Establishment of a long-term monitoring program for the proposed Dampier Archipelago Marine Park

Marine Science Project Plan

Prepared by Shannon Armstrong

August 2007

Marine Science Program
Department of Environment and Conservation

Cover photo: Survey being undertaken at the Montebello/Barrow Islands Marine Conservation Reserves in 2006 by DEC's Marine Science Program.

Department of Environment and Conservation

Science Division

Marine Science Project Plan

PART A TITLE AND LOCATION

SPP Number: [allocated by Biometrician]
Request No: [allocated by WASPP]
Concept Plan No: [allocated by Biometrician]

1. Project Title: Establishment of a long-term monitoring program for the proposed Dampier Archipelago Marine Park.

2. Science Division Program: Marine Science Program

3. Staff [Names and estimates of percentage of time]:

Supervising Scientist: Dr Chris Simpson
Other Scientists: Shannon Armstrong, Dr Alan Kendrick, Dr Suzanne Long
Other Staff: Geoff Kregor, Brad Daw, Alicia Edwards, Marissa Spears, Adam Williams
Technical Officers:
External Collaborators: Dr Dianne Watson - University of Western Australia
Volunteer(s):

4. a) Output Program: Nature Conservation

b) Relevant Departmental KRAs: KRA 1, KRA 2

5. a) IMCRA Region(s): Pilbara Nearshore

b) NRM Region(s): Rangelands

c) CALM Region(s)/District(s): Pilbara Region / Karratha District

d) Geocode(s): N/A

6. Related SPPs: N/A

7. Proposed commencement date: 17th September 2007 **and proposed completion date:** 28th September 2007 (field survey) Data analysis for the fish data will be undertaken by UWA in November 2007. Further statistical analysis and report writing will be undertaken on completion of the survey until the end of March 2008.

8. Date of submission of this Plan and signature of Supervising Scientist:

9. Nomination of an external scientist capable of providing expert advice on the scientific merit of the SPP: Dr Euan Harvey, University of Western Australia

PART B ENDORSEMENTS

10. List the relevant Regional Ecologist(s) and Nature Conservation Leader(s) whom you have consulted about the SPP:

Dr Alan Kendrick (Regional Ecologist)
Dr Peter Kendrick (Nature Conservation Leader)

11. What opportunities exist for collaboration with other Science Division Programs, other Departmental Staff, Universities, other Government agencies, Industry, traditional land owners and the broader community? Explain how these linkages were investigated/developed.

The project will involve collaborations between staff from DEC's Marine Science Program, Karratha and Exmouth District, including regional staff. Researchers from the University of Western Australia who are experienced in developing appropriate survey designs and are very familiar with the use of different methods for fish abundance surveys have been consulted continuously during the planning of the survey. A UWA research associate who is experienced in using stereo-video underwater visual fish census survey equipment in tropical reef environments will be part of the initial field survey team. UWA have also agreed to analyse the fish data that results from the survey. Private industry groups, consultancy agencies and the Western Australian Museum have been contacted in order to inform them of our survey and to obtain information regarding the positions of any of their past survey sites and associated data and reports. The Karratha Department of Fisheries have been contacted to informed them of the survey and obtain the latest information regarding the status of the region's commercial and recreational fisheries.

12. Biometrician: Mathew Williams
Return comments to Program Leader

13. Animal Ethics Committee: (If applicable)
Return comments to Program Leader

N/A

14. Program Leader, Flora Conservation and Herbarium (If applicable; see Point 22 below):
Return comments to Program Leader

N/A

15. Program Leader: Dr Chris Simpson
Program Leader arranges that a copy of the SPP is sent to the nominated external scientist (See No. 8) for a confidential assessment if required.

16. After endorsement please forward to Biometrician:
Biometrician to load approved SPP on WASPP, arrange filing at Directorate, publish in Science Communications, send photocopy of completed SPP to Supervising Scientist, copy cover sheet to Regional Manager, District Manager and relevant Program Leader (for their information)

PART C RELEVANCE AND OUTCOMES

17. Background and literature review (help us to understand why the proposed research is important):

The proposed Dampier Archipelago Marine Park and Regnard Marine Management Area (DAMPA) are located off the north-west coast of Western Australia approximately 1,650 km north of Perth and lie in the Pilbara Nearshore (PIN) marine bioregion. The area's comprise of a wide range of marine habitats that support diverse marine biota, including more than 736 fish species and 230 scleractinian coral species, making the Dampier Archipelago the second most diverse site in Western Australia for hard corals. The marine environment of the area has considerable regional ecological and social conservation significance and is subject to increasing human impacts, including offshore oil and gas production and associated port development.

