Marine Biodiversity Hub

National Environmental Science Programme

ATTACHMENT B

Project Proposals for 2020 RPv6 Marine Hub Research Plan

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For submission to the
Department of the Environment and Energy

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Project A10 – Conservation of handfish and their habitat

Project length: *5 Years/0 Months*
Project start date: 01/01/2018
Project end date: 31/12/2020

Project current status: Project extension submitted for approval

Project Leader: *Tim Lynch (FTE – 50%)*
Lead research organisation: *CSIRO*
Project leader contact details: *Dr Tim P. Lynch, Senior Research Scientist, CSIRO, GPO Box 1538, HOBART TAS 7001,*
(03) 6232 5239, Mob: 0416 089 749, tim.lynch@csiro.au

PROJECT FUNDING AND EXPENDITURE

Summary of project extension

The project extension provides for either: (a) costs for the transportation and release of the first batch of 'headstarted' juvenile red handfish successfully reared at Seahorse World during RPv5 extension, and field costs for following the juveniles post-release ($45,000 request for CSIRO with in-kind matching); and/or (b) the costs associated with a desktop study of morphometrics using the wealth of imagery collected on individual red (and spotted) handfish during previous field seasons ($45,000 request for IMAS, with in-kind matching specifically to cover 0.4FTE salary until Nov 2020 to perform the work). Either of these two components could be undertaken in isolation, or both could usefully be tied together. The Project funding table budget assumes both components of the extension occur.

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*TOTAL*
NESP funding CSIRO	*x*	$40,000	$40,000	$125,416	$170,830	$152,503	*X*	$ *$528,749*
NESP funding UTAS				$19,998	$19,998	$ 64,998		$ *$104,994*
Cash co-con	*x*	$30,000	$40,000			$45,000	*x*	*$115,000*
In-kind co-con	*x*	(CSIRO $40.000, Other $17,550)	(CSIRO $40,000 Other $110,957	(CSIRO $125,416, UTAS $35,346, Other $174,000)	(CSIRO $170,830, UTAS $25,363, Other $174,000)	(CSIRO $177,503, UTAS $90,363, Other $174,000)	*x*	*$1,355,328*
TOTAL	*x*	$127,550	$230,957	$480,176	$561,021	$704,367	*x*	*$2,104,071*

Expenditure statement- spotted handfish

The annual cost of the spotted handfish performance assessment surveys and counts of natural spawning habitat, reporting, design, permitting and outreach is approximately

$120,000 and is proposed to be funded by NESP ($60,000) and CSIRO ($60,000). This cost is similar across 2018-2020.

In 2018 and 2019 there were also costs for analysis of genetics from previously collected fin clips for spotted handfish. Labour is $14,572, while operations is $17 800, of which $12 800 went to AGRF for the SNP genotyping (one year only) as well as $5000 for bench fees (both years), extraction kits and plastic ware. We replaced the degraded array of 6000 artificial plastic spawning habitats with 3000 new ceramic spawning habitat and 3000 plastic units in 2018 for a cost of $46,851. The ceramics were found to be preferred by the handfish at almost twice the rate of plastic. We also discovered that ASH was not used if natural spawning habitats of stalked ascidians still persisted at a critical abundance. Both plastic and ceramic ASH degraded, though ceramics degraded more quickly. In 2019 we added counts of natural habitat during the monitoring program and then targeted sites which had levels of natural habitat below the critical threshold. We also redesigned the ASH to attempt to improve their robustness. We will continue this adaptive approach through 2020 to repair and deploy new arrays for the final year for a reduced cost of $34,800.

A PhD student Mr Lincoln Wong has commenced the Environmentally Sensitive moorings study and secured a scholarship. Mr Wong, in collaboration with the CSIRO engineer Mr Andrew Martini, has designed a new ES mooring system from off the shelf components. Preliminary modelling suggested that this design was superior in extreme conditions compared to traditional gear and four of these new ES moorings have been deployed and several rounds of monitoring conducted. Rick Stuart-Smith (0.10) FTE UTAS will be the primary supervisor of the PhD candidates (UTAS in-kind $15,379.70, direct cost to hub $19,998) while Jeff Ross (0.05) FTE UTAS will be a co-supervisor of PhD candidate Mr Lincoln Wong (UTAS in-kind: $9,983- Direct cost to Hub $0), Dr Lynch will also co-supervise the student. A Masters student (UTAS), Mr Alex Hormann, has now completed his field work and analysis on the assessment of use of plastic versus ceramic ASH and breeding behaviour and is drafting his thesis. An honours student, Mr Tyson Bessell has completed his work on spotted handfish age, growth and movements and received 1st class honours. Both students were supervised by Dr Neville Barrett (Total UTAS In-kind Masters: $9,983, Total Hub labour request: $0) and Dr Lynch.

Mr Bessel has since gone on to start a PhD on red handfish, this scholarship is funded by the UTAS Cash contributed to the Hub and is reported elsewhere. However, DoEE has made a $45,000 cash contribution to support Mr Bessell's work. Of this $25,000 was provided to CSIRO, who matched with an in-kind contribution ($25,000) to develop eDNA techniques for detecting unknown populations of fish using eDNA techniques. We undertook an audit of expenditure across 2016 figures which showed only minor adjustments were required for our 2018-20 budget request from NESP. In 2016 surveys of the 9 Derwent estuary sites required 62.5 FTE days of which 19 were by students and 43.5 FTE days of salaried staff. When two additional sites are added (abandoned sites for release) and support to the eco-mooring PhD and master's student projects, we estimate this is 60 salaried FTE days.

In kind contributions

In-kind commitments are predominately the on-going provision of service by SEA LIFE Melbourne Aquarium and Seahorse World for maintaining captive breeding populations of handfish. Our industry partners have committed to providing care of captive fish until at least 2020.

In-kind industry contribution

	2018	2019	2020
Seahorse World in-kind aquarium	$ 82,000	$ 82,000	$ 82,000
Sea LIFE aquarium in-kind aquarium	$ 82,000	$ 82,000	$ 82,000
Derwent Estuary Program	$10,000	$10,000	$10,000
Total	**$174,000**	**$174,000**	**$174,000**

The Derwent Estuary Program (DEP) is also providing in-kind assistance of 0.1 FTE for supporting the handfish recovery team and the eco-mooring work.

The Masters and PhD students were estimated to provide co-contributions of $10,000 and $25,000 per year in in-kind labour across their studies. Tas Govt (DPIPWE) can provide inkind support regarding processing of permit applications (estimated at 20 hours) and liaison with Commonwealth regarding EPBC permitting (estimated at 20 hours), data management (estimated at 20 hours) and Recovery team participation (estimated at 32 hrs based on 4x4hour meetings per year). This is estimated at 0.05 FTE or 10 FTE days which are estimated to be worth $10,000

In-kind labour FTE days

	2018	2019	2020
Planting of ASH (student)	10	10	10
Survey of ASH (year 1) student	5	5	5
PhD Eco-mooring student	200	200	200
Supervision Masters (N. Barrett) UTAS	10		
Supervision PhD (J. Ross) UTAS	10	10	10
Masters student	100	100	0
Eco-mooring liaison (I.Visby) DEP	20	20	20
PhD red handfish student	0	200	200
DPIPWE	10	10	10

Funds of $100,000 ($50,000 from NESP matched by CSIRO) are also required as part of an emerging priority for captive breeding of red handfish. These were all be spent in the 2019 calendar year and includes:

- run dive operations to discover and collect fish and egg masses ($2000)
- transfer previous knowledge as well as develop and carry out handfish captive husbandry techniques ($15,000)
- establish fish and egg masses into the aquarium facilitates at CSIRO ($5000)

- establish a live feed system at CSIRO (brine shrimps) and collect live feed from the wild for adults (amphipods) ($3500)
- provide daily monitoring, adjustments and record keeping of the aquarium facilities water quality parameters as per permitting requirements (including weekend and public holidays) ($7000)
- provide day to day husbandry of fish at CSIRO and subsequently at Seahorse World for 12 months including collection of live feed ($15,000)
- expand the aquarium infrastructure at our juvenile handfish grow-out partner, Seahorse World, so they can accept juvenile red handfish (5-8mm) at an earlier life stage than existing spotted handfish young of the year (25-30mm) ($12,000)
- package and transfer juveniles to the grow out facility ($3000)
- provide veterinary support in the case of fish sickness or for post mortem analysis ($1000)
- collect, preserve and provide metadata for any mortalities and then transfer material to collaborating geneticists ($500)
- undertake preliminary genetics work for captive stock and conservation assessments ($10,000)
- record and document basic reproductive biology, including video and still imagery ($7000)
- draft manuscript detailing captive husbandry and reproductive biology of handfish ($6,000)
- further develop the governance plan for the NHRT in regards to on-ground and *ex-situ* conservations including bio-security and other risk assessments ($6,000)
- seek funds to expand the work to include trials for release of animals and on-going monitoring ($2000)
- provide administration, permitting, record keeping and reporting ($5000)

Changes for RPv6 (2020)
Following specific requests by the Australian Government's Biodiversity Conservation Division, two additional options for expanding this project scope have been included below, representing: (a) costs for the transportation and release of the first batch of 'headstarted' juvenile red handfish successfully reared at Seahorse World during RPv5 extension, and field costs for following the juveniles post-release ($45,000 request for CSIRO with in-kind matching); and (b) the costs associated with a desktop study of morphometrics using the wealth of imagery collected on individual red (and spotted) handfish during previous field seasons ($45,000 request for IMAS, with in-kind matching specifically to cover 0.4FTE salary until Nov 2020 to perform the work). Either of these two components could be undertaken in isolation, or both could usefully be tied together.

PROJECT DESCRIPTION

Project Summary

Spotted and red handfish are critically endangered and in accordance with the signed recovery plan we will conserve them through various direct conservation actions guided by research. This includes replanting of the degraded plastic artificial spawning habitats (ASH) with a re-designed array of ceramic units, assessment of taut eco-friendly moorings in critical spotted handfish habitat, genetic and capture mark recapture studies for both species, a population viability analysis (PVA) and performance assessment of management actions. We will also continue our captive breeding project with industry and engagement with the broader

community through talks, outreach and publications and re-establishment of the handfish recovery team.

Addition for RPv6

This project can additionally contribute to one of two further key research needs for the red handfish:

- Evaluation of the suitability of release of captive hatched and reared juveniles to re-establish a depressed local population (a 'head-starting' study). Releasing and monitoring the first batch of 'head-started' juvenile red handfish and collecting a second female with an egg mass for hatching will help re-establish the struggling Primrose Sands population and pave the way for a future captive breeding program
- Using morphometrics to non-invasively determine red handfish gender. Identification of gender from morphological characteristics will be vital for captive breeding to ensure brood stock are a suitable mixture of males and females, and to allow investigation of sex ratios in the wild and potential movement, seasonal and habitat differences.

While the majority of threatened species research can be considered urgent, research needs for red handfish are now acute , with present opportunities to study the species in situ and obtain meaningful sample sizes limited, yet at the same time the species is facing imminent risk of extinction if basic research needs cannot support immediate conservation actions.

Project Description

1. What problem the projects seeks to address and how it will do this

Spotted handfish (*Brachionichthys hirsutus*, Lacepède, 1804) are critically endangered with a long history of conservation effort. Once widespread across Southern and Eastern Tasmania, spotted handfish were until the late 20th Century described as 'common'. However, in 1996, following declines first noticed in the late 1980s *B. hirsutus* had the dubious distinction of being the first marine fish to be listed as Critically Endangered on the International Union for the Conservation of Nature (IUCN) red list. They are also listed as Critically Endangered on the Environmental Protection and Biodiversity Conservation Act (EPBC). While extensive surveys across the historic distribution of spotted handfish have been undertaken only 10 small sites are now recognised to contain extant local populations. Local declines are continuing with no fish sighted in the 2017 surveys at one site (Ralphs Bay).

Red handfish (*Thymichthys politus*) are also a critically endangered marine fish, endemic to Tasmania. Previously widespread they are now only known to exist on two, small patches of rocky reef in Norfolk Bay. The estimated global population is fewer than 100 adults, making red handfish arguably the rarest marine fish in the world. At one of the two known locations, critical habitat of healthy sargassum seaweed has declined dramatically and the remaining plants are under intense grazing pressure from sea urchins. The future of this local population is at serious, immediate risk and half of the known global population may be extinct in the near future.

Unlike many marine species, handfish tend to directly recruit onto the benthos at the point of spawning. This excludes the potential for wide dispersal via plankton and when combined with a restricted range and sedentary benthic lifestyle this make handfish local populations both vulnerable to disturbance and makes re-establishment of locally extinct local populations unlikely. Over recent years there appears to be limited recruitment across most of the known meta-population of handfish, with few juvenile animals observed. Adult handfish are also poor dispersers, they do not possess swim bladders and preferring to walk rather than swim. In the past, with large robust populations, emigration and connectivity between handfish local

populations could have occurred over time through the small movement's adult animals make over multiple months and potentially larger seasonal movements to form breeding aggregations. However, as a poor disperser that are closely associated with particular habitats they are vulnerable to habitat degradation and fragmentation. Local populations appear to be operating independently and could now be disjunct populations that rarely if ever connect. Handfish hence may now require specific site remediation actions for their conservation and are at an increased risk of local sub-population extinction, similar to a documented collapse at Primrose Sands for spotted handfish in 2005 and the more recent decline at Ralphs Bay.

Threats

Current threats to the spotted handfish include habitat disturbance and ecosystem collapse from historic coastal scallop/bivalve and other demersal fisheries; siltation and nutrient enrichment from urbanisation; pollution; and swing moorings. One additional threat that has been consistently tackled by management is North Pacific seastars (*Asterias amurensis*) which were inadvertently introduced to Tasmanian waters via international shipping around 1986. While *A. amurensis* prefer to prey upon large bivalves they can exploit a broad range of food resources, including the stalked ascidians (*Sycozoa pedunculata* and *Sycozoa pulchra*). These ascidians are thought to provide critical breeding habitat for handfish, particularly in the Derwent estuary, following long-term declines in other spawning substrates such as seagrasses. Control efforts via trapping proved ineffective hence a recovery action has been the deployment of artificial spawning habitat (ASH). These are plastic, so are inedible to the starfish.

Demographic bottlenecks

Following mass plantings of ASH between 1998-2012 spotted handfish were repeatedly observed to use arrays for spawning. There is also now limited evidence that deploying ASH at sites is associated with near doubling of adult densities. Better performance assessment of this is required as statistically this may be co-incidental as non-ASH planting sites did not have adequate replication of surveys to be used as controls and sites were not randomised and were confounded by time. However, if this is an actual population scale effect - and if it was then the effect size was large - planting ASH may have off-set the ongoing threat of habitat modification and allowed handfish to persist at managed sites. The lack of suitable natural spawning habitat may thus be a demographic bottleneck. The functional life span of the light-weight plastic ASH arrays is also limited by sedimentary processes and bio-fouling.

Swing moorings

Swing moorings are a common method for securing yachts and larger non-trailer (>7.5m) motor vessels in Australian estuaries. Primarily used by the private and recreational sector, they work by the use of a long length of heavy chain anchored to the bottom, this is attached via a rope riser to the vessel which swings around the scope of the mooring on the surface. The chain provides most of the anchoring effect and also a catenary shock absorber to the effects of wind, wave and tide on the vessel. However, the chain has direct, ongoing and fixed mechanical impacts on the benthos. This destroys the micro-habitat complexity preferred by many fish including the spotted handfish.

Swath mapping has shown that in dense mooring fields a high percentage of habitat is scraped away, with chain swings interconnecting and destroying habitat. Preliminary observations also suggest there is a strong interactions between swing moorings and the introduced marine pest, the North Pacific sea star, with starfish feeding off wrack from the mooring lines and also being large and robust enough to be one of the few macro-invertebrates to be able to survive within the mooring scrap.

Red handfish

Very little is known about the biology and ecology (including population size and density) of red handfish, but the two populations are believed to have different threatening processes, and management intervention is an urgent consideration. Regardless of specific processes,

the highly localised nature of the populations makes the species vulnerable to stochastic events. The risk of global extinction of the red handfish is very real, and population decline could be extremely rapid.

One population is considered under threat of local extinction in the next three years (without intervention) as a result of habitat loss caused by a proliferation of sea urchins. The sea urchins have been released from predation pressure through the over-fishing of southern rock lobster, and a recent boom in the urchin population (in mid 2018) resulted in the area of suitable habitat for red handfish being rapidly reduced from 50 x 20 m to 15 x 20 m. Local population size appears to have plummeted during this period. The habitat at the other site has lower sea urchin densities and is composed of interspersed rock patches in sand. While this reduces the possibility of urchin over-grazing, this very shallow site is at threat from recreational boating propeller wash and anchoring. This second population at the present time is in better condition than the other, with a range of size classes present. It has a confirmed minimum population of at least 19 individuals, but 'recaptured' photographed individuals suggest the local population is probably twice this number.

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

Artificial Spawning Habitat

We will replace plastic ASH with new and more robust ceramic units. In the first year 3000 ceramic and 3000 of the proven plastic variety will replace the current degraded array across 6 sites. We will test if there is any difference in use between plastic and ceramic during the breeding season and replace all plastic with ceramics if they are used a) more or b) equally by handfish in the following year. Our preliminary results have since allowed us to a) stop using plastic ASH, as ceramics were preferred by the fish for spawning and b) better target the planting as we discovered ASH is only used when the stalked ascidians used as natural spawning habitat were in low densities. This knowledge will allow us to better understand which sites should be left as controls with no management actions. These actions commenced after the 2017 breeding season and will continue each year till 2020, so the BACI 'impact' treatments commence before the 2018 breeding season. This will allow for four years of temporal controls for all sites and, if the ASH have an effect as hypothesised, provide a response of an adult density increase at treatment sites, with a low number of natural habitats, by the 2020.

Ambassador fish and Captive breeding

In partnership with Sea life Melbourne Aquarium, Seahorse World and the Zoos and Aquarium Association, and with permitting from CSIRO the State and Federal government, we have established two captive populations of spotted handfish (n=10 x 2). CSIRO has constructed a holding facility in Hobart that was used to or transfer brood stock into captivity and will also hold fish for settling and quarantine purposes prior to release for re-stocking.

Assessment and preparation of re-stocking sites for re-introduction will occur through 2018-2020. We will continue to sample one site, Simpsons Point, which is a historic but now abandoned site, as well as commence sampling at Primrose Sands – another abandoned site. These sites and other low density sites, such as Ralphs Bay, may be considered for release of captive breed animals in the future.

The tentative time line for this work includes:

- 2018 - Raise the profile of the spotted handfish with the broader community through the captive fish program, media, talks, outreach, publications and interpretation materials
- 2018/20 - Prepare habitat for re-stocking by the planting of ASH
- 2018/20 - Have facilities on hand to receive and settle captive bred fish for release back into the wild for re-stocking

- 2019/20 - Restock areas and performance assess the results through the established survey

Red handfish captive breeding will follow in the footsteps of and be informed by knowledge gained through work on spotted handfish. Spotted handfish, as they may be more common, will also be used as a model for development of techniques.

We propose to collect up to two red handfish egg mass (with attendant, guarding adults, assumed to be the mother of the eggs – up to four fish) with the primary purposes of initiation and evaluation of ex-situ management of the species. This is considered as potentially an important tool in boosting the effective global population size of the species. This would be achieved through hatching eggs in the aquarium, and bolstering the population in the wild through:

(i) head-starting through rearing juveniles in the aquarium to the stage after which natural mortality is lower, e.g. the first year of life, and then releasing back into the wild, effectively increasing the recruitment success from the egg mass compared to a situation of expected high natural mortality of juveniles, and
(ii) captive breeding, which would involve maintaining *ex-situ* populations for breeding, using offspring to re-seed wild populations.

Replace Swing moorings with ES moorings

With our Derwent Estuary Program (DEP), Royal Hobart Yacht Club and Derwent Sailing Squadron partners we received $10,000 from NRM South in 2016 for ES moorings, five of which have been purchased and deployed. We have used one of these moorings to develop a method of assessment - a video transect procedure based on a randomised spatially balanced sampling plan - to asset recovery of the benthos. We also have one bungee in stock to deploy another mooring. We also received funding to deploy another 4 moorings in 2018.

We are providing PhD supervision, supporting labour and operational funds for a project assessing the ecological aspects of swing and ES moorings, engineering modelling and interactions with bio-fouling and north pacific sea stars and also handfish populations in regard to population viability analysis (PVA). Study sites would be in the Derwent estuary and North West Bay with UTAS as our partner.

Specific question may include:

- Identify the short term re-colonisation and long term succession of the benthic community after disturbance has ceased following deployment of taut moorings
- Detail governance processes for roll out of ES mooring
- Engineering studies of ES mooring performance
- Assess bio-fouling loads on taut vs swing moorings
- Model habitat impacts of mooring fields at regional scales for spotted handfish
- Undertake PVA of spotted handfish

Performance assessment

Methods are now well established and our proposal is to continue to survey 9 sites prior to the handfish breeding season (mid-August 2018), conducting 8-10 transects at each. We plan to also conduct 8-10 transects at 2 abandoned sites, one in the d'Entrecasteaux Channel (Simpson Point) and the other in Norfolk Bay (Primrose Sands) to establish baselines for potential release of captive bred fish.

As part of the 2016 work we developed a statistical model for the performance assessment survey program through to 2020. This spatially balanced design was provided as an

attachment to our August 2016 progress report and also considers assessment of ASH. The design includes aspects of both random and repeat measures as well as BACI. Half of all transect start location will be randomised within the study site's boundary and the other half will be repeat measures in accordance with the sampling plan. The transect length is determined by the search speed and time spent searching, and maximised dependant on the available air. SCUBA divers swim along the bottom either 2 abreast, each diver independently searching a 1.5 m swath for handfish, the optimal search width for spotted handfish. One diver in the party will tow a small surface buoy with a GPS logger (Holux GPSport 245) inside a water resistant case.

Transect start and finish positions, in addition to all fish recorded, will be photographed, allowing accurate positions and distances to be determined post hoc from the GPS track with proprietary software (Holux™ ez Tour for Loggers v2.4). For each transect we will determine the density of handfish per hectare based on the UVC count of fish observed, transect width and length, which we multiply to an area in metres, and then calculate the density for transect per hectare.

This method will allow for the replication of surveys across multiple years at all known sites with the one methodology, addressing recovery plan actions 4a, 4b, 4d and 4e by forming a scientifically robust survey program to track performance of management actions.

In 2019, following research discoveries in 2018, we added counts of stalked ascidians, which are used as natural spawning habitats by spotted handfish, to our monitoring program. This allowed us to better target our artificial spawning habitat (ASH) planting.

Capture-mark-recapture, Genetics and eDNA

Photo data from our geo-reference photographic method for cataloguing individual fish will allow for further development of a capture-mark-recapture model to determine local population size estimate. I3S pattern is being used, which automatically plots patterns from photos of fish for comparisons to a database. By the end of 2018 study we should have around ~500 individual observations of fish to work with from, with multiple images from each observation, often with both left and right sides of the fish photographed.

CSIRO has a collection of 241 fin clips of spotted handfish taken between 2006 and 2008 and three whole animal specimens. Fin clips samples were sourced from: Battery Point (9), Howrah (18), Sandy Bay (15), Mary-Anne Bay (15), Opossum Bay (20), Ralphs Bay (58) and Tranmere (106). DNA from spotted handfish for these clips has now be assessed to determine genetic diversity and connectivity of handfish from the sampled time period.

Other potential conservation outcomes include the contribution of genetic material for conservation actions such as the development of eDNA methods to detect any unknown populations. Genetic material, such as skin swabs, non-viable eggs or tissue from any mortalities will also be collected and used to develop genome protocols. This will provide information on the relative diversity of local populations as well as the genetic fitness of any captive breeding population. Other potential conservation outcomes include the contribution of genetic material for conservation actions such as the development of eDNA methods to detect any unknown populations.

Effectiveness of ASH and reproductive behaviour of handfish

A Masters project is proposed, in collaboration with the University of Tasmania that would focus on the effectiveness of the plastic vs ceramic ASH and the reproductive behaviour of spotted handfish.

This would include research questions such as:

- Effectiveness and choice of artificial spawning habitat (ceramics vs plastic) to increase population densities of the spotted handfish
- Relationship between natural habitat densities and use of ASH

- Egg survival and parental care, particularly in response to predators such as *A. amurensis* assessed via time-series videography for spotted handfish using time-shift video from Go-Pro recorders and CamDo blink controllers
- Capture-mark-recapture modelling of handfish populations based on I3S software
- Observations of breeding behaviour of captive populations

3. How the project links to other research and/or the work of other Hubs.

With Scott Foster we are implementing a balanced spatial design which has been widely used across other projects in theme D.

The genetic and eDNA research has the same approach as for various other projects in Theme A, such as work on hammerhead sharks. Development of genetic markers for spotted handfish is part of a separate NCRIS hub project led by Dr Sharon Appleyard, with material opportunistically sourced from previously collected specimens for the development of co-dominant polymorphic nuclear markers.

The research builds on the 2014 'proof of concept' work which increased statistical power and controlled costs, the 2015 larger pilot study and the 2016-17 sampling. The expanded pilot study was funded by the Threatened Species Commissioners Office to establish a baseline assessment across all known sites in the one year. The 2016-17 survey was funded by NESP, CSIRO the DoEE and the DEP. Prior to this, other research has included a recent honours project which established the consistency of spot patterns for individual identification of handfish. A small number of published taxonomic works and a wide variety of grey literature is also available on spotted handfish that extends back to 1996. Two papers from the 2015-17 work and unpublished historic data are currently in review.

The eco-mooring work looks to be scientifically novel both for soft sediment, larger scales and socio-economics with most previous work having been on impacts on seagrass. UNSW is currently undertaking work on assessing impacts via backscatter, microbes and cumulative impacts. We will liaise closely with our colleagues through our community of practise.

4. Summary of how it is expected that the research will be applied to inform decision-making and on-ground action.

The research and actions are all based on the signed recovery plan that is an agreement between Tasmanian state and Australian governments to provide a pathway to recovery of the species through tangible on-ground actions and their performance assessment.

<u>Artificial Spawning Habitat</u>

The replacement of the aging array provides a solution to the demographic bottleneck of lack of breeding habitat at the level of local populations. We will design and replace the highly degraded array of plastic ASH with a staged substitution with more robust ceramic types (Actions 1c, 1d). The new ASH arrays will improve habitat for spotted handfish spawning. Ceramic ASH provides prolonged benefits compared to the previous light weight plastic design, providing safe havens for breeding over 10 seasons rather than 1-5.

We will also incorporate counts of natural habitat into the monitoring program to guide planting of ASH at sites with depressed natural habitat. This will improve the efficiency of the management intervention with ASH only being planted where it will be immediately used.

<u>Ambassador fish and Captive breeding for red and spotted handfish</u>

Establishment of captive bred populations of handfish is a priority for both State and Federal governments (Actions 3b-c) to raise the profile of the species as 'ambassador fish' and as an

intervention to avoid extinction. Our industry partners for captive husbandry are the Zoos and Aquarium Association (ZAA) their affiliate Sea Life Melbourne Aquarium, and Seahorse World. Both industry partners have provided assurances of in-kind support across the project and are well located to display 'ambassador' handfish for public outreach and to undertake captive breeding programs. If successful in establishing a breeding program, animals will be available for re-stocking of populations that have gone locally extinct or for the enhancement of low density populations.

Community liaison

Besides work with the aquarium industry, liaison with other identified stakeholders will also occur across the entire project with an emphasis on habitat conservation (Action 6a). This will include discussion with relevant councils, scuba clubs, community groups, government, MAST, mooring owners, citizen scientist, schools and the indigenous community. The national handfish recovery team (NHRT) has been formalised by the DoEE and DPIPWE to oversee conservation for the species. The principle investigator is a member of the HRT and knowledge brokering and communication with end users at both state and federal levels will continue throughout the project through formal bi-annual meetings.

Replace swing moorings with ES-moorings

An Environmentally Sensitive (ES) mooring working group was formed with MAST, the DEP, CSIRO, UTAS and the mooring contractor. These discussions guided our thinking and probably the two most important lessons we have learnt so far is that you first need to get the governance and engineering right before you deploy the ES moorings. Governance included developing a contract to detail ownership, service schedules and liability with the mooring owners. We also have a process with MAST to approve the deployment location to avoid any unforeseen interactions with boats on nearby traditional chain swing moorings. The engineering was about modelling the specific boats and their locations to produce a design for the mooring that performs well even under extreme conditions. Replacement of traditional swing moorings with ES moorings, also known as 'eco-moorings', is a recovery plan action (2c) to minimise damage to critical habitat for spotted handfish. An ES mooring replaces the chain of a swing mooring with strops and bungee component. This has several effects: a) it removes mechanical destruction of the bottom, and b) it changes the types of mooring tackle used that can become bio-fouled.

Though it is assumed that these ES moorings have a beneficial impact on the environment, assessment of this looks to be scientifically novel both for soft sediment and across larger scales with most previous work having been on impacts on seagrass. The increased density of moorings allowed by wide-scale uptake of taut systems may also have unforeseen environmental effects.

While ES moorings may have many environmental benefits, liaison with DEP, MAST, NRM South, Yacht Clubs and the insurance industry has identified a raft of potential issues with broad scale uptake of taut moorings. Concerns around ES moorings include: the integrity of the mooring and associated risk to vessels, mooring field behaviour in extreme weather – especially in mixed fields of swing and ES moorings, comfort of ride for those aboard moored vessels, community support, perception and economics relating to service schedules and costs. The focus of the PhD project will hence be to look at performance of ES moorings across ecology, engineering, economics and policy.

Performance assessment

For scientifically robust performance assessment of management actions (ASH, restocking and ES-moorings) the tracking of local population trajectories of spotted handfish repeated at multiple replicate local populations are required (Actions 4a, 4b, 4d and 4e). In 2017 we established minimum replication ($n<3$) to track trends across multiple (9) sites without the confounding effects of time from previous work. We have also integrated historic data back to 1998 into our time-series and preliminary analysis suggest no statistical effect from our

change in method. This 'before' data provides an exceedingly rare opportunity to measure performance assessment of management actions for a threatened marine species. For performance assessment via a statistically robust Before, After, Control, Impact (BACI) approach, a time-series dataset across multiple sites and years is required with some sites maintained as controls, and other sites receiving 'on-ground' actions as treatments (impacts).

Capture mark-recapture and Genetics

An alternative hypothesis to the fragmentation scenario is that local populations of fish are large, well connected and are migrating between sites/subpopulations or to undiscovered sites. We will examine these questions with two methods, capture-mark-recapture and genetics.

Spotted handfish have spot patterns that allow for individual identification with a high (100%) level of confidence for adult (>70mm) fish. Reds also appear to have similar individual identification patterns but this is still to be tested. We have taken geo-referenced photos of all fished and an initial trial of a new automatic recognition software, I3S pattern, was successful in 2017, We will use photographic capture-mark-recapture on our data base to ask three questions: 1) how many recaptures are there within sites, 2) how many recaptures between sites, 3) based on capture-mark-recapture estimates, what is the minimum population size?

Molecular genomic techniques have also advanced to the state where they are highly useful for assessing both effective population sizes and tracking and tracing individual movements among populations. Undertaking these analyses would be possible from a collection of handfish fin clip samples taken from approximately 10 years ago, as this occurred after the populations declined. As part of a NCRIS funded National Research Collections Australia (NRCA) and Bioplatforms Australia (BPA) project we have already developed co-dominant polymorphic nuclear markers for spotted handfish to undertake single nucleotide polymorphisms (SNPs) analysis. These will be used to calculate how genetically diverse the total and local populations are and whether there is one well connected meta-population or a larger number of fragmented sub-populations where gene flow has been restricted. As we already have the SNP handfish library generated we don't need to test for the most appropriate restriction enzymes and just need to proceed to the 'batch' analyses of our DNA.

Cost effective methods for discovery of rare and cryptic fish will also be investigated by facilitating development of eDNA techniques to assess sites for presence of handfish, which is necessary as current methods are patently inadequate due to the cryptic nature of the animals. The benefits of this research are twofold. First to make it much easier to discover any unknown populations, which if other pockets of fish are still extant, will reduce the risk of extinction and second, to provide a tool to industry to provide greater certainty around the potential for environmental impacts on these cryptic species from various coastal developments. However, it should be made clear that the current research will only provide the genetic ground work for eDNA methods and the development of a field applicable eDNA test for handfish is outside of the scope of this project.

Red Handfish priorities added for RPv6

The urgent need for conservation action for red handfish is clear, but very little is known about the basic biology and reproduction of this species, slowing progress on effective recovery. Establishing a full captive breeding and release program will take many years and require extensive research on aspects such as distinguishing males and females, triggers for spawning, conditions for egg development and juvenile growth, food sources for hatchlings and juveniles, survival of released juveniles and persistence of released juveniles through to maturity in the wild (i.e. the ultimate success of released juveniles). This extension to project A10 will make a start on some of these research needs, providing the first evaluation of either sex discrimination or post-release survival of juveniles.

Post-release survival study

For both red and spotted handfish, captive breeding has been identified as a key component of the recovery plan for bolstering and connecting existing small fragmented populations. This is of particular concern for red handfish, with only two known sites – one of which collapsed in 2017 due to habitat loss. The habitat has been successfully rehabilitated at the collapsed site, and it is now a priority for 'head-starting' to avoid local extinction. 'Head-starting' is a restocking strategy that involves the captive rearing of juveniles to limit high natural mortality in early life-stages prior to release.

The first release of a clutch of captive-hatched red handfish (from project A10 in 2018) will be undertaken in 2020, and dive surveys used to evaluate whether juveniles can be relocated at 1 day, 3 days, and 7 days post-release. An additional female and egg mass will also be collected to continue to build the genetic diversity of the supplemented population and allow ongoing studies to evaluate success of release of 'head-started' juveniles.

Morphometric study

A fundamental requirement for captive breeding and any reproductive research on threatened species is being able to visually distinguish males and females. This is not yet possible for any handfish in the field. Sexual dimorphism is common in fishes and morphometrics studies have been widely used to distinguish sexes in birds, reptiles, mammals and crustaceans. Data already exists with ~500 individual spotted handfish and ~170 for red handfish observations in well-developed imagery databases. Images are currently available for handfish observed over the last decade, and many of these have images taken from numerous angles all around the fish and of fish from a wide variety of sizes. Field measurements are also easy to conduct with these sedentary fish and there are also extensive preserved collections located at TMAG and CSIRO. A small number of non-collection animals are also available for dissection. All of these avenues of investigation can be used to determine sexual dimorphism in the relative proportions and arrangement of handfish body parts.

A literature review will be undertaken first to explore the range of measurements and common sources of sexual dimorphism observed in fishes, with attention to measurements associated with closely related and better-studied anglerfishes. This review will guide the measurements to be taken from each individual handfish in this study (some examples shown in Fig. 1 and provided in Oliveira & Almada 1995 J Fish Biol; Falahatkar & Pousaeid 2014 An Hist Emb). There have also been anecdotal reports of larger nostril size in male red handfish, perhaps for use of scent to find females. The number and arrangement of the multiple sets of nostrils may also differ between sexes. Such information will also inform the measurements to be taken. Image analysis will be taken using Image J or similar software, using the field measured total length to standardise lengths in images. A number of statistical approaches have been used for evaluating the morphometric data in other taxa and the literature review will guide final statistical approach used. A first set of analyses will investigate univariate patterns in the data, such as looking for bimodal distributions in individual measurements (when standardised by total length). A second set of analyses will investigate the multivariate data and include approaches such as cluster analyses, ordination and PCA to determine axes of variation. Predicted gender will then be validated using preserved specimens.

Outcomes

- Reduced risk of extinction by bolstering collapsed population through head-starting. A second clutch of eggs hatched for continuing this while a larger program is being developed (option a).
- Ability to determine gender in the field, and therefore important guidance for establishing a larger-scale conservation breeding program for handfishes (option b).

- Estimation of sex ratios at both red handfish sites, allowing better prioritisation of management efforts and subsequent studies on demographics, niche separation and reproductive ecology (option b).
- 'Proof of concept' for a larger funding bid to address the other research needs identified (either option).

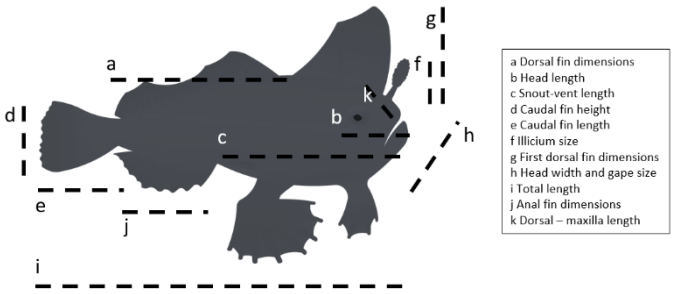


Figure 1. Example measurements for sexual dimorphism analysis

SUMMARY OF CHANGES SINCE PREVIOUS RESEARCH PLAN

- Incorporation of red handfish into the captive breeding program
- A PhD project on red handfish conservation

Additions for RPv6 (2020)

- Two options for progressing priority red handfish research needs, by either undertaking a field-based juvenile release study or a desk-top morphometrics study. Both elements are highly complementary, form important next steps in the priorities identified by the Australian Government and the National Handfish Recovery Team, and would extend a productive partnership between CSIRO and UTAS teams working on handfish conservation research.

NESP 2017 Research Priority Alignment

Maximising the efficacy of managing Australia's marine environment

Both our ASH and eco-moorings work are methods that will be trialled to restore degraded habitats including mixed bivalve beds (scallop and oyster), seagrass and other sub-tidal habitats.

Identify key social and economic values of the marine environment to build better stakeholder support and engagement in the management of marine and coastal environments

Our ambassador fish program has attracted considerable support from industry. The use of fish as assets for aquarium businesses demonstrates their value and will build stakeholder support and engagement in the management of marine and coastal environments.

Consider the social and economic value of the environmental asset/s and research outcomes, as appropriate

The more general environmental issue of swing moorings is the concentrated and persistent destruction of ecological communities found within highly specific depth (6-20m) and shelter conditions (low wave intensity) across many estuarine and coastal environments across Australia and the world.

Improving our understanding of the marine environment including biophysical, economic and social aspects

We will improve our knowledge of key marine species (handfish) to underpin their better management and protection through our capture mark recapture and genetics research. A better understanding of handfish distributions and conservation is also important for marine planning as all infrastructure proposals must consider this EBPC listed species.

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

The current density estimate database for spotted handfish at multiple sites provides a rare opportunity for performance assessment to evaluate management interventions for a rare and threatened marine species.

PATHWAY TO IMPACT

Outcomes
The project will move to further secure the spotted handfish from extinction, stabilise existing populations and allow for the option of recovery. We will do this through tangible on-ground actions. These include the planting of >6000 artificial spawning habitats at multiple sites, which are known to benefit handfish populations. We will also work to assesses and deploy additional eco-moorings. These not only conserve handfish habitat but also have a wider beneficial role for the ecosystem. We will continue our ambassador fish program with our industry partners and look forwards to captive breeding and re-stocking of sites where fish have become locally extinct. More information on fragmentation and decline of the species will also be provided by genetic analysis of a large collection of historically acquired fin clips and other genetic material to develop eDNA detection methods for discovery of unknown populations. We will also continue our surveys of local populations, which will allow for robust performance BACI assessment of the above management actions. We will also continue our outreach program with, scuba clubs, community groups, government, MAST, mooring owners, citizen scientist, schools and the indigenous community. New for RPv6 The success of most identifiable pathways to save the red handfish from extinction is inextricably tied with a need for basic biological information, including being able to identify males from females (and determine sex ratios in the remaining adult population). Likewise, scaling up of an *ex-situ* breeding program – which appears essential to the recovery of the species – requires assessment of proposed strategies. This extension to A10 has come about through discussions with, and an explicit request from, the Australian Government staff charged with the conservation recovery plan for three species of handfish. It has a clear pathway to impact already determined through the National Handfish Recovery Team, which includes scientific experts, state and Australian Government representatives and industry. Engagement and communication for this project will be planned and implemented consistent with the Hub's Knowledge Brokering and Communication Strategy.

Research-user	Engagement and communication	Impact on management action	Outputs
Handfish recovery team (see list below) Chair – Mr Andrew Crane (Director DPIPWE threatened species) DoEE representative Ms Lesley Gidding-Reeve (Director DoEE threatened species)	The work is based on the published Handfish Recovery Plan. This was developed in consultation between state and federal governments as well as a broad section of stakeholders represented now on the NHRT. The NHRT meets regularly (3-4 times per year) and also has out of session correspondence. All meetings and minuted.	The research and onground actions will implement the action following actions from The Recovery Plan for Three Species of Handfish: Deployment of ASH: Actions 1c,d Replace swing moorings 2c Establish ambassador fish 3b,c Performance assessment and genetics 4a, b, d, e Community liaison 6a	Master's thesis and submitted paper on ASH deployment and use. Captive populations of two species of handfish and reports detailing husbandry methods. Honours thesis (Wong) and published paper Honours thesis (Bessell) and submitted paper NESP Annual report and progress reports on husbandry and other aspects of the project Risk assessment for captive breeding developed in collaboration DPIPWE and DoEE Governance plan and ToR for NHRT PhD thesis on conservation of red handfish
MAST – Mr Ian Ross (Moorings manager) DEP – Ursula Taylor (Director) Derwent Sailing - Shaun Tiedemann Royal Hobart yacht club - Nick Hutton	Meetings and presentations Development of research questions Formalisation of working group	Engineering assessment of swing vs. eco-moorings will inform the debate on the relative safety of various systems and their potential uptake Evidence from BACI studies of the ecological effects of moorings will provide decision makers with evidence of the impacts of these leased activities on crown lands Perception studies with mooring owners will identify concerns relating to	Presentation to MAST and other on engineering performance of swing vs eco-moorings PhD thesis on the impact of swing and eco-moorings on benthic environments, engineering and socio-economic and perception concerns for uptake

Research-user	Engagement and communication	Impact on management action	Outputs
NRM South - Nepelle Crane Insurance companies – Club Marine		changing technology and how they can be addressed.	

Additional outputs

- We will submit at least one publication to a high quality journals based on our research and also present at a professional conference.
- A final report will be delivered to the NESP Hub and collaborators
- Public seminars will be held with stakeholder groups
- Two PhD, one honours and Master's thesis will be completed
- Regular postings to social media platforms
- Public interpretation for Seahorse World and SEA LIFE Aquarium

Added for RPv6

- Reporting to the DoEE and National Handfish Recovery Team on the results of surveys for the released juveniles (option A).
- Analysis and report on the morphological variation in red and spotted handfish, including confirmation of characters that can be used to distinguish gender, if possible (option B).

Public communication material about handfish morphology (option b).

INDIGENOUS CONSULTATION AND ENGAGEMENT

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement. This means the knowledge generated in this project will be effectively shared and communicated between relevant Indigenous peoples, communities and organisations.

As part of the handfish project, NRM South has provided an avenue for consultation through their Indigenous community engagement officer. During engagement we develop with NRM South and their community contacts a culturally sensitive fact sheet to explain the work and facilitate engagement with Indigenous and other communities. The spotted handfish does not appear to be of specific individual interest to local indigenous group. Rather, a broader perspective of the importance of considering the integration of the entire marine system was emphasised in our discussions. We will continue to seek opportunities to meet with NRM South and their indigenous representative throughout the project to inform them of progress. We have also worked extensively with schools across this project providing tours and talks to: Corpus Christie, Mt Nelson, Howrah, Fahan primary schools and also have planned talks with Friends senior schools. Additional schools that have a strong indigenous membership may be also targeted.

