

Project Plan SP 2015-015

Long-term monitoring in the area of the proposed Dampier Archipelago marine reserves

Marine Science

Project Core Team

Supervising Scientist	Molly Moustaka
Data Custodian	Molly Moustaka
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Project status as of Dec. 11, 2019, 1:45 p.m.

Approved and active

Document endorsements and approvals as of Dec. 11, 2019, 1:45 p.m.

Project Team	granted
Program Leader	granted
Directorate	granted
Biometrician	granted
Herbarium Curator	not required
Animal Ethics Committee	not required

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Biodiversity and Conservation Science Program

Marine Science

Departmental Service

Service 6: Conserving Habitats, Species and Communities

Project Staff

Role	Person	Time allocation (FTE)
Supervising Scientist	Molly Moustaka	1.0
Research Scientist	Thomas Holmes	0.05
Research Scientist	Shaun Wilson	0.01
Research Scientist	Alan Kendrick	0.01
Research Scientist	Kathy Murray	0.06

Related Science Projects

None

Proposed period of the project

July 15, 2014 – June 30, 2019

Relevance and Outcomes

Background

The Dampier Archipelago is situated adjacent to Dampier (pop. 1,341) and Karratha (pop. 25,907), 1,650 km north of Perth in the Pilbara Nearshore Marine Bioregion (Figure 1). The marine and coastal environment of the Dampier Archipelago/Cape Preston Region has a unique combination of 42 offshore islands, intertidal and subtidal reefs, mangroves, macroalgal communities and coral reefs. The area is the second most diverse region for hard corals in Western Australia, with coral reef habitats comprising 8% (approx. 18,300 ha) of the major marine habitats, consisting of 229 scleractinian coral species from 57 genera (Griffith 1998). In surveys carried out in 1998-2002 the Western Australian Museum recorded 736 fish species (Hutchins 2001), over 1,227 species of mollusc, including five regional endemics (Slack-Smith and Bryce 2004), 438 species of crustacean (Hewitt 2004), 275 sponge species (Fromont 1998), and 286 echinoderm species (Marsh and Morrison 2004).

Not only is there high species diversity in the area but many of the islands and beaches provide habitats and feeding areas for threatened marine fauna. A number of beaches in the area are important nesting sites for five species of marine turtle. There are at least 16 species of sea birds known to form large nesting colonies in the region. Over 50% of the mainland shore is lined with complex mangrove habitats, comprising six species, and are considered to be of international significance (Semeniuk and Wurm 1987). The area also contains important feeding and travelling grounds for marine mammals. The annual humpback whale migration passes through the Dampier Archipelago, and eight toothed whale species and four baleen whales have been documented utilising the area. Dugongs are also regularly sighted using the extensive seagrass beds within the area.

The Dampier Archipelago is rich in cultural and historical value, with the indigenous history of the Yaburara people extending back 20,000 years. The area is referred to as Murujuga land and contains some of Australia's

earliest art and cultural sites (CALM 2005). Other culturally significant areas include; quarries, middens, fish traps, rock shelters, ceremonial places, artefact scatters, grinding patches and stone arrangements.

Within the Dampier Archipelago/Cape Preston area, species and habitat depletion have been recorded (CALM 2005), with the area subject to increasing human pressures. The nearby town of Karratha has the highest per capita boat ownership in Australia (CALM 2005) and recreational fishing pressure in the archipelago waters is likely to be high. There are also commercial prawn, demersal finfish, and interim mackerel fisheries, with the area also important to Western Australia's aquarium fishery. There are also multiple pearl aquaculture sites, a productive saltworks (opened in 1972) and Dampier Port development, pipeline and processing facilities and shipping associated with industrial development.

Proposed MP Zoning

Figure 1 Map of the Dampier Archipelago showing locality and the three sections of the proposed marine protected area. Zoning in protected area; Green – General Use, General Use and Recreation zones. Yellow – Conservation Zones, Red – Sanctuary Zones.

