | CDU, NT Fisheries |
| *Glyphis glyphis* sampling for ageing | Nov 15 | Adelaide River | CDU, NT Fisheries |
| WA shark sampling | Dec 15 | Ord River | Murdoch, CDU |
| Floodplain sawfish survey | Oct 16 | Daly River | CDU, Malak Malak, NAILSMA |

# Project A3 - A national assessment of population status of white sharks

*Project length* - 2.5 years

*Project start date* – 1/07/2015

*Project end date* – 30/12/2017

*Project Leader* – Barry Bruce (FTE – 25%)

*Contact details* – 03 6235413; [Barry.Bruce@csiro.au](mailto:Barry.Bruce@csiro.au)

*Lead Research Organisation* – CSIRO Oceans & Atmosphere

*Total NESP funding* - $644,000

*Total Recipient and Other Contributions (co-contributions)* - $644,000

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* |
| *NESP funding* | *$197,000* | *$275,000* | *$172,000* | *x* | *x* | *x* | *x* |
| *Cash co-con* |  |  |  | *x* | *x* | *x* | *x* |
| *In-kind co-con* | *$197,000* | *$275,000* | *$172,000* | *x* | *x* | *x* | *x* |

**Project Summary**

White sharks are listed as Vulnerable under the EPBC Act and the subject of a national recovery plan, yet there is still no effective way to assess their population status and thus no way of determining the efficacy of conservation actions. Recent debate due to various human-shark interactions has highlighted the need for further information. This project will provide a national assessment of population size and status in order to establish the efficacy of existing recovery actions and provide a scientifically sound and rational basis from which to develop policies that balance conservation objectives and public safety.

**Problem Statements**

*Problem*

The white shark (*Carcharodon carcharias*) is listed as vulnerable and migratory under the EPBC Act and has been protected in Australian waters since the late 1990s. A review of the 2002 Recovery Plan, in 2008, concluded that although progress had been made on a number of listed actions, there was still no effective way to estimate population size or trends and thus no effective way of determining if current recovery plan actions were having any beneficial effect. Recent public and political debate in NSW, Western Australia and South Australia due to a series of shark attacks attributed to the species as well as claims of increasing interaction frequency, highlight the need to assess population status and trends in white sharks. This information is required to establish the efficacy of combined recovery actions, use such data to design effective and defendable recovery and population rebuilding strategies and provide a scientifically sound and rational basis from which to develop policies that balance conservation objectives and public safety. This project will build on the significant advances made under NERP by providing National population estimates for the species, advance the knowledge on movement patterns and key areas of habitat use (hotspots) as well as develop strategies for the future monitoring of the species. The novel genetic and integrated modelling tools developed and trialled nationally on white sharks have links to other project initiatives under NERP and NESP and, combined, serve as a testing ground for these new techniques to assess the condition and trend of Australia’s threatened species populations for which conventional data provide an inadequate base to do so. Importantly, combined with other NESP project initiatives (e.g. project A6 and A1) this project will contribute as a case study to identify how much information (and hence investment) is required to provide an adequate level of policy advice regarding the status of threatened marine species.

*How Research Addresses Problem*

NESP research on white sharks will focus on refining the initial population estimates for eastern Australia using data streams established under NERP and will provide first estimates of adult population size for white sharks west of Bass Strait. Estimating population size is a key deliverable, however, the information required for assessing the efficacy of Recovery Plan actions and underpinning policies that balance the species conservation with public safety also require an assessment of population trend and the ability to robustly assess the impact of any proposed mitigation policies or additional sources of impact. NESP project work will also provide scientifically robust tools and assessment procedures to measure and monitor trends as well as providing improved knowledge of the species’ movement patterns and habitat use.

*Alignment with NESP Research Priorities*

This project aligns with the following research priorities:

* Identifying hot spots and management strategies for top order marine predators, including research to identify effective non-lethal measures to manage human-shark interactions.
* Improve our knowledge of key marine species and ecosystems to underpin their better management and protection.
* Better understanding, measuring and reporting on the condition and trend of threatened species (links with Threatened Species Recovery Hub)

**Research**

*Description of research*

During NERP, we showed that new genetic technologies could be used to find half-sibling pairs in white sharks, which can be used to estimate current adult abundance via Close-Kin Mark-Recapture (CK-MR) analyses. Data continue to support the two population model for Australian white sharks with populations separated east and west by Bass Strait. We established on-going data streams to monitor shark movements and survival via internal tagging with long-life (5-10 year duration) acoustic tags matched with strategic deployments of acoustic receivers in nursery areas. These receiver deployments complement national scale receiver arrays managed by IMOS and collaborating institutions. These data streams are still providing data on sharks tagged up to six years ago. We continue to collate genetic samples from various research programs from both eastern and western white shark populations. These data and sampling streams were specifically designed to provide the required data for refining east-coast population estimates and for developing methods to estimate population trend. Refining eastern population estimates and applying the knowledge and techniques developed to the achieve estimates of the western population will be the focus of NESP research. This research will establish a national scale population assessment for white sharks in Australia. As part of this research, new CK-MR tools will be trialled that have the potential to estimate population trend from existing genetic samples. This latter development, if effective, holds promise for more rapid and effective assessments of the population status of Australia’s threatened species populations for which conventional data provide an inadequate base to do so

During 2015 to 2017, NESP research within this portfolio will focus on:

Consolidating existing data and refining east-coast population estimates using on-going data streams established through 2012-2014, thereby ensuring these streams will provide a useful base for future monitoring,

Trialling strategies for monitoring juvenile abundance and age/growth validation

Assembling and analyse movement pattern data for sharks west of Bass Strait based on historical and current electronic tagging of white sharks

Coordinating sample collection and undertaking assays of archived tissue to establish requirements for making population estimates for the western white shark population,

Estimating population size for Australian white sharks west of Bass Strait

Establishing and test tools for estimating population trend from existing samples

This will be achieved by:

1. Improving, monitoring and reviewing data streams established during under NERP (2015+2016)

Acoustic tagging of juvenile white sharks in eastern Australia provide on-going data streams for monitoring nursery area use, survival rates and ontogenetic changes in movement patterns and overall habitat occupancy. These data streams will be incorporated into a revised estimate of population size for white sharks in eastern Australia and update tools for similar estimates for white sharks west of Bass Strait. Recent additional tagging of juvenile white sharks by NSW DPI will complement and add to estimates of survival for juvenile white sharks in eastern Australia. All acoustic data will be archived in the IMOS/AATAMS database.

Estimating and monitoring juvenile abundance in nursery areas holds promise for future monitoring strategies for this species, particularly in eastern Australia. Aerial surveys provided some data during NERP but remain an expensive option. Baited underwater videos (BRUVs) have become a standard tool for surveys and monitoring. BRUVs will be trialled in the Port Stephens area (in collaboration with NSW DPI) to test their utility for assessing abundance and monitoring tagged juvenile white sharks. This will also complement BRUV deployments in the adjacent Hunter Commonwealth Marine Reserve as a means of assessing this reserve’s potential for contributing to the conservation outcomes for the species. The Port Stephens area is ideally suited to this trial due to the geographically discrete nature of the nursery area and existing knowledge of the percentage time spent by juvenile white sharks in highly localised zones near to shore as well as the propensity of tagged sharks to annually revisit these specific areas. Limited BRUV trials in 2014 met with immediate success in sighting juvenile white sharks and including close proximity passes suitable for individual identification and length estimation. BRUV deployments will be targeted in these nearshore-beach zones of the Port Stephens nursery area where acoustic tagging, satellite tracking and vessel-based surveys during NERP identified high contact rates with both tagged and untagged sharks.

1. Estimate adult population size via CK-MR analyses of SA/WA tissue samples (2015-2017)

Approximately 200 tissue samples from white sharks west of Bass Strait have already been archived for CK-MR analyses for this project. These samples will be assayed in 2015 and will provide the basis for establishing what samples are required to estimate population size and status for the western population in 2016-2017. This will provide guidance on the number of samples required to achieve an identified level of certainty and will be used to establish the 2016-17 research plan.

1. Close kin mark recapture – development of the ‘cousins’ approach (trial 2015 – test 2016-2017)

Current CK-MR techniques provide for identifying sharks that share one parent (half-sibling pairs) or both parents (full sibling pairs). The number of half-sibling pairs detected in the population has a direct relationship to the census (true) population size of adults that produced the population. Initial estimates for the number of adult white sharks on the east coast have been made under NERP. However, these analyses do not provide for estimates of population trend. NESP research will build on defining demographic parameters through the data streams established under NERP and via assimilating these data streams into an integrated model of the population that can be used to estimate trends and responses to pressures. However, with the same samples already in hand, it may be possible to estimate census population size and over previous generations thereby providing a clear understanding of population trend. The next level of complexity for CK-MR is to identify first cousins (H1CPs), animals that share one ‘grandparent’. This would provide a population estimate for the previous generation to compare with the half-sibling pair estimate of the current generation– giving a population trend without the need to wait for future data to roll in. To identify H1CPs larger components of the white shark genome needs to be compared between individuals. Pre-analysis checks of all of the species currently being assessed by under NERP-NESP by CK-MR reveal that white sharks are the best candidate species to trial this technique, which, if successful, may revolutionize the way assessments and management decisions are taken on data-poor listed species. This component will assemble the data necessary (genome assembly) for cousin-finding on white sharks in 2015, and assess the viability of the technique in 2016.

1. Integrated population modelling and developing an ongoing strategy for monitoring (2016-2017)

Development of an integrated, spatially-structured, population model for white sharks is fundamental to both assessing stock status and for the development of a robust ongoing monitoring strategy. The various research components either completed under NERP or proposed under NESP, will dramatically reduce the uncertainty in a variety of the parameters required for modelling the population ('census size' estimates of mature population size, survival rates, movements and spatial dynamics). This part of our project will integrate all data streams to allow for the determination of national population status (arguably the key management uncertainty). Developing a population model that can adequately simulate various monitoring programs will be vital to deciding on what is a cost-effective integrated monitoring program that can achieve the relevant management objectives.

*Links with other projects and hubs*

This project addresses issues not covered by other current NESP projects. However, it develops and applies similar techniques (CKMR and population assessment tools) to those used by:

'A1: Northern Australian hotspots for the recovery threatened euryhaline species'.

In conjunction with A1, this project provides information highly relevant to:

'A6: Prioritisation of research and management needs for Australian elasmobranch species'

specifically with respect to providing a detailed case study from which to assess what level of information is required to adequately inform policy decisions.

It has broad links to and or will have complementary input to:

A5: Establishing the status of Australia's hammerhead sharks

*Related research*

This project builds on white shark research undertaken under NERP as part of a scheduled extension of the portfolio of work to complete a national assessment of white shark population status. NERP research focussed on developing the information base and trialling tools for assessing population size in white sharks. NERP research focussed on the eastern population of white sharks (recognising that Australia has two white shark populations, separated east and west by Bass Strait). Research completed as part of the NERP (or currently underway as part of Emerging National Priorities funding in 2015) has successfully applied close kin mark-recapture to identify juvenile white sharks that share one or both parents, provided the first estimates of adult population size for eastern Australia, improved information on movement patterns and trialled aerial surveys for identifying the location of nursery areas and estimating juvenile abundance. Acoustic tags now deployed in sharks are providing an on-going data stream which, when combined with movement models, will provide the first estimates of juvenile survival that can be used to improve population assessment models. Initial research on the western population of white shark, as part of the same NERP portfolio, investigated the locations of nursery areas in South Australia and Western Australia and archived tissue samples for CK-MR analyses from white sharks through collaborative partnerships with WA Fisheries, Flinders University, and SARDI. This has built the information and sample base to apply the techniques developed in eastern Australia so as to achieve population estimates for the west and thus complete the national-scale analysis of population status.

**Expected Outcomes**

*Outcomes*

This project is phase two of the initiative commenced under the NERP, at Ministerial and Departmental request, to provide a national assessment of white populations. The project will, through its completion, advance efforts to halt the decline of marine biodiversity through: supporting the recovery of a threatened species, the white shark (*Carcharodon carcharias*) by meeting the requirements of the primary goal of the National Recovery Plan to assess population size and status.

The project will provide information on the status of white sharks in the context of marine matters of national environmental significance and fulfil obligations under the National Plan of Action (Sharks).

The project will contribute to:

* Priorities identified in the department’s Operational and Strategic Plans by advancing efforts to halt the decline of marine biodiversity;
* Responses regarding the management of human-shark interactions (a subject that has become a significant issue of public interest) by providing the scientific basis for informed, rational and effective policy decisions surrounding the species.
* Inform efficient and effective biodiversity data, information and knowledge systems, through its collaborative approach and integration of existing expertise and data.
* The ability to establish well-informed conservation management strategies for white sharks (and other threatened species) in Australian waters via innovative technologies and analytical techniques.
* State and Commonwealth Government policies directed at managing shark-human interactions (where they relate to white sharks) are based on robust and defensible scientific data on shark population status, habitat use, movements and behaviour – balancing conservation values and public safety.

*Specific management or policy outcomes*

The project will provide information from which on-going listing under the EPBC Act can be assessed, decisions (e.g. referred actions) on issues regarding human-shark interactions can be based on robust and defensible scientific data on white shark populations. This project will ensure that State and Commonwealth Government policies directed at managing shark-human interactions (where they relate to white sharks) are based on robust and defensible scientific data on shark population status, habitat use, movements and behaviour – balancing conservation values and public safety.

*Value*

White sharks are a listed threatened species and have been the subject of recovery plan actions since 2002. This project provides the first assessment of the efficacy of recovery plan actions by providing an assessment of population size and status – this highest priority action within the plan.

**Planned Outputs**

Tools to refine and integrate CK-MR, electronic tagging distribution and species demographic data for population assessments of a key threatened species at a national scale (combining knowledge developed under this project combined with similar techniques being applied under NESP to euryhaline sharks and planned for grey nurse sharks).

National estimates of (census) population size and trend for white sharks in Australian waters (western and eastern populations respectively) are established that fulfil the highest priority actions of the National Recovery Plan.

New genetic and statistical tools trialled for the estimation of historical population trend from contemporary tissue samples for key species for which other methods of population assessment are unreliable or unavailable.

Provide information that identifies movement corridors, hotspots and contributes to management strategies for top-order marine predators

Estimate juvenile white shark survival and abundance for input into integrated national population assessment models in order to refine population estimates.

National-level information on habitat use, behaviour and spatial dynamics of white sharks at various scales used to provide the scientific underpinning for government decisions and policies as well as provide for more informed public debate.

Identify national strategies to monitor white shark populations.

The project will provide peer-reviewed additions to the scientific literature that will add to the science-support for the development and implementation of policies to support the ecologically sustainable management of Australia’s marine environment.

**Delivery of Project**

*Project leader’s track-record*

The project leader successfully delivered project outputs under NERP and has an extensive track record in areas of shark research, project delivery and specifically in leading projects that review information at State and national scales.

*Delivery on time and within budget*

We will regularly review and report on progress towards project outputs and outcomes against budget trajectories. Any unanticipated challenges will be immediately discussed with Hub leadership to identify implications and identify pathways to ensure project delivery on time and budget.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. Incorporate established 2015 data streams into refined population estimates for white sharks in eastern Australia and evaluate the efficacy of these data streams for future monitoring. | October-December 2015 |
| 1. Trial BRUV approach for evaluating juvenile white shark abundance and for monitoring tagged sharks to improve estimates of demographic parameters in the Port Stephens nursery area | October 2015-March 2016 |
| 1. Run initial assays and analyses on archived western population tissue sets to assess requirements for estimating population size | October-December 2015 |
| 1. Test the development of the ‘cousins’ approach of CK-MR for estimating population trends. Initial assembly of the white shark genome from new PacBio and existing Illumina sequences | December 2015 |
| 1. Archive acoustic tag data into IMOS/AATAMS database; Project progress report | December 2015 |
| 1. Coordinate collection and central archiving of white shark tissue samples from western population; analyse samples in plate batches (plates of 94 samples each) as they become available; Tag juvenile and adult sharks in South Australian and Western Australian waters for movement pattern analysis, tissue sampling and for estimating survival rates. | January 2016 – June 2017 |
| 1. Test the development of the ‘cousins’ approach of CK-MR for estimating population trends - extension of statistical kin-finding methods to incorporate genomic data (from half sibs to half cousins) | June 2016 |
| 1. Archive 2016 acoustic tag data into IMOS/AATAMS database; Project progress report | December 2016 |
| 1. Progress report |  |
| 1. Finalise development of ‘cousins’ approach – assess results and applicability for estimating population trend; apply technique to archived east coast samples. | June 2017 |
| 1. Archive 2017 acoustic tag data into IMOS/AATAMS database | December 2017 |
| 1. Finalise development of ‘cousins’ approach – assess results and applicability for estimating population trend; apply technique to archived west coast samples; Incorporate established 2016-17 data streams into refined population estimates for white sharks in eastern and western Australia. Provide national assessment of population size and trend and finalise strategies for future monitoring. | December 2017 |
| 1. Project outputs and data will be made publically and freely accessible and available on the internet | December 2017 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |  |
| --- | --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE (2016)** | **FTE (2017)** |
| Barry Bruce (CSIRO) | Project leader | 0.25 | 0.25 |
| Russell Bradford (CSIRO) | Sample and field coordination; data analysis | 0.20 | 0.2 |
| Peter Grewe (CSIRO) | Genetic analysis | 0.10 | 0.10 |
| Mark Bravington (CSIRO) | Statistical analysis | 0.10 | 0.10 |
| Richard Hillary (CSIRO) | Population modelling | 0.10 | 0.10 |
| Rasanthi Gunasekera (CSIRO) | Genetics technical support | 0.10 | 0.10 |
| Toby Patterson (CSIR0) | Movement dynamics | 0.10 | 0.10 |
| David Harasti (NSW DPI) | NSW Dpi coordinator; field logistics; data analysis | 0.05 |  |
| Kate Lee (NSW DPI) | Data analysis | 0.15 |  |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | **Cash contribution** | **Co-investment** |
| CSIRO | 564,000 |  | 564,000 |
| NSW DPI | 80,000 |  | 80,000 |
|  |  |  |  |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | **Cash contribution** | **Co-investment** |
|  |  |  |  |
|  |  |  |  |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| |  | | --- | | Department of the Environment: Marine and Freshwater Species Conservation Section: Wildlife, Heritage and Marine Division | | Parks Australia  Queensland Government  NSW Government  (specifically NSW DPI)  Victorian Government  South Australian Government(specifically PIRSA and DENR)  Western Australian Government (specifically WA Department of Fisheries; WA EPA, Department of Premier & Cabinet)  SPRAT | | |  | | --- | | Ashley Leedman/Lesley Giddings | | Threatened Species Commissioner | |

|  |  |
| --- | --- |
| **Key Stakeholders (organisation/programme)** |  |
| NSW DPI  WA Department of Fisheries  PIRSA  AFMA |  |

**Knowledge Brokering and communication**

Knowledge brokering and communication strategies were well established during our activities under NERP and will be continued under NESP, guided by the Hub’s Communications Strategy. The primary end user of the information is the Marine and Freshwater Species Conservation Section: Wildlife, Heritage and Marine Division of DOE, although various Commonwealth and State Government agencies maintain significant interest in the outcomes of the project. Apart from the regular and required monthly reporting of project activities, we will maintain both direct formal (information sessions/seminars within the Department in Canberra) and informal contact with the Department (ad-hoc requests for information and advice via phone and email on request). Specific to these engagements will be a regular review of progress and outputs to ensure alignment with DOE needs. Information sessions/seminars will be held with other key end users/stakeholders including the NSW Government (via seminars at NSW DPI), the South Australia Government (via seminars at SARDI Aquatic Sciences) and the WA Government (via seminars at WA Department of Fisheries). We recognise that this project also has significant public interest. Public seminars were undertaken during NERP to continue to educate and inform the public on the project. These have included open-access public seminars in central NSW (central and mid-north coast, Sydney) and Victoria (Melbourne). These will be continued during NESP and opportunities will be explored to present similar public seminars in other States.

The pathway to adoption for the outputs of the project remain by fulfilling the highest priority needs of the national recovery plan for the species thereby providing the science-support base for informing the policies regarding conservation actions. This project also aligns with the National Plan of Action (Sharks).

Information from this project will also be communicated via media responses/engagement where appropriate and publications in the scientific literature.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species movement and distribution datasets, genetic datasets and produce reports that include species distribution maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Funding is required for contribution to salaries of staff, field work in strategic areas, data analyses, the development of molecular and statistical analyses and extension of results.

**Location of Research**

Areas of southern and central Qld, central NSW, SE Victoria, South Australia and Western Australia

**Indigenous Consultation and Engagement**

The extent to which project actions, outputs and outcomes are of significance to indigenous communities and groups is, from the outset, unclear. However, we recognise that this does not indicate that such significance does not exist. Our initial engagement strategy will be to make contact with relevant indigenous groups within the specific geographic areas where we either have (under NERP) or will under NESP be undertaking on-ground field work such as central NSW, SE Victoria and coastal areas of SA and southern WA. This contact will be in the form of identifying the nature of work we are undertaking, the reasons for such work and seeking input from such groups as to their level of interest in this work. We will seek guidance from the Hub and NESP leadership as to the most appropriate groups to make contact with and the most appropriate strategy to do so. The outcomes of these contacts will guide the extent of future indigenous engagement strategies for the project.

**Inclusions (in scope)**

This project will:

* refine current estimates of white shark population size for eastern Australia; provide first estimates of population size for the population west of Bass Strait and trial analyses to assess population trends,
* assess movement patterns for sharks in both eastern and western populations, identifying the distribution of temporal hotspots and migratory corridors
* identify national scale strategies/requirements for future monitoring of these populations.

**Exclusions (out of scope)**

This project will identify future monitoring strategies/requirements but will not implement them.

**Risks**

Much of the ground-work for this project was established and tested under NERP. The main risks are in obtaining sufficient samples for CK-MR analyses. However, this risk has been minimised by establishing collaborative tissue sampling and exchange programs with WA Fisheries, NSW DPI, SARDI, Flinders University and researchers working with QLD DPI. A significant tissue base exists and continues to grow.

**Data Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species distribution and movement datasets and produce reports maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Project Keywords**

Conservation status, population size and trend, close-kin mark-recapture, marine predator, shark, threatened species, movement dynamics

# Project A5 *-* Defining connectivity of Australia’s hammerhead sharks

*Project length* – 3.5 years

*Project start date* –1/7/2015

*Project end date* – 31/12/2018

*Project Leader* – Michelle Heupel (FTE – 20%)  
[m.heupel@aims.gov.au](mailto:m.heupel@aims.gov.au)  
07 4753 4205

*Lead Research Organisation* – Australian Institute of Marine Science

PMB No 3, Townsville MC, QLD 4810

*Total NESP funding* - $688,392

*Total Recipient and Other Contributions (co-contributions)* - $702,873

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* |
| *NESP funding* | *103,601* | *$240,225* | *$240,111* | *$104,455* |  |  |
| *Cash co-con* | *x* | *x* | *x* | *x* |  |  |
| *In-kind co-con* | *118,080* | *$204,305* | *$208,207* | *$172,281* |  |  |

**Project Summary**

Hammerhead sharks are the focus of conservation management through recent listing on CITES and CMS. The clear data gap for DOE and GBRMPA is connectivity of populations across national and international jurisdictions. This project applies genetic and satellite telemetry to examine the movement and connectivity of hammerhead sharks. This will help determine use of CMRs and the GBRMP, and define BIAs where possible. These data will be assimilated with current research to provide a more comprehensive understanding of the status of hammerhead shark populations to inform species listing and assist management and conservation policies at national and international levels.

**Problem Statements**

*Problem*

Linkages between Australia, Papua New Guinea and Indonesia where high fishing and mortality occurs need to be fully defined to ensure adequate state and national management plans are developed. There is currently fragmentary knowledge of stock structure and resolving this will have important implications for management and conservation actions. These data are integral to non-detriment findings for CITES, management of the Great Barrier Reef Marine Park, species assessments for EPBC listing, WTO assessment of Australian fisheries, and State and Territory fisheries management plans. Two tropical hammerhead species (scalloped, great) are being considered for EPBC listing highlighting the potentially threatened status of these populations and the imminent need for accurate data on population connectivity.

*How Research Addresses Problem*

This project will use a collaborative and multi-pronged approach to understand the connectivity of hammerhead shark populations within Australia and with neighbouring countries. Due to the tropical distribution of the two hammerhead species (e.g., QLD, NT, WA, Indonesia, Papua New Guinea) this project will be focussed in northern Australia. Knowledge gaps related to population connectivity will be investigated using two main approaches. The first is detailed genetic sampling and analysis of individuals from northern Australia, Papua New Guinea, Indonesia and other Pacific regions. This will allow analysis of stock structuring on genetic time scales to be determined. In addition, mark-recapture satellite tags and traditional tagging will be used to define the extent of movement of individuals over time frames of months to years to further define connectivity based on movement. Satellite data will be used to help determine whether hammerhead sharks are present in the GBRMP or CMRs and if any BIAs can be identified as defined using the BIA protocol (<http://www.environment.gov.au/marine/publications/bias-protocol>). Sampling in Torres Strait will also be conducted to see whether this little understood region plays a role in population connectivity or as a population sink. In conjunction, research into the cultural significance and value of hammerhead sharks in the Torres Strait and along the Queensland coast will be explored to better define the biocultural significance of these species. Where culturally and ethically appropriate, Traditional Indigenous Knowledge may be incorporated into the project to help refine any areas of importance for the species. Genetic, tagging and Indigenous information will be coupled with data collected in 2015 NESP research to further define the status of hammerhead shark populations in northern Australia. To address CITES NDF requirements DOE sources fishery data to ensure harvest and trade is sustainable. The data (e.g., catch composition, CPUE) that are provided to DOE, along with those extracted from 2014 reviews of fisheries (Koopman and Knuckey 2014, Simpfendorfer 2014), will be integrated with: 1) results of the 2015 NESP data synthesis project to compile available catch and distribution data for hammerhead sharks in Australian waters, and 2) movement and genetic data produced during this project to further refine our understanding of the status of hammerhead shark populations in Australia and provide advice for future versions of the NDF and management of hammerhead sharks under (anticipated) Conservation Dependent listing under the EPBC Act. This multidisciplinary approach will significantly advance the current state of knowledge and provide guidance for future research and management requirements for these species.

*Alignment with NESP Research Priorities*

This project will provide direct guidance relative to several Departmental research priorities under NESP including:

* 1. Improve our knowledge of key marine species and ecosystems to underpin their management and protection.
  2. Improve the management of marine and coastal biodiversity by evaluating and quantifying the results of management interventions.
  3. Better understand issues that are common to the fishing industry and the environment including identifying solutions to mutual benefit.
  4. Identify past and current pressures on the marine environment, and understand their impact to better target policy and management actions.

This project will also help inform species assessment for administration under the EPBC Act relative to species listing, WTO assessment, and obligations under CITES and CMS. In addition, results of this research are important to species protection within the GBRMP and policies related to state and Commonwealth fisheries.

**Research**

*Description of research*

This project consists of three main components and a synthesis exercise. The research components include:

1. Genetic analysis of hammerhead shark population structure and connectivity based on samples collected from *Sphyrna lewini* and *S. mokarran* from Qld, NT, WA, Indonesia, Papua New Guinea, Hawaii and other Pacific Islands (Pacific Island samples for broader linkage and comparative analyses). Genetic analysis (mtDNA, microsatellite loci and Single Nucleotide Polymorphisms (SNPs) will be used) will indicate population connectivity and genetic stock structure on an evolutionary time scale.
2. Use of external ID and satellite mark-recapture transmitters (MR tag) to define the scales of movement of hammerhead sharks to define population connectivity on shorter temporal scales. The MR tags can be programmed to release from the shark at a set time period (months in this case) and indicate the location of the individual at that time. This approach provides a more reliable mark-recapture approach than conventional identification tags and will produce movement data on more demographically relevant time scales. MR tags are significantly cheaper than archiving satellite pop-up tags, but do not retain detailed depth, temperature or location data.
3. Exploration of the cultural value, traditional use and Indigenous knowledge of hammerhead shark populations. This work will form part of Karin Gerhardt’s PhD research into traditional knowledge transfer in Indigenous communities. Part of this work will focus on the Torres Strait where hammerhead sharks are known to be an iconic totem species.

Data from the 2015 desktop study will be incorporated with genetic, movement and traditional knowledge results to refine conceptual models of hammerhead stock structures in the Australian region. These data will be used to inform species assessments, the National Plan of Action for sharks, CITES non-detriment finding and other national and international policy documents. Outputs from the 2015 synthesis project will be made available via the Hub web site.

*Links with other projects and hubs*

Outcomes of this project will have relevance to the Tropical Water Quality and Threatened Species Hubs.

*Related research*

This project will leverage data collected under NERP Tropical Ecosystems Hub project 6.2 and build on data synthesised in the 2015 NESP project “Exploring the status of Australia’s hammerhead sharks”. This project will also draw information from recent work carried out under the Fisheries Research and Development Corporation “Australian Shark Report card” project.

**Expected Outcomes**

*Outcomes*

* Assessment of genetic connectivity of hammerhead shark populations in northern Australia (QLD, NT, WA) and neighbouring countries (Indonesia, Papua New Guinea)
* Improved understanding of scales of movement of hammerhead sharks based on satellite and mark-recapture analysis methods including use of protected regions such as the GBRMP, Coral Sea CMR, North CMR Network and North-west CMR Network
* Revised conceptual models of hammerhead shark stock structure for use by stakeholders (DOE, GBRMPA, State and Territory agencies, commercial and recreational fishing bodies).
* Contribute information to Traditional Owner knowledge base on hammerhead sharks based on project results.
* Improved status assessment of hammerhead shark populations based on genetic, movement and stock structure results.

*Specific management or policy outcomes*

Analysis of genetic and movement scale connectivity of hammerhead sharks in northern Australia, Papua New Guinea and Indonesia. This information will be directly relevant to revision of the CITES non-detriment finding, EPBC listing and assessment of these species, reporting under CITES and CMS, and WTO assessments of Australian fisheries. Outcomes are also relevant to State and Territory fishery management agencies who may need to consider joint management arrangements or policy changes. These data are likely to be used in species assessment and subsequent management and policy decisions, and will be delivered within timeframes relevant to Departmental advice on CITES and EPBC actions.

*Value*

This project will establish the connectivity of hammerhead sharks in Australian waters to those of neighbouring countries, most specifically Indonesia and Papua New Guinea. Results of this research will be directly applicable to the CITES non-detriment finding, species listing advice to the Minister relative to pending EPBC nominations and WTO assessments of Australian fisheries. In addition, the acquired knowledge will be crucial to management of the GBRMP and relevant State, Territory and Commonwealth fisheries.

**Planned Outputs**

Outputs of the project will include:

* A report outlining the results of genetic and movement analysis of hammerhead shark populations in northern Australia, Indonesia and Papua New Guinea including identification of BIAs (aggregation sites) and use of CMRs where possible; revised conceptual models of stock structure and species status assessments; and a summary of Indigenous knowledge and traditional use of hammerhead sharks.
* Presentation of results to key stakeholders and end users
* Policy Brief (Research Summary for Managers) that describes project outcomes
* Manuscripts for scientific journals outlining the results of project components (eg, genetics, movement, Indigenous use and knowledge transfer)
* Presentation of recommendations at scientific conferences
* Communication of findings to the broader community via social media

**Delivery of Project**

*Project leader’s track-record*

Dr Heupel has a long track record of successful research results and delivery as demonstrated through on time reporting and production of over 15 journal publications from NERP research. NERP projects met all milestones on time and within budget.

**Project Milestones**

A description of all key project milestones. Progress will be judged against delivery of the milestones. It is expected that project milestones should encompass project outputs as well as regular reporting of results in a clear, digestible format suitable for use by decision makers.

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| Milestone 1 – Complete satellite and tagging deployment plan based on findings of the 2015 NESP project. Order satellite tags. Coordinate with project partners to begin tag deployment. | 30 March 2016 |
| Milestone 2 - Acquire available genetic samples for hammerhead studies, identify areas lacking samples and formulate a plan for obtaining samples from those areas. | 30 June 2016 |
| Milestone 3 –Meeting with research end-users e,g, DOE and GBRMPA to inform on progress and plans | June 2016 |
| Milestone 4 – Satellite tag deployment begun | 30 August 2016 |
| Milestone 5 – Traditional Owner groups engaged (data sharing agreements in place) and Indigenous knowledge research underway | 15 September 2016 |
| Milestone 6 – Present results to date to DOE and TSSC at their Nov meeting (if suitable) to inform on progress relevant to the NDF and species listing requirements. Present updated results to additional end-users via individual meetings | November 2016 |
| Milestone 7 – Progress report on genetic sample acquisition and processing; satellite tag deployments and Indigenous knowledge research | 1 December 2016 |
| Year 2 |  |
| Milestone7 – Continued deployment of satellite tags and processing of genetic samples. | 28 February 2017 |
| Milestone 8 –Analysis of acquired satellite tag movement and genetic data complete and summary provided to end-users | 31 May 2017 |
| Milestone 9 – Provide a briefing to DOE and TSSC on project findings and outcomes to date to inform listing advice to the Minister and 2017-18 review of the NDF | June 2017 |
| Milestone 10 – Continued interviews and data collection with Traditional Owners engaged in the project. | 1 October 2017 |
| Milestone 11 –Report on genetic analyses and satellite tag deployments; briefing to managers, stakeholders and end-users | 1 December 2017 |
| Year 3 |  |
| Milestone 12 - Finalise satellite tag data analysis to define movement connectivity, identification of BIAs and use of CMRs. Advise end-users and resource managers on use of areas | 30 June 2018 |
| Milestone 13 – Complete analysis of Indigenous knowledge and biocultural significance of hammerhead sharks | 30 Aug 2018 |
| Milestone 14 – Revise stock structure estimates based on genetic and movement data | 31 September 2018 |
| Milestone 15 – Final report on hammerhead shark population connectivity completed including revised stock structure estimates; presentation of results to managers and stakeholders | 1 December 2018 |
| Milestone 16 - All project outputs and data will be made publically and freely accessible and available on the internet | 1 December 2018 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Michelle Heupel – Australian Institute of Marine Science | Project leader, responsible for compiling report | 0.2 |
| Andrew Chin – Australian Institute of Marine Science and James Cook University | Data analyst, data collection, assimilation and analysis | 0.2 |
| Will White – CSIRO | Data advisor relative to Indonesian fishing and genetics | 0.05 |
| Sharon Appleyard - CSIRO | Genetic sample analysis | 0.15 |
| Colin Simpfendorfer – James Cook University | Population modeller, fisheries advisor | 0.05 |
| Karin Gerhardt – James Cook University | PhD student – Indigenous knowledge of hammerhead sharks and their biocultural significance | 0.4 |
| Grant Johnson – NT Fisheries | Status of hammerheads in NT | 0.2 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| AIMS | $520,318 |  | $154,482\* |
| CSIRO | $119,808 |  | $119,808 |

\*note much of the field work will be conducted with partners hence the distribution of project co-investment

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| James Cook University | $48,266 |  | $108,165 |
| WA Fisheries | $0 |  | $200,000 |
| NT Fisheries | $0 |  | $120,418 |
|  |  |  |  |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Department of the Environment | Ivan Lawler, Daniel Rothenfluh |
| Department of Agriculture |  |
| Great Barrier Reef Marine Park Authority | David Wachenfeld |
| NGO groups (e.g. WWF, HSI) | Jim Higgs (WWF), Alexia Wellbelove (HSI), Glenn Sant (TRAFFIC) |
| Torres Strait Regional Authority |  |
| Parks Australia |  |
| SPRAT |  |

|  |  |
| --- | --- |
| **Key Stakeholders (organisation/programme)** |  |
| New South Wales Fisheries | Vic Pedemmors |
| Queensland Fisheries | Ian Jacobsen |
| Northern Territory Fisheries | Thor Saunders, Grant Johnson |
| Western Australian Fisheries | Rory McAuley |

**Knowledge Brokering and communication**

Recent engagement with DOE and GBRMPA has indicated hammerhead sharks are a research priority with population connectivity being a primary data gap and area of concern. States and Territories also have concerns around these species in relation to active fisheries (eg, Qld, NT) or population status (ie, scalloped hammerheads are listed as Endangered in NSW). This project builds upon discussions with stakeholders to fill identified knowledge gaps and refine research needs for these species. Communication with DOE, GBRMPA and other stakeholders and partners will be crucial to the success of this research. As such regular briefings and discussions will be completed in addition to: reports, publications, newsletters, social media and web-based information outlets (eg, AIMS web page) as appropriate. Activities will be aligned with and coordinated through the Hub’s Knowledge Brokering and Communication Strategy.

A series of joint meetings with stakeholders has already begun and a schedule of future meetings at key times related to project milestones and policy decision points has already been developed. These meetings will be used to review project progress and evaluate the approaches applied relevant to meeting end user needs.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collect species distribution and movement datasets, genetic data, Indigenous knowledge and produce outputs that include species distribution maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Expenditure will include salary for participation of key researchers (Heupel, Chin, White, Appleyard), to purchase satellite tags and subsequent field costs for tag deployment, provide funds for genetic sample processing and analysis, support travel to Indigenous communities for data collection and provide travel funds to meet with relevant agencies and present outcomes.

**Location of Research**

This research will be conducted throughout northern Australia (Qld, NT, WA) and include linkages and effort into Papua New Guinea and Indonesia where possible.

**Indigenous Consultation and Engagement**

Sharks have varying levels of biocultural significance to Traditional Owner groups in Queensland and the Torres Straits, but what value hammerhead sharks have to each of the groups is not very well understood by Western society. The main region in Australia where hammerhead sharks are a known totem species is the Torres Strait Islands. The Traditional Indigenous Knowledge of the shark is captured in dance, song, art, and technical ‘stories’. Engagement with Traditional Owner groups in the Torres Strait and particularly the eastern coastline of northern Queensland would be a fundamental step in research on hammerhead species. Many Traditional Owner groups in Queensland and the Torres Strait have established their own protocols for working with researchers. This project will respect each group’s protocol and ensure that all ethics approvals and data sharing agreements are in place before work begins. This includes working with TSRA’s buddy system for knowledge brokering and community interaction.

This project will include focused research to understand the biocultural values of hammerhead sharks to different Traditional Owner groups and look to collaborate with groups to better understand what traditional ecological data may be available for these species. Traditional Ecological Knowledge (TEK) on species can contribute to place-based, fine scale, spatial and temporal information. This information can then assist in development of management techniques or governance frameworks that recognize and incorporate Indigenous people’s rights and interests. Working with Traditional Owners and incorporating their TEK can provide important avenues for discussion and build dialogue between scientists and communities in which they work. It can also help ground the research in the realities of ‘local’ communities throughout the research process. It is well recognized in literature that incorporating TEK in fisheries management can complement western science and management knowledge by providing long-term baselines for stock assessments, local knowledge of species ecology and behaviour, habitat conditions and trends, as well as customary management systems. Recognition (and inclusion) of cultural knowledge in science and management is fundamental for Indigenous communities to have significant roles in decision making affecting environmental management in sea country estates.

This research will be conducted via supporting the PhD research of Karin Gerhardt which focuses on traditional knowledge transfer in Indigenous communities. The intent of this portion of the project is to better understand historical perceptions of hammerhead presence and abundance as well as define biocultural significance. Inclusion of Traditional Owners outside Torres Strait will require contact and engagement. Karin has established relationships in several regions that can facilitate engagement if appropriate. Engagement of Indigenous communities will be conducted in accordance with the Hub Engagement and Participation Strategy, will meet ethical standards and respect and acknowledge the relevance and importance of Indigenous knowledge of these species.

**Inclusions (in scope)**

This project addresses connectivity issues, data gaps and requirements of hammerhead shark populations in northern Australia, Papua New Guinea and Indonesia as described above.

**Exclusions (out of scope)**

The project focuses exclusively on hammerhead sharks in northern Australia and as such excludes similar issues for other shark species, including the smooth hammerhead which is distributed in southern Australia.

**Risks**

This project will be based on an extensive desktop study completed in 2015 which will direct sampling and reduce risk of misplaced effort. Genetic samples have been obtained from multiple areas from previous research efforts which are available for use in this project. The genetic methods are established and well developed. The combination of already established knowledge and collected samples will work to ensure this project is successful.

Until we start working with Traditional Owners the sensitivity of the cultural information is not understood. Data sharing agreements will need to be developed with individual Traditional Owner groups interested in participating in the research. The level of detailed information available for the publically available reports may be limited by the groups.

**Project Keywords**

Hammerhead shark, fisheries, conservation, management, connectivity, biocultural

# Project A7 – Monitoring population dynamics of ‘Western’ Right Whales off Southern Australia

*Project length* – 3 Years

*Project start date* – 15/08/2015

*Project end date* – 30/03/2018

*Project Leader* – John Bannister (FTE 30%)  
[bannisj@bigpond.com](mailto:bannisj@bigpond.com)  
08 9212 3800

*Lead Research Organisation* – The Western Australian Museum

*Total NESP funding* - $120,000 (over 3 years), GST and inflation exclusive

*Total Recipient and Other Contributions (co-contributions)* - $15000

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* |
| *NESP funding* | *$40000* | *$40000* | *$40000* | *x* | *x* | *x* | *x* |
| *Cash co-con* | *x* | *x* | *x* | *x* | *x* | *x* | *x* |
| *In-kind co-con* | *$5000* | *$5000* | *$5000* | *x* | *x* | *x* | *x* |

**Project Summary**

Continuation (since 1993) of annual aerial surveys, to include counts and identification photographs, of Southern Right Whales between Cape Leeuwin (WA) and Ceduna (SA), where wintering animals come close to the coast – adult females to calve, at approximately three-year intervals, other adults and juveniles less regularly. The area is the main wintering ground of a major ‘western’ subpopulation of ‘Australian’ right whales, differing in number and extent of recovery (from 19th century hunting) from an ‘eastern’ subpopulation which so far shows little if any recovery. Counts allow estimation of population trend and current numbers; identification photographs allow estimation of life history parameters.