Indigenous engagement and participation contact:

Name: Tim Lynch

Email: tim.lynch@csiro.au

Phone: 0416 089 749

PROJECT MILESTONES

2016

Milestones	Due date	Milestone status
Milestone 1 - All research users and stakeholders have been engaged and understand the project and opportunities for further engagement	1 March16	Complete
Milestone 2 - Permitting submitted	1 March 16	Complete
Milestone Outreach activity Handfish card memory game developed and trailed with the public	20 April 16	Complete
Milestone 3 - Liaison commenced with MAST/mooring stakeholder	1 May16	Complete
Milestone 4 - Presentation at NZMSS/AMSA of preliminary results	6July-16	Complete
Milestone 5 - Submission of detailed project plan (2017-2021)	August 2016	Complete
Milestone 6 - Completion of dive surveys	30-Aug-16	Complete
Milestone – 7 final report	30-Dec-16	Complete

2017

Milestones	Due date	Milestone status
Milestone 1 - Deployment of all eco-moorings NESP/DEP	30 January 2017	Complete
Milestone 2 – All research users and stakeholders have been engaged and understand the project and opportunities for further engagement	1 March 2017	Complete
Milestone 3 – Permitting submitted	1 March 2017	Complete
Milestone 4 – Signing of MoU for captive breeding - ZAA	20 April 2017	Superseded
Milestone 5 – assessment of minimum population size ZAA	15 May 2017	Complete
Milestone 6 – Capture of brood stock ZAA	1 June 2017	Complete
Milestone 7 - Development of a culturally sensitive fact sheet with NRM south and indigenous contacts NESP	30 June 2017	Complete
Milestone 8 - Submission of detailed project plan (2018-2020) NESP	1 October 2017	Complete
Milestone 8 – Completion of dive surveys NESP for 6 sites and ZAA for 5 sites	30 August 2017	Complete
Milestone 10 – Final report	30 December 2017	Complete
Milestone 11. All project outputs including sharing of the consolidated database to be made accessible to the public	30 January 2018	On track

2018 - 2020

Milestones	Due date	Milestone Status
Milestone 1 – All research users and stakeholders have been engaged and understand the project and opportunities for further engagement	1 March 2018	Complete
Milestone 2 – Completion of performance assessment surveys	30 August 2018	Complete
Milestone 3 – Check of ASH	30 November 2018	Complete

Milestones	Due date	Milestone Status
Milestone 4 – Annual report	30 December 2018	Complete
Milestone 5 – Collect red handfish eggmass/es	1 January 2019	Complete
Milestone 6 – New red handfish aquarium set up built	2 February 2019	Complete
Milestone 7 – Transfer all juveniles red handfish to Seahorse World	15 February 2019	Complete
Milestone 8 – Completion of performance assessment surveys	30 August 2019	Complete
Milestone 9 – Check of ASH	30 November 2019	
Milestone 10 – Annual report (includes red handfish)	30 December 2019	
Milestone 11 – Completion of performance assessment surveys	30 August 2020	
**New for RPv6: Milestone X – Report to the NHRT on success of the first batch of juvenile red handfish released into the wild	30 October 2020	
Milestone 12 – Check of ASH	30 November 2020	
**New for RPv6: Milestone X – results of morphometric study available, with guidance on determining gender. Details to be added into the final report in Milestone 13.	30 November 2020	
Milestone 13 – Final report	30 December 2020	
Milestone 14 - All project outputs including sharing of the consolidated database to be made accessible to the public	30 January 2021	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles.

This project will continue the development of time-series density estimates across 9 sites for spotted handfish and at two abandoned sites. It will produce reports that include response of local populations to management actions such as deployment of ASH and also, if possible, restocking by captive bred juveniles

Project output	Data Management and Accessibility
A consolidated database of all available data on spotted handfish imagery, length frequency and GPS plots	We have consolidated all data and since 2015 and incorporated metadata and geo-referenced photographs into a Handfish Access database. Data management includes a manual and workflow for processing and entering data. The consolidated spotted handfish dataset and Access database is stored in long-term secure and backed-up storage at CSIRO: Public (\\fstas1-hba.nexus.csiro.au\CMAR-SHARE)(P:) Metadata has been created that meets the Marine Community Profile for metadata and has been and will continue to be published on the Australian Ocean Data Network Portal (http://portal.aodn.org.au/aodn/).

Project output	Data Management and Accessibility
Reports, publications and fact sheets	Publications, reports, factsheets, maps and images will be made publicly 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.

LOCATION OF RESEARCH

There are twelve sites: 9 in the Derwent, one in the D'Entrecasteaux Channel and two in Norfolk Bay. Sites names and GPS locations are provided in Table 6 with the exception of the 2nd Norfolk Bay site which is currently undisclosed.

Table 6. Location of research for spotted handfish

Site	Code	Estuary	Lat	Long
Battery Point	BP	Derwent	-42.88944	147.33937
Half Moon Bay	HMB	Derwent	-43.01396	147.40306
Opossum Bay	OB	Derwent	-42.98298	147.39555
Ralph Bay	RB	Derwent	-42.93350	147.42542
Mary-Ann Bay	MAB	Derwent	-42.97004	147.40157
Sandy Bay	SB	Derwent	-42.90749	147.34911
Howrah Beach	HB	Derwent	-42.88295	147.39508
Tranmere	TR	Derwent	-42.92501	147.41055
Bellerive	BR	Derwent	-42.88010	147.37820
Simpson Point	SP	D'Entrecasteaux	-43.24900	147.28700
Primrose Sands	PS	Norfolk Bay	-42.89987	147.68336

RISK ASSESSMENT AND MANAGEMENT

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
1. Sampling needs to occur outside of the species Austral spring (September) breeding season. As fish move from a solitary to an aggregated distribution this will confound the inter-annual density estimate statistics. Delays in signing	Not enough sampling is achieved within the year to have sufficient power to detect change in response to management actions.	Medium	We try to dive at least once every week so as not to fall behind schedule. We seek approval from the CSIRO BD to begin sampling prior to contracts being signed.	Tim Lynch Andy Stevens Nic Bax

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
contracts and hence starting the project, constrict the available time for surveying before the breeding season.				
2. There are health and safety risks associated with the use small boats and diving.	Minor, moderate and catastrophic injuries and death	Low	This risk is mitigated by having adequate time and flexibility to choose good weather windows to operate. Continuous low intensity operations to maintain skills and readiness and reduce fatigue and a well-established, balanced (age/sex) and seasoned team. While as many as 8 transects can be completed in one day of intense survey work, we found this rarely could be achieved. Due to weather, logistics, staffing availability and diver health we found that lower intensity sampling utilising small components of labour spread across a larger dive team was required to safely complete the work. This involved half FTE days (morning or afternoon diving) or, if conditions were ideal, full FTE days	Tim Lynch Claire Davies (Dive officer) Other CSIRO coxswains
3. Death of spotted handfish at all stages of the captive breeding process. Death rates of between 5-50% have been expressed for	This is primarily a reputational risk. For the project if the brood stock die we will not have the possibility to breed fish and re-stock sites	Medium	We have mitigated this by transfer of information to all parties (reports, unpublished lab notes) from the previous captive breeding program. Assessment of all facilities, development of husbandry/capture/transfer protocols, building of a	Tim Lynch Tim Fountain

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
different species during freight.			holding facility for pre-transport conditioning and being clear to all permitting and stakeholder parties that the risk of death of some fish is high – and death of fish will eventually occur in captivity inevitable with age. We are also permitted to take 40 fish but will aim to keep this to 20 fish	
4. Death of red handfish at all stages of the captive breeding process. Death rates of between 5-50% have been expressed for different species during freight.	This is primarily a reputational risk. For the project if the brood stock die we will not have the possibility to breed fish and re-stock sites	Medium	We have mitigated this through extensive methods development as part of the spotted handfish research. This closely related handfish (*Brachionichthys hirsutus*) has been the successful subject of ex-situ animal husbandry for conservation, with eggs, juveniles and adults surviving over the long term in captivity.	Tim Lynch Tim Fountain Stefanie Faber Rachelle Hawkins
5. Stakeholders perceive the project provides resources for captive breeding of red handfish beyond 2019	This is primarily a reputational risk		Project will clearly communicate with the handfish recovery team and other stakeholders the project is for a defined period and have a clearly defined course of action if ongoing funds are not secured.	Rick Stuart-Smith Tim Lynch NHRT
6. Released red handfish juveniles die or are not successfully re-located	This is primarily a reputational risk, and/or of appearing to not obtain sufficient results		Extensive effort will go into planning and executing the transport of juveniles from Seahorse World, acclimating them to current ambient conditions at the release site, and selection of the most suitable release site	Rick Stuart-Smith Tim Lynch

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
7. No variation is found in morphology and gender cannot be determined through morphometrics	This is still a finding in its own right, but simply means that further work is needed before being ready to build a successful captive breeding program, and hence the risk of population decline if conservation actions are delayed.		Ensuring the desktop study involves a sufficient literature review and the most knowledgeably field naturalists are engaged will help ensure the most useful measurements are considered. Being based on imagery, the opportunity will not be lost, and further measurements can be made at a later date if any particularly important characters are not considered.	Rick Stuart-Smith Jemina Stuart-Smith

PROJECT KEYWORDS

Spotted handfish, critically endangered, fish, eco-moorings, habitat restoration

PROJECT CONTACTS

RESEARCHERS AND STAFF

Name	Organisation	Project Role	FTE
Tim Lynch (0.5 FTE)	CSIRO	Principal investigator	0.5
Sharon Appleyard (0.10 FTE)	CSIRO	Genetics	0.10
Jeff Ross (0.05FTE)	UTAS	Co-supervisor PhD Lincoln Wong, eco-moorings	0.05
Rick Stuart Smith (0.1)	UTAS	Supervisor PhD, Lincoln Wong, eco-moorings, Tyson Bessell red handfish	0.2
Neville Barrett (0.05)	UTAS	Supervisor Masters Alex Hormann, ASH assessment	0.05
Jemina Stuart-Smith	UTAS	Morphometrics study, co-supervision of Tyson Bessell PhD	0.4 (for 11 months)

Name	Organisation	Project Role	FTE
Early career researchers Mr Lincoln Wong (PhD), Mr Alex Hormann (Masters) Mr Tyson Bessell (Hons – 2018) Mr Tyson Bessell (PhD 2019)	UTAS/CSIRO	Post graduate students	3
Carlie Devine (0.1 FTE)	CSIRO	Diver and database officer	0.1
Claire Davies (0.1 FTE)	CSIRO	Dive Officer/Coxswain	0.1
Curt Chalk (0.1 FTE)	CSIRO	Diver/Coxswain	0.1
Tim Fountain (0.05 FTE)	CSIRO	Aquariums officer	0.05
Kim Lee Chang (0.1 FTE)	CSIRO	Live feed and purchasing	0.1

DATA MANAGEMENT

Name	**Organisation**	**Email**	**Phone**
Carlie Devine	CSIRO	carlie.devine@csiro.au	03 6232 5478

CO-CONTRIBUTORS

Name	Organisation/	Contribution
Inger Visby	Derwent Estuary Program	In-kind labour (10K), assist with consolation with swing mooring owners and eco-moorings, secretariat to HRT
Jennifer Hemer	NRM South	Indigenous and community liaison
Rachelle Hawkins	Seahorse Pty Ltd	In-kind (82k), captive husbandry
Paul Hale	Merlin Pty Ltd	In-kind (82k), captive husbandry

KEY PARTNERS AND RESEARCH END USERS

The project will report its findings on a semi-annual basis to the Handfish Recovery Team. This is a governance body that is constituted between the Tasmanian State and the Commonwealth government with other interested parties to make decisions about the fate of the fish. However, the Tasmania government retains ownership of the all fish.

Key Partners (organisation/programme)	Name/s	Email (optional)
Derwent Estuary Program	Ursula Taylor	ursula.taylor@environment.tas.gov.au
Zoo and Aquarium Association (ZAA)	Craig Thorburn	Craig.Thorburn@kellytarltons.co.nz
Natural Resource Management (NRM) South	Jennifer Hemer	jhemer@nrmsouth.org.au

Key Partners (organisation/programme)	Name/s	Email (optional)
MAST	Ian Ross	Ian.ross@mast.tas.gov.au
Royal Yacht Club of Tasmania	Nick Hutton	sailing@ryct.org.au
Derwent Sailing Squadron	Shaun Tiedemann	manager@dssinc.org.au

Research End Users (section/programme/organisation)	Name/s	Email (optional)
The Handfish Recovery Team (HRT)	See list below	The chair is Dr Tim Lynch
Marine and Freshwater Species Conservation Section Wildlife, Heritage and Marine Division Department of Environment (DoEE)	Lesley Gidding-Reeve, Alex Hulme	Lesley.Gidding-Reeve@environment.gov.au Alex.Hulme@environment.gov.au
Threatened Species Policy and Conservation Advice Branch Department of Primary Industries, Parks, Water and Environment (DPIPWE)	Andrew Crane	Andrew.Crane@dpipwe.tas.gov.au
Office of the Threatened Species Commissioner (DoEE)	Fiona Fraser	

INVITED MEMBERS HANDFISH RECOVERY TEAM

Lesley Gidding-Reeve	Department of the Environment (Commonwealth)
Andrew Crane	Department of Primary Industries, Parks, Water and Environment (Tas)
Tim Lynch	CSIRO scientist, running current surveys and substrate trials
Neville Barrett	University of Tasmania, handfish research
Rachelle Hawkins	Seahorse World
Mark Green	CSIRO
Lincoln Wong	UTAS
Nepelle Crane	NRM South
Inger Visby	Derwent Estuary Program
Craig Thorburn	Zoo and Aquarium Association of Australia
Paul Hale	Curator, Sea Life Melbourne Aquarium
Carolyn Hogg	Sydney University, population geneticist
Michael Jacques	Marine Life Tassie
Graham Edgar	University of Tasmania, Reef Life Survey Foundation
Sam Ibbott	Marine Solutions, marine consultant
Rick Stuart-Smith	UTAS
Joe Valentine	Aquenal, marine consultant

Project A13 – Estimation of population abundance and mixing of southern right whales in the Australian and New Zealand regions1

Project length: 2.7 Years/31 Months
Project start date: 01/04/2018
Project end date: 01/12/2020

Project current status: Project extension submitted for approval

Project Leader: *Karen Evans (FTE:0.37)*
Lead Research Organisation: *CSIRO*
Project leader contact details: *GPO Box 1538, Hobart, TAS*
(03) 62325007/0484328180
karen.evans@csiro.au

PROJECT FUNDING AND EXPENDITURE

Summary of project extension

The extension to the project will further the migration of historical sightings datasets of southern right whales from the Australian region into the Australian Right Whale Photo-Identification Catalogue (ARWPIC). Specifically, this will include migration of all remaining sightings from the Head of the Bight (831 individuals); and migration of the last five years (2013-2018) of data collected from Western Australia. This extension also proposes to hold a second workshop of project partners and stakeholders. The workshop will bring expert modellers from the British Antarctic Survey and University of Auckland together with data holders, project partners and staff to progress the modelling components of the project.

Project funding table

	2018	***2019***	***2020***	***TOTAL***
NESP funding	***104,756***	***65,273***	***127,345***	***297,374***
Funding to CSIRO	*19,756*	*25,273*	*67,345*	*112,374*
Funding to project partners	*85,000*	*40,000*	*60,000*	*185,000*
Cash co-con	***0***	***0***	***0***	***0***
Cash CSIRO	*0*	*0*	*0*	*0*
Cash project partners	*0*	*0*	*0*	*0*

[1] temporary title awaiting Department approved management-outcome title

	2018	2019	2020	TOTAL
In-kind co-con	***48,605***	***39,744***	***61,312***	***149,661***
In-kind CSIRO	*39,531*	*24,632*	*48,212*	*112,375*
In-kind project partners	*9,074*	*15,112*	*13,100*	*37,286*
TOTAL	***153,361***	***105,017***	***188,657***	***447,035***

Expenditure statement

Funding expenditure will largely be associated with salaries for project staff to facilitate data migration into the ARWPIC, data preparation for population modelling, mark-recapture analyses and write-up of results ($176.5K). A small amount of funding ($10K) will support streamlining processes for migration of photographic data into the ARWPIC (database development). Remaining funds ($14.5K) will be used to hold a population modelling workshop, including travel expenses for an expert right whale population modeller to spend time with project staff in Australia and lead the workshop. Expenditure associated with an extension to the project will primarily be put towards salaries of project staff to migrate historical sightings datasets of southern right whales from Western Australia and the Head of the Bight, further work needed to be done to correct remaining issues with the database, and migration and matching process within ARWPIC and convene a second workshop of project partners and stakeholders. Remaining funds will be used the travel expenses of an expert right whale population modeller to attend the workshop

PROJECT DESCRIPTION

Project Summary

A comprehensive understanding of the population abundance and degree of spatial connectivity of southern right whales in Australian waters is currently lacking. This limits assessments of the species recovery and understanding of the nature and degree of difference between the south-eastern and south-western Australian populations. This project will provide, for the first time, an abundance estimate of the total Australian population of southern right whales. It will also investigate the connectedness of whales that utilise breeding areas on the eastern, southern and western coasts of Australia. Information provided by this project will allow the Australian government to better evaluate progress made against the Conservation Management Plan for southern right whales and ensure conservation efforts for the species are effectively coordinated at the regional level.

Project Description

Problem

The Australian Government Conservation Management Plan for the southern right whale, produced under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), sets out three key interim recovery objectives for the period 2011-2021. These are focused on identifying the population recovery of southern right whales in Australian waters and understanding the nature and degree of difference between the south-eastern and south-western Australian populations.

To date, monitoring of southern right whales across the whole of their range in Australian waters has not been consistent, with monitoring taking multiple forms at a number of locations. While we have learned much from this research, a comprehensive understanding of the population parameters, recovery rates movements and degree of spatial connectivity of

southern right whales across the whole range of the species in Australian waters is lacking. There is therefore a need to bring together available datasets to resolve both the population abundance and population structure of southern right whales.

Key to being able to resolve the population abundance and the degree of movements and therefore spatial mixing of southern right whales between south-east and south-west Australia, is the substantial collection of unique photographs of individual southern right whales collected by a number of agencies, institutions, organisations and individuals from various locations around southern Australia. Using unique identifying patterns known as callosities located on the heads of individual whales, individual whales can be identified from a sighting event (the 'mark') and then re-identified temporally and spatially at additional sighting events (the 'recapture'). Analyses of temporal and spatial matches of these photographs using mark-recapture methodology allows for the estimation of absolute population abundance and provides insights into the movements and spatial mixing of individuals.

Analysis of these data will provide the Australian Government with strategic information required for evaluating progress against the interim objectives of the Conservation Management Plan. They will also help guide any further research required for ensuring that the long-term recovery objective of the Plan is achieved, that is that the status of the southern right whale is improved to the degree "that it can be removed from the threatened species list under the EPBC Act".

Description of research

The Australian Right Whale Photo-Identification Catalogue (ARWPIC) currently holds photographs from south-western Australia, Tasmania and southeast Australia. It also contains a number of photographs submitted by the general public. While the catalogue is extensive in nature, there are a number of additional datasets of photographs being collected from the Australian region that could be migrated into the ARWPIC to expand the spatial and temporal coverage of photographs and associated matches. Further, a photographic dataset from New Zealand (containing photographs from approximately 1,000 individuals) waters, currently held by the University of Otago, if also included would facilitate an investigation of the movements of southern right whales between the two regions.

Population modelling of species such as southern right whales is complex largely due to a non-annual breeding cycle, requiring the development of bespoke multi-stage mark-recapture models . Application of mark-recapture statistics to a catalogue of photographically identified individuals therefore requires some understanding of the population dynamics of the species and how these dynamics might influence survival and sightings probabilities (see Caswell et al 1999; Fujiwara and Caswell 2001). A number of specialist groups have developed specific extensions to generalised population models for application to right whale populations.

Via engagement with experts at the Scottish Oceans Institute at the University of St Andrews in Scotland and the British Antarctic Survey, an initial workshop will be held to bring the project team (which comprises the data holders) and at least one expert population modeller with experience in developing mark-recapture models for right whales based on photographic records together. It is recognised that migration of all outstanding photographic datasets into the ARWPIC is beyond the scope of this project. The workshop therefore will firstly assess the data currently held in the ARWPIC and the capacity of those data in supporting a population assessment of southern right whales. Based on this assessment, the workshop will identify what additional data might be required for the population component of the project and the spatial and temporal aspects of those data, thereby setting priorities for the data collation, curation and photo matching components of the project. Second, key biological and demographic parameters and aspects of the distribution and movement of southern right whales required to be incorporated into population models will be identified. The workshop will also engage relevant research users and stakeholders to ensure that the project analyses and outputs are communicated and focused in such a way to support policy and management.

This engagement will also ensure that potential changes to policy and management measures are identified and discussed with the relevant agencies and the supporting information required from the project is identified.

Maximising the availability of the research expertise of the specialist modeller, a portion of the workshop will be opened up to the broader Australian research community to discuss population modelling methods and application to marine mammals, thereby providing an opportunity for capacity building for those attending.

The project team will also actively pursue any potential further funding sources to compliment this project that would facilitate the full migration of datasets of photographs from Australia and New Zealand into the ARWPIC. This will include applying to the International Whaling Commission at the meeting of the scientific committee in May 2018.

The project will employ a series of multi-stage mark-recapture (MSMR) methods to estimate the abundance and annual population growth rate of southern right whales. This will involve the use of a range of models that explicitly account for heterogeneity in capture. Utilising a range of models will allow for the performance of the models to be compared and an assessment of uncertainty associated with model results conducted. Models used will also estimate probabilities of movement amongst spatial locations to provide a measure of spatial mixing (see [2]). Using the outputs from the modelling components of the project, an assessment of future data collection needs to ensure precise abundance and trend estimates can be made for ongoing monitoring of populations will be conducted.

As well as engagement in the initial workshop, regular updates on the project will be provided to research users and other relevant stakeholders, throughout the project to ensure that information for supporting policy and management measures and any changes to these that might be required is provided to those relevant agencies. This will also allow for input by relevant management agencies in identifying future data collection needs for supporting policy and/or management into the future and ensure that research users and relevant stakeholders, including Indigenous communities for whom southern right whales are totemic, are kept up to date with the project's progress.

Regular monthly teleconference meetings of the project team will be held to ensure that all partners are kept up to date with the project's progress, are aware of any risks or issues associated with the project, and that the decision making processes involved with the project are inclusive.

Extending the project (2020)

The initial workshop held by the project identified that due to a number of errors within the data already contained within ARWPIC, it would be necessary to identify all data integrity issues, correct these and then re-validate the entire dataset before proceeding with migration of outstanding data held in regional catalogues (see NESP project A13 workshop report). The assessment of historical datasets that were available for migration and also the assessment of work needed to be done to address those data integrity issues identified that the project would only be able to facilitate migration of part of the Head of the Bight dataset (females and calves) and the outstanding dataset from south-east Australia.

While it was identified that the original project would still be able to proceed in providing a first estimate of population size and investigation of spatial connectivity, including the wider Australia datasets would increase the precision of estimates and ensure that the results provided to state and Commonwealth managers are contemporary (encompass historical as

[2] Fujiwara M, Caswell H. 2002. Estimating population projection matrices from multi-stage mark-recapture data. Ecology 83: 3257 – 3265.

well as more recent years and therefore reflect the current state of the population), robust and based on the vast majority of data available for the species.

An extension to the project is proposed to further the migration of historical sightings datasets of southern right whales from the Australian region into the ARWPIC. Specifically, this will include:

- Migration of all remaining sightings from the Head of the Bight (831 individuals);
- Migration of the last five years (2013-2018) of data collected from Western Australia

This migration involves first reconciling of data to formats suitable to that in the catalogue, second upload of the data to ARWPIC, third categorisation of individuals to facilitate the matching process, fourth matching of individuals to those in the catalogue, and finally independent validation of that categorisation and matching. Associated with this process, the extension will facilitate the further correction of remaining issues with the database, migration and matching process within ARWPIC. This will increase efficiencies in the processes associated with getting data into and out of ARWPIC.

This extension also proposes to hold a second workshop of project partners and stakeholders. The workshop will bring expert modellers from the British Antarctic Survey and University of Auckland together with data holders, project partners and staff to progress the modelling components of the project. This will ensure efficiencies in this component of the project as data holders and modellers will be able to work together quickly to address data intricacies and variability and also co-design approaches that are best suited to the Australian dataset.

Prior research and linkages to other research projects

The project leverages off considerable effort by a number of research agencies and Universities involved in collecting photographs and related data from southern right whales both in Australia and New Zealand over more than two decades, as well as public submissions of photographs into the ARWPIC. Many of these projects have been supported through substantial funding provided by the Department of Environment and Energy's Australian Marine Mammal Centre grants scheme.

The project also leverages off the substantial effort placed into the development of the ARWPIC, a research initiative developed through a partnership between the Department of Environment and Energy (Australian Antarctic Division), Tasmanian Department of Primary Industries, Water, Parks and Environment, Victorian Department of Environment, Land, Water and Planning and the Western Australian Museum, funded through the Department of Environment and Energy's Australian Marine Mammal Centre grants scheme and developed by Skadia Pty Ltd.

The project has direct linkages with the Marine Biodiversity Hub project A7 "Monitoring population dynamics of 'Western' right whales off southern Australia". Photographs of individuals collected by this project will contribute to those analysed by this project. The principal investigator on project A7 is a member of the ARWPIC steering committee and is one of the partners on this project.

The project will provide a series of logical next steps in progressing the ARWPIC to provide a comprehensive photo catalogue for the Australian region in the first instance and pending progress on the Australian datasets, the New Zealand region in the second. The project will ensure that the original drivers for development of the catalogue are achieved: providing information on the abundance, status and movements of southern right whales that can inform conservation management of the species. Further development of the ARWPIC will provide a key resource for the Australian Government and state managers particularly in relation to issues affecting matters of national environmental significance.

Application to decision making and on-ground action

Through the provision of an estimate of absolute abundance for southern right whales for the Australian region, the project will provide the Australian Government with a key index against which both past pressures and contemporary pressures on the population can be measured. This will allow for evaluation of policy and management actions currently in place, better targeting of policy and management actions for ensuring ongoing recovery of the species and ultimately, removal of the species from the threatened species list under the EPBC Act. Estimation of population abundance and structuring within the population will also reduce uncertainty in the assessment of current threats on population(s) and provide for better targeting of mitigation efforts aimed at reducing threats to the population(s) in the region.

NESP 2017 Research Priority Alignment

The research proposed aligns and directly contributes to a number of the NESP Research Priorities. These include:

Maximising the efficacy of managing Australia's marine environment

By providing an estimate of absolute abundance and associated uncertainty for southern right whales for the Australian region, the project will provide the Australian Government with a key index against which recovery of the population can be measured and the current management plan for southern right whales evaluated. Improved insights into the population structure of southern right whales will allow for refocusing of the plan and associated research priorities to ensure monitoring efforts are appropriate, targeted and attainable. Results from the project will allow for any assessment and mitigation of threats to the population(s) in the region to be appropriately focused and ensure that research is targeted in such a manner that the most relevant information for assessment is collected.

Improving our understanding of the marine environment including biophysical, economic and social aspects

The proposed project will employ mark-recapture methodologies to establish an estimate of the total population abundance of southern right whales across Australia; exact information that is currently lacking. This will provide the Australian Government with a key index against which recovery of the population can be measured and future trends monitored. It will also provide improved insights into the population structure of the species across the Australian and potentially the Australian and New Zealand region, providing for improved information required for management at the population level.

In analysing a previously under-investigated dataset and employing cutting edge population modelling approaches, the project will allow for an evaluation of the method, provide for an assessment of the capabilities of current data collection efforts in providing for ongoing monitoring needs for the species and identify what may be needed in order to reduce uncertainty in assessments of the population and ongoing evaluation of trends.

The dataset proposed to be analysed under this project has been built on the basis of contributions of photographs from researchers and the public, with the ARWPIC database able to be explored and contributed to by public citizens. The project therefore provides an important opportunity for citizens, including Indigenous communities, to participate in knowledge gathering that has clear relevance and provides inputs into the management of southern right whales in Australian waters.

PATHWAY TO IMPACT

Outcomes
By providing an estimate of absolute abundance and associated uncertainty for southern right whales for the Australian region, the project will provide the Australian Government with a key index against which recovery of the population can be measured and the current management plan for southern right whales evaluated. Improved insights into the population structure of southern right whale will allow, if appropriate, for the refocusing of the plan and associated research priorities to ensure monitoring efforts are appropriate, targeted and attainable. Results from the project will allow for any assessment and mitigation of threats to the population(s) in the region to be appropriately focused and ensure that research is targeted in such a manner that the most relevant information for assessment is collected. In analysing a previously under-investigated dataset, the project will provide a power-based assessment of the capabilities of current data collection efforts in providing for ongoing monitoring needs for the species and identify what may be needed in order to reduce uncertainty in future assessments of the population and ongoing evaluation of trends. Further development of the ARWPIC will provide a key resource for the Australian Government and state managers particularly in relation to issues affecting matters of national environmental significance.

Research-user	Engagement and communication	Impact on management action	Outputs
Migratory Species Unit, Australian Government Department of Environment and Energy Marine Policy Section, Marine and International Heritage Branch, Heritage Reef and Marine Division, Australian Government Department of Environment and Energy Queensland Government Department of National Parks,	Engagement: Consultation and engagement in research priority setting meetings held prior to the project and/or engagement in project development. Communication: involvement in project, briefings of research progress and findings	Research results will provide a key index against which recovery of the population can be measured and the current management plan for southern right whales evaluated. Development of the ARWPIC will provide a key resource for the Australian Government and state managers particularly in relation to issues affecting matters of national environmental significance	An expanded and substantially improved ARWPIC. Data summaries for populating models used to estimate abundance and connectivity An estimate of population abundance at the national scale and associated uncertainty. An evaluation of movement and spatial mixing across southern Australia. An assessment of future data collection needs to ensure precise abundance and trend estimates can be made for ongoing monitoring of populations A series of milestone reports and a final report A paper for presentation to the International Whaling Commission

Research-user	Engagement and communication	Impact on management action	Outputs
Sport and Racing New South Wales National Parks and Wildlife Service Biodiversity Division, Victoria State Government Department of Environment, Land, Water and Planning Policy and Conservation Assessment, Natural and Cultural Heritage, Tasmanian Department of Primary Industries, Parks, Water and Environment. Government of South Australia Department of Environment, Water and Natural Resources Parks and Wildlife Service, Government of Western Australia Department of Biodiversity, Conservation and Attractions			A peer –review paper for publication in a relevant journal
Additional outputs Nil			

INDIGENOUS CONSULTATION AND ENGAGEMENT

Because the proposed project does not have a field component and will not involve direct participation or employment of an Indigenous organization, group or individual, the proposed project is considered to be a Category 3 project, that is, a research project that is laboratory or desktop based and does not have direct collaboration with an Indigenous community, organisation, group or individual.

In consultation with the Marine Biodiversity Hub Theme leaders and the Department of Environment and Energy, the project will develop a process for outputs from the project to be effectively shared and communicated to Indigenous peoples, communities and organisations. In particular, the communities and Traditional Owners of Mirning, Wirangu, Yalata, Kooyang and Yuin and Monaro, all of which have identified southern right whales as important components of their heritage and culture will be contacted by members of the project team, some of which are already engaged with these communities. Direct communication with these communities will allow for the identification of information is of relevance to the communities, Traditional Owners and ranger groups and also aid in identifying further relevant communities, Traditional Owners or ranger programs that should be engaged by the project and/or might be interested in information generated by the project. This engagement will also include direct provision of information on the project, its aims and progress to communities, Traditional Owners and ranger groups through on ground visits and involvement in relevant community events.

PROJECT MILESTONES

Milestones	Due date	Milestone Status
Milestone 1- priority setting and population modelling workshop complete, migration and curation of outstanding photographs into ARWPIC started	01 October 2018	Complete
Milestone 2 – Migration and curation of outstanding photographs into ARWPIC complete	01 April 2019	Complete
Milestone 3 – Migration of Western Australian and outstanding Head of the Bight photographs into ARWPIC initiated, further fixes to ARWPIC outlined and underway	28 February 2020	Proposed
Milestone 4 – Second workshop and preliminary model development complete.	01 March 2020	Proposed
Milestone 5 – Migration of further datasets and further fixes to ARWPIC complete.	01 September 2020	Proposed

Milestones	Due date	Milestone Status
Milestone 6 – Model runs complete, paper presented to the International Whale Commission, initial draft of peer review publication.	01 September 2020	Proposed
Milestone 7 – Final report complete, paper submitted	01 November 2020	Proposed
Milestone 8 - Data archived and available according to Hub protocols	30 November 2020	Proposed

DATA MANAGEMENT AND ACCESSIBILITY

Project output	Data Management and Accessibility
Data summaries for populating models used to estimate abundance and connectivity	Data products generated by the project will be deposited, as per the Marine Biodiversity Hubs Data and Information Accessibility Guidelines, into the Australian Ocean Data Network with metadata records also deposited in the relevant data repositories of each of the project partners (e.g. Australian Antarctic Data Centre, CSIRO Data Access Portal).
An estimate of population abundance at the national scale and associated uncertainty	Data products generated by the project will be deposited, as per the Marine Biodiversity Hubs Data and Information Accessibility Guidelines, into the Australian Ocean Data Network with metadata records also deposited in the relevant data repositories of each of the project partners (e.g. Australian Antarctic Data Centre, CSIRO Data Access Portal).
An evaluation of movement and spatial mixing across southern Australia	Data products generated by the project will be deposited, as per the Marine Biodiversity Hubs Data and Information Accessibility Guidelines, into the Australian Ocean Data Network with metadata records also deposited in the relevant data repositories of each of the project partners (e.g. Australian Antarctic Data Centre, CSIRO Data Access Portal).
An assessment of future data collection needs to ensure precise abundance and trend estimates can be made for ongoing monitoring of populations	Communication products will be made available via the Marine Biodiversity Hub's website and deposited into the relevant publications repositories of each of the project partners (e.g. CSIRO Research Publications Repository) where they will be searchable and available to access.
A series of milestone reports and a final report	Communication products will be made available via the Marine Biodiversity Hub's website and deposited into the relevant publications repositories of each of the project partners (e.g. CSIRO Research Publications Repository) where they will be searchable and available to access.
A paper for presentation to the International Whaling Commission	Communication products will be made available via the Marine Biodiversity Hub's website and deposited into the relevant publications repositories of each of the project partners (e.g. CSIRO Research Publications Repository) where they will be searchable and available to access.

Project output	Data Management and Accessibility
A peer –review paper for publication in a relevant journal	Communication products will be made available via the Marine Biodiversity Hub's website and deposited into the relevant publications repositories of each of the project partners (e.g. CSIRO Research Publications Repository) where they will be searchable and available to access.

LOCATION OF RESEARCH

The research covers the range of southern right whales in Australian waters. On-ground activities will occur across the project partner's agencies and institutions.

PROJECT SPECIFIC RISKS

Risk Description	Likelihood 1 = very low 5 = very high	Impact 1 = very low 5 = very high	Mitigation Strategy proposed to reduce risk
Photographic records not currently in the ARWPIC are not made available to the project	1	4	The project partners have a track record of working with all of the relevant data holders, with migration of photos into the ARWPIC already agreed upon and identified as a priority. Specific funds within the project have been distributed to major photographic record holders to ensure that migration of photos can be facilitated by those holders.
The time required for collation, deposit and verification of photographic records is underestimated	1	2	Progress on this activity will be regularly reviewed and any issues with timelines on this component actively managed.
Mark-recapture records are not adequate for generation of a population estimate	1	2	The project partners have discussed the viability of generating abundance estimates given current records in the ARWPIC and incomplete migration of outstanding datasets. The overall view is that a population abundance is achievable. A key part of the project will be the initial workshop which will firstly assess the data currently held in the ARWPIC and the capacity of those data in supporting a population assessment of southern right whales. Based on this assessment, the workshop will prioritise what additional data might be required for the population component of the project and the spatial and temporal aspects of those data, thereby setting priorities for the data collation, curation and photo matching components of the project. Models applied by the project will generate an estimate of uncertainty around model outputs that will be communicated clearly to research end-users and stakeholders.

PROJECT KEYWORDS

Southern right whale, population abundance, population structure, population recovery, population status.

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE (WoL)
Karen Evans	CSIRO Oceans and Atmosphere	Principal Investigator	0.37
Mike Double	Department of Environment and Energy (Australian Antarctic Division)	Co-investigator, ARWPIC manager	0.05
Rachael Alderman	Tasmanian Department of Primary Industries, Parks, Water and Environment	ARWPIC steering committee, data contributor, data curator	0.2
Emma Carroll	Sea Mammal Research Unit, University of St Andrews	Population modeller	0.1
Claire Charlton	Claire Charlton – Environmental Consulting	Data contributor, data curator	0.9
Rob Harcourt	Macquarie University	Data contributor	0.05
Jen Jackson	British Antarctic Survey	Population modeller	0.1
Mandy Watson	Victorian Department of Environment, Land, Water and Planning	ARWPIC steering committee, data contributor, data curator	0.2
Judy Upston	CSIRO Oceans and Atmosphere	Data support and management	0.33

DATA MANAGEMENT

Name	Organisation	Email	Phone
Karen Evans	CSIRO	karen.evans@csiro.au	(03) 62325007

CO-CONTRIBUTORS

Name	Organisation/	Contribution
John Bannister	Western Australian Museum	ARWPIC steering committee, data contributor
Steve Burnell	Eubalaena Pty. Ltd	Data contributor

Name	Organisation/	Contribution
Will Rayment	University of Otago	Data contributor

KEY PARTNERS AND RESEARCH END USERS

Key Partners (organisation/program)	Name/s	Email (optional)
Migratory Species Unit, Australian Government Department of Environment and Energy	Sylvana Maas	Sylvana.Maas@environment.gov.au
Biodiversity Division, Victoria State Government Department of Environment, Land, Water and Planning	Nina Cullen	Nina.Cullen@delwp.vic.gov.au
Policy and Conservation Assessment, Natural and Cultural Heritage, Tasmanian Department of Primary Industries, Parks, Water and Environment.	Andrew Crane	Andrew.Crane@dpipwe.tas.gov.au

Research Users (program/section/branch/organisation)	Name/s	Email (optional)
Migratory Species Unit, Australian Government Department of Environment and Energy	Sylvana Maas	Sylvana.Maas@environment.gov.au
Marine Policy Section, Marine and International Heritage Branch, Heritage Reef and Marine Division, Australian Government Department of Environment and Energy	Suzi Heaton	Suzi.Heaton@environment.gov.au
Queensland Government Department of National Parks, Sport and Racing	Amanda Delaforce	Amanda.Delaforce@npsr.qld.gov.au
New South Wales National Parks and Wildlife Service	Susan Crocetti	Susan.Crocetti@environment.nsw.gov.au
Government of South Australia Department of Environment, Water and Natural Resources	Dirk Holman	Dirk.Holman@sa.gov.au

Research Users (program/section/branch/organisation)	**Name/s**	**Email (optional)**
Parks and Wildlife Service, Government of Western Australia Department of Biodiversity, Conservation and Attractions	Kelly Waples	Kelly.Waples@dpaw.wa.gov.au
Environment Protection and Assessment, Australian Government Department of Defence	Lloyd Woodford	lloyd.woodford@defence.gov.au

Project A15 – Conservation status of tropical inshore dolphins

Project length: 1 Year

Project start date: 01/01/2020

Project end date: 31/12/2020

Project current status: New project submitted for approval.

Project Leader: *Dr. Simon J Allen (FTE – 20%)*

Lead research organisation: *University of Western Australia*

Project leader contact details: simon.allen@uwa.edu.au / simon.allen@bristol.ac.uk;
+44 77047 53101 (UK) / +61 (0)416 083 653 (when in Australia)

PROJECT FUNDING AND EXPENDITURE

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding						*$35,000*		*$35,000*
Cash co-con								
In-kind co-con						*$35,000*		*$35,000*
TOTAL						***$70,000***		***$70,000***

Expenditure statement

The funding is solely for a desktop review of peer-reviewed publications, research projects, and reports (e.g. EIAs) associated with major port developments 2013-2019.

PROJECT DESCRIPTION

Project Summary

The *Conservation Status of Tropical Inshore Dolphins* project will entail the compilation and review of the results of numerous research projects completed under the *Whale and Dolphin Protection Plan,* as well as monitoring and offset programs associated with port developments. The aim is to provide a synthesis of scientific information to inform assessments of the conservation status of the: Australian snubfin dolphin, *Orcaella heinsohni*; Australian humpback dolphin, *Sousa sahulensis*; and Indo-Pacific bottlenose dolphin, *Tursiops aduncus.*

Project Description

In 2013, the (now) Department of Environment and Energy (DoEE) received a nomination to list the Indo-Pacific Humpback Dolphin (now known as the Australian Humpback Dolphin) as Vulnerable under the EPBC Act. The nomination was not progressed by the Threatened Species Scientific Committee (TSSC) due to a lack of data. The DoEE then developed the *Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins* in 2013. This framework was updated in 2015 when

funding became available through the *Whale and Dolphin Protection Plan* (a small funding program that included some $450,000 for dolphin research from 2014/15 to 2016/17).

James Cook University, led by Professor Helene Marsh, coordinated the allocation of funds under the *Whale and Dolphin Protection Plan* and this resulted in about ten research projects being undertaken across northern Australia. Additionally, other research and monitoring projects targeting inshore dolphins were undertaken as part of offset and post-approval monitoring programs required for projects approved under the EPBC Act. The most significant of these was the INPEX project on Darwin Harbour, that included long-term monitoring in Darwin Harbour and surrounds and one-off surveys across the entire NT coast.

As a result of this recent research and monitoring, there is now markedly more in the way of data and subsequent reporting available to assess the conservation status of the three tropical inshore dolphin species. Our understanding of their conservation status and current threats would benefit from a project to synthesise the outcomes of numerous projects completed since 2013. This would, in particular, be of great use to the TSSC since, in March this year, a second nomination to list the Australian Humpback Dolphin as Vulnerable under the EPBC Act was received. The project team will work closely with research-users to scope the project and shape outputs to meet their needs. Knowledge brokering and communication will be conducted in accordance with the Hub's Knowledge Brokering and Communication Strategy.

NESP 2017 Research Priority Alignment

This project is aligned with Marine Biodiversity 2 (Matters of National Environmental Significance) and, in particular, research priorities 2.2-2.4, and also 3.2 and 3.4.

PATHWAY TO IMPACT

Outcomes			
The outputs of this project will be used by the TSSC to assess whether or not the Australian Humpback Dolphin qualifies for listing as Vulnerable under the EPBC Act.			
Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
Dept. of Environment and Energy Threatened Species Scientific Committee	Research-users will be engaged in project scoping and development and shaping of output(s). Findings to be communicated via quarterly project update emails and final report.	The knowledge generated in this project will be packaged to inform DoEE's assessment of the conservation status of tropical inshore dolphins and decision-making around their listings under the EPBC Act.	A synthesis of research and monitoring data collected for three inshore dolphin species in northern Australia between 2013 and 2019, to inform assessments of the conservation status of these species.
Additional outputs • A publication synthesizing recent research and impact assessments to inform assessments of the conservation status of tropical inshore dolphins.			

Indigenous Consultation and Engagement

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement as it is a desktop review of peer-reviewed and grey literature. This means the knowledge generated in this project will be shared and communicated to relevant Indigenous peoples, communities and organisations. The Hub will communicate project progress to the DoEE Indigenous Advisory Committee (mediated through DoEE) and the Fisheries Research and Development Corporation Indigenous Reference Group through provision of updates to its chair. The information will be provided to the TSSC which is aware of Traditional Owners' interest in these species.

Project Milestones

Milestones	Due date	Milestone Status
Milestone 1 – Sign contract	*Jan 2020*	
Milestone 2 – Information sources identified and listed	*April 2020*	
Milestone 3 – Interim report	*Jul 2020*	
Milestone 4 – Final report	*Dec 2020*	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including metadata) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles.

Project output	Data Management and Accessibility
Final report	The final report, including reference list of reviewed material, will be provided to NESP, TSSC and DoEE.
Peer-reviewed publication	A peer-reviewed publication will be submitted to an open access journal for maximum utility and transparency.
Data	No new data are expected from this project

LOCATION OF RESEARCH

This project is solely a desktop review of peer-reviewed and grey literature. The review may have impact for the listing of tropical inshore dolphins under the EPBC Act and, thus, dolphins that inhabit coastal waters of the Australian tropics.

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
1. Data and report access may limit access to information	Moderate	Medium	List of available data sources to be provided as early product where any issues can be highlighted to TSSC and Department	Project leader

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
2. TSSC need for information to guide listing decisions may change.	Unrealistic timelines for project. High	Low	An interim report will be provided by July 2020. Contact will be maintained with TSSC and DoEE	Project leader and DOEE
3. Project Leader may become incapacitated	High	Low	Collected reports and information will be clearly identified and maintained in an accessible place.	Project Leader

PROJECT KEYWORDS

Tropical, inshore, dolphin, conservation, review.

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE
Dr Simon Allen	University of WA	Principal Investigator	0.2
Sylvana Maas	DoEE	Key partner and end user	
Prof Helene Marsh	TSSC and JCU	Key partner and end user	

Data Management

Name	Organisation	Email	Phone
Dr Simon Allen	University of WA	simon.allen@uwa.edu.au	+447704753101

Co-contributors

NA

Key Partners and Research End Users

Key Partners (organisation/program)	Name/s	Email (optional)
DoEE	Sylvana Maas	Sylvana.maas@environment.gov.au
DoEE	Fiona Bartlett	Fiona.bartlett@environment.gov.au
TSSC	Prof Helene Marsh	Helene.marsh@jcu.edu.au

Research Users (program/section/branch)	Name/s	Email (optional)
DoEE	Sylvana Maas	Sylvana.maas@environment.gov.au
DoEE	Fiona Bartlett	Fiona.bartlett@environment.gov.au
TSSC	Prof Helene Marsh	Helene.marsh@jcu.edu.au

Project D3 – Implementing monitoring of AMPs and the status of marine biodiversity assets on the continental shelf

Project length – 54 Months
Project start date – 01/07/2015
Project end date – 31/12/2020

Project current status - Submitted for re-approval

Project Leader: *Neville Barrett (FTE – 30%)*
Lead Research Organisation: *University of Tasmania*
Project leader contact details: *Neville.barrett@utas.edu.au, 03 6226 8210*

PROJECT FUNDING AND EXPENDITURE

Summary of significant changes to project

This plan has had two revisions subsequent to the RPV5 plan approval.