The Dampier Archipelago/Cape Preston area was identified for consideration as a marine conservation reserve by the *Marine Parks and Reserves Selection Working Group* (MPRSWG 1994), which identified representative and unique areas of Western Australia's marine waters for consideration as part of a statewide system of marine parks. Waters surrounding the Dampier Archipelago were reported as having significant conservation values, and the report highlighted the overlap of ecological values and high levels of human activity in the area. An Indicative Management Plan (IMP; CALM 2005) has been written to provide a framework for how the marine ecological and social values of the area can be protected. The IMP proposes creation of three separate marine protected areas; Dampier Marine Park East, Dampier Marine Park West and the Regnard Marine Management Area (Figure 1). In total the proposed protected areas cover 214,920 ha of State waters.

Woodside's Pluto liquefied natural gas (LNG) project is an approved operation utilising the Dampier area for processes around the extraction of gas, transport via a gas pipeline to an onshore processing facility, storage and then export via a shipping port, loading jetty and channel. Alongside the LNG processing and export facility, a large scale dredging program, removing 14 million cubic meters of sediment, has been occurring since 2003. The EPA approved the development on the condition that Woodside implement a substantive offset package. The Pluto LNG Offset 'D' Program was initiated as a result of Ministerial Approval Statement 757 and included a funding agreement between Woodside Burrup Pty Ltd in its capacity as operator of the Pluto LNG development and the state of Western Australia. The agreement defines the focus of the Pluto LNG Offset 'D' as '*Research and monitoring consistent with the Indicative Management Plan for the Dampier Archipelago Marine Park*'.

Aims

There are four main projects within the Pluto LNG Offset 'D' Program. They are to:

- i. *Review, assess and summarise historical data relevant to the management of the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area;*
- ii. *Determine distribution, patterns and key processes of major marine communities and large marine fauna of the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area;*
- iii. *Describe patterns and trends in human use in the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area; and*
- iv. *Establish long-term monitoring reference sites in the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area.*

The focus of this SPP is on the project 'iv' which required the implementation of monitoring within the Proposed Dampier Archipelago Marine Park and Regnard Marine Management Area. Monitoring will be consistent with the State Government's Indicative Management Plan for the area. The aim of project 'iv' is to:

Develop and implement a monitoring, evaluation and reporting (MER) program of key biodiversity asset condition and their major pressures at key sites in the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area.

The project will implement an integrated, effective and efficient monitoring, evaluation and reporting process that allows measurement and evaluation of condition and pressure changes in a way that is robust but practical and cost effective. The objectives of this project are:

- Complete a prioritisation of ecological assets listed in the indicative management plan to identify high priority assets for monitoring;
- Establish reference sites for monitoring high priority assets in the Proposed Dampier Archipelago Marine Park and Regnard Marine Management Area, taking into account, spatial and temporal distribution of key pressures acting on assets, previous data availability, the standards of the Western Australian Marine Monitoring Program and stakeholder recommendations;
- Provide quantitative evidence on the status and trends in selected indicators of asset condition and the pressure/s on these assets, to assist managers to make better-informed decisions within an active adaptive management framework;
- Contribute to the development of best practice monitoring techniques for assets and pressures where knowledge is lacking;
- Contribute data, as appropriate, to assist development of Parks and Wildlife's strategic marine planning and conservation initiatives;
- Assist other government departments and industry environmental management programs; and
- To establish links with indigenous owners and encourage their involvement in monitoring and marine conservation.

Expected outcome

- *A better understanding of the value, spatial extent and status of the shallow tropical communities of the Dampier archipelago.*

An established monitoring program will facilitate evidence-based long-term adaptive management for the proposed reserves, and promote environmental understanding for a range of stakeholders and the community.

- *Data on ecological assets will inform a baseline of natural and human induced change when the marine reserves are gazetted.*

This project will produce baseline data on various key ecological assets and the pressures acting on them. This will inform Parks and Wildlife managers, the vesting authority, stakeholders and the broader community of the condition of the marine reserves over time.