This project serves to implement a very high priority action in the Australian Government’s *Conservation Management Plan for Southern Right Whale (2011-21)* – Action Area B1: Measuring and monitoring population recovery; continue to obtain and refine population abundance and trends for the south-west population.

**Problem Statements**

*Problem*

Southern right whales were reduced almost to extinction by 19th Century whaling, throughout the southern hemisphere but including off Australia. There have been signs of recovery since the 1950s, but particularly since the mid-1970s given cessation of whaling on this species. The short-term question (a) is at what rate has the population been recovering, and to what current numbers; in the long-term (b) the aim would be to relate any such recovery, or alterations in it, to environmental changes on the (Antarctic) feeding grounds.

*How Research Addresses Problem*

a) From annual counts: estimates of numbers and hence trend in population growth since 1993.

b) From identified animals: estimates of life history parameters, and any changes in them, e.g. conception rates, that can be related to availability of food (amphipods, krill) on southern feeding grounds, south of 40°S

*Alignment with NESP Research Priorities*

* Improve our knowledge of key marine species and ecosystems to underpin their better management and protection.
* Determine and trial practical and repeatable methods for monitoring the status and trends of key coastal and marine species and environments,  and possibly:
  + Improve the management of marine and coastal biodiversity by evaluating and quantifying the results of management interventions.

**Research**

*Description of research*

Objectives:

a) continue collection of the dataset, i.e. counts and photographs, of southern right whales, from the southern coast between C Leeuwin WA and Ceduna SA, as in each year since 1993.

b) continue ‘matching’ photographs of head callosities obtained on the flights using a computer-assisted system against those (some 2000 individuals) in the existing identification catalogue.

c) continue databasing existing information on sightings, linked to animals already identified.

Methods:

As in previous years (see for example Bannister, 2014a, b) one flight will be undertaken from a high wing, single engine aircraft (Cessna 172) based on Albany WA. Each flight has recently lasted *ca* 39 hours, over four-five flying days. The plane is crewed by a pilot/observer and photographer/observer, flying at *ca* 100 knots and searching within *ca* 1 n mile of the coast at *ca* 1500 feet, descending to 500 or 700 feet (the minimum permissible height in WA and SA respectively) for photography. When whales are sighted, a count is made and individuals are circled for photography; the GPS sighting position is recorded, as latitude and longitude. For photographic identification, clear images of the head callosity pattern are required although body marks such as ‘birthmarks’ (‘white’ or ‘grey’ dorsal blazes) are photographed when present. A small proportion of animals occurs as ‘white’ (partial albino) calves, with characteristic dark spotting, the body colour turning to grey as the animal matures: the body pattern in such animals is also photographed.

The same aircraft and photographer/observer will be available as on all flights since 1998. The same pilot/observer will be available as in 1998-2004 and 2006-2014. As usual the flight will be close to the coast, searching an area *ca* 1 n mile (*ca* 1.8 km) wide seawards of the coast where right whales, particularly cows with newborn calves, are to be found. The flight will take place between C Leeuwin WA and Ceduna SA, over a distance of some 900 miles (*ca* 1700 km). ‘Legs’ of up to 4.5 hours duration are flown between fuelling points (towns or coastal settlements). An additional leg along the west coast between Augusta and Perth will be included, as in past years, to cover the small number of animals to be found on that part of the coast each winter. Each flight along the south coast usually consists of four legs, each being covered twice, once ‘outward’ and once ‘inward’. A further leg, between Albany and Cape Leeuwin, WA, and the one along the west coast between C Leeuwin and Perth, are, for logistical reasons, generally covered only once. Flying only takes place in ‘good’ or better conditions, i.e. in wind speeds of no more than 15 knots, usually following a high pressure weather system from Albany eastwards along the coast towards the Great Australian Bight. Depending on the weather conditions, and for comparability with previous years, a window of 30 days between 15 August and 15 September is allowed, but the survey should ideally take place towards the end of August when peak numbers can be expected.

As in previous years, direct counts will be obtained of animals observed within the search area. Counts are usually made by the observer but confirmed with the pilot as possible. Photographs (using a Canon EOS 5D digital camera, with 100-400mm lens) will be obtained by the photographer/observer of as many animals as possible but with emphasis on cows with calves, images being assessed on a laptop after each leg. The search area includes virtually all the area to which ‘western’ right whales resort in winter/spring, close to the coast, in particular for the females to give birth. Most animals, particularly cows accompanied by their calves of the year, are easily observed in the relatively clear waters on the south coast, and no corrections are made for the probability of sighting (g(0)), which is assumed to be 1. In the coastal shallow waters, over the sandy bottom where cows with calves, in particular, are to be found, all animals present, including those under water, can usually be seen. This makes for a relatively simple sighting protocol, readily repeatable over the years.

For the aerial survey, as in previous years, the maximum count on the flight will be compared with results since 1993 to obtain estimates of a) increase rate and b) current population size. Increase rate, both instantaneous and as an annual percentage is obtained by regression analysis for the total count as well as for cows accompanied by calves of the year (cow/calf pairs), of counts (log normal) against year.

Population size is currently obtained using a simple model based on the numbers of cow/calf pairs sighted. Given the relative paucity of animals that visit the remainder of the southern Australian coast, the ‘western’ population recorded between C Leeuwin and Ceduna is considered to represent the majority of the ‘Australian’ population. The model assumes that each reproductive female is recorded on the coast only once in three years, that the sex ratio is unity, that there are at least as many immature animals as adults.

Photographs from the flights will be added to the ‘WA’ catalogue for computer-assisted comparison (‘matching’ - using a system developed by Hiby and Lovell, 2001) with those already available from WA and elsewhere, including the Antarctic. Sightings information will be added to the existing database which relates detailed sightings information to individuals already identified photographically, and allows tabulation of individual sighting histories.

*Links with other projects and hubs*

Information obtained will be used in revising (as necessary) BIAs, and deriving local (ie State) management plans.

The project provides information for comparison with similar results being obtained for the ‘eastern’ Australian subpopulation through a project also previously funded by AMMC (Mandy Watson and Ian Westhorpe, Assessment of Numbers and Distribution of Southern Right Whales in South-east Australia), as well as for other Southern Hemisphere populations e.g. off South Africa and Argentina.

*Related research*

The project continues a series of annual surveys in the same area and using the same methodology on the same sub-population since 1993.

**Expected Outcomes**

*Outcomes*

Expected outcomes will be:

* Updated population trend, 1993-2016 and on
* Updated population size, 2016 and on
* Updated sightings database
* Updated photo-catalogue
* Information to be used towards providing a level of protection for such threatened species that migrate through the SW CMR.

*Specific management or policy outcomes*

The information obtained from these surveys has been, and will continue to be, used a) at State Level, in Mammal Action Plan Listings, b) Nationally, in National Recovery Plans, and c) Internationally, at the annual meetings of Scientific Committee of the International Whaling Commission, to provide a better understanding of the current status of the population and identify regions/specific localities of importance.

*Value*

In the long-term the project should provide data important in determining the effect of environmental change, particularly on the feeding grounds, on biological processes such as conception rate, as already demonstrated for animals in the southwest Atlantic/Antarctic (e.g. in Leaper et al 2006).

**Planned Outputs**

Data and analyses (obtained as described in Methods, above), i.e.

* Counts of animals (by class – cows accompanied by calves, other animals, by position (GPS) and time.
* Head and (where appropriate) body photographs, by position and time.
* Information on Biologically Important Areas for Southern Right Whales in the area surveyed
* ‘Progress’ and ‘Final’ reports, annually
* Report annually to the Scientific Committee of the International Whaling Commission
* Public information through press releases and on the Museum website.

**Delivery of Project**

*Project leader’s track-record*

Successful application for Commonwealth Government funding of this project annually since 1993 – apart from 2011 when the funding decision was made too late for the fieldwork and funds were obtained from the Island Foundation, Massachusetts, USA.

Data management has been approved by the AMMC and AAD, with data currently housed at AAD and in the AMMC-funded ARWPIC.

*Delivery on time and within budget*

The project will be delivered on time and within budget by meeting set deadlines, and ensuring cost controls.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1 - undertake aerial survey | 15 August -15 September 2016 |
| 2 - analyse count data | by 30 October 2016 |
| 3 - select identification photos from aerial survey | by 15 November 2016 |
| 4- provide Progress Report on 2015 activities | by 30 December 2016 |
| 5 - incorporate sightings data in the sightings database | by 30 January 2017 |
| 6 - provide Final Report on 2015 activities | by 30 March 2017 |
| 7 - All project outputs and data will be made publically and freely accessible and available on the internet | by 30 March 2017 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| John Bannister– WA Museum (Hon Associate) | Project Leader/ Manager | 30% |
| Jenny Schmidt (Great Southern Aviation) | Pilot | 2% |
| Andrew Halsall (A.H Photography) | Observer/photographer | 2% |
| Prof Phil Hammond (St Andrews Uni) | Statistical advice | <1% |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | **Cash contribution** | **Co-investment** |
| None |  |  |  |
|  |  |  |  |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | **Cash contribution** | **Co-investment** |
| WA Museum. |  |  | In kind provision of admin services |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Migratory Species Section/ Wildlife Heritage and Marine Division/Commonwealth Dept of Environment  Marine Science Program/WA Dept of Parks and Wildlife  SRAT and Parks Australia | Chris Schweizer  Holly Raudino |
| **Key Stakeholders (organisation/programme)** |  |
| International Whaling Commission/Scientific Committee/Head of Science | Greg Donovan |

**Knowledge Brokering and communication**

Through Final Report to the funding agency, with results conveyed to WA Dept of Parks and Wildlife, AAD, Commonwealth Dept of the Environment, Scientific Committee of the International Whaling Commission.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species distribution and movement datasets and produce reports maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary** (per year, excl GST and inflation)

Aerial survey: $19000

Photography: $3300

Data extraction/analysis/databasing/report writing: $17700

**Location of Research**

WA Museum

**Indigenous Consultation and Engagement**

This project has been running for >20 years without any request for engagement from Indigenous organisations. However local Aboriginal Corporations will be engaged to discuss research objectives and possible future project linkages to assess their interest in further engagement.

**Inclusions (in scope)**

Survey results – counts, population trend, numbers

Updated Databases – sightings, identified individuals

**Risks**

The major significant risk is inclement weather during the allocated 4-week period (15 August-15 September, chosen as the period during which maximum whale numbers occur). In the past the allocated period has provided sufficient flexibility, although numbers could be expected to drop off rapidly after 30 September.

A less significant risk is breakdown in the computer–assisted matching program, which is sensitive to incorrect data entry. In the past this has caused annoying delay, but has been overcome in due course.

**Project Keywords**

Right whale population trends, numbers.

**References**

Bannister, J L, 2014 a). Monitoring population dynamics of southern right whales off southern Australia, 2012 and 2013. Final report to the Australian Marine Mammal Centre, 20 pp.

Bannister, J L, 2014 b). Monitoring population dynamics of southern right whales off southern Australia, 2014. Progress report to the Australian Marine Mammal Centre, 3pp.

Hiby, L and Lovell, P, 2001. A note on an automated system for matching the callosity patterns on aerial photographs of southern right whales. Journal of Cetacean Research and Management (Special Issue 2): 291-295.

Leaper, R, Cooke, J, Trathan, P, Reid, K, Rowntree V, and Payne, R, 2006. Global climate change drives southern right whale (Eubalaena australis) population dynamics. Biology Letters 2: 289-292.

# Project A8 – Exploring the status of Western Australia’s sea snakes

*Project length* – 12 Months

*Project start date* –1/2/2016

*Project end date* – 31/12/2016

*Project Leader* – Michelle Heupel (FTE – 0.05%)  
[m.heupel@aims.gov.au](mailto:m.heupel@aims.gov.au)  
07 4753 4205

*Lead Research Organisation* – Australian Institute of Marine Science  
PMB No 3, Townsville MC, QLD 4810

*Total NESP funding* - $52,169

*Total Recipient and Other Contributions (co-contributions)* - $52,169

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* | *2022* |
| *NESP funding* | *$52,169* |  |  |  |  |  |  |
| *Cash co-con* | *x* | *x* | *x* |  |  |  |  |
| *In-kind co-con* | *$52,169* |  |  |  |  |  |  |

**Project Summary**

All sea snakes are listed marine species under the EPBC Act and three Australian endemic species are listed as Critically Endangered or Endangered, and as such are a national conservation priority. This project examines existing data from the northwest marine region to define sea snake relative abundance and distribution patterns, including within CMRs, to refine species status. Synthesis of existing data will be useful to DOE, DPaW, Parks Australia and others. This analysis will help establish baseline data, guide future research, define abundance in and use of CMRs and refine EPBC listings and recovery plans.

**Problem Statements**

*Problem*

Recently reported declines in sea snake abundance in Western Australia have increased concern about the status of sea snake species in this region. This region was once a global ‘hotspot’ for sea snake abundance that included numerous species, including the three endemic sea snakes that are listed as Endangered or Critically Endangered. There is currently limited knowledge about the distribution and range of sea snake species in the region in addition to a lack of understanding of population status. Data are needed to define the status of these species to assist with EPBC listing status as well as implementation of effective management and Recovery Plans. Sea snakes can be highly vulnerable to capture in some fisheries and are also used for their skin and flesh in some countries. The causes of recently observed declines have not been defined, indicating a need for research and exploration of the status of these species. An improved understanding of the distribution and status of sea snake populations within Australian waters is needed to fully define any required conservation action.

*How Research Addresses Problem*

This project will take advantage of already collected data to define the species range and distribution of key sea snake species in the northwest marine region. These data will also be used to examine relative abundance between habitats and identify any habitat preferences or association (where possible) to help refine the status of these listed species. This approach will provide a significant advance on the current state of knowledge and provide guidance for future research and management requirements for these species. Project outcomes will include exploration of data gaps and potential expansion of genetic stock structure analysis as well as confirmation of species identification and distribution.

*Alignment with NESP Research Priorities*

This project will provide direct guidance relative to several Departmental research priorities under NESP including:

* Improve our knowledge of key marine species and ecosystems to underpin their management and protection.
* Improve the management of marine and coastal biodiversity by evaluating and quantifying the results of management interventions.
* Better understand issues that are common to the fishing industry and the environment including identifying solutions to mutual benefit.
* Identify past and current pressures on the marine environment, and understand their impact to better target policy and management actions.

This project will also help inform species assessment for administration under the EPBC Act and Recovery Plans for sea snake species.

**Research**

*Description of research*

This project will integrate existing data to define the distribution and help inform the status of sea snakes within the northwest marine region, specifically reefs and shoals offshore of Western Australia. Information on sea snake presence and relative abundance will be defined using already collected baited remote underwater video data and records from the Reef Life Survey database. Information on the species and locations sighted as well as the habitats where highest sightings occur will be recorded. For example, anecdotal data suggest sea snakes may show a preference for chunky rubble or soft coral beds. Examination of habitat type and complexity will be considered in analysis. These data will be used to construct distribution maps based on sampling locations and indicate where additional sampling may be required, and/or if specific habitat types or depths should be preferentially sampled in the future. Data will be examined to identify biologically important areas where possible, as defined under the BIA protocol (<http://www.environment.gov.au/marine/publications/bias-protocol>).The intent of this project is to establish a baseline data set to inform where gaps exist and what future work would be required to better refine the population status of these species for EPBC listings and subsequent Recovery Plans or Conservation Advices.

*Links with other projects and hubs*

Outcomes of this project will have relevance to the Threatened Species Hubs.

*Related research*

This project will leverage data collected previously by the Australian Institute of Marine Science and contributed to public data repositories such as the Reef Life Survey. Additional data will be sourced where possible for inclusion in this analysis including trawl survey data.

**Expected Outcomes**

*Outcomes*

* Synopsis of survey data from the northwest marine region, including the North-west CMR Network for use by stakeholders (include DOE, Parks Australia, state agencies).
* Preliminary status assessment of sea snake populations where possible and identification of key knowledge gaps and research priorities to help refine species listing status for EPBC and state management.

*Specific management or policy outcomes*

A comprehensive analysis of currently available and unanalysed data for sea snakes will be directly relevant to EPBC and assessment and recovery planning for these species. Outcomes are also relevant to state fishery and resource management agencies.

*Value*

This project will establish the status of sea snakes in the northwest marine region and provide guidance for what additional knowledge is required to effectively manage and protect their populations within Australian waters. Results of this research will help define species status, assist in EPBC species listing and recovery planning where required, and guide effective conservation management.

**Planned Outputs**

Outputs of the project will include:

* A report outlining the presence and relative abundance of sea snakes in northwestern Australia with a focus on reef and shoal habitats including identification of BIAs or key habitats where possible. Research and management priorities will be highlighted.
* Presentation of results to key stakeholders and end users
* Presentation of recommendations at scientific conferences
* Communication of findings to the broader community via social media

**Delivery of Project**

*Project leader’s track-record*

Dr Heupel has a long track record of successful research results and delivery as demonstrated through on time reporting and production of over 15 journal publications from NERP research. NERP projects met all milestones on time and within budget.

This research will be based on several existing data sets which will help ensure success in a timely fashion. Integration of data sets and modelling will be conducted based on the available data and within the time frames of the research program. The main costs involved are salary time to conduct data synthesis and modelling. The time allocate for these tasks is appropriate and as such the project will be completed within budget.

**Project Milestones**

A description of all key project milestones. Progress will be judged against delivery of the milestones. It is expected that project milestones should encompass project outputs as well as regular reporting of results in a clear, digestible format suitable for use by decision makers.

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| Milestone 1 – Connect with project partners and discuss data assimilation, engage with key stakeholder and end-users relative to project plans and available data | 15 April 2016 |
| Milestone 2 – Collate available data (AIMS, WA Fisheries, CDU, JCU, etc) | 30 May 2016 |
| Milestone 3 – Continue data analysis and development species distribution maps and relative abundance indices. | 31 August 2016 |
| Milestone 4 – Provide an update on project progress to key stakeholders and end-users to help refine final analyses and reporting. | 31 October 2016 |
| Milestone 5 – Produce a report compiling the data gathered, knowledge gaps, and species status. Report will include recommendations for data additional collection and ongoing research efforts. | 1 December 2016 |
| Milestone 6 – All project outputs and data will be made publically and freely accessible and available on the internet | 1 December 2016 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Michelle Heupel – Australian Institute of Marine Science | Project leader, responsible for compiling report | 0.05 |
| Research Associate – Australian Institute of Marine Science | Data assimilation and analysis, draft report | 0.4 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| AIMS | $52,169 |  | $52,169 |
|  |  |  |  |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| James Cook University\* | $0 |  | $ |
|  |  |  |  |
|  |  |  |  |

\*researchers from JCU will serve an advisory role in this project to aid with sea snake identification and other aspects of sea snake ecology. No funds are requested or provided for this participation.

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Department of the Environment | Milena Rafic, Lesley Gidding-Reeve |
| Department of Agriculture |  |
| NGO groups (e.g. WWF, HSI) |  |
| DPaW, WA |  |
| Parks Australia |  |
| SPRAT |  |
| **Key Stakeholders (organisation/programme)** |  |
| Northern Territory Fisheries | Grant Johnson |
| Western Australian Fisheries | Dan Gaughan |

**Knowledge Brokering and communication**

Recent engagement with DOE has indicated sea snakes as a research priority. This project builds upon those discussions to fill identified knowledge gaps and refine research needs for these species. Based on 2016 data gathering, a report will be compiled including recommendations to DOE, and relevant fisheries and management agencies. This report will form the basis of ongoing discussions around the research priorities for subsequent years of NESP to ensure appropriate and useful outputs are achieved. Presentations of preliminary findings will be completed for key end users in conjunction with discussions about the current and future directions of sea snake research. Communication of sea snake status assessments will be also completed through press releases, social media and web-based information outlets (eg, AIMS web page) as appropriate. Activities will be aligned with and coordinated through the Hub’s Knowledge Brokering and Communication Strategy.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species distribution datasets and produce reports that include species distribution maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Expenditure will include salary for participation of key researchers, provide travel funds to access data from relevant agencies and present outcomes to Department of the Environment staff.

**Location of Research**

This research will be conducted in Townsville, QLD based on co-location of three participants. Since the project is primarily a desk-top study the project location is not critical.

**Indigenous Consultation and Engagement**

Sea snakes have varying levels of significance and use in Indigenous communities, but it is unknown how important sea snakes are, especially in remote regions of northwest Australia (eg offshore reefs). Therefore engagement with Indigenous communities is an important step in research on these species. During the course of this project consultation with Indigenous groups will be conducted to define their interest in these species and their significance to communities. Engagement of Indigenous communities will be conducted in accordance with the Hub Engagement and Participation Strategy, will meet ethical standards and respect and acknowledge the relevance and importance of Indigenous knowledge of these species.

**Inclusions (in scope)**

This project addresses data gaps and requirements of sea snake populations as described above.

**Exclusions (out of scope)**

The project focuses exclusively on sea snakes in the northwest marine region and as such excludes similar issues for species in other regions.

**Risks**

There are no significant risks associated with this project

**Project Keywords**

Sea snake, NW Marine region, conservation, management

# Project A9 - Grey Nurse Shark CK-MR Population Estimate – East Coast

*Project length* - 1 year

*Project start date* – 01/01/2016

*Project end date* – 30/06/2017

*Project Leader* – Russell Bradford (FTE – 0.16)  
[Russ.Bradford@csiro.au](mailto:Russ.Bradford@csiro.au)   
03 6232 5077

*Lead Research Organisation* – CSIRO Oceans & Atmosphere

*Total NESP funding* - $115,000

*Total Recipient and Other Contributions (co-contributions)* - $115,000

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* |
| *NESP funding* |  | *$95,564* | *$19,436* | *x* | *x* | *x* | *x* |
| *Cash co-con* |  |  |  | *x* | *x* | *x* | *x* |
| *In-kind co-con* |  | *$95,564* | *$19,436* | *x* | *x* | *x* | *x* |

**Project Summary**

A review of the 2002 National Recovery Plan for Grey Nurse Shark (DEWHA 2009) concluded it was not possible to determine if the east coast population had shown any signs of recovery (DoE 2014); recommending a new recovery plan be developed for this species. A primary objective of the new recovery plan (DoE 2014) is to improve knowledge of GNS population status. This will require a robust estimate of population size and trend – something that has not been provided to date. This project will use genetic SNP data to inform close kin-mark recapture analysis to estimate population size and trend, and provide guidance on future monitoring strategies for the east coast population of grey nurse shark.

**Problem Statements**

*Problem*

The grey nurse shark, *Carcharias taurus*, is distributed throughout the tropical and temperate waters of the North and South Atlantic, Indian, and western Pacific Oceans (Last and Stevens 2009). In Australia, *C. Taurus* is distributed throughout the entire region except for Tasmania, and is rare in waters of the Northern Territory (Last and Stevens 2009). Two populations of *C. Taurus* are recognised in Australia: one along the east coast of Australia from the central Queensland coast to at least the NSW/Victorian boarder (DoE 2014); the other along the west coast from Steep Point (~ 700 km north of Perth) to the South Australian border in the Great Australian Bight (Chidlow et al. 2005).

Globally, the grey nurse shark was designated in 1996 as “endangered” on the IUCN Red List of Threatened Species; this designation was elevated to “vulnerable” in 2000 (Pollard and Smith 2009). In Australia, protection was first afforded in 1984 when the NSW government protected the species in response to a precipitous decline in the population. The Queensland government followed suit in 1997 with full protection for the species. The Federal government also provided national protection in 1997, listing the grey nurse shark as vulnerable under the *Endangered Species Protection Act 1992* and the subsequent *Environment Protection and Biodiversity Conservation Act 1999* in 2000 (DoE 2014). The following year (2001) saw the separation into an eastern and western population with the eastern population being listed as critically endangered and the western population as vulnerable.

In 2002 a national recovery plan (EA 2002) was published detailing a pathway to recovery for the species. Although the recovery plan encompassed both the eastern and western populations, the focus was placed on the eastern population due to the greater concern over the population’s status. Progress towards achieving the objectives of the recovery plan were reviewed in 2014 and a new recovery plan published (DoE 2014). An overarching objective of the 2014 revised recovery plan was to improve the population status such that the species may be removed from the threatened species list of the EPBC Act (DoE 2014). The 2014 recovery plan consists of 10 main objectives, the first of which is to monitor and resurvey the population to assess population trends.

*How Research Addresses Problem*

This project aims to address the primary objective of the 2014 recovery plan (“*Develop and apply quantitative monitoring of the population status (distribution and abundance) and potential recovery of the grey nurse shark in Australian waters.* “) through the application of close kin-mark recapture (CK-MR) techniques to provide a robust contemporary estimate of population size and trend. The CK-MR approach has proven successful for several species of conservation concern.

*Alignment with NESP Research Priorities*

This project aligns with the following research priorities:

* Determine and trial practical and repeatable methods for monitoring the status and trends of key coastal and marine species and environments to underpin management of Commonwealth Marine Reserves.
* Improve our knowledge of key marine species and ecosystems to underpin their better management and protection.
* Better understanding, measuring and reporting on the condition and trend of threatened species (links with Threatened Species Recovery Hub)

**Research**

*Links with other projects and hubs*

This project addresses issues not covered by other current NESP projects. However, it develops and applies similar techniques (CK-MR and population assessment tools) to those used by:

A1: Northern Australian hotspots for the recovery threatened euryhaline species'.

A3: A National assessment of population status of white sharks’

In conjunction with A1 and A3, this project provides information highly relevant to:

A6: Prioritisation of research and management needs for Australian elasmobranch species'

It has broad links to and or will have complementary input to:

A5: Establishing the status of Australia's hammerhead sharks

*Related research*

This project builds on grey nurse shark research undertaken by the CSIRO Oceans & Atmosphere Flagship, funded through the Australian Government’s Department of the Environment. The previous work was aimed at obtaining grey nurse shark samples for genetic analysis.

**Expected Outcomes**

The project will provide information on the status of grey nurse shark in the context of marine matters of national environmental significance and fulfil obligations under the National Plan of Action (Sharks).

The project will contribute to:

* Priorities identified in the department’s Operational and Strategic Plans by advancing efforts to halt the decline of marine biodiversity;
* Inform efficient and effective biodiversity data, information and knowledge systems, through its collaborative approach and integration of existing expertise and data.
* The ability to establish well-informed conservation management strategies for grey nurse shark (and other threatened species) in Australian waters via innovative technologies and analytical techniques.

The project will also contribute to:

* Objective 1 of the grey nurse recovery plan: “Develop and apply quantitative monitoring of the population status (distribution and abundance) and potential recovery of the grey nurse shark in Australian waters.”
* Objective 9 of the grey nurse recovery plan: “Continue to develop and implement research programs to support the conservation of the grey nurse shark.”

*Specific management or policy outcomes*

The project will provide information from which on-going listing under the EPBC Act can be assessed based on robust and defensible scientific data on grey nurse shark populations. This project will ensure that State and Commonwealth Government policies are based on robust and defensible scientific data on shark population status.

*Value*

This project will directly address the primary objective of the 2014 Grey Nurse Shark Recovery Plan. The project output will be used to inform management of the east coast population of the grey nurse shark, and provide some direction for further research on the west coast population of grey nurse shark. There may be additional value to CMR managers depending on the outcomes of genetic analyses.

**Planned Outputs**

Tools to refine and integrate CK-MR and species demographic data for population assessments of a key threatened species at a national scale (combining knowledge developed under this project combined with similar techniques being applied under NESP to euryhaline sharks and white sharks).

A national estimate of (census) population size and trend for the eastern Australian population of grey nurse shark will be developed to fulfil the highest priority actions of the National Recovery Plan.

Identify national strategies to guide future monitoring of grey nurse shark populations.

The project will provide peer-reviewed additions to the scientific literature that will add to the science-support for the development and implementation of policies to support the ecologically sustainable management of Australia’s marine environment.

**Delivery of Project**

*Project leader’s track-record*

Russell Bradford has been the PI on two separate projects that precede this stage of developing an estimate of population size and trend for the grey nurse shark. These projects are delivering and will feed data into this, the final stage, project. Support will be provided by the larger team, which has been instrumental in delivering on the euryhaline and white shark projects.

*Delivery on time and within budget*

We will regularly review and report on progress towards project outputs and outcomes against budget trajectories. Any unanticipated challenges will be immediately discussed with Hub leadership to identify implications and identify pathways to ensure project delivery on time and budget.

**Project Milestones**

Note:

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. Payment on signing of the contract – 25% of cost | On signing |
| 1. Final collection of samples – 25% of cost | 20 May 2016 |
| 1. Complete SNP analyses | 19 August 2016 |
| 1. Deliver population estimate to DoE and initiate discussions on management options in light of the estimate. | 25 November 2016 |
| 1. Payment on acceptance of final report - 50% | 01 February 2017 |
| 1. All project outputs and data will be made publically and freely accessible and available on the internet | 25 November 2016 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Russell Bradford (CSIRO) | Project leader | 0.16 |
| Mark Bravington (CSIRO) |  | 0.13 |
| Richard Hillary (CSIRO) |  | 0.13 |
| Pierre Feutry (CSIRO) |  | 0.11 |
| Barry Bruce |  | 0.08 |
| David Harasti (NSW DPI) |  | 0.10 |
| Technical staff (NSW DPI) |  | 0.05 |
|  |  |  |

**References**

Chidlow, J.; Gaughan, D.; McAuley, R. (2005). Identification of Western Australian grey nurse aggregation sites. Final Report to the Department of the Environment and Heritage, Commonwealth of Australia. 36 pp.

DEWHA (2009). Review of the Grey Nurse Shark Recovery Plan. Report prepared by the Department of Environment, Water, Heritage and the Arts, Canberra.

DoE (2014). Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*). Department of the Environment, Commonwealth of Australia. Available: www.environment.gov.au/resource/recovery-plan-grey-nurse-shark-carcharias-taurus

EA (2002). Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) in Australia. Environment Australia, Commonwealth of Australia. Available: http://www.environment.gov.au/resource/recovery-plan-grey-nurse-shark-carcharias-taurus-australia. ISBN: 0642547882.

Last, P. R.; Stevens, J. D. (2009). *Sharks and Rays of Australia – Second Edition*. CSIRO Publishing, Melbourne, Australia.

Pollard, D.; Smith, A. (2009). *Carcharias taurus*. In: The IUCN Red List of Threatened Species. Version 2015.1. www.iucnredlist.org, accessed 02 June 2015.

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| CSIRO | 95,000 |  | 95,000 |
| NSW DPI | 20,000 |  | 20,000 |
|  |  |  |  |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
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|  |  |  |  |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| |  | | --- | | Department of the Environment: Marine and Freshwater Species Conservation Section: Wildlife, Heritage and Marine Division | | NSW Government  (specifically NSW DPI) | | |  | | --- | | Ashley Leedman/Lesley Giddings | | Threatened Species Commissioner |   Bob Creese, Alan Jordan, David Harasti |
| **Key Stakeholders (organisation/programme)** |  |
| NSW DPI  WA Department of Fisheries |  |

**Knowledge Brokering and communication**

The primary end user of the information is the Marine and Freshwater Species Conservation Section: Wildlife, Heritage and Marine Division of DOE, although various Commonwealth and State Government agencies maintain significant interest in the outcomes of the project. Apart from the regular and required monthly reporting of project activities, we will maintain both direct formal (information sessions/seminars within the Department in Canberra) and informal contact with the Department (ad-hoc requests for information and advice via phone and email on request). Specific to these engagements will be a regular review of progress and outputs to ensure alignment with DOE needs. Information sessions/seminars will be held with other key end users/stakeholders including the NSW Government (via seminars at NSW DPI). We recognise that this project also has significant public interest; opportunities will be explored to present public seminars at key venues.

The pathway to adoption for the outputs of the project remain by fulfilling the highest priority needs of the national recovery plan for the species thereby providing the science-support base for informing the policies regarding conservation actions. This project also aligns with the National Plan of Action (Sharks).

Information from this project will also be communicated via media responses/engagement where appropriate and publications in the scientific literature.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species distribution, movement and genetic datasets and produce reports that include species distribution maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Funding is required for contribution to salaries of staff, field work in strategic areas, data analyses, and development of molecular and statistical analyses and extension of results.

**Location of Research**

Areas of southern and central Qld and NSW

**Indigenous Consultation and Engagement**

The extent to which project actions, outputs and outcomes are of significance to indigenous communities and groups is, from the outset, unclear. However, we recognise that this does not indicate that such significance does not exist. Our initial engagement strategy will be to make contact with relevant indigenous groups within the specific geographic areas where we will be undertaking on-ground field work. This contact will be in the form of identifying the nature of work we are undertaking, the reasons for such work and seeking input from such groups as to their level of interest in this work. We will seek guidance from the Hub and NESP leadership as to the most appropriate groups to make contact with and the most appropriate strategy to do so. The outcomes of these contacts will guide the extent of future indigenous engagement strategies for the project.

**Inclusions (in scope)**

This project will refine estimates of grey nurse shark population size for eastern Australia and provide a trend. The project will identify national scale strategies/requirements for future monitoring of this population.

**Exclusions (out of scope)**

This project will identify future monitoring strategies/requirements but will not implement them.

**Risks**

Much of the ground-work for the analysis of data to be generated for this project has been established and tested under NERP (euryhaline shark and white shark projects (A1 and A3, respectively). The majority of the required tissue samples were collected under two projects funded directly through the Federal Department of the Environment. Additional samples are to be collected in partnership with NSW DPI.

**Project Keywords**

Conservation status, close kin mark recapture, shark, threatened species

# Project B1 – Road testing decision support tools via case study applications

*Project length* – 36 Months

*Project start date* – 1/7/2015

*Project end date* – 30/6/2018

*Project Leader*

Terry Walshe (FTE – 50%)

Australian Institute of Marine Science

email: T.Walshe@aims.gov.au

tel. +61 3 9035 6413

mob. 0437 829 055

*Total NESP funding* - $629,800 ($193,920 in 2016)

*Total Recipient and Other Contributions (co-contributions)* - $629,800 ($193,920 in 2016)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* |
| *NESP funding*  *- AIMS*  *- CSIRO*  *- UWA*  *- UTas*  ***Total*** | *$ 85,000*  *$ 11,000*  *$ 49,000*  *$ --------*  *$ 145,000* | *$113,920*  *$ 41,000*  *$ 29,000*  *$ 10,000*  *$193,920* | *$113,920*  *$ 41,000*  *$ 29,000*  *$ 10,000*  *$193,920* | *$ 56,960*  *$ 20,500*  *$ 14,500*  *$ 5,000*  *$ 96,960* |
| *Cash co-con* | *-* | *-* | *-* | *-* |
| *In-kind co-con*  *- AIMS*  *- CSIRO*  *- UWA*  *- UTas*  ***Total*** | *$ 85,000*  *$ 11,000*  *$ 49,000*  *$ --------*  *$ 145,000* | *$113,920*  *$ 41,000*  *$ 29,000*  *$ 10,000*  *$193,920* | *$113,920*  *$ 41,000*  *$ 29,000*  *$ 10,000*  *$193,920* | *$ 56,960*  *$ 20,500*  *$ 14,500*  *$ 5,000*  *$ 96,960* |

**Project Summary**

This project will deploy advances in decision-support to assist Commonwealth Marine Reserve managers progress the implementation of evidence-based adaptive management throughout the reserve estate. Two case studies will treat selected decision problems in detail. Specifically:

* The identification of decision thresholds that may trigger a change in management, framed within Parks Australia’s performance monitoring template.
* The prioritisation of information acquisition through research and monitoring.

The two case studies involve coherent integration of ecological models, social and organisational value judgments, and economic analysis.

**Problem Statement**

A difficult challenge for policy-makers is to identify the right tool for their specific context and constraints. The elements of a decision problem comprise objectives, defensible value judgments around the relative or absolute importance of each objective, alternative courses of action, and credible causal judgments of the performance of alternatives against objectives. The broad array of decision support tools place varying degrees of emphasis on these elements. This project will assist Commonwealth Marine Reserve managers sketch a set of policy and management issues, assess critical needs in effective decision-making, and identify the tools that can best meet those needs. Case studies will treat selected decision problems in detail.

***Alignment with NESP Research Priorities***

This project directly addresses the priority *decision thresholds for adaptive management* identified in the recent multi-stakeholder workshop on marine reserves. It will also contribute to the related priority, *Can we identify several achievable indicators now that examine zoning effectiveness and are SMART?*

This project will *develop and trial decision making tools that will support policy makers and managers to identify options, and prioritise activities* in Commonwealth Marine Reserves.

Selected case studies will *improve the management of marine and coastal biodiversity by evaluating and quantifying the results of management actions.*

This project provides the methodological underpinning of *Marine Planning* under the policy *A Cleaner Environment*. Specifically: *A more balanced approach to Marine Protected Areas will mean the areas are assessed in accordance with scientific, economic and social evidence. This will continue to protect marine environments and the fishing communities that rely on them.*

**Research**

This project will address two core elements of evidence-based adaptive management. It will (a) identify decision thresholds that may trigger a change in management, and (b) inform the prioritisation of information acquisition through research and monitoring. The two case studies comprise the following elements.

1. ***Decision thresholds***

Decision thresholds involve probabilistic descriptors of system change that trigger consideration of a change in management. Their specification requires considered treatment of non-linearities in ecological response of selected indicators together with organisational and social judgments of the consequences of ecological decline (or improvement) and the implications of a change in management. Decision thresholds have been successfully developed in settings characterised by stakeholder conflict and contested system understanding, including harvest policy in fisheries management. Extension to marine reserve management offers distinct clarity and progress in the implementation of adaptive management.

This case study will build on parallel work undertaken for the 2014 Portfolio Budget Statement deliverable for the Director of National Parks, ***Marine ecosystem health indicators have a baseline established by 30 June 2017.***Where possible, indicators will

* be based on existing monitoring programs or ongoing research,
* be capable of being monitored through remote technologies and or new and emerging new technologies,
* be valued by a range of stakeholders in order to facilitate communication around the value and effectiveness of marine reserves and to increase community awareness and engagement with CMRs,
* provide opportunities to engage the community in monitoring activities, such as citizen science programs,
* meet requirements regarding monitoring of protected matters within reserves (i.e. listed species) and/or matters covered within recovery plans,
* be cognisant of the pressures faced by reserves,
* be influenced through reserve management, and
* be cost effective.

Outcomes will be framed within ***Parks Australia’s performance monitoring template***, which maps the links between key result areas, objectives and outcomes of management plans, and indicators. The decision thresholds identified in this project will directly inform the *‘reference points’* that underpin performance monitoring and reporting.

Steps in case study development include:

A1. Problem formulation: Consultation with Parks Australia to establish the salience of alternative management decisions, including for example

* + changes in activity restrictions and allowances within zones
  + changes in zones within reserves
  + changes in the delineation of reserves

A2. Assist in the identification of ecosystem health indicators via consultation with Projects C1, C2 and D3.

A3. Simple models of system dynamics and risk to assist in the identification of ecological thresholds.

A3. Interim Report on Case Study A

A4. Use of stated preference techniques to characterise value judgments among Parks Australia personnel, and where appropriate, members of stakeholder forums.

A5. Coherent integration of ecological, social and organisational judgments in specification of decision thresholds.

A6. Integration of decision thresholds and monitoring to inform adaptive management via Parks Australia’s performance monitoring template.

A7. Final Report on Case Study A

1. ***Prioritising investment in research and monitoring***

Parks Australia has limited resources to treat the many gaps in the evidence base underpinning management of CMRs. For example, it needs to make difficult choices in whether or not to fund speculative advances and efficiencies in the characterisation of recreational impacts, the status and trend of iconic species, and the spatial distribution of benthic habitats. This case study will assist Parks Australia navigate these difficult choices through two complimentary tools – multi-criteria analysis, and analysis of the value of information.

Steps in case study development include:

B1. Multi-criteria decision analysis

B2. Progress Report on Case Study B

B3. Value of information

B4. Synthesis – complimentary insights form MCA and VoI.

B5. Final Report on case Study B, including a recommended decision protocol for rationalising Parks Australia’s investment in research and monitoring.

Scheduling of the two case studies and their constituent elements is shown below.



***Links with other projects and hubs***

In considering indicators and decision thresholds, this project will liaise with leaders and outcomes of

C1 - Improving our understanding of pressures on the marine environment (Dunstan)

C2 - Continental-scale tracking of threats to shallow Australian reef ecosystems (Edgar)

D3 - Evaluating and monitoring the status of marine biodiversity assets on the continental shelf- Phase 1-shelf reef key ecological features.

There are also opportunities to work collaboratively with research providers engaged under the Threatened Species Recovery Hub.

**Expected Outcomes**

At the end of 2016 this project will provide:

* Identification of ecological thresholds to inform decision thresholds for adaptive management in selected CMRs.
* A multi-criteria analysis protocol for the prioritisation of CMR research and monitoring.

Beyond 2016, this project will provide:

* Formalisation and application of decision thresholds to adaptive management in selected CMRs.
* Value of information analyses to compliment multi-criteria approaches to prioritisation of research and monitoring.