(1) There was a minor revision to add $50,000 to the 2020 budget for vessel support for the Elizabeth/Middleton reef survey. This revision was required due to the lack of availability of the initially proposed NSW fisheries patrol vessel, or suitable alternative local charter vessels from the region. Instead, the AMC/UTas vessel Bluefin will be chartered and provide the necessary vessel support. As this vessel is based in northern Tasmania, additional funding is needed to cover costs associated with transit to and from Newcastle, and crewing costs associated with the vessel while in Newcastle for equipment mobilisation and demobilisation. A total time of 4.5 days is estimated for vessel transit time (return from Beauty Point to Newcastle, on a 24h operational basis), and two days in Newcastle port. Estimated costs ate $10k per day for transit and $2500 per day while in port.

(2) The second revision is more substantial, but with no significant implications for research goals and budgets. A delay of the original D3 Project to survey the Gulf of Carpentaria (GOC) AMP, originally scheduled for November 2019, was required to understand and accommodate the needs of Traditional Owners. The planned GOC survey will not proceed due to constraints associated with the NESP funding period and the low likelihood of completing a collaborative GOC survey within the funding period. Instead, the resources allocated to this survey will be redirected to conduct a similar survey in another AMP in Northern Australia where the survey can be completed within the NESP funding period. Alternative AMPs in the Northern Network being considered are Arafura, Arnhem or Wessel – with the final location to be agreed between the Hub's partners and Parks Australia following assessment of existing data, risk, science objectives and management priorities. This variation will not alter the overall research outcomes of this project and have no substantive resourcing or financial implications, and the budget has not been changed.

Project funding table

	2015-2017	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	2015 $388,000 2016 $533,000 2017 $551,464 **Total $1,472,464**	GA $158,000 (Beagle $120k and Gulf prep $38k) UTAS (Beagle) $200,000 CSIRO (Seamounts) $50,000 NSW DPI (Hunter) $53,000 NSW OEH (Hunter) $53,000 AIMS Gulf prep $24,000 Beagle vessel support $120,000 **Total** **$658,000**	GA $275,000 (Beagle $55k and Gulf $220k) UTAS $205,000 ($105,000 Beagle, $100,000 Hunter/) CSIRO (Seamounts) $100,000 CSIRO (Ningaloo) $81,000 NSW DPI (Hunter) $53,000 NSW OEH (Hunter) $53,000 UWA Ningaloo $38,000 UWA SW Capes $25,000 AIMS Gulf survey $476,000 (includes vessel costs) Hunter survey Vessel support. $50,000 **Total** **$1,356,000**	GA $319,000 (Gulf $104k , SW Corner $165k; Survey support Elizabeth/Middleton AMP $50k) UTas (Hunter/Eliz Middleton/SW Corner/Hub synthesis), $210k CSIRO (Ningaloo) $154,000 AIMS (Gulf) $98k UWA, SW Capes ($180k) UWA, Ningaloo ($76,000) NSW DPI (Elizabeth/Middleton survey) $53K NSW OEH (Elizabeth/Middleton survey) $53K Elizabeth/Middleton vessel support $100k SW Capes vessel support $100k est **Total** **$1,343,000**	*TBD*	***$4,829,464***
Cash co-con	*x*	*x*	*x*	*x*	*x*	*x*

	2015-2017	*2018*	*2019*	*2020*	*2021*	***TOTAL***
In-kind co-con	2015 $526,000 2016 $692,500 2017 $642,464 **Total $1,860,964**	GA $158,000 UTAS $200,000 CSIRO (S) $50,000 NSW OEH $53,000 NSW DPI $53,000 AIMS $24,000 **Total $538,000**	GA $275,000 UTAS $205,000 CSIRO (S) $100,000 CSIRO (N) $81,000 NSW OEH $53,000 NSW DPI $53,000 UWA $38,000 UWA $25,000 AIMS $476,000 (includes vessel costs) **Total $1,306,000**	GA $369,000 UTAS $210,000 CSIRO (N) $154,000 NSW OEH $53,000 NSW DPI $53,000 UWA (SW) $180,000 UWA Ningaloo $76,000 AIMS $98,000 (includes vessel costs) **Total $1,193,000**	*x*	*$4,897,964*
TOTAL	3,333,428	1,196,000	2,662,000	2,536,000	TBD	***9,727,428***

Expenditure statement

The bulk of expenditure is used to support salary for researchers engaged in D3 projects. For UTas, DPI NSW, and UWA these funds support postdoc positions and associated technical support. For GA and CSIRO these support co-funded positions of core staff and operational costs for surveys. For NSW OEH these funds support field surveys. Additional funds, as specified, support vessel charter for surveys, equipment maintenance and minor equipment purchases.

PROJECT DESCRIPTION

Project Summary

There is a significant need to support Parks Australia in the establishment of an inventory and monitoring program for Australian Marine Park (AMP) networks, and ensure it is integrated within broader national monitoring frameworks. This project initiates a series of surveys, utilising standard operating procedures (SOPs), to demonstrate a sustainable path for a national survey program. By facilitating national approaches, including a standards-based approach to collecting new marine data, project outcomes will include key steps to assist Parks Australia to implement and initiate an AMP monitoring program, new knowledge to inform AMP management, a national integrated framework for State of Environment (SOE) reporting, and collaboration between State-based and Commonwealth-based programs.

Project Description

Problem

There is a significant and time critical need to support Parks Australia in the establishment of a baseline inventory and monitoring program for AMP networks, as well as initiating the integrated long-term monitoring program identified as a key need and recommendation in the National Marine Science Plan 2015-2025 (NMSP). Currently such programs do not exist in Commonwealth waters, and the new AMP network provides an appropriate national, regional, and bioregional framework around which such programs could be developed.

Hence, the proposed AMP inventory and monitoring program ideally integrates with, and sits within, the broader requirement to monitor and report on the marine ecosystem health of the Commonwealth marine area, and is complementary to state marine environment monitoring programs. A national approach is required to understand priority information needs and identify opportunities for cost-effective, national-scale collaborations that foster a standards-based approach to collecting new marine data and information. This approach should encourage innovative approaches to data collection, including learning by doing.

While addressing this need is a large task, one initial prioritisation has been to focus effort into environments where anthropogenic pressures are typically greatest (the continental shelf), and further during the initial phase of this project/program, onto hard substrates (reefs) that usually have greater biodiversity levels than soft substrates.

Currently, significant gaps remain in our knowledge of the distribution of key biodiversity assets of the marine estate on the continental shelf, their condition, and the management actions required to ensure these assets are adequately protected. This is equally the case for AMPs and off-reserve locations and conservation values identified in Marine Bioregional Plans.

How Research Addresses Problem/will be undertaken

The project will work with DoEE, Hub partners, IMOS and the wider research community to undertake seven AMP surveys that will apply, test and refine a minimum set of national standard approaches to collecting and analysing data for baselines and monitoring biodiversity in Australia's marine estate. The specific details of each survey are given in a complimentary set of survey plans to be read in conjunction with this project description (see Appendices 1-7). Survey plans are included for the following surveys: Ningaloo AMP, SW Corner AMP, Huon and Tasman Fracture AMPs (deep seamount surveys), Beagle AMP, Hunter AMP, Northern Network AMP(s), and Lord Howe AMP (i.e. Elizabeth and Middleton reefs). These are planned to provide broad regional representation, encompass areas of greatest pressures (shelf waters), develop regional capability, and complement national programs. They were developed following an extensive consultation and prioritisation process with DoEE and broader stakeholders, including a major prioritisation workshop. Survey plans for the Lord Howe AMP (i.e. Elizabeth and Middleton reefs) will be further refined as availability of vessels and opportunities for facility access (e.g. IMOS AUV) become clearer.

The proposed research will have a primary focus on monitoring to inform management of the new AMP network and working with Parks Australia to facilitate implementation of a national AMP monitoring program. It will link these approaches to facilitate development of a broader, nationally integrated monitoring program, including strong partnerships with state-based programs, RIMREP (Reef 2050 Integrated Monitoring and Reporting Program) and IMOS (Integrated Marine Observing System), developing a community of research providers to meet future needs and provide an ongoing reporting framework for AMPs, SOE, national estate and state-based information needs, including informed EPBC act decisions on environmental protection. While the project will not specifically develop or manage the national integrated monitoring program envisaged in the NMSP (National Marine Science Plan), it will continue to facilitate this through coordination of key components (AUV and BRUV benthic monitoring) at a national scale, as well as further development of matching databases and providing a forum for collaboration across agencies and jurisdictions.

Importantly, the project will continue to link with the SOP project (D2), bringing the expertise of the biological domain represented by project participants to assess the adequacy of current State agency, and MBH/partner approaches to marine reserve monitoring for meeting AMP and national marine estate baseline and monitoring needs. Surveys will report using standard indicators to inform the monitoring approach, and further refine a standard surveys database and reporting template. The project will link with project B1 to validate model-based predictions of species distributions in AMPs where appropriate. We will also work with DoEE and the marine science community to explore avenues for undertaking additional priority AMP surveys, including via potential DoEE co-funding.

Details of related prior research.

A significant amount of prior research has led up to this research proposal. This includes development of SOPs and experimental designs during CERF/NERP and NESP Hubs, assessing the capacity of predictive models to fill knowledge gaps in D1, refinement of SOPs and survey designs in D2, development of national monitoring networks in D3, collation of existing biological and mapping data and identification of major gaps (D1/D3) and a prioritisation framework for AMP surveys (D1/D3), including a national prioritisation workshop with DoEE, Hub partners and major stakeholders.

How the project links to other research and/or the work of other Hubs

As above, the project links strongly to projects D1 and D2, is informed by pressures data from Theme B, and will have links with Theme E in developing further understanding of pressures, including recreational fishing and cumulative pressures.

Summary of how it is expected that the research will be applied to inform decision-making and on-ground action.

As outlined above, the research is designed to be directly applied to decision making and on-ground action in many ways. These include decisions on how to best and cost-effectively undertake inventory and monitoring within the AMP network, and once surveys are undertaken, how to best manage the resources discovered within these. At an individual AMP level, this may include decisions and actions related to managing impacts to sensitive fauna/habitats, while at the broader level, the combined knowledge from AMP surveys and other integrated monitoring programs, may inform decisions on climate change adaptation, mitigation of the impacts of pest species, and region-wide, off-reserve management of habitats and species. A central premise of the AMP focus, however, is that the research will add to the information required for the longer-term evaluation of the effectiveness of AMP zoning arrangements, with an aim of achieving improved conservation outcomes if/where current zoning is not effective in ensuring planned outcomes are achieved.

NESP 2017 Research Priority Alignment

- This project aligns to at least five DoEE 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 AMPs,

  (iv) ***identify pressures on the marine environment, and understand their impact, including cumulative impacts and climate change, to better target policy and management actions*** ,

  (v) ***better understand issues that are common to the fishing industry and the environment including identifying solutions of mutual benefit*** and

  (vi) ***The role of citizen science in the management of marine biodiversity****.* The work in the Northern Network will include collaborations with Indigenous Sea Rangers (building on the existing AIMS Indigenous monitoring program) to facilitate monitoring in sea country within and adjacent to the AMP(s).

This project is also strongly aligned with recommendation 2 in the National Marine Science Plan - Establish and support a national marine baselines and long-term monitoring program, to develop a comprehensive assessment of our estate, and to help manage Commonwealth and State marine reserves.

PATHWAY TO IMPACT

Outcomes

Many of the project outcomes can be measured against the NESP research priorities for the Marine Biodiversity Hub.

Develop and trial decision making tools that will support managers to define and prioritise management actions in Australian Marine Parks. New knowledge within AMPs generated by proposed surveys, coupled with existing data generated by the projects D1 & D3, will provide a robust understanding of shelf reef systems (a Key Ecological Feature-KEF), their representation in the AMP 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 AMP network necessary to adequately protect the ecological values of this KEF. **– Outcome- Management decisions supported through knowledge availability.**

Identify past and current pressures on the marine environment, and understand their impact, including cumulative impacts such as climate change to better target policy and management actions. For example, identify the impact of cetacean ship strike. The results from the proposed surveys, coupled with existing data collated by the D3 & D1 project, will allow evaluation of AMP shelf reef associated biological assets against potential threats. While AMP focussed, this information, coupled with patterns detected from comparisons of impacted vs protected areas, will inform analysis of the extent of the impact of a range of pressures on the marine environment, and potential management responses if these pressures are suspected to have adverse consequences. **Outcome- basis to understand pressures and impacts.**

Determine the causes of, and relationships between, pressures on the marine and coastal environment to inform government investment. As above, by contrasting information from AMP 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. **Outcome - basis to understand interacting pressures.**

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 Australian Marine Parks. A core focus of this project will be to bring expertise developed in the CERF/NERP and NESP Marine Biodiversity Hubs, and by partner agencies, to this task with a focus on shelf systems. This expertise is well developed and advanced in its application to the task of informing AMP management, and the intention of the current survey-focussed project is to refine this expertise, apply it to as broad a range of AMPs as practicable utilise SOPs refined in D2, and to be able to use this more generally to monitor the status and trends in both on-reserve and off-reserve environments. In addition, we propose to do this within the prioritisation framework developed with DoEE during D3 that allows for a planned, stepwise approach to support Parks Australia to develop and implement their AMP baseline and monitoring program. Via the proposed national MPA scientific monitoring forum, we will ensure methods are consistent with state programs, and that their outputs fully align with management needs. **Outcome - methods trialled and evaluated in on-ground application.**

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, and shelf soft-sediment habitats that are critical habitats for many of our fisheries. Threats that impact these habitats (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. **Outcome - Knowledge for improved ecosystem-based fishery management.**

Improve our knowledge of key marine species and ecosystems to underpin their better management and protection. Key Ecological Features underpin marine regional plans and AMPs, yet many of these are shelf-based and with little sampling to provide a knowledge base. A range of KEFs will be surveyed during the proposed survey program, providing the knowledge necessary for improved protection actions. **Outcome - Improved knowledge of key species and ecosystems in shelf waters in particular.**

All of the above outcomes are both practical and tangible and are readily benchmarked against the DoEE research priorities above. They will inform a wide range of management and policy actions, including effective management of AMP conservation values and 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 conservation values and 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 habitat features of Australia's waters and their associated biodiversity necessary to effectively manage AMPs and other spatial closures that represent this habitat, to manage the Commonwealth's off-reserve assets in this space, and inform national approaches to ecosystem-based management of a range of Key Ecological Features.**

This project will provide a key part of the approach to address the national challenge of marine biodiversity conservation and ecosystem health identified in the National Marine Science Plan. Specifically, it will provide a cornerstone to establish and support a National marine biodiversity baseline and long-term monitoring program to develop a comprehensive assessment of the marine estate, and to help managed Commonwealth and State marine reserves.

Specific management or policy outcomes

The core outcome of this project will be to assist Parks Australia with the key steps towards implementation of a national AMP monitoring program via initiation of baseline surveys within a standard framework. Establishing this program is a central component of Management plans in place for the SE AMP network, and is anticipated to be a central component to management plans for the remainder of the AMP network. Information from these surveys will be essential for refining management plans and objectives of the AMPs in the future as a fuller understanding of the bio-physical assets they contain is made available. Hence the knowledge gained will flow directly into on-ground actions, such as adaptive changes to management prescriptions necessary to protect AMP values. Collaborative networks established by the project, coupled with strategically located surveys, will provide the framework for an integrated national marine monitoring program that will contribute directly to management objectives of effective and meaningful SOE reporting, and implementation of key recommendations in the National Marine Science Plan. Effective SOE reporting can also flow into on-ground actions, including adaptive changes to human activities at local to national scales to protect SOE values.

The knowledge gained via these surveys will also be integral to development of an AMP equivalent of the RIMREP process being developed by GBRMPA (Great Barrier Reef Marine Park Authority). By developing and refining a set of SOPs with broad regional representation, an initial understanding of the nature of habitats and the species they support will be vital to effectively informing this process, Whether an equivalent RIMREP is developed by the Hub in collaboration with Parks Australia or the next Hub, the need for such a process was discussed at the 2017 Theme D workshop and identified as an important management/policy outcome to work towards.

Highlight the environmental value of this project, if it will be measured and how

The project and surveys associated with it 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 AMPs. 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 DoEE and fisheries values managed through AFMA. Moreover, through refining and developing baseline 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.

Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
DoEE- Parks Australia (AMPs) inc planning, management and operations *Jason Mundy, Dave Logan, Hilary Schofield, Bianca Priest and Jacqui Doyle*	*Needs of research users have been identified through ongoing engagement and consultation, including a specific workshop in 2016 to identify research survey priorities. The project leader will continue to engage research-users to refine survey plans and develop project outputs to ensure they are fit-for-purpose.*	*Information will be used to inform AMP management, including planning, and future monitoring program design.*	***Key outputs will include:*** • ***detailed reports specific to each AMP survey, including a plain English summary*** • ***survey data stored in national databases and portals.*** • ***At least one presentation will be given to Parks Australia on the completion of each regional survey.*** ***The types of outputs and expectations have been discussed with end users over the D3 project development stages 2015-17.***
DoEE- Marine Policy Section (Jillian Grayson) and Pacific and Coral Triangle Section	*As Above, where engagement in steering groups is desired by end user*	*As above, with knowledge gained contributing to broader marine regional management (off-reserve), including KEFs*	*As above*
DoEE SOE reporting and Essential Environmental Measures and ERIN (Knowledge and Technology Division) Boon Lim, and Carolyn Armstrong	*As above*	*As above, with knowledge gained contributing to broader marine regional management (off-reserve), including KEFs, SOE reporting, EEMs, and environmental information (ERIN)*	*As above*

Research-user	Engagement and communication	Impact on management action	Outputs
NOPSEMA	*As above*	*As above*	*As above*
Department of Agriculture and Water Resources	*As above*	*Where appropriate new knowledge gained will inform the development of fisheries policy*	*As above*
IMOS/AODN (Australian Ocean Data Network)	*As above*	*New information and data will inform future decisions on priorities and deployments of relevant IMOS infrastructure (e.g. AUV facility) and add biophysical datasets to the AODN portal for use and reuse by a broad spectrum of data users*	*As above*
State government fisheries and conservation agencies TSRA	*As above*	*Where appropriate new knowledge will inform the policy development and management of the marine environment, including State marine parks*	*As above*

Additional outputs

- ***At this stage the core outputs will be the overall survey reports****, however, information will also be generated for DoEE as requested, including timely contributions to the AMP atlas currently being developed by the department.*
- *Further outputs include (i) new multibeam mapping data from AMP survey areas and adjacent waters to be stored and made available through data repository mechanisms currently being developed by project D2 and a Geoscience Australia working group (ii) new data on benthic invertebrate cover obtained from AUV imagery surveys to be added to national imagery platform Squidle+, and all imagery to be added to the AODN portal, (iii), new data on benthic fish abundance obtained by BRUV surveys to be added to the national Global Archive database, with data and original imagery linked to the AODN portal, (iv) primary literature publications (at least 4) describing national survey approaches and regional findings, (v) presentations (at least one per regional survey) to Parks Australia on each of the surveys upon completion.*

Knowledge brokering and communications activities

Engagement and communication for this project will be planned and implemented consistent with the Strategy. This project will involve ongoing knowledge brokering with Parks Australia in particular, given the primary focus on Australian Marine Parks. All individual surveys will involve extensive interaction with Parks Australia and regional management in the development, implementation and reporting phases. These phases will be brokered by the project leader, as well as individual survey leaders. Likewise, opportunities, including project annual reviews, will be used to disseminate learnings to broader stakeholder interests, both

within DoEE, as well as externally to agencies such as NOPSEMA (National Offshore Petroleum Safety and Environmental Management Authority) and AFMA (Australian Fisheries Management Authority). Communications activities will include an annual review (as part of a broader Theme D review) with additional communication via media opportunities arising from individual surveys.

Indigenous Consultation and Engagement

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. The research detailed includes eight surveys that provide a range of opportunities for Indigenous engagement. In this context some of the survey areas have clear overlaps with Indigenous interests and others may not. The category of Indigenous engagement will vary depending on the nature and location of each proposed survey (e.g. Southern Seamounts survey as Category 3 with lower engagement, and Northern Network AMP(s) survey as Category 1, with a very high level of engagement).

At this stage, individual surveys have yet to be developed to full survey plan status, however, once project approval is given, and each survey is approved for further development, there will be extensive consultation with relevant stakeholders around the details of the final plans. While some details of likely Indigenous consultation have been outlined in the current survey descriptions that accompany this proposal, we appreciate that in some cases the fuller and final survey details will be shaped through this engagement, process, and it is therefore appropriate to provide flexibility for this to occur. Hence, the final survey plans will include details of both how ongoing consultation and engagement will be maintained, as well as details of how engagement at the earlier planning stage has shaped the final proposal.

In all cases, individual surveys will include engagement well ahead of project refinement. This process has begun at the initial stakeholder consultation for the overall program (D3 prioritisation workshop in 2017), and will continue as projects are developed. The Gulf of Carpentaria project will have the greatest extent of engagement, and planning for this includes a six month stage of engagement prior to survey initiation.

Overall, the indigenous consultation and engagement will be consistent with the Hub's Indigenous Engagement and Participation Strategy. At the broadest level engagement will be through provision of updates to the DoEE Indigenous Advisory Group and the Fisheries Research and Development Corporation Indigenous Advisory Group. These groups will also be asked for advice on opportunities to enhance Indigenous engagement across individual survey plans as they are developed.

We will also be guided by DoEE engagement processes where appropriate, to avoid duplication and to develop mechanisms that may facilitate future survey consultation approaches. For example, we will engage with the SE AMP Network Forum established by Parks Australia for surveys relevant to the SE region (Southern Seamounts and Beagle AMP). The forum has Indigenous representation from Victoria and Tasmania, and it is anticipated this type of forum may be replicated in other regional AMP networks as Parks Australia develops and implements new AMP network management plans.

The project team is interested to explore how collated information on shelf reefs could be used to reveal Indigenous knowledge on ancient coastlines. Indigenous engagement with the project may provide opportunities to learn more about the values of sea country through the knowledge gained and/or participation in research programs. The research will be conducted according to the highest ethical standards and respects Indigenous priorities and values.

We will explore opportunities for Indigenous engagement, employment, skills transfer, sharing of knowledge and the increase of cultural awareness amongst all parties. Where opportunity exists, representatives of the community will be invited to participate in research cruises to gain first-hand experience of sea country. This is most likely to include involvement of the Sea Ranger program for the Northern Network survey.

Indigenous Cultural Intellectual Property (ICIP) will be protected by ensuring that the consultation process with Indigenous groups includes discussion of, and identification of, all sensitive issues that involve ICIP and defining a pathway to be guided by that (e.g. excluding sensitive areas from surveys) while otherwise keeping IPIC confidential where requested.

For projects where high levels of engagement are required, this engagement will be funded from the projects and resourced from a range of sources depending on the most suitable mix of engagement processes on a project by project basis.

Indigenous engagement and participation contact:

Name: Neville Barrett
Email Address: Neville.Barrett@utas.edu.au
Phone Number: 03-62268210

Project Milestones

Milestones	Due date	Milestone Status
Initial plan milestones		
Milestone 1 Completion of Y1 research plan	Due 1 June 2015	Complete
Milestone 2. Completion of workshop on mapping and classification approaches	Due 30 October 2015	Complete
Milestone 3. Completion of Workshop report	Due 30 Dec 2015	Complete
Milestone 4 Completion of desk top study report and collation of all existing shelf reef mapping data, identification of gaps	Due 1 June 2016	Complete
Milestone 5. Completion of report on national classification scheme for shelf reef systems	Due 1 June 2016	Complete
Milestone 6. Completion of initial gap-filling survey and associated survey report	Due 1 June 2016	Complete
Milestone 7. Data trawler developed to a national standard facility and incorporated within the national data infrastructure	1 Dec 2016	Complete
Milestone 8. Report on national database management protocols for acquired survey data, and links with data trawler	1 Dec 2016	Complete
Milestone 9. Report on collation of available biological and habitat inventory data for Commonwealth shelf waters and associated model development.	20 Dec 2016	Complete
Milestone 10. Completion of forward research plan with DOEE for gap-filling research projects	20 Dec 2016	Complete
Milestone 11. Updated blueprint on monitoring reef KEFs	1 June 2017	Complete

Revised plan milestones 2017	**Due date**	**Milestone Status**
Milestone 1: Completion BRUV national monitoring program workshop	28 Feb 2017	Complete
Milestone 2: Completion of prioritisation workshop	31 March 2017	Complete
Milestone 3: Completion of prioritisation workshop report	30 June 2017	Complete
Milestone 4: Completion of BRUV workshop report	30 June 2017	Delayed
Milestone 5: First National MPA scientific monitoring forum (management and science)	July 2017	Complete
Milestone 6: Report on outcomes from the first national marine monitoring forum	30 September 2017	Complete
Milestone 7: Report on national database management protocols for acquired survey data	1 December 2017	Complete
Milestone 8: Completion of agreed reporting template for CMR survey reporting	1 December 2017	Complete
Milestone 9: Completion of initial survey report from Hunter CMR surveys in 2017	30 December 2017	Complete
Milestone 10: Report on analysis of current CMR/MPA datasets for power/suitability of a range of potential indicators for national level reporting (inc AUV and BRUV datasets).	30 December 2017	Complete
Milestone 11: Report on national progress towards a national integrated monitoring program and how CMR monitoring may sit within it	30 December 2017	Complete
Milestone 12: All project outputs and data will be made publicly available and freely accessible on the internet	30 December 2017	Complete

Updated (2018-2020) milestones		
Milestone 1 – Signing of contract	*Due 1 Jan 2018*	*Complete*
Milestone 2 – Detailed research plan developed- Beagle/Hunter stage 2 AMPs	*Due 30 April 2018*	*Complete*
Milestone 3 - Detailed research plan developed for Lord Howe AMPS survey (pending MNF approval)	*Due 31 December 2018*	*Complete*
Milestone 4 - Beagle, Hunter Stage 1 and AMP surveys completed, Seamounts survey completed	*Due 31 December 2018*	*Complete*
Milestone 5 - Detailed research plan for Gulf of Carpentaria and Ningaloo surveys completed	*Due 1 April 2019*	*Complete*

Updated (2018-2020) milestones		
Milestone 6 – Gulf of Carpentaria AMP survey completed	*Due 31 December 2019*	*Survey will not proceed, resources directed to survey an alternative AMP. New survey scheduled for Northern Network AMP(s) with survey completion by 31 December 2020 (see new Milestones 19-25)*
Milestone 7 - Hunter stage 2 surveys completed	*Due 1 September 2019*	*Complete*
Milestone 8 – Detailed research plan developed for Elizabeth/Middleton survey completed	*Due 1 September 2019*	*Complete*
Milestone 9 – Draft survey reports for Beagle, Hunter stage 2 and Seamounts surveys completed	*Due 1 November 2019*	
Milestone 10 – Final survey reports for Beagle, Hunter stage 2 and Seamounts surveys completed	*Due 31 December 2019*	
Milestone 11 – Ningaloo survey completed	*Due 31 December 2019*	*Complete*
Milestone 12 – Hunter phase 2 survey completed	*Due 31 December 2019*	*Complete*
Milestone 13 – Detailed research plan developed for the SW Corner AMP survey	*Due 31 December 2019*	
Milestone 14 –SW Corner AMP survey completed	*Due 30 June 2020*	
Milestone 15 – Elizabeth/Middleton survey completed	*Due 1 November 2020*	
Milestone 16 – Elizabeth/Middleton report draft completed	*Due 1 November 2020*	
Milestone 17 – Synthesis products from cross Hub analysis of survey results, effectiveness of SOPs, and potential to inform cumulative pressures	*Due 31 December 2020*	
Milestone 18 – Elizabeth/Middleton, SW Corner and Ningaloo final reports completed	*31 December 2020*	
Milestone 19: Location of survey in northern network AMP finalised	Due 23 December 2019	
Milestone 20: Detailed research plan developed for northern network AMP survey (including a communication plan)	Due 31 July 2020	
Milestone 21: Northern network AMP survey completed	Due 30 November 2020	
Milestone 22: Northern network survey short-form Voyage Report completed	Due 31 December 2020	
Milestone 23: Northern network survey draft AMP Eco-Narrative submitted to Parks Australia	Due 20 March 2021	

Updated (2018-2020) milestones		
Milestone 24: Communication products for Northern network AMP survey made available on Northwest Atlas and submitted to PA for inclusion on AMPs Science Atlas	Due 20 March 2021	
Milestone25: Archive of data, samples and products for northern network AMP survey completed to approved open standard	Due 20 March 2021	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles.

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/*. Currently the project plans to have two main components to data management. The first is to work with the wider marine community to ensure data generated by key methods used in AMP surveys (BRUV, AUV, Towed video and multibeam) is able to be stored (or linked directly to) in national data facilities developed for each of these, and linked to an national integrated marine monitoring program. The second component will be new datasets generated by new AMP surveys outlined here. This data will be stored on the new data facilities (above) with metadata retained on the AODN portal. AUV data will be stored on Squidle + (currently being further developed by partnership with AODN), BRUV and Towed video data will be stored on Global Archive, Multibeam sonar data will be stored on the newly developed cloud facility at GA, with copies supplied directly to ERIN. Any biological specimens collected will be deposited as reference specimens in regional museums under guidance from MoV.

Publications, reports, factsheets, maps and images will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au. The Hub is also developing data access and visualisation methods in project D1, and we will work with that project to ensure all information products are readily discoverable and available to the department and are freely and openly available.

Name: Neville Barrett
Email Address: Neville.barrett@utas.edu.au
Phone Number: 0408334569

Project output	**Data Management and Accessibility**
Survey report for each specified AMP survey	Survey reports will be made available publicly available via the Hub website upon completion of each report
Research papers	All peer-research papers will be made available to the public through open access via the Hub's website (in accordance with the NESP Data Management and Accessibility Guidelines).
Communication products	Summaries of research voyages and major discoveries will be made available through the Marine Parks Science Atlas, including addition of new data layers with links to relevant data holdings for AMPs

BRUV datasets	All BRUV-based data will be added to the Global Archive database for public access on completion of the project. Metadata also available via AODN portal.
AUV datasets	All AUV imagery will be added to the AODN portal as per current practices. Scored data will be added to the Squidle+ archive developed by AODN, with metadata on the AODN and data publicly available on Squidle+ on completion of the project
Multibeam sonar datasets	All data will be processed and stored with Geoscience Australia and/or CSIRO, with processed data publicly available from their websites on completion of the project, and metadata on the AODN.
Towed video datasets	TBD
Taxonomic collections	TBD

LOCATION OF RESEARCH

It is anticipated that research will be undertaken within the Ningaloo, Tasman Fracture, Huon, Beagle, Hunter and Northern Network AMPs during the 2018-2019 period, with research in the Elizabeth/Middleton AMP in 2020 (to be updated in the 2019 plan) and research in the SW Corner AMP (to be updated in the 2020 plans). Additional research will be undertaken in adjacent waters as part of seamounts research, and shelf-based studies in the Hunter and Beagle region (examining trawl impacts).

PROJECT SPECIFIC RISKS

The major constraints to the success of the project are outlined in the table below.

Note: Table includes all project risks identified throughout the full life of the project, with many concurrent across project development through time.

In addition, 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.

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
1. Project approvals, i.e. not all surveys funded adequately	Moderate-may require project restructure	Low	Project mix, and specific project tasks will be adjusted for the available budget and capacity of researchers to engage.	Project leader
2. Under-budgeted, resulting in inability to complete all tasks within a given survey	Moderate-will require some project restructuring	Low	Delivery of each survey will be closely coordinated with Parks Australia, and survey goals will be adjusted flexibly to balance tasks with priority outcomes.	Project leader in collaboration with individual survey leaders.

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
3. Weather, staff, vessel and key equipment availability	Moderate, may result in delays or shortening of days at sea.	Low	Surveys will plan for contingencies, including flexible timing and as above, closely coordinate with Parks Australia to optimise outcomes if sea time is restricted.	As above.
4. Day to day OH&S risks e.g. shipboard injury	Moderate-may impact days at sea for example	Low	Managed through the OH&S protocols in each institution/workplace. All partner organisations have national standard level protocols and procedures in place.	Project leaders on individual survey components, and associated delegated representatives within each collaborating institution.
5. Coordination and cooperation across Hub partners	Moderate- may impact on extent of project deliverables	Low	Managed through a mix of face to face meetings, regular fortnightly phone meetings once project planning is initiated, clear within-survey plan milestones, and engagement with partners with a track record of collaboration.	Project and survey leaders.
6. Insufficient Indigenous engagement.	Moderate- variable across projects.	Low	Managed via well-developed Indigenous engagement across surveys (detailed in survey plans) with appropriate budgeting for engagement and adequate lead time for project planning in areas of highest Indigenous interest.	Survey leaders
7. Poor or disrespectful Indigenous relationships	Moderate - project does not achieve its collaborative potential for Indigenous engagement and participation and potential benefits to Indigenous people and communities are not realised	Low/Medium	Respective survey leaders will effectively engage with relevant/interested Indigenous communities at all stages of the surveys, including planning and execution of survey and also to communicate the survey findings, and where agreed in development of communication products. Survey leaders will also effectively and promptly communicate any changes to planned surveys to ensure relevant Indigenous people and communities are informed.	Survey leaders

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
8. Changing departmental priorities- e.g. emergence of higher priority survey areas from Parks Australia	Moderate- Will require significant restructuring of staff and resources	Low	Has been managed to date via extensive consultation with DoEE and Parks Australia in particular. Current plans are sufficiently flexible to allow some changes to target AMPs, and the project partners have capacity to undertake additional surveys if co-funding is available to meet emerging priorities.	Project leader and survey leaders

PROJECT KEYWORDS

biodiversity, rocky reef, monitoring, AMP, Key Ecological Feature (KEF).

PROJECT CONTACTS

Researchers and Staff

******NOTE: Current FTE's shown here are for whole of project across the years 2018-2020.***

Name	Organisation	Project Role	FTE	2018	2019	2020
Alan Williams	*CSIRO*	Survey Leader, ecology- Seamounts	0.1	0.05	0.05	
TBA	CSIRO	Benthic ecologist- Seamounts	1.0	0.5	0.5	
Darryn Sward	University of Tasmania	PhD student – ROV SOP development	3.0	1.0	1.0	1.0
Neville Barrett	University of Tasmania	Project leader, ecological studies	0.9	0.3	0.3	0.3
Jacquomo Monk	University of Tasmania	Postdoc-benthic ecology	3.0	1.0	1.0	1.0
Justin Hulls	University of Tasmania	Technical support, fieldwork, data analysis, GIS	3.0	1.0	1.0	1.0
Vanessa Lucieer	University of Tasmania	Spatial analyst co-ordinating	0.3	0.1	0.1	0.1
Scott Nichol	GA	Survey leader/geoscience	0.75	0.2	0.25	0.3
Ian Atkinson	GA	Multibeam engineer/operations*	0.6	0.15	0.2	0.25
Justy Siwabessy	GA	Multibeam acquisition/processing*	0.6	0.15	0.2	0.25
Kim Picard	GA	Multibeam acquisition/interpretation*	0.6	0.15	0.2	0.25
Rachel Nanson	GA	Geomorphology/sediments interp	0.65	0.10	0.35	0.20
Andrew Carroll	GA	Benthic ecology – epifauna*	0.25	0.05	0.15	0.05
Rachel Przeslawski	GA	Benthic ecology – infauna (tbc)	0.45	0.15	0.15	0.15
Zhi Huang	GA	Spatial analysis/modelling	0.3	0.05	0.2	0.05
Marcus Stowar TBC	AIMS	Voyage leader*	0.15		0.15	0.15
Neill Roberts	AIMS	Towed video technician*	0.15		0.15	
Matt Birt TBC	AIMS	BRUVS technician*	0.15		0.15	

Name	Organisation	Project Role	FTE	2018	2019	2020
Mark Case TBC	AIMS	Field data management*	0.15		0.15	
Jamie Colquhoun	AIMS	Image analysis (benthic)	0.3			0.3
Kathy Cure	AIMS	Image analysis (fish)	0.1			0.1
Marji Puotinen	AIMS	Predictive modelling	0.3		0.2	0.1
Karen Miller	AIMS	Project Lead	0.5	0.05	0.25	0.2
Martial Depczynski	AIMS	Indigenous coordination	0.3	0.05	0.15	0.1
Russ Babcock	CSIRO	Project co-ordination, Ningaloo survey	0.1		0.05	0.05
Mat Vanderklift	CSIRO	Benthic ecology	0.1		0.05	0.05
Tim Langlois	UWA	BRUV and fish ecology	0.1		0.20	0.20
Emma Lawrence	CSIRO	Sampling design and biostatistics	0.25		0.15	0.1
Mick Haywood	CSIRO	BRUV and fish ecology	0.25		0.2	0.15
Stuart Edwards	CSIRO	Acoustics engineer/multibeam operations	0.1		0.1	
Karl Forcey	CSIRO	Benthic video sampling	0.3		0.15	0.15
TBC	UWA	Video analysis	1.2		0.6	0.6
Mark Tonks	CSIRO	BRUV sampling	0.2		0.1	0.1
Mike Taylor	UWA	BRUV sampling	0.2		0.1	0.1
Simon Collings	CSIRO	Multibeam analysis and habitat modelling	0.6		0.3	0.3
Cindy Bessey	CSIRO	Tow video analysis	0.4		0.2	0.2
TBA	UWA	Biological surveys (Capes AMP 2020)	0.5			0.5
TBA	UWA	Biological surveys (Capes AMP 2020)	0.5			0.5
Peter Davies	NSW OEH	Mapping	0.3	0.1	0.1	0.1
Tim Ingleton	NSW OEH	Mapping	0.3	0.1	0.1	0.1
Alan Jordan	NSW DPI	Mapping/Ecological studies	0.3	0.1	0.1	0.1
David Harasti	NSW DPI	Mapping/Ecological studies	0.3	0.1	0.1	0.1
Joel Williams	NSW DPI	Mapping and BRUV collation, sampling and post processing	1.8	0.6	0.6	0.6
Technical Officer	NSW DPI	Field surveys for BRUVs and towed video/ROV	0.3	0.1	0.1	0.1

Data Management

Name	Organisation	Email	Phone
Neville Barrett	*University of Tasmania*	Neville.barrett@utas.edu.au	0408334569

Co-contributors

Name	Organisation/	Contribution
Dr Stefan Williams	IMOS AUV facility	Co-investment IMOS capacity
Roger Proctor	IMOS/AODN	National Database development (BRUV/AUV)

Key Partners and Research End Users

Key Partners (organisation/program)	Name/s	Email (optional)
DoEE- Parks Australia (AMPs)	Jason Mundy/David Logan/Hilary Schofield/Bianca Priest/Jacqui Doyle	
DoEE- Parks Australia-SE AMP management	John Lloyd/Samantha Fox/Bianca Priest	
DoEE- Regional Marine Planning	Jillian Grayson	
DoEE SoE reporting.	Boon Lim	
DoEE Knowledge and Technology Division- ERIN	Carolyn Armstrong	
Department of the Environment and Energy – Biodiversity Conservation Division – Biodiversity Policy Section	Tia Stevens	Tia.Stevens@environment.gov.au
Department of the Environment and Energy - Heritage Reef and Marine Division – Reef Trust	Kevin Gale	Kevin.Gale@environment.gov.au
Department of Agriculture and Water Resources	Emma Lowe	Emma.lowe@agriculture.gov.au
Wetlands Section, CEWO	Jenny Tomkins	
Department of the Environment and Energy - Biodiversity Conservation Division - Protected Species and Communities Branch - Marine and Freshwater Species Conservation Section (inc Black cod).	Lesley Gidding-Reeve	

Research Users (program/section/branch/organisation)	Name/s	Email (optional)
All DoEE Key Partners listed above	As per Key Partners	
AFMA	Ryan Murphy	
NOPSEMA	Christine Lamont/Cameron Sim	
Torres Strait Regional Authority	Stan Lui	
State Fishery and Conservation agencies	e.g. Alan Jordan (NSW DPI- Fisheries), Dr Lynda Bellchambers, WA Fisheries.	
IMOS	Michelle Heupel Anna Lara-Lopez	
AODN	Sebastien Mancini	
Regional fishing and conservation groups	Dependent on survey location	
Regional Indigenous groups	Dependent on survey location	

PROJECT D3 – APPENDIX 1
- SURVEY PROPOSAL: BENTHIC HABITATS AND BIODIVERSITY OF MARINE PARK(S) IN THE NORTHERN NETWORK

Project length – 2.5 Years
Project start date – 1/7/2018
Project end date – 20/03/2021
Project approval date - TBC
Project current status - In progress

Project Leaders – Nichol/Miller
Lead Research Organisation – GA/ AIMS
Project leaders contact details: - k.miller@aims.gov.au; scott.nichol@ga.gov.au

Project Funding

	2018	2019	2020	TOTAL
NESP funding	*AIMS $24,000 GA $38,000*	*AIMS $476,000 GA $220,000*	*AIMS $98,000 GA $104,000*	*$960,000*
Cash co-con				
In-kind co-con	*AIMS $24,000 GA $38,000*	*AIMS $476,000 GA $220,000*	*AIMS $98,000 GA $104,000*	*$960,000*
TOTAL	*$190,000*	*1,294,000*	*$386,000*	*$1,870,000*

Project Variation The original survey to the Gulf of Carpentaria (GOC) AMP, originally scheduled for November 2019, was delayed to understand and accommodate the needs of Traditional Owners. The planned GOC survey will not proceed due to constraints associated with the NESP funding period and the low likelihood of completing a collaborative GOC survey within the funding period. Instead, the resources allocated to this survey will be redirected to conduct a similar survey in another AMP in Northern Australia where the survey can be completed within the NESP funding period. Alternative AMPs in the Northern Network being considered are Arafura, Arnhem or Wessel – with the final location to be agreed between the Hub's partners and Parks Australia following assessment of existing data, risk, science objectives and management priorities. This variation will not alter the overall research outcomes of this project and have no substantive resourcing or financial implications, and the budget has not been changed.

Project Summary

This collaborative project will be centred on an (up to) 16-day field survey (duration dependent on final location). The survey will be in November 2020, because this is the time of year with the best water quality and weather conditions in the Northern region which will maximise the quality of data collected and its value to end users. The voyage will build baseline information and test the effectiveness of SOPs for tropical benthic and demersal habitats in a Northern Network Marine Park and intersecting Key Ecological Features (Fig. 1). There are known canyon and/or reef features within each of these parks that support live coral and sponge communities (Wilson 2005, Reef Life Survey), but their true extent is unknown and they remain to be fully described from a biodiversity and ecological perspective. The survey will extend high resolution bathymetry, benthic imagery and sampling coverage within one of the Park(s), targeting features such as submerged reefs or canyons as well as representative

areas of soft sediment habitat. Data collected will be used to produce benthic habitat maps for mapped areas, as well as predictive habitat models. The survey will employ Standard Operating Procedures (SOPs) for all activities as developed in Project D2. These SOPs will include application of a spatially balanced sampling design informed by existing (legacy) data (i.e. high resolution bathymetry, benthic samples, Reef Life survey data), and testing/refinement of standardised procedures for multibeam sonar mapping, benthic sampling (sleds, grabs), towed video and BRUV deployment. Data processing and analysis will also adopt standard procedures (e.g. CATAMI for image scoring, SOPs for multibeam processing and lab analysis of samples; and predictive models). The project will incorporate available legacy data into analysis of new datasets, where possible (e.g. to identify change in benthic communities) and produce scientific outputs readily accessible to managers and the public.