The region from Cape Preston to Cape Lambert, encompassing the Dampier Archipelago, is subject to a range of commercial and recreational fishing activities. The Dampier Archipelago lies between the Onslow and Nickol Bay Prawn Fisheries with extraction occurring within the Archipelago and around its margins. The Pilbara Demersal Finfish Fishery operates offshore from the Archipelago. The WA North Coast Shark Fishery has been closed for some 18 months and did not operate within the Archipelago region. The Mackerel Interim Managed Fishery occurs within the Archipelago with sites concentrated to the outer margins. The Archipelago falls within Zone 1 of the Pearl Oyster Fishery but is not a main fishing area. The majority of Beche-de-mer fishing licenses in Western Australia are currently dormant and no extraction occurs at present within the Archipelago, although significant resources exist in certain areas. Some aquaculture ventures, namely pearling, also occur within the Archipelago. Approximately 80% of effort from Western Australia's marine aquarium fishery is exerted in the Archipelago, extracting a variety of fish, invertebrates, live rock, substrate and corals (Fletcher and Head 2006). Western Australia has the highest per capita boat ownership globally; the Pilbara has the highest within Western Australia and Karratha and Dampier arguably have the highest within the Pilbara region (Osborne *et al*. 2000; Tourism Western Australia 2006). High use recreational fishing areas include; the eastern margin of Mermaid Sound, Hamersley Shoals, north of Miller Rocks, the northern perimeter of Dixon Island, the shoals northwest of Enderby Island, Sailfish Reef, shoals north of Legendre Island western tip and the costal margin southeast of North-East Regnard Island (CALM and MPRA 2005). Appendix 1 summarizes the main commercial fishing activities and details the key recreationally targeted species of the Dampier Archipelago.

If trends in resource condition over time due to management are to be detected, baseline resource condition before the establishment of the DAMPA needs to be determined. The proposed project will directly address many of DEC's research and monitoring responsibilities by establishing a scientifically robust long-term monitoring program for the DAMPA.

18. Project aims (state these very clearly):

The overall aim of the DAMPA long-term monitoring program is:

- To monitor targeted fin fish abundance and length and rock lobster density such that any differences over time between protected and non-protected zones of the DAMPA can be detected.

Following a beyond BACI approach (Kingsford and Battershill, 2003) this require development of an understanding of the magnitude of variation (seasonal, long-term temporal, within site, between site, within habitat and between habitat) in fish abundance and length and rock lobster density. These data will provide an estimate of the magnitude of natural variation against which we can compare any future differences between impact (e.g. sanctuary zones) and control sites (e.g. general use zones).

Specific aims of the first survey are:

- To establish long-term monitoring sites such that before zoning enforcement data on the abundance of recreationally targeted fin fish species and cover of benthic reef communities can be obtained. Where possible historical data will be compared with modern data to identify any long-term temporal changes in these variables. (i.e. where appropriate sites will be established in close proximity to historical sites; if time allows additional historical study sites will be re-surveyed).

- To pilot methods for estimating tropical rock lobster and crown of thorns starfish (COTS) densities such that a statistically robust, precise and cost efficient method and survey design can be incorporated into the DAMPA long-term monitoring program.

19. Anticipated project outcome(s) including benefits to DEC. Include specific reference to management plan KPIs or similar indications that this is a high priority area for research.

The baseline data collected during the survey will serve a critical management function by enabling trends in resource condition over time to be detected. Over time, the project will determine the effectiveness of the different management regimes of the DAMPA in terms of protecting exploited species (i.e. finfish and tropical rock lobsters) which will improve future marine planning, policy and management of the area. The project will directly address many of DEC's research and monitoring responsibilities for the proposed Dampier Archipelago and Regnard Marine Protected Areas (outlined below).

Management Plan: The following management strategies outlined in the *Indicative Management Plan for the Dampier Archipelago Marine Park and Regnard Marine Management Area (2007-2017)* will be partly or fully addressed during this survey:

- Coral Reef Communities KPI (section 7.1.4 pg. 25): Assess the nature, level and potential impacts of human activities on coral reef communities within the proposed reserve and implement an appropriate monitoring program (H-KMS); Initiate research programs to characterise the floral and faunal diversity, and natural variability, of coral communities within the proposed reserve (M).

- Finfishes KPI (section 7.1.13 pg. 45): Facilitate research to characterise finfish diversity and abundance in the proposed reserves (M).