Recent research indicates that poor choice in decision support protocols can lead to 30 – 50% losses in environmental benefits[[1]](#footnote-1). This project will avoid these arbitrary losses through informed selection and use of appropriate decision-support tools.

**Planned Outputs**

2016

* Progress reports describing interim outcomes of the (a) decision thresholds and (b) research and monitoring prioritisation case studies.
* At least two publications in high impact peer-reviewed journals.

Beyond 2016 (pending further support)

* Two final reports describing outcomes of the (a) decision thresholds and (b) research and monitoring prioritisation case studies.
* At least two publications in high impact peer-reviewed journals.
* Training and associated materials

.

**Delivery of Project**

Walshe has an excellent track record of delivering timely and polished products in research and consultancy. In his past role as Knowledge Broker for the Environmental Decisions Hub, he worked extensively with DoE line areas, including productive collaboration with Parks Australia. For information regarding how the project will be delivered on time and within budget, please refer to the Marine Hub Performance and Evaluation Protocols.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| Milestone I Progress Report on Case Studies A and B | Due 1 Jul 2016 |
| Milestone II Progress Report on Case Studies A and B | Due 1 Jan 2017 |
| Milestone III Final Report on Case Studies A and B, including specific recommendations. | Due 1 Jul 2018 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Terry Walshe – AIMS | Project Leader | 0.50 |
| Sean Pascoe - CSIRO | Partner investigator | 0.20 |
| Abbie Rogers - UWA | Partner investigator | 0.20 |
| Neville Barrett - UTas | Partner investigator | 0.05 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| Department of the Environment (CMR) personnel |  |  | 0.25 FTE |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| NA |  |  |  |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DoE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Parks Australia (Cth Marine Reserves) | Amanda Parr |
| **Key Stakeholders (organisation/programme)** |  |
| Reserve Network Stakeholder Forums |  |

**Data management**

Contact: Terry Walshe

Note that this project does not involve the capture of biological data.

**Knowledge Brokering and communication**

Knowledge brokering and communication are core elements of this project. We will conduct interviews with CMR business units to gain a full appreciation of decision support setting, needs and constraints. We will arrange end-user and stakeholder targeted workshops to develop case studies. We will build capacity via delivery of dedicated training modules. Generic elements are addressed in the Hub’s Knowledge Brokering and Communication Strategy.

**Expenditure Summary**

Project funding provides direct salary costs for

* The project leader (Walshe)
* Partner investigators (Pascoe, Rogers and Barrett)

Plus operating costs, including

* Workshops and
* Travel and accommodation.

**Location of Research**

Workshops will be held in Canberra and/or Hobart. Case study applications may involve workshops and travel to other destinations.

**Indigenous Consultation and Engagement**

We will assume Indigenous interests are relevant to selected case studies. We will seek feedback and approval on case studies from appropriate authorities. We will invite Indigenous representation in the development of case studies. We will confirm ethics approval prior to undertaking research, and we will ensure the conduct of research respects cultural and intellectual property and traditional knowledge. The approach to Indigenous engagement will be consistent with the Hub’s Indigenous Engagement and Participation Strategy.

**Inclusions (in scope)**

All decision support tools are candidates for exploration under this project.

**Exclusions (out of scope)**

Nil

**Risks**

The success of this project is highly dependent on engagement of CMR managers. Considering the high priority placed on this project by DoE this risk is characterised as low.

**Project Keywords**

Adaptive management, Prioritisation, Multi-criteria analysis, Value of Information

Cost-effectiveness

# Project B3 – Enhancing access to relevant marine information –developing a service for searching, aggregating and filtering collections of linked open marine data

*Project length* – 18 months to develop a working prototype linked open data delivery system, and to perform usability testing with stakeholder groups.

*Project start date* – 01/07/2015

*Project end date* – 31/12/2016

*Project Leader* – Johnathan Kool (FTE – 10%)  
*Lead Research Organisation* – Geoscience Australia  
[johnathan.kool@ga.gov.au](mailto:johnathan.kool@ga.gov.au)  
02 6249 5842

*Total NESP funding* - $91,750

*Total Recipient and Other Contributions (co-contributions)* - $106,000

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* |
| *NESP funding* | *$40,250* | *$51,500* | *x* | *x* | *x* | *x* |
| *Cash co-con* | *x* | *x* | *x* | *x* | *x* | *x* |
| *In-kind co-con* | *$54,500* | *$51,500* | *x* | *x* | *x* | *x* |

**Project Summary**

We aim to improve the searchability and delivery of sources of linked open data, and to provide the ability to forward collections of discovered data to web services for subsequent processing through the development of a linked open data search tool. This work will improve access to existing data collections, and facilitate the development of new applications by acting as an aggregator of links to streams of marine data. The work will benefit managers (i.e. Department of the Environment staff) by providing fast and simple access to a wide range of marine information products, and offering a means of quickly synthesizing and aggregating multiple sources of information.

**Problem Statements**

*Problem*

An emerging priority in information management is building smarter information search engines that are tailored to specific types of end users. These end-user-focused systems can provide highly targeted and relevant results immediately, in contrast to the common experience of sifting through extensive collections of potentially irrelevant items.

*How Research Addresses Problems*

We intend to develop a flexible interface focused on the information requirements of the Department of the Environment (DOE) to search, filter and deliver connections to linked open marine data (this tool could also be applied to data within DOE). This will help provide efficient access to a wide range of information sources using a Google-type search interface that will be familiar to most users. The interface will accept a single search string, and will return an ordered/sorted list of results. The ranking of the results would be weighted on the basis of user type (e.g. specific types of users within DOE, scientists, general public). The resulting collections of data resources can then be forwarded on to other web services for plotting, ingestion into modelling tools and virtual laboratories, or saving as a report. This contrasts with previous efforts to generate map ‘portals’ by providing a targeted subset of information tailored to individual needs that can be updated dynamically (akin to an Amazon search for marine information as opposed to books and household goods).

*Alignment with NESP Research Priorities*

The proposed project aligns with Marine Biodiversity Research Priorities to:

• Develop and trial decision making tools that will support managers to define and prioritise activities.

• Provide meaningful and accessible information on the status and trends of key social and economic values associated with the marine environment.

• Improve our knowledge of key marine species and ecosystems to underpin their better management and protection

• Enhance the role of citizen science in the management of marine biodiversity.

**Research**

*Description of research*

The proposed project will apply data science to develop an online tool that can be used to search, filter and deliver sources of marine data (geospatial or otherwise), and to aggregate and forward these information streams to web services for analysis, delivery or visualisation. The concept would be similar to the interface of Amazon.com which allows for search and retrieval of different products, classification of different product types, as well as providing user-specific recommendations for linked items of interest. There would be three components to the initial development of the tool: *data harvesting, data searchability,* and *web service delivery*.

It is important to distinguish the capabilities of the proposed project from existing information portals. Most existing portals emphasize online mapping capability. The proposed project will handle multiple types of information (e.g. documents, images, tables, hyperlinks as well as spatial data). The data elements will also have semantic tags added to them, permitting queries across collections of heterogeneous data objects (the linked open data concept). To the best of our knowledge, no existing service leverages the capabilities of linked open data, which is a key reason for this pilot initiative. Taking advantage of enterprise search technologies such as Solr and ElasticSearch also make it possible to provide user-specific recommendations (i.e. search results for an environmental manager could be different than those of a researcher or industry specialist). Lastly, the tool would have the capability of saving the collection of filtered information objects so that they can be forwarded on to other web services for further processing (e.g. mapping, downloading, or custom aggregation).

The harvesting component will identify and ingest sources of metadata (and potentially data, as available) from a range of different providers, including GA, AIMS, IMOS/AODN, CSIRO, GBRMPA and possibly BOM. Although many data sources will consist of spatial information (i.e. GIS data), the tool will be able to accommodate a variety of sources, including documents, images and video. For this stage, we will also be developing ways of linking the data with formal semantic descriptions/tags (machine-interpretable definitions of what the data *is* – e.g. temperature, currents, coastal infrastructure).

Searchability will be accomplished through the use of industry-standard software libraries (e.g. [Solr](http://lucene.apache.org/solr/) and [ElasticSearch](https://www.elastic.co/products/elasticsearch) – built on [Lucene](https://lucene.apache.org/)). In addition to possessing full-text search capability, these libraries can be used to perform fuzzy topic searches, identify closely related items, cluster groups of items into categories, sort items by relevance, and filter out low-ranked items. Search strings can be monitored to identify usage patterns and hotspot topics, including topics of interest that are missing from the base of searchable information. [Stanbol](https://stanbol.apache.org/) can be used to automate the extraction of semantic tags from unstructured documents.

Web service delivery will consist of retrieving hyperlink information from the filtered subset of information resources, and presenting these links as an organized collection for ingestion by online services. Examples might include plotting the resources on a map (if they are tagged as being mappable), downloading as a collection of text files (if they are a type of resource that can be converted to text), or aggregating data into a time series (e.g. measurements of a consistent temperature type, in conjunction with having a time attribute).

Project activities would include:

* Generate prototype collections of linked open marine data;
* Confirmation of interoperability of the software and products with existing information delivery frameworks;
* Addition of linked-open data functionality to an initial test set of data products (e.g. data generated through previous CERF and NERP hubs); and
* User testing with stakeholder organizations to refine interface design

*Distinguishing features*

* *Development of capability for leveraging linked open data*. Linked open data makes it possible to connect online information (documents, images data) with one another via hyperlinks that provide a formal definition of the relationship. This makes it possible to quickly identify linked items of interest, follow branching link chains, and automatically aggregate information (the relationships are machine-readable). The principal value for managers lies in being able to survey a broad range of information in a distributed manner (i.e., across multiple data sources/websites), identify the most relevant items, and synthesize them quickly and concisely into a product list.
* *Browsing and filtering general information (not just maps).* We are proposing adding linked open data functionality to a range of information (e.g. documents, regulations, topics of interest) not just spatial data. We expect that synthesizing and being able to link to a wide range of products and topics will be of value to users faced with finding general marine and coastal research on a broad range of topics and locations collected by a broad suite of agencies.
* *An interface designed specifically for non-technical users.* With the development of the user interface patterned after familiar commercial product search pages, users will be able to take advantage of the benefits of linked open data without needing to delve into the details of the process. We also intend to make a clear separation between the back-end search engine and the front-end graphic user interface, making it possible to easily set up multiple entry points if desired.
* *Leveraging proven and highly performant open-source technology (Lucene for search, Stanbol for semantic content management).* These technologies are in widespread use in large, commercial operations (e.g. Twitter, LinkedIn, Comcast) and are supported by extensive and well-developed user communities.

*Links with other projects and hubs*

This type of work has application across the spectrum of NESP research in that it improves the accessibility and delivery of information in general. The tools and techniques developed as part of this project will have immediate application for other hubs and areas of research. Within the Marine Biodiversity Hub, we can confirm collaborations with AIMS and CSIRO relating to projects D1 and D3 as a way of demonstrating the capability of the service. We explicitly state our commitment to complement the work of IMOS/AODN to improve data delivery as a whole, anticipating that the workflows and data products that we pilot-test as part of this project can be incorporated into their systems once their value has been demonstrated. We envision working closely with the Hub Data manager to ensure strong alignment with the Hub’s Data Management Strategy and broader initiatives (e.g. National Environmental Information Infrastructure, National Plan for Environmental Information Initiative). This project would also seek to directly engage with other Hubs with regards to information management and data delivery approaches.

*Related research*

The project leverages off of existing data holdings generated through previous generations of the Marine Biodiversity Hub (i.e. CERF, NERP) as well as existing data collections belonging to partner organisations (e.g. GA, AIMS, CSIRO, IMOS/AODN) by helping to improve the exposure and delivery of these resources.

**Expected Outcomes**

*Outcomes*

The project will ultimately enhance the ability of Department of the Environment officers, partner organizations and the general public (i.e. not just researchers) to find, filter and retrieve information related to Australia’s coastal and marine environments.

We intend to develop a working prototype linked open data delivery web service. The service will search general sources of marine information (e.g. documents, images, spatial and non-spatial data); synthesize information on the basis of semantic links; rank, facet and filter the information; and select subsets of the information for forwarding on to other online services.

Meeting and collaborating with stakeholder organizations will help enhance communication among government data managers, resulting in more coordinated management and delivery of Hub data across the organizations. We also intend to link with efforts such as the [Ocean Data Interoperability Platform](http://www.odip.eu) (<http://www.odip.eu/>) to facilitate synthesis of data at the international level.

*Specific management or policy outcomes*

The concrete form of this effort will ultimately be the availability of the search tool described above, as well as the further development of web services using the tool as a mechanism for delivering information streams. The user interface will be developed with non-technical users in mind, with a search flow similar to commercial websites such as eBay or Amazon’s main search page.

*Value*

This work will improve the value of existing data holdings through increased exposure and accessibility, as well as laying the foundations for IT innovation through the development of new websites, smartphone and tablet applications or [GovHack](http://www.govhack.org/about-us/) (https://www.govhack.org/about-us/) initiatives. We also foresee that the information could be used to feed information to social media applications (e.g. new data updates), or be used by citizens to identify information sources of interest/use to them. Another potential use of the tool would be for reviewing information sources for the State of the Environment and State of the Reef reports (DoE/GBRMPA). The use of the tool can be quantitatively measured through web hits, statistics and performance measures (e.g. response time) and usage patterns can be tracked by monitoring submitted search terms. Value will also be obtained by adding linked-open data functionality to selected existing data sets (e.g. existing NERP and CERF data) where feasible.

**Planned Outputs**

* Delivery of open source code to perform the search functions described above.
* A simple initial web interface for performing the search and retrieval of results.
* Expanded collections of data holdings available in linked open format, including the use of semantic mark-up to enable fully-automated data aggregation and web services. In particular, addition of linked-open data capability to a pilot collection of existing data sets (GA, CERF and NERP data sets).

**Delivery of Project**

*Project leader’s track-record*

Johnathan Kool and Brendan Brooke have both been part of GA’s efforts as part of the NERP Marine Biodiversity Hub, and were able to successfully deliver project deliverables associated with Themes 3 and 4 (National ecosystems knowledge and Regional biodiversity discovery to support marine bioregional plans). Both Kool and Brooke have interacted with stakeholders at the Department of the Environment and other partner organizations. GA is committed as an organization towards effective data and metadata management, and the project described here will further enhance our capability to deliver in this regard. Project impact will be identified through user uptake and website metrics.

*Delivery on time and within budget*

For information regarding how the project will be delivered on time and within budget, please refer to the Marine Hub Performance and Evaluation Protocols.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. All research users and stakeholders for this project have been engaged and understand project and how it relates to their interests. | 1 April 2016 |
| 1. Conduct a workshop involving representatives from the Department of the Environment and other stakeholder partners to ‘beta’ test the product to ensure capability and value above and beyond existing data search capabilities | In advance of 1 September 2016. |
| 1. Delivery of a prototype user-tested open-source linked open data search tool to the Department of the Environment and stakeholder partners (see Research End Users and Key Stakeholders list for anticipated contacts), with the additional possibility of eventual uptake by businesses capable of leveraging linked open data sources (e.g. for app development), and the general public. For a detailed project timeline see Attachment A. | 1 January 2017 |
| 1. All project outputs and data will be made publically and freely accessible and available on the internet | 1 January 2017 |

**Researchers and Staff**

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Johnathan Kool – Geoscience Australia | Project Leader/Data Scientist | 0.10 |
| Brendan Brooke – Geoscience Australia | Project Advisor | 0.05 |
| Software Developer | Software Development | 0.15 |

**Research End Users and Key Stakeholders**

|  |  |
| --- | --- |
| **Research End Users (section/programme/organization)** | **Contact Name/s (optional)** |
| Parks Australia | Nyssa Brunk, Suzie Gaynor |
| Department of the Environment | Amelia Tandy |
| ERIN | Jeffrey Tranter (meeting arranged) |
| IMOS/AODN | Tim Moltmann, Roger Proctor |
| AIMS | Scott Bainbridge, Eric Lawrey |
| CSIRO | Piers Dunstan, Tara Martin |
| GBRMPA | Leath Muller, Trevor Gilbert |
| Bureau of Meteorology | Jamie Treleaven |

Note that as part of our initial scoping work, we have already engaged in consultations with Parks Australia, the Department of the Environment, IMOS/AODN, AIMS, CSIRO, GBRMPA and the Bureau of Meteorology (meetings with remaining stakeholders are planned for later in 2015). The consensus among the stakeholders appears to be that the project is feasible, and that the project does have the capability to deliver value through an improved ability to synthesize and deliver information products in general. In particular, GBRMPA noted how the project could generate efficiencies and time savings when assembling their State of the Reef and Outlook Reports, and there was clear interest by Parks Australia officers in the ability to synthesize a broad range of information types via a simple search interface.

**Knowledge Brokering and communication**

The principal goal of the project will be to develop a working prototype of the linked open data delivery service. To this end, we will hold at least one workshop among research end users and key stakeholders to work through the design of the tool, as well as discussing aspects of the user interface design. The final product would be intended to be made available as an online service, and should be designed for intuitive use by an untrained user. Well-used similar interfaces have already been developed (e.g. Amazon, eBay) that can inform the design of the tool. Advertising the availability of the tool can take place via GA’s web page, GA’s media group, and also through NESP communication channels (e.g. fact sheets, tweets, presentations). We also intend to make any code or workflows associated with the service available as open-source (e.g. in a GitHub repository). The project will adhere to the principles and protocols outlined in the Marine Hub’s Communication Strategy.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project is focused on improving discovery and access to data. It will make use of a range of existing data to demonstrate the benefits of the prototype data search tool. Data and information generated by this project will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub.

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

Although the project is intended to facilitate access to existing information sources, the project will be enhancing metadata with semantic markup. This information will be exposed in its entirety through the delivery tool’s web interface. We will also make any software developed as part of this project available through GitHub.

**Expenditure Summary**

Funding will primarily be used for performing prototype development. Funds will also be used for travel to perform stakeholder engagement, and to host a workshop regarding the development of the service.

**Location of Research**

Most of the software development work will take place at Geoscience Australia, however we also expect to have close collaborative ties with partner organisations such as IMOS/AODN, AIMS, and CSIRO.

**Indigenous Consultation and Engagement**

The project primarily involves delivery of existing data sources as linked open data, meaning that there will be equal opportunity to access the data across all user groups. The project will seek advice from Hub leadership regarding points of contact in order to assess the level of indigenous interest in the work. If there is significant interest from indigenous groups in participating as a stakeholder group, we will incorporate elements identified as relevant within the data collection to the extent that they are available. We will also ensure that the project remains consistent with the Hub’s Indigenous Engagement and Participation Strategy. All work undertaken as part of this project will be conducted according to ethical research standards, and will be performed in a manner that respects and acknowledges cultural and intellectual property as well as traditional knowledge.

**Inclusions**

The project will include the development of a prototype linked open data delivery service, and working up of prototype linked open data collections. We will also engage with stakeholders and partner organizations (as set out above), to align the development of the tool to complement their needs.

**Exclusions**

The tool will be developed as a prototype. Although we will design the system such that it can be upgraded and enhanced, a software system that incorporates any and all sources of marine information from both inside and outside of the Marine Biodiversity Hub is clearly outside the scope and budget of the project. While we anticipate that the tool will harvest metadata, it will not be designed to ingest raw data or data streams. The tool is also intended as a means of accessing sources of information (via their metadata), and forwarding metadata on to other services, however development of these processing services will be a subsequent project. The prototype will be for demonstration purposes, with the intent of further development if it is found to meet user needs.

**Constraints and Risks**

There is some risk relating to unavailability of developers with requisite skills, however this is mitigated by GA’s ability to hire on external contractors if required. Linked open data sets will need to be ingested into the tool, however there are a number of data elements available at GA and through the previous CERF and NERP Hubs that can be worked up to use during prototype development.

**Project Keywords**

Marine Data; Linked Open Data; Web Services; Business analytics; Information accessibility.

**Attachment A – Project Timeline**



Commencement of

proposed 2016 work

Note: timelines are indicative, and represent duration intervals, not effort (i.e. 7 days to work on a task, not 7 days of work on a task)

# Project B4: Underpinning the repair and conservation of Australia’s threatened coastal-marine habitats – Phase 2

*Project length* – 2.5 years

*Project start date* - 01/07/2015

*Project end date* - 01/01/2018

*Project Leadership* - Colin Creighton colinmwnrm@bigpond.com;   
Mobile: 0418 225894*;   
Home office: 07 4958 4775 (mobile coverage is not always available so please leave messages or email)*  
Dr Ian McLeod, TropWATER, JCU jointly with  
Dr Chris Gillies, The Nature Conservancy

*Lead Research Organisation* - TropWATER, James Cook University

**Total NESP funding**: $520,000 ($390,000 total in 2016-2017 to build on the $130,000 investment into Phase 1) (all GST exclusive)

**Total recipient and other contributions (co-contributions)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| NESP funding | $130,000 | $195,000 | $195,000 | Later years in the Hub to be determined | | |
| In-kind contribution | $180,000 | To be determined but commensurate or greater than NESP funding | | To be determined with any follow on NESP investments | | |
| Accompanying Works |  | **Shellfish Reefs**  In excess of $1.3M underway or already planned in shellfish repair works. See Table 1 for full details + proposed work plan to underpin these works along with parallel *Nature Conservancy* commissioned science investment.  **Salt marshes**  NSW - $800,000 in HSBC Bank funded *Mapping Ocean Wealth* project that will use NESP outputs for the salt marsh component, northern NSW, Richmond and Clarence estuaries  -$4M already confirmed for GBR seascape repair. Additional GBR funds in pipeline – awaiting Ministerial announcement + NSW via Rec Fishing levy. | | To be determined with any follow on NESP investments | | |

**Phase 1 Outputs**

***Shellfish***

*Reports*

* Main report: Gillies CL, Creighton C and McLeod IM (Eds) (2015) **Shellfish reef habitats: a synopsis to underpin the repair and conservation of Australia’s environmentally, socially and economically important bays and estuaries.** TropWATER Report 15/58, James Cook University, Townsville, 88 pp
* Seven Regional Reports(GBR region, Southeast Queensland, New South Wales, Victoria, Tasmania, South Australia and Western Australia)
* All reports available for download from: https://research.jcu.edu.au/tropwater/research-programs/coastal-estuarine-ecology/shellfish-reef-protection-and-repair

*Website*

* www.ShellfishRestoration.org.au.
* This website includes background information relevant to the project and an information Hub where people can download the NESP reports and other relevant documents. The website is currently in review with the NESP Hub leaders and can be viewed as a draft at this address: https://research.jcu.edu.au/tropwater/research-programs/coastal-estuarine-ecology/shellfish-reef-protection-and-repair

*Journal articles*

* Invited Feature Article and Cover Story in the journal of Coastal, Estuarine and Shelf Science. Working title: Shellfish restoration in Australia
* The regional report for South Australia now published (Alleway and Connell 2015)
* The regional report for Victoria has been submitted for publication

*Summary brochure*

* 4 page glossy summary brochure from the main report in preparation

*Twitter*

* @Shellfishreefs

***Salt marshes***

*Reports*

* Main report: Creighton C, Gillies CL and McLeod IM (Eds) (2015) **Saltmarsh habitats: A synopsis to underpin the repair and conservation of Australia’s environmentally, socially and economically important bays and estuaries.** TropWATER Report 15/59, James Cook University, Townsville, 88 pp
* Five Regional Reports(GBR region, New South Wales, Victoria, Tasmania, South Australia and Western Australia)
* All reports available for download from: https://research.jcu.edu.au/tropwater/research-programs/coastal-estuarine-ecology/protection-and-repair-of-australias-saltmarshes

*Website*

* www.saltmarshrestoration.org.au
* This website includes background information relevant to the project and an information Hub where people can download the NESP reports and other relevant documents. The website is currently in review with the NESP Hub leaders and can be viewed as a draft at this address: https://research.jcu.edu.au/tropwater/research-programs/coastal-estuarine-ecology/protection-and-repair-of-australias-saltmarshes

*Journal articles*

* Invited Feature Article and Cover Story in the journal of Wetland Ecology and Management. Working title: Salt marsh repair in Australia

**Preamble**

Our initial submission of our Phase II application met with the following response:

*1. Departmental response*

***Not approved.***

*This project is weak in reference to its management implications, tangible outcomes and trial programs. A greater focus on on-ground outcomes and the inclusion of the Indigenous-led communication initiative into the main project is encouraged for Research Plan Version 3.*

This was somewhat surprising given

* our strong Indigenous engagement, including Indigenous attendance at our Network forums;
* our desire to do more Indigenous work and hence the unfunded additional proposal as an attachment; and
* our very clear links to investment in works in both shellfish reefs and wetland repair such as Table 1 in the previous phase 2 application [repeated in this application].

The request to rewrite is however timely as since the writing of the initial Phase II proposal through our ongoing work a series of wonderful successes have been announced that now allow us to further focus this important work. The successes following on from our Phase I work and Australia-wide interaction include:

* working with the SA team members to get up a SA specific research proposal via FRDC to underpin the SA Govts investment in shellfish reef repair – St Vincent’s Gulf;
* working with GBRMPA and Greening Australia on two saltmarsh repair projects - $5M and $4M respectively and the second of these now already confirmed;
* working through *The Nature Conservancy* to find additional resources for *Ostrea angasi*, especially in Tas, WA and possibly Victoria;
* supporting the Pumicestone Passage team, with their initial funding for repair works now confirmed; and
* increasing interest in NSW via the Recreational Fishing levy to repair saltmarshes in major estuaries – yet to be formally finalized.

Therefore in responding to the Dept. feedback we have altered the proposal in two key respects;

1. making explicit our already established proposals for Indigenous leadership via Gubbi Gubbi
2. constraining and focusing both our saltmarsh and shellfish repair science to strongly underpin the confirmed and proposed works in GRB, SEQ and northern NSW

The momentum towards coastal restoration ecology is gathering impetus. We are pleased for NESP to be part of this exciting time.

We are of course available to provide input and clarity on the proposed Phase II investment.

- Colin Creighton, Ian McLeod and Chris Gillies.

**Project Summary**

The primary objective of this project is to provide essential research to underpin restoration efforts to increase the success and efficiency of shellfish and saltmarsh repair. The secondary objective is to quantify clear easily understood benefits of repair to further increase groundswell, Indigenous and interest group support for repair efforts. For Phase 2 this involves:

*Shellfish reefs*

1. Providing critical research to underpin the success of companion works investments into Sydney rock oyster(*Saccostrea glomerata*) restoration in Qld and NSW
2. Ongoing engagement with Indigenous groups, focused around especially SEQ and NSW to match the emphasis on Sydney rock oyster;
3. Through the *Nature Conservancy*, linking to shellfish restoration works in Port Phillip Bay (Vic), St Vincent’s Gulf (SA) and Oyster Harbour (WA) so that a National Business Case complete with examples of successes to date can be developed;
4. Underpinning this succinct business case with an information base for any follow-on activities such as assessment of shellfish reefs as an endangered community.

*Salt marshes*

1. Estimating the benefits of salt marsh repair for an easily publicly understood indicator - prawn species.
2. Undertaking this work in NSW and Qld in parallel with proposed repair works so that very concrete case studies are available to demonstrate the benefits of repair.
3. **Project Support Details**
   1. ***Conservation Status***

Native shellfish reefs are considered imperiled marine ecosystems within Australian coastal waters, nominally classified as “Functionally Extinct” by Beck et al. (2011) and “Collapsed” by Kirby et al. (2009). Salt marshes are listed as “Vulnerable*”* under the EPBC Act and *“*Endangered*”* under the NSW Threatened Species Conservation Act 1995. Both habitats are vital to the health of Australia’s bays and estuaries supporting high levels of marine biodiversity and providing ecosystem benefits such as fish production, improving water quality and reducing coastal erosion (Creighton et al. 2015; Gillies et al. 2015). Both shellfish reefs and salt marshes are ‘listed habitat types’ under the Ramsar Convention. Salt marshes also act as carbon sinks and provide foraging habitat for migratory birds protected under bilateral migratory bird agreements such as CAMBA and JAMBA.

***1.2 Shellfish Reefs, building on Phase 1 outputs***

Phase 2 of this project will address several of the *Priority Actions* (detailed in the Phase 1 report; Gilles et al. 2015), which we believe are urgently required to underpin current and future shellfish reef restoration efforts and which align with the broader research and engagement objectives of the NESP Marine Biodiversity Hub.

For shellfish reefs, Phase 2 of the project will focus on addressing *Priority Action 4*:

* **Quantify the benefits and ecology of Australian shellfish reefs** (including nitrogen cycling, filtration capacity, fish production, shoreline protection and biodiversity) to better understand their ecological, social and economic value.

The project will also contribute to *Priority Action’s 1 and 2:*

* **Improve community knowledge** and awareness of the value of shellfish reef habitats through the development of communication campaigns and materials (*Priority Action 1*);
* **Increase Indigenous engagement** in restoration activities by capturing and communicating Indigenous knowledge and stories and invest in programs which support the inclusion of Traditional Ecological Knowledge in shellfish reef management and restoration (*Priority Action 2*).

We will prioritize the reef-forming shellfish complex of Sydney rock oyster (*Sacosstrea glomerata*) dominated reefs, which, of the eight known reef-forming species documented in Gillies et al. (2015), are, along with *Ostrea angasi* (native flat oyster) the most imperiled and have the highest restoration potential.

This work will directly support and underpin the management and restoration objectives of existing shellfish reef repair projects (See Table 1) and will assist future projects and management decision-making by developing appropriate methods and setting of repair targets based on natural reference conditions (see Project Outcomes, Section 5 for further details).

The communication media and resources produced in Phase 2 will, amongst other locations (e.g. NESP Marine Biodiversity website; partner websites, social media), be hosted on the shellfish reef restoration website which was developed during Phase 1 of the project (www.shellfishrestoration.org.au).

**Table 1 – Ongoing Shellfish Reef Repair Investments in Australia**

|  |  |  |
| --- | --- | --- |
| **Shellfish Repair Site** | **Resources** | **Partners** |
| Port Phillip Bay  (*O. angasi* reefs) | $300k over 3 years | Fisheries Vic., Melb. Univ., Albert Park Yachting and Angling Club, The Nature Conservancy |
| Gulf St Vincent  (*O. angasi* reefs) | $650k over 3 years | SA Govt., NRM group, RecfishSA, The Nature Conservancy, SARDI, FRDC |
| Albany  (*O. angasi* reefs) | $80k pilot project at this stage funded for 1 year | South Coast NRM, UWA, Recfishwest, The Nature Conservancy |
| Noosa River\*  (*S. glomerata* reefs) | $40k background study funded,  $300k proposal in development | Noosa Parks Association, Thomas Foundation |
| Pumicestone Passage\*  (*S. glomerata* reefs) | Total funding to be confirmed – already in excess of $100K | SEQ Catchments NRM group, Indigenous (Gubbi Gubbi (Kabi Kabi) and Joondoburri Traditional Owners), Sunfish and Local Government |
| Sydney, NSW\*  (*S. glomerata* reefs) | ~$100K over 2 years | Oceanwatch, Local Government and Local Land Services with 3 sites under consideration (Manly Lagoon, Upper Lane Cove River & Botany Bay) |

**\*** = focus for this NESP investment

***1.3 Salt marshes – working towards repair investments***

The Phase 1 report for salt marshes (Creighton et al. 2015) highlighted the lack of detailed understanding of the ecosystem benefits provided by Australian salt marshes. Furthermore, the report identified that different salt marsh communities are likely to support different types and values of ecosystem benefits (e.g. fish production, carbon sequestration and shoreline protection) and hence a ‘once size fits all’ approach to communicating the ecosystem benefits of Australian salt marshes is not appropriate.

Phase 2 of the salt marsh project will pair up with works in NSW and GBR to quantify prawn production, in two contrasting community types (tropical and temperate). The project will also develop communication resources, which articulate these and the more detailed values of salt marshes. This will be an important contribution to the protection, conservation and repair of Australian salt marshes.

1. **Description of project alignment with departmental research priorities**

* NESP 2015 research priority: Maximising the efficacy of managing Australia’s marine environment and in particular: *Identify and trial methods to restore degraded habitats such as oyster and mussel beds, seagrass, and intertidal habitats to underpin on-ground management actions*;
* Contributes to the NESP 2015 research priority: *Improving our understanding of the marine environment including biophysical, economic and social aspects*, and in particular: *Better understand issues that are common to the fishing industry and the environment including identifying solutions of mutual benefit and: Meaningful and accessible information on the status and trends of key social and economic values associated with the marine environment*;
* The project will also develop a number of educational resources accessible to public and seek contributions to the research from Indigenous groups, such as the location and/or historic locations of past shellfish middens, the need for management of culturally significant sites and how best to re-establish indigenous customary food resources.

1. **What Government policy objective is this project addressing?**

***3.1 Shellfish reefs***

EPBC Act:

* Conserve Australia’s Biodiversity - Nationally Threatened Ecological Communities;
* Ramsar Convention on wetlands (protect high value habitats and ecosystem services). Several of the restoration projects occur adjacent or within Ramsar sites. Ramsar sites are also likely to be locations of future restoration works

***3.2 Salt marshes***

EPBC Act:

* Subtropical and Temperate Coastal Saltmarsh Threatened Community Recovery Plan;
* Undertaken effective community engagement and education to promote the value of the ecological community;
* Undertake surveys encompassing a wide taxonomic range, across the national extent of the ecological community to identify:
  + - sites of high conservation priority;
    - threatened species that may require conservation measures;
    - areas that would most benefit from removal of tidal restriction and/other regeneration restoration efforts.
  + Capricorn (Dawson) subspecies of the yellow chat (*Epthianura crocea macgregori*) is listed as “Critically Endangered”. Salt marsh in the Fitzroy River Delta and Torilla Plains is critical for breeding, feeding and shelter for this species.

1. **Research**

***4.1 Quantifying the benefits, ecological functioning and biodiversity of Australian shellfish reefs***

Shellfish reef ecosystems were historically overfished to near extinction and their natural recovery is inhibited by a loss of suitable substrate and recruitment. Active repair is therefore required and efforts have begun with the promise of significant benefits. These projects (and future efforts), however, require a detailed understanding of the ecology and benefits to develop appropriate repair methods and to set targets based on natural reference conditions.

Phase 2 research with focus on Sydney rock oysters (*Sacosstrea glomerata*) as it has been identified as a promising species for successful restoration efforts, repair works are about to start in both NSW and SEQ and we have been successful in gaining support to underpin repair efforts for more temperate reefs such as *Ostrea angasi,* Vic, SA and WA.

In year 3 we will be bringing together lessons learnt in all repair efforts to develop the National Business Case.

in addressing *Priority Action* *4* listed in the Phase 1 report (Gillies et al. 2015) of *Quantify the ecosystem benefits and ecology of Australian shellfish reefs (including nitrogen cycling, filtration capacity, fish production, shoreline protection and biodiversity) to better understand their ecological, social and economic value* this component of the project has three key objectives:

1. Describe the extent, morphology and size class of natural *Sacosstrea glomerata* reefs in order to develop nationally relevant methods for the construction and deployment of new shellfish reefs;
2. Quantify the biodiversity (fish, invertebrates, algae and meiofauna) inhabiting *Sacosstrea glomerata* reefsto determine their biodiversity value and to develop targets for current and future works projects;
3. Conduct preliminary investigations to quantify the benefits (supporting secondary productivity, providing habitat for fish and their food, water filtration and nitrogen cycling) of natural *Sacosstrea glomerata* reefs to inform appropriate sampling design for the next stage of research (to quantify the ecological, social and economic benefits of shellfish reefs).

Known locations for *Sacosstrea glomerata* dominated reefs (Qld, NSW) will be surveyed and described using a combination of sampling methods including: size class measurements, and biodiversity assessments using a combination of quadrat, transect and core sampling protocols. The ecology and benefits of shellfish reefs will be compared to other coastal marine habitats (e.g. rocky reef, seagrass meadows) to assess their ecological function, benefits and unique biodiversity attributes. These results will be compared amongst the broader marine seascape as a means to better support coastal management and conservation decision-making.

As well as addressing *Priority Action* *4*, Phase 2 will also include an Indigenous community engagement component in support of *Priority Action* *2* - *Increase Indigenous engagement in restoration activities by capturing and communicating Indigenous knowledge and stories* and will continue to build publically accessible and open source communication resources - *Priority Action* *1*: *Improve community knowledge and awareness of the value of shellfish reef habitat through the development of communication campaigns and materials*.

The Indigenous engagement component of the project has two key objectives:

1. Increase engagement of Indigenous Australians in shellfish reef restoration by capturing cultural stories and Traditional Ecological Knowledge (TEK) of shellfish reef use and restoration to strengthen relationships and build trust amongst restoration practitioners and local Indigenous groups;
2. Communicate the cultural significance of shellfish reefs to the broader Australian public by promoting stories and TEK through videos, webpages, brochures, social media and media releases.

The project will be led by our most active Indigenous group and at least, will extend to all the Indigenous groups that were involved in the Phase I work – see Table 2.

**Table 2: Indigenous partnerships and key outcomes**

|  |  |  |
| --- | --- | --- |
| **State** | **Key Indigenous Groups** | **Key outcomes** |
| South East Queensland - Pumicestone Passage & Great Sandy Strait | Engagement and regular consultation for shellfish reef restoration is underway with representatives of the Gubbi Gubbi (Kabi Kabi) and Joondoburri Traditional Owners | Gubbi Gubbi (as the most mature Indigenous engagement so far) will provide early application of techniques that can then be tested and then applied in all focal sites  Activities are likely to include midden interpretation, field trips with traditional owners and communication products – e.g. Indigenous stories as videos |
| South Australia - Gulf St Vincent | Wirangu, Bungala and other groups |
| Victoria - Port Phillip Bay | Wadawurrung and other groups |
| New South Wales - Botany Bay | La Perouse LALC and other groups |

Table 3 details proposed activities and the break-up of resources for the shellfish component of the NESP investment.

**Table 3: Proposed activities and break-up of resources (Phase 2)**

|  |  |  |
| --- | --- | --- |
| **Activities – shellfish reefs** | **Timing** | **$** |
| **1. Quantify the benefits and ecology of Australian shellfish reefs** | | |
| Conduct ecological benefit assessments of *Sacosstrea glomerata* reefs including descriptions of the extent, morphology and size class of reefs, associated epifauna and infauna and habitat value for fish in Qld and NSW and underpin repair investments such as Pumicestone Passage. | January 2016 to December 2017 | $210,000 |
| **Total resources – Shellfish reef assessments** | | **$180,000** |
|  | | |
| **2.** **Indigenous engagement and communications** | | |
| Salaries for Indigenous engagement and TEK capture in 4 focal areas led by Gubbi Gubbi |  | $40,000 |
| Multi-media production (videos, brochures, scientific papers, social media, website summaries) | Completed by November 2017 | $50,000 |
| **Total resources – Communications and Indigenous engagement** | | **$90,000** |
|  | | |
| **3. Business case to foster further investment in shellfish reef repairs** | | |
| Collate lessons learnt from all works activities [Table 1) to build the Australia-wide Business Case, complete with detail of all the pilot repair works, lessons learnt and ecological benefits of repairing these important coastal ecosystems. Underpinned by information base for any follow-on activities such as assessment of shellfish reefs as an endangered community | June 2017 to December 2017 | $30,000 |
| **Total resources – Australia-wide Business Case** | | **$30,000** |
|  | |  |
| **Total resources – shellfish reefs** | | **$300,000** |

\*Costs includes research staff salaries, vessel and car hire, field equipment, laboratory analysis, publication costs, travel and consumables

***4.2 Developing blueprints for salt marsh repair***

Australia’s coastal salt marshes comprise a variety of habitats ranging from samphire flats, through salt couch to mangroves. Salt marsh habitats are vital to biodiversity and fisheries. As well as providing essential habitats for significant marine biodiversity, they play critical roles in supporting healthy estuarine and nearshore ecosystems and coastal fisheries. This support involves both their vital role of integrating terrestrial nutriments into coastal food webs and the provision of essential nursery grounds for a wide range of species, including many of high fisheries value.

The project provides primary research to address two vital inter-related objectives:

1. Collect data on prawn and fish productivity in estuaries and relate that to the size, type, extent and condition of associated saltmarshes / seascapes.
2. Assess the economic and environmental costs and benefits of repair by actively working with proposed repair activities, especially GBR.

These are critical to ensure effective rehabilitation of salt marshes and associated wetlands. All are dependent on objective 1 which represents a critical gap in our knowledge (Creighton et al. 2015) that prevents definitive understanding of the specific values that repair can bring, identification of optimal sites for repair, and understanding of the best and most effective approaches to repair.

The project will be based in GBR catchments where repair works to seascapes are planned to start in 2016 [e.g. $4M Aus. Govt. – Greening Australia partnership] and on the Clarence, which is the largest school prawn fishery in NSW. These two subtropical and tropical study areas should enable the establishment of a widely applicable model of prawn and fish productivity and its relationship to the size, type, extent and condition of associated salt marshes.

These areas have been selected because there is already a substantial database that can underpin directed studies. The available knowledge will be collected and assessed to determine the specific research needed to acquire the required knowledge and appropriate research sites. Following on from this, studies to expand and refine the existing knowledge will be conducted in replicate estuaries or sub-estuary components with different levels of wetland extent, type and condition. This will provide a series of estimates of productivity and its relationship to wetland characteristics that will allow the development of models that can provide valid estimates of the relationship between wetland productivity and prawn and fish productivity. These models will provide the basic information need to underpin subsequent restoration and repair work, and stand as base models that can be adapted and tested for other areas.