- *Parks and Wildlife and the scientific community will benefit from having newly developed, tested and documented indicators and methods for monitoring Pilbara marine environments.*

This project will develop new marine monitoring indicators and methods for key ecological assets and habitats that are largely novel to northern WA. Development of these monitoring indicators and methods may also assist marine monitoring implementation and reserve management in the Kimberley region.

- *Assistance for other government departments and Industry through better understanding of the importance of, and change in, the natural assets of the Dampier Region.*

The data collected by this project will be accessible in the event of an environmental incident, so that industry has baseline evidence of the condition of marine communities. Providing information to major industrial users of the area will create awareness of the condition and pressure on assets and values in the proposed marine reserve and it will also highlight the role of Parks and Wildlife in conservation management.

- *Foster operational collaborations with traditional owners.*

Parks and Wildlife recognizes joint management with Aboriginal people as a primary objective of conservation management. This project will nurture collaboration and information sharing through consultation with the Murujuga Aboriginal Corporation, whose ranger group is to be involved in field activities.

Knowledge transfer

The most significant use of this information is for the management of the marine environment, both through the Parks and Wildlife planning department, specialist branches (e.g. science and conservation division) and regional operational staff. The information gained from this project will be used to inform planning for the proposed marine reserves (by Parks and Wildlife and the vesting authority), and assist Parks and Wildlife regional staff to gain an understanding of change in ecological assets in relation to marine park management.

Information collected in this project will also be provided to other government management agencies. This work may advise the Office of the Environmental Protection Authority during the Environmental Impact Assessment and support research and monitoring carried out by Department of Fisheries and CSIRO. When the park is established, historical data, as well as data collected through this program, will be ready to feed directly into the MPRA (Marine Parks and Reserves Authority) reporting process carried out by Marine Science Program.

A copy of all major reports will be forwarded to Woodside and baseline/monitoring data will be made available to the oil spill response team in the event of an incident.

One of the aims of this work is to involve the indigenous community and keep them updated on the condition of the system. Researchers on this project will also seek advice from traditional owners throughout the program.

As part of this work we will communicate information on the current status of WA marine assets to the community. Communication outputs will include more 'general reading' publications, e.g. Parks and Wildlife Landscape.

Tasks and Milestones

The specific outputs of this project are:

Project Administration:

- Annual progress reports to Woodside completed by 30 September each year;
- Pluto Offset 'D' 'iv' final summary report completed and distributed by 30 June 2019;

Project Science-Management Outputs

- Science outcomes and new knowledge will be published in peer-reviewed journals;
- Monitoring related updates sent to Pilbara District and Regional managers, and Murujuga Aboriginal Corporation;

Project General Communication:

- Literature regarding the Dampier marine environment, methods for monitoring assets and indicative long-term trends will be presented in Parks and Wildlife publications (e.g. Landscape, brochures and social media).

[variant=american]The major tasks and milestones for this project are [Milestone and Major Activities](#)

References

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Study design

Methodology

Context

The Indicative Management Plan describes 14 ecological assets detailed in the Indicative Management Plan, which are: geomorphology, sediment and water quality, coral reef communities, mangrove communities, macroalgae and seagrass communities, subtidal soft-bottom communities, intertidal sand and mudflat communities, rocky shore communities, turtles, marine mammals, seabirds, finfishes, and invertebrates.

Prioritisation

All assets need to be considered for monitoring, however, managers must prioritise assets to ensure the effective use of limited resources (Simpson *et al.* 2015). Following the framework outlined in Simpson *et al* (2015) a preliminary monitoring prioritisation was completed prior to planning this project and proceeding with field surveys. This involved requesting the assistance of a panel of experts, with experience in the Dampier region, to score the value of each asset and the pressure they perceive this asset to be under. Assets that

were considered of high value and under high pressure will be the initial focus of monitoring. Twelve experts from government, industry and academia, with good knowledge of the marine environment in the Dampier Archipelago, were surveyed and the resultant order of asset priority is presented in Table 1.