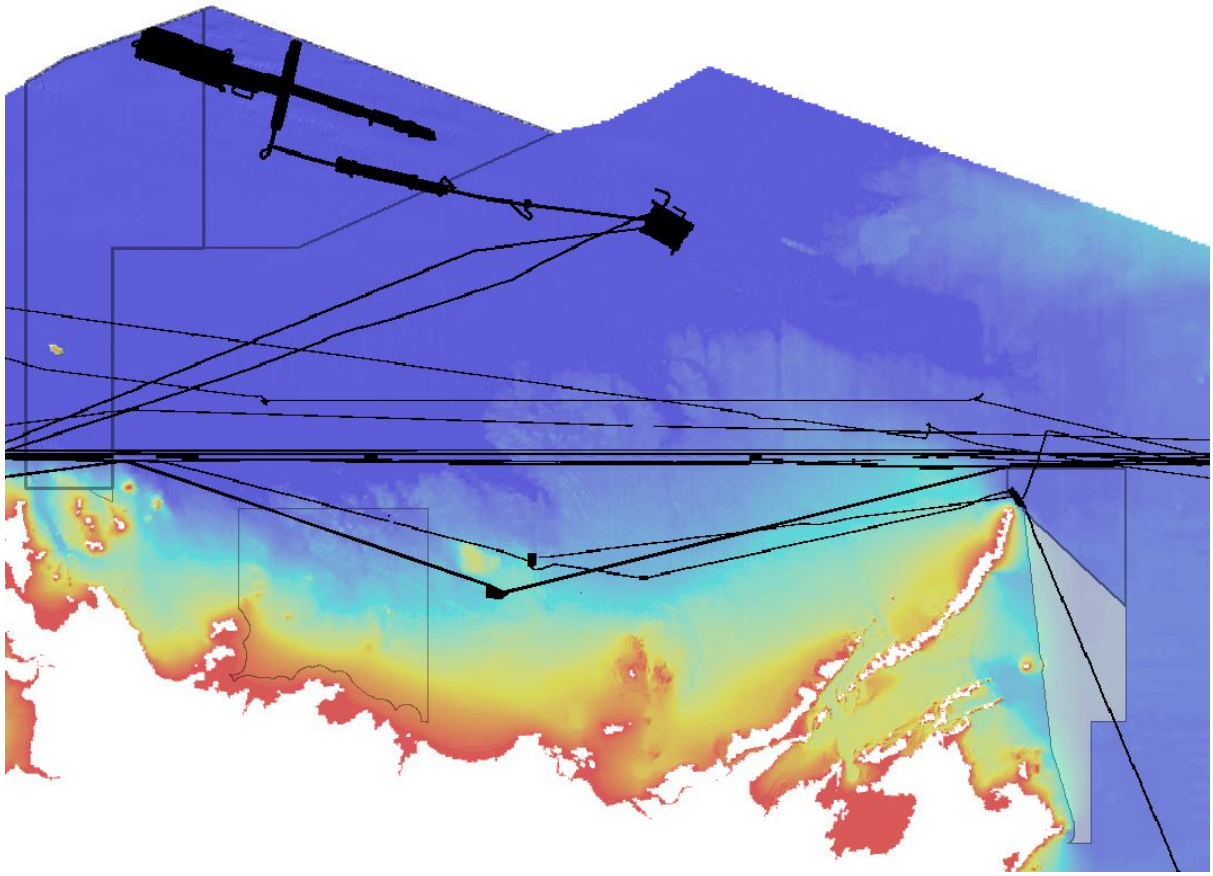


Fig. 1: Map of the three candidate marine parks (from left to right – Arafura, Arnhem, Wessel) in the Northern Network. Black lines indicate existing multibeam coverage in each park as of January 2019.

Indigenous engagement: During survey planning, the project leaders will engage with representatives from relevant Traditional Owners groups to align scientific objectives to the management plans for Indigenous Protected Areas (IPA) where they exist, or for sea country generally. This engagement will include exploring opportunities for direct participation of indigenous representatives in the project, building on the Indigenous SOPs program currently underway within AIMS and being implemented with a range of Traditional Ranger Groups across Northern Australia. AIMS and Parks Australia have existing relationships with the

relevant TO organisations associated with each of the potential survey areas which should minimise risk associated with engagement, collaborations and permissions.

Background and Research Questions

Beyond a general and high-level understanding of the biodiversity and environmental processes, our knowledge base to inform the ongoing management of most marine parks in the Northern Network is very limited. This was demonstrated in the 'gap analysis' of available data for the North and Northwest Marine Regions undertaken in Project D1 that identified most marine parks in the Northern Network were data deficient (Miller et al. 2017). Key data gaps are in bathymetry coverage, benthic reef and soft sediment biological assemblages, and data to describe spatial variations in those communities. As such, the project will address the following research questions.

- Do benthic communities vary in composition across the environmental gradients represented in the Marine Park (i.e. with distance offshore, depth, geomorphology and substrate type)?
- How well are the known benthic communities represented across the extent of Marine Park zones (where relevant)?
- How effective are available platforms (i.e. tow-video, BRUVs, grabs) for monitoring benthic communities in a tropical turbid setting, and what are the practical limitations?

Leveraging Existing Initiatives

The key opportunity for leveraging existing work in the Northern Network is to link with work already being undertaken with indigenous groups in Northern Australia. This includes, and will build on the AIMS NAMMA initiative (Northern Australia Marine Monitoring Alliance) which is empowering traditional owner groups to undertake monitoring in IPAs and sea country. Successful initiatives to date include work with the Anindilyakwa Land Council (see Mapping Makarda) and the Bardi Jawi Sea Rangers (see Indigenous Monitoring).

Legacy Data

A review of available data for the candidate marine parks will be undertaken and will feed into the decision-making process and planning for the survey. Data will be sourced from ARMADA, AODN and Reef Life Survey, and will include:

- High resolution multibeam bathymetry (Figure 1)
- Single beam bathymetry
- Seabed sediment samples
- Demersal trawl/sled samples
- BRUVS and Towed Video data
- Oceanography (CTD casts, ADCP current profiles)
- RLS Records (Figure 2)

The satellite imagery archive will also be utilised to provide additional context for assessing cyclone impacts including assessments of the spatial extent of turbid waters following cyclones and to track temporal trends in SST across Northern Australia. This will leverage work underway in the Hub within Project A12 and D2 (in terms of SOPs for using remote sensing as a monitoring tool).

Fig. 2: Reef Life Survey sites within the three candidate marine parks (from left to right – Arafura, Arnhem, Wessel) in the Northern Network.

Draft Project schedule:

The project variation will commence in November 2019 and run through to March 2021, with the following schedule:

2019 Nov-Dec:

- Review & collate legacy data (bathymetry, physical & biological samples, oceanography)
- Consultation with partners and Parks Australia to finalise AMP(s) to be surveyed and refine research questions; final survey destination to be determined by 23 December 2019

2020

- Survey planning, including sampling design (survey plan to be submitted to MBH by 31 July)
- Indigenous stakeholder consultation
- Prepare permit applications to undertake research in Marine Park and to Access Biological Resources
- Aug-October: Survey logistics planning, mobilisation
- Nov-Dec: Survey implementation, demobilisation, sample/data processing/archiving (Voyage Report delivered to MBH by 31 December)

2021

- Jan-March: Initial data processing/analysis and preparation of final report in the form of an EcoNarrative (draft delivered to PA and MBH by 20 March)
- Archival of data, samples and products to be completed to approved open standard by March 20, 2021

Planned Outputs

The outputs for this project will include:

- Short-form voyage report listing survey activities, data collected (plus metadata) and preliminary observations;
- High resolution bathymetry and acoustic backscatter data and maps for targeted areas;
- Underwater images (video, still) of benthic communities and demersal fish assemblages;
- Species inventory for observed epibenthic biota and demersal fish;
- Habitat map(s) and coverage estimates representing areas mapped within the park(s), showing seabed features, and associated coral and sponge communities (where possible, maps will integrate data from previous CSIRO/MNF, RLS and GA surveys with results from this survey);
- Maps of predicted habitat distributions for key benthic taxa (sponges, hard corals, octocorals, demersal fish) across the marine park, including estimates of uncertainty;
- Eco-narrative summarising key physical and biological characteristics of the marine park, incorporating new knowledge from this survey;
- Publications in peer reviewed literature;
- Communications products (see below)

Science Communication Plan

Products to publicly communicate the conservation values of the chosen Marine Park will be targeted on highlighting the undersea landscape of features such as reefs or canyons and associated biota, such as hard corals and fish communities. Products to include photos and videos of benthic communities, and a bathymetry flythrough. These products and linked data to be made publicly available on the Marine Parks Science Atlas and/or Northwest e-Atlas. We will also actively engage the public during the survey (e.g. social media, blog, media release). Results will be presented and provided to the relevant Traditional Owner groups as well as Parks Australia.

References

Miller, K. Puotinen, M., Przeslawski, R., Huang, Z., Bouchet, P., Radford, B., Li, J., Kool, J., Picard, K., Thums, M., Meeuwig, J., Nichol, S. 2017. Ecosystem understanding to support sustainable use, management and monitoring of marine assets in the North and North-west regions: Final Report. NESP Marine Biodiversity Hub Report.

Wilson, GDF (2005) Arafura Sea Biological Survey – Report of RV Southern Surveyor Expedition 05/2005 28 April-28 May 2005. Report prepared for the Department of the Environment and Heritage – National Oceans Office by the Australian Museum.

Case, M., Harries, S. and Miller, K. (2019) Wessel Marine Park Multibeam Survey. Report to Parks Australia. 13 pp

PROJECT D3 – APPENDIX 2 – SURVEY PROPOSAL: BENTHIC HABITATS AND BIODIVERSITY OF THE BEAGLE CMR SHELF WATERS

Project length – 2 Years
Project start date – 1/1/2018
Project end date – 31/12/2019
Project approval date - TBC
Project current status - In progress

Project Leaders – Neville Barrett/Scott Nichol
Lead Research Organisation – (UTas, GA)
Project leader contact details: - Neville.barrett@utas.edu.au/ scott.nichol@ga.gov.au

Project Funding

	2018	*2019*	*2020*	*TOTAL*
NESP funding	*UTas $200,000 GA $120,000 CSIRO MoV Vessel charter (Agency independent) $100,000*	*UTas $100,000 GA $55,000 CSIRO MoV*		
Total NESP Funding	*$420,000*	*155,000*		*$575,000*
Cash co-con				
In-kind co-con	*UTas $200,000 GA $120,000 CSIRO MoV*	*UTas $100,000 GA $55,000 CSIRO MoV*		
TOTAL	*$740,000*	*$310,000*		*$1050,000*

Project Summary

This project will undertake a field survey to build baseline information for benthic habitats in shelf waters of the Beagle CMR, in addition to establishing a sound monitoring baseline for ongoing monitoring of Bass Strait habitats. It applies a standard operating protocol (SOP)-based standard and consistent approach to inventory and monitoring as a model example of how such surveys should be undertaken more widely throughout the CMR network in shelf waters. The prioritisation of this CMR, and methods used, is based on (1) the need for additional baseline/monitoring within the SE CMR network as part of the current 10 year management plan; (2) known significant pressures, including commercial fishing (trawling and shark) on low profile shelf reef and sediment systems, (3) need for baseline biological data

(despite listing on the basis of representation of sponge gardens there is no quantitative knowledge of their presence/distribution) (4) potential for SOE reporting based on condition of targeted fish stocks (including trawl species) and habitats, and climate-related shifts in benthic species distributions; (5) potential for linking surveys and SOPs with adjacent O&G developments and monitoring programs- including future assessment of impacts/benefits of O&G infrastructure and operations, leading to industry uptake of SOP approaches; (6) significant alignment with state interest, including adjacent (conjoining) MPA's and MPA monitoring programs in Victoria (Wilsons Promontory Marine Park) and Tasmania (Kent Group Marine Reserve); (7) potential for engagement with the Indigenous communities in the region based on improved understanding of land-bridge connections between Tasmania and Victoria, including migration pathways.

The intent of the survey is to apply the core benthic SOPs being developed by the Hub for inventory and monitoring programs (e.g. MBS, AUV, BRUV, TV) while also providing opportunity to trial use of IMOS tools such as passive midwater acoustics to map aspects of pelagic productivity.

There has been some limited previous seabed mapping of the area as part of Australian Hydrographic Office (AHO) surveys (including a recent charter of the MNF), that indicate that the area may be primarily dominated by soft sediments with some low-profile reef. The reefs are recognised as a Key Ecological Feature (KEF) but their true extent is unknown and they remain to be described from a biodiversity and ecological perspective. Preliminary mapping data from the AHO suggests there may be a narrow, elevated reef ridge running between the Hogan Island Group and the Kent Group, one that potentially formed part of a land bridge between Tasmania and Victoria during the last glacial period. Improving our understanding of the bathymetry of this region will allow modelling of this, leading to engagement with regional Indigenous communities who have expressed significant interest in understanding migration pathways.

The Beagle CMR currently has category VI zoning which means demersal trawl, danish seine and scallop dredge fishing methods are not allowed. As this reserve will have been in place for a decade in 2018, it provides an opportunity to assess changes associated with protection from such fishing activities, by contrasting the condition of biological assemblages in it with those of adjacent fished areas, and potentially with those associated with O&G infrastructure (such as pipelines), that have had de-facto protection from fishing activities over a longer period. Hence, new surveys in this region will not only provide a biological baseline, but also establish a basis for a longer-term monitoring program, while undertaking a first assessment of the effectiveness of category VI zoning for benthic habitat protection.

The proposed survey will produce a full coverage, high resolution maps of representative habitats within the CMR, including areas of the rocky reef KEF, allowing these to be subsequently surveyed quantitatively using the SOP-based biological sampling activities, as developed in Project D2. Currently, proposed SOPs include MBES, AUV, Towed Video, BRUVs to provide broad scale to fine scale quantitative descriptions of the habitats, assemblages and fish species that represent the CMR. Biological surveys will follow best-practice spatially balanced designs developed during the NERP Hub and refined under project D2 in the NESP Hub. Data processing and analysis will also adopt standard procedures (e.g. CATAMI for image scoring of AUV and TV derived imagery, SOPs for multibeam processing and BRUV processing.

Proposed outcomes include

A successful demonstration of the utility of a nationally consistent approach to survey and inventory of shelf habitats in CMRs, with a focus on shelf reefs, leading to longer-term uptake by Parks Australia in a well-structured monitoring program.

Successful uptake of SOPs and incorporation of outputs into national databases, demonstrating a data acquisition and management pathway to be adopted by long-term CMR monitoring programs, as well as by all agencies involved in inventory and monitoring by SOPs in state and commonwealth waters (including oil and gas industries-a key focus of the Beagle survey).

An improved understanding of the habitats and biota in a CMR region subject to heavy human pressures (fishing, O&G), leaving to an improved capacity to adaptively manage these pressures to meet planned conservation outcomes.

Improved integration of CMR inventory and monitoring programs with state programs based around standard methods such as AUV and BRUV (e.g. as used in adjacent MPAs).

Improved ability to report into the SOE, via enhanced regional coverage, analysis of decade-scale trends (AUV), and a focus on key reporting metrics such as biomass of target finfish species and lobsters (BRUVs and potentially limited lobster potting).

An initial evaluation of the effectiveness of Category VI protection of benthic habitats in the SE network, where benthic trawling has been prohibited for a decade.

Planned Outputs

The outputs for this project will include:

- Post survey report describing data acquired on the survey and preliminary interpretations, in a format to be used as an example reporting template for subsequent CMR surveys (similar to existing Tasman Fracture survey report)
- Acquired data contributed to national databases (e.g. AUV-Squidle, BRUV- Global Archive, MBES –GA/AHO)
- High resolution bathymetry and acoustic backscatter data and maps for representative areas of shelf waters (including rocky reef KEF) within the Beagle CMR
- Underwater images (video, still) of benthic invertebrate and fish communities
- Species inventory for observed and sampled biological specimens (epibenthic and infaunal)
- Habitat map(s) and coverage estimates representing the submerged reefs KEF and soft sediment habitats within representative waters of the Beagle CMR, including sponge dominated low-profile reefs and higher profile reef ridges
- Qualitative model for the rocky reef KEF and associated soft sediment habitats within the Beagle CMR
- Publications in peer reviewed literature
- Communication products (images, bathymetry flythrough) highlighting submerged reefs and associated biota. Published in the proposed MPA/CMR atlas and MBH website.

Overall justification against requested additional criteria

1. Likely uptake of results by Parks Australia: High. This survey addresses the need for initiation of baseline inventory and monitoring in the SE CMR network as outlined in the SE network management plan. This is currently the only network with a management plan in place. As there is currently no knowledge of the distribution of habitats and species within this CMR, the acquired knowledge will be essential to informing ongoing management planning and responses. More generally, by applying a broad set of SOPs specifically tailored to CMR monitoring, in a typical shelf setting, the demonstration of the efficacy of such approaches will be of significant interest to PA in evaluating the merit of such approaches for use in the longer-term.
2. Contribution to a 10 year monitoring strategy. High. Benthic shelf habitats have been assessed as those most under anthropogenic pressure, most likely to benefit from CMR protection, and under-represented in higher levels of protection with respect to other environments (slope, abyssal plains, seamounts). This survey will evaluate the effectiveness of SOPs specifically developed for benthic shelf habitats and their associated biodiversity in a regional context (SE CMR network), and form a component of a planned program intended to provide representative national coverage over a ten-year period. By also focussing on evaluating human impacts on these habitats (including benthic trawling) it will allow evaluation of the efficacy of current management strategies (Habitat protection zoning) in time for future reviews of management plans. Finally, part of the 10 year strategy is to assist PA in meeting inventory and monitoring goals, and this survey does so addressing needs within the current SE network management plan, including inventory and baselines in previously unsurveyed CMS in the network.
3. Opportunity for collaboration with industry partners. High. A primary determinant of the Beagle CMR survey proposal as a priority for the SE region (as opposed to other listed proposals such as the Huon and Freycinet CMS, or potential for other such as Apollo, Zeehan, Franklin or Boags, was the interest from Oil and Gas industries in understanding the Beagle region adjacent to offshore Gippsland O & G developments, and the potential to collaborate with industry in evaluation of the influence of O & G infrastructure in enhancing biodiversity values of the area (e.g. via protection from trawling, or provision of habitat structure). As part of this, there is potential for uptake of Hub-developed SOPs as part of industry0basedenviornmental monitoring of the broader Gippsland region.
4. Science excellence. High. In addition to a commitment to science excellence through undertaking surveys based on Hub-developed SOPs and statistically-based sampling designs, and subsequent publication of these approaches and results in the primary literature, the survey will have a core focus on assessing human impacts on soft sediment and low profile reef fauna and flora via trawl fisheries and scallop dredge fisheries, as this CMR will have been protected from these for over ten years by the time of the survey. By contrast with adjacent fished habitats, and those protected for longer periods via O & G infrastructure such as pipelines, and linking with quantitative effort data from VMS, we will develop the first quantitative assessment of the efficacy of habitat protection zonation in shelf waters subject to moderate trawl effort. This will not only be an excellent science outcome of international interest, it will significantly influence public and management understanding of human impacts and management responses.
5. Capacity of science communication from the survey to achieve high public interest - high. Many of the research activities lead to visually appealing communication products, including detailed bathymetric maps, BUV-based video footage, AUV based still and video imagery, and towed video imagery. In addition to public interest in the biodiversity values of waters near major population centres such as Melbourne, there is

significant international interest in understanding the environmental impacts of trawl fisheries.

Indigenous engagement:

During survey planning, the project leaders will engage with representatives from the Tasmanian and Victorian Indigenous communities, including representatives from the Federation of the Victorian Traditional Owner Corporations and the Tasmanian Aboriginal Centre who currently represent these communities on the SE CMR Forum facilitated by Parks Australia. Initial discussions with members of the Tasmanian aboriginal community indicate a significant interest in gaining further knowledge of the migration pathways connecting Tasmania and Victoria during previous glacial periods as the Beagle CMR spans an elevated portion of the land-bridge that once connected the island groups of this region to the adjacent states. Improved bathymetry will reveal likely pathways as well as potential refuges in rocky outcrops, and there may be potential for grab sampling to target adjacent sediments for evidence of middens if distinct features are identified.

Researchers and Staff

* - denotes on survey

Name	2018 FTE	2019 FTE	Organisation	Project Role
Scott Nichol	0.1	0.05	GA	Project co-ordination, geoscience*
Ian Atkinson	0.15		GA	Acoustics engineer/multibeam operations*
Andrew Carroll	0.05	0.05	GA	Benthic ecology / SOPs
Zhi Huang	0.05	0.1	GA	Spatial analyst
Rachel Nanson	0.1	0.15	GA	Geomorphology interpretation
Kim Picard	0.15		GA	Seabed acoustics/geomorphology*
Rachel Przeslawski	0.05	0.05	GA	Benthic ecology / SOPs
Justy Siwabessy	0.15		GA	Seabed acoustics/mapping*
Neville Barrett	0.3		UTas	Project leadership, benthic ecology
Jacquomo Monk	1.0	0.5	UTas	Benthic ecology – AUV and BRUV
Vanessa Lucieer	0.1	0.1	UTas	Acoustics-spatial analysis
Justin Hulls	1.0	0.5	UTas	Technical support
Scott Foster			CSIRO	Statistical support (from D2)
Rudy Kloser			CSIRO	Passive acoustics – mesopelagic productivity- From IMOS
Tim O'Hara	0.1		MoV	Benthic taxonomy – From D4

Co-contributors

Name	Organisation/	Contribution
Stefan Williams	USyd/IMOS	AUV facility support-IMOS

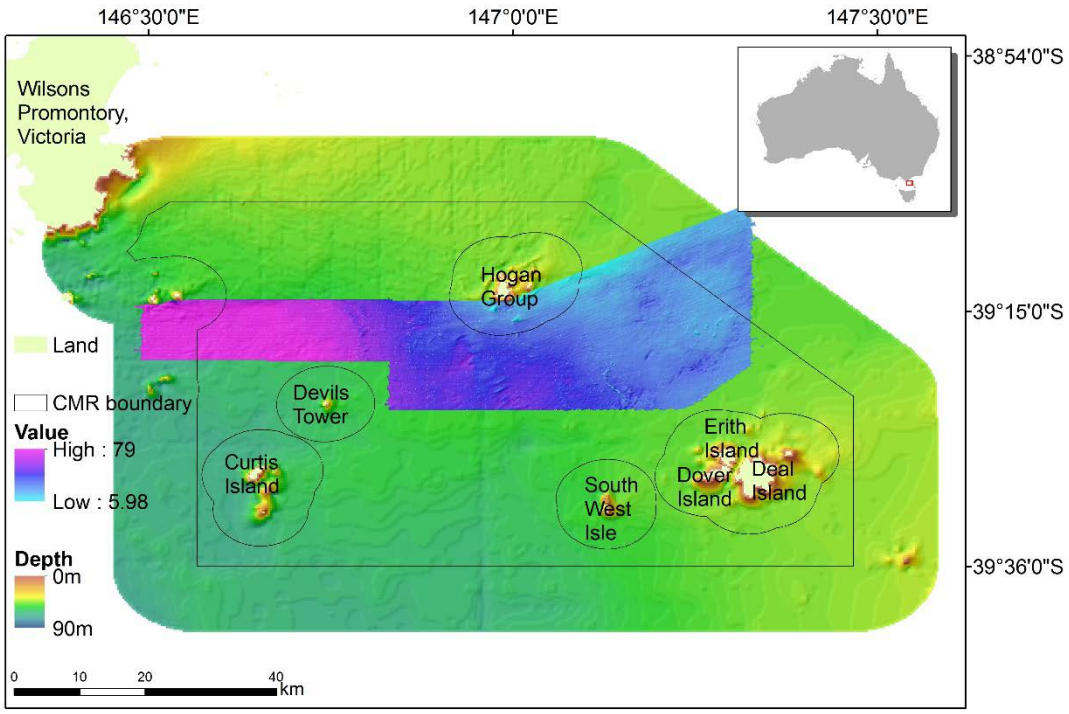


Fig. 1: High resolution bathymetry coverage in Gulf of Carpentaria CMR

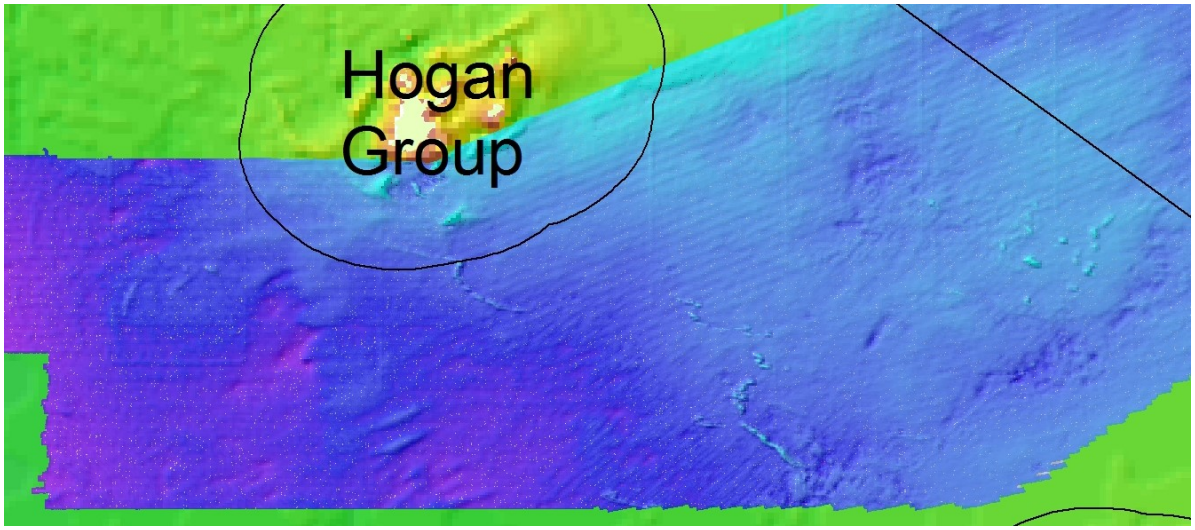


Fig. 2: High resolution bathymetry coverage in the Beagle CMR showing fine ridges between the Hogan Group and the Kent Group to the SE.

References

Nil. No previous surveys have been reported from this area.

PROJECT D3 – APPENDIX 3
- STATUS AND RECOVERY OF DEEP-SEA CORAL COMMUNITIES ON SEAMOUNTS IN THE ICONIC HUON AND TASMAN FRACTURE COMMONWEALTH MARINE RESERVES

Project summary

Australia has gazetted an ambitious national network of Commonwealth Marine Reserves that includes the iconic Huon and Tasman Fracture reserves off Tasmania where seamounts ('undersea mountains') support unique deep-water coral reefs. These reefs are among the most bio-diverse globally.

Protection of deep-water coral reefs is a high-priority conservation concern nationally and internationally because deep-water corals are very fragile, easily impacted by human activities including bottom trawling, and are believed to recover very slowly. These corals may also be highly vulnerable to climate change because projected changes in water chemistry could limit the ability of corals to build calcareous skeletons.

Despite these concerns, and Australia's significant investment in marine conservation, several fundamental ecological issues remain to be evaluated. These include defining the spatial extent of deep-sea coral communities inside and outside the Tasmanian reserves, and evaluating the resilience of the communities to bottom trawling. This information is important to understanding the dynamics of deep-sea communities globally, and for further developing and implementing Australia's conservation management plans.

A 26-day survey aboard RV Investigator will determine the spatial extents of deep-sea coral communities in and adjacent to the Huon and Tasman Fracture reserves, and quantify changes in the communities by comparing samples taken in 2018 to samples taken, using similar methods, in 2007 and 1997. There will be supplementary sampling on the heavily trawled St. Helens Seamount which was surveyed in 2008, and analysis of comparable data from New Zealand. Remarkably, these are the only two sets of replicated surveys encompassing areas of contrasting conservation status and impact history in the world's oceans.

Our results will be novel and significant by providing world-first recovery and resilience data to the Australian government and other national and international bodies that will help achieve effective monitoring and management actions to enhance the long-term survival probabilities of deep-sea corals.

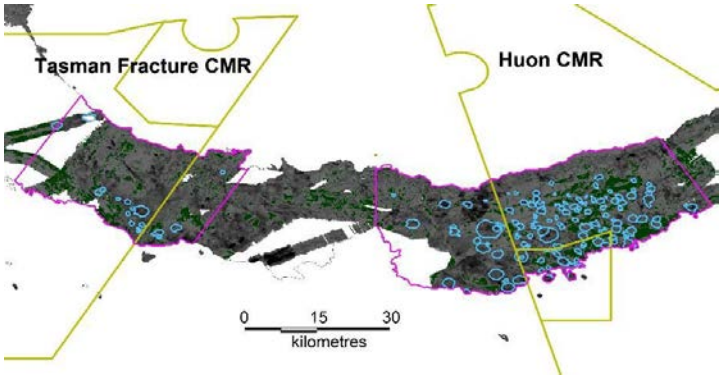


Figure 1. The two survey areas (pink boundaries) representing the areas containing the clusters of seamounts (blue outlines) off southern Tasmania, and bounded by the 500 and 2000 m isobaths. Map underlay shows high resolution MBS data coverage in the 500-2000 m depth zone.

Six types of sampling will occur: (1) Multi-beam sonar mapping of gaps in study area coverage; (2) Towed camera surveys of seamount and non-seamount areas to ground-truth predictive maps of coral community distributions; (3) Repeat towed camera surveys of previously sampled seamounts to extend the time-series dataset on the recovery trajectory of deep-sea coral communities; (4) CTD sampling of water chemistry; (5) BOAGS static camera deployments for very close and high resolution imagery, including of arrays of settlement plates on the 'Sisters Seamount'; (6) Beam trawl and benthic sled collections of fauna to improve taxonomic understanding of the fauna, and to provide tissue samples for related studies.

Planned outputs

The distributional extent, habitat associations, composition, biodiversity, and biological traits of deep-sea coral communities off Tasmania, both inside and outside the Huon and Tasman Fracture reserves, will be determined and mapped for the first time. This information will contribute to a status report on coral communities and provide context for the recovery study. The status report and an understanding of changes in coral communities through time will inform future planning by the Australian and other management agencies to monitor and manage deep-sea coral reefs as conservation assets. Our results also have international relevance to understanding and managing fishing impact on comparable deep-sea coral communities, including in High Sea areas beyond national jurisdictions.

New data will be combined with previous surveys of the seamounts in the Huon and Tasman Fracture CMRs in 1997 and 2007, the St. Helens Seamount in 2008, and parallel New Zealand studies in 2001, 2006, 2009 and 2015, to address three broad objectives:

1. Determine the extent, ecological characteristics, and conservation status of deep-sea coral reefs on Tasmanian seamounts inside and outside of existing reserves.
2. Measure recovery trajectories and dynamics of deep-sea coral communities (multi-species and successional changes) following cessation of bottom trawling.
3. Provide the first set of empirical data on conservation status, resilience and recovery potential to enhance management and conservation of deep-sea coral habitats nationally.

Researchers and staff

There are opportunities to include NESP Hub staff, including students, in addition to staff listed below:

Alan Williams, Scott Foster, Franzis Althaus, Ron Thresher (CSIRO): establishing and managing the overarching project; designing and implementing the field survey; acquisition, analysis and write up of data, especially those related to climate change; spatial predictive modeling

Nic Bax (CSIRO/ UTAS): input to, and oversight of, the project's links with stakeholders – especially Australia's Dept. of Environment and Energy – and with the NESP Biodiversity Hub.

Malcolm Clark (NIWA): lead role in the acquisition, analysis and write up of data, especially those related to the complementary datasets from New Zealand.

Neville Barrett, Nicole Hill (UTAS): marine ecology and Hub linkage; spatial predictive modelling Tim O'Hara (MV): deep sea biodiversity

Karen Miller (AIMS): coral ecology

Thomas Schlacher (USC): lead role in the acquisition, analysis and write up of data, especially those related to the faunal recovery objectives.

Resources

26 days on RV Investigator are secured (22 Nov to 17 Dec, 2018) (26 days @ 129K = 3.354 M); the proposal was reviewed by, and has strong support from, the Department of the Environment and Energy

NESP contribution: 415K: initial estimate - 50% of 3 FTE (e.g. pre-survey predictive mapping, survey implementation, post survey analysis, reporting, outreach, peer-reviewed papers) plus consumables

Co-investment by CSIRO and NIWA: agreed in principle

PROJECT D3 – APPENDIX 4
- ASSESSMENT OF ECOLOGICAL ASSETS AND CONDITION OF SHELF HABITATS IN THE HUNTER CMR

Project Timeframe: January 2018 - December 2019

Project Leaders: Alan Jordan, Peter Davies, Neville Barrett

Project Partners: NSW OEH, NSW DPI, University of Tasmania

Indicative project cost

$106K NESP cash contribution in each of years 1 and 2 with matching in-kind for NSW DPI and OEH, with $100k NESP Cash contribution to UTas in 2019 with matching in-kind. Total $312,000.

Project Summary

There is a significant and time critical need to support Parks Australia in the establishment of a baseline inventory and monitoring program for CMR networks, and ensure it is integrated within a broader national monitoring framework. Previous seabed mapping surveys of the mid-shelf areas of the Hunter CMR have identified areas of shelf rocky reefs. These reefs are recognised as a Key Ecological Feature but their extent is unknown and their biodiversity remain to be described. The proposed surveys will extend high resolution bathymetry and benthic invertebrate and fish sampling coverage across the CMR, targeting features such as the shelf rocky reefs and adjacent areas targeted by demersal trawlers. By facilitating national approaches, including a standards-based approach to collecting new marine data, the project outcomes will include key steps to assist Parks Australia to implement and initiate a CMR monitoring program, new knowledge to inform CMR management planning, a national integrated framework for SOE reporting, and strong collaboration between State-based and Commonwealth-based programs.

Description of the problem

While work so far in theme D has improved our knowledge of the distribution of key biodiversity assets on the continental shelf within the Hunter CMR, the coverage represents a very small fraction of the marine park. In particular, the seabed habitats on the inner shelf of the CMR adjacent to mapped features in the adjacent Port Stephens Great Lakes Marine Park are expected to contain both extensive shelf rocky reefs and sand habitats that are regularly fished by both demersal trawl and ocean trap and line fisheries. There are also known features that are targeted by recreational fishers. Previous seabed mapping in the CMR in project D3 has identified such features, which differ in structure to the inshore reefs.

Much of the area of the mid-shelf in the Seal Rocks and Broughton Island region was considered during the CMR review process to provide a suitable area for the only no-take zone in the reserve, but information gaps on ecological assets and recreational and commercial values resulted in this area remaining as open to all activities.

This proposal aims to address these significant knowledge gaps in conjunction with the pressures assessment identified in the Hub proposal in Theme E that is examining recreational fishing in the region. It would also include an initial assessment on the potential impacts associated with demersal trawling in the mid shelf region of the CMR, and examine this in the context of ecological risk using established methodologies. The surveys would also allow further baseline information to be collected on the current condition of the shelf rocky reefs, with the adjacent PSGLMP no-take zones being used as the CMR reference sites. This includes an assessment of the significance of these habitats for threatened and protected

species. This area provides a unique opportunity to conduct this condition analysis on reef fish assemblages on a shelf CMR in the temperate east region given the significant no-take zone datasets in state waters that can be compared. It would also allow a unique opportunity to compare reef fish assemblages using BRUVs with that landed in the recreational fishery in the related project in Theme E. Such a complimentary dataset would provide key information to inform short term needs on ecological assets and provide longer term data to inform future zonings to allow enhanced conservation outcomes for the Hunter CMR.

Project Objectives

- Map and quantify the extent, distribution and structure of seabed habitats, fish and benthic assemblages in priority areas in the Hunter CMR using standard operating procedures
- Establish the condition of benthic invertebrate and fish assemblages on CMR shelf reefs
- Integrate data into a national framework (SOPs, spatial distribution), including:
    - Build further knowledge of KEFs and TEPs
    - Applying the SOPs and working within limits of targeted sampling platforms (e.g. towed video, BRUVs, ROVs)
    - Conduct discovery surveys that double as a baseline

Project methods

The project proposes to implement are wide range of survey methods to map and quantify the extent, distribution and structure of seabed habitats, fish and benthic assemblages using standard operating procedures currently being developed in theme D. This includes:

- Bathymetry data and digital elevation models
- Habitat maps
- Habitat coverage estimates
- Assessment of fish assemblages using stereo BRUVs
- Mapping sponge dominated community distribution and abundance using ROV's and AUV's
- Application of SOE data and indicators to CMRs
- Integration and analysis of biological data, pressures data and climate/other models

What solutions will the research provide?

The project will work with DoEE, Hub partners and the wider research community to test and implement a minimum set of national standard approaches to collecting and analysing data for baselines and monitoring biodiversity in Australia's marine estate with a primary focus on monitoring to inform management of the new CMR network and working with Parks Australia to facilitate implementation of a national CMR monitoring program. It will link these approaches to facilitate development of a broader, nationally integrated monitoring program, including strong partnerships with state-based programs.

Baselines/discovery, SOPs (MBES, BRUVs, towed video) and continuation of ongoing work in the only Temperate East CMR with significant shelf representation. It will build on existing knowledge developed during NESP studies to extend our understanding of shelf habitats across shelf waters, with a focus on benthic invertebrate and fish assemblages. We will also contrast condition between adjacent MPA/CMR on reef fish assemblages, with potential for co-management and monitoring. There will also be a focus on trawling impacts by contrasting habitats within the CMR shelf region open to trawling with similar habitats in adjacent waters where trawling is excluded.

Planned outputs

The outputs for this project will include:

- Survey report on design, methods and preliminary findings
- High resolution bathymetry and acoustic backscatter data for targeted areas made available through the AODN
- Underwater images of benthic invertebrate and fish communities
- Habitat map(s) and coverage estimates representing the shelf rocky reefs KEF made available on the Seamap Australia web portal
- Detailed baseline information on invertebrate and fish communities in the CMR
- Communication products (images, bathymetry flythrough) and data to made available through the NESP website
- Publications in peer reviewed literature

Staff - per calendar year

Alan Jordan (NSW DPI)	0.1 FTE
David Harasti (NSW DPI)	0.1 FTE
Joel Williams (NSW DPI)	0.6 FTE
Technical Officer (NSW DPI)	0.1 FTE
Peter Davies (NSW OEH)	0.1 FTE
Tim Ingleton (NSW OEH)	0.1 FTE
Neville Barrett (IMAS)	0.2 FTE
Jacquomo Monk (IMAS)	0.5 FTE
Justin Hulls	0.5FTE

PROJECT D3 – APPENDIX 5 – SURVEY PROPOSAL: BENTHIC HABITATS AND BIODIVERSITY OF THE SOUTH-WEST CORNER CMR

Project length – 2 Years
Project start date – 1/1/2019
Project end date – 31/12/2020
Project approval date - TBC
Project current status - In progress

Project Leaders – Tim Langlois/Gary Kendrick/Neville Barrett/Scott Nichol
Lead Research Organisation – (UWA/UTas/GA)
Project leader contact details: - timothy.langlois@uwa.edu.au/gary.kendrick@uwa.edu.au/ Neville.barrett@utas.edu.au /scott.nichol@ga.gov.au

Project Funding

Indicative at this early stage of proposal development. While the bulk of the project will be completed in 2020, some pre-planning, including for Indigenous engagement will be needed in 2019.

	2019	*2020*	*TOTAL*
NESP funding	*UTas $20,000* *UWA $25,000* *GA* *$10,000*	*UTas $130,000* *UWA $180,000* *GA* *$165,000* *Vessel charter (Agency independent) $100,000*	
Total NESP Funding	*$55,000*	*$575,000*	*$630,000*
Cash co-con			
In-kind co-con	*UTas $20,000* *UWA $25,000* *GA* *$10,000*	*UTas $130,000* *UWA $180,000* *GA* *$165,000*	
TOTAL	*$110,000*	*$1050,000*	*$1160,000*

Project Summary:

This project will undertake a field survey to build baseline information for benthic habitats in shelf waters of the South West Corner (SWC) CMR. It will apply a standard operating protocol (SOP)-based approach to inventory and monitoring as a model example of how such surveys should be undertaken more widely throughout the CMR network in shelf waters. The prioritisation of this CMR, and methods used, is based on (1) the need for additional baseline/monitoring within the south west CMR network as part of the current 10 year management plan; (2) known significant pressures, including recreational fishing (line) on discrete shelf reefs, (3) need for baseline biological data (except for limited BRUV drops there is virtually no quantitative knowledge of their presence/distribution of biota within the SWC CMR (see Figures 1-4) (4) potential for SOE reporting based on condition of targeted fish stocks (including recreational species) and habitats, and climate-related shifts in benthic species distributions; (5) significant alignment with state interest, including adjacent (conjoining) State Marine Park monitoring programs in Western Australia (Ngari Capes Marine Park); (7) potential for alignment with existing BRUV and Reef Life Survey monitoring programs with the State MP; (8) adjacent to existing survey in the Geographe Bay CMR that provides a template for the survey methods to be used; (9) potential for engagement with the Indigenous communities in the region based on improved understanding of historical management of terrestrial areas, that are now below sea level, and marine resources.

The intent of the survey is to apply the core benthic SOPs being developed by the Hub for inventory and monitoring programs (e.g. multibeam sonar, autonomous underwater vehicle, baited remote underwater video, towed video).

There has been some limited previous multibeam seabed mapping of the area as part of Australian Hydrographic Office and Southern Surveyor/Investigator surveys, that indicate that the continental shelf area may be primarily dominated by soft sediments with some high-profile reef in the 30-150 m bathome within the CSW CMR (Figure 5). The reefs are recognised as a Key Ecological Feature (KEF) but their true extent is unknown and they remain undescribed from a biodiversity and ecological perspective.

While the majority of the continental shelf within the SWC CMR are proposed to be zoned either IUCN category IV and VI there are two distinct IUCN category II which means no fishing methods are not allowed (Figure 6). Hence, new surveys in this region will not only provide a biological baseline, but also establish a basis for a longer-term monitoring program, while undertaking a first assessment of the effectiveness of category IV and VI zoning for benthic habitat protection.

The proposed survey will produce a full coverage, high-resolution maps of representative habitats within the CMR, including areas of the rocky reef KEF, allowing these to be subsequently surveyed quantitatively using the SOP-based biological sampling activities, as developed in Project D2. Currently, proposed SOPs include MBES, AUV, BRUVs and TV to provide broad scale to fine scale quantitative descriptions of the habitats, assemblages and fish species that represent the CMR. Biological surveys will follow best-practice spatially balanced designs developed during the NERP Hub and refined under project D2 in the NESP Hub. Data processing and analysis will also adopt standard procedures (e.g. CATAMI for image scoring of AUV and TV derived imagery, SOPs for multibeam processing and BRUV processing).

Proposed outcomes:

A successful demonstration of the utility of a nationally consistent approach to survey and inventory of shelf habitats in CMRs, with a focus on shelf reefs, leading to longer-term uptake by Parks Australia in a well-structured monitoring program.

Successful uptake of SOPs and incorporation of outputs into national databases, demonstrating a data acquisition and management pathway to be adopted by long-term CMR

monitoring programs, as well as by all agencies involved in inventory and monitoring by SOPs in state and commonwealth waters (including oil and gas industries).

An improved understanding of the habitats and biota in a CMR region subject to significant human pressures (fishing), leaving to an improved capacity to adaptively manage these pressures to meet planned conservation outcomes.

Improved integration of CMR inventory and monitoring programs with state programs based around standard methods such as AUV and BRUV (e.g. as used in adjacent Marine Parks).

Improved ability to report into the SOE, via enhanced regional coverage, analysis of decadal-scale trends (AUV), and a focus on key reporting metrics such as biomass of target finfish species and lobsters (BRUVs and potentially limited lobster potting).

Planned Outputs

The outputs for this project will include:

- Post survey report describing data acquired on the survey and preliminary interpretations, in a format to be used as an example reporting template for subsequent CMR surveys (similar to existing Tasman Fracture survey report)
- Acquired data contributed to national databases (e.g. AUV-Squidle+, BRUV and Towed Video- Global Archive, MBES –GA/AHO) and biological samples to appropriate museums under guidance of MoV.
- High resolution bathymetry and acoustic backscatter data and maps for representative areas of shelf waters (including rocky reef KEF) within the Southwest Corner CMR
- Underwater images (video, still) of benthic invertebrate and fish communities
- Species inventory for observed and sampled biological specimens (epibenthic and infaunal)
- Habitat map(s) and coverage estimates representing the submerged reefs KEF and soft sediment habitats within representative waters of the Southwest Corner CMR, including sponge dominated low-profile reefs and higher profile reef ridges
- Qualitative model for the rocky reef KEF and associated soft sediment habitats within the Southwest Corner CMR
- Publications in peer reviewed literature
- Communication products (images, bathymetry flythrough) highlighting submerged reefs and associated biota. Published in the proposed MPA/CMR atlas and MBH website.