Table 4 details proposed activities and the break-up of resources:

**Table 4: Proposed activities and the break-up of resources for salt marsh research**

|  |  |  |
| --- | --- | --- |
| **Activities** | **Timing** | **$K** |
| **1. Quantify the benefits of saltmarsh repair using prawns as a simple indicator** | | |
| Collect data to address the knowledge gaps on the key ecosystem benefits provided by salt marshes by quantifying prawn production, in two contrasting community types (tropical and subtropical); | January 2016 to November 2016 | $80,000\* |
| **2. Build a summary Business Case that articulates benefits and identifies key sites for further works** | | |
| Undertake above research in parallel with proposed works investments to assess the economic and environmental costs and benefits of saltmarsh restoration. Compile as a Business Case | January 2016 to November 2016 | $10,000\* |
| **Total resources – salt marshes** | | **$90,000** |

\*Cost includes research staff, vessel and car hire, field equipment, laboratory analysis, travel and consumables

**5. Project Outcomes**

***5.1 Shellfish reefs***

*Project outcomes to support coastal management and the scale-up of shellfish reef restoration works:*

1. Improved understanding for restoration practitioners of how to construct and deploy new shellfish reefs (or expand the extent of existing shellfish reefs) to aid the national recovery of an imperiled ecological community;
2. Understanding of the flora and fauna associated with *Sacosstrea glomerata* reefs which could be used to underpin the nomination of *Sacosstrea glomerata* reefs as a “Threatened Ecological Community” under the Commonwealth EPBC Act and/or NSW and Qld state Flora and Fauna Acts;
3. Comparison of the costs associated with shellfish reef conservation versus active repair and improved knowledge of the anticipated biodiversity benefits, to help guide decision-making processes for coastal management and repair and strengthen the case for further investment in shellfish reef restoration;
4. Recommended key milestones and ecological targets to develop best practice methods for *Sacosstrea glomerata* reefs projects;
5. Increased Indigenous engagement in shellfish reef repair and coastal management and inclusion of Traditional Ecological Knowledge in shellfish reef management.

***5.2 Salt marshes***

1. Improved understanding of prawn productivity and broader ecosystem benefits of salt marshes in two contrasting salt marsh communities (sub-tropical and tropical);
2. Quantification of an easily understandable, ecosystem benefit (prawn production) provided by salt marshes in which to communicate their value in terms of benefits to coastal stakeholders (e.g. recreational fishers) and the broader Australian public.
3. Communication resources which simply articulate the value of salt marshes and their need for protection, conservation and repair.

**6. Links to other projects and hubs**

* Project C3 - GA/UTAS to use the last 20+ years of satellite data to identify changes in the coastal environment;
* Project C2 - UTAS/CDU/CSIRO - to identify the changes in biological communities downstream of major population centres (Sydney, Melbourne, Hobart);
* Projects C1, C4 and C5 – these three projects will all provide excellent links, especially as this project details the water quality and quantity conditions amenable to shellfish reef repair. Links to salt marsh environments, especially tidal water quality also apply.

**7. Details of related / previous research**

Refer to Phase 1 reports for shellfish and salt marshes.

**8. Expected Outcomes for Key Sectors**

* *Nationally* - Information towards the development of a national recovery plan. Identification and description of reference sites to underpin best practice restoration;
* *State and Regionally* - Natural Resource Management Agencies, Catchment Management Authorities, state government environmental and resource management agencies become aware of loss of shellfish reefs and their ecosystem benefits and convinced of benefits of restoration;
* *Local groups* - increase financial and resource support for shellfish reef and salt marsh repair and conservation;
* *Indigenous groups* - these groups have the information to link remaining historic shellfish middens to the condition of the current nearby shellfish resource - an important basis to understand ecological change and important information upon which to advocate recovery of the resource;
* *Science investment* - to determine further research priorities in terms of marine repair and habitat ecosystem services;
* *Coastal managers and managers of repair programs* - to improve communication on the value of shellfish reefs and salt marshes in terms of their ecological services (e.g. productivity for prawn and fish species, water filtration, coastal protection) and economic value which in turn will increase community support for coastal repair projects;
* *Marine private sector stakeholders* - information on value upon which to increase support for and investment in repair activities.

**9. Practical and tangible outcome/s the project will deliver**

This investment will provide base information required to inform and scope large-scale repair investment opportunities for Australia’s most threatened coastal marine habitats. Equally importantly, it will be paralleled by investments in hands-on repair in a number of small to medium scale projects.

Estuary habitat repair is a developing area of community interest, especially in those states with recreational fishing license fees, as habitat improvements generally rank at the top of the investment priorities of recreational fishing communities. Importantly, ‘habitat’ is also the common ground between the recreational and commercial fishing sectors and environmental groups.

The practical outcomes this project will deliver include:

1. Improved understanding of the location, ecology and functional role of shellfish reefs and salt marshes and their role in supporting the ecological health and productivity of estuaries (documented in journal papers and in media);
2. Documented, synthesized current and past national distributions for shellfish reefs, nearby middens and thereby providing a link for Indigenous groups between history and current resource condition and availability;
3. Summary evidence of the productivity and economic benefits that are expected to be generated with repair (shellfish and salt marsh);
4. Framework for data collection, analysis and reporting to accompany/evaluate any repair investment and best-practice restoration;
5. Provide an easily understandable demonstration of the benefits of salt marshes and their repair to the community (prawn productivity).

**10. Management or policy action that will be able to be taken as a consequence of the delivery of this project**

The outcomes provided by this project will underpin management and repair by:

1. Establishing the biodiversity and functional value of *S. glomerata* shellfish reefs and thereby understanding their functional role in the marine seascape and requirements for their protection, conservation and restoration, including, if they meet the requirements for nomination for Threatened Ecological Communities;
2. Establishing a detailed ecological description of *S. glomerata* shellfish reefs for use by management agencies, including Ramsar wetland sites to better delineate shellfish reef habitat;
3. Establishing key milestones and ecological restoration targets to develop best practice methods for future *S. glomerata* reefs restoration projects;
4. Comparison of the costs associated with shellfish reef conservation versus active repair and improved knowledge of the anticipated biodiversity benefits, to help guide decision-making processes for directing resources for shellfish reef management and repair.

The outcomes provided by this project will underpin management and restoration of salt marshes by:

1. Establishing the functional value of salt marshes in terms of prawn production to increase community awareness, engagement and support for salt marsh protection, conservation and repair.

The research will also support *The Nature Conservancy* and other groups such as NRM agencies, academic institutions and community groups in seeking increased support from private sector investments (including philanthropy, corporate businesses, commercial and recreational fishers). This funding is used as co-investment with state and Australian government agencies to financially resource in-water repair works, such as the Port Phillip Bay and Albany shellfish projects. Such private-public partnerships, with strong community involvement and ownership has been extremely successful in the U.S. in driving policy change and increased investment in coastal repair.

**11. Value the project demonstrates for the environment and measurement**

The long-term outcomes of this work will ultimately be measurable in the number, size and success of shellfish and salt marsh repair works proposed or undertaken by state agencies, NRM agencies, research institutes, Indigenous groups and other community groups such as recreational fishing. The hectares restored and projected productivity improvements will provide evidence of the value of the investment.

**12. Delivery of Project**

The core research team comprises:

**Colin Creighton**, Principal Research Scientist, TropWATER, JCU

**Dr Ian McLeod**, Senior Research Scientist and Communications Manager, TropWATER, JCU

**Dr Chris Gillies**, The Nature Conservancy

**13. Project delivery on time and within budget**

See *Marine Hub Performance and Evaluation Protocols.*

**14. List of all outputs planned under the project, including communication and promotional material**

*Shellfish reef project outputs:*

1. A scientific paper published in an eminent, peer-reviewed journal describing the ecology and biodiversity of shellfish reefs and biodiversity comparison against other marine habitats;
2. A scientific paper published in an eminent, peer-reviewed journal which identifies trajectories of change from past baselines to current condition and develops achievable targets for repair;
3. News stories, web articles, social media, brochures and oral presentations at national/international conferences, which communicate the key research findings to coastal stakeholders such as fishers, divers, NRM groups and government agencies;
4. News stories, web articles and social media which communicate the importance of shellfish reefs and shellfish food sources to Indigenous Australians;
5. Summary of community benefit and business propositions for coastal wetland repair expanding on the vision of a rejuvenated coastal ecology and written at the level required for input to various investors, agencies and public policy;
6. Updates at the end of 2016 as part of stakeholder engagement and continued communication.

*Salt marsh prawn productivity outputs:*

1. A scientific paper published in an eminent, peer-reviewed journal quantifying and contrasting prawn productivity in healthy and degraded salt marsh communities in tropical and temperate environments;
2. Publically accessible communication resources (brochures, social media, media releases and webpages) which articulate simply the prawn productivity values of salt marshes and links this to the need for the protection, conservation and restoration of degraded salt marsh communities.

**15. Project Details**

*15.1 Project Milestones*

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| Milestone 1 – Confirmation of project partners/ scope of research works and key dates for delivery | Due: 1 January 2016 |
| Milestone 2 – Final report for salt marsh component and mid-project update for shellfish reefs | Due: 1 January 2017 |
| Milestone 3 – Final publications and reports for shellfish together with a summary business proposition for major investment in coastal repair – shellfish reefs and seascapes and draft science papers | Due: 1 January 2018 |

*15.2 Key Researchers and Staff*

|  |  |  |
| --- | --- | --- |
| **Name/Organization** | **Project Role** | **Weeks 2016 & 2017** |
| Colin Creighton, TropWater, JCU | Project leader | 32 weeks |
| Chris Gillies, Marine Manager, Australian Program, TNC | Temperate shellfish reefs + link to USA experiences; leadership team | 12 weeks  50% inkind by The Nature Conservancy |
| Ian McLeod, JCU | Principal Investigator; Communications; Data Management; leadership team | 32 weeks |
| Additional staff as appropriate – and to include Dr Ben Diggles for SEQ shellfish, Dr Matt Taylor and Carla Wiegsheidl for the two saltmarsh sites | Investigators | To be determined |

*15.3 Research end users and key stakeholders*

|  |  |
| --- | --- |
| **Research End Users** | **Organisation/section** |
| Marine ecologists | Multiple – universities, CSIRO, State agencies |
| Marine and estuary managers and policy groups (including fisheries agencies) | All jurisdictions, State, GBRMPA |
| National Estuary Network | All jurisdictions |
| NRM, Indigenous and other community groups such as recreational fishing focusing on repair of coastal ecosystems | All jurisdictions |
| **Key Stakeholders** |  |
| MEPA advocates and managers | All jurisdictions |
| Fishers / resource users – commercial, recreational and Indigenous | All jurisdictions, exception is Commonwealth fishery |
| Conservation groups | Local to national and international (e.g. WWF and its Pacific coastal resources program) |
| Nature appreciation groups | e.g. Birds Australia |

**16. Expenditure Profile**

The project will entail:

* Shellfish Reefs, including $50K specifically allocated for Indigenous - $300K over 2016 and 2017;
* Salt Marshes - $90K in 2016 only.

**17. Data and Information**

All data derived from the project will become part of the IMOS system. Dr Ian McLeod will undertake data management and electronic capture of all outputs. Specific web pages are already in place as part of Phase 1 activities.

**18. Knowledge Brokering and Communication**

For both salt marshes and shellfish reefs, all information derived will be widely communicated as part of the processes to foster investment in protection and repair. Knowledge brokering, exchange and communication is built into the project design as follows:

* participation of key management agencies;
* interface to policy groups in management agencies;
* broader science engagement (multiple research groups engaged);
* action groups, especially investment in repair and protection;
* interest groups and community investors (e.g. private sector, fishing groups);
* Indigenous groups**;**
* broader community awareness(social media, media releases, websites).

The Hub’s Knowledge Brokering and Communication Strategy will assist the communication and engagement objectives of this project and Hub Communication Protocols will be applied within the context of this project.

**19. Location of Research**

Australia’s developed east coasts – NSW through to and including Great Barrier Reef.

**20. Indigenous Consultation and Engagement**

Covered in detail in the project plan – Indigenous involvement and outcomes are an integral part of the project and its implementation.

The project team will also ensure all activities are consistent with the Hub’s Indigenous Engagement and Participation Strategy.

**21. Inclusions (in scope)**

For shellfish reefs:

Temperate to tropical Australia and GBR lagoon, generally within estuary, embayment or sheltered waters

For salt marshes:

Subtropical and tropical areas within estuary, embayment or sheltered waters

**22. Exclusions (out of scope)**

Actual on-ground repair works – this project provides research that underpins works.

**23. Constraints**

In the brief timeframe of this project, the following constraints are likely:

* Assessments for all known shellfish and salt marsh sites- only a subset of known locations will be included;
* Inability to fully consult and engage with all the potential beneficiaries and stakeholders;
* Inability to have the scientific papers published by end of the project, papers will be submitted for review in the timeframe of the project.

**24. Risks**

*Risk:* Co-investigators fail to provide resources in timely fashion.

*Mitigation:* All co-investigators engaged early in process with project timeline outlined in initial workshops. Regular telephone and email meetings convened to ensure everyone is on track.

*Risk*: Stakeholders not engaged/aware of final outcome or research results.

*Mitigation*: Co-investigators consult early to engage their agency communication departments. Media alerts produced and shared amongst all co-investigator communication departments. TropWATER’s communication team will coordinate media releases on behalf of co-investigator agencies.

*Risk:* Meaningful Indigenous engagement does not happen throughout all locations of the project.

*Mitigation:* By including non-confidential information on current and prior middens in the assessment the team will have an excellent practical base to explore partnership opportunities with Indigenous groups. Secondly, by working through Gubbi Gubbi as the lead Indigenous group for the project we expect strong Indigenous support to continue.

To conclude, should the project proceed as planned in 2016 and 2017, building on the initial base provided in 2015, it should lead to substantial engagement towards partnerships in repair.

**25. Project Keywords**

Shellfish Reefs; Restoration Ecology; Ecosystem Repair; Salt Marsh; Prawns; Net Primary Productivity

**26. Selected References**

Alleway, H. and Sean D. Connell, S. (2015) Loss of an ecological baseline through the eradication of oyster reefs from coastal ecosystems and human memory. Conservation Biology. DOI: 10.1111/cobi.12452

Baggett LP, Powers SP, Brumbaugh R, Coen LD, DeAngelis B, Greene J, Hancock B, Morlock S. (2014). Oyster habitat restoration monitoring and assessment handbook. The Nature Conservancy, Arlington, VA

Beattie, K. (2001). Oyster culture in Queensland. Queensland Department of Primary Industries. Information Series. ISSN 0727-6273. 28pp

Beck MW, Brumaugh RD, Airoldi L, Carranza A, Coen LD, Crawford C, Defeo O, Edgar GJ, Hancock B, Kay MC, Lenihan HS, Luckenbach MW, Toropova CL, Zhang G and Guo X (2011) Oyster Reefs at Risk and Recommendations for Conservation, Restoration, and Management. Bioscience 61: 107-116

Chavez, F.P. Messié M., and Pennington J.T (2011) Marine Primary Production in Relation to Climate Variability and Change. Annual Review of Marine Science 3: 227-260

Creighton, C (1984) Keppel Islands Environmental Survey – a baseline for archaeological reconstruction, the Woppaburra and their food resources and for resource management. Archaeology Branch, Dept. of Community Services Brisbane and Australian Heritage Commission

Creighton, C (2013) Revitalizing Australia’s Estuaries. FRDC Report 2012-036 http://frdc.com.au/research/Documents/2012-036-Business-Case.pdf

Creighton, C., Boon, P., Brookes, J., and Sheaves, M (2015) Repairing Australia’s estuaries for improved fisheries production: What benefits, at what cost? Journal of Marine and Freshwater Research 66: 493-507

Creighton, C Gillies C, McLeod IM (In Review). Saltmarsh habitats: A synopsis to underpin the repair and conservation of Australia’s environmentally, socially and economically important bays and estuaries. TropWATER Report 15/59 for the NESP Biodiversity Hub.

Diggles BK (2013) Historical epidemiology indicates water quality decline drives loss of oyster (*Saccostrea glomerata*) reefs in Moreton Bay. Australia New Zealand Journal of Marine & Freshwater Research, 2013.

Gillies C, Creighton C, McLeod IM (In Review). Shellfish reef habitats: A synopsis to underpin the repair and conservation of Australia’s environmentally, socially and economically important bays and estuaries. TropWATER Report 15/60 for the NESP Biodiversity Hub

Great Barrier Reef NRM groups (2015) Investment Plan – responding to the Long Term Sustainability Plan 2050 <http://www.rgc.org.au/wp-content/uploads/2015/01/Investment-Plan-NRM-proposal-190115.pdf>.

Hamer, P., Pearce, B., Winstanley, R. (2013) Towards reconstruction of the lost shellfish reefs of Port Phillip Bay. Recreational Fishing Grants Program Research Report. Project SG/117. 35pp

Howarth, R.W, (1988) Nutrient Limitation of Net Primary Production in Marine Ecosystems Annual Review of Ecology and Systematics Vol. 19: 89-110

Nell, J.A. (2001). The history of oyster farming in Australia. Marine Fisheries Review. 63: 14-25

Huston, MA and Wolverton S (2009) The global distribution of net primary productivity: resolving the paradox Ecological Monographs 79(3) pp 343-377

Schrack, E., Beck, M., Brumbaugh, R., Crisley, K. and Hancock, B. (2012). Restoration works: Highlights from a decade of partnership between The Nature Conservancy and the National Oceanic and Atmospheric Administration’s Restoration Center. The Nature Conservancy, Arlington, VA, USA

# Project C1 – Improving our understanding of pressures on the marine environment

Project length – 30 Months

Project start date – 1/7/2015

Project end date – 31/12/2017

Project Leader – Piers Dunstan (FTE – 15% + 10% theme leader).  
Team Leader Marine Biodiversity  
Oceans and Atmosphere Business Unit  
CSIRO, Hobart.  
[Piers.Dunstan@csiro.au](mailto:Piers.Dunstan@csiro.au)  
03 6232 5382

Lead Research Organisation – CSIRO

Total NESP funding - $540,778

Total Recipient and Other Contributions (co-contributions) - $540,778

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| NESP funding | $65,000 | $234,725 | $241,053 | X | x | x |
| Cash co-con |  | x | x | X | x | x |
| In-kind co-con | $65,000 | $234,725 | $241,053 | X | x | x |

**Project Summary**

The marine environment in Australia is influenced by a wide range of different pressures that impact on different parts of the marine ecosystem in different ways. This project aims to assist DoE, and other research users, to improve understanding of the potential impacts of anthropogenic disturbance to marine conservation values by providing up-to-date data and analyses on the spatial distribution of pressures and trends. The research is designed to inform decision making under the EPBC Act (acceptability of proposed activities, evaluation of effectiveness of mitigation measures) on NMES (including Key Ecological Features), implementation of multiple strategies in four Marine Bioregional Plans (i.e. strategies B, C, D and F), management of Commonwealth Marine Reserves (e.g. strategies1 and 2 in the South-east Commonwealth Marine Reserve Network Management Plan 2013-23) and State of the Environment reporting.

The project will involve a re-examination of the pressure analyses undertaken through the marine bioregional planning program and the 2011 SOE Report (marine chapter) and determine where pressure mapping can be improved to enhance those analyses (for instance for those pressures for which data deficiency was identified). It will also examine the strengths and weaknesses of the different pressure assessment methodologies used by both the MBP process and the SOE 2011 process and propose a methodology that can support both initiatives into the future. The project will provide pressures profiles for CMRs and will assist Parks Australia in understanding how pressures interact with the values they identify in CMRs.

The project will also consider relative impact, and how spatial mapping can assist in understanding both relative and cumulative impact. As an adjunct to the cumulative impact investigation, the project will also investigate how changes in socio-economic valuing of conservation values may influence the degree of investment in understanding and management of cumulative impact. This particular work will further the risk-based approach to cumulative impact that was investigated under the NERP Hub.

**Problem Statements**

Under the marine bioregional plans, pressure analyses were undertaken for four of the six marine regions. These pressure analyses provide a high level signal to proponents and decision-makers as to the likelihood of significant impact of proposed activities. The analyses also provide some sense of possible cumulative impact arising from multiple pressures (of concern, or of potential concern) operating on the values.

While the MBP high level analyses is an important advance, a more spatially refined (within, rather than across marine regions) understanding of pressures (and their likely contribution to significant impact) would be useful for decision-making by both DoE, Parks Australia and other regulators (such as NOPSEMA and AFMA).

In addition, the analyses do not inform prioritisation of action to support recovery or conservation of values. For instance, light pollution is a pressure of concern for turtles in the NW Marine Region, but so too is marine debris, physical habitat modification, human presence at sensitive sites and invasive species. The MBP analysis does not provide insight into which of those pressures may be the most appropriate to target in setting of conditions, in recovery actions, in spatial planning and other possible interventions. Prioritisation based on relative contribution that pressures make to values, will inform the project’s proposed investigation of relative and cumulative impact and proposed development of a risk assessment framework to help prioritise interventions. Estimating risk will also include attribution of the relative impacts and risk from multiple different pressures where appropriate. The project will work with DoE and Parks Australia to identify options for risk assessment at an ecosystem level, consistent with processes outlined in strategic assessment.

Another issue is that of inconsistency between pressure assessments published in the 2012 MBPs and the 2011 SOE Report. A methodology that can serve possible annual reporting under SOE and which can also inform a potential review of MBPs is required.

*Alignment with NESP Research Priorities*

The project will feed into the NESP Marine Biodiversity Research priorities:

* Identify past and current pressures on the marine environment, and understand their impact to better target policy and management actions.
* Determine the causes of, and relationships between, pressures on the marine and coastal environment to inform government investment
* Improve prediction of likely future pressures and their potential impacts on marine and coastal biodiversity and economic and social values to enable the mitigation of avoidable impacts

**Research**

Work Post 1 January 2016 after consultation with DoE

1. The project will continue the aggregation of pressure data and expand the scope to include all waters in the Australian EEZ (state and commonwealth). The project will identify what the spatial distribution mapping of pressures can add to the analyses of pressures already achieved under the MBP process and the SOE2011 process. We will produce summaries of pressure data to better inform the outputs of SOE and to inform CMAR management. The project will continue to collate pressure data for the life of the project to ensure that up to date information on the state and trend of pressures is available. Trends in the changes in pressures over the next decade will be explored and explore how impact might change over that timescale. The project will coordinate with Project B4 (Underpinning the repair and conservation of Australia’s threatened coastal-marine habitats) and Project C2 (Continental-scale tracking of threats to shallow Australian reef ecosystems) to include coastal pressures in this analysis and will include summaries of available data for marine debris.
2. The project will assist the department with a re-evaluation of the pressure assessments published in the 2012 Marine Bioregional Plans and will provide pressure profiles for the CMRs, KEFs, BIAs, and Marine Bioregions. Summaries of pressure profiles, historical footprints and projected future trends will be delivered for the Commonwealth Marine Area, with additional summaries for CMRs, KEFs, BIAs, & Marine Bioregions. These summaries will be delivered through web services that can be incorporated into DoE web tools (in collaboration with ERIN).
3. Given that the department and other regulators need to make decisions with varying levels of confidence in the information base (both in terms of certainty around values, and certainty about presence and impact of pressures), we will investigate a framework (based on risk) to manage that uncertainty. We will provide DoE with case studies on how the framework can be applied in different decision-making requirements. The project will coordinate activities and approaches with Project A2 (Quantification of national ship strike risk) and cumulative risk projects in the Tropical Water Quality Hub to ensure that species and ecosystem based approaches are complementary.
4. The project will provide key capability home for qualitative modelling for other Marine Biodiversity Hub Projects. The support for qualitative modelling will be used by projects C1, C2, D1, D2 and D3.
5. The project will also investigate the role of changing socio-economic valuing of conservation values to the concept of acceptable impact, or acceptable risk of impact. The project will consult with the DoE to determine the appropriate methodologies, and build on work already completed through NERP with UWA. Specifically, the project will identify:
6. Is there a link between the value (intrinsic or extrinsic) of biodiversity components (such as conservation values & MNES) & the pressures that are acting on them?
7. If there is what happens to the ascribed value when the pressures change? Further, can the value of biodiversity change?
8. Are there thresholds and trigger points in the interactions between values and pressures such that management of interactions becomes increasingly important? Does this link to “social licence to operate”?
9. Do values change the response to significant impacts? Are some biodiversity components valued so highly that they should ideally remain below significant impact whereas others are valued so little that they can exceed significant impacts?

The project will collaborate with a Cumulative impacts project in the Tropical Water Quality Hub on methods of assessment and the Earth Systems and Climate Change hub on interannual to decadal climate variability. It will integrate data on pressures coming from other Marine Biodiversity Hub projects (eg C2, B4).

**Expected Outcomes**

* DoE will have an improved understanding of the current state of pressures and historical trends in the data for the Australian EEZ. The project will deliver summaries for all KEFs and all CMRs.
* The project will assist the Department in addressing the Strategies outlined in the Marine Bioregional Plans; in particular
  + Strategy B (Establish and manage a Commonwealth marine reserve network … as part of a national representative system of marine protected areas,
  + Strategy C (Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act),
  + Strategy D (Increase collaboration with relevant industries to improve understanding of the Impacts of anthropogenic disturbance and address the cumulative effects on the region’s key ecological features and protected species) and
  + Strategy F(Improve monitoring, evaluation and reporting on ecosystem health in the marine environment).
* DoE will have a methodology for pressure assessment that serves both SOE and MBP reporting and can assist in informing CMR management
* DoE will have improved understanding of the relationship between pressures and impacts, including cumulative impacts, particularly in the inshore area.
* DoE will have improved understanding of the links between socio-economic values and pressures and impacts.

**Planned Outputs**

* Produce description of summary of changes and trends in pressures on the commonwealth marine environment in the offshore marine environment from 1991 to 2010.
* Production of inshore and offshore pressure summaries to inform SOE reporting (2011-2015)
* Produce description of trends in pressures acting on the commonwealth marine environment (onshore & offshore) between 1991 & 2015, with refined summaries for all KEFs and CMRs.
* Distribute pressure data and pressure data summaries through NPEI compliant data infrastructure.
* Produce analysis and description of the likely future states (for example, climate (interannual and decadal), shipping, modification of fisheries activity, coastal eutrophication)
* Re-evaluation of the pressure assessments published in the 2012 Marine Bioregional Plans , ensuring consistency of output, updating the profiles for all KEFs
* Report on the changing socio-economic valuing of conservation values to the concept of acceptable impact, or acceptable risk of impact
* Report on a risk based framework to manage the uncertainty information bases for different decision making requirements with example case

**Delivery of Project**

The Project Leader has delivered on a similar project in the NERP Marine Biodiversity Hub, collating pressures to 2010, producing new pressure information and estimates of impact. The project team has a long history of engagement with the Department of Environment. The Project leader authored the NERP Marine Biodiversity Hub data policy with the Deputy Director.

Deliverables from this project are available from http://www.nerpmarine.edu.au/maps/. Pressure data sets range from 1996 to 2010 and are arranged corresponding to SoE reporting periods. This data includes new estimates of the change in SST and the variance associated with this. This analysis and application of the same methods to ocean productivity has been used to support the National Monitoring Blueprint.

The PL has also authored the NERP hub data framework and the development of the Marine Information Platform (MIP), which is hosted on the NERP hub web site at http://www.nerpmarine.edu.au/maps/.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date (either the 1st of Jan or June)** |
| 1. Summary of changes and trends in pressures the offshore commonwealth marine environment from 1991 to 2015, delivered to Marine Policy section and Parks Australia. | 1 Jan 2016 |
| 1. Delivery of Summary of changes and trends in pressures the offshore commonwealth marine environment from 1991 to 2015 delivered to SoE to meet SoE 2016 delivery. Data Sets and maps will be delivered through web services, delivered in collaboration with ERIN | 1 March 2016 |
| 1. All research users and stakeholders have been engaged and understand the project and opportunities for further engagement | 1 April 2016 |
| 1. Re-evaluation of the pressure assessments published in the 2012 Marine Bioregional Plans delivered to Marine Policy section and SOE | 1 Jan 2017 |
| 1. Initial report on progress on links between conservation, socio economic values and pressures delivered to Marine Policy section | 1 Jan 2017 |
| 1. Summary of changes to natural and anthropogenic pressures acting on in the marine environment (onshore & offshore) between 1991 & 2015, delivered to Marine Policy section and Parks Australia. | 1 Jan 2017 |
| 1. Summary of changes in pressures 2016 to the Commonwealth Marine Environment (including CMRs, KEFs & BIAs) | 1 June 2017 |
| 1. Report on assessment of likely future states (for example, climate (interannual and decadal), shipping, modification of fisheries activity, coastal eutrophication) based on scenario development from projected sectoral changes, delivered to Marine Policy section and Parks Australia. | 1 Jan 2018 |
| 1. Summary of all data sets developed by project delivered to ERIN & location where they can be accessed using web services. | 1 Jan 2018 |
| 1. Report on assessment of response of values (social, economic and ecological) to changing pressures to the Commonwealth Marine Environment (including CMRs, KEFs & BIAs), delivered to Marine Policy section | 1 Jan 2018 |
| 1. Summary of changes in pressures 2017 to the Commonwealth Marine Environment (including CMRs, KEFs & BIAs) | 1 Jun 2018 |
| 1. Report on a risk based framework for the impacts of pressures to manage the uncertainty information bases for different decision making requirements with example case, delivered to Marine Policy section | 1 Jan 2019 |
| 1. Report on the role of changing socio-economic valuing of conservation values to the concept of acceptable impact, or acceptable risk of impact, delivered to Marine Policy section | 1 Jan 2019 |
| 1. All project outputs and data to be made accessible to the public | 1 Jan 2019 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Jeff Dambacher, CSIRO | Qualitative models | 0.3 |
| Piers Dunstan, CSIRO | Project leader | 0.15 |
| Michael Fuller, CSIRO | Data management and analysis | 0.35 |
| Ryan Downie, CSIRO | Data collation and summaries | 0.5 |
| Cass Hunter, CSIRO | Linking Pressures and Values (socio-economic researcher) | 0.25 |
| Abbie Rogers, UWA | Linking Pressures and Values (socio-economic researcher) | 0.3 (in 2017 only) |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| CSIRO | 503,278 |  | 503,278 |
| UWA | 37,500 |  | 37,500 |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| Foundation, Uni, etc. |  |  |  |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DoE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Parks Australia/ DoE | Amanda Parr |
| Domestic and International Policy/ DoE | Kat Dunstan & Claudia Cooney |
| EACD/ DoE | Mat Whitting |
| SoE / DoE | Lin Boon |
| ERIN | Marg Coonan-Jones & Carolyn Armstrong |
| **Key Stakeholders (organisation/programme)** |  |
| NOPSEMA | Christine Lamont |
| AMSA | Matt Johnstone & Paul Irving |
| AFMA | Beth Gibson |

**Knowledge Brokering and communication**

* Research end users and key stakeholders will be involved in the development of the project & a contact schedule developed to ensure ongoing communication
* Ongoing engagement will be maintained with DoE through regular meetings associated with project deliverable. Opportunities will be taken to expand the access to outputs with other groups such as the SE SMR stakeholder forum, NOPSEMA, the Oil and Gas industry, state fishery and conservation agencies and commercial and recreational fishing groups.

Summaries of scientific outputs will be made available as both written documents and as digital downloads to ensure easy access.

* All data outputs will be stored on NPEI compliant servers and accessible through AODN and specialised web services on the NESP Hub website.
* Other communication mechanisms identified on the Hubs Knowledge Brokering and Communication Strategy will be adopted as necessary to ensure broad uptake,
* The project will implement the objectives identified in the Hub Communications Strategy. The project will engage with end-users and stakeholders at appropriate periodic intervals to ensure understanding of the projects outputs and to ensure that the outputs and outcomes continue to be aligned with the NESP priorities and the needs of other potential users. The project will use the Hubs Data Management Framework to ensure timely and easy access to research datasets, outputs and synthesis and ensure that any publications receive the necessary approvals.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate a broad range of pressure data and produce reports that include pressure maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Pressure datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>. An email will be sent to [marinemetadata@environment.gov.au](mailto:marinemetadata@environment.gov.au) each time a data set is published.

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

Data sets that will be released from January 2016 will be:

|  |  |
| --- | --- |
| Pressures | Spatial Management |
| Fisheries (grouped by gear, over SOE period) | CMR, KEF, BIA |
| Seismic | Fisheries Closures/Fisheries Zones |
| SST | Cable & Pipeline Exclusions |
| Pollution | Sea-Lanes |
| Shipping | Oil & Gas leases |
| Population | PSSA & Areas to be Avoided |
| Cables |  |
| Pipelines |  |
| Oil & Gas Infrastructure |  |
| Marine Debris (global analysis, microplastics) |  |
| Cyclones |  |

**Expenditure Summary**

The funds will be used to support analysis of existing data that was collected during the NERP hub to produce trends in the pressures on the marine environment over the previous 20 years. We will also begin scoping DoE support for cumulative risk assessment, including an understanding of where socio-economic values could be used.

**Location of Research**

The research outputs will be for the Australian EEZ.

**Indigenous Consultation and Engagement**

The identification of traditional and cultural values has become an increasingly important topic, at local, national and global levels. The project will test DoE interest in including Indigenous knowledge and heritage into the conservation values considered by the project. This will include an option to use the values component of the project to support the identification indigenous cultural and heritage values and the pressures that are acting on them. The details of this engagement will need to be scoped with DoE and include the Hub Knowledge Broker. The further development of the project will build this engagement (where appropriate) consistent with the Hub’s Indigenous Engagement and Participation Strategy.

**Inclusions (in scope)**

A brief statement to highlight what elements are in the scope of the project

**Exclusions (out of scope)**

A brief statement to highlight what elements are out of the scope of the project

**Risks**

The project requires engagement with DoE at several key points to achieve process outcomes around values and risk assessment. The project will also require access to data that will be held by external stakeholders.

**Project Keywords**

impact, pressure, risk, socio-economic values, conservation values

# Project C2 - Continental-scale tracking of threats to shallow Australian reef ecosystems

*Project length* – 30 Months

*Project start date* – 1/7/2015

*Project end date* – 31/12/2017

*Project Leader* – Graham Edgar (FTE – 20%)  
[*G.Edgar@utas.edu.au*](mailto:G.Edgar@utas.edu.au)03 6227 7238

*Lead Research Organisation* – University of Tasmania

*Total NESP funding* - $807,147

*Total Recipient and Other Contributions (co-contributions)* - $1,759,030

|  |  |  |  |
| --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* |
| *NESP funding* | *$322,197* | *$247,475* | *$237,475* |
| *Cash co-con* | *$0* | *$0* | *$0* |
| *In-kind co-con* | *$488,478* | *$635,276* | *$635,276* |

**Project Summary**

The project will integrate Australia’s largest, most detailed datasets of shallow-water tropical and temperate marine biodiversity, and assess how pollution, fishing, rising sea temperatures and introduced species are impacting associated natural values. An initial outcome will be the identification of state-of-the-environment indicators for inclusion in the 2016 State of the Environment report, with subsequent activities aimed at contributing additional data products needed for other NESP projects, Parks Australia, and the Essential Environmental Measures initiative. The project will also describe a national shallow-water baseline of biodiversity in Commonwealth Marine Reserves for assessment of change through the long term.

**Problem Statements**

*Problem*

The marine environment is out of sight, with little standardised information available on its ecological state. Available data are generally qualitative, collected for different reasons with different methodology in different studies, and highly patchy in space, time and target taxa. Yet without good information on ecosystem condition, management actions can be inefficient, with resources prioritised in some cases at threats that have little ecological impact, while other critically-important threats could potentially be overlooked. Moreover, high-quality ecological monitoring data represent a critical tool when assessing the success or otherwise of management interventions, in part for project evaluation, but also when considering extensions of those interventions to other locations.

A related problem is a lack of a standard suite of indicators that distil important ecological detail and can be used for state and national State of the Environment reporting. These need to reduce the multivariate complexity associated with marine ecosystems to univariate metrics that are sensitive to specific threats. Data streaming protocols are additionally needed that collate and publicly distribute relevant marine ecological indicators in near real time.

*How Research Addresses Problem*

This NESP project will in part address these problems by aligning and validating outputs of the major shallow reef monitoring programs underway around Australia, most notably AIMS Long Term Monitoring Program (LTMP), Reef Life Survey (RLS), and UTAS Long Term Marine Protected Area Monitoring Program (LTMPA). The project will use these data and co-located data on pollutants, natural environmental stressors and socio-economic conditions to clarify relationships between magnitude of major anthropogenic stressors (pollution, sea temperature rise, fishing, introduced species) and ecological change. It will identify key ecological indicators that are sensitive to different environmental stressors, and that can be used by all major marine ecological monitoring programs for consistent continent-wide State of the Environment reporting. Through regular consultation with Department staff and Marine theme leaders, Year 1 project outputs will be tailored to align and feed into 2016 SoE reporting. Research plans for Years 2 and 3 are designed to efficiently fill outstanding knowledge gaps associated with data needs of other Marine Biodiversity Hub projects, ongoing environmental condition reporting, the Essential Environmental Measures initiative, the National Monitoring Blueprint, and evaluation of biodiversity conservation goals associated with Commonwealth Marine Reserves.

*Alignment with NESP Research Priorities*

This project contributes to the majority of Departmental research priorities:

*•* Determine and trial practical and repeatable methods for monitoring the status and trends of key coastal and marine species and environments to underpin management of Commonwealth Marine Reserves.

This priority represents the core aim of this project.

*•* Improve the management of marine and coastal biodiversity by evaluating and quantifying the results of management interventions.

The project will quantify ecological consequences for marine and coastal biodiversity of different management interventions associated with regulations and planning in the coastal zone. This will include extension of CERF and NERP analyses outlining benefits to marine biodiversity from declaration of marine protected areas (MPAs), including how different design features of MPAs (e.g. size, configuration) affect ecological responses.

• Identify past and current pressures on the marine environment, and understand their impact to better target policy and management actions.

Through analysis of impact indicators developed through NERP and NESP projects, which are associated with threats of overfishing, pollution, introduced species, bleaching, and warming, current pressures on the marine environment will be quantified and mapped. Historical pressures will also be tracked through the past 25 years by analysis of LTMP and LTMPA data, which extend back over two decades and encompass all six states and Commonwealth waters at Jervis Bay.

• Determine the causes of, and relationships between, pressures on the marine and coastal environment to inform government investment.

The project will directly assess impacts of different stressors on biodiversity of marine and coastal environments.

• Define the impact of sewerage outfalls and stormwater runoff on Australia’s marine environment to identify real actions to improve outcomes for marine water quality.

Field surveys of sewage, microplastics, and heavy metal levels at polluted and reference ecological sites undertaken through the project will allow ecological impacts of sewerage outfalls and other pollutants on Australia’s shallow reef environments to be quantified and mapped.

• Improve prediction of likely future pressures and their potential impacts on marine and coastal biodiversity and economic and social values to enable the mitigation of avoidable impacts.

A key output is improved knowledge of tipping points in relationships between pressures and ecological condition, with tools produced that allow tracking of proximity to critical ecological transitions, which can thereby be avoided.

• Improve our knowledge of key marine species and ecosystems to underpin their better management and protection.

Through field surveys that quantify abundances of >3000 marine species spanning the Australian continent, including reptiles and large predatory fishes, the project will greatly improve knowledge of numerous key and threatened species. The combined LTMP, RLS and LTMPA datasets provide the only quantitative information available to assess population trends for the majority of non-commercial species surveyed.

• The role of citizen science in the management of marine biodiversity.

Over 100 highly-trained citizen scientists will provide data that contributes to the project through the Reef Life Survey program, with educational extension of results through RLS to the diving community via public presentations, articles, website etc.

• Better understand issues that are common to the fishing industry and the environment including identifying solutions of mutual benefit.

Through analysis of ecological changes in fished versus unfished (i.e. no-fishing marine reserve) areas, outputs will provide a much clearer understanding of the impacts of fishing on conservation values, and improved ways to maximise conservation benefits while minimising economic cost to fishers.

• Identify key opportunities to collaborate and build Indigenous participation and knowledge into the management and protection of marine species.

The project will extend and strengthen ongoing collaborations between Reef Life Survey citizen scientists and Indigenous communities.

**Research**

Six major research components contribute to this project: (i) integration of Australian long-term ecological reef datasets (AIMS LTMP, RLS and UTAS LTMPA), (ii) collection of data on levels of sewage, microplastics and heavy metals at ecological monitoring sites, (iii) statistical cross-matching of fish, macro-invertebrate, sessile invert, algal, environmental, socio-economic and pollutant datasets to identify impacts of different anthropogenic stressors on reef communities, (iv) identification of indicators specific to particular stressors, which can be tracked long-term through the three on-going long-term monitoring programs, (v) collation and provision of indicator data for improved SoE reporting, and (vi) collation and provision of data for other NESP Marine Biodiversity Hub projects and Parks Australia.

Integration of Australian long-term reef datasets.

Three long-term ecological monitoring programs using standardise protocols that extend across Commonwealth/State jurisdictions are currently underway around Australia.