Table 1 Results of monitoring prioritisation carried out by 12 experts with knowledge of the Dampier region. The mean values are presented with both upper and lower Confidence Intervals. The asset with the highest mean rank, and all other assets with 95% confidence intervals that overlap with highest asset, were highlighted in bold as high priority for monitoring.

Asset	KPI?	Mean Score	Lower 95% CI	Upper 95% CI
Coral communities	Y	181.28	151.42	211.13
Finfish	Y	169.43	141.60	197.25
Turtles	Y	124.66	95.51	153.80
Mangrove communities	Y	123.26	91.88	154.64
Macroalgae and seagrass communities	N	115.77	91.10	140.53
Invertebrates	Y	103.22	78.32	128.12
Marine mammals	N	100.21	59.88	140.54
Water quality	Y	90.54	60.20	120.88
Geomorphology	N	84.75	44.34	125.15
Seabirds	N	71.56	52.01	91.11
Subtidal soft-bottom communities	Y	66.26	40.81	91.71
Intertidal sand and mudflat communities	Y	64.58	42.60	86.56
Sediment quality	N	63.56	40.92	86.20
Rocky shore communities	N	54.75	41.69	67.81

Based on the prioritisation of assets, coral communities were identified as having the highest mean rank, though fish communities, mangroves and turtles were also considered high priority and will be the focus of monitoring efforts. Macroalgae and seagrass, as well as invertebrates also ranked highly, but as a lower priority for monitoring. Monitoring of other assets may be undertaken opportunistically or by other researchers and we will endeavor to support their programs where appropriate.

Site selection process

Sites are to be selected based on a combination of factors; the availability of historical data, site descriptions, and vicinity to anthropogenic pressures. Sites will be selected to maximize potential of recording change as a result of anthropogenic pressures, while minimizing the potential range of confounding factors (including natural pressures). Detailed site descriptions by the Western Australian Museum (Jones 2004) will assist with site selection. Also, pressure variables found within datasets, such as water quality and industrial development projects will be used to advise site selection.

A scoping fieldtrip is to be carried out to visit an extended number of potential sites for monitoring high priority assets. These will be identified using the above criteria and assessed for suitability. Wherever possible, sites will be selected where multiple assets are well represented. For example, at reef sites attempts will be made to monitor coral, finfish and invertebrate communities concurrently. By monitoring multiple assets at the same site, results can advise on interactions between communities and highlight secondary pressures.

Indicators

WAMMP 'Asset Knowledge Reviews' highlight important asset condition, pressure and management response (CPR) indicators and recommend methods for their measurement. This project will measure the condition of selected assets in the context of possibly interacting natural, anthropogenic and climate change pressures. Monitoring will use standard WAMMP methods, except where new indicators and methods need to be identified.

Table 2 Summary table of assets and condition and pressure metrics. Condition and pressure metrics for tropical macroalgae and seagrass communities have, as of yet, not been well defined

Assets	Asset Condition Metrics	Pressure Metrics
Coral Communities	% live coral cover Community composition Coral recruitment	Water temperature Predator abundance i.e. Crown of thorns starfish and corallivorous gastropods Physical disturbance i.e. storms and cyclones Sedimentation/Turbidity
Finfish	Abundance of fishery target spp Abundance of functionally important spp Community composition Community size structure	Habitat change Fishing pressure
Turtles	Breeding metrics (assist current programs) Strandings/incidents	Island visitors Boat use/ownership
Mangrove Communities	Spatial extent Canopy cover Tree density Foliage condition (leaf colour) Mortality	Salinity Air Temperature Clearing
Macroalgae & Seagrass	% cover/density Community composition	Water Temperature Physical disturbance i.e. storms and cyclones Sedimentation/Turbidity
Invertebrates	Abundance of fishery target spp Abundance of functionally important spp	Habitat change Fishing pressure

High Priority Assets – Sites and Methods

Assets identified as high priority in the prioritisation process will be monitored initially, with main effort focusing on establishing permanent sites, collecting baseline datasets and where appropriate publication of results.