- Generic Research and Monitoring Strategies (section 8.4 and 8.6 pg. 106): Develop and progressively implement a coordinated and prioritised research program of key values and processes of the proposed reserves (H - KMS); Develop and progressively implement a coordinated and prioritised monitoring program of key values and processes of the proposed reserves (H - KMS).

20. Who are the anticipated users of the knowledge to be gained? How will they access the information?

The information gained from this study will be stored and used by DEC's Marine Science Program and Karratha District Staff. A data report containing all raw data collected during the survey will be produced and archived by DEC. Knowledge gained from the project in the form of all reports and other communication mediums will be distributed to all relevant DEC staff. A copy of all major reports will also be forwarded to the Karratha Department of Fisheries, the Western

Australian Museum and the Dampier Port Authority. People outside of DEC will be able to gain the information obtained during the survey by contacting DEC's Marine Science Program. A comprehensive communication component of the project will be undertaken in order to communicate the findings of the project to DEC, other marine science providers and the wider public. Communication outputs will include a DEC Landscope article, an article in the local newspaper and an article in DEC's Conservation News. Additional communication outputs will also be explored. By communicating information about and findings of the survey we will be helping to increase Western Australians' appreciation of the need to conserve their marine environment, including the proposed DAMPA.

The information gained will give an invaluable insight into the current health of marine communities of the proposed DAMPA and will provide a basis on which to compare the results of future surveys in the area. In addition, the information gained from the project will improve marine management, planning and policy regarding the proposed DAMPA. Monitoring of resource condition over time is essential for assessment of the effectiveness of the different management regimes proposed for the Dampier Archipelago. Monitoring of human impacts as manifested in changes in the marine environment over time will facilitate best possible management of the Dampier Archipelago.

The results of the survey will be directly relevant to the marine management performance assessment reports that the Marine Parks and Reserves Authority requires from DEC at regular intervals. Additionally, the information gained can be used by the day to day managers of the reserves in recognizing areas of high conservation significance. Managers can then target these areas during compliance and enforcement patrols, potentially resulting in increased protection of these areas.

21. Milestones [Detailed timeline or Gantt Chart describing milestones (including reports) and when they will be completed]:

Table 1. Summary of milestones and timing.

Milestone	Timing
Project planning	**9/7/07 – 14/9/07**
Project Concept Plan	**15/6/07**
Project Plan	**22/8/07**
Field Program Report	**24/8/07**
Undertake survey	**17/9/07 – 28/9/07**
Data Report	**30/3/08**
Submission of scientific paper (historical trends)	**31/6/08**
Technical report describing best methods for tropical rock lobster and COTS densities	**31/5/08**
Communication component	
LANDSCOPE article	**Autumn edition 2008**
Conservation News article	**October issue 2007**
Pilbara News newspaper article (pre and post survey)	**TBD**
Other communication opportunities will be explored	**TBD**

PART D STUDY DESIGN

22. Detailed methods:

Overview

This project will: a) provide before zoning enforcement data on fish abundance and length and benthic cover, b) determine historical long-term trends in benthic cover (and possibly fish abundance depending on comparability of methods) by establishing sites in close proximity to where previous studies have been undertaken, c) determine appropriate methods and survey design for estimating rock lobster and crown of thorns size and density, d) provide within and between site and within habitat variance data on fish abundance and length as a pilot study which will also enable the statistical power of the results to be determined and the appropriateness of the survey design to be confirmed. It is likely that the data collected during the pilot study will be able to be used for subsequent spatial and temporal comparisons.

The first survey will be undertaken in September 2007 and will collect data on fish abundance and length and cover of benthic reef communities using diver based methods: a diver operated stereo-video underwater visual census method for fish abundance and length, and an underwater diver operated video method for benthic reef cover. Methods and survey design for estimating rock lobster and crown of thorns density and size will be piloted during the first survey. The fish sampling will also effectively be treated as a pilot study that will provide variance data. Power analyses will be undertaken on the pilot data to confirm the appropriate size and number of transects needed per site to detect desired relative change with a high level of statistical power.