Overall justification against requested additional criteria

(1) Likely uptake of results by Parks Australia: High. As there is currently limited knowledge of the distribution of habitats and species within this CMR, the acquired knowledge will be essential to informing ongoing management planning and responses. More generally, by applying a broad set of SOPs specifically tailored to CMR monitoring, in a typical shelf setting representing the SW CMR network, the demonstration of the efficacy of such approaches will be of significant interest to PA in evaluating the merit of such approaches for use in the longer-term.
(2) Contribution to a 10 year monitoring strategy. High. Benthic shelf habitats have been assessed as those most under anthropogenic pressure, most likely to benefit from CMR protection, and underrepresented in higher levels of protection with respect to other environments (slope, abyssal plains, seamounts). This survey will evaluate the effectiveness of SOPs specifically developed for benthic shelf habitats and their

associated biodiversity in a regional context (SW CMR network), and form a component of a planned program intended to provide representative national coverage over a ten-year period. By also focussing on providing baselines in proposed category II protection zones in this CMR, and contrasting with adjacent areas open to fishing, it will allow future evaluating human impacts on these habitats and of the efficacy of current management strategies (e.g. Cat. II zoning) in time for future reviews of management plans. Finally, part of the 10 year strategy is to assist PA in meeting inventory and monitoring goals, and this survey does so, including inventory and baselines in a previously unsurveyed CMR, and providing an example survey design for similar shelf regions of the SW CMR network.

(3) Opportunity for collaboration with industry partners. High. The Western Rock Lobster Council and the Department of Primary Industries and Regional Development are being consulted to develop an experimental design for sampling rock lobster using commercial pots, that will involve the deployment of POTBot's to collect imagery of benthos and fish assemblages.

(4) Science excellence. High. In addition to a commitment to science excellence through undertaking surveys based on Hub-developed SOPs and statistically-based sampling designs, and subsequent publication of these approaches and results in the primary literature, the survey will have a core focus on assessing human impacts on high and low profile reef fauna and flora, and the value of Cat. II protection zones.

(5) Capacity of science communication from the survey to achieve high public interest. High. Many of the research activities lead to visually appealing communication products, including detailed bathymetric maps, BUV-based video footage, AUV based still and video imagery, and towed video imagery. In addition to public interest in the biodiversity values of waters near major tourist centres such as Ngari Capes Marine Park.

Indigenous engagement

During survey planning, the project leaders will engage with local representatives from the West Australian Indigenous communities. Project leaders have submitted a proposal for a Traditional Knowledge Participatory Value Mapping project covering the Southwest corner and the adjacent Geographe Bay AMP and Nagari Capes State Marine Park that will be highly complementary to the current D3 biodiversity survey and provide a case-study of Category 1 Indigenous engagement.

The proposed Traditional Knowledge Participatory Value Mapping project will broaden the opportunity for Indigenous group involvement throughout all stages of the D3-Southwest corner AMP biodiversity surveys from planning, field work, data analysis, interpretation and communication of results.

Researchers and Staff

* - denotes on survey

Name	2019 FTE	2020 FTE	Organisation	Project Role
Scott Nichol		0.1	GA	Project co-ordination, geoscience*
Ian Atkinson		0.15	GA	Acoustics engineer/multibeam operations*
Andrew Carroll		0.05	GA	Benthic ecology / SOPs

Name	2019 FTE	2020 FTE	Organisation	Project Role
Zhi Huang		0.05	GA	Spatial analyst
Rachel Nanson		0.1	GA	Geomorphology interpretation
Kim Picard		0.15	GA	Seabed acoustics/geomorphology*
Rachel Przeslawski		0.05	GA	Benthic ecology / SOPs
Justy Siwabessy		0.15	GA	Seabed acoustics/mapping*
Neville Barrett		0.3	UTas	Project leadership, benthic ecology
Jacquomo Monk	0.25	0.5	UTas	Benthic ecology – AUV and BRUV
Gary Kendrick	0.1	0.2	UWA	Project leadership, benthic ecology
Tim Langlois	0.20	0.5	UWA	Benthic ecology – AUV and BRUV
Mike Taylor		1.0	UWA	Technical support
Justin Hulls		0.5	UTas	Technical support AUV and potentially ROV
Scott Foster		0.05	CSIRO	Statistical support (from D2)

Co-contributors

Name	Organisation/	Contribution
Stefan Williams	USyd/IMOS	AUV facility support-IMOS

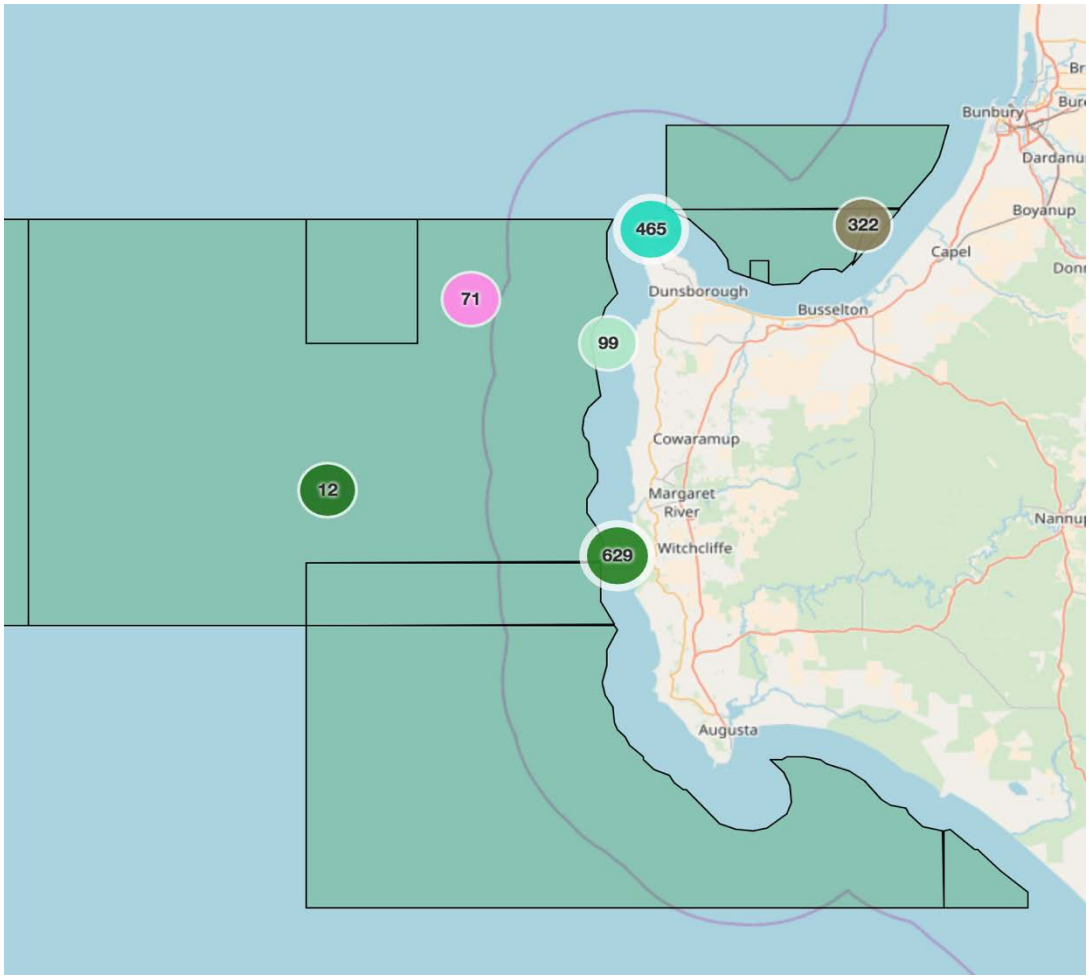


Figure 1: Overview of BRUV sampling in and around the SWC CMR.

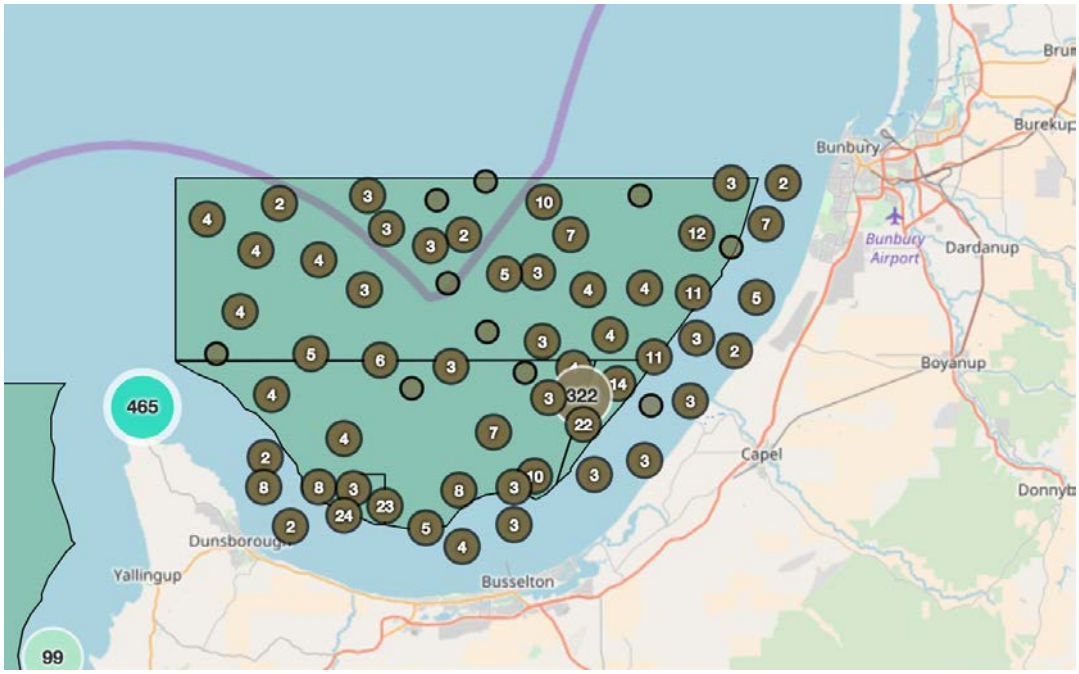


Figure 2: Existing adjacent BRUV surveys in Geographe Bay CMR.

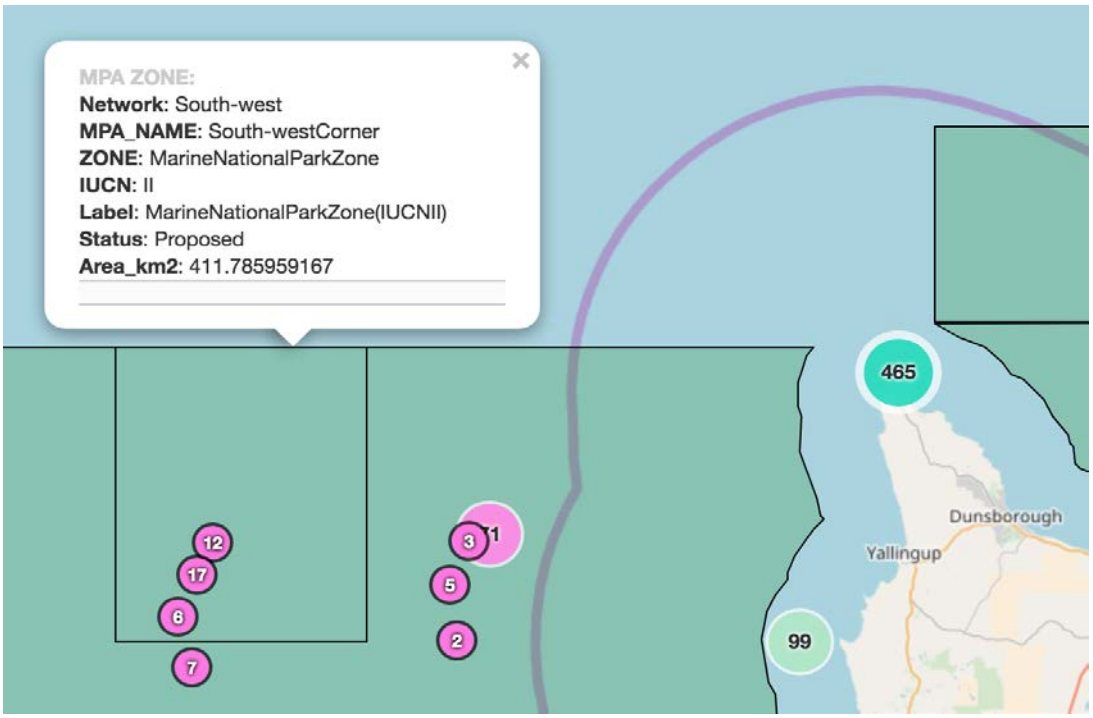


Figure 3: Location of existing BRUV data in and around the proposed IUCN zone II offshore of Yallingup.

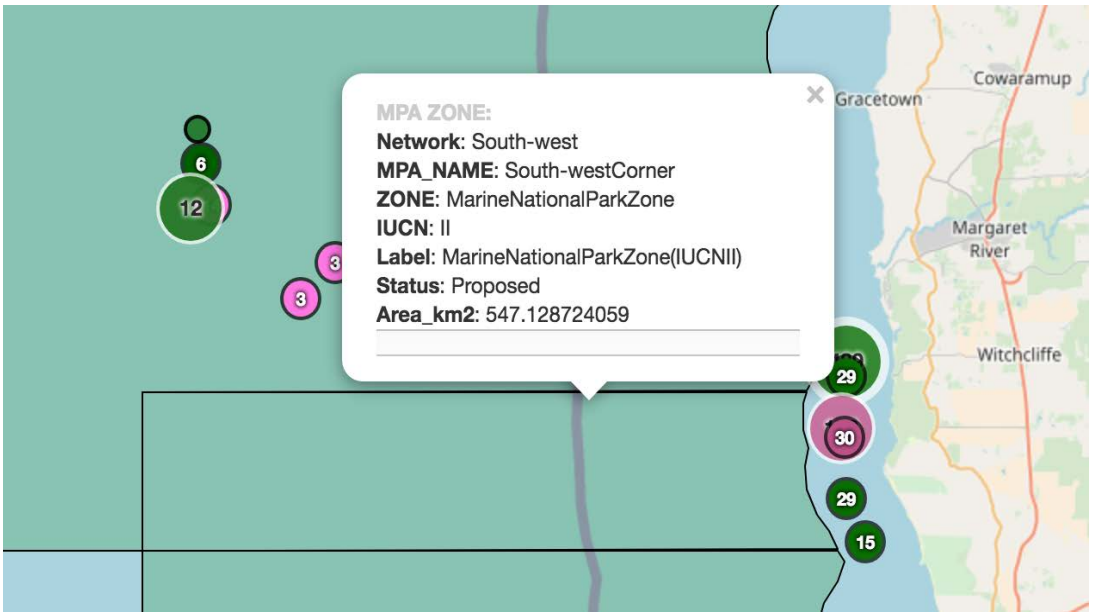


Figure 4: Existing BRUV data adjacent the SWC CMR IUCN zone II offshore of Margaret River.

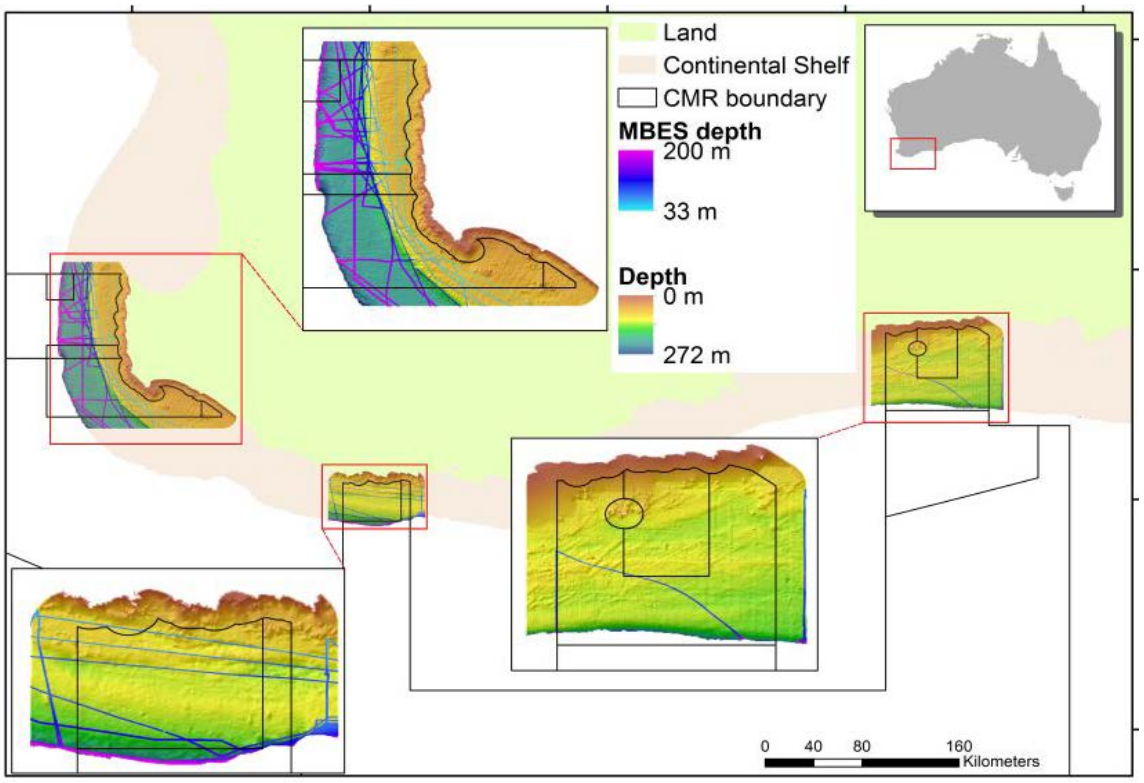


Figure 5: Map of the limited coverage of multibeam sonar mapping (MBES depth: pink to blue colour ramp) overlaid on coarse bathymetry data based on the 250 m Australian Bathymetry grid (depth: red to blue) within the SWC CMR.

Figure 6: Map of draft protection zones within the SWC CMR.

PROJECT D3 – APPENDIX 6 – SURVEY PROPOSAL: INITIAL BASELINE SURVEY OF DEEPWATER FISH IN THE NINGALOO CMR

Project length – 18 months
Project start date – 1/8/2017
Project end date – 31/1/2019
Project approval date - TBC

Project current status - In progress

Project Leaders – Russ Babcock, Mat Vanderklift, Tim Langlois
Lead Research Organisation –CSIRO, UWA
Project leader contact details: - CSIRO Oceans and Atmosphere, EcoSciences Precinct, GPO Box 2583, QLD 4001. russ.babcock@csiro.au

Project Funding

NOTE: This project is now proposed for 2019 to 2020, with overall budget as per the D3 project proposal. The table below has yet to be adjusted to reflect this.

		2019	2020	TOTAL
NESP funding	CSIRO	$81,035	$153,297	$234,332
	UWA	$37,961	$75,921	$113,882
Cash co-con				
In-kind co-con	CSIRO	$81,035	$153,297	$234,332
	UWA	$37,961	$75,921	$113,882
TOTAL				$696,664

Project Summary

The Ningaloo Commonwealth Marine Reserve (NCMR) lies offshore and adjacent to the state-managed Ningaloo Marine Park (Figure 1). The reserve extends for ~300 km along the west coast and the depth ranges from 50 to 500 m. The NCMR is zoned IUCN Category II – Recreational Use Zone and no commercial fishing is permitted. However, an increasing number of recreational fishers are choosing to move offshore from the state managed Ningaloo Marine Park into the deeper waters of the NCMR. This is concerning because very little is known about the composition and abundance of demersal fish the habitats and depths encompassed by the Commonwealth reserve. It is also one of the few Commonwealth Marine Reserves readily accessible to recreational fishers (the distance from the recently enlarged Tantabiddi boat ramp to the NCMR is as little as 10 km).

We propose a non-extractive survey to establish baseline composition and abundances of fish in the NCMR, and align this with standardised surveys of fishing effort. Our team has been strongly engaged in research in the Ningaloo Marine Park (State waters) since 2006, compiling detailed time series of abundance and composition for shallow water habitats of Ningaloo, and we have research programs on the ecology of targeted fish species and megafauna (including whale sharks and turtles). We work closely with WA DPaW and DoF

(now DPIRD) to ensure our information is relevant, and we can leverage on existing data and efforts such as re-surveying IMOS AUV sites within the CMR in 2017. We would link the deepwater research with our other research programs on shallow reefs and the ecology of megafauna to maximise the benefits of the research program. We will also leverage on a voyage of the MNF in October 2017, which will transit through the NCMR and will collect high resolution multibeam data for the 125m ancient shoreline isobath during transit. The survey will employ Standard Operating Procedures for all mapping and sampling activities, as developed in Project D2.

The project will execute each of the pre-conditions, as follows:

- *Validate SOPs*: The project will implement and validate existing SOPs, including those for towed video and BRUVs
- *Legacy Data*: Some BRUV and AUV data for deeper areas of Ningaloo were collected in 2013 in the 40-60m depth range (collected by DPaW in collaboration with CSIRO and UWA) and some earlier samples collected in the CMR (UWA WAMSI project). We will be able to re-survey many of these sites to leverage the benefits from the baseline data they provide, as well as deploying BRUVs in deeper water.
- *Leverage off existing initiatives*: We will leverage off existing work being conducted through Ningaloo Outlook (multibeam, tow video and Starbug and IMOS AUVs), and the MNF cruise (multibeam). We will use and extend the data provided by these programs.
- *Science communication*: CSIRO O&A has established a web page for the research conducted at Ningaloo (research.csiro.au/ningaloo), and through the Ningaloo Outlook project we have established strong links with online, radio and print media.

We will also meet the over-arching-objectives:

- Excellence in science: The project will use best practice science, including new tools in analysis of deepwater habitats and deepwater BRUVs.
- Meet needs of CMR network: We aim to explicitly address a key knowledge gap in the establishment and management of the CMR network, namely the effects of fishing on the deep (i.e. beyond diving depths) fish assemblages. We will do this by establishing a baseline and comparing to existing data and trends. The work will also address knowledge gaps relating to the Ancient Shoreline KEF
- Long-term data collection: CSIRO has been studying the fish assemblages of shallow reefs at Ningaloo since 2006, and it is through the depth of insights gained through this research that we have developed the understanding necessary for this project, including the knowledge that recreational fishers are increasingly moving further offshore.
- Cost-effectiveness: Through leveraging off existing activities we have developed a highly cost-effective survey program.
- Multidisciplinary: The research to be conducted will include habitat mapping through multibeam and tow video as well as characterisation of fish assemblages associated with those habitats through BRUVs. The project will also have tight links with research into the patterns of recreational fishing at Ningaloo and the behaviours that influence those patterns.

Planned Outputs

The outputs for this project will include:

- Post survey report describing data acquired on the survey and preliminary interpretations;
- High resolution bathymetry and acoustic backscatter data and maps for deepwater reefs within Ningaloo CMR;

- Underwater images (video, still) of benthic communities, demersal and pelagic(tbc) fish assemblages;
- BRUV data from 200 sites to provide initial baseline data on fish assemblages of shelf-break habitats in the eastern Ningaloo CMR;
- Publications in peer reviewed literature;
- Communication products (images, bathymetry flythrough) highlighting submerged reefs and deepwater fish communities. Published on the North-west Atlas and MBH website.

Researchers and Staff

Name	2019-20 FTE	Organisation	Project Role
Russ Babcock	.1	CSIRO	Project Leader,
Mat Vanderklift	.1	CSIRO	Benthic ecology
Tim Langlois	.1	UWA	BRUV and fish ecology
Emma Lawrence	.25	CSIRO	Sampling design and biostatistics
Mick Haywood	.25	CSIRO	BRUV and fish ecology
Stuart Edwards	.1	CSIRO	Acoustics engineer/multibeam operations
Karl Forcey	.3	CSIRO	Benthic video sampling
TBC	1.2	UWA	Video analysis
Mark Tonks	.2	CSIRO	BRUV sampling
Mike Taylor	.2	UWA	BRUV sampling
Simon Collings	.45	CSIRO	Multibeam analysis and habitat modelling
Anthea Donovan	.15	CSIRO	co-ordination
TBC	.4	CSIRO	Tow video analysis
TOTAL	2.3+1.5		

Co-contributors

Name	Organisation/	Contribution
Di McLean	UWA	BRUV and fish ecology

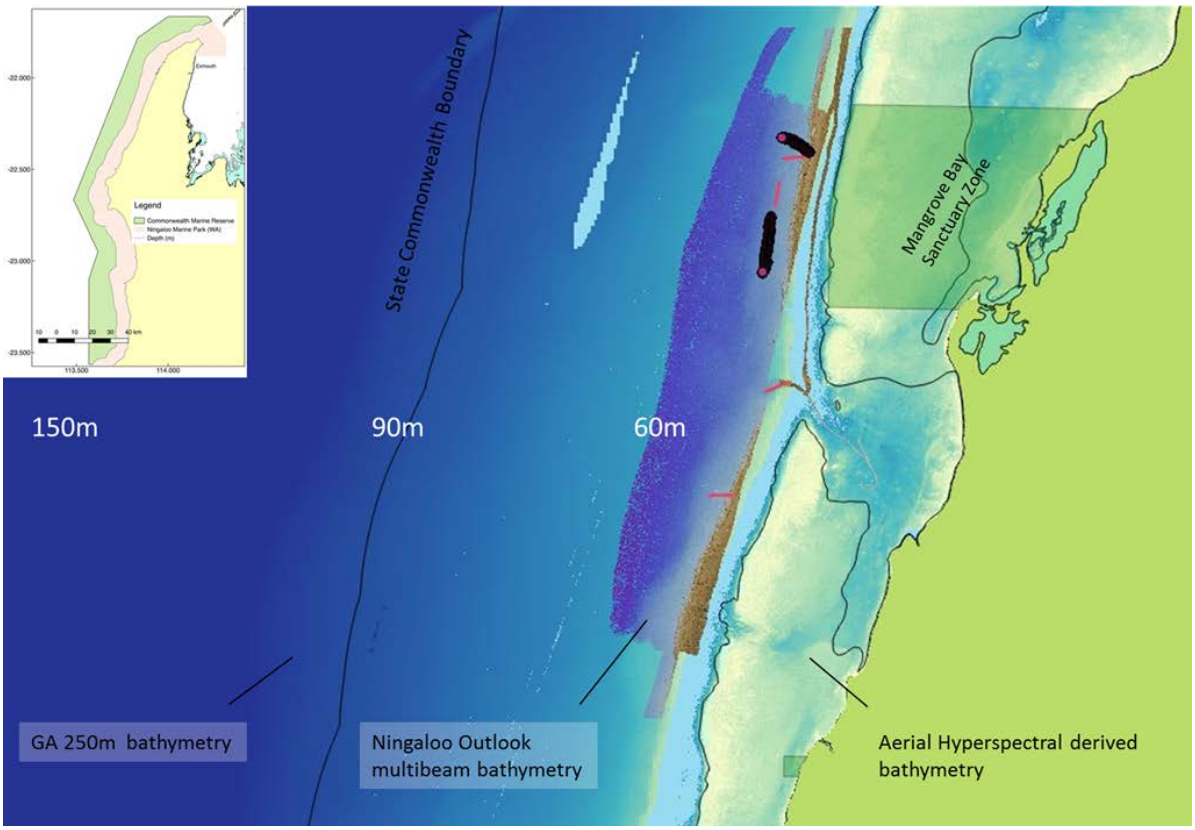


Figure 1. Map of Mangrove Bay area of Ningaloo demonstrating current bathymetry layers and depth ranges across Commonwealth and State marine parks. Inset: Map of the Cape Range showing the location of the Ningaloo Commonwealth Marine Reserve and the Ningaloo Marine Park.

PROJECT D3 – APPENDIX 7 (UPDATED RPV5) – SURVEY PROPOSAL: BENTHIC HABITATS AND BIODIVERSITY OF ELIZABETH AND MIDDLETON REEFS, LORD HOWE MARINE PARK

Project length – 18 months
Project start date – 1/7/2019
Project end date – 31/12/2020
Project approval date - TBC

Project current status - In progress

Project Leaders – Andrew Carroll/Scott Nichol
Lead Research Organisations – (GA, UTAS)
Project leader contact details: - andrew.carroll@ga.gov.au/ scott.nichol@ga.gov.au

Project Funding

	2019	2020	2021	TOTAL
NESP funding	GA $0 UTas $0 NSW DPI $0	GA $100k UTas $70k NSW DPI $53k, NSW OEH $53k Vessel support $50k		
Total NESP Funding	$0,000	$326,000		$326,000
Cash co-con				
In-kind co-con	GA $10k UTas $5k MoV	GA $100k UTas $70k DPI $53k, NSW OEH $53k MoV		
TOTAL	$15,000	$276,000		$291,000

Project Summary

This is a preliminary survey plan of the areas surrounding Elizabeth and Middleton Reefs located at the northern end of the Lord Howe Marine Park. The purpose of the proposed surveys is to fill knowledge gaps on the distribution, extent and structure of seabed habitats and associated sessile and mobile biota in the lagoon and shelf areas of Elizabeth and Middleton Reefs using a range of standard survey tools and operating procedures. The survey would be undertaken between late Jan and end of Feb 2020 depending on vessel availability, cost and logistics. This is the only viable survey period due to the presence of unsuitable wind and sea conditions in most other months of the year. This particularly relates to the need to conduct some survey components from small tender vessels, including deployment of BRUVs and divers. The survey is currently designed and costed to complete a set of core activities (mapping, sampling, AUV and BRUV) over a 10 day period (excluding vessel mobilisation), with optional activities (Reef Life Survey, Drone survey) that will require an additional 4-5 days.

Project Update 2020
This plan has had minor revision to add $50,000 to the 2020 budget for vessel support for the Elizabeth/Middleton reef survey. This revision was required due to the lack of availability of the initially proposed NSW fisheries patrol vessel, or suitable alternative local charter vessels from the region. Instead, the AMC/UTas vessel Bluefin will be chartered and provide the necessary vessel support. As this vessel is based in northern Tasmania, additional funding is needed to cover costs associated with transit to and from Newcastle, and crewing costs associated with the vessel while in Newcastle for equipment mobilisation and demobilisation. A total time of 4.5 days is estimated for vessel transit time (return from Beauty Point to Newcastle, on a 24h operational basis), and two days in Newcastle port. Estimated costs ate $10k per day for transit and $2500 per day while in port.

Rationale and Background

The prioritisation of this AMP, and methods used, is based on (1) the need for baseline information and monitoring within the Temperate East AMP network as part of the 10 year management plan; (2) an opportunity to undertake a comparative assessment of benthic communities within different protection zones – with Middleton Reef in a National Park Zone and Elizabeth Reef partly within a Recreational Use Zone; (3) an opportunity to revisit Reef Life Survey monitoring sites; (4) potential for SOE reporting based on condition of mesophotic reef habitats and responses to climate stressors; (5) significant alignment with NSW state interest in the context of recreational fishing activity; and (6) potential for engagement with the local community on Lord Howe Island based on improved understanding of benthic and fish communities (e.g. Black Cod) within the Lord Howe Marine Park.

This new environmental data will significantly increase our knowledge of the distribution and characteristics of key ecosystem features and benthic communities in the northern Tasman Sea, where little is known of the ecological significance of the remote seamounts, shelves and reefs we will visit. Our survey data will greatly improve knowledge of the environmental assets in the Lord Howe Marine Park, an area that is identified by Parks Australia as a priority for asset inventories, baseline data and monitoring. Utilising the Hub's nationally standardised Standard Operating Procedures, this survey will establish survey sites that set the baseline for monitoring and which can be revisited to detect future change in benthic habitats and ecological communities.

There has been some limited previous seabed mapping of Elizabeth and Middleton Reefs with a compilation of LIDAR on the shelf and multibeam sonar data (2003, 2009, 2011, 2013 transit tracks) in deeper waters providing evidence for complex seabed geomorphic features, including low profile ridges and mounds (Fig. 1). The true extent and character of these features is unknown and they remain to be described from a biodiversity and ecological perspective.

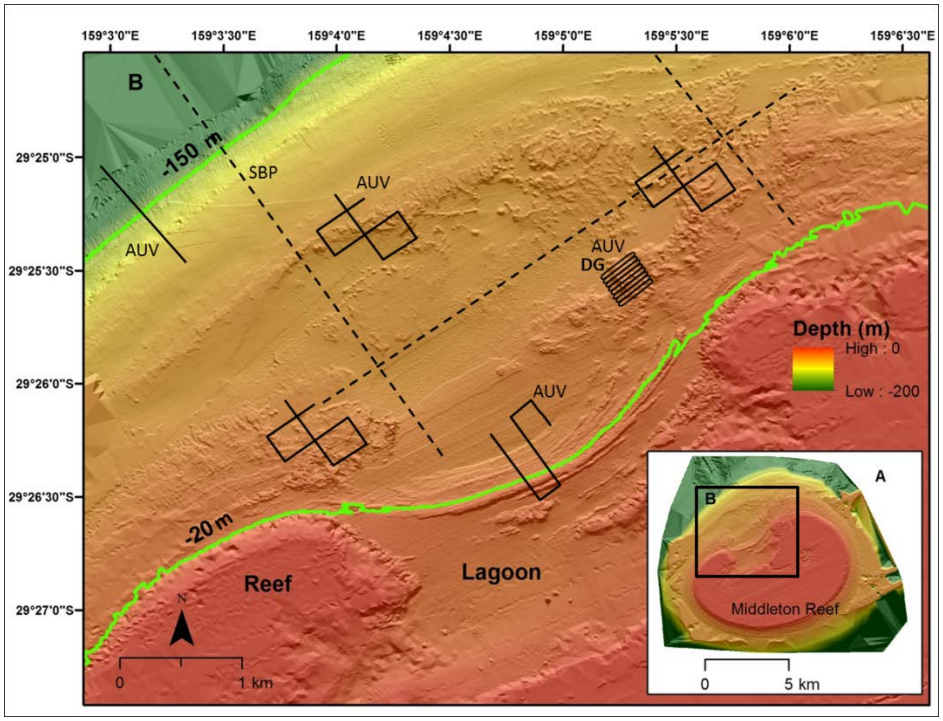


Fig. 1: Bathymetry of NW margin of Middleton Reef derived from LIDAR survey of the reef and multibeam sonar transits. A shelf and terraces occur outboard of the near-surface reef. Indicative survey design for broad and dense (DG) AUV survey grids, and SBP lines are shown

Proposed Survey Activities & Outputs

This project will undertake a field survey to reveal the extent of tropical coral growth on the margins of Elizabeth Reef and Middleton Reef that may represent critical refugia for reef-building corals as global sea temperatures continue to rise. Using multibeam sonar, autonomous underwater vehicles (AUVs), towed underwater camera systems we will identify critical mesophotic coral habitat. Baited Remote Underwater Video (BRUV) surveys will also be conducted in order to characterise the fish assemblages. Proposed SOPs include Multibeam Echo Sounder, AUV, Towed Video, BRUVs and sediment grabs to provide broad scale to fine scale quantitative descriptions of the habitats, assemblages and fish species. Biological surveys will adopt a spatially balanced design as developed and refined under project D2. Fish and habitat surveys using a remotely operated vehicle (ROV) will be used to complement both stereo-BRUV surveys and AUV deployments to provide additional species assemblage information. In addition, drones will be flown over the lagoon region of these reef systems to collect very high resolution imagery that will be incorporated into a whole of lagoon mosaic that could be used to identify features at the scale of ~40 cm, although the exact resolution will be determined following estimation of flight time available, which will determine flight height. This imagery would be suitable to ground-truth remote sensing imagery, although additional spectral reflectance data is likely to be required, which is a specialist activity. Further discussion with JCU or AIMS scientist will be required to determine if this reflectance data already exists.

Core activities
Survey duration: approximately 10 days on site allowing for completion of the following core activities:

- High resolution seabed mapping and sampling of the shelf and lagoon (multibeam echo sounder, sub-bottom profiles, grabs)
- AUV deployment on shelf to acquire high resolution seabed imagery
- BRUV deployment on the shelf and in the lagoon
- ROV deployment in the lagoon and across outer reef

Potential optional activities that will require an additional 4-5 days on site (and additional budget)

Optional activities

- Shallow coral reef monitoring via underwater visual census
- Drone deployment over the lagoon to acquire seabed imagery (for bathymetry)

The survey will aim to produce high resolution maps of representative habitats within the shelf waters of Elizabeth and Middleton Reefs, allowing these to be subsequently surveyed quantitatively using the SOP-based biological sampling activities, as developed in Project D2. Data processing and analysis will also adopt standard procedures (e.g. CATAMI/Squidle+ for image scoring of AUV and TV derived imagery; SOPs for multibeam processing and BRUV processing).

Proposed outcomes

Successful demonstration of the utility of a nationally consistent approach to survey and inventory of shelf habitats in AMPs, with a focus on shelf reefs, leading to longer-term uptake by Parks Australia in a well-structured monitoring program.
Successful uptake of SOPs and incorporation of outputs into national databases, demonstrating a data acquisition and management pathway to be adopted by long-term AMP monitoring programs.

An improved understanding of the habitats and biota in a remote region of the marine estate subject to potential climate change pressures.

Improved ability to report into the SOE, via enhanced regional coverage, analysis of decade-scale trends (AUV), and a focus on key reporting metrics such as biomass of target finfish species and lobsters (BRUVs).

Planned Outputs

The outputs for this project will include:

- Post survey report describing data acquired on the survey and preliminary interpretations, using the standard Marine Hub template for AMP surveys.
- Acquired data contributed to national databases (e.g. AUV-Squidle, BRUV- Global Archive, MBES –GA/AHO).
- High resolution bathymetry and acoustic backscatter data and maps for representative areas of shelf waters (including rocky reef KEF) of Elizabeth and Middleton Reefs.
- Underwater images (video, still) of benthic invertebrate and fish communities
- Species inventory for observed and sampled biological specimens (epibenthic and infaunal), including abundances and distribution of black cod

- Habitat map(s) and coverage estimates representing reef and soft sediment habitats within representative waters of Elizabeth and Middleton Reefs.
- Publications in peer reviewed literature
- Communication products (images, bathymetry visualisations) highlighting reefs and associated biota. Published in the proposed AMP Science atlas and MBH website.

Indigenous engagement

During survey planning, the project leaders will work with Parks Australia officers to engage with representatives from the Lord Howe Island community. These discussions will seek to identify local interest in the project from the perspective of descendants of early settlers, and potentially pre-European occupants of the island. However, previous archaeological investigations on Lord Howe Island found no evidence to indicate human colonisation earlier than the first Europeans.

Researchers and Staff

* - denotes on survey

Name	2019 FTE	2020 FTE	Organisation	Project Role
Andrew Carroll*	0.05	0.15	GA	Survey lead/Benthic ecology
Scott Nichol	0.05	0.05	GA	Project co-ordination, geoscience
Nick Dando*		0.15	GA	Acoustics engineer/multibeam operations*
Justy Siwabessy*		0.15	GA	Seabed acoustics/mapping*
Kim Picard*		0.15	GA	Seabed acoustics/geomorphology*
Zhi Huang		0.05	GA	Spatial analyst
Neville Barrett		0.1	UTas	Project leadership, benthic ecology
Jacquomo Monk		0.3	UTas	Benthic ecology – AUV and BRUV
Justin Hulls		0.3	UTas	Technical support
Alan Jordan		0.1	NSW DPI	Benthic ecology - BRUV
Joel Williams??		1.0		
Scott Foster			CSIRO	Statistical support (from D2)
Tim O'Hara			MoV	Benthic taxonomy – From D4

Co-contributors

Name	Organisation/	Contribution
Stefan Williams	USyd/IMOS	AUV facility support-IMOS

Project D6 – Socio-economic benchmarks

Project length: 2 Years

Project start date: 10/01/2019

Project end date: 31/12/2020

Project current status: Extension to existing project

Project Leader: Tim Langlois (FTE – 0.1)

Lead research organisation: University of Western Australia

Project leader contact details: tim.langlois@uwa.edu.au, (0423) 708312.

PROJECT FUNDING AND EXPENDITURE

Summary of project extensions

Socio-economic assessments have been recognised as a knowledge and skill gap for marine management by the National Marine Science Committee, National Environmental Science Program (NESP) - Marine Biodiversity Hub and by the Department of the Environment and Energy.

The socio-economic benchmarks project was devised in collaboration with Parks Australia to identify key socio-economic metrics to inform the AMPs MERI framework, and to collect benchmark data on a subset of these metrics.

The base project is conducting 3 socio-economic benchmark surveys: a targeted survey of fishing and yacht club members, a charter operator survey and a general public survey. Parks Australia and the project team have identified 4 additional activities that would add substantial value for Parks Australia, participating agencies in the project (Parks Victoria, NSW DPI, DEWNR and GBRMPA), and marine management nationally:

Extension 1:

- A **national boat ramp survey** to complement the benchmark surveys of fishing and yacht club members by capturing more representative metrics of awareness use and perceptions of recreational fishers, and non-extractive recreational users.
- A **national workshop** to build consensus and capacity for socio-economic assessment of marine parks in Australia as a follow-up to regional workshops conducted in the project.

Extension 2:

- **Cost-efficiency analysis and training package** to ensure cost-effective repeats of the 4 benchmark surveys (likely after 4 and 8 years) to inform the MERI framework.
- **National random utility modelling** of recreational fishing to generate essential socio-economic metrics for the MERI framework. The national utility model will estimate the impact of the AMPs on fisher welfare and use at the national, marine park and zone levels. Due to lack of direct observational data, this is the only means of estimating change in recreational fisher welfare and use for the MERI framework.

These project extensions do not involve changes to the total project length.

Project funding table

KEY: *RPv5* ***Extension 1*** *Extension 2*	*2019*	*2020*	***TOTAL***
NESP funding	*$50,000*	*$100,000 +* ***$60,000*** *+ 71,902*	281,902
Cash co-con Parks Australia	***$48,858***	*x*	48,858
Cash co-con UWA	***$2,500***	***$2,968 +*** *$2,500*	7,968
Cash co-con NSW	*x*	***$1,400***	1,400
In-kind co-con UWA	*$68,247*	*$ 136,494 +* ***$108,624 +*** *$130,163*	443,528
TOTAL	**$169,605**	**$614,051**	**783,656**

Expenditure statement

RPv5
Most of the project funding ($125k) is being used to support a post-doc position over the first year of the project to deliver essential socio-economic metrics to inform the Australian Marine Parks (AMPs) Monitoring Evaluation Reporting Improvement (MERI) framework. Activities conducted by this position include conducting regional workshops, reviewing literature on metrics for monitoring socio-economic outcomes of the AMPs, constructing, analysing and reporting on surveys of fishing and yacht club members, charter operators and the general public's awareness, use and perceptions of the AMPs. Approximately $25k will be used to conduct an online balanced panel survey of the general public.

Extension 1
A $48k cash co-contribution from Parks Australia will be used to conduct boat ramp surveys in 12 key locations around Australia and to expand the general public online survey sample size. $60k will be used to support a postdoc position for 5.5 months. This position will be used to conduct the boat ramp data analysis and organise, run and report on the national workshop. A $5.5k cash co-contribution from UWA and $1.4k from NSW DPI will be used to support travel and organisation of the national workshop.

Extension 2
$72k will be used to support a postdoc position for 6.5 months. This position will be used to conduct a cost-efficiency analysis to establish on-going essential socio-economic surveys of the AMPs and national random utility model to generate essential MERI metrics. In addition, a training package for Parks Australia staff/contractors will be delivered on how to conduct surveys, analyse data and produce MERI metrics. Extension 2 also includes a 2.5k cash co-contribution from UWA to support travel associated with consulting with Parks Australia and obtaining NSW recreational fishing data.

PROJECT DESCRIPTION

Social and economic values are key drivers for marine science and marine policy but are too rarely integrated with marine biodiversity monitoring programs. Parks Australia (PA) are currently considering options for developing social and economic baselines to inform the Australian Marine Parks (AMPs) Monitoring Evaluation Reporting Improvement (MERI) framework. As management plans for 44 marine parks came into effect in July 2018, PA are keen to identify and capture key social and economic metrics as soon as possible, while still considering existing work and being part of a nationally consistent approach. We are at an ideal stage to engage with PA and other management agencies to provide scientific input to develop theoretically rigorous and practical frameworks that can be applicable nationally to capture social and economic values associated with Marine Parks.

The NESP Marine biodiversity hub Socio-economic benchmarks project was devised in collaboration with PA to identify key socio-economic metrics to inform the AMPs MERI framework, and to collect baseline data on a subset of these metrics.

The base project is measuring socio-economic baseline metrics using 3 surveys: a targeted survey of fishing and yacht clubs, a charter operator survey and a general public survey. PA and the project team have identified four additional activities that would add substantial value to the project for Parks Australia, participating agencies in the project (Parks Victoria, NSW DPI, DEWNR and GBRMPA), and marine management nationally. These additional activities for consideration in RPv6 are presented first before a description of the original project proposal approved under RPv5.

Project Extension 1

National boat ramp survey

Measuring awareness, use and perceptions of recreational users of the AMPs will provide key metrics for the AMPs MERI framework. Some information is being provided by the benchmark survey of fishing and yacht club members; however, respondents to this survey are unlikely to be representative of average recreational users: both because they are members of a club, but also as the surveys will be opt in and mainly attract respondents with strong views.