Coral communities

Digital still imagery along fixed transects will be used to provide data on the live cover, composition, and diversity of coral communities. At each site, three replicate 50 m transects will be permanently marked with star pickets positioned at each end of each transect and marked for relocation using a GPS at the surface. To help ensure the accurate resampling along the transect steel marker rods will be fixed to the substrate every 10m. Benthic community along these transects will be monitored by taking 50 digital images per transect at a height of 1 m from the substrate. This will enable analysis of the structural benthic community metrics in the laboratory using a point count method, while providing a permanent record for potential investigation.

Coral settlement is also highlighted as an important functional metric for monitoring coral reef communities (coupled with the examination of shifts in coral size frequency). The use of coral settlement tiles can estimate larval supply to an area and provide a relatively simple estimate of recruitment potential (Babcock *et al.* 2003). Crude assessments of juvenile coral abundance may also be gathered from digital images (Turner *et al.* 2015).

Coral communities will be monitored every two years at a range of sites over the proposed marine reserves. Fifteen preliminary sites (Figure 2) have been selected for monitoring and attempts will be made to monitor other assets (fish and invertebrates) concurrently at these sites.

Coral and Fish Monitoring Sites

Figure 2 [variant=american]Preliminary locations (red points) of fish, coral and invertebrate monitoring sites in the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area. The location of temperature loggers are marked with blue crosses. Also included is a table listing site names.

Fish

Fish communities will be monitored for changes in community abundance, diversity and population structure (major indicators, Table 2) using stereo video methods, which enables the identification of species and measurements of fish size (Harvey *et al.* 2002).

Six independent 50 meter transects will be completed by employing Diver Operated Video (DOV). This provides a permanent record of the fish assemblage and allows analysis of the videos in the laboratory by experienced staff. At each site, video transects will be swum by a two diver team. The first person in the dive team swims the DOV unit, with the second person measuring the transect. The divers leave a 10 meter gap between each transect to maintain independence of replicates. Transects are swum at a rate of three-four minutes per 50m in a relatively straight line (following habitat and depth gradient), in a direction away from the sun.

The stereo-video equipment comprises two forward facing video units secured to an aluminium frame. A light emitting diode is positioned on a rod in front of the cameras so the footage can be synchronised when it is viewed on a computer. The video units are configured to record the fish from different angles. Analysis of high definition video footage is completed in the laboratory following the fieldtrip, allowing accurate identification of individuals and length measurements. Digital imagery is analysed using the seaGIS software 'Event Measure', which allows for the calculation the accurate size of the fish by mathematical triangulation.

Fish communities will be monitored at the same 15 sites assessed for the benthic community surveys (Figure 2). This allows fish community data to be associated with benthic structure and composition information. Fish communities will be monitored every two years.

Turtles

Turtles have dedicated research and monitoring programs through the Marine Science Program. At present there is a large-scale study of the turtle populations in the Pilbara, being undertaken by Parks and Wildlife, Marine Science Program (SPP 002-2013), and this will include an assessment of populations in the Dampier Archipelago. There are presently multiple programs monitoring turtle nesting running throughout the Dampier Archipelago. Parks and Wildlife are working with Rio Tinto to monitor Hawksbill, Green and Loggerhead turtles at Rosemary Island (Spiers *et al.* 2013). In addition Rio Tinto is also funding a long term turtle monitoring program at Legendre and Delambre Island (Biota Environmental Sciences 2009). Since this asset is well covered in the Dampier region, it would not be cost effective to establish another program, when time and funding could be spent focusing on other less researched assets. Therefore, this project will attempt to assist the current turtle monitoring work where possible through field support and the collection and contribution of pressure related data.

Mangroves

The extent, condition and cover of mangrove communities are the main indicators (Table 2) of health and these will be assessed using remote sensing techniques. It is a requirement that these images be ground-truthed, and this will allow for assessment of on ground health indicators including tree density and foliage condition.