1. AIMS Long-term Monitoring Program (LTMP). This program grew out of surveys of crown-of-thorns starfish populations on the Great Barrier Reef (GBR) that began in the early 1980s. The program was expanded to include detailed surveys of reef fishes and benthic organisms in 1992. Marked sites are surveyed annually or more recently, in alternate years, on the NW slopes of 47 reefs. The reefs are grouped by latitude and by position across the continental shelf, since the major biophysical gradients in the GBR are between the Coral Sea and the Queensland coast. Fish from a list of 191 species, representing 10 families, are counted on the five 50m transects in each of three sites at each reef. Benthic organisms are surveyed from sequences of photos taken along the same transects. The same transects are also surveyed for coral disease and other sources of coral mortality such as predatory snails, *Drupella* sp. The entire perimeter of each reef is surveyed for crown-of-thorns starfish (*Acanthaster planci*) and general cover of hard coral, which provides a wider context for the surveys on the fixed sites at each reef. See: <http://www.aims.gov.au/docs/research/monitoring/reef/sampling-methods.html> and <http://www.aims.gov.au/docs/research/monitoring/reef/sops.html>
2. UTAS Long Term Marine Protected Area Monitoring Program (LTMPA). The LTMPA program encompasses >600 sites distributed across the temperate Australian coast from Jervis Bay (NSW) to Jurien Bay (WA) and around Tasmania. Surveys are conducted in collaboration with state government personnel (NSW DPI, Parks Victoria, Tasmania Parks and Wildlife Service, SA DEWNR, WA DPaW), and provide a consistent framework for state MPA assessment programs. Densities and size-structure of all fishes within 5 m wide bands, and cryptic fishes and mega-invertebrates within 1 m wide bands, are assessed along 50 m transect lines. Percent cover of sessile invertebrates and macro-algae are estimated along the same transects by in situ counts by divers. Sites surveyed extend back to 1992 in Tasmania, to 1996 in NSW, to 1997 in WA, to 1998 in Vic, and to 2004 in SA. This dataset is unprecedented globally in geographic span (~4,000 km) for assessing temperate reef ecosystem change over decadal scales.
3. Reef Life Survey (RLS). Following a pilot study from 2007-10 funded through the Commonwealth Environmental Research Facilities Program (the forerunner of NERP and NESP), the Reef Life Survey Foundation, a charitable environmental NGO, was established to support the training and activities of committed diving citizen scientists. Volunteer divers trained to a scientific level in underwater visual census techniques have now established marine biodiversity baselines through field surveys at more than 2500 sites worldwide. Over 500,000 species abundance counts for 4500 species have been recorded, and annual surveys are conducted at priority sites around Australia. RLS is unique in its combination of standardised underwater census methods, fine taxonomic and body size resolution, and rigorous training of participants, which include both professional scientists and skilled citizen scientists. Using the RLS protocol, sizes and abundances of all fishes. and abundances of all large mobile invertebrates, sighted are recorded along 50 m transects, plus cover of macroalgae and sessile invertebrates (including corals) obtained for ~60 functional groups (following the CATAMI classification scheme, a NERP product) using digitised photoquadrats (for methods see http://reeflifesurvey.com/files/2008/09/rls-reef-monitoring-procedures.pdf). While the quality of citizen science data is sometimes queried, RLS differs from other volunteer dive programs in its primary emphasis on quality of data outputs rather than wide public engagement, headhunting the best and most committed divers. Data quality has been assessed rigorously, with differences in data produced by volunteers and professional scientists statistically non-significant and trivial (<0.5%) in comparisons of variation between divers, depths, transects, sites and regions (Edgar & Stuart-Smith 2009).

While the three long-term ecological monitoring protocols are consistent in major features, such as use of 50 m transect tapes as the basic unit, they differ in details, most notably in target taxa (all observed species are counted in LTMPA and RLS versus a large subset of species for LTMP), transect replication within sites, depth of transects, method of laying transects (between permanent stakes versus GPS), and application of in situ counts versus quadrats for assessing sessile cover. These differences may or may not generate substantial errors when data are aggregated across methods and compared. If major errors are detected, then integration remains possible if appropriate correction factors can be identified and applied.

Huge benefits would be generated through integration of data from reef monitoring programs Australia-wide. Such benefits include establishment of the largest marine ecological dataset available for any country for SoE reporting, scientific analysis of biogeographic patterns and ecosystem function, and assessment and tracking of ecological impacts generated by human-related stressors.

The main step in integration of monitoring outputs is validation of data from different programs. This is most accurately undertaken through field surveys where multiple methods are applied along the same transects. Given available data density and statistical noise contributed with each added methodology, this NESP project will focus on field validation for the three major programs plus other programs with similar methods (e.g. CoralWatch). Validation surveys will be conducted on the GBR, with major desired outcome the identification of any correction factors needed when cross-linking outputs from the different survey sources.

Survey of pollutants at ecological monitoring sites

Investigations of the impact of sewage, microplastics and heavy metal inputs on inshore rocky reef communities have been limited to date because the scale of information on levels of pollutants has been much broader than the span of transects at sites investigated. As a consequence, analyses have been confounded by poor information on the variety of stressors operating at any site. Finer resolution data on pollutants are needed.

To address this deficiency, the influence of sewage, microplastics, heavy metals and other pollutants will be assessed by collecting sediment samples at RLS ecological monitoring sites and measuring a range of associated markers. These will include basic biogeochemical information (pH, salinity, turbidity, grain size, total phosphate, TKN, total organic carbon), stable isotopes (delta15N, delta13C), microplastics, heavy metal concentrations, hydrocarbon concentrations, and routine bacterial counts (faecal coliforms, enterococci).

Identification of impacts of different anthropogenic stressors on reef communities

Relationships between pollutants, environmental covariates, and community-level responses (e.g. filamentous algal cover, herbivorous fish biomass, large carnivore biomass, proportion of introduced species) will be identified using a variety of statistical, machine learning and modelling techniques, including new methodologies recently developed through the CERF and NERP Marine Biodiversity Hubs. Methods previously used by investigators and to be applied in this project include generalised linear models (GLMs), quantile regression, generalised additive models (GAMs), and machine learning procedures (e.g. random and gradient forests, boosted regression trees). Structural equation modelling will also be used to disentangle intermediate microbial and nutrient pathways linking pollutants to macro-community condition. Notably, the great quantity of coincident biological and environmental data available through the three long-term monitoring programs and Hub partners (CSIRO, AIMS and GA) should allow system non-linearities and the magnitude of interactions between covariates to be considered and formally assessed, in most cases for the first time. Available data to be included in analyses encompass thousands of sites Australia-wide.

Identification of ecological indicators

This NESP study will generalise and extend NERP outputs dealing with fishing and climate indicators, including the identification of sensitive indicators associated with different types of pollution and invasive species. Emphasis will be placed on identifying indicators that apply generally across a range of habitats and realms, such as fish body size indicators that correspond with the magnitude of fishing pressure.

Fundamentally, analyses will seek to reduce complex multidimensional patterns pertaining to ecological communities along time and space gradients of each threat to simple but informative univariate metrics. Thus, a major aim is to identify which taxonomic components of reef communities are most affected by a particular threat, and which summary statistics capture the range of responses to that threat in the simplest and most informative manner. For some threats, the magnitude of impact should be readily estimated using simple metrics that are largely independent of other environmental factors, and hence can be robustly applied in most situations; however, other threats may interact with environmental factors, resulting in a need for more complex models to be developed to explicitly account for covariation in the geospatial and natural environment.

Analytical procedures will assess the value of existing SoE metrics, such as those based on species richness or other recognised properties of community structure. They will also identify which taxonomic elements of reef communities are most affected by a particular threat, and break-points and other non-linearities in relationships between community structure and level of threat, allowing the construction of robust metrics based on these elements. For example, if one or two taxonomic or functional groups are found to be disproportionately affected by a particular threat, then these functional groups will be incorporated into the relevant ecological indicator metric. The value of “multi-metrics” that integrate several component metrics (Henriques et al. 2008) will also be assessed.

Metrics will be developed for five major threats:

Introduced and invasive species. Simple metrics are presently available that involve, for example, summing densities or number of invasive species at sites. However, invasive species differ individually in their impacts on native components of reef communities, hence risk associated with individual species ideally should also be taken into account. Impacts of individual introduced species will be assessed here using time series data to quantify ecological changes to other local species that accompany arrival of introduced (e.g. the kelp *Undaria pinnatifida*) and invasive (e.g. *Acanthaster, Centrostephanus*) species at individual sites, while using nearby uninvaded sites as control reference sites.

Over-fishing. A variety of metrics of effects of fishing have been developed, including species richness, size-distribution and trophic indices (Murawski 2000, Fulton et al. 2005). The predictive value of these metrics will be assessed by comparing metrics calculated for the range of sites studied with indices of fishing pressure ([i.e., distance from port, number of fishing boats observed in aerial photos, see Stuart-Smith et al. 2008](#_ENREF_6)), and by comparing patterns inside versus outside long-established MPAs, including using time series data since MPA establishment where available. New metrics based on the size-distribution of communities will be developed and their predictive ability compared with established metrics.

Organic and heavy metal pollution. Pollution impacts will be assessed using outputs from analyses based on new field data on levels of pollution at RLS ecological monitoring sites.

Urbanisation. Effects of urban development will be assessed using gradient analysis based on human population density in the coastal fringe adjacent to sites studied.

Sea warming. Metrics of thermal stress, a surrogate of climate change impact, will be developed using the subset of sites with long-term ecological monitoring data and warming trends. These metrics include the recently developed ‘community thermal index’, as developed through NERP ([Bates et al. 2014a](#_ENREF_1)).

Application of ecological indicators

Long-term ecological monitoring data will be reduced to quantitative indicators to underpin the marine thematic chapter in SoE reporting. Given the short 9-month timeframe available for development of these products for the 2016 Report, some products advanced over this period will be interim. These will be finalised in subsequent years, and all ecological indicators maintained within an area on the AODN website that is planned to provide the quantitative information underpinning future SoE reporting. Ecological monitoring data will also contribute to the Essential Environmental Measures initiative, which is to provide more detailed and updated information on marine status and trends.

Provision of data products for other NESP MBH projects and Parks Australia

The project will maintain close linkages with the three Australian long-term monitoring programs described above, and value-add ecological data generated through monitoring into products needed as foundational layers for other MBH projects. These will include continent-scale maps describing pressures on the inshore marine environment, for utilisation through project C1. Products will also include reporting on new data streams established through the Reef Life Survey program, such as baseline data for Northern Australian Commonwealth Marine Reserves, and repeat surveys of sites to assess change in the Coral Sea Marine Reserve.

*Links with other projects and hubs*

Data developed and provided through this project will contribute as an important input to:

* ‘C1 Improving our understanding of pressures on the marine environment’, and
* ‘B2 Analysis and elicitation to support State of the Environment reporting for the full spectrum of data availability’, and
* ‘D2 Analysis methods and software to support Standard Operating Procedures for survey design, condition assessment and trend detection’.

Project outputs also integrate with several other projects, including:

* ‘B1 Road testing decision support tools via case study applications’
* ‘D3 Evaluating and monitoring the status of marine biodiversity assets on the continental shelf’, and
* ‘D4 Best practice spatial management of marine biodiversity’.

Outside the NESP Marine Biodiversity Hub, this project aligns directly and will feed into the development of an integrated monitoring program (IMP) for the GBR, which is a significant initiative under the *Reef 2050 Long-Term Sustainability Plan.* Alignment of RLS with the AIMS LTMP potentially allows coverage of reefs in the GBRWHA to be extended significantly in a cost effective manner, including surveys undertaken in the largely unknown far northern GBR region and Coral Sea, as well as providing an additional component of citizen science into the GBR IMP. This objective also aligns with two of the research priorities of the NESP Tropical Water Quality Hub:

* Combine existing indicators and monitoring programmes to develop a cost-effective integrated monitoring programme to support natural resource management, evaluate results and communicate trends.
* Explore the opportunities for citizen science and Indigenous participation to improve tropical water quality awareness and outcomes.

In part through AIMS contribution and participation of Dr Sweatman across Hubs, this Marine Biodiversity Hub project will also link closely with projects established through the Tropical Water Quality Hub, particularly projects associated with monitoring of environmental condition.

**Related research**

The project adds substantial value to the three largest reef monitoring datasets in Australia by integrating their outputs into readily-comprehensible products. The Reef Life Survey dataset was a product of CERF, with development of data products and analytical outputs facilitated through NERP, including applications of new statistical tools developed through that Hub. The project also leverages off the cost of ongoing ecological survey surveys undertaken through the LTMP, RLS and UTAS monitoring programs, the latter two primarily covered by non-Commonwealth agencies, with field survey costs and some analysis costs covered.

**Expected Outcomes**

*Outcomes*

Specific outcomes of the project include:

* Compilation and categorisation of different shallow-water monitoring programs currently in place around Australia.
* Integration of outputs of the three largest standardised marine ecological monitoring programs operating in Australia.
* Characterisation of levels of sewage, microplastics and heavy metal pollution at ecological monitoring sites, and application of pollutant markers to assess impacts of pollutants on reef condition.
* Identification of nonlinear ‘break points’ in relationships between reef communities and threats that are appropriate as benchmarks of condition in SOE reporting.
* Application of metrics to long-term monitoring datasets to identify trends in impacts of stressors on marine ecosystems over the past 25 years.
* Establishment of data streams that feed routinely into State of the Environment Reporting and the Essential Environmental Measures initiative.
* Mapping of the condition of shallow reef ecosystems and associated pressures at a national scale.
* Reporting on biodiversity values and trends in condition of shallow reef systems within the Commonwealth Marine Reserve Network.
* Generation of conceptual models that explain the underlying functional basis of threats, including how interacting threats influence the resilience of inshore marine communities.
* Increased training and mentoring of postdoctoral fellows and postgraduate students within a near ideal collaborative research framework.

*Specific management or policy outcomes*

Through improved management decision-making and wider public knowledge, the project will lead to improved condition of the inshore environment relative to ‘business as usual’. Long-term measurement of condition comprises an output of the project itself, through expanded ecological surveys conducted by RLS divers and continued observations through LTMP and LTMPA.

Specific management outcomes include:

* Improved decision-making when managers assess cost/benefit trade-offs for threats that potentially affect marine biodiversity, including considering the scale of fishing impacts on marine biodiversity relative to other threats.
* Identification and dissemination of a suite of metrics and numerical models that sensitively characterise the impacts of different threats to Australia’s shallow marine biodiversity.
* Incorporation of long-term ecological marine datasets into SoE reporting.
* Increased environmental stewardship through expanded engagement of diving citizen scientists in activities that map and track the distribution of stressors on Australian shallow marine environments.
* Increased public knowledge on the distribution and ecological impact of threats to inshore marine biodiversity.

*Value*

The project will lead to better monitoring of the marine environment and better understanding of the impacts of different anthropogenic threats, leading to improved and more cost-effective management intervention, and improved environmental condition relative to ‘business as usual’.

**Planned Outputs**

Publications describing:

* Environmental values at all sites investigated in Commonwealth waters by Reef Life Survey divers
* Compatibility of survey data obtained through LTMP, RLS and LTMPA programs, and corrections factors needed when linking outputs of these monitoring programs
* Time series data depicting interannual variation over the past two decades in ecological indicators specific to individual threats
* Relationships between anthropogenic stressors and reef condition, with emphasis on impacts of sewage and heavy metal pollution, fishing, warming sea temperature, urbanisation and introduced species
* Sensitive and cost effective indicators of threats to environmental condition.

Coherent marine ecological data streams that feed into SoE reporting, the Essential Environmental Measures initiative, and future evaluation of Commonwealth Marine Reserves.

**Delivery of Project**

*Project leader’s track-record*

Graham Edgar is a global leader in conservation science, one of only three scientists to be awarded Australia’s highest honours in both environmental science (Eureka Award) and marine science (AMSA Jubilee Award). He has published over 120 scientific journal articles, including in the most highly regarded journals *Nature* and *Science*, and received three Whitley Awards for popular books on the marine environment. Prof Edgar has successfully completed many projects of this scale, including ARC Linkage projects involving multiple government partners, the only CERF Significant Project awarded fully in the marine space, and related projects within CERF and NERP Marine Biodiversity Hubs.

*Delivery on time and within budget*

The project will fully adhere to the Marine Hub Performance and Evaluation Protocols to ensure it is managed to deliver on time and within budget. The partners engaged in this project have successfully collaborated on similar research within the CERF and NERP Marine Biodiversity Hubs, and investigators including Edgar, Sweatman, Barrett, Stuart-Smith and Jordan all have significant experience and track record in managing large research projects involving multiple staff and multi-disciplinary teams.

**Project Milestones**

Program activities extending from 2017 will depend on the outcomes from the 2015-16 review and analyses. Thus, 2015 and 2016 activities will explicitly be directed at determining what is needed by DoE in terms of a global synopsis of the status and trends of reefs around Australia, what are the best indicators of this, and also what gaps exist in terms of spatial, taxonomic or functional coverage that need to be filled with additional surveys by the partners in later years.

|  |  |
| --- | --- |
| **Milestones** | **Due date (either the 1st of Jan or June)** |
| 1. Initial meeting of investigators, end users and stakeholders to scope project details including specific sampling design. 2. Undertake field surveys and complete processing of pollution markers. 3. Undertake initial validation surveys to compare LTMP, LTMPA and RLS survey data outputs. 4. Commence analysis of discrepancies between outputs of different survey programs. 5. Commence analysis of most useful threat indicators. 6. Identify interim set of indicators based on ecological survey data that are sensitive to specific threats and appropriate for SoE reporting. 7. Work with Departmental staff and SoE marine theme leaders to deliver interim results for key components for inclusion in SoE 2016 report. | 1 Jan 2016 |
| 1. Finalise charting of trends in threat indicators to 2015 for SoE reporting. | 1 March 2016 |
| 1. Complete survey validation fieldwork 2. Produce report detailing the magnitude of any major discrepancies between outputs of different survey programs, with recommendations on any corrections needed for consistent program output. 3. Identify cost-effective and sensitive threat indicators that summarise ecological monitoring data. 4. Hold annual meeting of investigators and end users outlining project outputs and implications for management. 5. Contribute data and information to Essential Environmental Measures initiative and the National Monitoring Blueprint | 1 June 2016 |
| 1. Submit draft report describing reef condition, biogeographic relationships and conservation issues associated with sites investigated in Commonwealth waters by Reef Life Survey divers to DoE 2. Work with Departmental staff to develop detailed research plan for extended NESP Hub project that effectively fills knowledge gaps associated with environmental condition reporting, Essential Environmental Measures, the National Monitoring Blueprint, and evaluation of Commonwealth Marine Reserves | 31 Dec 2016 |
| 1. Complete final reporting on ecological indicators and analysis of relationships between threats, indicators and community structure. 2. Submit at least 8 scientific papers to international journals. 3. Hold meeting of investigators and stakeholders outlining project outputs and implications for management 4. Report to the Department on marine reserves and recommended survey methodologies 5. Finalise products agreed as useful for Essential Environmental Measures initiative and the National Monitoring Blueprint 6. All project outputs and data will be made publically and freely accessible and available on the internet (see section on data and information management) | 31 Dec 2017 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE 2015** | **FTE 2016** | **FTE 2017** |
| Graham Edgar (UTAS) | Oversight of project, including participation of RLS citizen scientists, statistical analyses, student supervision, and reporting | 0.2 | 0.2 | 0.2 |
| Rick Stuart-Smith (UTAS) | Oversight of indicator development statistical analysis, and reporting | 1.0 | 1.0 | 1.0 |
| Database manager (UTAS) | Oversight of data quality, inputs and outputs | 0.5 | 0.5 | 0.5 |
| Technical Officers (UTAS) three positions, year 1 only | Field sampling of pollution markers | 0.25 | 0.25 | 0.25 |
| Researcher (AIMS) | Oversight of GBR validation trials, LTMP input, statistical analysis, and reporting | 0.4 | 0.2 | 0.2 |
| Hugh Sweatman (AIMS) | LTMP input, statistical analysis, and reporting | 0.15 | 0.15 | 0.15 |
| Neville Barrett (UTAS) | LTMPA input, statistical analysis, student supervision, and reporting | 0.1 | 0.1 | 0.1 |
| Alan Jordan (NSW DPI) | Input of management expertise | 0.05 | 0.05 | 0.05 |
| Peter Davies (NSW DPI) | Contribute expertise on distribution and consequences of pollution impacts along NSW coast | 0.1 | 0.1 | 0.1 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| University of Tasmania | 683,466 |  | 948,687 |
| AIMS | 123,681 |  | 135,000 |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| Reef Life Survey Foundation Inc |  |  | $540,000 |
| NSW DPI |  |  | $135,343 |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Parks Australia, Department of the Environment | Amanda Parr |
| Environmental Information Policy and Reporting, Department of the Environment | Boon Lim, Jason Ferris |
| **Key Stakeholders** |  |
| Tas Parks and Wildlife Service | Peter Mooney |
| NSW Department of Primary Industries | Nathan Knott |
| Parks Victoria | Stefan Howe |
| DEWNR, SA | Daniel Brock |
| GBRMPA | Fergus Molloy |
| Dept Parks and Wildlife, WA | Tom Holmes |
| Dept Primary Industry and Fisheries, NT | Brian McDonald |
| Reef Life Survey Foundation Inc | Scoresby Shepherd |
| NRM Councils |  |

**Knowledge Brokering and Communication**

Project outputs will be distributed following guidelines described in the Marine Biodiversity Hub ‘Knowledge Brokering and Communication Strategy’. End users and stakeholders will be engaged throughout the project using a range of formats. In particular, project investigators and staff will engage directly with DoE at all stages of the project, including via an early planning workshop and during ongoing meetings with the Department, both directly to key staff and indirectly via the Hub knowledge broker. DoE will also provide input through the Reef Life Survey Foundation Advisory Committee, which *inter alia* provides direction on priority locations for field surveys. Additional communication will be through the Hubs’ knowledge broker in alignment with the Hub’s Knowledge Brokering and Communication Strategy.

Regular discussions will also be held with stakeholders and interested groups to identify opportunities for increased uptake of products. Outputs will be communicated through RLS and NESP Marine Biodiversity Hub websites, and general media releases, describing project outputs and outcomes. Project findings will also be presented as scientific talks at national (e.g. AMSA, ASFB, ESA, Coast to Coast) and international conferences (e.g. International Temperate Reefs Symposium, International Coral Reefs Symposium), and by publication in key peer-reviewed journals. Given track record of the research team and the unprecedented geographic scale of project outcomes, we expect these publications to include the most highly-cited journals. Media liaison personnel at the University of Tasmania and AIMS will actively assist the process of disseminating knowledge about the project.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will produce status and trend data (ecosystem and pressure data) and produce reports (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>. All RLS data will be made immediately available through the online portal (<http://reeflifesurvey.imas.utas.edu.au/portal/home>) which is directly accessible to the AODN and MBH systems. The Department will be informed by email to marinemetadata@environment.gov.au when any data additional to these RLS data are published, and provided with a link to the full dataset.

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. The project will adhere to NESP requirements that all journal publications are made publicly and freely available within 12 months of publication.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

|  |  |  |  |
| --- | --- | --- | --- |
| Budget item | 2015 | 2016 | 2017 |
| UTAS postdoctoral fellow Stuart-Smith | 60,991 | 121,982 | 121,982 |
| UTAS data manager/technical support (HEO4) | 37,155 | 69,966 | 69,966 |
| UTAS staff field surveys | 46,444 | 0 | 0 |
| AIMS staff salary (total 0.2 FTE, Level 6) half costs including overheads | 32,727 | 32,727 | 32,727 |
| Field survey costs (food, accommodation, boat, vehicle, flights - 36 days) (UTAS) | 35,580 | 0 | 0 |
| Field survey consumables (underwater water proof paper, transect tapes, bags, diving gear repairs) (UTAS) | 8,000 | 0 | 0 |
| AIMS vessel costs for survey comparisons between programs | 25,500 | 0 | 0 |
| Sample processing costs (heavy metals $35, sediment chemistry $30, stable isotopes $60, microplastics $80, sewage markers $100) (UTAS) | 63,000 | 10,000 | 0 |
| Travel/meetings (UTAS) | 12,800 | 12,800 | 12,800 |
| Total | 322,197 | 247,475 | 237,475 |
|  |  |  |  |
| In kind contributions |  |  |  |
| ProfEdgar, Level E, 0.2 FTE + 1.2x overheads | 46,596 | 93,192 | 93,192 |
| DrBarrett Level C, 0.1 FTE + 1.2x overheads | 16,305 | 32,609 | 32,609 |
| DrJordan 0.05 FTE + 1.2 x overheads | 9,023 | 18,046 | 18,046 |
| DrDavies 0.1 FTE + 1.2 x overheads | 18,046 | 36,091 | 36,091 |
| Dr Sweatman 0.15 FTE | 12,273 | 12,273 | 12,273 |
| AIMS staff salary (total 0.2 FTE, Level 6) half costs | 32,727 | 32,727 | 32,727 |
| Oncosts associated with UTAS postdoctoral, database manager and technical support positions | 173,508 | 230,338 | 230,338 |
| Reef Life Survey Foundation (volunteer diver time ($300 / day x 500 diver days = $150,000) + boat costs ($30,000) | 180,000 | 180,000 | 180,000 |
| Total | 488,478 | 635,276 | 635,276 |

**Location of Research**

Analysis of data Australia-wide, including all States and Territories.

**Indigenous Consultation and Engagement**

Engagement of Indigenous groups will follow guidelines described in the Marine Biodiversity Hub ‘Indigenous Engagement and Participation Strategy’. The project will extend and strengthen past collaborations between Reef Life Survey Foundation and Indigenous communities (e.g. surveys with Carpentaria Land Council at Mornington Island). Information pertaining to sea country will be obtained and communicated in consultation with local Indigenous groups. The Hub’s knowledge broker will, as part of consultation for the wider Hub community, also raise awareness of our findings and stimulate engagement with interested members of the Indigenous community. This engagement will follow the Hub’s Indigenous Engagement and Participation Strategy.

**Inclusions (in scope)**

Field surveys to cross-reference co-located data from AIMS LTMP and RLS programs.

Analysis and integration of LTMP, RLS and UTAS reef ecological monitoring data.

Reports describing all RLS ecological monitoring data collected from locations within Commonwealth jurisdiction other than the Coral Sea, with assessment of ecological condition and relationships between sites surveyed.

**Exclusions (out of scope)**

LTMP, RLS and UTAS field surveys, other than those undertaken for cross-comparison and validation of the three ecological datasets.

**Risks**

Loss of key staff, or difficulty in finding appropriate people during appointment process.

Mitigated by the broad mix of expertise amongst project investigators and staff, with duplication of all skills needed.

Availability of LTMP, RLS and UTAS data.

Mitigated by institutional agreements that allow access to data, and ready availability of compiled data.

Bad weather interfering with field surveys.

Mitigated by three month window available for undertaking field surveys, allowing considerable flexibility for timing of surveys if postponement is necessary due to weather.

**Project Keywords**

Ecological indicators, inshore monitoring, reef condition, sewage impacts, microplastics, heavy metal pollution impacts

# Project C4 - The National Outfall Database project (Clean Ocean Foundation)

*Project length* – 48 Months

*Project start date* – 1/7/2015

*Project end date* – 30/6/2019

*Project Leader* – John Gemmill (FTE – 20%) Dr John Cumming (FTE – 10%)  
johng@cleanocean.org

*Lead Research Organisation* – Clean Ocean Foundation

*Total NESP funding* - $400,000

*Total Recipient and Other Contributions (co-contributions)* - $400,000

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| NESP funding | $65,000 | $135,000 | $100,00 | $100,00 | x | x | x |
| Cash co-con | x | x | x | x | x | x | x |
| In-kind co-con | $65,000 | $135,000 | $100,000 | $100,000 | x | x | x |

**Project Summary**

NOD addresses the need of government and community to understand the impacts on health and the ocean environment that occur from sewerage outfalls around Australia.

The project will be delivered over a three year time frame and will provide:

* A publically accessible national outfall database and reports.
* A ranking of the outfalls (and sewerage treatment systems) according to health and impact criteria with peer review of the ranking system and resulting ranking outcomes.
* Comparison of geographical regions in sewerage volume and pollution impact.
* Mapping of the database.
* Community engagement in conduct of this research and consumption of the outcomes.

**Problem Statements**

1. The performance of existing Australian sewerage treatment plants is thought to be variable with potential residual impacts on human health and the environment. At the same time existing sewerage treatment plants may be failing to take advantage of economic opportunities available through the more efficient treatment and recycling of plant outputs. Collected data are not currently available in a suitable form to make these determinations.
2. Governments need to be able to prioritise action on sewerage treatment systems with reference to the impacts on both the aquatic environment and the recreational use of the oceans. This can be aided by a suitable database that provides information about pollutants arising from sewerage treatment and the distribution of these from sewerage outfalls.
3. The recreational water users also have a capacity to input into safer and cleaner water. This knowledge needs to be developed and utilised to better advantage with improved communication of the interplay of human impacts on water systems and human wastes entering these systems.
4. By and large outfall data is available but it has not been consolidated from across the country. The consolidation of this data together with checking of data completeness and accuracy can be used to the advantage of water users as well as those planning improvements to the treatment of sewerage.
5. This data can show the potential for sewerage pollution impacts on sensitive marine areas such as marine Ramsar sites, national marine parks and marine areas under stress from development. Mapping of high pollution areas can be examined in relation to areas of marine biodiversity and biologically important areas for listed marine species.

**Research**

The research will address the parameters of outfall flows, pollutant concentrations and loads by initial use of the sewerage treatment company monitoring data and consolidated data determined by regulatory authorities in each state. This data will be cross checked with a program that will utilise community action in a similar way to the program “WaterWatch” which uses the community to monitor fresh water systems, but with a research learning aspect from community knowledge about ocean conditions.

The NOD database will be developed with a mapping function that provides an assessment of the volume and pollution loads per capita serviced in geographical regions. It is recognised that major population centres will have contributions to sewerage inflow from industry, commerce as well as residential wastewater. This will be examined with the view to adjusting volumes and pollutant loads to reflect the impacts of residential wastewater.

A significant amount of work has been undertaken by different state bodies to examine the health and environmental impacts of ocean pollution. This work will be examined and used where possible to improve the outcomes of the research work to develop the NOD.

In reviewing data we will conduct a statistical analysis of data from different outfall studies to identify patterns among study results and to further understand relationships between the multiple studies.  The meta analysis will include:

1. A literature and datasets search
2. Selection of studies based on quality criteria
3. Selection of meta-regression statistical model and multivariate analyses (e.g. simple, fixed-effect meta-regression or random effect meta regression)

The breadth and depth of this analysis will depend on resources available to the study.

The project will link to B4, C2, C4 and C5 as well as projects on marine pollution being conducted by the Tropical Water Quality and the Northern Hubs

**Expected Outcomes**

The outcomes of the research are:

1. A national outfall database and reports for public consumption
2. Ranking of the outfalls (and sewerage treatment systems) according to health and impact criteria with peer review of the ranking system and resulting ranking outcomes.
3. Comparison of geographical regions in sewerage volume pollution and impact
4. Mapping of the database
5. Community engagement in conduct of this research and consumption of the outcomes
6. Improvements in outfalls can be tracked using the NOD and improvements in water and wastewater usage efficiency.

**Delivery of Project**

The project leaders have experience with community engagement through the Clean Ocean Foundation and other NGO activities over several decades. They have a foundation of knowledge in the water industry and have experience in environmental monitoring from a practical as well as a theoretical standpoint. Peter Smith and John Gemmill have worked within the surfing and recreational water using community to improve understanding of environmental and health issues for many years. John Cumming is an appointed Environmental Auditor, has worked with the water industry for many years and has experience in PhD supervision at RMIT University from 2000 to 2012.

Simon Perraton has recently completed his PhD thesis at the University of Tasmania and has been a participant in Clean Oceans Foundation for over a decade. Simon brings a strong knowledge of the work at hand with an overview of the governing framework of wastewater treatment.

**Expected outputs**

The National Outfall Database will be in the form of a publically accessible website and related app.

Appropriate information brochures on scope of project to stakeholders

Media opportunities featuring community involvement.

Published data will be subject to data accuracy and peer review in accordance with the NESP Data and Accessibility Guidelines, will follow the principles outlined in the NERP Data and Information Guidelines, and reflect current industry standards for data management. Data collected from public agencies is publically available information and will be treated in accordance with the objectives of the Freedom of Information Act 1999 (Cth) and equivalent legislation in each jurisdiction, which require government agencies to make information publically available, subject to certain exceptions listed in that legislation.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| Milestone 1 – project activities plan including responses to the detailed comments by DoE in the Summary Assessment report | Due 30 March 2016 |
| Milestone 2 – all research users and stakeholders have been engaged, understand project and opportunities for further engagement | Due 30 March 2016 |
| Milestone 3 – database designed / web site operational and ready for review by project stakeholders | Due 30 June 2016 |
| Milestone 4 – treatment data for at least one state and one water authority collected for 2015 | Due 30 June 2016 |
| Milestone 5 – database/web site made public for information that has been peer reviewed | Due 30 December 2016 |
| Milestone 6 – 1st community monitoring program undertaken and reported (2 states) | Due 30 June 2017 |
| Milestone 7 - treatment data collected and available for review on database/web-site for at least 3 states for 2016 | Due 30 September 2017 |
| Milestone 8 – data analysis report 2015 and 2016 | Due 30 December 2017 |
| Milestone 10 – rankings of participating outfalls and sewerage treatment systems available for peer review | Due 30 December 2017 |
| Milestone 11 – extended community monitoring program undertaken and reported (all states) | Due 30 June 2018 |
| Milestone 12 – rankings of participating outfalls and sewerage treatment systems made public | Due 30 June 2018 |
| Milestone 13 – data analysis report 2017, summarising progress and providing options to complete national coverage for treatment data and/or community monitoring where not yet available | Due 30 June 2018 |
| Milestone 12 – data analysis report 2018, including geographic comparisons of volume, impact and effectiveness of community monitoring. | Due 30 June 2019 |
| Milestone 13 – prospectus for continuation of NOD and community engagement available following feedback from all stakeholders | Due 30 June 2019 |
| Milestone 14 - All project outputs and data publically and freely accessible and available on the internet (see section on data and information management) | Due 30 June 2019 |

**Researchers and Staff**

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE**  **2015-19** |
| John Gemmill – Clean Ocean Foundation | Project director | 0.2 |
| John Cumming – Infotech Research | Technical director | 0.1 |
| Simon Perraton – Clean Ocean Foundation | Project manager | 0.8 |
| Andrew Fischer - UTAS | Advisor | IMAS |
| Cate Caven – Clean Ocean Foundation | Community Education officer | 0.25 |
| Rebecca Banks, Marci Katz, Meagan Donahue – Clean Ocean Foundation | Project officers | 0.2 |

|  |  |
| --- | --- |
| **Funds over Project Life** | $ NESP |
| Clean Ocean Foundation | 390 |
| UTAS - scholarship to research students 2017 & 2018 (still to be negotiated) | 10 |

**Other contributors** – only list contributors who are not already identified as Researchers and Staff

|  |  |
| --- | --- |
| **Organisation/name** | **Contribution** |
| Surf Riders Association | Beach and water monitoring |
| Recreational fishers | Water monitoring |
| Local Environment Groups | Beach and water monitoring |

**Research End Users and Key Stakeholders**

|  |  |
| --- | --- |
| **Research End Users** | **Organisation/Section** |
| All stakeholders in Coastal Sewerage Impacts | Federal and State governments  the water industry  Marine researchers  Recreational marine water using community |
| **Key Stakeholders** |  |
| Australian Federal Government | Federal government  IMAS / University of Tasmania  Clean Ocean Foundation |

**Knowledge Brokering and communication**

National Database Website and Community ranking of outfalls on a yearly basis beginning at end of 2017. This data will be live and freely accessible to the public. Opportunities to publicise the database will be used to build awareness and opportunities to spread datasets into other public systems will be openly investigated.

This database will be archived and learnings will be published at all opportunities to foster its longevity and usefulness for the marine research community.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate sewage outfall datasets and citizen science data and produce reports (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2015 | 2016 | 2017 | 2018 | 2019 | Total (1000) |
| Outfall Analysis N |  | 100 (100) | 40 (40) | 30 (30) |  | 170 |
| Ocean condition and outfall monitoring C |  | 85 (85) | 45 (45) | 55 (55) |  | 185 |
| Ranking Outfalls and Communication R |  | 15 (15) | 15 (15) | 15 (15) |  | 45 |
|  |  | 200 (200) | 100 (100) | 100 (100) |  | 400 |

() In kind– In kind contribution from researchers and staff. Community volunteers will contribute significantly more in latter years of project especially in C and R

**Location of Research**

Australian Coastline, focussed around sewerage outfalls.

**Indigenous Consultation and Engagement**

Indigenous water users will be approached to participate in monitoring and communications.

**Inclusions (in scope)**

All treated sewerage outfalls registered across the country will be included in the survey and database of outfalls. This will be undertaken for three years 2016-2018.

**Exclusions (out of scope)**

The project does not include septic tank discharge, untreated sewerage discharge and pumping station overflows. The database will record treated water recycled but not examine water quality in detail.

**Risks**

Cooperation of relevant water authorities, limited funds for data collection and analysis, community engagement and involvement in monitoring activities particularly in remote areas.

Each element of the project as given presents a risk of inadequate or poor quality of inputs:

* Availability of complete data on outfalls – cooperation of water companies
* Correlation of sea water monitoring with outfall water quality over time
* Correlation of pollution loads with visible impacts on water quality where people use it
* The ability to engage sufficient people to volunteer to undertake a satisfactory monitoring program.

It is unlikely that existing datasets will be complete for each of the registered treated sewerage outfalls. While this will be pursued and we do expect state governments to cooperate, some allowance for data gaps will be required. These gaps can be tolerated in the short term and renewed efforts to fill gaps will be undertaken.

The monitoring program with community involvement will develop with a broad cast of analyses initially to see which pollutant monitoring elements best fit the criteria of marine impact and correlation with overall pollution loads. Ongoing efforts in community education and monitoring support with communication of outcomes will build volunteer enthusiasm and skills in this program.

The NESP Marine Biodiversity Hub Steering Committee requested that UTAS conduct a risk assessment for this project which was developed outside the standard Hub procedures. The risk assessment highlighted the comparative lack of experience of Clean Ocean Foundation in running large research projects, despite the expertise of individual participants. The risk assessment recommended that a senior UTAS researcher, with experience in research project management and coastal water quality be appointed as an advisor to this project. Dr Andy Fischer a lecturer at IMAS has accepted this position.

**Project Keywords**

Citizen science, sewerage, coastal, environment, ranking, aquatic pollution

# Project C5 – Quantification of risk from shipping to large marine fauna across Australia

*Project length* – 30 Months

*Project start date* – 01/07/2015

*Project end date* – 31/12/2017

*Project Leader* – David Peel (0.35) and Natalie Kelly (0.4)

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Ph. 03 6232 5179 Ph. 03 6232 5141

*Lead Research Organisation* – CSIRO

*Total NESP funding* - $367,000

*Total Recipient and Other Contributions (co-contributions)* - $392,000

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| NESP funding | $80,000 | $131,000 | $156,000 | x | x | x | x |
| Cash co-con | $0 | $0 | $0 | x | x | x | x |
| In-kind co-con | $85,000 | $141,000 | $166,000 | x | x | x | x |

**Project Summary**

Given the substantial increases in coastal/port development along the Australian coastline, and associated increase in recreational and commercial shipping, there is an increasing potential for adverse interactions with marine species. Two risks associated with these activities for large marine fauna are ship collisions and the impact of chronic ocean noise. Research is urgently needed to quantify these risks in both a spatial and temporal context to help develop and implement appropriate management strategies. This project aims to provide directed science (species- and area-specific) to inform decision-making by the Department of Environment in its application of the EPBC Act.

**Problem Statements***Problem*

Collisions with ships is a significant cause of anthropogenic mortality to baleen whales and other large marine fauna worldwide. While humpback whales are one of the most frequently reported victims of vessel strikes worldwide, there has been little focus on the impacts of vessel strikes on this or other species in Australian waters. Increasing noise from growing vessel traffic and other marine activities has also been implicated as significant risk to large marine fauna. To better understand these risks and potential impacts of ship strike and ship noise on large marine fauna, it is necessary to accurately assess and quantify risk.

*How Research Addresses Problem*

The project will provide quantitative estimates of relative and, where possible, absolute risk of ship strike through space and time, based on the integration of data on (1) shipping type, density and speed (i.e., from AIS data) and (2) species distribution/habitat models. These estimates of risk can be used to identify areas and times when there is co-occurrence of at-risk marine fauna and shipping. Using known individual vessel speeds, it will be possible to provide an indication of where and how frequently lethal and/or sub-lethal interactions are most likely to occur. This quantitative assessment will provide the basis for making informed and accurate management decisions for example, mitigation strategies (including, but not limited to, recommendations such as speed reduction zones/times) could be implemented to minimise the impact of vessel strike on marine fauna.

With respect to noise, this project will provide the first steps towards mapping temporal, spatial, and spectral characteristics of resulting shipping noise. These maps will use environmental descriptors and the distribution, density, and acoustic characteristics of human activities within Australian waters to develop first-order estimates of their contribution to ambient noise levels at multiple frequencies, depths and spatial/temporal scales. A similar exercise is presently underway for the USA and this project will build on lessons learned from that process (e.g., NOAA’s SoundMap/CetMap project for an example of sound mapping; see: <http://cetsound.noaa.gov/sound-index>).

Much of the data required to quantify ship strike risk is the same as that required to develop a national ship noise map. For example, both components will require (1) processed data of shipping density, vessel type and speeds to produce vessel density/traffic maps and (2) species habitat models to produce maps of co-occurrence of vulnerable species. This project will include initial scoping and the development of preliminary models of national shipping noise. It may also be possible for the outputs of these models to be assessed and ground truthed against existing data (e.g., data from passive acoustic loggers maintained by the Integrated Marine Observing System (IMOS)) and the potential for integrating it with shipping data.