A national boat ramp survey at 12 key locations around Australia and with strong in-kind support from PA is being proposed to address this gap. This fourth benchmark survey will ensure the AMPs MERI framework is underpinned with robust collection of awareness, use and perceptions of recreational users around Australia. The surveys will also collect key information about adjacent State marine parks, supporting decision making, and provide opportunities to align State and Commonwealth data collection.

National workshop

Socio-economic assessments are a key skill gap for marine management and remain a challenging aspect of marine park management nationally. Vitally, there is currently no commonly agreed upon methods to socio-economic assessment, and quality of assessments vary substantially across states. Building towards a consensus on approaches to socio-economic assessment would help lead to a nationally consistent approach, enhanced cost-efficiencies through collaboration and data sharing, and cross-marine park comparisons.

The socio-economic benchmarks project has conducted regional workshops on the socio-economics of marine parks with managers and experts in South Australia, Tasmania, New South Wales, Queensland and Western Australia. These workshops have started a productive conversation about approaches to socio-economic assessment of marine parks. There is an opportunity to capitalise on this momentum by holding a national workshop, bringing together State agencies and experts, and working towards consensus on approaches to socio-economic assessment of marine parks. This workshop would include participants from State marine park management agencies (e.g. SA DEWNR, WA DBCA, Parks Victoria, NSW-DPI, GBRMPA), Commonwealth agencies (Parks Australia, DoEE-Environmental accounting) and academics in the field such as those in the Centre for Marine Socioecology. The aims of the workshop would be to work towards a common understanding of methods of socio-economic assessment of marine parks, including a national cohesive approach to socio-economic assessment and to identify key opportunities for collaboration and cost-efficiency.

Project Extension 2

Cost-efficiency analysis and training package

The project is conducting four benchmark surveys to produce socio-economic metrics for the AMPs MERI framework. These surveys include: a boat ramp survey, a targeted survey of fishing and yacht clubs, a charter operator survey and a general public survey. PA intend to repeat these surveys in 4 and 8 years under their MERI framework. As such, it is vital that surveys be repeatable at the lowest possible cost.

The cost-efficiency analysis and training package aims to reduce the cost of repeating these benchmark surveys. The cost efficiency analysis will identify optimal sample sizes for each survey by calculating changes in errors and predictive power under reduced sample sizes. By discussing acceptable predictive power for each metric with PA an optimal sample size will be identified that minimises survey costs. A training package will aim to make repeats of the benchmark surveys as streamlined as possible. This will include provision of future-proofed surveys that can be uploaded to an online survey program, reproducible and robust R statistical software code that will automate data analysis and produce key figures for MERI reporting (including expected time series), and training resources for PA staff/contractors on how to use these materials.

National Random Utility Model

A key metric for the AMPs MERI framework is understanding the change in recreational fishing welfare resulting from the implementation of the AMPs. Previous NESP Marine Biodiversity Hub projects (E4) have found that state-based recreational fishing data is not adequately spatially resolved to estimate changes in recreational fishing at the marine park scale.

The National Random Utility Model proposed here aims to fill this key gap in AMPs MERI reporting whilst generating useful outputs for other participating agencies (Parks Victoria, NSW DPI, SA-DEWNR and GBRMPA). Key outputs will include estimates of the welfare and site choice impacts from implementing the no-take National Park Zones in the AMPs at marine park, network and national scales, within ~100 km from shore. The model will also focus on quantifying uncertainties in these estimates. This will allow managers to understand the limitations of the estimates provided, and indicate priority areas for additional data collection, potentially in collaboration with State agencies.

Our approach will be to create a generalisable site choice model that explains how individuals choose their fishing sites in areas with high quality data (WA and NSW) (Figure 1). Site choices for different trip types (demersal and pelagic) will be explained using variables such as distance from boat ramp, depth, rugosity, weather conditions, and sea-surface temperature. We will also use spatially explicit estimates of demersal fish abundance as a driver for demersal fishing site choice, to be provided by a national synthesis currently in preparation for publication.

In areas lacking high quality data, ground truth data will be provided by the boat ramp surveys conducted as part of the project at 12 key locations around Australia to compare with the predicted usage patterns from the site choice model. Resultant site-choice models will be used to predict the welfare impacts of the establishment of National Park Zones by marine park, network and national scales within 100km of the coast. Other model outputs will include the level and change in usage of each of these marine parks.

Critically this approach minimises reliance on *in-situ* observed trip data for particular locations. Instead, we will create a generalisable model of how fishing sites are chosen and then use this to predict welfare impacts and changes in use in areas that lack direct observational data.

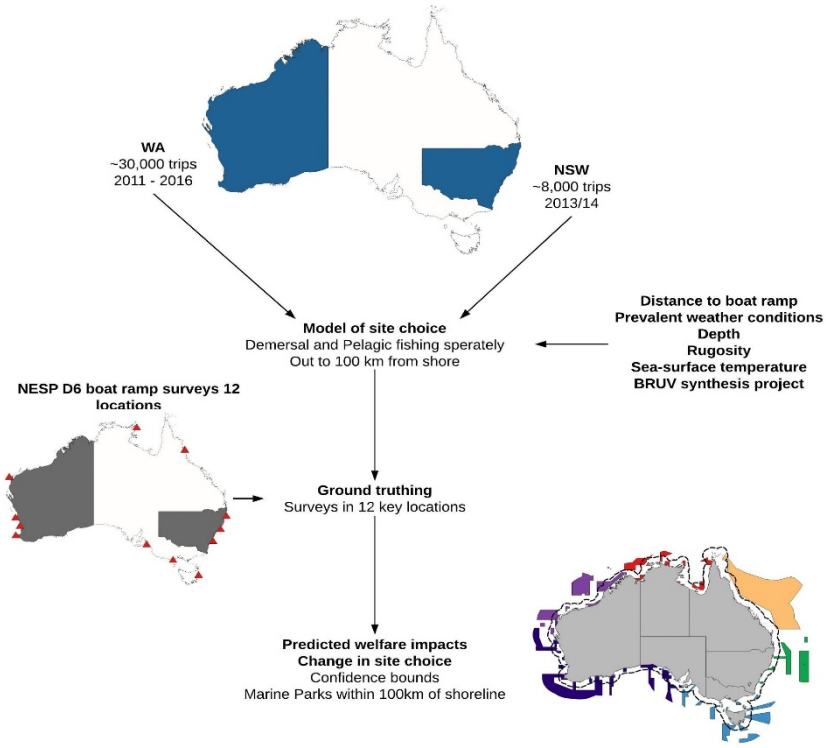


Figure 1. National random utility model methodology

ORIGINAL RPv5 PROPOSAL:

Problem

There is a significant and time critical need to support PA in the establishment of a benchmark and monitoring program for the social and economic values of AMP networks. This information will be used in the AMPs MERI framework to support adaptive management. Long-term monitoring programs were identified as a key need and recommendation in the National Marine Science Plan 2015-2025 (NMSP). Currently such programs do not exist for Commonwealth waters, and the new AMP network provides an appropriate national, regional, and bioregional framework around which such programs could be developed.

The Opportunity

Benchmarks and robust monitoring of social and economic values for the newly established AMPs will provide essential information to inform management. When management plans for established AMPs are planned to be reviewed (~10 years), such information, in collaboration with other initiatives across the NESP Marine Biodiversity Hub (MBH) and beyond, will be useful for reviewing the social and economic objectives and impacts of the existing management plans.

Details of related prior research

We have conducted an extensive review of existing prior research on the social and economics of marine parks in Australia and Internationally. This review has also been facilitated by 5 regional workshops conducted with lead marine park managers and research scientists around the country. The review is being used to identify suitable metrics for the AMPs MERI framework. Where possible these metrics are being aligned with State agency metrics.

How research addresses problem/will be undertaken

We have been working closely with PA to identify a list of established and essential (key) social and economic value metrics, relevant to AMPs, to be collected as initial national benchmark surveys. These metrics are being incorporated into the AMPs MERI framework. The project has also assisted PA in developing a social values hierarchy for use in the AMPs MERI framework.

Our recommendations are informed by 5 workshops conducted with researchers and marine park agency staff in Western Australia, South Australia, Tasmania, New South Wales and Queensland and a thorough desktop review of approaches for socio-economic monitoring used in Australia and internationally. This initial metric recommendation phase of the project includes 8 core stakeholder groups: Aboriginal and Torres Strait Islanders, recreational fishers, commercial fishers, non-fishing recreational users, fishing and non-fishing tourism operations, petrochemical and mineral industries and the general public.

Along with the key metrics, the project has identified four national surveys to collet benchmark information on social and economic metrics of the AMPs. These include a targeted survey of fishing and yacht clubs, a charter operator survey, a national boat ramp survey and a general public survey. We have also produced estimates of the cost of conducting these benchmark surveys.

The second phase of the project involves collecting baseline data for a subset of the identified key metrics for four stakeholder groups: recreational fishers, non-fishing recreational users, charter fishers and the general public. Explicitly, this project will not

collect independent data on the economic values of commercial fisheries, as PA are working directly with Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) and fisheries agencies to ascertain these and the Australian Institute of Marine Science (AIMS) survey of marine industries provides additional information. Equally different State (e.g. fisheries and marine park) and Commonwealth agencies (e.g. Australian Fisheries Management Authority (AFMA), Fisheries Research Development Corporation (FRDC), PA also have different requirements reflecting their different management areas.

Objectives and Outputs

Stage 1

1. In close consultation with PA we have reviewed existing metrics used to survey social and economic values associated with Marine Parks. This review includes consulting with national and international expertise and actively consulting with State and other Commonwealth agencies, some of whom are currently conducting reviews or have existing frameworks of how to measure and conduct social and economic values (e.g. GBRMPA and NSW DPI).

2. In collaboration with PA we have organise a series of regional methods workshops to discuss and refine metrics and methods to quantify social and economic benchmarks for marine parks State and Commonwealth waters and produce an SOP relevant to AMPs. This is being done in close collaboration with PA. Overlapping interests with DoEE have been explored, though overlaps appear to be minimal, reflecting that applying an environmental accounting approach to marine park monitoring is challenged by a lack of quantifiable understanding of the bio-physical system, and the effects of marine parks on it.

3. During these review and workshop processes, we have worked closely with PA to identify a list of established and essential (key) social and economic value metrics, relevant to AMPs, to be collected as an initial national benchmark survey. We have also estimated the cost of these surveys.

Stage 2

4. We have, and will continue to, work closely with PA to complete some of these national surveys.

5. The last phase of the project will be devoted to finalisation SOP's relevant to measuring social and economic values of AMPs and reporting and publication of results.

How the project links to other research and/or the work of other Hubs

In particular, we have recognised the need for cross collaboration across NESP MBH projects. We have assigned Burton (UWA) the role of NESP coordination. Direct links with E4 have been explored and incorporated into recommendations for key metrics for the AMPs.

Summary of how it is expected that the research will be applied to inform decision-making and on-ground action.

The proposed AMP social and economic values program ideally integrates with, and sits within, the broader requirement to monitor and report on the marine ecosystem health of the Commonwealth marine area, and is complementary to State marine environment monitoring

programs. The five regional workshops have ensured that our recommended approaches are aligned with approaches used by state agencies. We have also identified opportunities for collaboration with State agencies.

Benchmarks and robust monitoring of social and economic values for the newly established AMPs will provide essential information to inform management. When management plans for established AMPs are planned to be reviewed (~10 years), such information, in collaboration with other initiatives across the NESP and beyond, will be useful for reviewing the social and economic objectives and impacts of the existing management plans.

NESP 2017 Research Priority Alignment

This project aligns directly to a key cross-cutting issue across all NESP hubs:

1. consider the social and economic value of the environmental asset/s and research outcomes, as appropriate

In addition, it aligns with the following NESP - MARINE BIODIVERSITY: RESEARCH PRIORITIES in

Maximising the efficacy of managing Australia's marine environment (1) to:

- Identify key social and economic values of the marine environment to build better stakeholder support and engagement in the management of marine and coastal environments (1.3).

In addition, it aligns with NESP - MARINE BIODIVERSITY: RESEARCH PRIORITIES - Improving our understanding of the marine environment including biophysical, economic and social aspects (3) to provide:

- Meaningful and accessible information on the status and trends of key social and economic values associated with the marine environment (3.2).

In addition, this project aligns to at least two of DoEE 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 information necessary to:

I. improve the management of marine biodiversity through an evaluation of the results of management interventions;
II. better understand issues that are common to the fishing industry and the environment including identifying solutions of mutual benefit

In future research, it will be important to be ready to propose comprehensive and robust programs to capture change in social and economic values in collaboration with PA, State and other specialised government agencies (e.g. ABARES).

PATHWAY TO IMPACT

Outcomes
Social and economic values are key drivers for marine science and marine policy. In the case of the AMPs, PA have adopted an adaptive management framework (MERI) that requires robust metrics of social and economic outcomes to be measured to inform management plan reviews. Capacity for developing social and economic monitoring approaches within PA is limited, and the project is a direct response to a need for technical capacity. By providing advice on robust methods of social and economic monitoring the project is ensuring that the AMPs MERI framework is fit for adaptive management purposes and will provide useful outputs for planned management reviews. The timing of the project also ensures that benchmark data is being collected as soon as possible to the zoning

of the AMPs in July 2018, ensuring that time series in the MERI framework are capable of detecting change.

New for RPv6
Through the regional workshops it has become apparent that marine park managers in all jurisdictions are searching for guidance on approaches to socio-economic monitoring. By conducting a national workshop on the socio-economics of marine parks the proposed RPv6 extension will build capacity for, and form a common understanding of, social and economic monitoring of marine parks nationally. This will lead to improved standards of socio-economic monitoring, better decision making in the review of marine parks, and foster cross-marine park and cross-state collaborations contributing to great cost efficiency in marine parks monitoring.

Research-user	Engagement and communication	Impact on management action	Outputs
DoEE- Parks Australia (AMPs) including planning, management and operations and Environmental - Economic accounts Section	Engaged in the development and design of project and outputs. Findings and outputs to be communicated via project workshops, quarterly project update emails and presentations. <u>Update:</u> Engagement with Parks Australia has been frequent (approximately fortnightly) by email, in person and video-conference engagement.	Information will be used to inform AMP management, including MERI reporting. <u>Update:</u> Benchmark surveys will be used directly in MERI reporting on socio-economics. Project team has directly assisted MERI framework development including the identification of a socio-economic values hierarchy. **New Under RPv6** Cost efficiency analysis and training will reduce costs of repeat survey and data analysis.	***Key outputs will include:*** ● *Regional workshop report* ● *List of agreed essential* (key) *social and economic metrics for AMP benchmarks, developed in collaboration with PA* ● *Draft SOP for measuring social and economic metrics for AMPs* ● *Final report and publication providing social and economic metrics benchmarks for AMPs* ● Developed shared understanding about options for monitoring social and economic values ● Established benchmarks for monitoring social and economic trends for AMPs <u>Update</u> ● Metrics on awareness, use and perceptions of the AMPs from charter operator survey, targeted survey and general public survey for MERI benchmarks. **New Under RPv6** ● Report and manuscript on national review of marine park socio-economics co-authored with agency staff - based on national workshop. ● Report on cost-efficiency analysis for the four benchmark surveys.

Research-user	Engagement and communication	Impact on management action	Outputs
			• Training resources to enable reproducible data collection and analysis. • Submitted manuscript on national random utility model.
State government fisheries and conservation agencies <u>Update</u> GBRMPA Parks Victoria SA DEWNR NSW DPI Tas Parks and Wildlife WA DBCA	Will be engaged in national workshop and SOP development <u>Update</u> Have engaged extensively with key State and Commonwealth agencies through regional workshops and follow up conversations and emails. Agencies engaged include: SA DEWNR, WA DBCA, Parks Victoria, NSW-DPI, GBRMPA, Tas Parks and Wildlife	*Where appropriate new knowledge will inform the policy development and management of the marine environment, including State marine parks* <u>Update</u> Consulted agencies have expressed a clear interest in the outputs of this project to inform their own socio-economic values assessments **New Under RPv6** The boat ramp surveys and national RUM will generate metrics for State marine park agencies. A national workshop will help coordinate and guide State marine park agencies on methods for socio-economic assessment	*As above*
Additional outputs • At this stage the core outputs will be those identified above.			

INDIGENOUS CONSULTATION AND ENGAGEMENT

Overall, the Indigenous consultation and engagement of the project is consistent with the Hub's Indigenous Engagement and Participation Strategy with the proposed project being a Category 3 Indigenous engagement project. At the broadest level engagement will be through the DoEE Indigenous Advisory Committee and the FRDCs Indigenous Reference Group. These groups will be asked for advice on opportunities to enhance Indigenous engagement across individual survey plans as they are developed.

The project has included a review of existing socio-economic baselines and methodologies (stage 1 of the project). The socio-economic baseline surveys delivered through stage 2 of this project will not include collecting Indigenous social and economic baselines. The Stage 1 review will be used to inform discussions about options for future research to advance Indigenous social and economic measures for AMPs.

PROJECT MILESTONES

Milestones	Due date	Milestone Status
Milestone 1 – Signing of contract	10 February 2019	*Completed*
Milestone 2 - Draft essential (key) AMP social and economic metrics report with review of conceptual understanding of the systems they are intending to collect social and economic information on – for feedback from PA	1 May 2019	*Completed*
Milestone 3 – Draft costed plan for PA for a benchmark AMP social and economic metrics survey – for feedback from PA	1 May 2019	*Completed*
Milestone 4 - Regional workshop on social and economic metric surveys of Marine Parks	15 July 2019	*Completed*
Milestone 5 - Draft regional workshop report – for feedback from PA	1 September 2019	*Completed*
Milestone 6 - Final report on essential (key) AMP social and economic metrics with review of conceptual understanding of the systems they are intending to collect social and economic information on	1 November 2019	*Completed*
Milestone 7 – Final costed plan for PA for a benchmark social and economic AMP metrics survey	1 November 2019	*Completed*

Milestones	Due date	Milestone Status
Milestone 8 – Agreement between PA and NESP MBH regarding which benchmark surveys will be designed and delivered as part of this project	1 November 2019	*Completed*
Milestone 9 – Draft benchmark survey design - for feedback from PA	1 November 2019	*Completed: boat ramp and targeted surveys* *In progress: online and charter operator surveys*
Milestone 10 – Final benchmark survey design agreed	14 November 2019	*Completed: boat ramp and targeted surveys* *In progress: online and charter operator surveys*
Milestone 11 – Update and draft report on benchmark survey of essential (key) AMP social and economic metrics – for feedback from PA	1 February 2020	*on-track*
Milestone 12 – Draft SOP for essential (key) AMP social and economic metrics – for feedback from PA	1 July 2020	*on-track*
Milestone 13 – report on benchmark survey of essential (key) AMP social and economic metrics	1 October 2020	*on-track*
Milestone 14 – submitted manuscript on benchmark survey of essential (key) AMP social and economic metrics	1 November 2020	*Not commenced*
Extension 1 - *Also includes improved delivery of Milestone 13 and 14 through inclusion of boat ramp survey data into metrics report and manuscript*		
Proposed milestone 15 – National workshop on social and economic metric surveys of marine parks.	1 July 2020	*Not commenced*
Proposed milestone 16 – Report and submitted manuscript documenting national review of marine park socio-economic monitoring to be co-authored by state and national agency staff	1 August 2020	*Not commenced*

Milestones	Due date	Milestone Status
Extension 2 - *Also includes improved delivery of Milestone 13 and 14 through inclusion of national random utility model into metrics report and manuscript*		
Proposed milestone 17 – Report on cost-efficiency analysis of options for ongoing monitoring of socio-economic metrics of AMPs	15 December 2020	*Not commenced*
Proposed milestone 18 – Benchmark survey training package.	15 December 2020	*Not commenced*
Proposed milestone 19 – Submitted manuscript on national random utility model	15 December 2020	*Not commenced*

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including metadata) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles.

However, for social and economic surveys where personal information will be collected, all data will be stored in a non-identifiable format to maintain the privacy of participants and in accordance with UWA Human Ethics committee recommendations and guidelines, although metadata and metric summaries will be available through the AODN.

Publications, reports, factsheets, maps and images will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au. The Hub is also developing data access and visualisation methods in project D2, and we will work with that project to ensure all information products are readily discoverable and available to the department and are freely and openly available.

Name: Tim Langlois
Email Address: tim.langlois@uwa.edu.au
Phone Number: (0423) 708312

Project output	Data Management and Accessibility
Milestone final reports	Milestone reports will be made available publicly via Hub website upon completion of each report
Research papers	All peer-research papers will be made available to the public through open access via the Hub's website (in accordance with the NESP Data Management and Accessibility Guidelines)
Communication products	Summaries of research and surveys will be made available through the Marine Parks Science Atlas, including the addition of new data layers with links to relevant data holdings for AMPs.

Project output	Data Management and Accessibility
Social and economic survey data	TBD <u>Update</u> For benchmark surveys where personal information will be collected, all data will be stored in a non-identifiable format to maintain the privacy of participants and in accordance with UWA Human Ethics committee recommendations and guidelines. Metadata and metric summaries will be available through the AODN.

LOCATION OF RESEARCH

Social and economic surveys will be undertaken at a national scale with a spatial focus on the location of user groups and stakeholders in AMPs.

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
1. Lack of engagement with State and National agencies (e.g ABARES and DoEE) and Australian and international researchers on marine parks	High	Medium <u>Update</u> Low	Ensure good communication with State and National agencies and Australian and international researchers, including driving communication collaboratively through Parks Australia. Implicitly create the workshop to be attractive to all relevant experts and invite them to attend to contribute to the development of an SOP. <u>Update</u> The regional workshops and out of workshop engagements have been highly successful. The project team has received positive feedback on the workshops and has continued to work with state agencies to assist in delivery of benchmark surveys.	Project leader

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
2. Under-budgeted, resulting in inability to engage post-doc for 2nd year	High - require additional funding in project	Medium	Project leader will apply for additional funding through UWA internal program and engage with Parks Australia. <u>Update</u> Under the extensions proposed here co-contribution from PA and NESP will provide required budget.	Project leader
3. Coordination and cooperation across Hub partners	Medium may impact on extent of project deliverables	Low	Burton (UWA) has the role of NESP coordination. Direct links with E4 will be explored through case studies with recreational fishermen.	Project leader and Burton
4. Changing departmental priorities	Medium	Medium <u>Update</u> Low	Has been managed to date via extensive consultation with PA. Regular and collaborative communication will be maintained with PA throughout the project.	Project leader
New under RPv6				
5. Failure to access state recreational fishing data for national RUM	Medium	Low	Permission to use the data for a national RUM has been sought and in principle support has been obtained well ahead of planned commencement date. NSW DPI staff have been added to the project to improve access to NSW data Should data not be provided, an alternative analysis has been planned using less data intensive gravity models.	Project leader

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
6. National site choice models fail to explain site choice well	Medium	Low	Previous experience has shown that site choices of recreational fishers are highly predictable from travel distance alone. A range of explaining covariates will be explored. Should problems persist, an alternative approach using less data intensive gravity models is planned.	Project leader

PROJECT KEYWORDS

Social values, economic values, monitoring, AMP, benchmark.

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE	Email
Michael Burton	University of Western Australia	NESP Coordination	1 year @ 0.05 **RPv6** 1 year @ 0.1	michael.burton@uwa.edu.au
Abbie Rogers	University of Western Australia	Data analysis	1 year @ 0.05	abbie.rogers@uwa.edu.au
Marit Kragt	University of Western Australia	Survey design	1 year @ 0.05 **RPv6** 1 year @ 0.05	marit.kragt@uwa.edu.au
Matthew Navarro	University of Western Australia	Post-doc	1 year @ 1 **RPv6** 1 year @ 1	matthew.navarro@research.uwa.edu.au
Update				
Alan Jordan	NSW DPI	Data acquisition	**RPv6** 1 year @ 0.05	alan.jordan@dpi.nsw.gov.au
Kate Thornborough	NSW DPI	Data acquisition	**RPv6** 1 year @ 0.025	kate.thornborough@dpi.nsw.gov.au
Asha McNeil	NSW DPI	Data acquisition	**RPv6** 1 year @ 0.025	asha.mcneill@dpi.nsw.gov.au

Data Management

Name	Organisation	Email	Phone
Tim Langlois	University of Western Australia	tim.langlois@uwa.edu.au	(0423) 708312

Co-contributors

Name	Organisation/	Contribution	Email
Cath Samson	Parks Australia (AMPs)	Advisor	Cath.SAMSON@environment.gov.au
Mitchell Ryan	Parks Australia (AMPs)	Advisor	Mitchell.Ryan@environment.gov.au

Key Partners and Research End Users

Key Partners (organisation/program)	Name/s	Email
Parks Australia (AMPs)	Cath Samson (Project Contact) David Logan (Science Coordination) Mitch Ryan (MERI)	Cath.SAMSON@environment.gov.au David.Logan@environment.gov.au Mitchell.Ryan@environment.gov.au
Update		
NSW DPI - Marine Ecosystems	Alan Jordan (Marine Ecosystems) Kate Thornborough (Marine Ecosystems) Asha McNeil (Marine Ecosystems)	alan.jordan@dpi.nsw.gov.au kate.thornborough@dpi.nsw.gov.au asha.mcneill@dpi.nsw.gov.au
WA DBCA - Marine Parks	Amanda Smith (Social Science) Peter Barnes (Marine Park coordinator)	amanda.smith@dbca.wa.gov.au peter.barnes@dbca.wa.gov.au
SA DEWNR - MER	Simon Bryars Alisson Wright	Simon.Bryars@sa.gov.au Alison.Wright@sa.gov.au
GBRMPA - Human Dimensions	Michelle Dyer	Michelle.Dyer@gbrmpa.gov.au

Research Users (program/section/branch/ organisation)	Name/s	Email
Parks Australia (AMPs)	Cath Samson (Project Contact) David Logan (Science Coordination) Mitch Ryan (MERI)	Cath.SAMSON@environment.gov.au David.Logan@environment.gov.au Mitchell.Ryan@environment.gov.au
DoEE - Environmental Accounting	Zak Baillie (Environmental accounting)	zak.baillie@environment.gov.au
Update		
Parks Victoria - Social and Visitor Research	Michelle Rose, Kelly De Bie	michelle.rose@parks.vic.gov.au kelly.debie@parks.vic.gov.au

Research Users (program/section/branch/ organisation)	Name/s	Email
NSW DPI - Marine Ecosystems	Alan Jordan (Marine Ecosystems) Kate Thornborough (Marine Ecosystems) Asha McNeil (Marine Ecosystems)	alan.jordan@dpi.nsw.gov.au kate.thornborough@dpi.nsw.gov.au asha.mcneill@dpi.nsw.gov.au
WA DBCA - Marine Parks	Amanda Smith (Social Science) Peter Barnes (Marine Park coordinator)	amanda.smith@dbca.wa.gov.au peter.barnes@dbca.wa.gov.au
SA DEWNR - MER	Simon Bryars Alisson Wright	Simon.Bryars@sa.gov.au Alison.Wright@sa.gov.au
GBRMPA - Human Dimensions	Michelle Dyer	Michelle.Dyer@gbrmpa.gov.au

Project D7 – NESP Hub support for Parks Australia's Monitoring, Evaluation, Reporting and Improvement System for Australian Marine Parks

Project length: 1 Year

Project start date: 02/01/2020

Project end date: 20/12/2020

Project current status: New project submitted for approval

Project Leader: Neville Barrett/Piers Dunstan (FTE – 10%)

Lead research organisation: UTAS/CSIRO

Project leader contact details: neville.barrett@utas.edu.au / piers.dunstan@csiro.au

PROJECT FUNDING AND EXPENDITURE

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	*x*	*x*	*x*	*x*	*x*	*$100,000*	*x*	*$100,000*
Cash co-con	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
In-kind co-con	*x*	*x*	*x*	*x*	*x*	*$100,000*	*x*	*$100,000*
TOTAL	***x***	***x***	***x***	***x***	***x***	***$200,000***	***x***	***$200,000***

Expenditure statement

The funds will be used across the Hub to support engagement of hub expertise as required by Parks Australia to support development and implementation of a MERI framework for Australian Marine Parks. This will be primarily staff time, with some contribution towards costs associated with face to face meetings and workshops with Parks Australia staff.

Project Summary

Project Summary: This application is to facilitate Hub engagement with Parks Australia during development and initiation of their Monitoring, Evaluation, Reporting and Improvement (MERI) System for Australian Marine Parks. A key priority for the Marine Parks Branch over the next 18 months is finalising the Australian Marine Park MERI System. The Marine Biodiversity Hub will play an important role in development and implementation of this system. Hub partners have had previous experience in developing the integrated monitoring framework for the Great Barrier Reef, developing a process for identifying indicators for monitoring Key Ecological Features, and also have collected much of the ecological data that exists within Australian Marine Parks.

Project Description

Description: Parks Australia is currently developing a MERI System to support adaptive management of Australian Marine Parks. Parks Australia would like to utilise the Marine Biodiversity Hub's previous work and experience in identifying key values and pressures relevant to the Australian Marine Parks, and developing integrated monitoring and reporting programs, to assist with the development of the MERI System.

In discussions with Parks Australia, to ensure the MERI system is optimally integrated with current scientific knowledge and capability, there are a number of tasks and information needs that the Hub is well positioned to provide assistance with, these include:

- Review the 'common language' proposed for Australian Marine Parks, including natural values and pressures classifications, hierarchies and definitions.
- Coordinate the inputs of the MBH to the identification of natural values, pressures and human uses within Australian Marine Parks and, where required, coordinate the provision of spatial data layers from existing and previous projects for incorporation into Parks Australia's spatial information systems (i.e. Wylie) and other mapping portals.
- Review conceptual models developed for each of the key ecosystems across the Australian Marine Park networks.
- Review ecological risk assessments for natural values and pressures.
- Provide advice on the process and criteria for identifying monitoring and inventory priorities.
- Coordinate with project SS2 to develop detailed conceptual models for areas identified as monitoring priorities for selected AMP Networks.
- Contribute to the development of monitoring questions.
- Provide advice on the process and selection criteria for identifying appropriate value and pressure indicators (noting that the NESP D6 project is helping to identify appropriate social and economic indicators and measures).
- Provide advice on best practice approaches for assessing management effectiveness.
- Identify the suitability of existing data sets to support the identified monitoring priorities.
- Provide advice on evaluation and reporting including best approaches for using a combination of quantitative data and expert opinion, and to help ensure alignment and consistency across objectives, key evaluation questions and reporting.
- Provide marine park pressure profiles for each AMP Network describing the state of pressure in each network and the trends (where possible).

This project is required to provide relevant expertise to assist Parks Australia when and where input is needed and to cover the time and travel costs of this engagement as it arises. The project plan is broadly stated to provide sufficient flexibility to identify and address priority tasks/needs for developing and implementing the MERI framework. The project team will work closely with Parks Australia and other research-users to scope and develop the project and shape project outputs to meet research-users needs. Knowledge brokering and communication will be conducted in accordance with the Hub's Knowledge Brokering and Communication Strategy. Priority tasks for this project will emerge after Parks Australia complete their initial draft MERI Framework (expected in December 2019, see Figs. 1 & 2 below for a schematic of the MERI system and adaptive management framework), and be followed by a series of discussions and workshops as required to focus the Hub's contributions and ensure tasks can be achieved within the limitations of the project (i.e. within the project's allocated budget and timeline). It is anticipated there will numerous meetings and likely to be between 3-4 workshops to address priority tasks.

The governance arrangement for this project (a steering group, including Parks Australia representatives), will ensure the timely contribution to the development of the MERI System

within the budget allocated. This process will ensure that engagement and feedback processes can be planned prior to the formal start of the project.

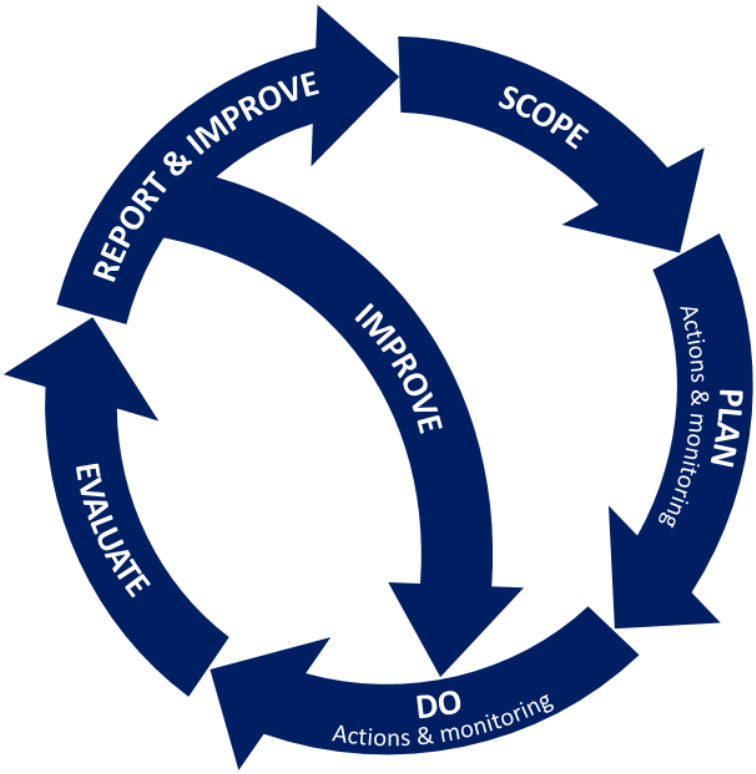


Figure 1. *The Australian Marine Park Adaptive Management Cycle.*

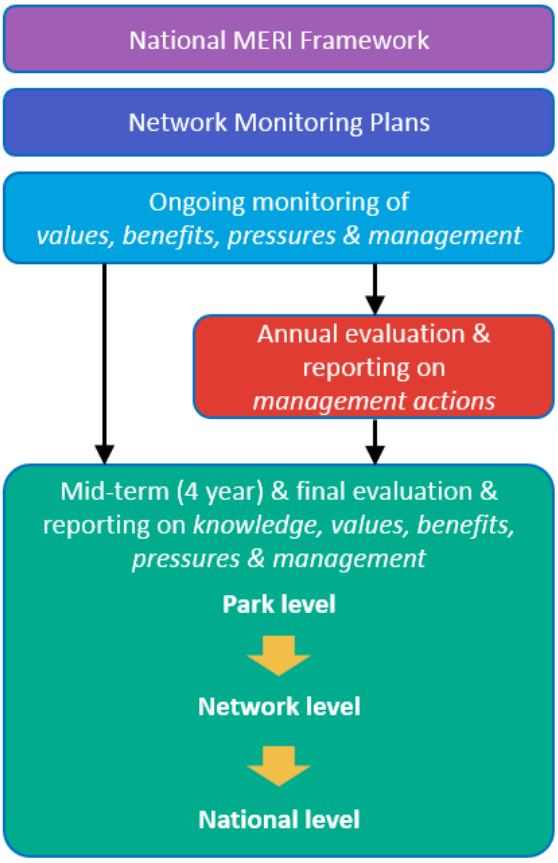


Figure 2. *The Australian Marine Park MERI System.*

NESP 2017 Research Priority Alignment

This project directly aligns with the core NESP marine priority 1.2:

"improve the management of marine biodiversity through an evaluation of the results of management interventions" that falls within the broader NESP marine priority 1 "Maximising the efficacy of managing Australia's marine environment".

This priority will be addressed by directly working with Parks Australia to ensure that information from the national science community is able to be effectively harnessed to inform management of Australian Marine Parks.

PATHWAY TO IMPACT

Outcomes
This project is directly targeted to the specific needs of Parks Australia. Key components are: • Successful incorporation of appropriate science advice/evidence and best practice approaches into the Australian Marine Park MERI System. • Uptake of Hub expertise in MERI application into the overall development of adaptive management approaches by Parks Australia for Australian Marine Parks (including experience in developing such frameworks for GBRMPA and NSW DPI). The major environmental benefits that will flow from this project are conservation of marine biodiversity and sustainable use of marine resources in Australia's Exclusive Economic Zone (via the establishment of a MERI System for Australian Marine Parks that is effectively informed by robust scientific advice and evidence on environmental values and the effect of pressures and management responses).

Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
Parks Australia	The Hub's researchers are working closely with Parks Australia to understand their needs and requirements for a MERI System and scope the project plan. Parks Australia will be directly involved in the project, including guiding product development and scoping and organising workshop/meetings. Research findings and outputs will be directly communicated to Parks Australia as part of an oversight committee they will be part of.	This project is directly focused on establishing a MERI System that will inform decision making about management responses/investments for managing Australian Marine Parks. It is intended to produce information and advice to ensure the MERI System is optimally integrated with management needs and marine science capacity in Australia.	Specific outputs will be determined after priority tasks are identified for developing/implementing the MERI framework. Outputs are likely to include: workshop reports or summaries, spatial layers for natural and social values, and pressures for incorporation into Wylie. Project outputs will inform specification of the MERI Framework and regional network monitoring plans that Parks Australia is required to develop.
Additional outputs Nil			

INDIGENOUS CONSULTATION AND ENGAGEMENT

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement as it is a desktop study requiring deep engagement with the agency that has responsibility for managing Australian Marine Parks (i.e. the knowledge generated in this project is primarily targeted to meet the needs of Parks Australia). The Hub will communicate project progress to the DoEE Indigenous Advisory Committee (mediated through DoEE) and the Fisheries Research and Development Corporation Indigenous Reference Group through provision of updates to its chair.

Progress to develop and implement the MERI System is the responsibility of Parks Australia. The MERI System will include components that are of direct relevance Australian Aboriginal

and Torres Strait Islanders. Parks Australia have a developing Indigenous engagement program and established regional advisory committees for AMP networks to include stakeholders and Indigenous peoples in park management. The Marine Biodiversity Hub will not be providing advice on sea country into the MERI framework, as this will be undertaken separately by PA. PA has existing relationships, engagement programs and advisory groups (Regional Advisory Committees) that can be leveraged to identify the opportunities to build traditional ecological knowledge and management capability into the Framework. Given this, the Hub will not be providing quality assurance for incorporating Indigenous sea country knowledge and management practices into the AMP MERI system, as this is the responsibility of Parks Australia.

PROJECT MILESTONES

Milestones	Due date	Milestone Status
Milestone 1 – Signing of contract	*Due 1 Jan 2020*	
Milestone 2 – Agreement on priority project tasks and required project outputs. This will include agreed timing of deliverables, including core tasks and outputs	*20/03/20*	
Milestone 3- Oversight progress evaluation on priority tasks and required project outputs. Formal evaluation by Parks staff and Oversight Committee of progress to date, and scoping of deliverables necessary before end of project. The milestone status will be measured against goals set by an Oversight Committee established at commencement of the project	*1/07/20*	
Milestone 4- Summary Final Report	*20/12/2020*	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including metadata) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles.

Project output	Data Management and Accessibility
Mapping layers as requested by Parks Australia	No new data will be generated as a result of this project. Outputs will be in the form of some new data products (e.g. mapping layers) and workshop reports. Mapping layers will be made available to Parks Australia as specific products that may not be of wider public interest. However, all products will be available via national data platforms (e.g. the Australian Marine Parks Science Atlas) at the discretion of Parks Australia. This project will meet the NESP data management guidelines (http://www.environment.gov.au/system/files/pages/2f561690-b47e-4bf2-b028-d18739b3486f/files/nesp-data-accessibility-guidelines-v3.pdf) by making all data products deemed by Parks Australia to be of public interest findable, accessible and re-useable via meta data on the AODN, and data layers on applicable national platforms as listed above (Parks Atlas) as well as Seamap Australia, AusSeabed, and distributed to ERIN, where applicable.
AMP pressure profiles for each AMP Network	The outputs will be a summary of the existing pressures in AMP networks, aligned to the PA pressure hierarchy.

LOCATION OF RESEARCH

There are no planned on-ground actions other than meetings and workshops at locations that are yet to be determined.

PROJECT SPECIFIC RISKS

All of these risks will be managed via an Oversight Committee involving Parks Australia in addition to representatives of Hub partner agencies engaged in the project. The MERI project is now well progressed, so lack of progress over the next 12 months is unlikely. It is anticipated that the Hub's engagement will involve the Research Leadership team as a core component of the Oversight Committee for this project. As the RLT meets monthly, there is a mechanism there to ensure products are delivered in a timely manner, and a work program is clearly established.

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
1. Ineffective engagement of Parks Australia in the project	Poor understanding about needs and outputs may not be fit-for-purpose	High	Formation of an oversight committee for the project. Key staff from Parks Australia will participate on this committee	Low	Project leaders
2. Delayed identification of priority tasks for this project (for developing MERI System)	Increase time constraints for project activities – noting that research under NESP must be completed by end of 2020	High	A key task for the oversight committee will be early agreement on priority tasks for this project (see milestone 3)	Low	Project oversight committee

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
3. Hub does not provide timely access to relevant expertise/data to complete priority tasks for this project	Not delivering on time for a priority task	Medium	Agreement of priority tasks will need to consider likelihood of timely access to required expertise/data to deliver desired outputs.	Low	Project leaders
4. Parks Australia has unrealistic expectations of this relatively small expertise-based project	Priority tasks identified are not achievable with available resources	Medium	Key staff from PA on oversight committee will reduce this risk and communicate regularly to PA senior staff	Low	Project oversight committee
5. Parks Australia's priorities change requiring a refinement to agreed priority tasks, timelines or required outputs	Inefficient use of project resources and increased time constraints for delivery outputs that meet needs	Medium	Ensure oversight committee meets at least four times in 2020 and ensure risk management is a rolling agenda item. If change is required ensure these are effectively communicated to oversight committee and key project staff/researchers	Low	Project oversight committee
6. Loss of key researchers or PA staff	Project loses momentum or ambiguity about priorities emerges	Medium	Rapid replacement of staff/researcher and communication to oversight committee. If not, oversight committee needs to convene to resolve issue	Low	Project leaders/ oversight committee
7. Late delivery of Hub outputs or delivery of outputs that do not meet user needs	Decreased impact of research inputs	Medium	Identify realistic delivery dates for outputs and oversight committee to review progress at least quarterly. Document specifications of user requirements for outputs and provide to researchers. Researchers to involve PA staff in development of outputs.	low	Project leaders

PROJECT KEYWORDS

MERI, Adaptive management, marine parks

PROJECT CONTACTS

Researchers and Staff

Note that this list includes Hub staff likely to make a significant contribution to the project. However, FTEs have yet to be determined as the engagement of individual staff will be determined by the Hub directorate as the project develops and the specific needs of Parks Australia are formally identified. Estimated FTE across all staff is 1.0.

Name	Organisation	Project Role	FTE
Michelle Thums	AIMS	RIMREP learning transfer and threatened species expertise/representation	TBD
Scott Nichol	GA	Geoscience input into MER	TBD
Rachel Przeslawski	GA	Role of SOPs in MER frameworks	TBD
Paul Hedge	Hub directorate	MER expertise and national science (NMSC)	TBD
Nic Bax	Hub directorate	MER expertise and national science (NMSC)	TBD
Keith Hayes	CSIRO	Expertise from multiple MER projects and modelling	TBD
Piers Dunstan	CSIRO	Theme E leader input (Pressures)	TBD
Neville Barrett	UTas	Project coordinator and national monitoring networks	TBD
Jacquomo Monk	UTas	Benthic ecology – indicators for management	TBD
Jeffrey Dambacher	CSIRO	Qualitative modelling expertise & RIMREP input	TBD
Alan Jordan	NSW DPI	NSW MER expertise and state/national science	TBD
Rick Stuart-Smith	IMAS	National UVC indicators for reefs	TBD
Tim O'Hara	MV	Taxonomy, bioregional and NMF expertise	TBD
Geoff Hosack	CSIRO	Expertise from MER development and associated modelling	TBD
Scott Foster	CSIRO	Statistically robust design in reporting programs	TBD
Estimated total FTE			1.0

Data Management

Name	Organisation	Email	Phone
Neville Barrett	University of Tasmania	Neville.Barrett@utas.edu.au	03 6226 8210

Co-contributors

Name	Organisation/	Contribution
Nil		

Key Partners and Research End Users

Key Partners (organisation/program)	Name/s	Email (optional)
DOEE/Parks Australia	Jason Mundy	Jason.Mundy@environment.gov.au

Research Users (program/section/branch/organisation)	Name/s	Email (optional)
DOEE/Parks Australia	Sebastian Lang	Sebastian.Lang@environment.gov.au
DOEE/Parks Australia	Mitch Ryan	Mitchell.Ryan@environment.gov.au
DOEE/Parks Australia	Steffan Howe	Steffan.Howe@environment.gov.au
DOEE/Parks Australia	Cath Samson	cath.samson@environment.gov.au
DOEE/Parks Australia	Amanda Richley	Amanda.Richley@environment.gov.au

Project D8 – Canyon mapping & biodiversity in Gascoyne Marine Park

Project length: 1 Year
Project start date: 01/01/2020
Project end date: 31/12/2020

Project current status: New project submitted for approval

Project Leader: Rachel Przeslawski (FTE – 20%)
Lead research organisation: Geoscience Australia
Project leader contact details: rachel.przeslawski@ga.gov.au, (02) 6249 9101

PROJECT FUNDING AND EXPENDITURE

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	*x*	*x*	*x*	*x*	*x*	*$10,000 (GA) $10,000 (UTAS) $10,000 (WAM[a])*	*x*	*$30,000*
Cash co-con	*x*	*x*	*x*	*x*	*x*	*$30,000 (from Parks Australia to GA)*	*x*	*30,000*
In-kind co-con	*x*	*x*	*x*	*x*	*x*	*$50,000 (GA)[b] $10,000 (UTAS)*	*x*	*$60,000*
TOTAL	***x***	***x***	***x***	***x***	***x***	***$120,000***	***x***	***$120,000***

[a] *To be administered by GA*

[b] *This does not include in-kind costs associated with the approved voyage from Schmidt's Ocean Institute which exceed $300,000 contribution from Western Australian Museum and associated universities.*

Expenditure statement

All funding will be applied to additional activities and outputs not currently mandated in the original voyage proposal to the Schmidts Ocean Institute. Requested funding will be equally split between NESP and Parks Australia to the total amount of $60k. Parks Australia have agreed in principle to support this proposal if NESP also does so. Expenditure will be used to support the salary for researchers engaged in this project. $40k of requested funding will be used to support full survey participation of a NESP researcher from Geoscience Australia, as well as to support staff to develop the data and communication products specified in this project plan. This will be matched with in-kind investment from the project

partner (GA). In addition, $10k will be directed to the Western Australian Museum to expedite taxonomic identifications of specimens of interest, to be decided during onboard operations based on likely importance to a biological dataset (e.g. all molluscs) or management implications (e.g. threatened or new taxa). The final $10k of requested funding will be used to ensure the use of the deep-sea ROV used on the survey informs the ROV field manual being developed as part of NESP Project D2.