Rectified and calibrated satellite imagery allows for fast, cost effective monitoring of mangroves over large spatial scales. This will be achieved using ALOS or SPOT 6 imagery, which have a pixel size of ten and five meters, respectively. A time series of three historical records will be analysed initially to develop an appropriate baseline time series index of vegetation trends. Images will then be purchased every two years of the monitoring program, to reduce cost outlay, and also align with the bi-annual schedule used for monitoring other assets. Imagery will be collected in November, when they become available. The major aim of this monitoring is to identify communities that are stable, in decline or increasing over the time period of years captured by quantifying change in mangrove extent and foliage cover (as a proxy for condition).

Ground truthing will be undertaken at predetermined points among the survey sites. The purpose of ground truthing is to verify data calculated from remote techniques, it is therefore not necessary to have ongoing *in situ*

work for the monitoring program. However, there are cases where re-survey may be necessary, such as after a major event or where difficulty exists interpreting the results of the remote study.

Ground truthing sites will be chosen according to satellite image characteristics. Two types of 'set point photograph' will be taken at each point; the first will be a wide angle overview of the community as a whole; the second will be a series of close up photographs taken along the fringes of the communities, or in areas of disturbance (as these are the areas that are the most accessible and where change is most likely to occur). In the second series of photos individual trees will be identified and photographed from a distance of 8 meters. A surveyor's staff will be included in all photos taken to determine tree height and foliage width. Four upward facing photos will be taken, capturing the canopy cover and 4-6 photos of the substrate under/around the tree will be collected. Field notes will be collected along with the photographs and these will include basic measurements, including; tree height and trunk width, tree mortality and damage, and pneumatophore density. A photo of the tripod position relative to the tree will also be taken for future reference. Additional GPS marks will be collected for the tree trunk and tripod position.

A total of 10 areas have been selected for mangrove monitoring (Figure 3) based on the availability of GIS imagery encompassing existing mangrove forests. The sites are distributed inside and outside of the proposed marine reserves and at varying proximity to development.

Mangrove Ground Truth Sites

Figure 3 Locations (blue boxes) of GIS imagery for long term monitoring of mangrove communities. Points for ground truthing will be selected within these boundaries

Secondary Priority Assets – Methodological Development

In order to increase the capacity of the Marine Science Program, attempts will be made to develop some asset monitoring programs that are not currently established. This work will be second priority to the assets identified above, and these projects will only be attempted if time and capacity allow.

Macroalgae and Seagrass

Indicators and methods for monitoring tropical seagrass and macroalgae in northern WA are yet to be identified. With the assistance of the WAMMP Asset Leader for seagrass and algae, this project will collaborate with internal and external groups to identify appropriate monitoring techniques. In order to develop techniques, there will be an initial collection of research work, drafting a literature review and trial of appropriate methodologies in the field. A cost-benefit analysis will then be undertaken to determine a method which is achievable and returns appropriate data. Once a Standard Operating Procedure is in place, appropriate sites will be selected using remote imagery, ground truthed, and monitoring will commence in the Dampier region.

Primary productivity, and natural variability, of benthic primary producers has been identified as potential area of focus for research in the Dampier Archipelago, and has been highlighted as a research priority in Pluto Offset 'D' project 'ii'. The work undertaken in this project, will compliment and extend the findings of that research.

Invertebrates

The main indicator for change in invertebrate communities is abundance (Table 2), particularly those targeted through human activities (e.g. collection of crustaceans, large clams, topshells, urchins and sea cucumbers), but also species which may pose a threat to other communities, e.g. pressure on the condition of corals from crown-of thorns starfish (*Acanthaster planci*) and the corallivorous gastropod *Drupella*.

Methods have been established to monitor invertebrates on coral reefs; however, if time allows, part of this project will include research into the development of monitoring techniques for an array of target invertebrates harvested from other habitats, such as mangroves and seagrass. As part of this work, research will be undertaken to identify priority species targeted by commercial and recreational fisheries and aquarium collectors in the region.

Invertebrate monitoring will be undertaken at multiple sites throughout the Dampier, and attempts will be made to monitor within a subset of different benthic communities including coral reefs, mangroves, seagrass and macroalgae. In some cases, and where appropriate, invertebrate monitoring may be carried out at complementary benthic monitoring sites. This co-location of assessment sites will allow for comparison between

benthic structure and composition, to assess how invertebrate abundance can influence other communities, and how changes in habitat structure can influence invertebrate communities.