Furthermore, a workshop will be held in 2017 (i.e., the second year of the project), bringing together relevant Australian researchers and stakeholders to produce a plan to develop a national map of shipping noise, and to discuss the issue more broadly (including the issue of acute noise, such as that produced during oil and gas exploration).

As this project will explore ship strike and shipping noise pollution risk on a number of large marine fauna species around the coastline of Australia, several Commonwealth Marine Reserves, Biologically Important Areas and Key Ecological Features will be covered/included in analyses to some degree. Therefore, results of this project could also potentially inform and/or refine delineation of these areas and features. Findings from this project will support implementation of multiple strategies in four Marine Bioregional Plans, including: provision of relevant, accessible and evidence-based information to support decision-making with respect to development proposals (strategy C); collaboration with industry, to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on protected species (strategy D); developing targeted collaborative programs for species recovery (strategy E) Furthermore, results of the project will provide guidance for the further development of the National Ship Strike Strategy, and for future revision of the North East Shipping Management Plan, which will outline how shipping traffic in the Great Barrier Reef is to be managed. Results from this project will also provide guidance for development or revision of Recovery Plans and Threat Abatement Plans and management of Commonwealth Marine Reserves (e.g. strategies 1 and 2 in the South-east Commonwealth Marine Reserve Network Management Plan).

*Alignment with NESP Research Priorities*

This work will be fundamental to the further development of the National Ship Strike Strategy, and conservation and recovery plans for various individual species.

Furthermore, this research would feed into the NESP Marine Biodiversity research priority:

*“Identify past and current pressures on the marine environment, and understand their impact to better target policy and management actions. For example, identify the impact of cetacean ship strike.”*

**Research**

*Description of research*

Work to Dec 2015 – Phase 1

An initial project to begin work on quantifying ship strike for marine animals in Australian waters was approved as a short-term project in the first 2015 NESP cycle. The aims of the short-term project are to produce a qualitative analysis of large marine fauna data and information to identify the best 2-3 examples of species that have both a putative higher risk of ship strike and reasonable quality data on distribution, migration and abundance to support analysis of habitat use. Specifically:

1. To coordinate the 2016-2017 project component, we need to identify for which of the at-risk species there is sufficient available data to build distribution/habitat models. A process vital to the success of this work will be engagement and collaboration with key large marine animal researchers. The aim being to work toward developing appropriate distribution models, and to champion/represent this work within the research communities focussed on individual species. These collaborations are being already underway as part of this project.
2. Investigation of data sources detailing fatalities or injury, such as the various State stranding data bases and the potential for identifying indications of injury from marine species photographic identification data bases (e.g., whales, dolphins, turtles, dugongs, whale shark).
3. The Australian Maritime Safety Authority (AMSA) can provide fine-scale and highly detailed ‘raw’ shipping data from 2012 onwards, which represents the details, locations and speeds of larger vessels operating in Australian waters. In this phase we shall acquire commercial shipping data from AMSA, and proceed with development of processing protocols for cleaning such data for our purposes.
4. When examining risks of ship strike for smaller species such as dolphins, turtles, and dugongs, we need to consider the impact of smaller vessels, which are also potentially capable of both lethal and sub-lethal interactions. This data is presently not consistently collected by AMSA. Therefore, a review of the potential for modelling and estimating recreational vessel usage in Australian waters is required (most likely at a small- or regional-scale) with scope for extending to broader regions around the Australian coastline.

Work January 2016-

For the species identified as potentially at-risk in Phase 1, and those species with enough data to support further analyses, we will build the most complete distribution models possible, describing species’ distributions in space and time. To reach this goal the following work will be completed:

1. Gather and integrate the available data, and build species habit usage models. Some methodological development may be required during this stage to consolidate disparate data types, for example, sighting survey data and movement/satellite tag data.
2. To estimate ship strike risk, the AIS data must be cleaned/filtered, and converted from a time based sampling to distance based. Utilising data at the Australian National level will require significant time and computer resources for this grooming and processing. The data is then further processed to produce summary maps detailing features such as vessel density, median speed, etc. Due to the size of the data sets involved, analysis for this work is not trivial. This current processes, protocols and analysis methods will be updated and streamlined, including scaling up for the larger Australia-wide data, to allow data to be processed efficiently.
3. By overlaying models of species density and shipping density, relative risk can be estimated to indicate possible areas and times where risk of ship strike is higher. We currently have two risk metrics. The first, known as ‘co-occurrence’, is simply based on the idea that the more vessels and animals using a given location the greater the risk of interaction will be. The second method being developed is based on probabilities and provides a relative index proportional to the expected number of ship strike fatalities, incorporating vessel speed and beam, and animal dive behaviour. Some further methodological development will be done on both of these risk measures.
4. When examining risks of ship strike for smaller species such as dolphins and turtles, we need to consider the impact of smaller vessels, which are also potentially capable of lethal and sub-lethal interactions. The AIS shipping data doesn’t contain many records for smaller, recreational vessels (i.e., those vessels not required to carry AIS equipment) and, therefore, modelling the risk of ship strike for such species, will need to be augmented with supplementary information from sources such as the Moorings Database, or the Small Boat Registrations, for various States and Territories. Given this broad-scale information, we can potentially build a general map of small vessel distribution and produce regional comparisons of ship strike risk. However, this is likely to be high-level and fine-scale risk maps will probably not be possible given the limited data available on small vessel traffic.
5. In June 2015, during a stakeholder meeting for the presentation of results of modelling the risk of ship strike for humpback whales in the Great Barrier Reef, attendees suggested they were interested in quantification of ship strike risk in terms of absolute numbers of fatalities and injuries. For species where there is data available on ship strike fatalities and injuries (e.g., most likely to be various sea turtle species), models of the relationship between shipping density and fatality rate may be possible to allow the conversion of relative risk to absolute risk. Where data is not available, expert elicitation and worldwide findings may be used to provide some indication to rank of species’ absolute risk. We shall investigate evidence of ship related mortality in data sources such as the various State stranding data bases and the potential for identifying indications of injury from photo identification data bases.
6. With regard to working towards a better understanding of the extent and impact of shipping noise, much of the work planned to address ship strike risk is also relevant for the noise issue. That is:
   1. Processing and mapping the shipping density, vessel type and speed is the first step toward producing general maps of shipping noise (for example NOAA link).
   2. Having species habitat models can allow us to produce maps of co-occurrence of vulnerable species and shipping noise.
7. To produce general maps of shipping noise from the AIS shipping data work will be done on the acoustic modelling. The potential for using existing data shall be examined (e.g., data from IMOS passive acoustic loggers) to help build and validate these models. These maps will feed directly into NESP project C1 and form part of the suite of data/information available within that project.
8. Finally, a workshop will be held in 2017 (i.e., the second year of the project), bringing together relevant Australian researchers and stakeholders with the aim of producing a collaborative plan to develop a national map of shipping noise, and to discuss the issue more broadly (including the issue of acute noise from processes such as oil and gas exploration, for example).

*Links with other projects and hubs*

As part of this research, existing distribution data and models of large marine vertebrates will have to be identified and consolidated, which could also feed into the NESP Threatened Species research priority:

“*Improved information on the distribution of threatened species and ecological communities to better pinpoint their location. Including the review of current species distribution models, and incorporating the capacity for species to adapt to climate change.”*

This research will potentially engage with the following NESP projects:

**Project D1: North West Shelf**   
The shipping data and ship strike risk methodologies can be applied to any models the project produces. Conversely, any relevant data/models collected in project D1 can possibly inform our more general habitat models.

**Project C1: Improving our understanding of pressures on the marine environment**  
The project on risk to marine fauna from shipping (ship strike and noise) has strong links and integration with NESP project C1, with our final risk maps adding to the overall picture of pressures that Project C1 will be quantifying. Furthermore, the AIS data acquisition and initial processing/cleaning will be done with engagement and coordination with the work done for project C1. Other data/models developed in the project may be of interest or done in collaboration with Project C1, e.g. general probability map of approximated small vessel distribution. Finally, habitat models developed under this project on risk of shipping to marine fauna may be useful when looking at other risks covered by project C1. .

The project should have linkages with the following organisations:

**Geoscience Australia**   
Geosciences Australia is engaged in surveys that may collect data useful to the project so there will be future discussions.

**IMOS (Integrated Marine Observing System)**

The IMOS network will be extremely useful in terms of data and expertise for the noise/acoustic modelling component. This link will be developed further once the project commences.

*Related research*

This project is related to a previous Australian Marine Mammal Centre (AAD) project:

***AMMC project 13-46****: Quantitative assessment of the risk of shipping traffic to whales: a case study for humpback whales in the Great Barrier Reef.*

This project will benefit from leverage from a number of methodological developments made within AMMC 13-46, specifically:

* AIS data processing, protocols and analysis (in collaboration with scientists from NOAA in the USA).
* Habitat modelling of east-coast Australian/Great Barrier Reef humpback whales should help in developing a similar models for other populations (e.g. West-coast Australian humpback whales) or other cetacean species.
* Some of the methodological developments for how to combine the shipping and animal distribution maps to produce indications of relative risk of vessel-animal interaction are directly of use in this project.

**Expected Outcomes**

*Phase 1: For work up to Dec 2015 (i.e., RPV1)*

* The Commonwealth Department of Environment (DOE) and other stakeholders will have a short-list of species at risk of ship-strike that are best suited for detailed analysis.
* DOE, related NESP hub projects, and other stakeholders will have a better understanding of the availability and extent of data/distribution models for at-risk marine species. This will involve an assessment of data deficiencies in terms of coverage of data/models to inform future resource allocation to surveys and other data collection.
* As part of a collaboration, the related NESP projects will have access to a single source of cleaned and processed AIS data (dated from 2012 onwards).

*Phase 2: For work from Jan 2016 (i.e., RPV2)*

* DOE and other stakeholders will have a better understanding of shipping density and speed.
* DOE, related NESP hub projects, and other stakeholders will have a better understanding of national distribution and habitat usage of the key species identified in Phase 1 of the project.
* DOE and other stakeholders will have a better understanding of national ship strike risk for key species selected in Phase 1.
* DOE and other stakeholders will have a better understanding projected future risk (for key species selected in Phase 1) based on projected shipping growth and animal population predictions (where available).
* DOE and other stakeholders will have a better understanding of the absolute risk of ship strike on marine fauna, where such estimates are feasible and their uncertainty.
* DOE and other stakeholders will have a better understanding of the issue of shipping noise, preliminary maps proof of concept for general shipping noise mapping and a roadmap for future work.

*Specific management or policy outcomes*

Information collated and synthesised during Phase 1 will provide information for funding bodies, various stakeholders and marine fauna (i.e., mammal, turtle, dugong) researchers to consider when making decisions such as prioritising future allocation of resources to study animal distribution, specifically for locations and species for which more information is needed in terms of quantifying risk from ship strike.

Ultimately, the final outcome of the project would be to produce a comprehensive report on national risk from ship strike to the limits of current data and knowledge (e.g., species risk maps). From these risk maps, spatial and temporal mitigation strategies and recommendations could be implemented to minimise the impact of vessel strike large marine fauna. These could range from ‘no action required’ through to active management, including options such as:

* Speed reduction zones at certain times as the methods developed in the project can potentially quantify the reduction in risk associated with various management scenarios.
* Requirements for increased observation of marine mammals in the path of vessels by bridge crew in higher risk areas.
* Modification of vessel routes to avoid areas of higher animal density.
* Recommendations for further targeted small-scale surveys to establish fine-scale spatial animal distribution in the identified risk areas, or surveys to establish and map small recreational vessel density.

These outcomes can inform management and administrative decision-making by the Department of Environment in its application of the EPBC Act. Findings from this project may also contribute to strategies repeated in the various marine bioregional plans, including: provision of relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act; and, in collaboration with industry, to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the/a regions key ecological features and protected species. Furthermore, results of the project will provide guidance for the further development of the National Ship Strike Strategy, and for future revision of the North East Shipping Management Plan, which will outline how shipping traffic in the Great Barrier Reef is to be managed. Results from this project will also provide guidance for development or revision of Recovery Plans and Threat Abatement Plans.

*Value*

The ultimate value to the environment would be reduced pressure on at-risk marine fauna arising from management decisions informed by this research. Some major outcomes of this project include:

* A prioritisation list of marine species for which we think ship strike may be an issue and, equally importantly, species for which we assess there as being a lower or no risk.
* A quantitative assessment of areas and times where and when risk is likely to an issue for key marine megafauna.
* A quantitative assessment of the utility of possible mitigation and management measures (e.g., speed limitations, alternative shipping routes).
* Overall, all these models will allow for the effective and appropriate allocation of resources and actions by management agencies commensurate with risk

However, for many of the species, the prevalence of ship strike and impacts of noise is difficult to ascertain (particularly given a lack of physical evidence), so measuring the effectiveness of management and value to the environment is also difficult. Some potential monitoring methods could be available such as via comprehensive vessel based monitoring or for land based monitoring for species where fatalities are washed ashore and recorded. However, even this would need an ongoing measure of relative abundance; otherwise, any inferred change in ship strike incidence may be confounded by a putative change in abundance.

**Planned Outputs**

***Outputs for the phase 1 2015 (RPV1)***

* Initial scoping report of ship strike risk summarising what is currently known about species that were tentatively nominated as being at-risk for ship strike, the data available, shipping size/type data needed and recommendations on what species to investigate further with a qualitative ranking from easiest to most difficult.
* AIS data base for the Australian EZ and initial processing protocols.

***Outputs for phase 2 2016-2017 (RPV2)***

* Full Australia-wide fine-scale shipping density and average speed maps for 2012 – present including information such as vessel length, beam and draft. This data will directly feed into future noise mapping.
* A national map of approximate density of small vessel distribution based on available proxies such as population density, boat registration data and boat ramp locations.
* A suite of distribution and density surfaces for the various species nominated during Phase 1;
* Spatial and temporal risk profiles for selected species. The risk maps will range from full fine-scale maps when data is present, to coarse-scale ‘regions of concern’ for species where distribution data is limited to approximate extent.
* An updated version of a database of ship strikes (historical and recent) within the Australian EEZ Report on national ship strike risk to the limits of current data and knowledge.
* Report on our ship strike risk methodological developments
* Report on initial shipping noise mapping
* Report on the recommendations and findings of the 2017 workshop on chronic noise in the marine environment.

**Delivery of Project**

*Project leader’s track-record*

Both proposed project leaders have delivered significant outputs

* Including reports, papers, chapters for the Memorial presented to the International Court of Justice Case on Special Permit Whaling).
* Many research projects within the Australian Marine Mammal Centre including leading a three-year aerial survey for Antarctic minke whales in the Southern Ocean, and Steering Group of the Antarctic Blue Whale Project.
* Significant contributions to the SESSF FIS project
* Australian Marine Mammal Centre external grant on Quantitative assessment of the risk of ship strike on humpback whales in the GBR.

*Delivery on time and within budget*

The design of the project is such that there are numerous standalone outcomes (i.e. nominated species, distribution and shipping) which to a large extent these can be run in parallel. The initial step will be to gather all information available and to categorise species based on the data availability and effort required. This will allow an informed strategic approach to the work plan to minimise the risk of delays or budget overruns. Furthermore, this initial work in 2015 of establishing a detailed view of available data and models and taking what has been learnt from previous work on humpback whales should reduce the possibility of unforeseen issues. The exact timelines and longer term funding of the project will to some extent be dependent on the number of species that are chosen to be examined/included. The plan would be of a staged approach with individual species results delivered during the life of the project.

**Project Milestones**

| **Milestones** | **Due date** |
| --- | --- |
| **Milestone 1**  **Deliverable**: Report summarising at-risk species, data availability and recommendations on species. Species will be grouped into three tiers of based on importance and feasibility.  **Key end-users:**   * AMMC, DoE and specific researchers/interested parties identified in end-user section. | 31 December 2015 |
| **Milestone 2.1**  **Deliverable:** Establish channel of communication (ostensibly, email and phone) with nominated stakeholders. So that all research users and stakeholders understand the project and how it relates to their interests | 31 March 2016 |
| **Milestone 2.2**  **Deliverable:** Updated Australian EEZ historical reported ship strike data base  **Key end-users:** AMMC, DoE – to report to the IWC Human Induced Mortality (HIM) subcommittee | 1 June 2016 |
| **Milestone 2.3**  **Deliverable:** Risk Map of first test species  **Key end-users:**   * AMMC, DoE - for use in developing the National Ship Strike Strategy, and informing relevant conservation and recovery plans for specific individual species. * Species specific researchers/interested parties identified in end-user section. | 30 June 2016 |
| **Milestone 2.4**  **Deliverable:** Initial National maps of shipping density and speed and summary of recreation vessel information  **Key end-users:** DoE, other NESP projects/researchers | 31 December 2016 |
| **Milestone 2.5**  **Deliverable:** Risk Map of second tier of species  **Key end-users:**   * AMMC, DoE - for use in developing the National Ship Strike Strategy, and informing relevant conservation and recovery plans for specific individual species. * Species specific researchers/interested parties identified in end-user section. | 31 December 2016 |
| **Milestone 3.1**  **Deliverable:** Risk Map of third tier of species  **Key end-users:**   * AMMC, DoE - for use in developing the National Ship Strike Strategy, and informing relevant conservation and recovery plans for specific species. * Species specific researchers/interested parties identified in end-user section. | 1 June 2017 |
| **Milestone 3.2**  **Deliverable:** Preliminary map of shipping noise  **Key end-users:**   * AMMC, DoE - for use in conservation and recovery plans for specific individual species. * All stakeholders – for discussion at workshop | 1 June 2017 |
| **Milestone 3.3**  **Deliverable:** Workshop on shipping ocean noise  **Key end-users:**   * AMMC, DoE, AMSA, GBRMPA, DoD – to allow input/engagement on a plan for future research on ocean noise issues. | July 2017 |
| **Milestone 3.4**  **Deliverable:** Refined National maps of shipping density and speed and small non-AIS vessel information.  **Key end-users:** DoE, other NESP projects/researchers | 31 September 2017 |
| **Milestone 3.5**  **Deliverable:** Report on national shipping risk to the limits of current data and knowledge  **Key end-users:** All end-users and stakeholders. Particularly for AMMC/DOE for use in National Ship Strike Strategy, and conservation and recovery plans for specific individual species. | 31 December 2017 |
| **Milestone 4**  **Deliverable:** All project outputs and data will be made publically and freely accessible and available on the internet (see Data and Information Management section) | 31 December 2017 |

**Researchers and Staff**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE 2016** | **FTE 2017** |
| Natalie Kelly (CSIRO) | Statistician/Marine animal Modelling | 0.4 | 0.4 |
| David Peel (CSIRO) | Statistician/Shipping data/ship strike | 0.35 | 0.35 |
| Josh Smith (Murdoch University) | Marine Mammal scientist | 0.2 | 0.2 |
| Toby Patterson(CSIRO) | Modeller – Tagging/movement | 0.1 | 0.1 |
| Simon Childerhouse (BPM) | Marine Mammal Scientist | 0.05 | 0.05 |
| TBA | Acoustician/Acoustic modeller | 0.1 | 0.1 |
| Jessica Redfern (NOAA) | Ecologist/Ship strike | 0.04 | 0.04 |
| TJ Moore (NOAA) | AIS Shipping data expert | 0.04 | 0.04 |
| AIMS/GA/UTAS\* | Potential collaboration on specific species/areas or certain modelling aspects as they arise |  |  |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| CSIRO | 367000 | 0 | 367,000 |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name\*** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| NOAA/Jessica Redfern (4% FTE) | 0 | 0 | $12,500 |
| NOAA/ TJ Moore (4% FTE) | 0 | 0 | $12,500 |
| Murdoch University/Josh Smith (20% FTE) | 0 | 0 | Cost to project is $40,000 and is just salary component. So Murdoch is co-investing overhead costs. |

\* Depending on species and data availability that is established in Phase 1 of the project, other contributors/organisations may potentially be engaged. e.g., researchers at UQ, SCU, JCU.

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DoE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Australian Marine Mammal Centre (AMMC) /Australian Antarctic Division (AAD) | Mike Double; Elanor Bell |
| Department of the Environment (DoE) | Sylvana Maas/Peter Benson |
| Australian Maritime Safety Authority (AMSA) |  |
| International Whaling Commission (IWC) | Human Induced Mortality (HIM) subcommittee |
| Australian Marine mammal and turtle researchers   * Acoustics * Dugong * Turtle * Dolphin * Humpback whale * Southern right whale * Whale Shark * Other species | Doug Cato (DSTO) Helene Marsh (JCU)  Russ Babcock (CSIRO)  TBC  TBC  John Bannister (WA museum)  Barry Bruce (CSIRO)  TBA |
| Great Barrier Reef Marine Park Authority (GBRMPA) |  |
| All State and Territory Governments   * MSQ |  |
| Threatened Species Commissioner (DoE) |  |
| Department of Defence (particularly the Defence Science and Technology Organisation) |  |
| National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) |  |
| Parks Australia |  |
| **Key Stakeholders (organisation/programme)** |  |
| AMMC/AAD | Mike Double/Elanor Bell/Brian Miller |
| DoE | Sylvana Maas/Peter Benson |
| AMSA |  |
| IMOS |  |
| International Fund for Animal Welfare (IFAW) |  |

**Knowledge Brokering and communication**

The main pathway to impact for the ship strike component will be via informing the National Ship Strike Strategy. The noise component will be via the scheduled workshop in 2017 and by integration into project C1’s data suite.

Also there are a variety of known and potential end-users, stakeholders and partners for this project as indicated in the Table above. The project will communicate results (as appropriate, at regular intervals, and potentially with the need for permission from original data custodians). Delivery of such will be sensitive to the context in which information will be received and used, as per guidance from the Hub’s specialist knowledge broker, and in alignment with the Hub’s Knowledge Brokering and Communication Strategy and its objectives. The key outputs of the project will generally be in the form of: maps and associated spatial data products; reports will be available via the Hub’s Data Management Framework to provide open and easy access. Finally, where possible, methods will be published as scientific papers (after receiving necessary approvals), in open-access journals (where possible and appropriate).

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species distribution and shipping movement and pressure datasets and produce reports that include species distribution and pressure maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Spatial data layers of results, models, summaries, etc, of both species distributions and shipping-associated features, will be provided to the DoE at various spatial scales and extents, including Marine Bioregions and Commonwealth Marine Reserves, Key Ecological Features and Biologically Important Areas.

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Majority of the funding will be used for staffing and meeting key data custodian/researchers/stakeholders. $40k is budgeted for the workshop in 2017, to bring together researchers and stakeholders to develop a roadmap for the issue of noise.

There was an increase in budget from the initial draft 2015 proposal, to incorporate the noise issue, notably the funding of the workshop and extra project team time and the addition of an acoustic modeller to the project. There is potential to use this investment to source external funds to increase the acoustic modelling capability further.

**Location of Research**

The research impact will be at the National level.

**Indigenous Consultation and Engagement**

We recognise the importance of Indigenous consultation and engagement and, as such, we will seek advice from the hub executive, as well as the researchers we are engaging with for specific species, to ascertain potential Indigenous interest in this work. Furthermore, we will ensure, via discussion with the hub, and the species researchers, that any opportunity to seek consultation and engagement with the Indigenous community is identified and taken. We will also ensure that if any existing data we use incorporated Indigenous intellectual and/or traditional knowledge that permission is granted for its use and this input is acknowledged and respected. We believe this approach is congruous with the Hub’s Indigenous Engagement and Participation Strategy.

**Inclusions (in scope)**

All species in Australian national waters at potential risk from ship strike injury and general mapping of shipping noise

**Exclusions (out of scope)**

This project will not look at other shipping risk to the ocean environment (for example oil spills, non-animal vessel collisions/grounding or biosecurity issues with bilge/ballast water).

No field work is included in this project, but rather the identification of knowledge gaps and need of further data collection.

A final component of quantifying the risk from noise is an understanding of the biological effects/response on individual species this will not be within the remit of this project, but shall be discussed at the workshop.

**Risks**

The main risk to the project is difficulty finding enough accessible data to build distribution models. To minimise this risk, extra effort, especially in the first stage of the project, will be put towards building engagement and collaborations with key researchers and relevant industry groups. Also, identification of the absence of appropriate data is useful to identify future survey work for relevant researchers. The project has collaboration with the Murdoch University Cetacean Research Unit, and engagement with AMMC and industry consultants. It is planned that the project will use these established engagement pathways with marine fauna researchers and industry data owners to enable the development of collaborative access to suitable data to build the species distribution models.

**Project Keywords**

Marine mammal; large marine vertebrates; ship strike; shipping noise; cetacean; risk; Distribution.

# Project D1 – Ecosystem understanding to support sustainable use, management and monitoring of marine assets in the North and North-west regions

*Project length* – 3½ years

*Project start date* – 01/07/2015

*Project end date* – 31/12/2018

*Project Leader* – Karen Miller (FTE – 30%), Scott Nichol (2IC; FTE – 5%)

*Contact Details* – [k.miller@aims.gov.au](mailto:k.miller@aims.gov.au), (alternate: [scott.nichol@ga.gov.au](mailto:scott.nichol@ga.gov.au))  
08 6369 4007 02 6249 9346

*Lead Research Organisation* – Australian Institute of Marine Science

*Total NESP funding* - $1,898,200

*Total Recipient and Other Contributions (co-contributions)* - $2,226,112

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *2016* | *2016* | *2017* | *2018* |
| *NESP funding* | *AIMS - $221,000*  *GA - $65,200*  *UWA - $85,000* | *AIMS - $220,000*  *GA - $130,000*  *UWA - $159,000* | *AIMS - $220,000*  *GA - $130,000*  *UWA - $159,000* | *AIMS - $220,000*  *GA - $130,000*  *UWA - $159,000* |
| *Cash co-con* |  |  |  |  |
| *In-kind co-con* | *AIMS - $174,112*  *GA - $95,000*  *UWA - $85,000* | *AIMS - $319,000*  *GA - $135,000*  *UWA - $170,000* | *AIMS - $319,000*  *GA - $135,000*  *UWA - $170,000* | *AIMS - $319,000*  *GA - $135,000*  *UWA - $170,000* |

**Project Summary**

Effective management of marine assets requires an understanding of ecosystems and the processes that influence patterns of biodiversity. Focusing on the North and North-west regions, this project will leverage previous research to improve ecosystem understanding through a synthesis of existing information and by making testable predictions about the character and extent of conservation values, including for key ecological features (KEFs) and Commonwealth Marine Reserves. End-users and stakeholders will benefit from improved regional descriptions of marine ecosystems and uncertainty statements. In turn, this will inform prioritisation of future investments in monitoring marine ecosystems and State of the Environment reporting.

**Problem Statements**

*Problem*

Australia’s North and North-west (NW) marine bioregions boast an array of highly diverse ecological communities. Together, they include 29 Key Ecological Features (KEFs) and over 250 species that are protected under the *EPBC* Act as threatened, migratory or listed. The region also hosts large populations of megafauna, such as whales, turtles and sharks, some of which are endemic to the region (e.g. the flatback turtle). This diversity and conservation value is reflected in the Commonwealth Marine Reserve (CMR) network, with 21 reserves established across the North and NW. Research completed through the NERP Marine Biodiversity Hub and by partner institutions through other programs confirms the hotspot status of CMRs for some pelagic and benthic communities, but they also reveal extensive data gaps for many key areas (Figure 1).

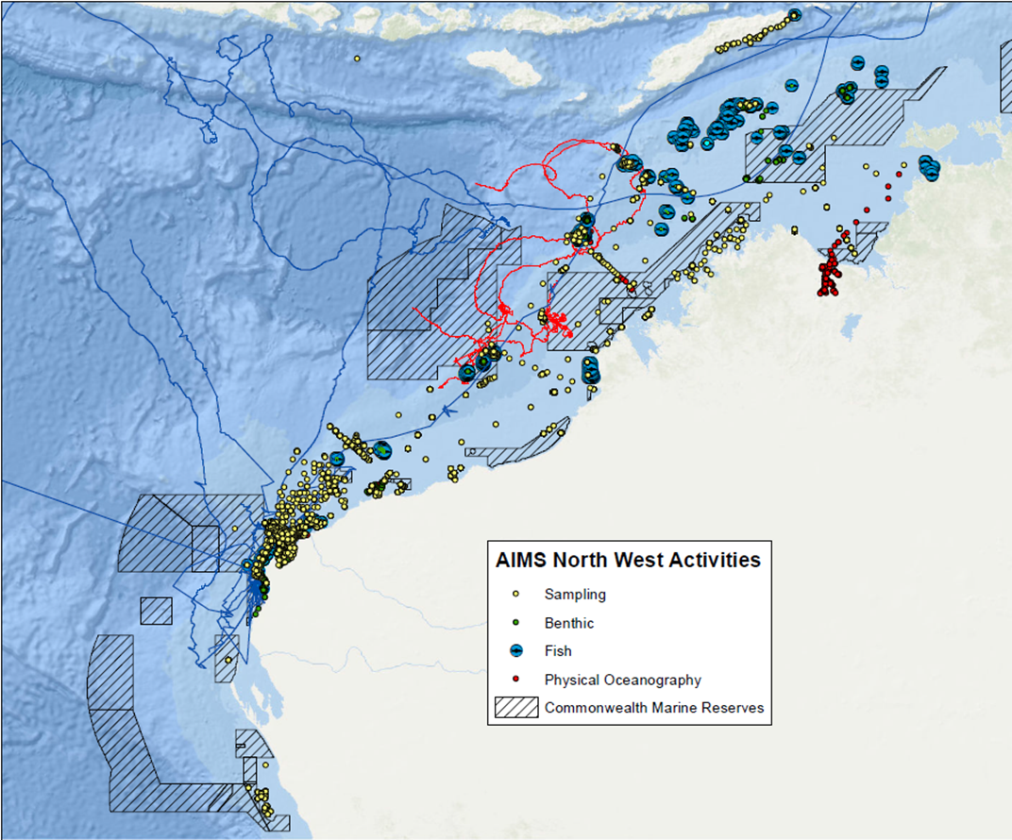


Figure 1: Example data coverage for the North-west region based on first pass collation of AIMS data holdings.

The North and NW also support important cultural and economic activities. Traditional owners have deep connections to sea country in the regions. Modern activities include commercial and recreational fisheries, pearling and aquaculture, defence, shipping, petroleum exploration and production, with the latter encompassing Australia’s most significant reserves of conventional oil and gas. Geopolitically, the North is Australia’s closest continental connection to regional neighbours and the NW is positioned on the Indian Ocean rim. Ensuring ecologically sustainable use of this area is a major national challenge involving multiple government, industry and community stakeholders including the oil and gas, tourism and fishing sectors, the Wildlife, Heritage and Marine Division of the Department of the Environment (DOE), Parks Australia, Department of Industry, NOPSEMA, Department of Fisheries and other Commonwealth and State Government agencies.

A key responsibility of DOE and other agencies is ensuring that management actions are delivering conservation outcomes while supporting sustainable use of marine resources. Management in the North and NW includes initiatives such as the establishment of the CMR network, threatened species recovery plans, and oversight of industry regulation; and information to underpin and assess the effectiveness of these management activities is critical. For instance, following the CMR zoning review, Parks Australia will be working to develop a network management plan and to monitor CMR performance against specific objectives. Baseline knowledge of assets, their inherent values and their current status is needed to underpin this process; a requirement that is echoed in the National Marine Science Plan 2015-2025. In addition, environmental compliance and risk mitigation across a range of industries (e.g. oil and gas, fishing, tourism) will be strengthened when areas at risk can be assessed in a broader bioregional context, including the rarity/uniqueness of habitats and natural levels of environmental variation.

The risks associated with management in the absence of knowledge are recognised, however the challenge presented by the North and NW regions is that they are large and remote, restricting our capacity to gather comprehensive baseline data of values, status, functioning and pressures across the region. However, significant investment in knowledge generation through programs such as CERF, NERP, WAMSI, IMOS and joint industry/government research collaborations has generated considerable empirical information that has been the foundation for the development of spatial predictive models for focal areas. For example, the AIMS benthic community model combines physical and biological data from submerged reefs and shoals and has been used to estimate the extent and nature of submerged coral reef habitat, including for KEFs (e.g. carbonate banks of the Sahul Shelf, pinnacles of the Bonaparte Basin, and waters surrounding emergent reef such as the Scott Reefs, Ashmore Reef, Rowley Shoals, Ningaloo and Glomar Shoal). Similarly, the GA 4D connectivity model and UWA’s pelagic models, all developed within the NERP Marine Biodiversity Hub, are used to predict larval dispersal across the North and NW across depths, and hotspots of marine wildlife based on benthic features, respectively. An opportunity exists therefore to utilise these data and models to strategically improve the ecosystem understanding of the North and NW regions.

*How Research Addresses Problem*

Recognising that it will not be possible during the course of NESP to survey a representative subset of the entire North and NW region in order to provide baseline data to underpin management, the main focus of this project is to leverage prior investment in data collection and collation to apply and refine spatial models previously developed under CERF and NERP. This project will enable predictions of the extent of benthic habitats, pelagic hotspots and connectivity in priority areas in the North and NW regions, particularly for KEFs and CMRs where data is particularly sparse (Figure 1). Through data collation and the application of predictive models, key information gaps relevant to the management and the CMR network will be derived and used, in consultation with DOE staff, to prioritize and plan future activities necessary to fill the most important data gaps. These activities in combination with integration of our current understanding (observed and predicted) of benthic, pelagic, megafauna movement/behaviour and oceanographic patterns will help identify and characterise Biologically Important Areas (BIAs) where we see concentrations of species/biodiversity within the region. Over the three years, the project will be achieved as a three step process:

* Apply existing models generated through CERF, NERP, WAMSI and elsewhere to predict key ecosystem attributes at locations (e.g. CMRs and KEFs) identified and prioritised through science and stakeholder workshops;
* Identify and prioritise opportunities to fill data gaps, based on the information needs of DOE, through targeted field programs in ways that will maximize the gain of new information for these priority areas and to consolidate our understanding of biodiversity values and ecosystem function; and
* Assess the application of equivalent approaches nationally, based on regional learnings.

Insufficient information exists to build qualitative models for a number of North and NW KEFs (e.g. Ancient Coastline at 125 m Depth Contour, Commonwealth Waters Surrounding Ningaloo Reef, Glomar Shoal). Similarly, many of the CMRs of the North and NW regions (e.g. Oceanic Shoals, Kimberley, Eighty Mile Beach and Gascoyne) suffer from a lack of baseline data. Moreover, many regions around Australia are challenged by the same data limitations. The above process will create a basis to progress the description of regional biophysical characteristics, and conservation values, and make predictions about these KEFs and CMRs based on existing models with clear statements of data gaps and uncertainty. This then forms the basis for “road-testing” these predictions through carefully targeted field programs prioritised by stakeholders, supporting KEF characterisation and CMR monitoring and management. This then forms a model for application to other regions of Australia with respect to testing model predictions.

Access to information is fundamental to effective decision-making. This project will also support the ongoing development of the Northwest Atlas ([www.northwestatlas.org](http://www.northwestatlas.org)). The Atlas allows managers, regulators and industry stakeholders to access synthesised data products through maps. E-Atlas tools are a proven product and their uptake has already been demonstrated via industry co-funding and the utilisation of data from the Ningaloo Atlas to underpin EIAs and risk assessments. Furthermore, the user-friendly interface of the NW Atlas and links to social media will strengthen public engagement and understanding of the value of the marine environment in the North and NW regions.

*Alignment with NESP Research Priorities*

This project aligns with several key marine biodiversity research priorities identified by DOE. Through increased knowledge generation based on the consolidation of existing data and models generated through significant past investments by CERF, NERP and collaborating institutions, and by testing these models, this project will provide new integrated information on the marine assets of the North and NW to *improve our knowledge of key marine species and ecosystems to underpin their better management and protection*. This knowledge will be accessible to end-users through the Northwest Atlas, new qualitative models for KEFs and CMRs, and through communication documents (e.g. fact sheets, full colour brochures, etc.). In addition, this project will contribute to the development of *practical and repeatable methods for monitoring the status and trends of key marine species and environments* through the provision ofbaseline data that can be used to understand the spatial distribution of diversity and ecological processes in the North and NW regions, supporting project B2 (Standard Operating Procedures). While the work undertaken in this project will focus on the North and the NW regions, it provides a framework for the application of similar approaches nationally. It builds on other regional work (Great Barrier Reef, Torres Strait and the South West of Australia), where regional approaches have provided significant steps forward in building a national picture of our marine environment.

This project also addresses the Clean Water component of the Cleaner Environment Policy, by providing information and tools to assess the significance and performance of CMRs, to identify and monitor KEFS, and to underpin the protection of marine environments in the North and NW regions of Australia.

**Research**

*Description of research*

The project builds on the results of the synthesis of spatial data, existing predictive models and the identification of key data gaps in the context of CMRs and KEFs in the North and NW that was delivered as part of the 2015 D1 Science Workshop. Through subsequent consultation with DOE, we have identified key areas for which we have the greatest confidence that the existing data will adequately inform predictive modelling that can be used to identify the values and assets within CMRs and KEFs, and where knowledge generation will be of most value to DOE. These areas are the target for the work that will be undertaken as part of Project D1 in future years and include the Oceanic Shoals CMR, Kimberley CMR, Glomar Shoal KEF and Ancient Coastline KEF.

A major strength of the project is in its integration of numerous spatial data sets in advancing ecosystem understanding of processes that structure and maintain biodiverse communities in the North and NW regions. For example, we can investigate how topographic features such as the Ancient Coastline KEF interact with oceanography to drive migration patterns of marine species (turtles, whales, sharks, fish and larvae) or sustain biodiversity hotspots.

The approaches that we will use to synthesise information in this project will identify values and assets within key CMRs and KEFs that will underpin future monitoring and management initiatives across the remote North and NW regions, based on consultation with DOE. The overlay of existing and modified predictive models will enable us to describe benthic habitats within CMRs, identify BIAs, develop and refine predictions of migratory corridors, foraging and breeding grounds, and characterise pelagic communities. This knowledge then allows assessments of sensitivity to environmental variability and anthropogenic pressures, as well as improving our understanding of the value of CMRs and KEFs in a regional context. Testing the models against field data (acquisition planned for 2017/2018) will ensure that management authorities will have a clear measure of the accuracy of the models, the degree of confidence that can be applied to the predictions and most importantly, their utility in underpinning monitoring and management programs across large spatial scales.

This proposal maps out a three year project (2016-2018), during which we will:

Year 1 (to Dec 2016):

* Finalise the collation of information for the North and NW regions by building on prior CERF & NERP investment in data acquisition and development of predictive tools, and workshops held in 2015.
* Analyse and report on the links between benthic communities, fish biomass, megafauna migration routes, oceanography and the geomorphic features for prioritised locations (e.g. Ancient Coastline KEF) based on the collation of existing baseline data undertaken in 2015 (bathymetry, towed video and BRUVs).
* Model the spatial-temporal dynamics of natural pressures affecting biota in the North and NW (e.g. cyclones, significant wave energy, thermal stress and oceanographic conditions) and identify how these might affect ecological processes such as turtle migration pathways, larval dispersal and fish biomass that need to be considered in management planning.
* Contribute to a National Prioritisation Workshop in conjunction with other Marine Hub projects (i.e. D3, C1) to inform decisions regarding future information and research needs of stakeholders.
* Work with the DOE to incorporate new data and ecosystem knowledge to refine descriptions and build qualitative models for existing KEFs (where previously none could be developed because of insufficient data, e.g. Glomar Shoals) and identify potential new KEFs in the North and NW.
* Integrate model and synthesis outputs to develop a series of communication products (e.g. fact sheets) including maps of the spatial distribution of communities, qualitative models of ecosystem functioning of target CMRs and KEFs in the North and NW region,
* Relate the integrated datasets and predictive models to the CMR network across the North and NW and assess the potential for these approaches to provide baseline information that is of value to DOE (i.e. standardised and comparable) and to support the prioritisation of areas for future monitoring efforts as part of the National Prioritisation Workshop with Project D3. Specifically, we will use the results from the Oceanic Shoals CMR as a test case for the application of predictive modelling for identifying assets and values in the marine estate and as a guide for stakeholders in identifying future data needs and tools required to adopt a similar approach nationally.
* Upload new information identified and developed through this project to the Northwest Atlas web platform to make data readily accessible to end users and engage with key stakeholders (DOE, NOPSEMA, industry, traditional owners) to support decision-making in the region, including, environmental risk assessments.