The second survey which will be conducted at a later date (likely to run in mid 2008) will collect data on fish abundance and length using the stereo baited underwater video (BRUV) method (Cappo, et al., 2003). The combination of survey techniques will give more comprehensive fishery-independent information on changes to fish species abundance and assemblage over time. In addition it is possible that some larger targeted fish species may avoid SCUBA divers but are likely to be successfully sampled using baited remote stereo-video. The results of this survey will provide additional before zoning enforcement data on fish abundance and length and will provide within and between site and within and between habitat variance data as a pilot study which will also enable the statistical power of the results to be determined and the appropriateness of the BRUV survey design to be confirmed. The BRUV survey will target some different fish habitats than the first survey and may also establish sites with the aim of determining the effectiveness of the proposed benthic protection zones in protecting demersal fish species over time. Planning for the second survey will be undertaken at a later date.

To gain a better understanding of the seasonal variations in fish abundance and length and rock lobster size and density at the Dampier Archipelago, both the diver and BRUV based surveys will be repeated during different seasonal times over the next two years. Following a beyond BACI approach (Kingsford and Battershill, 2003), the first few years of the study will be used to estimate the size of seasonal, within site, between site, within habitat and between habitat variations in fish abundance and length and rock lobster size and density. These data will provide an estimate of the size of such differences against which we can compare the differences between impact (e.g. sanctuary zones) and control sites (e.g. general use zones) that we may see in the future.

Note that the rest of the document focuses solely on the details of the first survey.

Survey design

A hierarchical nested survey design will be used (Table 2). Three locations will be surveyed within both the east and west regions of the proposed DAMPA (Figure 1). Previously compiled habitat maps, aerial photos, positions of previous study sites and advice from researchers familiar with the area were used to identify appropriate study locations. See appendix 2 for preliminary GPS

coordinates and maps of the positions of all sites. Each location will have an inside and outside sanctuary zone component ("reserve status"), with the exception of the locations in the West DAMPA, as no comparable sanctuary zones are proposed for this region, i.e. there will only be non-sanctuary components to the locations within the West DAMPA region (Figure 2). At each of the location/reserve status combinations three sites will be established. At each site six 50 m transects will be surveyed for fish abundance and length and benthic reef cover (Figure 3).

Sampling will be stratified by habitat and depth. Sampling for the first field component of the survey will be stratified by coral reef habitat. During a study on the habitat association of different fish species in the Dampier Archipelago, Hutchins (2004) determined that the majority of recreationally targeted fish species within the Archipelago are most strongly associated with coral reef habitat. For this reason coral reef habitat will be the focus of the first survey. To minimise the effect of habitat variability on changes to fish assemblages, effort will be made to select survey sites of comparable coral cover and coral type. The depth range will be relatively shallow and is likely to be from 5 to 10 m below mean sea level (to be confirmed in the field).

Table 2. Summary of the survey design.

DAMPA **region**	**Location**	**Reserve status** (inside/outside sanctuary zone)	Number of **sites** per reserve status	Number of 50 m **transects** per site
East	Delambre Is	inside	3	6
		outside	3	6
	Legendre Is	inside	3	6
		outside	3	6
	Hamersley Shoals	inside	3	6
		outside	3	6
West	Sailfish 1	outside	3	6
	Sailfish 2	outside	3	6
	Kendrew Is	outside	3	6

Locations = 6
Reserve status: inside east = 9
Reserve status: outside east = 9
Reserve status outside west = 9
Total sites = 27
Total transects = 162

Use of historic data

To make use of historical data, effort will be made to establish sites where surveys for benthic cover and fish have been undertaken previously. Some of our proposed sites have been surveyed previously during other studies. If time allows, additional previous study sites will be re-surveyed (although these sites will not form part of the long-term monitoring program). Data from previous studies will be compared with the data collected during this study to enable long-term temporal trends before MPA establishment to be determined. Statistical analyses will be undertaken to validate any comparisons between our data and previous data. Three major historical surveys collected quantitative data on fish abundance and benthic reef cover at the outer reefs of the Dampier Archipelago: Simpson & Grey, (1989); AIMS in 1993; and the Western Australian Museum (WAM) in 2004 (Hutchins, 2004; and Morrison, 2004). (See appendix 2 for GPS coordinates and maps of the positions of historical survey sites in the proposed DAMPA region).

1) Simpson and Grey (1989) collected data on benthic reef cover and densities of *Acanthaster planci* (crown of thorns starfish) in 1989.
2) The AIMS collected data on fish abundance and benthic reef cover in 1993, there is no report associated with this data however we have obtained the analysed data from AIMS.

3) The WAM in collaboration SKM collected data on fish abundance and benthic reef cover in 1998 and 1999 (Hutchins, 2004; Morrison, 2004).