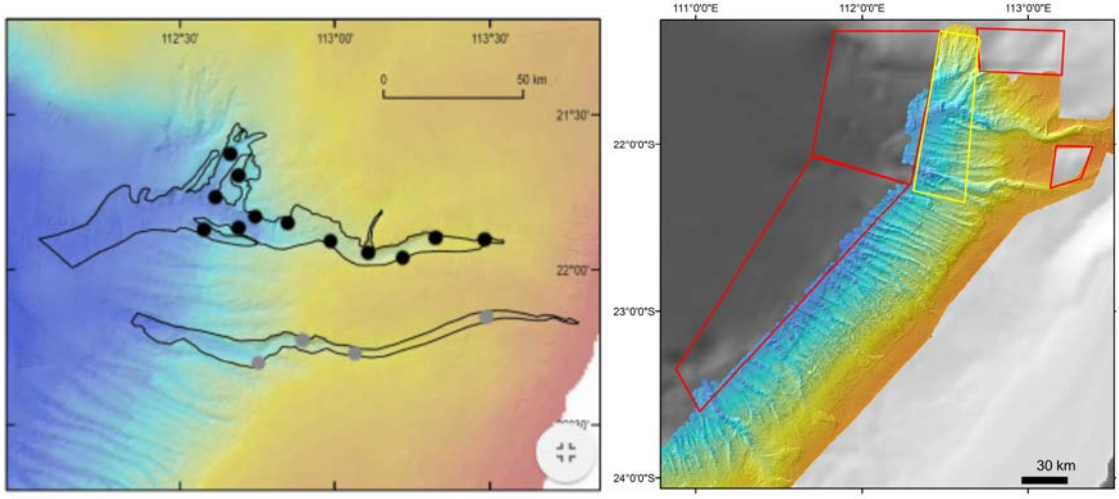
PROJECT DESCRIPTION

Project Summary

The approved survey to the Gascoyne canyons aims to map the surrounding marine park using multibeam sonar and to characterise the biodiversity of North-West canyon fauna, using an ROV to undertake a comprehensive taxon inventory and eDNA analyses to provide a methodological comparison. The proposed project will extend the survey's capability and increase its relevance to marine park management, particularly in deep-sea and canyon habitats. The proposed project will yield communication products such as a fly-through, eco-narrative, and image library, as well as products consistent with previous NESP reporting such as a voyage plan and post-survey report.

Project Description

Very little is known about the deep waters of Australia's marine parks. Recent NESP-supported surveys have targeted eastern abyssal depths and Tasmanian seamounts (NESP Project D4), but there have been no similar efforts in Western Australia. To counter this information deficit, we plan to actively map and sample two significant and biologically unexplored submarine canyons (Cape Range and Cloates Canyon) in the habitat protection and multiple use zones of the Gascoyne Marine Park. Standard operating procedures for marine sampling (multibeam, survey design) will be followed, with other sampling platforms (e-DNA, ROV) informing future SOPs (NESP Project D2).



LEFT: Proposed sample sites (16) for Cape Range (black dots) and Cloates (grey dots) canyons. RIGHT: Existing high-resolution mapping, with polygons showing proposed new mapping areas (red) and re-mapping area to quantify seabed mobility (yellow).

Information from this survey will greatly enhance our understanding of the Gascoyne Marine Park and deep-sea environments throughout Western Australia, as well as facilitating comparisons between recent deep-sea information from eastern and southern Australia. This information will be applied to generate data and communication products useful to Parks Australia in their management of this region, as well as other research agencies undertaking current projects in the region (e.g. Australian Institute of Marine Science, Western Australian Museum). In addition, the baseline data will inform industry activities in the North-West. Specifically:

- The resulting faunal inventory provides baseline environmental information fundamental to monitoring undertaken in deep water WA environments. This may then be used to assess impacts of natural and anthropogenic activities that occur in the region (e.g. heat waves, petroleum exploration and extraction).
- The seafloor mapping will extend our map of the Gascoyne Marine Park and develop the regional context of canyon habitats in which to interpret the faunal inventory.
- The repeat mapping area will provide information on sediment and bedform mobility in the canyons of the Gascoyne Marine park, illustrating a rare case of true monitoring using multibeam in Australian waters.
- The e-DNA component will serve as a comparison to more traditional techniques to inform future baseline and monitoring approaches that may be suitable (or unsuitable) for marine park management, thereby informing future SOPs that may develop.
- The use of a state-of-the-art ROV will provide information to improve the ROV field manual to be added to the existing suite of standard operating procedures supported by Parks Australia

The funding requested in the current project will ensure that the above outcomes are able to be achieved in a timely manner and by the end of the current Hub. In addition, the proposed project will include the development of data and communication products directly informed by and relevant to Parks Australia.

NESP 2017 Research Priority Alignment

This project aligns to at least three DoEE 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 deep-sea information necessary to:

(vii) ***develop and apply methods for monitoring the status and trends of key marine species*** associated with deep-sea and canyon habitats,

(viii) ***build the knowledge base of key marine species and ecosystems*** associated with the Australian continental slope, particularly within AMPs,

This project is also strongly aligned with recommendation 2 in the National Marine Science Plan - Establish and support a national marine baselines and long-term monitoring program, to develop a comprehensive assessment of our estate, and to help manage Commonwealth and State marine reserves.

PATHWAY TO IMPACT

Outcomes
We will execute the first biological survey of Cape Range and Cloates canyons, and provide information useful for the management of the canyon as part of the North-west Marine Park Network. North-western Australian deep sea environments are used by oil and natural gas industries, but an overall lack of understanding of these environments inhibits environmental impact assessments and appropriate mitigation or conservation actions. More than half of Australia's petroleum reserves are in the Carnarvon Basin (encompassing Exmouth and Cape Range Canyon), so canyons to the north of that basin are the closest, and thus the most vulnerable, to industrial disturbances. Climate change has also resulted in pronounced marine heatwaves, which are another concern in WA. A major new petroleum lease released in 2017 directly overlaps the Gascoyne Marine Park, but we know very little about the deep-sea fauna in this region, and without this knowledge we cannot begin to assess faunal changes when adverse events occur. Our proposed work will contribute important baseline information critical in

the event of an industrial spill/accident, which we know have dramatic and often difficult to evaluate impacts on the marine environment. Establishing faunal knowledge in marine parks is prudent for monitoring activities and to assess effectiveness of zoning.

Using eDNA to compare traditional voucher-based survey techniques in the deep sea is highly innovative. Given that the tropical deep Indian Ocean is vastly understudied, the outlook for important discoveries is extremely high. Our team will produce an effective and integrative project, which boosts our understanding of poorly known deep marine biodiversity in Australia, and guides the validity and need for identifying key areas or approaches for follow-up sampling investment. Our outreach concepts are strong and imaginative and are highly motivated by authentic community engagement

Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
DoEE- Parks Australia *Jason Mundy, Bianca Priest, Dave Logan, Cath Samson,*	*Needs of research users have been identified through ongoing engagement and consultation, including discussions specific to this proposal and co-investment from PA. The project leader will continue to engage PA to refine survey plans, liaise with survey leader, and develop project outputs to ensure they are fit-for-purpose.*	*Information will be used to inform marine park management, including planning and future monitoring options particularly as related to deep-sea parks more generally.*	Key outputs will include: • detailed post-survey report • survey data stored in national databases and portals. • A range of communication products specified as milestones, including an Eco-narrative on the Gascoyne The types of outputs and expectations have been discussed with end users over the project development stages in 2019.
DoEE- Marine and International Heritage Branch	As above, where engagement in steering groups is desired by end user	As above, with knowledge gained contributing to broader marine regional management of deep-sea regions, including KEFs	As above
NOPSEMA Chris Lamont, Cam Sim	As above	As above	As above
IMOS/AODN	As above	New information and data will add biophysical	As above

Research-user	Engagement and communication	Impact on management action	Outputs
Michelle Heupel, Indi Hodgson-Johnston, Ana Lara-Lopez		datasets to the AODN portal for use and reuse by a broad spectrum of data users and potentially inform IMOS infrastructure and funding priorities	

Additional outputs

All outputs listed will be of use to Parks Australia, as well as other stakeholders, with the overarching outcome of increasing environmental baseline knowledge of a deep-sea region in a marine park and informing the broader management and use of resources in deep-sea regions.

INDIGENOUS CONSULTATION AND ENGAGEMENT

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement. This means the knowledge generated in this project will be effectively shared with and communicated to relevant Indigenous peoples, communities and organisations.

The team will leverage off Hub Indigenous engagement mechanisms to ensure generated knowledge is communicated shared and communicated to relevant organisations. This will include communication to the DoEE Indigenous Advisory Committee (mediated by DoEE), the Fisheries Research and Development Corporation Indigenous Reference Group (providing updates to their Chair who sits on the Hub's Steering Committee), the Australian Marine Sciences Association Indigenous Engagement Sub-committee.

PROJECT MILESTONES

Milestones	Due date	Milestone Status
1. Voyage plan to be developed with consultation from Parks Australia and applying NESP survey design SOP	Feb 2020	
2. Post-survey report to follow NESP post-survey report template.	July 2020	
3. Eco-Narrative for Gascoyne Marine Park	Nov 2020	
4. Fly-through	Dec 2020	
5. Visualisation and communication products to NESP and Pav(Bathy visualisation products, image library, Atlas article)	Dec 2020	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles. Datasets will be stored in a long-term secure storage, metadata will be created to meet the standards 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 each time a data set is published. A full data management plan is detailed in the original SOI proposal and summarised in the table below, with products specific to this proposal marked with an asterisk. Reports, maps and imagery will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au.

Onboard data will include sorted and processed biological samples and imagery, which will be entered into a custom built Filemaker Pro database onboard, and then exported into the WA Museum database after the expedition end. An annotation log will be kept running during ROV activities to link in situ imagery of individual specimens, the latter of which will be curated at the Western Australian Museum.

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

Project output	Data Management and Accessibility
Image library*	Representative images from the ROV will be compiled onboard, with appropriate meta-data. These will be archived on the Australian Marine Imagery Collection at the NCI through THREDDS and made available to Parks Australia.
Flythrough / derived bathy products*	*Derived bathymetric products will be made available through the Geoscience Australia website and linked to relevant portals, including the Marine Park Atlas and North-West Atlas.*
Taxonomic catalogue	Taxonomic identifications and associated meta-data will be made available online through Atlas of Living Australia (ALA) web portal. Data from all major Australian Museums are made public via this collaborative, national project that aggregates biodiversity data nationally, and subsequently feeds global initiatives like GBIF.
Sanger genetic sequences	Sequences will be submitted to databases (such as NCBI's Genbank, short read archive or DataDryad) prior to publication, ensuring it has life past the end-date of the project. To deal with the large amounts of data involved in the eDNA survey, computing facilities are paramount. Curtin University is a founding partner of the Pawsey supercomputing facility, which is also supported by the state government – the most recent installation being a Cray XC40 Supercomputer (Magnus), which ranks at #41 in the Top 5000 list of supercomputers globally. This processing power enables analysis of large volumes of pairwise (Blastn) comparisons. Data visualisation is vital for the proposed project and the $1 million Hub for Immersive Visualisation and eResearch (HIVE) facility at Curtin is ideal for this purpose
e-DNA sequences	As above

Project output	Data Management and Accessibility
Processed bathymetric grids	Multibeam data will be processed at Geoscience Australia and made available via the AusSeabed portal (ausseabed.gov.au).

LOCATION OF RESEARCH

Research will be conducted in and around the Cape Range and Cloates canyons in the Gascoyne Marine Park. See figure in project summary for proposed sampling waypoints and mapping areas.

Eastern bounding coordinate: 113.5°
Western bounding coordinate: 110.8°
Southern bounding coordinate: -23.6°
Northern bounding coordinate: -21.8°

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
Permits are not approved in required time	Moderate-may require project restructure	Low	Permit applications will be submitted months in advance.	Survey leader
Under-budgeted, resulting in inability to complete all tasks within a given survey	Moderate-will require some project restructuring	Low	Delivery of each survey will be closely coordinated with WAM, SOI, and Parks Australia, and survey goals will be adjusted flexibly to balance tasks with priority outcomes.	Project leader, survey leader
Weather, staff, vessel and key equipment availability	Moderate, may result in delays or shortening of days at sea.	Low	Surveys will plan for contingencies, including flexible timing and as above, closely coordinate with Parks Australia to optimise outcomes if sea time is restricted.	Project leader, survey leader
Day to day OH&S risks e.g. shipboard injury	Moderate-may impact days at sea for example	Low	Managed through the OH&S protocols in each institution/workplace. All partner organisations have national standard level protocols and procedures in place.	Survey leader, SOI vessel crew

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Who is responsible for managing risk?
Coordination and cooperation across Hub and non-Hub partners	Moderate- may impact on extent of project deliverables	Low	Managed through a mix of face to face meetings, regular fortnightly phone meetings once project planning is initiated, clear within-survey plan milestones, and engagement with partners with a track record of collaboration.	Project leader, survey leader, collaborators

PROJECT KEYWORDS

Canyon, taxonomy, deep-sea, ROV, e-DNA

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE
Rachel Przeslawski	GA	Project manager, ecologist	.10
Michele Spinoccia	GA	Geophysicist	0.05
Scott Nichol	GA	Geologist	0.05
Jacquomo Monk	UTAS	Ecologist	0.05

Data Management

Name	Organisation	Email	Phone
Rachel Przeslawski	Geoscience Australia	Rachel.przeslawski@ga.gov.au	02 6249 9101

CO-CONTRIBUTORS

Name	Organisation/	Contribution
Nerida Wilson	WAM	Survey leader, co-leading taxonomy component
Lisa Kirkendale	WAM	Co-leading taxonomy component
Michael Bunce	Curtin	Leading e-DNA component
Dave Logan	PA	Providing input and suggestions from Parks Australia
Cath Samson	PA	Providing input and suggestions from Parks Australia

Key Partners and Research End Users

Key Partners (organisation/program)	**Name/s**	**Email (optional)**
Parks Australia	Jason Mundy, Cath Samson, Bianca Priest	Jason.Mundy@environment.gov.au

Research Users (program/section/branch /organisation)	**Name/s**	**Email (optional)**
Parks Australia	*Jason Mundy, Bianca Priest, Dave Logan, Cath Samson*	David.Logan@environment.gov.au
DoEE- Marine and International Heritage Branch	Nicole Coombe	Nicole.Coombe@environment.gov.aau
NOPSEMA	Chris Lamont, Cam Sim	Christine.Lamont@nopsema.gov.au
IMOS/AODN	Michelle Heupel, Indi Hodgson-Johnston, Ana Lara-Lopez	michelle.heupel@utas.edu.au

Project E1 – Guidelines for analysis of cumulative impacts and risks to the Great Barrier Reef

Project length: 12 Months

Project start date: 1 Jan/ 2020

Project end date: 31 Dec 2020

Project current status: Project extension submitted for approval

Project Leader: Jeff Dambacher and Piers Dunstan

Lead research organisation: *CSIRO*

Project leader contact details: *Jeffrey.Dambacher@csiro.au, 03 62325096*
Piers.Dunstan@csiro.au, 03 6232 5382

PROJECT FUNDING AND EXPENDITURE

Summary of project extension

The extension is to support the adaption of the guidelines to the specific requirements of GBRMPA, DoEE and Queensland Government. Discussions with these uses indicated that they wanted specific modifications tailored to each jurisdiction. In addition, a GBRMPA specific case study will be developed, in collaboration with GBRMPA Staff.

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	*x*	*x*	*x*	*350,000*	*x*	*$50,000*	*x*	*$400,000*
Cash co-con	*x*	*x*	*x*	*X*	*X*	*x*	*x*	
In-kind co-con	*x*	*x*	*x*	*619,132*	*X*	*$50,000*	*x*	*$669,132*
TOTAL	***x***	***x***	***x***	969,132	***X***	***$100,000***	***x***	***$1,069,132***

Expenditure statement

Funds for 2020 will be used to pay salary and travel expenses to Canberra, Brisbane and Townsville.

PROJECT DESCRIPTION

Project Summary

The project will develop guidance for the analysis of cumulative impacts and risks to the environmental, social and economic values of the GBR. The project will use existing information to develop guidance for use by GBRMPA, DoEE, the Queensland Government and proponents of future development proposals. The project will build on the work undertaken in the GBR Strategic Assessment and support works undertaken under the Reef 2050 plan. The guidance will provide a practical science-based approach to assessment of cumulative risks to the Reef. Research will focus on providing a general and repeatable approach to be applied at the whole-of-reef scale (to meet planning, assessment and reporting requirements of the GBRMPA) and also at the development-site-scale (to meet the environmental assessment requirements of the GBRMPA and future proponents). The guidance will be developed in close collaboration with the GBRMPA and DoEE to ensure it is practical and compatible with relevant legislation and policy applicable to proposed actions within the GBR. The project will include a case study focused on attributing impacts of pressures and their cumulative impacts on shallow-water coral reefs of eastern Australia (including cumulative impacts for the whole-of-GBR). It will also examine how this could be applied to shallow temperate reefs follow recent risk assessments conducted in NSW. Research is primarily designed to meet the specific needs of GBRMPA and future proponents. NSW DPI, QLD Government and Parks Australia, may also benefit from the case study and insights to assessment of cumulative impacts.
2020 Extension

The guidelines have gone through three iterations of stakeholder consultation. Based on the positive response, further work is needed to:

1. Embed the guidance within the Reef 2050 Framework.
2. Ensure that the guidance and operational processes for cumulative impact risk assessment are suitable for use by proponents.
3. Work with GBRMPA managers to identify how guidelines improve consideration of cumulative impacts for permitting and assessing, and whether additional products are required.
4. Ensure links to policy and legislation at Commonwealth and State levels are clearly documented and to ensure that the guidance is fit for purpose and articulated at appropriate scales of operation.
5. Work with Commonwealth and State Governments to describe case studies relevant to their regulatory responsibilities and deal with any linguistic or policy variation.

Original Project Description

Existing guidance and standards for assessing cumulative impacts to the marine environment are typically high-level allowing for considerable variation in approach, cost and outcomes from assessments. While GBRMPA and DoEE provide guidance to proponents on how to assess potential impacts of proposed activities, and GBRMPA has recently released a draft cumulative impact policy, these are high–level documents will little operational detail about how to approach the assessment of cumulative pressures and impacts to the Reef. These approaches are well intended but fall short of meeting the current needs of managers and proponents, and there is an identified need for guidance on how to properly assess cumulative impacts across a broad range of circumstances and settings. High-level guidance on assessing cumulative impact needs to be supplemented with science-based approaches that are practical and repeatable and can be understood by both regulators and proponents.

How Research Addresses Problem

The research aims to complete four tasks within the year.

- To develop guidance for assessing cumulative risks and impacts on the GBR.
- To demonstrate application of the guidance for assessing cumulative risk and impacts on the GBR, including how it accommodates scale issues and provide technical advice on appropriate methodologies.
- To investigate options for how social and economic values can be better integrated into analysis of, and guidance for, ecological impact and risk
- To complete a case study focused on attributing impacts of pressures and their cumulative impacts on shallow-water reefs of eastern Australia (including cumulative impacts for the whole-of-GBR) demonstrating the methodologies outlined in the guidance

Description of research

- Guidance development stage

The guidance development stage of the project will be progressed with close collaboration between researchers, the GBRMPA, DoEE ESD and relevant industry and QLD government stakeholders. The guidance will be developed to ensure that it is compatible with the approaches outlined in the Integrated Monitoring Framework as applied by RIMREP.

The guidance will be shaped by the management/regulatory use-cases (e.g. reef planner, reef regulator and proponent), the varying levels of complexity of interactions between values and activities, data availability and levels of certainty, for example providing guidance for how to deal with:

1. Data poor areas where there is high uncertainty (e.g., poorly known populations or habitats and other MNES within the GBR).
2. Areas with intermediate levels of data, or mixtures of different types of data (e.g., where there is existing recreational activity linked to the values of different zones).
3. Areas with high levels of data and good understanding of social and economic values where more quantitative methods can be tested (e.g., shallow reef systems of the GBR).

The guidance will need to need to accommodate assessment at different spatial scales, corresponding with the scales at which GBRMPA manages and make decisions, for example

(1) At a Plan of Management (POM) scale - The POM scale will support assessment of broad scale impacts, including frequent low level impacts and seascape scale pressures such as climate change.
(2) At a site specific scale for assessment of proposed activities -the site scale will support assessment where specific new developments are occurring (e.g., Public Environment Reports or Environmental Impact Statements).

The guidance will be developed so that a triage-type approach can be taken for the analysis of new impacts to allow rapid screening of low risk activities, moving to detailed analysis for high risk activities. This approach will provide a more practical means to implement EPBC significant impact criteria for matters of MNES. It will also assist GBRMPA to develop cumulative risk-based assessment process to prioritise protection and plans of management actions. The guidance will include options for how social and economic values can be better integrated into analysis of cumulative impacts and risk. It will be tested with key user groups and stakeholders to establish a practical set of procedures that can be implemented across the range of circumstances encountered in the GBR. For example, in state and Territory

jurisdictions (e.g., Integrated risk assessments are a key need across marine and terrestrial parks, New South Wales has recently developed and implemented a Marine Estate Threat and Risk Assessment Report) or for management of Australian Marine Parks.

- Guidance development informed by data analysis case study

The guidance development phase will include a study of analytical approaches to test and demonstrate the effectiveness of the approaches. This will be undertaken by collating and combining data on the most important pressures identified across the Coral Sea coral reef systems and the Great Barrier Reef, with detailed quantitative data on shallow reef biodiversity. This case study will use the rich ecological datasets available from the Reef Life Survey and AIMS LTM programs related to spatial footprint and levels of impact associated with identified pressures. Fishing pressure is one of these pressures, and will be investigated through new collation of existing charter fishing vessel AIS data and recently collected recreational fishing effort collected for the Great Barrier Reef. Climate change is another key pressure, to be investigated using 'before-after' data from the 2016 bleaching event. Impacts of extreme climate events will be assessed, and risk forecast, using observed spatial patterns in community composition (which provides an indication of local vulnerability to species loss, as identified in project C2), in combination with forecasts of marine heatwaves through the ESCC Hub project on Decadal Forecasting. COTS and water quality are additional key pressures that may be of possible significance in these analyses. The case study will provide a valuable means to assess whether the risk assessment framework can correctly identify cumulative impacts or attributed changes to pressures.

- Links to past and current research

The GBRMPA Draft Cumulative Impacts Policy articulates the need for effective approaches to assessing cumulative risks and impacts to fulfil Reef 2050. More specifically, it calls for operationalising the approach to cumulative impact assessment laid out in the strategic assessment for the GBRWHA. These two documents set the policy context for this research project. The project team is building on considerable experience in this area and is well positioned to carry this research forward. Specific experiences include:

  - Co-project leader JMD provided a general approach and methodological strategy to understand and assess cumulative impacts that was adopted and implemented within the GBRWHA Strategic Assessment (SA).
  - Co-project leader JMD, with AIMS researchers, conducted a supporting research project to the SA, in which they developed a systematic approach to assess cumulative impacts and apply structured decision making across jurisdictions from activities and developments within and adjacent to the GBRWHA.
  - Co-project leader JMD, along with NERP Hub researchers, in another supporting research project to the SA, developed the Integrated Monitoring Framework for the GBRWHA. This Framework laid out the general principles and procedures required for effective monitoring in the GBR, and is foundational for the Reef Integrated Monitoring and Reporting Program (RIMREP). JMD is currently assisting the implementation of this Framework as a RIMREP co-chair.
  - Co-project leader Piers Dunstan led NESP MBH project focused on N*ational collation of pressures, understanding of how values inform risk and impact analysis and options for assessing cumulative impacts* (NESP MBH Projects C1). The pressure data collated through this project is being used by MBH researchers to support their work on the status and trends of biodiversity.
  - The project will incorporate understanding developed through project C2 on the impacts of pressures on shallow reef systems to inform the case study.

Project Description for 2020 Extension

Consultation with stakeholders and further refinement of the guidelines has continued through 2019. This project will enable support for this through to end of 2020 and ensure that the final guidelines incorporate the views and needs of relevant stakeholders.
The guidelines have gone through three iterations of stakeholder consultation. Based on the positive response further work is needed to:

- Embed the guidance within the Reef 2050 Framework.
- Ensure that the guidance and operational processes for cumulative impact risk assessment are suitable for use by proponents.
- Work with GBRMPA managers to identify how guidelines improve consideration of cumulative impacts for permitting and assessing, and whether additional products are required.
- Ensure links to policy and legislation at Commonwealth and State levels are clearly documented and to ensure that the guidance is fit for purpose and articulated at appropriate scales of operation.
- Work with Commonwealth and State Governments to describe case studies relevant to their regulatory responsibilities and deal with any linguistic or policy variation.

To achieve this, we plan to:

1. Work with GBRMPA to develop a case study that uses examples relevant to GBRMPA.
    a. An initial meeting with GBRMPA Directors (to the extent possible, Belinda Jago, Roger Beeden and Kirstin Dobbs) to agree on the case study(s) and process to be used in applying the guidance to permitting and assessment activities
    b. A workshop with GBRMPA managers to evaluate the guidance in permitting and assessments, including the identification of products that would be required for routine implementation of the guidance and to develop the case study for GBRMPA.
2. Produce a plain language summary specific to the needs of GBRMPA that can be used by proponents and regulators as an entry point to the technical guidelines
    a. A description of the Acts and legislation that application of the guidance will interact with and where the guidance could be used.
    b. A description of the key values and pressures (which may be reference to existing lists) expected to occur within the area of competence of GBRMPA.
    c. A meeting/s with GBRMPA to ensure that the text in the summary and report aligns with GBRMPA legislation.
3. Produce a plain language summary specific to the needs of DoEE/ESD that can be used by proponents and regulators as an entry point to the technical guidelines
    a. A description of the Acts and legislation that application of the guidance will interact with ESD and where the guidance could be used.
    b. A description of the key values and pressures (which may be reference to existing lists) expected to occur within the area of competence of ESD.
    c. A meeting/s with ESD to ensure that the text in the summary and report aligns with ESD needs.

4. Produce a plain language summary specific to the needs of QLD State Government that can be used by proponents and regulators as an entry point to the technical guidelines
    a. A description of the Acts and legislation that application of the guidance will interact with QLD State Government and where the guidance could be used.

   b. A description of the key values and pressures (which may be reference to existing lists) expected to occur within the area of competence of QLD State Government.
   c. A meeting/s with QLD State Government to ensure that the text in the summary and report aligns with QLD State Government needs.
5. Produce a plain language summary specific to the needs of Parks Australia that can be used by proponents and regulators as an entry point to the technical guidelines
   a. A description of the Acts and legislation at application of the guidance will interact with Parks Australia and where the guidance could be used.
   b. A description of the key values and pressures (which may be reference to existing lists) expected to occur within the area of competence of Parks Australia.
   c. A meeting/s with Parks Australia to ensure that the text in the summary and report aligns with Parks Australia needs.
6. Development as readiness assessment that describes that data and capability needs to complete each step of the guidelines and test this assessment on at least one AMP network.

NESP 2017 Research Priority Alignment

This project aligns with:

- *consider the impact of climate change in the research design, delivery and recommendations, as appropriate*

Climate change remains one of the most significant pressures on the Marine Environment and may be especially pervasive as its impacts are expected to often be cumulative to existing impacts. The project will coordinate with the ESCC Hub project on the development of Decadal Forecasting capability to include outputs from the Decadal project into the analysis of impact and particularly risk of future impacts on MNES. This will include approaches to analyse the direct, indirect and cumulative impacts.

Maximising the efficacy of managing Australia's marine environment

- *Identify key social and economic values of the marine environment to build better stakeholder support and engagement in the management of marine and coastal environments*

The project will work with stakeholders to identify and populate a framework on the social values held within marine reserves and parks and the context of those values

Improving our understanding of pressures on the marine environment

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

The project will specifically develop guidelines for the analysis of impacts of pressures, including direct, indirect and cumulative impacts on MNES. Past NESP projects have identified past and future pressures and this project will allow understanding of their impact. Further, this will allow other researchers within the Hub to apply common approaches, facilitating uptake by research end users.

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

Development of standard approaches to the analysis of impact and risk, including indirect and cumulative, on MNES, will allow clear understanding of the causes and relationships between pressures and marine biodiversity.

- Improved 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.

Linking to the ESCC Hub will allow the integration of outputs from the decadal forecast program that will provide explicit forecasts on the future states of climate over the next 10 years. These forecasts can be added directly to the analytical approaches of this project.

Meaningful and accessible information on the status and trends of key social and economic values associated with the marine environment

- Meaningful and accessible information on the status and trends of key social and economic values associated with the marine environment.

PATHWAY TO IMPACT

Outcomes
It will provide environmental managers and proponents a pathway to estimate the cumulative risk to environmental values of current and new activities. The guidance will provide criteria that will allow for selection of appropriate methods to describe the impacts on, and risks to the social, economic and environmental values that have already been described by DoEE and extend to include other values types

Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
Great Barrier Reef Marine Park Authority DoEE-Environmental Standards Division Queensland Government	Research-users were actively engaged in the development of the project plan in the last quarter of 2017. The plan has been progressively refined to ensure it is aligned to research user policies and needs. There is strong history of engagement with GBRMPA through projects supporting its Strategic Assessment and rolling out of its Reef2050 plan. The project team will continue to engage research users in the further refinement and delivery of this project through workshops and multilateral meetings.	This project is specifically focused on delivering practical means to operationalise GBRMPAs cumulative impact management policy.	Guidance for assessing cumulative risk and impact assessment. The guidance will provide a step by step process for each definition (as above) that can be used by regulators and detailed technical information and examples for proponents and scientists. The guidance will contain a summary relevant to the jurisdictional needs of GBRMPA, DoEE and Queensland State Government and a GBRMPA specific case study.

Research-user	Engagement and communication	Impact on management action	Outputs
Parks Australia	Parks Australia requested a plain language summary of project to assist their planning, and also a case study report on the impacts in the GBR and Coral Sea.	Lessons and understanding developed can assist Parks Australia in operationalisation of their risk framework, and the case study will assist Park Australia in managing the Coral Sea Marine Park.	Plain English summary communicating the purpose, use and portability of the guidance. Case study report on assessment of data on shallow coral reefs.
NSW Government	NSW Government has engaged in the development of the Project and is on the project team	NSW Government will use the lesson learnt to inform cumulative impact analysis in their marine estate.	Plain English summary communicating the purpose, use and portability of the guidance
Additional outputs			

INDIGENOUS CONSULTATION AND ENGAGEMENT

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement. This means the knowledge generated in this project will be effectively shared and communicated between relevant Indigenous peoples, communities and organisations. The project leaders will consult with GBRMPA and NESP Tropical Water Quality Hub to determine the most appropriate mechanisms for sharing and communicating knowledge generated by the project.

Indigenous consultation and engagement contact:

Piers Dunstan
Ph: 03 6232 5382
Email: Piers.Dunstan@csiro.au.

PROJECT MILESTONES

Milestones	Due date	Milestone Status
1. Project planning workshop with research-users and researchers	Feb 2018	Completed
2. Agreed refinements to project plan based on workshop and follow-up discussions	March 2018	Completed
3. Workshop to elicit options for technical guidance from stakeholders and researchers, held in Townsville.	May 2018	Completed
4. Draft report - guidance for consultation	September 2018	Completed
5. Case Study Report on GBR & Coral Sea reefs pressure analysis	December 2018	Completed
6. Final report - guidance for analysis of cumulative impacts and risk	December 2018	Delayed while consultations are on-going. There have been 3 rounds of Draft documents thus far.
7. Plain English summary of guidance	December 2018	Delayed while consultations are on-going. There have been 3 rounds of Draft documents thus far.
8. Agreement with end user groups (QLD Gov, GBRMPA, DoEE, Parks AU) on engagement plan and process	March 2020	
9. Agreed case study with GBRMPA directors	April 2020	
10. Test readiness assessment on one AMP network	June 2020	
11. GBRMPA Specific Case Study	November 2020	
12. Summary specific to , GBRMPA & DoEE	November 2020	
13. Summary specific to QLD Government,	November 2020	
14. Summary specific to DoEE	November 2020	
15. Data archived and available according to Hub protocols	November 2020	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles. 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/, which is consistent with Reef 2050 Integrated Monitoring and Reporting Program requirements. An email will be sent to marinemetadata@environment.gov.au each time a data set is published.

Publications, reports, factsheets, maps and images will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au.

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

Project output	Data Management and Accessibility
Guidelines for analysis of direct, indirect and cumulative impacts	*Report will be made available through the Hub website and provided to research end users*
Extension Outputs	
Case Study specific to needs of GBRMPA	*Case Study will be integrated into the guidelines and made available in the report*
Summary of guidelines with specific reference to QLD legislation & needs	Summary will be integrated into the report as a separate section that precedes the technical section
Summary of guidelines with specific reference to GBRMPA legislation & needs	Summary will be integrated into the report as a separate section that precedes the technical section
Summary of guidelines with specific reference to DoEE legislation & needs	Summary will be integrated into the report as a separate section that precedes the technical section
Summary of guidelines with specific reference to Parks Australia legislation & needs	Summary will be integrated into the report as a separate section that precedes the technical section

LOCATION OF RESEARCH

The GBR, Queensland and NSW state waters and Australian Marine Parks.

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
The guidelines will not have broad support amongst MBH researchers and will not utilise all the expertise of Hub researchers	The guidelines will not be broadly applied to cumulative impact problems without broad support.	High	The development of the guidelines will have broad consultation and will explicitly build on existing work. Objectives will be communicated early to all hub researchers. The guidelines will be sent to partner representatives in the draft stage for independent review.	Low	Piers Dunstan
Research-users are not effectively engaged in project	User needs are not understood, and project outputs may not meet specific	High	Project leader will identify primary project contacts for each research-user and maintain effective	Low	Jeff Dambacher

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
	needs of research users		communication with these individuals, in particular for developing engagement processes to understand needs and for scoping and developing research outputs.		
Loss or lack of coordination amongst partners	The approaches will not be applied across all partners and some partners will act independently.	Medium	Project team will hold monthly meetings to ensure that tasks for all project members are clear.	Low	Piers Dunstan
Failure to agree on fit-for-purpose outputs within the project constraints (time and budget)	Project outputs may will meet specific needs of research users	Medium	Project leader will identify primary project contacts for each research-user and maintain effective communication with these individuals, in particular for developing engagement processes to understand needs and for scoping and developing research outputs.	Low	Jeff Dambacher

PROJECT KEYWORDS

Cumulative, indirect, impact, risk

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE
Piers Dunstan	*CSIRO*		0.1
Jeffrey Dambacher	*CSIRO*		0.2

Data Management

Name	Organisation	Email	Phone
Piers Dunstan	CSIRO	Piers.Dunstan@csiro.au	03 6232 5382

Co-contributors

Name	Organisation/	Contribution
Alan Jordan	NSW DPI	NSW specific application

Key Partners and Research End Users

Key Partners (organisation/program)	Name/s	Email (optional)
Greening Australia	Jane Smith	

Research Users (program/section/branch/organisation)	Name/s	Email (optional)
Primary Research Users		
Great Barrier Reef Marine Park Authority	Amanda Brigdale	Amanda.Brigdale@gbrmpa.gov.au
DOEE Environmental Standards Division	Karina McLachlan	Karina.Mclachlan@environment.gov.au
Queensland Government	Graeme Kenna	Graeme.Kenna@dsdmip.qld.gov.au
Parks Australia	David Logan	David.Logan@environment.gov.au
Secondary Research Users		
NSW Department of Primary Industries	Natalie Gollan	natalie.gollan@dpi.nsw.gov.au
Department of the Environment and Energy, Heritage Reef Marine Division, Reef Delivery	Peter Chase	

Project E3 – Microplastics in the Australian marine environment

Project length: 1 Year

Project start date: 01/02/2020

Project end date: 30/11/2020

Project current status: New project submitted for approval

Project Leader:	*Marcus Haward (FTE – 10%)* *Joanna Vince (FTE – 10%)*
Lead research organisation:	*IMAS, University of Tasmania*
Project leader contact details:	*Marcus.Haward@utas.edu.au, 03 6226 2333;* *Private Bag 129 Hobart 7001.*

PROJECT FUNDING AND EXPENDITURE

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	*X*	*x*	*x*	*X*		*$50,000*	*x*	*50,000*
In-kind						*50,000*		*50,000*
TOTAL	*X*	*x*	*x*	*X*		*$50,000*	*x*	*100,000*

DoEE Staff Member FTE (5 %)

Expenditure statement

Funding will be used for salaries for preparatory work and workshop reporting.

Workshop attendees will be expected to fund their own attendance, although there may be some funds available for selected individuals from overseas organisations.

PROJECT DESCRIPTION

Project Summary

The project will inform national policy and action to reduce the release and impacts of microplastics on our environment and oceans:

1. A literature review will firstly identify key marine microplastics research and policy development internationally, with a focus on research that is contextual to microplastics in the Australian marine environment
2. From this literature review, an options paper will be developed to explore the most feasible and impactful policy approaches for the Australian context and that can be used to form the basis for discussions at a workshop.

3. A one day workshop will draw together policy-makers, researchers and relevant industry peak bodies to discuss and recommend policy and other options to limit microplastics release into the environment. A workshop report will be drafted to summarise findings, recommendations, and next steps.

    a. The report will provide evidence to underpin the development of national policy aimed at reducing microplastic pollution, including by identifying priority actions to deliver Australia's 2018 National Waste Policy .

Project Description

Plastic pollution is a growing issue in Australia and globally. In its January 2016 report, the World Economic forum estimated that there are over 150 million tonnes of plastic waste in the oceans and that this amount is forecast to grow to 250 million tonnes in 2025. In the EU, it is estimated that between 75,000 and 300,000 tonnes of microplastics are released into the environment each year[3].

A recent report by the WHO[4] concluded that microplastics are present in all biota - air, soil, sediment, freshwater, seas, oceans, plants and animals. In controlled experiments, at high concentrations microplastics were shown to cause physical harm to the environment and living creatures. While some knowledge of microplastic concentration exist for the ocean surface and some freshwaters, little is known about air and soil compartments and about concentrations and impacts below the ocean surface. The WHO report also concluded there is a need to undertake a great range of work to understand the impacts of microplastics, in particular nanoplastics, from risk analysis to fate, exposure, impacts and modelling that can simulate flow through the environment.

Finding a solution to the problems caused by plastics and microplastics is complex, requiring a multi-faceted approach. Evidence[5] suggests that in the EU over two-thirds (by weight) of microplastic pollution comes from the break-up of large pieces of plastic litter and the other third enters the environment already as microplastics, either intentionally produced (e.g. plastic pellets, microplastics added to products), or as a result of wear and tear during the normal life-cycle of plastic-containing products (e.g. synthetic textile fibres, tyre abrasion, automotive brakes, artificial turf, etc.). Tyre abrasion and synthetic textile fibres represent the greater proportions of overall microplastic emissions with city dust and plastic pellets also accounting for sizeable proportions (Fig. 1).

The EU are currently considering a range of measures to restrict and reduce microplastics from entering the environment. The EU Plastics Strategy[6] will be one part of this, since targeting the reduction in leakage of large plastics stops their fragmentation into microplastics in the environment. Actions to specifically reduce microplastics leakage are also being considered. For example, ECHA are undertaking public consultation on a proposal for a wide-ranging restriction on intentional uses of microplastics in products on the EU market[7].

[3] Eunomia.
[4] https://www.sapea.info/wp-content/uploads/microplastics-conclusions.pdf
[5] https://ec.europa.eu/info/sites/info/files/research_and_innovation/groups/sam/ec_rtd_sam-mnp-opinion_042019.pdf
[6] https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf
[7] https://echa.europa.eu/hot-topics/microplastics

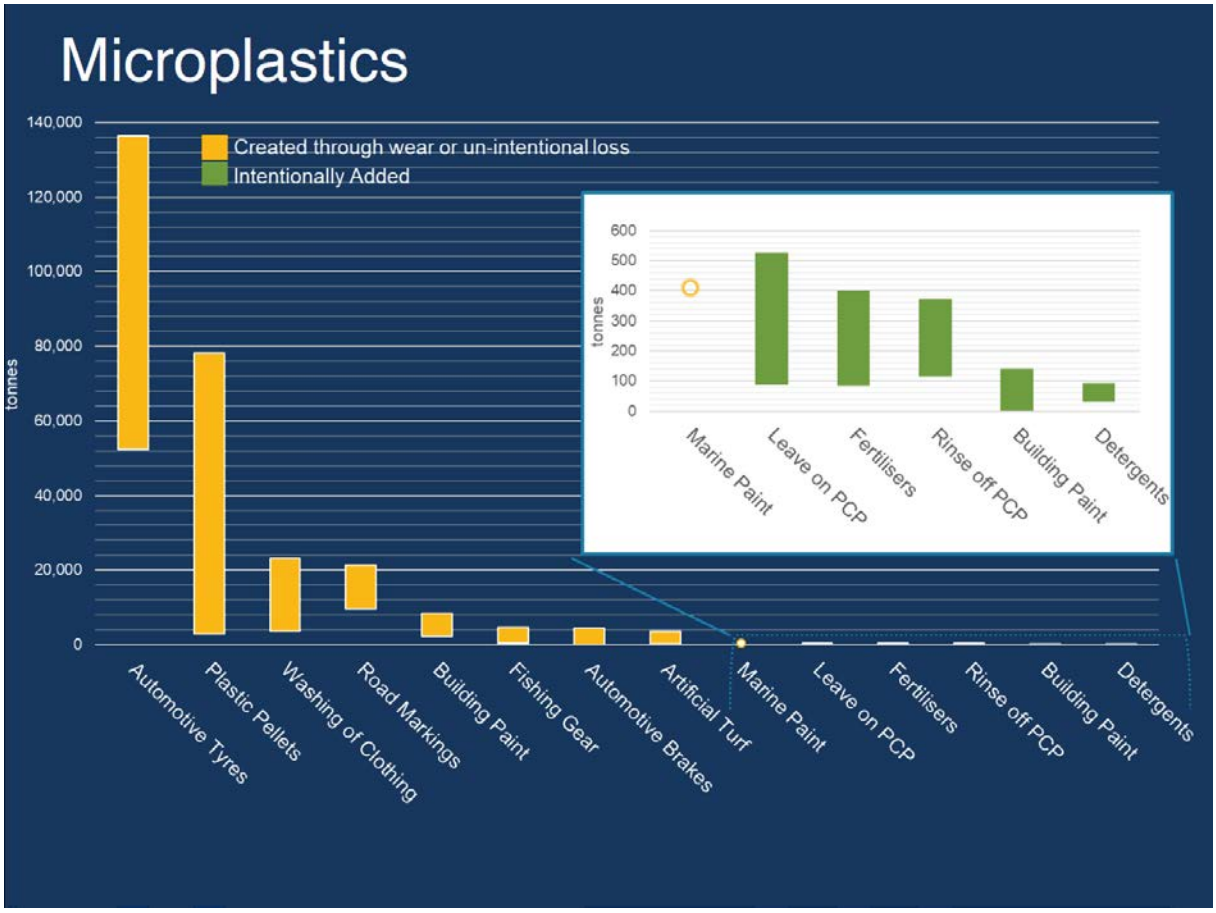


Fig. 1 Distribution of 'microplastics' in the marine environment. Matjaz Malgaj, Head, Marine Environment and Water Industry, Directorate General Environment, European Commission. Personal communication.