Years 2 and 3 (2017 - 2018):

* Based on outcomes from National Prioritisation Workshop, extend approaches used and proven in 2016 to priority areas to predict spatial distribution of biodiversity, describe natural assets and values and ecological processes of target CMRs and KEFs in the marine estate. Target areas might include the Kimberley, Eighty Mile Beach and Gascoyne CMRs for which we have already identified considerable existing data in adjacent areas that would inform predictive modelling, but may also include other regions of the national marine estate.
* Following consultation with stakeholders, undertake field survey(s) to collect biological and physical data that can be used to test predictions within CMRs developed from models (an application for sea time on the RV Investigator in 2017/18 has been submitted to support this component).
* Support the development of management and monitoring plans for the North and NW CMRs, and risk assessments associated with oil and gas industry operations by using new data to test and refine predictive models for the North and NW. In particular, model refinement will incorporate new data to facilitate model outputs that are of direct relevance to identified management needs
* Integrate model outputs to predict attributes of ecosystem processes for key components within the North and NW regions (e.g. carbonate banks and shoals, ancient coastlines, canyons and CMRs). This integration will consider benthic invertebrates, demersal and pelagic fishes, larval connectivity, marine megafauna (turtles, whales, sharks) and driving processes including topography, oceanography and natural pressures such as temperature and extreme events including cyclones.
* Reconvene with stakeholders through formal and informal meetings to disseminate research findings and to ensure project progress and direction remains relevant to management needs. Incorporate results on biodiversity distributions and drivers into management decision frameworks in collaboration with DOE and Project B1 and use this forum to develop interactive risk assessment maps
* Continue knowledge dissemination through the NW Atlas and upload of relevant data layers as well as the inclusion of interactive risk maps, qualitative models and other summaries. Produce updated maps, data syntheses, and communication tools for end-users that capture key environmental attributes of the North and NW regions, and incorporate risk.
* Undertake detailed discussion/workshops with DOE and other key stakeholders and end-users to disseminate the results from the project and to refine our on-going understanding of management needs/directions and further the extension of this project. Our communications into the department will focus on: describing values within the CMR network and their regional context; the ongoing development of appropriate monitoring strategies based on new biological and physical data and the SOP project, and; the potential for developing new, targeted models to address key knowledge gaps and prioritize data collection needs. We will also assess the value of collecting additional information against the need to support specific s (e.g. allocation of conservation management resources, EPBC Act approvals).

*Links with other projects and hubs*

Within the Marine Biodiversity Hub, this project links directly with:

Project D3 ‘*Evaluating and monitoring the status of marine biodiversity assets on the continental shelf*’ which has a focus on shelf reefs and is national in scope. Opportunities exist, therefore, to share datasets (e.g. shelf reef maps for the North and NW) and to use the reef classification scheme developed in Project D3 as a framework for interpreting biodiversity patterns in the North and NW.

The information generated in this project can also be used for the case studies proposed by Project B1 – ‘*Road testing decision support tools via case study applications.*’ In particular, baseline information assembled for CMRs in the North and NW (e.g. Oceanic Shoals, Kimberley CMRs) and associated models for features such as carbonate banks and shoals can provide the required scientific framework for informing the decision support process developed in Project B1. To facilitate this transfer of information, Project B1 will include an FTE commitment into this Project in Year 3.

Other project links in the Marine Biodiversity Hub include:

Project D2 - ‘*Analysis methods and software to support Standard Operating Procedures for survey design, condition assessment and trend detection*’, whereby outputs related to sampling design and analytical procedures (e.g. BRUVs, towed video images) will be used for the survey component of this project and results used to refine SOPs where necessary.

Project B3 – ‘*Enhancing access to relevant marine information – a pilot service for searching, aggregating and filtering collections of linked open marine data’*, whereby datasets and map layers generated in our project (and loaded onto the NW Atlas and AODN) will be discoverable through the web service tool being developed within Project B3.

Project C1 ‘*Increasing our understanding of pressures in the marine environment’* is focussing on anthropogenic pressures and their associated risk. Our predictive models will both inform and be informed by the outputs from C1. It is intended to include an FTE commitment in Project C1 in Year 2 to facilitate this integration.

More broadly, this project also will contribute to projects in the Hub’s Threatened Species Theme by providing capacity to better understand functional relationships between benthic environments (e.g. ancient coastline features) and the migratory behaviour of fauna such as whales and turtles.

*Related research*

This project will draw on past investment by the Marine Biodiversity Hub (CERF and NERP) and partner institutions in the collection of physical and biological data and model development across the North and NW regions, as well as the Great Barrier Reef, Torres Straits and the South West of Australia. The focus of this past work has been on benthic habitats associated with carbonate banks, reefs and shoals, and submarine canyons. Under the NERP program this work extended into the pelagic realm, through analysis of fish distributions in relation to benthic environments. Separately, through WAMSI, a wealth of information is now available on the spatial and temporal behavioural patterns of megafauna (humpback whales, whale sharks) and other listed species (e.g. flatback turtles). Further, the project aims to draw upon oceanographic data collected as part of IMOS (e.g. offshore Kimberley), and data collected by the oil and gas industry (accessible via IGEMS). For the first time, this project will begin the integration of these multiple datasets with the express purpose of building the ecosystem-scale understanding of both benthic and pelagic patterns of biodiversity.

Importantly, this project reflects an evolution from data collection and modelling to synthesis of information and model evaluation in relation to stakeholder requirements. This approach will generate knowledge relevant to management and monitoring and will guide investment in future data collection to underpin management of Australia’s marine estate. Using the North and NW regions as focal study areas, this approach will be leverage regional and national scale understanding generated by previous departmental investments in understanding these regions and will in turn develop new regional scale understanding and approached the will feed back into the development of greater understanding of large scale processes that maintain the national marine estate.

**Expected Outcomes**

*Outcomes*

* A knowledge framework to inform management plans for CMRs in the North and NW regions, particularly for maintaining patterns of marine biodiversity and associated ecosystem processes;
* An agreed understanding between end-users (including indigenous communities) and research providers on priorities for managing and monitoring in the North and NW marine regions that will be used to prioritise future research within the project, specifically to fill recognised data gaps and reduce knowledge uncertainties;
* A foundation for the evolution from precautionary management based on minimal information to informed and effective management decisions based on a more rigorous scientific understanding of these ecosystems that acknowledges uncertainty while prioritizing its reduction through strategically focussed investment in the acquisition of new information;
* Clear communication of environmental values associated with the CMRs and KEFs to the public, industry, and managers to support management strategies and associated policy in the region;
* Guidance to end-users on uncertainty in our understanding of ecosystems and the implications of this uncertainty for decision making;
* Maintenance and building of research and management capability within Australia, building on previous government and industry investment.

*Specific management or policy outcomes*

The products of this research that will underpin more informed management will include:

* A synthesis of data sets for the North and NW regions that will provide the knowledge to underpin CMR and KEF monitoring and management, as well as a context for risk assessments to inform approvals processes for sustainable use of marine resources in the region;
* Baselines for monitoring in priority areas of the CMRs and KEFs to maximise information relative to return on investment;
* Newly acquired environmental information in data-poor CMRs (e.g. Kimberley, Gascoyne, Eighty-Mile Beach) to describe environmental values, spatial patterns of biodiversity, and ecosystem processes in order to inform future management plans;
* Qualitative models that summarise the biodiversity, spatio-temporal dynamics of CMRs, KEFs and other features of significant conservation value in the North and NW CMRs, and the ecological processes structuring these ecosystems;
* An increased understanding of the distribution and structure of tropical marine biodiversity in the North and NW regions, which will provide a greater bioregional context of their significance in tropical Australia, as well in a global context as part of the broader Indian Ocean ecosystem;
* A model describing habitat use and migration pathways of marine megafauna and turtles that will allow us to objectively identify the areas of importance within the North and NW regions (e.g. BIAs), their representation in the CMR network, and their proximity to current and prospective industrial developments and the large-scale processes that influence their migration.

Overall, this project will identify, with associated levels of confidence, the spatial distribution and relative abundance of key natural assets of the region, as well as quantify ecosystem processes that shape patterns of biodiversity.

*Value*

The outcomes from this project will be of direct relevance for management of CMRs and monitoring of KEFs and will inform a range of management and policy actions. Approvals under the EPBC Act are binary decisions around whether or not a proposal poses acceptable risk. The notion of acceptable risk requires fundamental information on the spatial distribution of values and their exposure to a proposal’s footprint. Likewise, prioritising management actions in CMRs requires core knowledge of the distribution of biodiversity, its exposure to threats, and the extent to which candidate actions insulate against pressures.

This project will lead to better informed EPBC Act approvals, more informed prioritisation of management actions and monitoring in the North and NW CMRs and will assist industry in risk assessments and the refinement of its environmental plans (e.g. oil spill response plans). The value of the project can be demonstrated by comparing the costs and outcomes of informed decision-making with those of less informed approvals and management and by demonstrating the value of CMR implementation.

**Planned Outputs**

Project outputs from 2016 will include:

* A report on the synthesis (based on collations completed in 2015) of datasets and models for the North and NW identifying areas of greatest information coverage, gaps and themed to CMRs and KEFs in those regions. This report will also describe key spatial patterns in biodiversity (benthic and pelagic) and associations between benthic environments, fish and megafauna and large scale processes (e.g. oceanography).
* Predictions and related products (maps) of the spatial distribution of biodiversity across the Oceanic Shoals CMR that encompasses benthic habitat, pelagic and demersal fish and megafauna communities. This will provide an example/test case at the National Prioritisation Workshop of how confidently predictive modelling can be used to describe assets and values in data poor areas to inform management and monitoring.
* An updated conceptual model of ecosystem processes (benthic and pelagic) within the Oceanic Shoals CMR based on extension of modelling into pelagics.
* A review of existing knowledge of the Ancient Coastline KEF.
* A qualitative model of Glomar Shoal KEF (to be confirmed in consultation with DOE).
* Communication products that capture activities and general interest stories of scientific results disseminated through NW Atlas social media links.
* Upload of new relevant spatial data layers in NW Atlas for management and planning, and engagement with end users to maximize uptake of the NW Atlas products.

Through the life of the project, we will target the dissemination of our research results through multiple avenues to ensure broad uptake; these include qualitative models of KEFs and CMRs, fact sheets, full colour brochures, peer reviewed publications in the scientific literature, conference presentations and social media.

**Delivery of Project**

*Project leader’s track record*

The project will be jointly led by Karen Miller (AIMS) and Scott Nichol (GA). Together, these scientists have experience in the management of multi-million dollar research programs, have worked closely with government departments, research organisations and universities to effectively deliver scientific outcomes relevant to the management of Australia’s marine environment.

Karen Miller has worked in State (e.g. NSW MPA) and Commonwealth Government departments (e.g. Dept of Environment) in the development of policies and identification of research needs for management. Over 20 years in marine science she has led multiple national and international collaborative projects that have both an applied (e.g. fisheries management, deep sea conservation) and strategic (biodiversity discovery, evolutionary and ecological) research framework; and all of these being completed on time and within budget. She currently is a Senior Research Scientist at the Australian Institute of Marine Science delivering on projects providing baseline data to the oil and gas industry as well as understanding biogeographic and ecological processes in tropical marine ecosystems in Australia’s North and NW regions.

Scott Nichol is a senior marine geoscientist at Geoscience Australia with 25 years of experience leading research projects in Australia and overseas (NZ, Ireland, Canada). Since 2011, he led the development and delivery of Theme 3 – National Ecosystems Knowledge of the NERP Marine Biodiversity Hub, and worked closely with Julian Caley and Jessica Meeuwig in Theme 4 – Regional Biodiversity Discovery to Support Marine Bioregional Plans. Both themes generated new datasets and knowledge for the North and NW marine regions, with tailored products delivered to DOE to support uptake at the policy level. These projects met all delivery and budgetary requirements, with datasets accessible through AODN and the new web services tool on the Marine Biodiversity Hub website.

*Delivery on time and within budget*

The project will fully adhere to the Marine Hub Performance and Evaluation Protocols to ensure it is managed to deliver on time and within budget. This includes completion of monthly progress reports and contributions to the Marine Hub annual report.

**Project Milestones** (milestones beyond 2016 to be approved by annual research planning process)

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. All research users and stakeholders for this project have been engaged and understand project and how it relates to their interests | 30 April 2016 |
| 1. New maps and products based on existing data and knowledge from the North and NW available to all end-users through the NW Atlas to support development of CMR management plans and updates to KEF descriptions | 1 July 2016 |
| 1. Completion of National Prioritisation Workshop in collaboration with Projects D3 (Shelf Reefs) and C1 (Pressures) and stakeholders | 1 September 2016 |
| 1. Report summarising outputs from synthesis of datasets and predictive models for the North and NW, including priority areas identified through stakeholder consultation to support development of CMR management plans | 1 December 2016 |
| 1. Delivery of qualitative models to end users for priority areas identified through consultation (e.g. Glomar Shoals KEF) to inform ecosystem understanding of priority KEFs in the North and NW | 1 April 2017 |
| 1. All project outputs to date made accessible to the public (see section on Data and Information management) | 1 Jan 2017 |
| 1. Completion of field survey(s) to fill data gaps in priority areas of the North and North-west | 1 Dec 2017 |
| 1. Delivery of report summarising datasets and new knowledge acquired by field survey(s) | 1 September 2018 |
| 1. All survey datasets made accessible to the public (see section on Data and Information management) | 31 December 2018 |

**Researchers and Staff**

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE 2016** |
| Karen Miller – AIMS | Project Leader, benthic ecologist | 0.3 |
| Ben Radford – AIMS | Ecological modeller | 0.2 |
| Marji Puotinen - AIMS | Ecological modeller | 0.25 |
| Andrew Heyward - AIMS | Benthic Ecologist | 0.03 |
| Julian Caley – AIMS | Ecologist | 0.03 |
| Mark Meekan - AIMS | Megafauna Ecologist | 0.03 |
| Michele Thums - AIMS | Megafauna Ecologist | 0.15 |
| Rebecca Fisher - AIMS | Ecological statistician | 0.05 |
| Scott Nichol – GA | Geoscientist | 0.05 |
| Johnathan Kool – GA postdoc | Connectivity modeller, ecologist | 0.2 |
| Zhi Huang – GA postdoc | Spatial analyst | 0.2 |
| Rachel Przeslawski - GA | Ecologist | 0.2 |
| Kim Picard – GA | Geoscientist, seabed acoustician | 0.1 |
| Jessica Meeuwig - UWA | Ecologist | 0.1 |
| Phil Bouchet – UWA postdoc | Modeller | 1 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| AIMS | 881,000 | 0 | 1,131,112 |
| GA | 455,200 | 0 | 500,000 |
| UWA | 562,000 | 0 | 595,000 |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |
| --- | --- |
| **Organisation/name** | **Contribution** |
|  |  |

**Research End Users and Key Stakeholders**

|  |  |
| --- | --- |
| **Research End Users** | **Organisation/Section** |
| Amanda Parr | DOE/Parks Australia |
| Nicole Coombe | DOE- Regional Marine Planning |
| Boon Lim | DOE SoE reporting. |
| Christine Lamont | NOPSEMA (secondary beneficiary) |
| **Key Stakeholders** |  |
| APPEA | Oil and Gas Industry – APPEA and individual companies |
| AFMA |  |
| State Mining, Fishery and Conservation agencies |  |
| Regional fishing and conservation groups |  |
| NAILSMA, KLC |  |

**Knowledge Brokering and Communication**

The project will adhere to the Marine Hub Knowledge Brokering and Communication Strategy with a focus on regular interaction with project end-users and stakeholders as listed above. Accordingly, this project includes a milestone in the first quarter of 2016 that requires full engagement with research users to ensure they understand how the project meets their interests in the North and NW regions. Additionally, the National Prioritisation Workshop will provide an additional forum for knowledge exchange and discussion with end users. The project will also develop a schedule for product delivery and stakeholder engagement in consultation with the Marine Hub Knowledge Broker, and will look to extend particularly to the Indigenous communities through other NESP hubs and projects (e.g. Northern Australia Environmental Resources Hub which is assessing Indigenous Protected Areas in the Kimberly) as well as other organisations including the Rangelands NRM

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

Data to be delivered by this project will include:

* Spatial data layers describing benthic and pelagic ecosystems in the North and North-west marine regions, incorporating new and existing samples, observations and measurements.

Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Web services interface will also be delivered through the Northwest Atlas <http://northwestatlas.org> with spatial data layers and model outputs. The project will adhere to the NESP requirement that all journal publications be made publicly and freely available within 12 months of publication. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The Department of the Environment will be informed by email to [marinemetadata@environment.gov.au](mailto:marinemetadata@environment.gov.au) each time a dataset is published and provided with a link to the full dataset.

Data and information management contacts for project are Ben Radford (AIMS) [b.radford@aims.gov.au](mailto:b.radford@aims.gov.au) and Zhi Huang (GA) [zhi.huang@ga.gov.au](mailto:zhi.huang@ga.gov.au).

**Expenditure Summary**

In 2016, funding will be used to support the deployment of staff resources from AIMS, GA and UWA to provide requisite expertise in analysis and interpretation of physical and ecological data and spatial modelling, plus data management and delivery. Funds will also support travel to facilitate interactions among spatial analysts across partner organisations to ensure integration of data and predictive models to understand ecosystem processes. The budget request also factors in travel to attend workshops and Hub meetings as required.

**Location of Research**

Analysis and synthesis will focus on the North and NW regions of Australia, including CMRs and KEFs (see Figure 1) and building on existing knowledge for offshore banks and shoals, canyons, ancient coastlines and pelagic ecosystems. In year one, the specific areas for focal studies (test cases for the National Prioritisation Workshop) will be the Oceanic Shoals CMR and Glomar Shoal KEF. The gap analysis undertaken in 2015 indicated the potential for this approach to be extended confidently into the Kimberley, Eighty Mile Beach and Gascoyne CMRs as well as the Ancient Coastline KEF but future target areas will be developed in consultation with stakeholders and as part of the 2016 National Prioritisation Workshop.

**Indigenous Consultation and Engagement**

The project will directly address the Hub’s communication priority for Indigenous Engagement and Participation through consultation with Indigenous communities and encouraging the participation of Traditional Owners in all aspects of the science. AIMS and UWA have established relationships with Traditional Owners across the North and NW region linked to ongoing projects within WAMSI. Engagement is regular and includes meetings with land councils and ranger groups to understand the cultural significance and use of coastal study areas and integrate traditional knowledge of biological use/significance into research projects. We are also actively engaging traditional owners in established field projects; for example Bardi Jawi rangers join WAMSI field work around the Cygnet Bay area and we are collaborating with Dambimangari Sea Rangers to gather additional temporal and spatial data on benthic communities in the nearshore areas around Camden Sound. The importance of the offshore areas that are the focus of this hub project to Indigenous groups is poorly understood. However through our established relationships with Kimberley Indigenous groups, and additional relationships we aim to develop as part of this project e.g. through the Rangelands NRM and NESP Hubs, we will have the opportunity to build an understanding of the cultural significance of offshore areas and incorporate this into data synthesis, survey planning and the development of the project overall to ensure relevance and participation of Indigenous communities. In later years of the project, we plan to extend invitations to the Indigenous community to participate in field surveys that overlap with any areas of cultural significance and thus build a stronger link between indigenous, scientific and management agencies as well as capture the cultural as well as biological significance of CMRs and KEFs within communication products such as the NW Atlas.

**Inclusions (in scope)**

The project will deliver data synthesis products and predictive models of benthic habitats, pelagic hotspots and natural pressures for key areas in the North and NW for example, the Oceanic Shoals, Kimberley, Eighty Mile Beach and Gascoyne CMRs as well as Ancient Coastline KEFs and Glomar Shoal KEF. Qualitative models of ecosystem processes across the North and NW will be developed through the synthesis of predictive models. Spatial data layers relevant to the management and of the North and NW will be made available through the Northwest Atlas

**Exclusions (out of scope)**

Out of scope factors will be agreed upon with DOE during ongoing consultation as guided by Department priorities for the North and NW regions, in terms of geographic areas of focus and key biodiversity values.

**Risks**

This project is potentially constrained by the level of funding to support survey work in particular (to enable rigorous testing of models) and by timely access to staff resources from the partners. However, this can be minimised through careful project management and setting of achievable objectives for surveys and subsequent analysis of samples and data collected.

**Project Keywords**

Ecosystems processes, marine assets, marine environmental baselines, North and NW Australia, Commonwealth Marine Reserves, Key Ecological Features

# Project D2 – Analysis methods and software to support Standard Operating Procedures (SOP) for survey design, condition assessment and trend detection

*Project length* – 3 Years

*Project start date* – 01/07/2015

*Project end date* – 15/01/2018

*Project Leader* – Scott Foster *Lead Research Organisation* – CSIRO

03 6232 5178

scott.foster@csiro.au

*Total NESP funding* - $317,187

*Total Recipient and Other Contributions (co-contributions)* - $317,187

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* |
| *NESP funding* | *$100,000* | *$111,700* | *$105,487* | *x* | *x* | *x* | *x* |
| *Cash co-con* | *X* | *x* | *x* | *x* | *x* | *x* | *x* |
| *In-kind co-con* | *$100,000* | *$111,700* | *$105,487* | *x* | *x* | *x* | *x* |

**Project Summary**

Understanding of the status and trends of indicators in Australia’s marine environment requires standardised monitoring, without which monitoring is unlikely to be comparable through time and space – status and trends are unlikely to be available. This project will build on the monitoring blueprint by providing foundation for Standard Operating Procedures in the collection and analysis of monitoring data. In particular, the project will 1) provide some delineation of what kind of monitoring is required (and when), 2) providing a simple tool for designing surveys in space that also analyses the resulting data, and 3) provide a worked end-to-end SOP example for a baited underwater video for collection of data in benthic key ecological features (including recommendations for field protocols to ensure ecological relevance).

**Problem Statements**

*Problem*

Reporting on the status and trends of environmental resources requires cost effective monitoring. In an area as large as the Commonwealth Marine Area, it is undesirable and unrealistic to expect monitoring activities to be conducted by any one single agency or organisation. It is important, that when different organisation or agencies collect data to serve the same, or comparable, objectives that it is collected, analysed and reported in a consistent manner. Inconsistent survey design, data collection and analysis impedes analysis of status and trend detection.

Theme 1 of the NERP Marine Biodiversity Hub demonstrated and implemented a standard approach to survey design. At the end of Hub, two things were clear: 1) designing a monitoring effort is technically demanding and requires highly specialised skills, and 2) the analysis of the resulting data is non-trivial because of the large variety of sampling tools, data scoring methods and analysis methodologies. This project will build on the lessons learnt in NERP Theme 1, and will demonstrate how to implement the essential monitoring functions listed in the Integrated Monitoring Framework (IMF) developed in the Theme. The IMF was written for the Great Barrier Reef but the essentially monitoring functions it lists are generic, and based on the procedures developed and implemented by the United State National Parks Service.

*How Research Addresses Problem*

This project aims to provide the foundation for Standard Operating Procedures in the collection and analysis of monitoring data for (at least in the first two years) a limited set of “no-regrets” objectives by: 1) providing a simple tool for designing surveys in space, and 2) providing a core set of analysis methods, tailored to specific survey methods, that should be undertaken as a routine part of the monitoring process. A putative set of objectives will be developed in collaboration with the Hub projects D1 and D3, which both have survey aspects that will benefit from the tools developed within this project. This putative set will be refined with input from the DoE.

If the design tool is used and analysis techniques are followed, then management authorities and industry consultants will be provided with concise, consistent, interpretable and fit-for-purpose evidence on the status and trends of environmental assets.

The project will identify the gear deployment (design), data scoring (processing) and statistical methods (analysis) that support evidence based decision-making and evaluation of the empirical evidence with respect to management benchmarks. Further, due to the standardisation of these methods, the information will be comparable from one project to the next. This establishment of clear design and analytic guidelines will provide the foundation for Standard Operating Procedures designed to support the Department’s management and monitoring requirements in the CMA.

*Alignment with NESP Research Priorities*

This project aligns to two DoE research priorities that together seek to maximise the efficacy of managing Australia’s marine environment and call for an improved understanding of that environment, specifically:

• Determine and trial practical and repeatable methods for monitoring the status and trends of key coastal and marine species and environments to underpin management of Commonwealth Marine Reserves.

• Meaningful and accessible information on the status and trends of key social and economic values associated with the marine environment.

Any successful standard operating procedure requires 'buy-in' from stakeholders and end-users. To this end, the project will actively engage key scientists and managers throughout all types of organisations. This will be done through individual discussions, conference presentations, workshops and publications.

**Research**

*Description of research*

This project is a desk-top analysis of techniques that if implemented correctly will deliver nationally consistent assessments of CMA assets and will inform the evaluation of the status of ecosystem condition and of the efficacy of management actions.

Research tasks and timeline as follows:

Year 1:

1. Choose a limited set of “no regret” objectives, relevant to NESP monitoring/survey projects (see below for identified projects to partner with). These objectives will be chosen from the list developed in Project 1.2 from Theme 1 of NERP marine biodiversity hub, and be informed by outputs from Project 2.1 from Theme 2.
2. Identify response variables (the things we measure and subsequently analyse) based on monitoring methods and scoring techniques (e.g. broad scale versus fine scale scoring on CATAMI schema), and identify relevant marine environment covariates, and where appropriate relevant management interventions.
3. Identify methods for status assessment and trend detection relevant to response variables identified in item 2
4. Develop prototype of easily used software for spatial survey design and analysis in the R statistical programming language.
5. Recommend standard operating procedures for survey design, scoring and data analysis to support evidence based decision making, for example, to test the efficacy of commonwealth marine reserves.

Years 2 and 3:

1. Finalise survey design and analysis software, release this as an R-package.
2. In conjunction with survey design and data collected in Year 2 of NESP project: “Evaluating and monitoring the status of marine biodiversity assets on the continental shelf” demonstrate application of the R-package to continental shelf reef monitoring objectives.
3. Provide a worked example of the process for survey design and analysis. This will be an R-script for generating a survey design, ingestion of survey data into R, and data analysis. The outcome from this will be a set of detailed R-scripts that will act as a template for future researchers.

*Links with other projects and hubs*

This project is designed to link to the on-the-ground monitoring and survey projects. We expect that particularly strong links to the first project (below) as this provides the clearest ‘no regrets’ opportunities.

* “Evaluating and monitoring the status of marine biodiversity assets on the continental shelf”,
* “Developing a Toolbox of Predictive Models for the Monitoring and Management of KEFs and CMRs in the North and North-west regions”, and
* “Monitoring and assessing impact of sewage and other pollutants on inshore fish, invertebrate, algal and microbial ecosystems”.

It is also related to the reporting/elicitation/analysis project:

* “Analysis and elicitation to support State of the Environment reporting for the full spectrum of data availability”

*Related research*

This project leverages off the outcomes of Theme 1 and Theme 2 of the NERP marine biodiversity hub, and also builds on capacity gained during the CERF marine biodiversity hub (prediction and surrogate themes).

**Expected Outcomes**

*Outcomes*

It is expected that this project will contribute to an improved information flow from survey through to management decision for the task of managing benthic fish communities. In addition, it will aid the cost-effective sampling of the national marine estate – even when that sampling is performed by different institutions. The SOPs will provide a reference point for regulatory and management agencies with a requirement to monitor the trend and status of demersal fish communities: The DoE for ecosystem health monitoring, Parks Australia for monitoring CMRs, NOPSEMA for regulating oil and gas activities, and GBRMPA for monitoring protected areas.

*Specific management or policy outcomes*

This project will provide a minimum standard that, if adhered to, will enable the national collation and analysis of data sets collected by disparate agencies and at disparate times. We use monitoring of benthic fish communities as a ‘no regret’ objective, which is illustrative of this process. While we focus on benthic fish in the first instance, many/most of the lessons learnt and the tools developed will be applicable to other monitoring objectives.

*Value*

With increased information and increased clarity comes increased capacity for evidence-based management. This project aims to assist the flow of information from surveys to decisions, and further it aims to standardise a core component of the information content between surveys. The standardisation of information content allows more straight-forward, and more holistic, synthesis of multiple surveys by multiple institutions.

**Planned Outputs**

The outcomes for this project will consist of:

* Standard Operating Protocol (SOPs) for deploying observation platforms, processing raw data and then analysing processed data for a set of ‘no regrets’ objectives. This includes clear recommendations about how to choose sampling locations and how to analyse the resulting survey data.
* A piece of software (an R package) that implements spatially balanced designs. The software will require a minimal skill level.
* A worked example, from a partner project, that will form the template for future surveys.
* Scientific publications, which will be made publically and freely available within 12 months of publication.

**Delivery of Project**

*Project leader’s track-record*

Scott Foster has been a core member of projects within both previous Marine Biodiversity Hubs. He has taken responsibility for sections of those projects and delivered results on time and on budget. He has the support of more experienced researchers that are willing to advise him with administrative and programme requirements.

*Delivery on time and within budget*

The project leader and science support team will implement standard project management and reporting mechanisms to ensure that the project stays on track, and cost/time deviations are identified early and if appropriate reported to NESP leadership team. The project will also be subject to the project management and reporting procedure implemented across the entire NESP biodiversity hub, which will include regular (monthly) progress reports that will be routinely delivered to the hub’s steering committee.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| 1. Identification of “no regrets” objectives to partners, and with partners, for finalisation and scene setting. | 1 Oct 2015 |
| 1. Prototype R-package for Spatial Survey Design to partners for trial use. | 15 Jan 2016 |
| 1. All end-users and stake-holders have been engaged and understand project and how it relates to their interests. | 15 Jan 2016 |
| 1. Initial draft manuscript regarding a description of monitoring for evidence-based management to end-users for input, feedback and discussion. | 30 June 2016 |
| 1. Initial draft manuscript regarding spatial survey design (describing methods in the R-package) to end-users for input, feedback and discussion. This is expected to be a technical document, but the Abstract and Introduction will be assessable to all interested in monitoring. | 15 Sep 2016 |
| 1. Identification of analysis methods for status estimation and trend detection. Developed in collaboration with partners and for agreement to enable further forward movement. | 15 Jan 2017 |
| 1. Preliminary worked R-scripts (and R package for design *and* analysis) to act as a pattern for future researchers. Delivered to partners and all associates for comment in input. | 15 Oct 2017 |
| 1. Final R scripts and package to the end-users for use in future surveys. | 15 Jan 2018 |
| 1. All project outputs and data will be made publically and freely accessible and available on the internet (see section on Data and Information Management | 15 Jan 2018 |

**Researchers and Staff**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE 2016** | **FTE 2017** |
| Scott Foster – CSIRO | Project lead | 0.15 | 0.15 |
| Emma Lawrence, CSIRO | Design and analysis | 0.06 | 0.09 |
| Geoff Hosack – CSIRO | Design and analysis | 0.10 | 0.10 |
| Keith Hayes – CSIRO | Design and analysis | 0.10 | 0.05 |
| Alan Williams - CSIRO | Field Ecologists | 0.05 | 0.05 |
| Neville Barrett – UTAS | Field ecologist | 0.05 | 0.05 |
| Julian Caley – AIMS | Quantitative ecologist | 0.05 | 0.05 |
| Jin Li – GA | Design and analysis | 0.05 | 0.05 |
| Rachel Przeslawski | Field Ecologist | 0.05 | 0.05 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| CSIRO | $230,855 |  | $230,855 |
| UTAS | $23,483 |  | $23,483 |
| AIMS | $23,483 |  | $23,483 |
| GA | $39,366 |  | $39,366 |

**Other contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| None |  |  |  |
|  |  |  |  |

**Research End Users and Key Stakeholders**

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| DoE, Wildlife, Heritage and Marine Division (marine policy)  DoE, Environmental Standards Division (assessments)  DoE, Office of Environmental Science and Economics (Essential Environmental Measures Program)  Parks Australia, Commonwealth Marine Reserves  GBRMPA, Integrated Monitoring  NOPSEMA, Environmental Effects  IMOS/AODN | Kat Dunstan  TBC Amanda Parr, TBC Roger Proctor |
| **Key Stakeholders (organisation/programme)** |  |
| Partner Organisations   * AIMs * GA * CSIRO * UTas | Julian Caley, Hugh Sweatman  Scott Nichol, Rachel Przeslawski, Jin Li  Keith Hayes, Alan Williams (& other project staff)  Neville Barrett |
| Other Research Organisations | TBC in course of project development. |

**Knowledge Brokering and communication**

This project will be seeking guidance and collaboration, from partners, the DoE and other stakeholders, to aid in refining the scope and direction of this research. In the first instance, this will be in the form of discussions with scientists from CSIRO, AIMs, GA and UTAS to define a set of putative “no regrets objectives”. During implementation, the methods will be developed using survey design issues from other Hub projects (e.g. D1 and D3). This will require close collaboration between partners and researchers. To ensure project impact, we will actively seek engagement from research users and stakeholders throughout the project. At the end of the project, all project outputs will be made available to the public, researchers-users and stakeholders. However, we do not intend to deliver only at the end of the project, for instance, and for end-users, we intend to demonstrate utility and application through a workshop, possibly held in conjunction with a Hub-wide meeting.

**Data Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate information to produce a standard operating procedure and develop a software package (see milestones). Information and data will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

Funding will be primarily used to pay salaries.

**Location of Research**

Research impact is national. This study will be conducted on the computers of researchers in Hobart, Brisbane, Canberra, and Townsville. On ground work will be conducted through associated NESP projects.

**Indigenous Consultation and Engagement**

We acknowledge the importance of conducting this project in a way that is respectful of Indigenous culture, intellectual property and traditional knowledge. We will take advice about the level of Indigenous interest in the project, and the project will be consistent with the Hub’s Indigenous Engagement and Participation Strategy. The researchers involved with this project will all conduct their research with the highest ethical standards.

**Inclusions (in scope)**

A review and critical analysis of observation platform deployment, raw data processing and processed data analysis for a set of “no regret” objectives around the status and trends of environmental assets within the commonwealth marine area

**Exclusions (out of scope)**

The project will initially be limited to a set of monitoring objectives drawn from the progress made, and outcomes of, Theme 1 and Theme 2 of the NERP biodiversity hub. This analysis will be limited to no more than three specific well-operationalised objectives, as defined in the Integrated Monitoring Framework report.

**Risks**

* Failure for the department to agree on a limited set of “no regrets” objectives.
* Loss of key researchers from the hub (Foster, Hosack, Lawrence, Hayes).

**Project Keywords**

Standard operating procedure, survey methods, analysis methods, core information, monitoring

# Project D3 – Evaluating and monitoring the status of marine biodiversity assets on the continental shelf- Phase 1-shelf reef key ecological features.

*Project length* – 30 Months

*Project start date* – 01/07/2015

*Project end date* – 30/12/2017

*Project Leader* – Neville Barrett (FTE – 30%)  
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(03) 6227-7210

*Lead Research Organisation* – University of Tasmania

*Total NESP funding* - $1,654,000

*Total Recipient and Other Contributions (co-contributions)* - $2,181,000 in-kind

|  |  |  |  |
| --- | --- | --- | --- |
|  | 2015 | 2016 | 2017 |
| NESP funding | GA $98,000  UTAS $97,000  CSIRO $42,000  NSW DPI $76,500  NSW OEH $26,500  UWA $13,000  AIMS $10,000  UTAS work- shop and data management $25,000  **Total $388,000** | GA $95,000  UTAS $193,000  CSIRO $83,000  NSW DPI $53,000  NSW OEH $53,000  UWA $26,000  AIMS $10,000  UTAS travel  support $20,000  **Total $533,000** | GA $95,000  UTAS $193,000  CSIRO $83,000  NSW DPI $53,000  NSW OEH $53,000  UWA $26,000  AIMS $10,000  UTAS travel  support $20,000  UTAS Vessel support for  field programs $200,000  **Total $733,000** |
| Cash co-con | x |  |  |
| In-kind co-con | GA $154,000  UTAS $187,000  CSIRO $42,000  NSW DPI $82,000  NSW OEH $32,000  UWA $16,000  AIMS $13,000  **Total $526,000** | GA $125,000  UTAS $354,000  CSIRO $83,000  NSW OEH $110,000  NSW DPI $110,000  UWA $33,000  AIMS $12,500  **Total $827,500** | GA $125,000  UTAS $354,000  CSIRO $83,000  NSW OEH $110,000  NSW DPI $110,000  UWA $33,000  AIMS $12,500  **Total $827,500** |

**100 Word Project Summary**

Rocky reefs are an important habitat on the continental shelf and subject to multiple pressures. Their high productivity and biodiversity values has led them to be identified as Key Ecological Features within the Commonwealth marine bioregional planning framework. The vast majority are unmapped and knowledge of their biology or representation within the CMR network is limited. This project will collate all existing mapping of cross-shelf habitats, allowing major gaps to be identified to prioritise future research in subsequent stages. This knowledge will inform a range of on-ground work, including management of Commonwealth assets via marine regional plans, CMRs, and fisheries.

**Project Overview.**

Rocky reefs form an important habitat on the continental shelf and one subject to disproportionate fishing pressure given the high productivity of this habitat relative to adjacent sandy seabed. Reef features on the continental shelf are identified as conservation values (i.e. key ecological features - KEFs) in the Australian Government’s four marine bioregional plans (MBPs). Shelf reefs are a characteristic component of almost half of the KEFs identified in MBPs. Despite this, little is known of the extent and nature of these systems beyond their value to the fishing industry.

This project will provide a national collation all known mapping data from government and industry (including data acquired during CERF and NERP Hubs) to improve understanding of the distribution and extent of this key habitat around Australia, and will identify critical gaps in this knowledge to be filled by targeted surveys. This will significantly improve understanding of KEF boundaries and conservation values or assets within Commonwealth Marine Reserves on Australia’s continental shelf. A classification system will be developed for these reefs, and matched with refinement of inventory and monitoring approaches to track reef health through time, including standard approaches to SOE understanding and reporting consistent with measures developed for coastal systems within NESP (i.e. see project C2). By default, the project will also involve collation of all mapping data on non-reef hard substrate, and all non-reef soft substrate, with this information also being available as a significant output.

The first 12 months of the project will set up a clear research plan for subsequent years, based on consultation with the Department and stakeholders. The following 6 months (to end of 1016) will utilise all collated knowledge to develop products that summarise available knowledge on CMRs and spatial variation in shelf reef KEFs, and linking with project D1, develop refined models of these to further inform inventory and monitoring priorities. Subsequent years (2017 onwards) will focus on research to fill in critical mapping gaps identified above, and implementing CMR and KEF-based inventory and monitoring programs as guided by the DOE. This will be undertaken in close collaboration with the D1 project partners, to ensure programs are coordinated and coherent at a national level while leveraging the institutional strengths and priorities of the Hub’s research partners.

The project provides important information for improving marine ecosystem health monitoring (i.e. strategy F - Australian Government MBPs), moving toward monitoring KEFs in the Commonwealth Marine Area (i.e. as outlined in *Towards a Blueprint for Monitoring Key Ecological Features in the Commonwealth Marine Area* developed by the NERP Marine Hub for the Department of the Environment) and managing Commonwealth Marine Reserves (i.e. strategy B - Australian Government MBPs).

**Problem Statements**

*Problem*

Significant gaps remain in our knowledge of the distribution of key biodiversity assets of the marine estate on the continental shelf, their condition, and management actions required to ensure these assets are adequately protected. This is equally the case for CMRs and off-reserve locations managed under Marine Bioregional Plans.

One of the key gaps is the extent and nature of rocky reefs on Australia’s continental shelf, which consist of both rock and coral dominated reefs and those formed on relict coastlines (hereafter reefs). These are recognised in marine bioregional plans as a related set of Key Ecological Features (KEFs) that support a range of benthic and pelagic marine communities, including migratory species. Despite their nationally significant status, the extent and distribution of reef habitats remains poorly delineated across the continental shelf, and particularly within Australia’s marine reserve network. Further, many of these reef systems are actively targeted by commercial fishers using traps, droplines, lobster pots and demersal trawl. Hence these habitats are subject to a wide range of pressures that may require managing to maintain biodiversity values. Within the CMR network, some or all of these activities have been excluded, but in virtually all cases the extent of impact and their subsequent rate of recovery is unknown, there is little or no baseline inventory in shelf waters of most CMRs and virtually no monitoring programs are in place. Once the extent of reef systems are known to underpin biological inventory and monitoring programs, such programs can begin in earnest. This biological information will be critical for evaluating the need for, or consequences of management strategies. Hence, survey and monitoring programs are needed to both identify the biological values of such habitats, and the extent that these may be protected via various management tools, including CMRs, adjacent state marine reserves, Marine Bioregional Plans and traditional fisheries management. Such programs need to have a common approach to reporting of outputs that are consistent at a national scale for State of Environment (SoE) understanding and reporting. The importance of these reef systems to threatened and protected sharks also warrants further examination, as relict coastline reefs are thought to provide an important migration pathway. Improved mapping of such systems will allow this relationship to be better evaluated.

*How Research Addresses Problem*

In this project we will take a stepwise approach to filling these knowledge gaps and utilising this information to further develop and refine appropriate survey and monitoring protocols to inform effective management of the commonwealth’s marine estate.

This project will improve our understanding of the characteristics and distribution of these key habitats nationally and provide a spatial basis to understand the impacts of, and recovery from, fishing pressure. In year one, it will provide an updated national map of the distribution of reef features on the shelf, and a geomorphological classification of reef types to aid in structuring monitoring programs and explaining spatial patterns in biodiversity. This will be facilitated through collation of all existing mapping information and associated biological values from Hub partners (including data acquired during CERF and NERP Hub research), stakeholders, including government and industry, in addition to a priority survey in NSW to identify the key reef features associated with the Hunter CMR in NSW. Despite the focus on collating knowledge on reef distribution, by default, the project will also collate existing knowledge on non-reef hard substrate and non-reef soft substrates, thus providing the building blocks for expanded knowledge on all marine habitats in shelf waters. This combined task has high upfront costs as it, by necessity, involves a large time contribution across state and commonwealth agencies (including NESP partners). This time includes collation and processing both the physical data, and where possible, available biological data, to ensure the new map layer is as comprehensive as possible, and relationships between reef physical classification and associated biodiversity are clearly defined. This latter component will also significantly enhance our ability to make predictions about the distribution of biodiversity values in cross-shelf ref systems. Upon completion of this task in June 2106, the following 6 months (to end of 1016) will utilise all collated data (reef mapping, off reef habitat mapping and associated biological data) to develop products that summarise available knowledge on CMRs and spatial variation in shelf reef KEKs, and linking with D1, to develop refined models of these to further inform inventory and monitoring priorities for surveys proposed in 2017 and onwards.