Other surveys that have generated quantitative benthic cover data have been undertaken in areas relating to port development including MScience for the Dampier Port Authority in the Dampier Port area (Stoddart & Stoddart, 2005) and Sinclair and Knight Merz consultants (SKM) for Robe (Rio Tinto) in the Cape Lambert port proposal area (Sinclair and Knight Merz, 2007).

Data analysis

Analysis of the raw stereo-video UVC fish data will be undertaken under contract by the University of Western Australia in November 2007. Analysis of the benthic video will be performed using the AVTAS method according to Abdo *et al.* (2004) as outlined in the Australian Institute of Marine Science's standard operational procedure manual for surveys of benthic reef communities using underwater video. Each benthic transect will be filmed in normal definition rather than high definition format, to avoid potential problems during the analysis stage. Analysis of the benthic video data is also likely to be undertaken under contract (to be confirmed). The rock lobster and crown of thorns density and length data will not require any major analysis as they are comprised of visual counts. Raw data will be entered into an EXCEL spreadsheet.

Statistical analysis

Power and precision analyses will be performed on the fish, rock lobster and crown of thorns data to determine appropriate transect size and replication for each target. Multivariate analyses using PRIMER will be used to investigate the importance of replication at the transect versus site level (i.e. is it more important to have a low number of sites nested within a location, with a high number of transects per site; or alternatively, a higher number of sites per location, with a low number of transects per site?).

For the multivariate fish assemblage data PERMANOVA (permutational ANOVA, Anderson 2001) and CAP (canonical analysis of principal coordinates, Anderson and Robinson 2003; Anderson and Willis 2003) will be used to determine the significance of within site, between site, within habitat and between habitat variations in fish abundance, assemblage and length. ANOVAs will be used to investigate changes in live hard coral cover between 1993 (AIMS 1993 Dampier survey data) and 2007.