Pressure Metrics

The Department's marine monitoring program operates within a condition, pressure and management response (CPR) framework to enable and facilitate the assessment of management effectiveness. Monitoring enables a better understanding of the effects of anthropogenic pressures on marine assets, and through subsequent targeted but adaptive management allows for mitigation of their impacts. Understanding pressures is vital to being able to respond to changes in the condition of assets and determining management and level of protection required. As part of this project, it is necessary to understand and monitor the major pressures on the assets that are sought to be conserved and managed in the proposed reserve.

Pressures to be monitored are listed in Table 2. Some of these are already addressed through monitoring of other or assets e.g. habitat loss which is a pressure on fish and invertebrate communities is measured through monitoring changes in cover of benthic communities. For other pressure metrics, data will be collected independently.

Variation in the physical condition of coastal waters can drive change in marine communities. Temperature is one of the most significant pressure parameters for ecological assets. At five coral monitoring sites, two temperature loggers will be deployed for the extent of the project, and replaced at alternating six month periods (one swapped in May, the other in Nov). Each logger will collect an hourly reading every day for 12 months. Results from these will be assessed to determine how many are replaced after the first year, and these in-situ recordings will be compared to remotely collected sea surface temperature data collected and modeled by NOAA.

Data Analyses

Broad spatial and temporal patterns in asset condition will be investigated using univariate and multivariate analyses. Relationships between the structure of the biological communities and physical variables and human use will be assessed where possible. The relationship between condition and pressure can be analysed using a suite of metrics including regression and correlation techniques. The proposed marine reserve is extensive and encompasses diverse habitats, a range of pressures and varied conditions. Spatial variability must be considered when analysing data from this project. Given the short time frame of this project, it is unlikely that meaningful long-term comparisons will be possible. In many cases sites have been selected where historic sites existed, and attempts will be made to compare the findings from this program to historic data. However, in many cases the metrics measured or the techniques used may not be comparable, and other parameters may limit interpretation of relationships with historic data. The data will be regularly tested for power and considered for trend analysis when the strength of the data allows for confidence in the results.

Biometrician's Endorsement

granted

Data management

No. specimens

Herbarium Curator's Endorsement

not required

Animal Ethics Committee's Endorsement

not required

Data management

All raw data will be presented in a data report and archived on DPaW's Marine Science Program server and on an archived hard drive.

Hard copies of any reports resulting from the project will be held at the following locations:

1. Woodside – Pluto Program.
2. Marine Science Program, Science & Conservation Division, Department of Parks and Wildlife, 17 Dick Perry Avenue, Western Australia, 6152. Ph: (08) 9334 0333.
3. Woodvale Library, Science & Conservation Division, Department of Parks and Wildlife, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641.
4. Archives, Woodvale Library, Science & Conservation Division, Department of Parks and Wildlife, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641 (CD also attached).
5. Department of Parks and Wildlife: Pilbara Region, Lot 3 Mardie Rd, Karratha, WA, 6714. Ph: (08) 9182 2000 Fax: (08) 9144 1118.

Digital copies of any reports and data will be held at the following:

1. The Science Division Server:
T:\529-CALMscience\Shared Data\Marine Science Program\
2. Archived hard drive
3. Uploaded to the Marine Science Program data catalogue (CKAN)

Budget

Consolidated Funds

Source	Year 1	Year 2	Year 3
FTE Scientist			
FTE Technical			
Equipment			
Vehicle			
Travel			
Other			
Total			

External Funds

Source	Year 1	Year 2	Year 3
Salaries, Wages, Overtime	91,014	99,716	105,381
Overheads	42,642	35,000	37,000
Equipment	9,491	2,500	2,500
Vehicle	17,003	25,100	15,600
Travel	6,092	8,100	3,300
Other	10,826	19,331	14,220
Total	173,368	189,747	178,001