Through these approaches to improved assessment and prioritisation of knowledge gaps, this project will focus on planning further targeted surveys in 2017 and onwards, in consultation with the Department and stakeholders. These gap filling surveys will be undertaken with methods developed and refined within the NERP Hub, and the NESP SOP project, and will be guided by the National Monitoring Blueprint. This new knowledge will allow refinement of KEF maps and understanding of CMR values through infilling critical regional gaps in our understanding. It will also allow refinement of approaches for monitoring the status and trends of key coastal and marine species and environments within reef systems, with programs and tools tailored to suit the reporting and management needs of all agencies involved in biodiversity conservation. This would inform both CMR management and decisions undertaken within Marine Bioregional Plans. By providing the detailed spatial information on habitats and ecosystems it will allow refinement of Key Ecological Feature models at bioregional scales, information necessary to evaluate the pressures on shelf reef systems associated with activities including resource use, marine pollution, biosecurity, and climate change.

In summary, year one is focussed on delivering a substantially refined map of the distribution, extent and structure of shelf reef KEFs throughout Australian waters, and a nationally standardised classification scheme for these reef systems. This mapping layer and associated extensive collation of current mapping data, associated biological attributes, and identification of major knowledge gaps will be the significant output from year 1. While reef KEFs are the major focus, the work will also collate existing non-reef hard substrate and non-reef soft substrate mapping data, this contributing to a new national shelf habitat mapping layer for Australia. A workshop will be held in 2015 for discussions on reef classification and collation of datasets, with a workshop report by Dec 2015 listing the identified datasets, describing methods for updating the shelf reef (and non-reef) map and a preliminary reef classification system. The workshop report with be the major output from 2015.

The first six months of year 2, (6 months to end of 1016) will utilise all collated data (reef mapping, off reef habitat mapping and associated biological data) to develop products that summarise available knowledge on CMRs and spatial variation in shelf reef KEFs (and non-reef habitats), and linking with D1, to develop refined models of these to further inform inventory and monitoring priorities for surveys proposed in 2017 and onwards. Research from 2017 onwards would be coordinated with project D1 to provide a national focus on filling priority gaps in this understanding through surveys of both physical habitat distribution and biological processes that build upon the methods and knowledge obtained during NERP Hub research, this project, planned work in D1 and the SOP project (D2). Work in this space will be guided by the Department, stakeholders, and the National Monitoring Blueprint, with discussions held throughout year 1 to clearly identify the objectives and outcomes of research undertaken during years 2-3. It is anticipated that CMRs will be a major focus of field surveys, particularly where these intersect KEFs. The knowledge gained will lead to refinement of KEF profile descriptions and models, and improved KEF mapping that informs CMR management and decision support for implementation of Marine Bioregional Plans, in addition to refinement of cross-shelf inventory and monitoring techniques and capability developed through the NERP Marine Biodiversity Hub. Where possible, the National Monitoring Blueprint will be implemented via new surveys, and existing data from previous surveys further analysed to provide baseline inventories and refine performance indicator metrics.

*Alignment with NESP Research Priorities*

This project aligns to at least five DOE research priorities that together seek to maximise the efficacy of managing Australia’s marine environment and call for an improved understanding of that environment. Specifically, the project will provide shelf reef information necessary to: (i) improve the management of marine biodiversity through an evaluation of the results of management interventions on shelf reefs; (ii) develop and apply methods for monitoring the status and trends of key marine species associated with reef habitats, (iii) build the knowledge base of key marine species and ecosystems associated with reefs in waters of the Australian continental shelf, particularly within CMRs, (iv) identify pressures on the marine environment, and understand their impact to better target policy and management actions , and (v) better understand issues that are common to the fishing industry and the environment including identifying solutions of mutual benefit.

**Research**

*Description of research*

The first phase of this multi-year project is designed to encompass a desk-top analysis of our current knowledge of continental shelf reef habitats that will deliver a nationally consistent assessment of the distribution and structure of shelf reefs, and identify the major gaps in that knowledge. This will be coupled with, and informed by a second phase that will include:

• trialling and testing of biophysical habitat modelling that aligns with the predictive modelling toolbox developed in the North and North West,

• targeted field surveys to fill major gaps in our understanding of shelf reefs and their associated biology with a particular focus on CMRs as primary survey locations,

• amending qualitative KEF models of shelf reef systems using local data if this proves necessary and data is available (with a CMR focus),

• informing evaluation of the status of ecosystem condition and of the efficacy of management actions, including CMR representation and current management arrangements.

The targeted surveys will refine our approaches to monitoring priorities based on the monitoring blueprint, with the endpoint being a functional framework from which the department may transition towards a routine monitoring program. This transition will be supported by the outcomes and products of the NESP Standard Operating Procedures project. Related Hub PhD projects will examine a range of indicator metrics derived from AUV still imagery and video to refine approaches to monitoring and reporting.

Research tasks and timeline as follows:

Year 1 (to 30 June 2016)

i. Initiate the project with a workshop of key stakeholders and NESP partners to identify datasets and appropriate methods for updating the shelf reef map, as well as identifying the most critical information gaps to be targeted by Hub partners directly or through opportunities such as transit voyages of “RV Investigator”. The workshop will also focus on reef classification systems based on both physical characters such as geology and geography, and patterns in biological assemblages. A workshop report will be produced by December 2015 as the first major output from this project, describing the range of datasets available and methods to be used to collate datasets, update the mapping layer, interpolate gaps, develop a reef KEF classification scheme, and integrate biological knowledge into this scheme.

ii. Collate existing spatial layers for shelf rocky reefs (and other non-reef habitats) from partner institutions, previously funded Departmental programs (CERF and NERP), and collaborating agencies such as Parks Victoria, Australian Hydrographic Office, and develop them into a nationally consistent GIS (shape file) format. An example of current data is GA’s existing national reef shapefile, which could be readily updated with multibeam data from the 50 m national grid. In addition to the production of a new rocky reef KEF map, and identification of priority gaps, all collated mapping data will be fully described by metadata records on the AODN portal, and where possible, original fine scale mapping outputs will also be added to national databases.

iii. Develop and complete the reef classification system based on geomorphology, biology, depth and latitude that can be applied at a national scale for the entire continental shelf. This classification scheme can be used for planning, as a monitoring framework, evaluation of representation of the CMR network, and as a basis for predicting and describing the associated biodiversity values.

iv. Trial and evaluate habitat modelling tools (against reef and macro-invertebrate maps compiled in the NERP and CERF hubs) being further developed in the North and North West under NESP, align and/or amend models as necessary to move towards a national applicable toolbox possibly with region-specific variations.

v Clearly identify, with stakeholders including the Department, the proposed outputs and outcomes of projects planned for years 2-3, establishing a clear research plan for these subsequent years.

Year 2 and 3 +

vi. Upon completion of the above phase of this task in June 2106, the following 6 months (to end of 1016) will utilise all collated data (reef mapping, off-reef habitat mapping and associated biological data) to develop products that summarise available knowledge on CMRs and spatial variation in shelf reef KEKs, and linking with D1, to develop refined models of these to further inform inventory and monitoring priorities for surveys proposed in 2017 and onwards.

Informed by the desk-top reef mapping and classification results, and subsequent model-based evaluation of gaps, we will design a cost-efficient and targeted survey series to acquire high resolution acoustic and biotic data for currently unmapped or poorly mapped regions of the shelf in priority areas chosen in consultation with DOE and AFMA. It is anticipated that these surveys will have a strong CMR focus, and reflect gaps at the bioregional scale that CMRs represent. This work will be undertaken concurrently with studies based on existing NERP and CERF physical and biological data that will refine image sampling protocols (both field collection approaches and post-collection analysis of imagery) for inventory, monitoring and interpretation of bioregion-specific patterns and processes. Thus building on the approaches to survey designs and methods developed during CERF/NERP, by further refinement based on lessons learnt during the limited field programs undertaken. Overall, the extent that research in years 2-3 is balanced between technique refinement and further surveys will be contingent on sufficient funding to cover field-based costs. We have included $200,000 in the 2017 budget to cover vessel support for two field campaigns of similar magnitude to the Flinders CMR survey undertaken within NERP.

For potential new surveys, the survey design will be developed with reference to:

• the extent to which the existing marine reserve network encapsulates the bioregional and cross shelf reef diversity, including CMRs

• the current and historical distribution of fishing activity and other pressures

• relevant habitat and connectivity model predictions developed under the CERF and NERP programs: and,

• the need for surveys to provide an adequate inventory for baseline understanding of biodiversity assets, while also providing a robust experimental design for future monitoring aimed at evaluating the effectiveness of CMR’s, Marine Bioregional Plans and related biodiversity management measures in Commonwealth and coastal waters.

A series of targeted field programmes will be designed to better delineate the boundaries of shelf reef habitat, improve our understanding of their physical and biological characteristics, and where possible improve our understanding of the way in which they recover from fishing pressure. The surveys would deploy high resolution Multibeam Sonar, sub-surface profilers, Baited Underwater Remote Video (with additional rear facing cameras), and the IMOS Automated Underwater Vehicles facility, to acquire acoustic and biological data. Survey designs will build on the knowledge gained during NERP Hub research to optimise the tools used for the task, the underlying statistical design for surveys, and post-survey analysis of acquired data. Where possible, such surveys will also target CMR locations where little or no current knowledge is available on the nature and extent of shelf habitats within them. Ultimately, the project will provide all the essential background knowledge necessary to transition from a survey design and evaluation phase to a planned monitoring program for shelf reef KEFs, and further our baseline understanding of shelf habitats within CMRs.

*Links with other projects and hubs*

This project links and is complementary to the project D1, “Developing a Toolbox of Predictive Models for the Monitoring and Management of KEFs and CMRs in the North and North-west regions” and delivering to similar Departmental Research Priorities. Specifically, the development of predictive models for shelf reef KEFs in the N/NW will be informed by the reef distribution and classification developed within this project, and the models used here to refine our understanding of the distribution and function of these habitats.

The project is also linked with the project D2, “Analysis methods and software to support Standard Operating Procedures (SOPs) for survey design, condition assessment and trend detection”. In stage two of the project, in years 2-3, we will undertake a series of small gap-filling surveys. These will be based on standard operating procedures developed within the NERP Hub for shelf reef inventory and monitoring studies, to be refined within the SOPs project. That project will in turn assist in developing field programs, and be further informed by the results of such programs, including the applicability of SOPs across a range of bioregions.

The project will link with and complement the project C2, “Continental-scale tracking of threats to shallow Australian reef ecosystems”. Ultimately both projects intend to inform SoE reporting and sound environmental management of reef ecosystems via approaches identified in the marine monitoring blueprint. The former does this on shallow reefs, while this project continues the development of this on deeper cross-shelf reefs. SOP protocols developed during the NESP Hub and refined in the SOPs project above, allow reef indicator metrics such as indices of trophic structure and target species biomass to be tracked by standardised methods. Gap-filling surveys undertaken as phase 2 of this project will add to the biogeographical coverage provided by such standardised methods on shelf reefs, establishing a baseline for future SoE reporting and adaptive management. Guided by the marine monitoring blueprint both projects aim to develop a common approach to delivery of outputs and advice such that we have a standardised way to deliver information on national studies and report on SoE objectives.

Work and data collated on reef KEF’s within this project will be utilised by B2, “Analysis and elicitation to support State of the Environment reporting for the full spectrum of data availability”, and in turn, the needs for SOE reporting identified in project B2 will inform the optimal data management and reporting of outputs from this project for SoE objectives.

As rocky cross-shelf reefs are KEF’s that significantly intersect a range of anthropogenic pressures and CMRs, the knowledge gained within this study will potentially inform B1, “Road testing decision support tools via case study applications” as the management of human pressures within shelf-areas of CMRs is likely to be a key area where decision support tools are needed.

Linked with the project B2 above, project C1 “Improving our understanding of pressures on the marine environment” By significantly improving our understanding of the spatial extent and nature of shelf reef KEFs around Australia, we will provide the knowledge necessary to understand the spatial distribution of pressures, how these may intersect with reef systems, and how management approaches designed to minimise these pressures (such as CMRs) are located spatially with respect to such pressures and conservation values.

In addition, datasets and map layers generated in this project will be discoverable through the web service tool being developed within the project B3. “Enhancing access to relevant marine information – scoping the development of a service for searching, aggregating and filtering collections of linked open marine data”. Likewise, refinement of the NERP data trawler tool within this project will be complimentary to B3 by further discovering “non-open access data” (i.e. legacy datasets) and refining the tool to the extent that it may be incorporated within AODN, and potentially linked with the B3 outputs as a tool for discovering all available datasets.

*Related research*

The project will leverage off three previous projects undertaken by the Marine Biodiversity Hub: (i) Physical Surrogates research undertaken under the CERF Program which acquired high resolution datasets (multibeam sonar, AUV) for reef habitats in the South-east (TAS), Temperate East (Lord Howe) and South-west (Ningaloo) marine regions; (ii) Approaches to Monitoring developed under NERP which also acquired reef information and also applied new sampling designs to inform monitoring, (iii) Models developed under the National Ecosystems Theme of NERP that can be used to test connectivity relationships for large scale reef and relict reef features, and; (iv) state-based seabed mapping projects in WA, Vic, Tas and NSW that have conducted considerable mapping of reefs on their respective continental shelfs. This project will extend this previous work by (1) integrating datasets and methods from those programs and applying them to targeted studies of reef condition and trends, (2) infilling critical gaps in our knowledge of the extent of reef systems within shelf waters, and their representation in CMRs,(3) utilising the learnings from NERP Hub research to ensure the series of field programs undertaken are adequate to describe the features of interest, and can act as robust biological baselines for future monitoring programs (4) completing all necessary steps required to transition from a methods development phase to a full monitoring program for reef systems.

**Expected Outcomes**

*Outcomes*

Many of the project outcomes can be measured against the NESP research priorities for the Marine Biodiversity Hub.

1. *Develop and trial decision making tools that will support managers to define and prioritise management actions in Commonwealth Marine Reserves*. This work will provide a robust understanding of shelf reef systems (a Key Ecological Feature), their representation in the CMR network, the biological assets associated with them, and the types of threats that these systems may be facing. This information will be critical to evaluating the management actions within the CMR network necessary to adequately protect the ecological values of this KEF.

2. *Identify past and current pressures on the marine environment, and understand their impact to better target policy and management actions. For example, identify the impact of cetacean ship strike*. This work will focus on evaluating CMR shelf reef associated biological assets, and by linking on-ground studies of these assets and potential threats with validation and testing of current models of KEF ecosystem function, will inform the likely extent of the impact of pressures on this marine environment and potential management responses if these pressures have adverse consequences.

3. *Determine the causes of, and relationships between, pressures on the marine and coastal environment to inform government investment.* As above, by contrasting information from CMR surveys and models with off-reserve surveys and models, we will be able to inform management of the various pressures on shelf reef systems in general, and highlight issues, or regions of particular concern. E.g. introduced species, climate change, ecological effects of fishing in marine and coastal waters.

4. *Determine and trial practical and repeatable methods for monitoring the status and trends of key coastal and marine species and environments to underpin management of Commonwealth Marine Reserves.* A core focus of this project will be to bring expertise developed in the CERF and NERP Marine Biodiversity Hubs, and by partner agencies, to this task with a focus on shelf reef systems. This expertise is well developed and advanced in its application to the task of informing CMR management, and the intention of the current project is to refine this expertise, apply it to as broad a range of CMRs as practicable, and to be able to use this more generally to monitor the status and trends in both on-reserve and off-reserve environments.

5. *Better understand issues that are common to the fishing industry and the environment including identifying solutions of mutual benefit.* The fishing industry, the marine environment and protection of biodiversity are intrinsically linked. This project better defines the shelf reef KEF that is a critical habitat for many of our fisheries. Threats that impact this habitat (e.g. introduced pests, ecosystem effects of fishing) are equally important to understand for both on-reserve and off-reserve management, hence, knowledge gained here will be critical for co-management of fishing and conservation issues in the marine environment.

6. *Improve our knowledge of key marine species and ecosystems to underpin their better management and protection.* Shelf reef systems have been identified as a Key Ecological Feature with national representation, hence the focus of this project on better understanding this feature. The work will provide the information to refine existing ecosystem models of this KEF, and specifically to inform this priority on the key species of this KEF and the ecosystems that support them.

All of the above outcomes are both practical and tangible and are readily benchmarked against the DOE research priorities above. They will inform a wide range of management and policy actions, including effective management of core CMR assets through development of an understanding of the nature and extent of these, their status, and the threats to them that may be addressed by management measures. In addition to informing on-reserve management, the outcomes are equally informative to managing off-reserve assets in Commonwealth and coastal waters, such as through Marine Bioregional Plans, and providing benefits to both conservation and fishery management.

The environmental value that the project brings is essentially the significantly enhanced understanding of the shelf reef features of Australia’s waters and their associated biodiversity necessary to effectively manage CMRs and other spatial closures that represent this habitat, to manage the Commonwealths off-reserve assets in this space, and inform national approaches to ecosystem-based management of this Key Ecological Feature.

*Specific management or policy outcomes*

This project will deliver essential information on the physical and biological assets contained within Commonwealth and adjacent State waters on the continental shelf; specifically the location, extent and nature of rocky reef habitats, as these are currently poorly known. This information, gained through collation and analysis of existing data and targeted gap filling studies, is critical to development of management planning for CMRs, implementation of regional marine plans, and ensuring fisheries are managed on an ecologically sustainable basis (via links with AFMA). It identifies the types of assets that need to be managed, and by furthering our understanding of the regional variability in biological assets within these reef system, allows refinement and development of appropriate monitoring programs for CMRs and regional areas, providing information essential to adaptive management.

*Value*

The project actually identifies the values of the marine environment across the shelf. Currently, many shelf areas within the Commonwealth marine estate have little to no mapping, including within existing and newly established CMRs. By identifying physical assets and their underlying biological values, we will be adding significant measurable value to all aspects of this estate, including conservation values managed through DOE and fisheries values managed through AFMA Moreover, through refining and developing inventory and monitoring approaches through new surveys and approaches to analysing acquired data, we will establish the mechanism through which these values can be benchmarked through time and tracked through SOE reporting using national standard approaches.

**Planned Outputs**

The first substantial output will be a workshop report (by Dec 2015) detailing the workshop outcomes, including identified data sources and stakeholders, methods for developing the mapping layer for cross-shelf reefs, the draft reef classification system and approaches for refining the final classification system.

The major output of the first phase of the project (June 2016) will be an updated and significantly improved map of the shelf reef KEF around Australia, with an associated classification system that allows reef types to be better classified and associated biodiversity attributes to be better characterised and predicted. This will also include an associated GIS-based collation of the underlying mapping data used to generate the KEF maps to be made readily available to all agencies involved in marine management. That data will include distribution of non-reef habitats within currently mapped areas, including non-reef hard substrate and non-reef soft substrate.

Subsequent outputs will include a series of detailed inventory and baseline reports on each targeted field program (guided by gaps identified in the desk-top study and input of priority areas from DOE).

Linking with the SOPs project, a recommended set of monitoring protocols tailored to regional needs, reef classifications and key species of interest.

A national database protocol for repository of all acquired data from surveys of Commonwealth assets (i.e. effectively utilising the AODN and associated data facilities).

A data trawler and web service capability to more effectively identify and utilise marine spatial data holdings of Hub partners, state and national institutions. This will build on the data trawler prototype developed within the NESP Hub with the intent to have a fully functioning spatial search tool available to the department and the wider research community. This differs from the NSEP Hub project D3 which intends to develop a search tool for open access data, in that we focus on discovering and making available legacy datasets held by major institutions and partners that are NOT open access. These two projects are complimentary, and are aimed at being adopted as tools to ultimately be incorporated into the AODN infrastructure.

An updated monitoring blueprint for reef KEFs, including updated qualitative models and indicator predictions if necessary, around Australia that builds on the learning within this project, and guides future inventory and monitoring of these features.

Additional communication and promotion will be undertaken within the overall Hub communication plan, and will involve regular presentations at forums such as the SE CMR stakeholder forum (with representatives from a wide range of key stakeholders present), national conferences, publication of results in the scientific literature and media opportunities as they arise.

**Delivery of Project**

*Project leader’s track-record*

This project brings the strength of a range of partner investigators, a number of whom have collaborated within the CERF and NERP Marine Biodiversity Hubs to develop and deliver major research projects. These are in addition to individual projects that researchers have delivered for funding agencies including ARC and FRDC. For example, Barrett and Nichol collaborated effectively within the CERF Hub to evaluate the effectiveness of multibeam sonar (MBS) as a surrogate for prediction of habitat and key species distribution in a project that met all delivery and budgetary requirements and formed the basis of widespread MBS use within NERP Hub research, and widespread adoption of this tool in shelf-based surveys of CMRs.

More recently, investigators Hayes, Nichol, Barrett, Jordan and Davies collaborated effectively within the NERP Hub to develop and refine survey tools and methodology for the effective evaluation of CMR physical and biological assets. In all cases the program research requirements were met and all data generated is either deposited in national data facilities or is in the process of doing so.

*Delivery on time and within budget*

The project will fully adhere to the Marine Hub Performance and Evaluation Protocols to ensure it is managed to deliver on time and within budget. The partners engaged in this project have successfully collaborated on similar research within the CERF and NERP Marine Biodiversity Hubs, and investigators including Barrett, Nichol, Hayes and Jordan all have significant experience and track record in managing large research projects involving multiple staff and multi-disciplinary teams.

**Project Milestones**

|  |  |
| --- | --- |
| **Milestones** | **Due date (either the 1st of Jan or June)** |
| Milestone 1 Completion of Y1 research plan | Due 1 June 2015 |
| Milestone 2. Completion of workshop on mapping and classification approaches | Due 30 October 2015 |
| Milestone 3. Completion of Workshop report | Due 30 Dec 2015 |
| Milestone 4 Completion of desk top study report and collation of all existing shelf reef mapping data, identification of gaps | Due 1 June 2016 |
| Milestone 5. Completion of report on national classification scheme for shelf reef systems | Due 1 June 2016 |
| Milestone 6. Completion of initial gap-filling survey and associated survey report | Due 1 June 2016 |
| Milestone 7. Data trawler developed to a national standard facility and incorporated within the national data infrastructure | 1 Dec 2016 |
| Milestone 8. Report on national database management protocols for acquired survey data, and links with data trawler | 1 Dec 2016 |
| Milestone 9. Report on collation of available biological and habitat inventory data for Commonwealth shelf waters and associated model development. | 20 Dec 2016 |
| Milestone 10. Completion of forward research plan with DOE for gap-filling research projects | 20 Dec 2016 |
| Milestone 11. Updated blueprint on monitoring reef KEFs | 1 June 2017 |
| Milestone 12. completion of initial survey reports | 30 Dec 2017 |
| Milestone 13. All project outputs and data will be made publically and freely accessible and available on the internet (see section on data and information management) | 30 Dec 2017 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE 2016** |
| Neville Barrett, University of Tasmania | Project co-ordination, ecological studies | 0.3 |
| Postdoc, UTAS | Collation of regional data and planning of biological studies | 0.5 |
| Technical officer for project support (UTAS) | Assist in collation/analysis of datasets, workshop and field studies | 1.0 |
| Vanessa Lucieer University of Tasmania | Spatial analyst co-ordinating | 0.5 |
| Keith Hayes, CSIRO | Project coordination | 0.1 |
| Tara Martin, CSIRO | Marine mapping/GIS collation | 0.1 |
| Alan Williams, CSIRO | Ecological input to reef Kef Classification | 0.05 |
| Rudy Kloser/Gordon Keith | Marine mapping/GIS collation | 0.1 |
| Dave Watts | Data aggregation for shelf reefs | 0.15 |
| John Keesing | GIS collation (NW) | 0.05 |
| Franziska Althaus | Ecological input to reef Kef Classification | 0.05 |
| Scott Nichol, Geoscience Australia | Mapping/Geomorphology | 0.2 |
| Zhi Huang, Geoscience Australia | Spatial Analyst | 0.25 |
| Johnathon Kool, Geoscience Australia | Mapping/connectivity/modelling | 0.15 |
| Floyd Howard, Geoscience Australia | Mapping/Geomorphology | 0.3 |
| Brendan Brooke, Geoscience Australia | Geomorphology | 0.1 |
| Tim O’Hara, Museum Victoria | Biodiversity | 0.05 |
| Peter Davies, NSW OEH | Mapping | 0.1 |
| Tim Ingelton, NSW OEH | Mapping | 0.1 |
| Alan Jordan, NSW DPI | Mapping/Ecological studies | 0.1 |
| David Harasti NSW DPI | Mapping/Ecological studies | 0.1 |
| Spatial analyst, NSW DPI | Mapping collation | 0.5 |
| Jessica Meeuwig, University of Western Australia | Mapping collation/ecological studies | 0.1 |
| Postdoc, UWA | Mapping collation and reef classification | 0.25 |
| Julian Caley, AIMS | Researcher | 0.1 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
|  |  |  |  |
|  |  |  |  |

**Other contributions** – only list contributors who are not already identified as Partners

|  |  |  |  |
| --- | --- | --- | --- |
| **Organisation/name** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| Dr Stefan Williams, IMOS AUV facility |  |  | IMOS capacity |
| Dr Stefan Howe, Parks Vic. Coastal mapping |  |  | Mapping data |

**Research End Users and Key Stakeholders –**

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| DOE- Parks Australia (CMRs) | Amanda Parr |
| DOE- Parks Australia-SE CMR management | Andrew Read |
| DOE- Regional Marine Planning | Nicole Coombe |
| DOE SoE reporting. | Boon Lim |
| **Key Stakeholders (organisation/programme)** |  |
| AFMA | Yvonne Zunic |
| NOPSEMA | Christine Lamont |
| State Fishery and Conservation agencies | e.g. Alan Jordan (NSW DPI- Fisheries), Dr Lynda Bellchambers, WA Fisheries. |
| Regional fishing and conservation groups |  |

**Knowledge Brokering and communication**

End users will be engaged in a range of formats during this project. As DOE will be a key end user we will engage directly with DOE at all stages of the project, including via an early planning workshop and during ongoing meetings with the department, both directly to key staff and indirectly via the Hub knowledge broker. The primary output of the first year of the project is the detailed mapping layer of shelf reef systems and reef classification scheme which is particularly invaluable for understanding the nature of CMR assets on the shelf, and values within marine bioregional plans. This output will be actively promoted to the department.

In addition it will also be promoted to other key stakeholders via meetings such as the SE CMR stakeholder forum and similar forums that offer the opportunity to interact with stakeholders such as AFMA, NOPSEMA, the Oil and Gas industry, state fishery and conservation agencies and commercial and recreational fishing groups. As gap-filling surveys are proposed to be undertaken in the second phase of the study, along with refinement of monitoring approaches and KEF models, DOE will be actively engaged in the process of identifying and selecting propriety locations for additional surveys. Remaining communication will be via the outputs listed earlier, and actively promoted to stakeholders by the Hubs knowledge broker in alignment with the Hub’s Knowledge Brokering and Communication Strategy as the major pathway to impact.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate datasets on the spatial extent of shelf reefs, develop a shelf reef classification system and produce reports that include maps (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions.

The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

The funding will be used in accordance with a project schedule to be agreed with the department. In the first year it is anticipated funding will be primarily utilised by the research partners to undertake an initial workshop and collate existing mapping data, to identify gaps in that knowledge and to generate a classification scheme for rocky shelf reefs. Depending on department priorities this may also be used to fund new small-scale surveys in known significant gaps. In subsequent years it funds further surveys, and postdoc, PhD and research positions in partner agencies to address the projects objectives.

**Location of Research**

This research will focus on shelf rocky reef systems around Australia. The initial focus includes all such systems in the data collation phase, with targeted future surveys intended to inform major knowledge gaps. The location of these surveys will be guided by the gaps identified and the priorities of the department, including gaining new knowledge on CMRs and for best informing regional marine plans.

**Indigenous Consultation and Engagement**

Shelf habitat mapping is revealing many features unseen to the eye but potentially known to the indigenous peoples through stories of coastal occupation handed down through stories. These include ancient river paths, and connecting features such as relict coastlines. The Hub’s knowledge broker will, as part of consultation for the wider Hub community, raise awareness of our findings in this area and stimulate engagement with interested members of the Indigenous community. There is also scope for engagement with some state-based Indigenous consultative groups and processes that are relevant to this project. This engagement will refer back to the Hub’s Indigenous Engagement and Participation Strategy. In general we will work with the department (DoE) to explore further Indigenous collaborative opportunities, and our regional partners will work with regional NRM groups to further identify communication and collaboration opportunities through Indigenous facilitators.

**Inclusions (in scope)**

The scope includes (1) a revised and significantly enhanced spatial layer for rocky reef KEFs, (2) new gap-filling surveys for reef KEFs, (3) refinement of survey methodology, post processing, analysis and reporting of survey data, (4) improved data access via links to a web services tool and an upgraded data trawler.

**Exclusions (out of scope)**

Exclusions are to be discussed with the department, as the intent is to further our knowledge of the key elements that structure shelf-based biodiversity in Australia’s coastal waters, and the most effective way to identify threats to these and to monitor biodiversity values within CMRs and the commonwealth marine estate in general. The project is readily adaptable to either excluding or including components at the direction of DOE.

**Risks**

The major constraints to the success of the project are the level of funding and the extent of engagement by DOE with all stages of this. The project is intended to meet high priority needs of the department with results readily adopted within management frameworks for commonwealth waters, including CMRs, bioregional plans, SoE reporting, and ecosystem-based management of marine resources.

The project team contains a mix of researchers with a proven record of project delivery and completion. Hence, while some elements may be less successful than others (e.g. a particular field survey), the demonstrated level of collaboration between partners is such that all intended outputs have a high level of success with low risk.

**Project Keywords**

biodiversity, rocky reef, monitoring, CMR, Key Ecological Feature (KEF).

# Project D4 – Expanding our spatial knowledge of marine biodiversity to support future best-practice reviews

*Project length* – 3.5 Years

*Project start date* – 01/07/2017

*Project end date* – 31/12/2018

*Project Leader* – Tim O’Hara (FTE – 70%),   
tohara@museum.vic.gov.au  
03 8341 7441

*Lead Research Organisation* – Museum Victoria, GPO Box 666, Melbourne, 3001

*Total NESP funding* - $640,000

*Total Recipient and Other Contributions (co-contributions)* - $1,496,944

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *2016* | *2016* | *2017* | *2018* | *2019* | *2020* |
| *NESP funding* | *$120,000* | *$170,000* | *$200,000* | *$150,000* |  |  |
| *Cash co-con\** |  |  |  |  |  |  |
| *In-kind co-con\*\** | *$202,803\*\*\** | *$418,106\*\*\** | *$432,183\*\*\** | *$443,852* |  |  |

\*The University of Melbourne is effectively contributing two PhD scholarships through the APA and MIRS/MIFRS schemes (total value approx $75,000 per annum).

\*\* Calculated according to Australian Research Council funding rules

\*\*\* Does not include contributed salaries of co-investigators of MNF voyages which would be in excess of $300,000

**Project Summary**

This project will fill data gaps and evaluate methods relevant to the ongoing spatial management of seafloor biota across the Australian marine domain. The objective is to prepare Australian, State and Territory governments for future best-practice reviews of Australia’s marine bioregionalisation that can be used to improve marine spatial planning and management initiatives (e.g. marine bioregional plan and marine protected area reviews, environmental impact and natural heritage assessments). The project will incorporate results from field trips to unexplored offshore areas of Australia’s marine domain and communicate biodiversity values of the CMR network to the Australian public.

**Problem Statements**

*Problem*

Australia’s existing bioregionalisation is based on limited information (demersal fish only) and imperfect analyses (one dimensional species range analyses) that were available at the time of compilation (shelf: 1995, slope: 2005). Subsequent studies have suggested different patterns. A future best-practice review of Australia’s bioregionalisation or zoning within the CMR network will have to incorporate substantial amounts of new data, comprehensive oceanographic models, and newer innovative analyses.

*How Research Addresses Problem*

The primary objective of this project is to identify and fill data gaps and evaluate the importance of new data layers, models and technologies to marine spatial planning at national scales. This will enable DOE to undertake bioregional reviews when they are required. A second objective is to increase our knowledge of biodiversity from unexplored parts of Australia’s marine domain through targeted MNF voyages, including the deeper areas of the CMR network, and to communicate this knowledge to the people of Australia.

*Alignment with NESP Research Priorities*

The project aligns with the following NESP Research Priorities: a) supporting national approaches to marine planning including research to support evidence-based decision making and b) building national capacity for monitoring and reporting on coastal and marine species and ecosystems.

**Research**

*Description of research*

Tasks include an assessment of the usefulness of phylodiversity and connectivity data to spatial marine planning, enhancing methodologies to utilise as much existing data as possible, surveying the major gaps in national marine knowledge (the major spatial gaps are: the deep-sea and the Cocos Keeling/Christmas Island Territories) by value-adding to research time on the NMF ‘Investigator’, testing the surrogacy of existing biological datasets to predict macro-faunas, and assessing the potential to downscale bioregional maps to scales useful for site environmental assessment and heritage protection.

*Links with other projects and hubs*

The research is linked to other NESP projects including D1 and D3.

*Related research*

This project will utilise the marine distributional and phylodiversity data accumulated for the NERP project ‘National maps of biodiversity and connectivity’.

**Expected Outcomes**

*Outcomes*

* Enhancing Australia’s capacity to spatially manage its extensive marine domain.
* Prepare DOE for a future best-practice reviews of the existing bioregionalisation products, including management zoning of the CMR network, review of KEFs by preparing biological data layers, enhancing methodologies, and evaluating the usefulness of new technologies and oceanographic datasets.
* Baseline biodiversity data for the deep-sea regions of the east coast CMR network, including community, species and genetic diversity data and summary spatial layers.
* Improved understanding of the environmental and evolutionary drivers that structure biodiversity in Australia’s marine domain.
* Improved public understanding of biodiversity values of the deep-sea and Australia’s offshore territories.

**Planned Outputs**

* Report evaluating the usefulness of phylodiversity (genetic diversity) to spatial marine planning (2015 funded project).
* Report outlining extensions of known statistical approaches to be able to utilise available mixed-resolution biological data (including museum and historical data) for the production of best-evidence bioregional maps (2016)
* Report evaluating the usefulness of connectivity (current) models to spatial marine planning (2017)
* Report including description and images of deep-sea biological communities of the east coast, including the CMR network, on a scheduled November 2016 expedition of the NMF ‘Investigator’ (2016-7). This survey will be presented to the public in the format of a “bioscan” which will result in significant media, education and outreach opportunities to promote the values of the CMR network.
* Report including description and images of banks, seamounts and pelagic aggregations within the Cocos Keeling/Christmas Island territories. This would require a successful application for ship-time on the NMF ‘Investigator’ (2nd half of 2017 – to be confirmed in March 2016)
* Report investigating the possibility of downscaling biogeographic maps to the typical scale of areas of conservation concern (1-100 km) by utilising emerging fine-scale multibeam and water movement data (2018).

The geographical scope of the project will include all of the Australian marine domain (including State waters and Antarctica) and surrounding waters, at all depths, within the area from 60E-160W, 0-70S.

**Delivery of Project**

*Project leader’s track-record*

Tim O’Hara has participated in the CERF marine biodiversity hub as a researcher, and in the NERP hub as a project leader and researcher. He has participated in numerous Government processes (e.g., SOE, bioregionalisation) and committees (e.g., marine introduced pests, bioregional planning, fishery management, research management) at various levels of government. He chairs an international scientific working group on biogeography. He has co-authored over 60 scientific articles in peer-reviewed journals and numerous reports to government.

*Delivery on time and within budget*

• The project will be delivered on time and within budget by breaking it down into smaller tasks that can be completed within one year. The data for most tasks have already been collected, meaning that the project can focus on analysing and evaluating management recommendations.

**Project Milestones**

A description of all key project milestones. Progress will be judged against delivery of the milestones. It is expected that project milestones should encompass project outputs as well as regular reporting of results in a clear, digestible format suitable for use by decision makers.

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| --- | --- |
| **Milestones** | **Due date** |
| Milestone 1: All research users and stakeholders engaged and understand project and opportunities for further engagement | 1 April 2016 |
| Milestone 2: Report summarising methodological approaches that could be used in future bioregionalisations | 1 Nov 2016 |
| Milestone 3: Report into the deep-sea biological communities of the east coast CMR network. | 1 Jul 2017 |
| Milestone 4: Report into the biological communities of the Cocos/Christmas EEZs [only if MNF voyage approved for 2017]. | 1 Jul 2018 |
| Milestone 5: Report evaluating the potential of using multi-beam seafloor habitat and current flow data to inform bioregional studies | 1 Jul 2018 |
| Milestone 6: Report comparing marine bioregional patterns derived from different animal groups | 1 Dec 2018 |
| Milestone 7: All project outputs and data will be made publically and freely accessible and available on the internet | 1 Dec 2018 |

**Researchers and Staff** (including early career researchers/PhDs – if names not yet known, list position/role)

|  |  |  |
| --- | --- | --- |
| **Name/Organisation** | **Project Role** | **FTE** |
| Tim O’Hara, Museum Victoria | Project leader, researcher | 0.70 |
| Robin Wilson, Museum Victoria | Researcher | 0.30 |
| Andrew Hugall, Museum Victoria | Post-doc | 0.50 |
| Lupita Bribiesca, University of Melbourne | PhD student | 0.50 |

**Partner contributions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Partner** | **NESP $$ requested** | Cash contribution | **Co-investment** |
| Museum Victoria | $640,000 | - | $1,496,944 |

**Research End Users and Key Stakeholders –** Identify at least one section or programme within DOE who will be an end user for this project, as well as any end users external to the department.

|  |  |
| --- | --- |
| **Research End Users (section/programme/organisation)** | **Name/s (optional)** |
| Parks Australia | Amanda Parr |
| Australian National Heritage Assessment Tool | Tania Laity |
| **Key Stakeholders (organisation/programme)** |  |
| Parks Australia |  |
| National Heritage Assessment Tool |  |

**Knowledge Brokering and communication**

We will work in collaboration with the DOE team preparing the Australian National Heritage Assessment Tool to map phylodiversity across Australia’s marine domain. We will work closely with Parks Australia in preparing media releases arising from bio-discovery fieldwork. We will work within the guidelines of the Marine Biodiversity Hub’s Communications Strategy to 1) promote the values of the CMR network and the overall marine domain to the Australian public, 2) ensure that milestone reports meet the standards and expectations of end users.

**Data and Information Management**

Hub researchers are required to make their research outputs publically and freely accessible and available on the internet, for use by all persons, as required by the NESP Programme Guidelines.

This project will collate species distribution datasets, generate new data on benthic invertebrate communities and produce reports (see milestones). Data and information will be managed in accordance with the data management framework for NESP Marine Biodiversity Hub. Species distribution datasets will be stored in a long-term secure storage, metadata will be created to meet the Marine Community Profile for metadata and published on the Australian Ocean Data Network Portal <http://portal.aodn.org.au/aodn/>. The Department will be informed by email to marinemetadata@environment.gov.au each time a dataset is published and provided with a link to the full dataset.

Publications, reports, factsheets, maps and images will be made publically and freely accessible and available on the Hubs website <http://www.nespmarine.edu.au>. Journal publications be made publicly and freely available within 12 months of publication. Access to journal publications will also be provided via the Hub’s website to the extent permitted by journal licensing conditions. The primary contact point for data and information management contact for this project is the project leader (see details in front page).

**Expenditure Summary**

The majority of the project expenditure will be used to fund a post-doc position at Museum Victoria that will focus on best practice bioregionalisation. Other expenditure will support communication activities associated with successful MNF voyage proposals.

**Location of Research**

The scope of the project is national (including eastern Antarctica) but much of the data has already been collected. Two planned surveys include a NMF Investigator expedition to the abyssal plain off Australia’s east coast (Brisbane to Hobart) scheduled for November 2016, and a potential application for ship time in late 2017 to explore seamounts, banks and pelagic aggregations within the Christmas Is/Cocos Keeling Territories.

**Indigenous Consultation and Engagement**

Indigenous communities will be consulted if any native title claims overlap with proposed fieldwork.

**Inclusions (in scope)**

Preparation of data layers, evaluations and methodologies to support best-practice bioregionalisation in Australia’s marine domain.

**Exclusions (out of scope)**

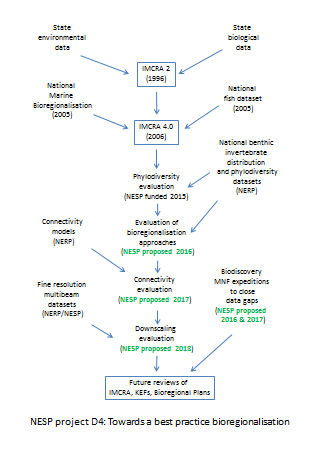
A formal replacement of the existing bioregionalisation (IMCRA5).

**Risks**

The proposed survey of the marine domain within the Christmas Is/Cocos Keeling Territories is dependent on a successful application for NMF-funded ship-time on the RV Investigator in the current application round.

**Project Keywords**

Spatial management, bioregionalisation, connectivity, phylodiversity, deep-sea

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| www.nespmarine.edu.au |
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1. Pannell, D.J. and Gibson, F.L. (2014) Testing metrics to prioritise environmental projects, Australian Agricultural and Resource Economics Society Conference (58th), February 5-7, 2014, Port Macquarie, Australia. [↑](#footnote-ref-1)