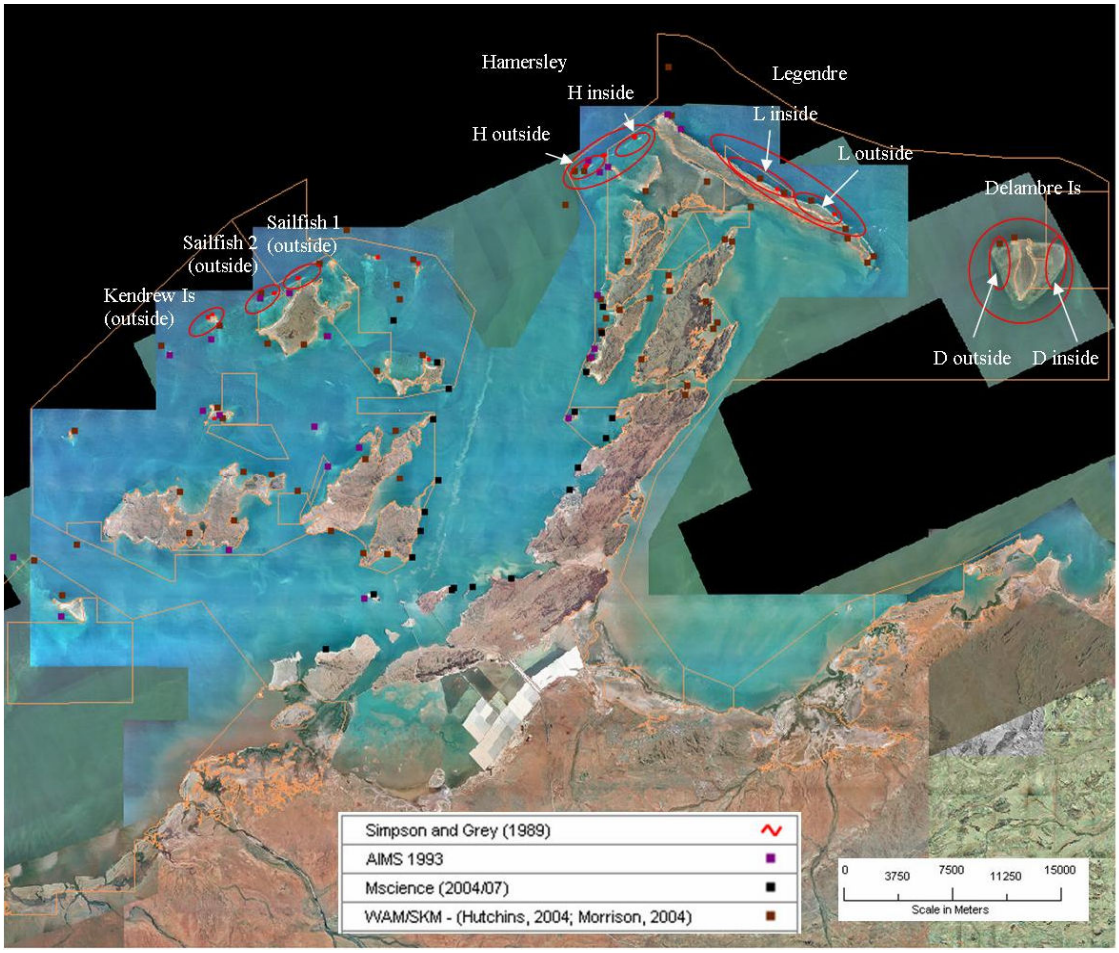


Figure 1. Map of the study area showing west and east DAMPA, survey locations, and reserve status sites (inside or outside) within each location. Within each reserve status, 3 sites will be established. At each site six 50 m transects will be surveyed. Sites from previous studies that collected quantitative data on fish abundances and benthic cover are also shown (see legend). To make use of historic data, where appropriate, our sites will be established in close proximity to previous study sites.

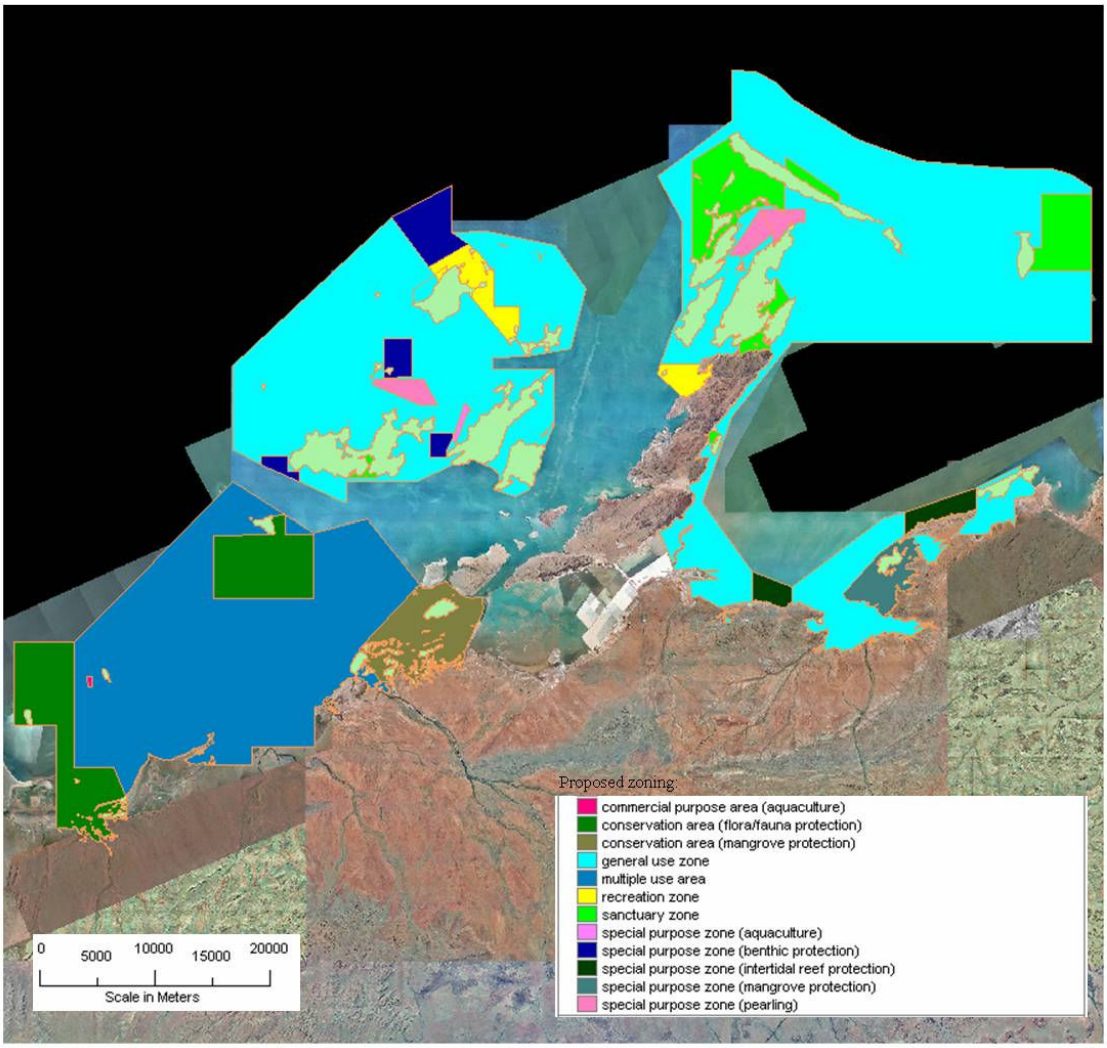


Figure 2. The proposed zoning scheme for the Dampier Archipelago Marine Protected Area.