In Australia we generate around 205 million tonnes — or 102 kg per person — of plastic waste each year. Marine plastic pollution and microplastics (between 0.1 µm and <5 mm, and nanoplastics, <0.1 µm) are an issue of growing concern in Australia and internationally due to their prevalence, persistence and potential adverse impacts on marine ecosystems.

Recent studies have shown widespread contamination of the central Great Barrier Reef environment with microfibers, which comprised 86% of all items detected[8], closely matching the results of an earlier NESP study (84%) for 40 sites along the Southeast Australian coast[9]. The sources of the microfibers are unknown, however most were deemed to be of textile origin, likely derived from clothing and furnishing.

The Australian Government has recognised plastic pollution as a problem and, along with State and Territory Governments, has identified reducing plastic pollution as a priority in implementing Australia's 2018 National Waste Policy[10]. A National Action Plan is now being developed to implement the Policy. The Australian Government recognises that the sources and impacts of microplastics in the Australian marine environment are not fully understood.

Environment ministers have supported industry led initiatives to phase out microbeads from personal care, cosmetic and some cleaning products. In April 2018, Ministers announced that a voluntary phase-out of microbeads is on track with 94 per cent of cosmetic and

[8] https://www.nature.com/articles/s41598-019-45340-7
[9] https://www.sciencedirect.com/science/article/pii/S0025326X17304265
[10] http://www.environment.gov.au/system/files/resources/d523f4e9-d958-466b-9fd1-3b7d6283f006/files/national-waste-policy-2018.epdf

personal care products now microbead free. They remain committed to eliminating microbeads from the remaining cosmetic and personal care products and examining options to broaden the phase-out of microplastics to other products.

To develop the next major steps Australia can take to reduce the leakage of microplastics into the marine environment we need an understanding of the current state of microplastics science and policy options other countries are considering or have taken.

The project consists of three pieces of work.

1 A literature review will firstly identify key marine microplastics research and policy development internationally, with a focus on research that is contextual to microplastics in the Australian marine environment

2 From this literature review, an options paper will be developed to explore the most feasible and impactful policy approaches for the Australian context to reduce both intentionally added and not intentionally added microplastics in the marine environment (it would be beneficial to understand the policy options that can address both categories of microplastics because the options are different).

3 These two reports would form the basis of a one day workshop that will draw together policy-makers, researchers and relevant industry peak bodies to discuss and recommend policy and other options to limit the release / impact of microplastics in the environment. A workshop report will be drafted to summarise findings, recommendations, and next steps (including identifying gaps in both science and policy will inform any future work required).

   a The report will provide evidence to underpin the development of national policy aimed at reducing microplastic pollution, including by identifying priority actions to deliver Australia's 2018 National Waste Policy .

The scope of microplastics investigated will include:

- Microplastics that are intentionally added to products (for example microbeads and microplastics added to fertilisers, cosmetic products, detergents and paints etc).
- Microplastics that are not intentionally added but rather created during the lifecycle of a product through wear and tear or emitted through accidental spills.
- All forms of microplastics, including microfibers.

The EU Commission research on the impacts of both intentionally added and not intentionally added microplastics on the marine environment has led to new policy and proposed changes in legislation. This includes regulations to manage microplastics entering the marine environment[11].

The EU Commission has published significant reports on the sources of unintentionally produced microplastics[12] and products intentionally containing microplastics[13].

A recent SAPEA publication[14] is an Evidence Review Report on micro- and nanoplastic pollution, which informs the EU Environmental and Health Risks of Microplastic Pollution report[15].

[11] https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73
[12] Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products
[13] Reference to come
[14] https://www.sapea.info/topics/microplastics/
[15] https://www.sapea.info/wp-content/uploads/report.pdf

In Australia, existing policies include the National Waste Policy[16] and the draft National Action Plan, and the Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans[17].

Australian microplastics research in the Australian marine environment has focussed on the GBR and the South-East coast of Australia[18] although results of microplastics sampling on deepwater surveys in GAB and East coast are in preparation.

Australian industry, led by the Australian Packaging Covenant Organisation, is undertaking research to support the delivery of industry led national packaging targets that will see, by 2025, 70 per cent of Australia's plastic packaging being recycled or composted, 30 per cent average recycled content across all packaging, and phasing out of problematic and unnecessary single-use plastic packaging through design innovation or introduction of alternatives. The targets will cover all packaging made, used or sold in Australia, including business and imported packaging.

This project will use information from prior Hub research, especially:

- C2 – Continental-scale tracking of threats to shallow Australian reef ecosystems (2015-2017)(see footnote #7),
- C4 – National Outfall Database project (2015-2019), and its continuation (2019-2020) and
- EP1 – Assessing effectiveness of waste management in reducing the levels of plastics entering Australia's marine environment.

While Australian Environment Ministers are committed to taking a broader approach to reducing the sources of microplastics entering the marine environment how this can be done is not understood.

This work will inform national policy and action on plastic pollution. The Australian Government is currently developing a National Action Plan to implement the 2018 National Waste Policy. The National Action Plan will be reviewed annually and updated to include actions, including to reducing impacts of plastic waste, including microplastics, on the environment and human health.
The project team will work closely with research users to scope and develop the project and shape project outputs to meet research-users needs. Knowledge brokering and communication will be conducted in accordance with the Hub's Knowledge Brokering and Communication Strategy.

NESP 2017 Research Priority Alignment

Marine debris and supporting implementation of the Threat Abatement Plan was identified as an area of particular importance by DoEE for the 2018 research plan and this advice remains unchanged.

Original priorities that this research proposal responds to include:

- Develop and trial decision making tools that will support policy makers and managers to identify options, and prioritise activities, and
- 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.

[16] http://www.environment.gov.au/system/files/resources/d523f4e9-d958-466b-9fd1-3b7d6283f006/files/national-waste-policy-2018.pdf
[17] http://www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris-2018
[18] References to come

PATHWAY TO IMPACT

Outcomes
This research will be used to inform policy options and actions in implementing Australia's 2018 National Waste Policy, including the phase out of intentionally added microplastics such as microbeads. This workshop seeks to provide a communicative and collaborative platform for policy-makers and researchers and potentially other relevant stakeholders to inform national policy and action on microplastic pollution (cf. Fig 1) in the marine environment. Importantly the workshop will take a systems approach to identifying and prioritising potential actions, to ensure that all possible (known) impacts and actions are considered. Briefing papers will be developed prior to the workshop to provide comprehensive overviews of available science and gaps (cf.[19]). Identifying the science and policy gaps that when filled will reduce microplastics from entering the marine environment.

Research-user	Engagement and communication	Impact on management action	Outputs
DoEE Waste Branch State and territory EPAs Waste Industry and business sector Communities All stakeholders involved in the development of the National Action Plan	The needs of the research-users have been identified through the National Waste Policy and the National Action Plan and the priorities of Australian Environment Ministers. National Action Plan provides activities aligned with the roles and responsibilities of all stakeholders, including the business sector, communities, local governments, state and territory governments and the Australian Government. It will also identify who are the key proponents of the actions identified and who partners will include. At this stage the plan involves input by all stakeholders identified	The research findings will be used to inform national policy and action. A National Action Plan being developed by the Waste Branch for the Australian Government in partnership with State and Territory Governments and in consultation with industry, the business community and all other relevant stakeholders. The Australian Government has effectively dealt with microbeads and now wants to consider the next major actions to stop microplastics entering the marine environment.	Three reports. Report A will contain a review of the contemporary research into microplastics in the marine environment. Report B will be a policy options paper based on the EU and other policy options some of which are in a consultation phase. Report C will be the outcomes of the workshop, which will include science-based policy options and next steps the Australian Government can take stop the leakage of microplastics into the Australian marine environment. It will also identify the gaps that need to be addressed in the science to inform

[19] https://www.sciencedirect.com/science/article/pii/S2468584418300436

Research-user	Engagement and communication	Impact on management action	Outputs
	in the National Action Plan.		preferred policy options.

INDIGENOUS CONSULTATION AND ENGAGEMENT

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement. This means the knowledge generated in this project will be effectively shared and communicated between relevant Indigenous peoples, communities and organisations.

The team will leverage off Hub initiatives to ensure generated knowledge, data and results are effectively shared and communicated between Indigenous peoples, communities and organisations. This will include communication to the Hub Research-user Committee and Steering Committee, the AMSA indigenous engagement sub-committee, FRDC Indigenous Reference Group and the DoEE Indigenous Advisory Group.

PROJECT MILESTONES

Milestones	Due date	Milestone Status
Milestone 1 – Signing of contract	*Due 1 Feb 2020*	
Milestone 2 – Scoping of pre-workshop reports with DoEE	*Due 31 March 2020*	
Milestone 3 – Pre-workshop reports submitted for approval	*Due 30 June 2020*	
Milestone 4 workshop planning completed	*Due 30 June 2020*	
Milestone 5 Workshop completed (summary of workshop)	*Due 30 August*	
Milestone 6 Final Workshop report submitted to DoEE for input	*Due 30 October 2020*	
Milestone 7 All reports and data archived to open repositories	*Due 30 November 2020*	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles. 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 each time a data set is published.

Publications, reports, factsheets, maps and images will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au.

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

Project output	Data Management and Accessibility
Reports	*Published on Hub web-site*
Endnote bibliography	*Online version made available to DoEE for future use*

LOCATION OF RESEARCH

Research will be desk-top project in collaboration with DoEE and other stakeholders.

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
Unable to secure suitable ECR to undertake review and reporting from Hub official partners.	Delays with start to and completion of project	High	Early identification of ECR options and confirmation engagement in this role. If necessary, we will look outside the Hub partners for a suitable person	Low	Project lead
Engagement and participation of DoEE is not effective	DoEE needs are not understood and project outputs are not fit-for-purpose	High	Confirm primary contact/participant for departmental officer (i.e.Sarah Fieg), is allocated sufficient time to participate on project. If primary contact is no longer available, we will confirm a suitable replacement with DoEE. Will also need to ensure DoEE senior executive are provided with progress reports	Low	Project lead

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
Lack of stakeholder support for project and workshop	Unable to gain attendance of key participants (industry, government, researchers) at workshop.	High	Purpose of project, dates of workshop and desired workshop participants to be communicated early and well in advance of workshop. Effective communication with National Waste Taskforce to gain their support and, as appropriate, participation. Ministerial support of workshop will be considered as an additional option.	Low	Project lead
Unable to attract suitable contributor from EU or Taiwan	Loose first-hand knowledge and input from overseas	Medium	Will attempt to secure additional Australian options to attract visitor, or failing that contact remotely	Low	Project lead

PROJECT KEYWORDS

Microplastics, marine environment, impact, policy

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE
Marcus Haward	*UTAS*	Oversight	0.1
Sarah Fieg	*DoEE*	Oversight	TBD
Joanna Vince	*UTAS*	Review and reporting	0.1
ECR	*UTAS*	Review and analysis	0.25

Data Management

Name	Organisation	Email	Phone
Emma Flukes	*UTAS*	Emma.flukes@utas.edu.au	

Co-contributors

Name	Organisation/	Contribution
Nil		

Key Partners and Research End Users

Key Partners (organisation/program)	**Name/s**	**Email (optional)**
DoEE Waste Strategy Taskforce	Ilse Kiessling	Ilse.Kiessling@environment.gov.au
DoEE Product Stewardship and Waste	Carl Warburton	Carl.Warburton@environment.gov.au
DoEE Reef Branch	Peter Chase	Peter.Chase@environment.gov.au

Research Users (program/section/branch/organisation)	**Name/s**	**Email (optional)**
DoEE Waste Strategy Taskforce	Ilse Kiessling	Ilse.Kiessling@environment.gov.au
DoEE Product Stewardship and Waste	Carl Warburton	Carl.Warburton@environment.gov.au
DoEE Reef Branch	Peter Chase	Peter.Chase@environment.gov.au

Project SS2 – Interpreting pressure profiles (Synthesis project)

Project length: 12 months

Project start date: 15/01/2020

Project end date: 30/12/2020

Project current status: New project submitted for approval

Project Leader: *Keith Hayes (FTE – 0.12) and Piers Dunstan (FTE – 0.12)*

Lead research organisation: *CSIRO*

Project leader contact details: *keith.hayes@csiro.au, P:03 62325260*

Project Funding and Expenditure

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	*x*	*x*	*x*	*x*	*x*	*$151,777*	*x*	*$151,777*
Cash co-con	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
In-kind co-con	*x*	*x*	*x*	*x*	*x*	*$151,777*	*x*	*$151,777*
TOTAL	*x*	*x*	*x*	*x*	*x*	*$303,554*	*x*	*$303,554*

Expenditure statement

All staff on this project are CSIRO officers. Funding will cover CSIRO salary costs, together with operating and travel costs for elicitation workshops in the second phase.

Project Description

Project Summary

This project has two objectives:

(i) to provide a spatial *explicit* analysis of the relative risks posed to marine conservation values, *as defined by the natural values hierarchy of Park Australia's Monitoring, Evaluation, Reporting and Improvement (MERI) framework,* by pressures that operate within Australia's Exclusive Economic Zone and state/territory waters (a "hotspots" analysis)*;* and,

(ii) provide a proof of concept of an adaptive, probabilistic assessment of the cumulative risks posed to these values, in a region determined to support the Parks Australia MERI project D7, in a manner that is consistent with the seascape-scale cumulative assessment described in the "Guidelines for analysis of cumulative

impacts and risks to the Great Barrier Reef" (developed and tested with Commonwealth, State and Industry stakeholders in project E1).

The relative risk assessment will provide interval-scale risk estimates – also known as semi-quantitative risk estimates - that are meaningful when compared within a study, e.g. between locations within the study's geographic scope, but are not calibrated to observable outcomes in nature. The methodology will be based on the approach developed and applied during phase 2 of the Northern Marine Bioregion (project A12) and similar approaches in the published literature.

The probabilistic risk assessment will provide a proof of concept of a fully quantitative risk assessment, providing risk estimates on a ratio scale that are calibrated with, and hence can be compared to, observed outcomes in nature and between all bioregions. The methodology will build on the approaches developed and applied during phase 2 of the Northern Marine Bioregion (project A12) by using elicitation methods developed by the project team for the Bioregional Assessments to quantify the (often) non-linear response of values to cumulative pressures.

Delivering these two objectives will synthesize existing data and information for Australia's EEZ and state/territory waters, using the approaches developed in hub projects A12, C1 and E1. The project's deliverables do not depend on the collection of new data, nor updating species distribution records or models, but will access the many types of information generated by the Marine Biodiversity Hub since 2007.

The project will deliver nationally but will utilise the natural conservation values, developed by Park's Australia for the MERI framework. It will also work with Parks Australia to align their pressure categorisation and nomenclature with the pressure profiles developed by the hub. Aligning the description of values and pressures used by the project and Park's Australia's MERI framework will ensure that projects outputs are directly applicable to Park Australia and complimentary to the new project A7, that is supporting articulation of their new framework. Without the synthesis of information and risks provided through this project, the Hub will be unable to support articulation of the MERI framework to the extent that we expect to be needed.

The final product from this project will be based on the best available information. Rather than an endpoint itself, we anticipate that the output will define the start (following appropriate discussion) of an iterative process that will assess the risks and their cumulative impact on the natural values in the EEZ and state/territory waters, supporting the management of all MNES, areas of the marine environment outside MNES, and reporting for State of Environment and other needs.

Project Description

Objective (i): National "hotspots" maps.

To meet the first objective the project will primarily build upon existing data collations completed in several recent NESP products (Figure 1), including the:

(i) the collation and mapping of pressures in Australia's EEZ and state/waters developed by the Hub in projects C1, C5, E2, E4 and D6, thereby including the more recent layers covering noise, small vessels and recreational use. This will be added to with State and Territory Fisheries commercial fisheries data (final deliverable for project C1), assuming that relevant authorities provide the necessary permissions;

(ii) the mapping and description of natural values, as defined in the MERI framework, through the base-line surveys of Australian Marine Parks (MBH project D3) and the description and mapping of reefs on the continental shelf - a distinct group of Key Ecological features described in Australian Governments Marine Bioregional Plans (with mapping and characterisation undertaken by MBH project D3);

(iii) the collation of spatial products based on (typically) multi-beam sonar acquired data describing benthic habitats around the Australian shelf (coordinated by MBH project D3 and provided through Seamap Australia (https://seamapaustralia.org/);

(iv) the modelling of key species distributions in Northern Australia (MBH Project A12); and,

(v) the detailed conceptual modelling of value/pressure interactions in the North marine bioregion (MBH Project A12) using signed directed graphs and Qualitative Mathematical models.

The relative risk assessment will use a weighted sum of pressures to determine relative risks, with weights determined by the sensitivity of natural values to individual pressures It will reflect, and be informed by, the rapid risk assessments that have already been completed by Parks Australia for the MERI framework.

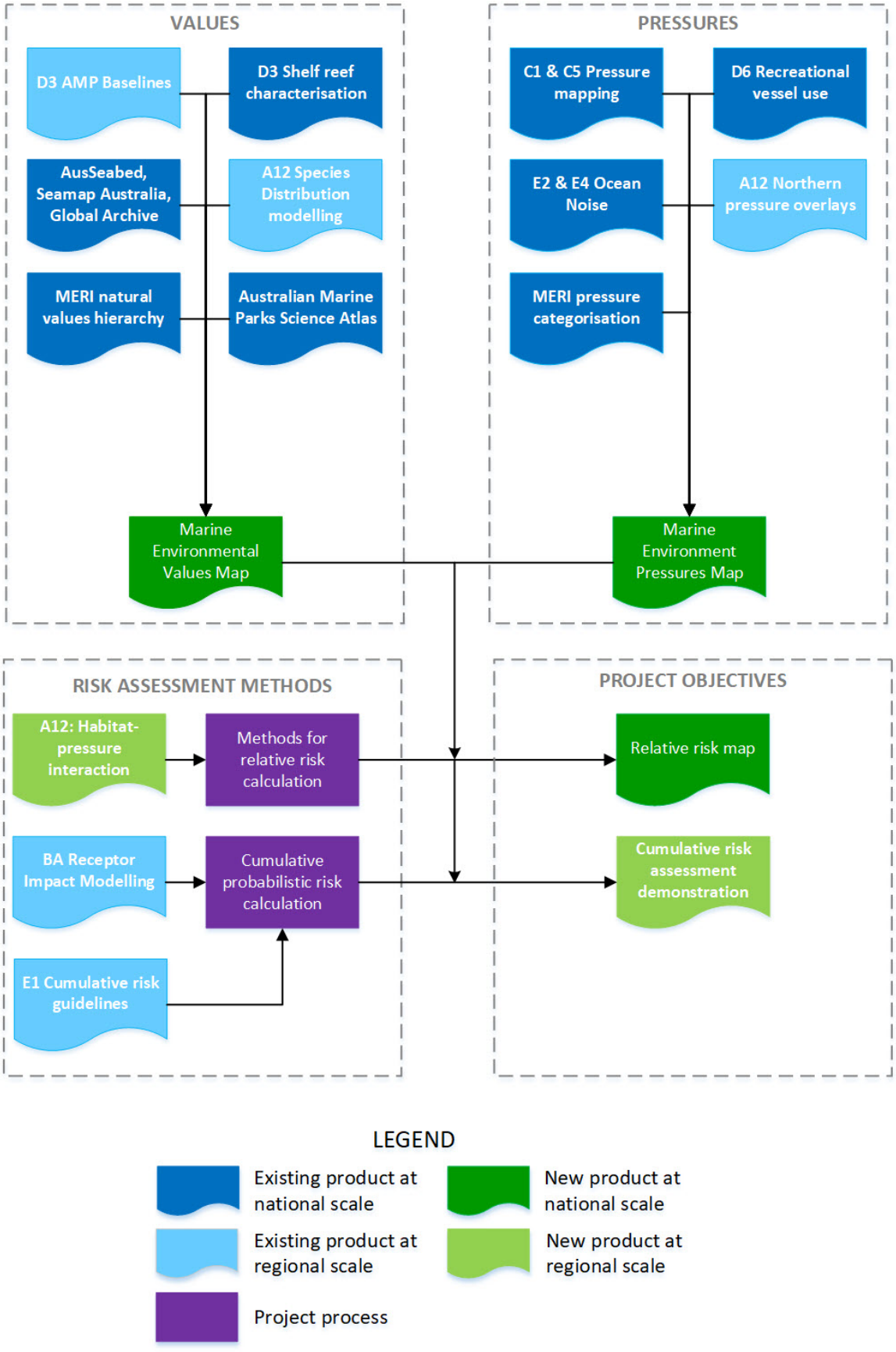
This part of the project does not depend on access to, nor generation of, new data products, although to conduct a national “hotspots” analysis across all of the EEZ and state/territory waters the project may need to extend the geographical scope of some of the NESP products described above (e.g. state and territories commercial fisheries data).

A project go/no-go workshop will be held early in the project (second project milestone) in collaboration with Parks Australia, to assess the availability and coverage of all pressure and value data shapefiles, to determine if there is sufficient information to proceed as planned. In the event that the available data is deemed sufficient the project will produce national ‘hotspots’ maps (provided as GIS products and summarised in the project final report) that indicate the relative risk from each mapped pressure on natural values in Commonwealth and state/territory water.

The maps will show ‘stacked’ pressures and include weights that reflect the severity of the interaction with Parks Australia’s values relative to our parks. The map will use grey colours to indicate where no data currently exists. A colour scheme (with a small amount of transparency) will be used where known (mapped) values are interacting with known (mapped) pressures. Opaque colours (with higher levels of transparency) will be used in those areas where the presence/absence of values or intensity of pressures are considered uncertain.

A similar effect to reflect uncertainty can be achieved by weighting the pressure/value interactions. The project will explore this possibility. The Department’s ability to manage particular pressures in AMPs can also be considered in the weighting applied to specific

Figure 1: Schematic representation of the Integrated Pressures project showing how new and existing Marine Biodiversity Hub products, together with existing products developed outside of the hub, will be integrated to meet the project's three objectives.



values and pressures interactions when generating the map. For example, in the simplest case assigning a weight of 0 to pressures that Parks Australia deems it cannot manage will immediately emphasise those locations where management of pressures is possible.

Finally, with or without data on values, a stacked pressure map will still provide Parks Australia a means of prioritising monitoring in parks (and other values of interest to Department) yet to be inventoried.

The project's output will provide users the ability to compare impacts of individual or cumulative pressures throughout Commonwealth and state/territory waters on conservation values, and importantly will provide the necessary context to correctly interpret and regionally based analysis of cumulative impacts within one or more AMPs.

The project will demonstrate this use case by providing a Narrative resulting from the analysis for a single marine region, delivered as either a written summary and/or or as information (attribute tables) that can be interrogated and possibly summarised through the Wylie reporting function (contingent on Wylie capability and available data).

The regional focus of the Narrative, and its content will be agreed in consultation with Parks Australia and other interested Departmental parties, but would likely include: (i) commentary on how hotspots compare inside and outside of parks within the marine region, with accompanying graphs; (ii) comparison of hotspots relative to zones within the Parks; (iii) a description of the different pressure/value interactions that may lead to similar looking hotspots (for different reasons); and (iv) recommendations about where future research is needed on the location or status of values, the presence and intensity of pressures, or the nature of specific pressure/value interactions.

Objective (ii): Probabilistic assessment of the cumulative risks posed to natural values in a selected marine region.

The second objective is designed to show how it is possible to move from qualitative estimates of risks (that can't be compared between studies) to quantitative estimates that can be compared and summarised nationally. This part of the project will use the recent advances in expert elicitation and cumulative impact modelling, developed and implemented by members of the project team for the Bioregional Assessments (and are not therefore dependent on further outcomes of Project E1). These methods enable quantitative (absolute) cumulative risk estimates to be made within a probabilistic adaptive, framework (see https://www.bioregionalassessments.gov.au/methods/receptor-impact-modelling for additional details).

With input from the Parks Australia, the project will nominate a set of locations (e.g. within one or more IUCN zones of one or two AMPs) within a defined region and make testable predictions about the probability that selected, measurable, environmental values at these nominated locations will be in a particular condition after an agreed period of time (risk assessment endpoint) accounting for the range of known pressures affecting these locations, their interaction and cumulative impact.

The nominated locations (prediction sites) will be chosen to allow the effect of management interventions to be assessed by choosing sites across two or more Australian Marine Park (AMP) zones or boundaries. If sufficient data exists for the selected sites and assessment endpoints the project will demonstrate how the predictions can be updated (using standard, well-established, Bayesian statistical inference methods) in light of this information and provide a more in-depth analysis of the effect of pressures at the AMP sites.

The output from this part of the project will be a product that will show users how likely it is that agreed thresholds for measurable characteristics of a selected set of natural values

within selected AMPs will be exceeded within the time frame of the analysis, for example the 5-year period between SOE reports. This will provide an absolute measure of managed (contingent on the prediction site selection) and unmanaged risk, and thereby enable the user to measure the risk reduction benefits of alternative marine environmental management measures. The project will work closely with Parks Australia in the delivery stage for this objective to ensure that the outputs have direct relevance to implementation of the MERI framework.

NESP 2017 Research Priority Alignment

This project is a synthesis project that draws together, and builds on, several existing NESP projects (at least C1, E1, E5, D3, E2, E4, D6 and A12) and aligns with the following NESP 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

By gathering data sets, synthesising existing NESP products and demonstrating methods for Integrated Environmental Assessment, this project will synthesize many of the data products and tools developed by Hub scientists into a product focussed on delivery to Departmental managers (with a focus on AMPs). It will also support the objectives of the cross-hub integrated knowledge program especially for the marine environment.

Pathway to Impact

Outcomes
A national map of relative risk to environmental benefits in Australian commonwealth waters, together with a demonstration of a probabilistic assessment of the cumulative risks faced by natural values due to the multiple pressures that operate at selected sites in selected AMPs

Research-user	**Engagement and communication**	**Impact on management action**	**Outputs**
Parks Australia	Prediction site selection will be informed by Marine Park boundaries. Approach, findings and outputs to be communicated via project workshops, project reports and presentations.	By identifying pressure hotspots in and around the AMP estate, and by considering the effect of AMP management (i.e. relevant zoning and management activities) during a defined period if the site selection process in the selected regions enables this during the probabilistic risk demonstration	National hotspots maps for the Commonwealth Marine Area (GIS products), estimate of risk-benefit of management, summarised and documented in project final report

Research-user	Engagement and communication	Impact on management action	Outputs
DoEE – Marine and International Heritage Branch	Identified and endorsed the need for the project Approach, findings and outputs to be communicated via project workshops, project reports and presentations.	By providing a demonstration of the methods and necessary components for conducting an Integrated Environmental Assessment (IEA), the Department will be better able to identify the benefits of, and current impediments to, any future movement beyond hotspot mapping towards IEA's in the commonwealth marine area.	National hotspots maps for the Commonwealth Marine Area (GIS products) summarised in project final report
DoEE - State of the Environment	Approach, findings and outputs to be communicated via project workshops, project reports and presentations.	By demonstrating how cumulative risk predictions can be made and updated periodically with observed outcomes, the project will provide a proof of concept for addressing cumulative impact and risk predictions within the State of the Environment reports	Project final report with risk predictions that can be updated on a regular (e.g. SoE cycle) basis.

Indigenous Consultation and Engagement

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is currently considered a category three project for Indigenous engagement. This means the knowledge generated in this project will be effectively shared and communicated between relevant Indigenous peoples, communities and organisations. The Hub will communicate project progress to the DoEE Indigenous Advisory Committee (mediated through DoEE) and the Fisheries Research and Development Corporation Indigenous Reference Group through provision of updates to its chair who sits on the MBH Steering Committee. The site selection process needed to complete Objective 2, however, could include risk prediction sites in Indigenous Protected Areas. The Indigenous Consultation and Engagement strategy will need to be further developed in this instance.

Indigenous consultation and engagement contact:

Piers Dunstan

Ph: 03 6232 5382

Email: Piers.Dunstan@csiro.au

PROJECT MILESTONES

Milestones	Due date	Milestone Status
Milestone 1 – Signing of contract	15th Jan 2020	
Milestone 2 – Workshop with PA to confirm alignment of pressures and natural values, identify data gaps and confirm links to, and boundaries with, project D7 and project go/no-go decision.	Date to be confirmed (but no later than 30th April 2020) following outcomes of Dec 2019 Parks workshop,	
Milestone 3 – Compilation of pressures and values, production of relative risk map	30th June 2020	
Milestone 4 – Workshop with PA to finalise project outputs from part 1, agree on narrative for a single marine region and scope focus of indirect elicitation workshops	15th August 2020	
Milestone 5 – Completion of indirect elicitation workshops	30th October 2020	
Milestone 6 – Submission of draft final report to Department for comment	15th December 2020	
Milestone 7 – All data and metadata archived on open data repository	15th December 2020	
Milestone 8 – Submission of final report to Department	2 weeks after receipt of Department's comments	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles.

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 each time a data set is published. Publications, reports, factsheets, maps and images will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au.

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

Project output	Data Management and Accessibility
National hotspots maps	Data (Map Layers) and meta data on hotspot maps will be provided through NEII compliant infrastructure. Analytical approaches and interpretation will be provided in the Final Report.
Proof of concept of quantitative probabilistic cumulative risk assessment	Outputs documented in final report
Final report	Report will be made available through the Hub website and provided to research end users.

LOCATION OF RESEARCH

All desk top analysis will be conducted in Hobart. All project workshops, including indirect elicitation workshops will be conducted at locations that are most convenient for the participants concerned.

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
Failure to engage with research users to ensure that needs are understood and met	The outputs of the project will be poorly aligned to the needs of DoEE	Medium	Project staff will consult with DoEE, and in particular PA, to identify key individuals to provide advice for this project. Project team will maintain effective communication with these individuals and their replacements in the event of staff movement two including	Low	Keith Hayes and Piers Dunstan

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
			planning and evaluation workshops.		
Failure to align existing pressure layers, and/or detailed conceptual models of natural values, to the categorisation of pressures and values used by the MERI framework	Project output do not align to, and cannot therefore inform, MERI framework outcomes	Medium	Project staff have already engaged with Parks Australia, and will continue to do so before and during the project, to ensure that existing detailed conceptual models and data products, align with natural values hierarchy, and pressure profiles align with MERI pressure categories	Low	Keith Hayes, Piers Dunstan, Parks Australia
Failure to implement approach within the project constraints (time and budget)	Technical challenges will limit the ability to produce national hotspot map.	Medium	Project team will hold monthly meetings to ensure that tasks for all project members are clear and emerging risks are identified early and managed effectively. Any ongoing dependencies on other projects will be identified early and communicated to the end-users, alternatives developed if necessary.	Low	Keith Hayes
Data gaps for values and/or pressures	Project products are considered to be incomplete and/or not fit for purpose	Medium	Project team will clearly communicate to research-users at the go/no-go workshop ((project milestone 2) the limits of existing data and will highlight gaps for future research and analyse implications of incomplete products	Low	Keith Hayes

PROJECT KEYWORDS

Cumulative, risk, national, map, pressures

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE
Keith Hayes	CSIRO	Project lead and risk methods	0.12
Piers Dunstan	CSIRO	Risk methods and coordination	0.12

Name	Organisation	Project Role	FTE
Geoff Hosack	CSIRO	Risk methods and elicitation	0.18
Skipton Woolley	CSIRO	Pressure/values mapping	0.30
Dave Peel	CSIRO	Pressure/values mapping	0.10
Scott Foster	CSIRO	Values development	0.08

Data Management

Name	Organisation	Email	Phone
Piers Dunstan	CSIRO	piers.dunstan@csiro.au	

Co-contributors

Name	Organisation/	Contribution
NA		

Key Partners AND Research End Users

Key Partners (organisation/program)	Name/s	Email (optional)
NSW Office of Environment and Heritage, Department of Primary Industries	Alan Jordan	alan.jordan@dpi.nsw.gov.au

Research Users (program/section/branch organisation)	Name/s	Email (optional)
DoEE – Marine and International Heritage Branch	Paula Perrett	Paula.Perrett@environment.gov.au
DoEE – Heritage, Reef an Marine Division	Stephen Oxley	Stephen.Oxley@environment.gov.au
DoEE – Environmental Reporting Section	Jeanette Corbit	Jeanette.Corbitt@environment.gov.au
Parks Australia	David Logan	David.Logan@environment.gov.au
DoEE - ERIN	Carolyn Armstrong	Carolyn.Armstrong@environment.gov.au

Project SS3 – National trends in coral species following heatwaves (Synthesis project)

Project length: 1 Years/ 1 Month

Project start date: 1/1/2020

Project end date: 30/12/2020

Project current status: New project submitted for approval

Project Leader: *Rick Stuart-Smith (FTE – 10%) & Graham Edgar (FTE – 5%)*

Lead research organisation: *University of Tasmania*

Project leader contact details: *rstuarts@utas.edu.au , 0418 112 825, 03 6226 8214*

PROJECT FUNDING AND EXPENDITURE

Project funding table

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	***TOTAL***
NESP funding	*x*	*x*	*x*	*x*	*$26,000 (IMAS)*	*$26,000 (IMAS)*	*x*	*52,000*
Cash co-con	*x*	*x*	*x*	*x*	*$44,000*	*x*	*x*	*44,000*
In-kind co-con	*x*	*x*	*x*	*x*	*$14,000 (IMAS)*	*$20,000 (IMAS) $26,850 (AIMS)*	*x*	*60,850*
TOTAL	***x***	***x***	***x***	***x***	***$84,000***	***$72,850***	***x***	***156,850***

Expenditure statement

All funding will be for the employment of a coral taxonomic expert to annotate the imagery, through IMAS, UTAS. This includes the cash contribution from Reef Life Survey Foundation of up to $44,000, which will be used to cover remaining employment expenses required on top of NESP funding. In-kind represents only the time of Prof Edgar and Dr Stuart-Smith. Database costs represent an additional in-kind (not estimated here) that will be provided by IMOS funding for the National Reef Monitoring Network.

PROJECT DESCRIPTION

Project Summary

This project will engage coral taxonomic experts to annotate existing Reef Life Survey photoquadrats taken across northern Australia before and after major disturbances, to allow:

- Quantification of the spatial and species-level responses of Australian corals to the 2016 and 2017 marine heatwave and mass bleaching events (and cyclones that occurred during this period).

- Identification of the species most threatened by warming and cyclones, and species likely to respond best to restoration efforts.

- Contribution to a coral-specific analysis to the next national State of the Environment report, through project D5

Project Description

Extensive coral losses have been observed in northwestern WA, Coral Sea, and along the GBR following the 2016 and 2017 marine heatwaves and mass bleaching events. Reports of surveys undertaken at local and regional scales indicate particular coral species have been badly affected by bleaching mortality, while other species exhibited considerable resistance (e.g. Hughes et al 2018 Nature). Indeed, previous studies have identified 'winners' and 'losers' from such disturbances amongst species in the coral community (e.g. Loya et al 2001 Ecology Letters) or made predictions based on simulation models or traits for which species would be winners and losers (e.g. Kubicek et al 2019 Scientific Reports; Darling et al 2012 Ecology Letters). However, generalisation from such studies has been difficult due to their limited geographic and taxonomic scope. In most cases where empirical data have been collected, it has been impossible to determine whether the responses of species were associated with the species or the impact that occurred at that location. To determine any taxonomic consistency in responses of corals to bleaching events or cyclones, empirical data on species level trends are needed that span many locations and impacts of different intensities.

Photoquadrats taken by Reef Life Survey divers represent a unique potential source of standardised data for identifying species-level responses of corals, allowing a general understanding of coral responses to heatwaves at a scale greater than previously considered possible. Archived photoquadrats are available from RLS surveys undertaken before and after the 2016 bleaching event at all major coral reef systems in Australia (e.g. Ningaloo, Rowley Shoals, Scott, Ashmore, Hibernia, Lord Howe, Elizabeth/Middleton and along the full spans of the GBR and Coral Sea). Most have not previously been scored, and were not otherwise going to allow assessment of coral cover for project D5 (coral cover was not an indicator possible for the national reefs case study for the last SoE either, due to the added expense required to score imagery). Images are typically used only for classifying biota into coarse functional and taxonomic classes, but with expert taxonomic assistance, many taxa (~150) could be accurately classified to species, allowing impacts on populations of these species to be assessed nationally. Such data would provide an invaluable input to the 2021 SOE report, added to the analyses of fishes and mobile invertebrates already underway (including trends for 600-1000 species), and form the basis for multiple scientific analyses (bioregionalization, threatened species assessment, impact assessment). The project will be able to test predictions based on species responses reported from particular locations and those made based on simulation studies or species traits.

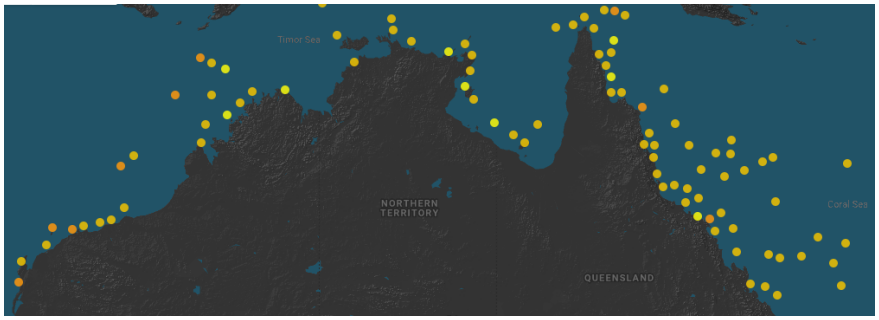


***Figure 1**. Locations of RLS surveys around northern Australia. Note that overlapping sites at each location have been aggregated, with the colour representing the density of points underlying each (yellow < 20, orange 21-50).*

To date, RLS photoquadrats have been annotated using coarse functional groupings, with the primary purpose of providing estimation of total live hard coral cover. Many images have not yet been annotated. This project specifically involves the annotation of available images by experts in coral identification (primarily Emre Turak, with input from James Gilmour, AIMS), with points scored to the highest possible taxonomic resolution. Not all coral species can be identified to species-level from images, but with Emre's experience and arguably un-matched capacity to contribute, many species will be scorable (and those that aren't can be flagged as such). While all scoring data will be valuable, the high-confidence species will be the focus of species-level analyses to be undertaken as part of project D5.

The total workload is estimated to be 250 days @160 images per day (500 sites x 2 transects x 2 time periods = 2,000 transects = 40,000 images).

Specific Australian Marine Parks to be included are Ashmore Reef, Mermaid Reef and Coral Sea.

NESP 2017 Research Priority Alignment

The project covers two cross-cutting NESP priorities by explicitly considering current and future climate risks (Priority 1) for coral reefs, and includes world heritage areas (Great Barrier Reef; priority 3). It also covers Australian Marine Parks in the NW and Coral Sea (MBH priority 1).

PATHWAY TO IMPACT

Outcomes
The project will primarily produce a dataset as the main output, which will then provide input to broaden outcomes in project D5 (SoE analyses for national reef case study). As an open dataset (that will be compatible with Squidle+ and the proposed IMOS underwater imagery sub-facility) the possible indirect scientific and management outcomes relating to coral restoration and protection, as well as automated imagery annotation, will be far-reaching, rare and valuable.

Research-user .	Engagement and communication	Impact on management action	Outputs
Crystal Bradley, SoE team (DoEE) Jeanette Corbitt, DoEE, Knowledge and Technology Division, EASB, State of Environment	Will engage DoEE in the scoping of the project plan, although the primary mode of engagement to ensure outputs are fit-for-purpose will occur through project D5	Used by DoEE to inform State of the Environment reporting – informing the public on condition of Australia's coral reefs	This synthesis project will provide an invaluable dataset as the main output. The primary pathway to impact from this will occur through project D5 outputs. Specifically, it will allow expanded scope of project D5, allowing a component to national reef assessment for SoE that includes corals. The dataset will also be available for authors of the SoE chapter to interrogate independently.
Jason Mundy, Parks Australia	The project involves many locations in Australian Marine Parks, and Cath Samson has been engaged in project development. Findings for the NW will be communicated through addition to an independent RLS report to Parks Australia, and for the Coral Sea through face to face updates.	Used by DoE for inventory/baselines and public communications for Australian Marine Parks	Data on coral species distribution and change in NW network and Coral Sea marine parks will be provided to another report for Parks Australia being undertaken by the Reef Life Survey Foundation. Although this report is outside the MBH, the data product will be a valued addition to this.

Additional outputs

- Dataset - AODN open data on corals accessible through the National Reef Monitoring Network sub-facility
- Inclusion of the data in analyses for project D5 will provide a unique standardised baseline for future SoE analysis and international reporting obligations (e.g. SDGs and CBD)
- A unique broadscale and high resolution training dataset based on scores from taxonomic experts, for automated scoring of coral imagery by UMI/ReefCloud.

Indigenous Consultation and Engagement

Indigenous consultation and engagement for this project will be undertaken in a manner that is consistent with the Hub's Indigenous and Participation Strategy. This project is considered a category three project for Indigenous engagement as it is a desktop study. This means the knowledge generated in this project will be effectively shared and communicated between relevant Indigenous peoples, communities and organisations. The Hub will communicate project progress to the DoEE Indigenous Advisory Committee (mediated through DoEE) and the Fisheries Research and Development Corporation Indigenous Reference Group through provision of updates to its chair.

Project Milestones

Milestones	Due date	Milestone Status
Milestone 1 – Signing of contract	15 Jan 2020	
Milestone 2 – Scoring of all NW Australia images completed, including those from the NW Australian Marine Parks Network	30 April 2020	
Milestone 3 – Scoring of all remaining images completed, with data ready for analysis	31 July 2020	
Milestone 4 – incorporation of coral data and their analysis as a separate chapter of the final report from Project D5	31 Dec 2020	

DATA MANAGEMENT AND ACCESSIBILITY

All project outputs (including data) will be made publicly available in accordance with the NESP Data Management and Accessibility Guidelines. To facilitate a consistent standards based approach, the Hub has produced a Data Management Framework. The framework provides project leaders with clear directions on publishing metadata, storing data and satisfying requirements for open access to journal articles. Datasets will be stored in a long-term secure storage, metadata will be created to meet the standards for metadata and publishing on the Australian Ocean Data Network Portal http://portal.aodn.org.au/aodn/. An email will be sent to marinemetadata@environment.gov.au each time a data set is published.

Publications and reports and images will be made publicly and freely accessible and available on the Hubs website http://www.nespmarine.edu.au.

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

Project output	Data Management and Accessibility
Dataset on % cover of corals to highest taxonomic resolution possible from surveys around northern Australia before and after the 2016 mass bleaching event.	Data will be available through the AODN, following standard RLS and ATRC data management protocols

LOCATION OF RESEARCH

This is a desk-top analysis and scoring of imagery will be undertaken remotely by Emre Turak.

PROJECT SPECIFIC RISKS

Risk to project	Potential impact on project	Risk rating (low, medium high, severe)	How will risk be managed?	Residual Risk after mitigation	Who is responsible for managing risk?
Loss of key staff (Emre Turak)	Incompletion of coral analysis	High	The project team have back-up expertise for the coral analysis if needed	Low	Project leader
Failure of software or engagement by software managers	Loss of training dataset for automated image analysis	Medium	Involve software managers in project scoping and maintain communication to ensure a no-surprised approach to project, including requirements of software managers and the course of action if issues emerge	Low	Project leader

PROJECT KEYWORDS

Reef; bleaching; Coral Species; imagery; Reef Life Survey

PROJECT CONTACTS

Researchers and Staff

Name	Organisation	Project Role	FTE
Rick Stuart-Smith	UTAS	leader	0.1
Graham Edgar	UTAS	leader	0.05
James Gilmour	AIMS	Expert coral analysis	0.05
Emre Turak	consultant	Expert coral analysis	0.7

Data Management

Name	Organisation	Email	Phone
Rick Stuart-Smith	UTAS		

Co-contributors

Name	Organisation/	Contribution
NA		

Key Partners and Research End Users

Key Partners (organisation/program)	Name/s	Email (optional)
NA		

Research Users (program/section/branch/organisation)	Name/s	Email (optional)
Parks Australia	*Cath Samson*	
Environmental-Economic Accounts Section	*Crystal Bradley*	
State of the Environment Reporting (DoEE)	*Jeanette Corbitt*	
Heritage Reef Marine Division, Reef Delivery (DoEE)	*Peter Chase*	