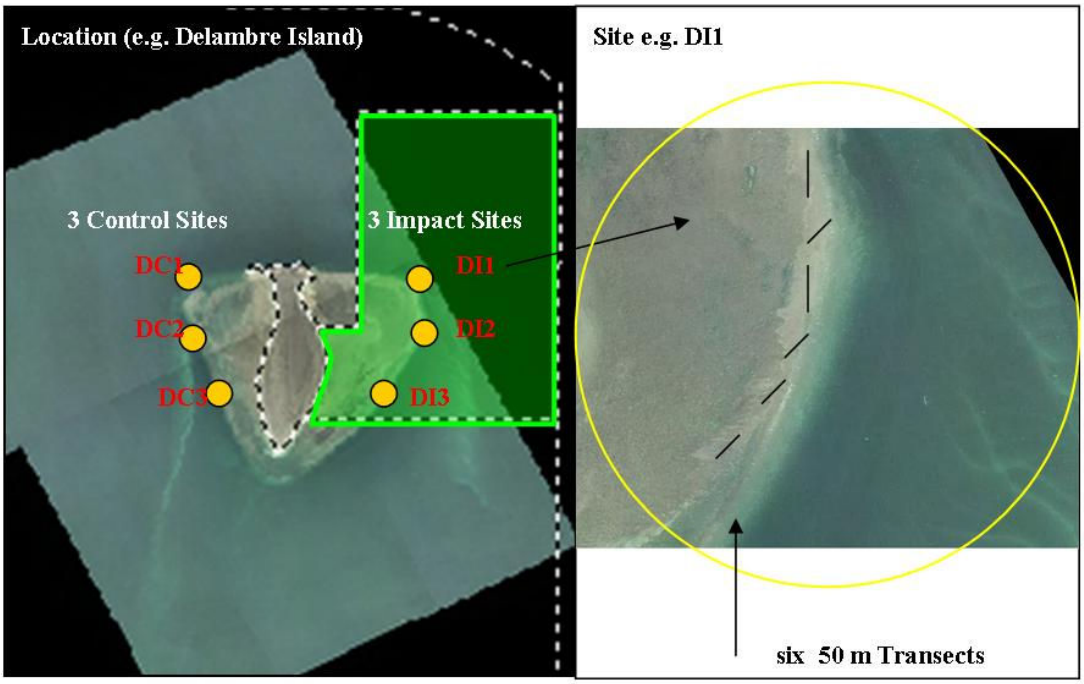


Figure 3. Example illustration of the survey design. Delambre Island is used in this example. Note the three control sites outside the sanctuary zone (DC, 1-3) and three impact sites inside the sanctuary zone (DI, 1-3). At each site we will survey six randomly positioned 50 m transects.

Methods

Fish abundance and length

The abundance and length of fishes will be determined using a diver operated stereo-video underwater visual census method (known as the stereo-video UVC method) developed by researchers at the University of Western Australia (Harvey *et al.* 2001, 2002) (Figure 5).

The use of stereo video enables conclusive identification of species from the video footage and tests have shown the accuracy of size estimates to be within 2 mm (Harvey *et al.* 2002). Video footage can be stored for long-term comparisons or re-analysis, and the method reduces measurement error in comparison to estimates made by novice and experienced scientific divers. The reduction in measurement error substantially increases the statistical power of a monitoring programme to detect changes in the mean length of a population of fish. Fewer samples need to be taken per site using stereo-video to obtain an equivalent level of power compared to experienced underwater visual census (UVC) scientific divers, saving both time and money in the field.

The stereo-video UVC equipment comprises of two forward facing video units secured to an aluminum frame. A light emitting diode is positioned on a rod in front of the cameras so the footage can be synchronized when it is viewed on a computer. The video units are configured to record the fish from different angles. A computer program is then used to calculate the exact size of fishes by mathematical triangulation using two sets of video footage.

The video units will be swum along the entire length of each 50 m underwater transect. Tags will be videoed at the beginning of each site and each transect for site and transect identification and to distinguish between left and right side cameras (this is particularly important). Each transect will take between 3 and 5 minutes to sample.

At present no data are available to undertake a power analysis to determine the required number of transects needed per site using the stereo-video UVC fish survey method in a tropical coral reef environment. Therefore advice from experts in the field of stereo-video UVC and investigation into the numbers of replicates used by other researchers employing the stereo-video UVC method in Western Australian tropical reef environments (Fitzpatrick & Harvey, 2007, Dianne Watson pers. comm., 2007) was used to estimate the likely number of transects required per site. The fish survey will effectively be treated as a pilot study and the results will be used to statistically validate the number of transects needed per site (e.g. power analysis) to give a high level of statistical power to detect a desired level of relative change in fish abundance and length.

Figure 4. Photo showing the stereo-video UVC equipment being used in a Western Australia tropical reef environment (Abrolhos Islands 2007). Source: Dianne Watson, UWA.

Benthic cover

The benthic community along each transect will be recorded using a Sony HDR-HC1/E digital video camera in an Amphibico underwater housing. The diver will move slowly along the transect, holding the camera approximately 50 cm above the substratum on wide angle zoom whilst recording the entire 50 m transect. Filming should occur at a maximum speed of 10 m/minute, therefore each transect should take approximately 5 minutes to complete. A panoramic shot of the reef surrounding the start of each transect will be taken after filming the tag that identifies the site and transect number. Emphasis should be on recording the general structure of the reef, following the reef substrate at all times. The diver will turn slowly in a clockwise direction, holding the camera as steady as possible and filming for approximately 30 seconds, ending at the initial view.

Benthic reef cover data collected by the Australian Institute of Marine Science (AIMS) at the Dampier Archipelago in 1993 was subjected to a power analysis to estimate the number of 50 m transects needed per site to maintain a desired statistical power and level of relative change (Figure 6). Data from three outer reef sites was used in the analysis and alpha was set to 0.05. The results of the analysis determined that 6 replicate 50 m transects per site gives a statistical power of 80% (probability of correctly rejecting a null hypothesis) for detecting a 40% relative change in live coral cover. The number of transects suggested by the power analysis must obviously be balanced with what is logistically viable in the field. Since the methods for benthic cover are rapid and each transect can probably be completed in 5 minutes, it is likely that 6 transects can be completed using one scuba cylinder (i.e. in one dive). This will be tested in the field and if necessary the number of transects may be decreased.

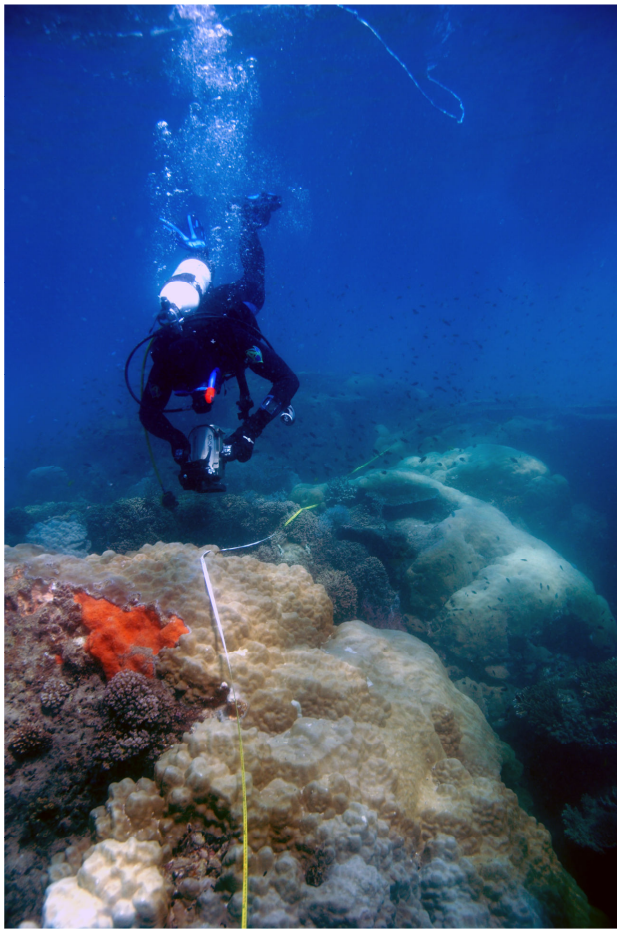


Figure 5. Photo showing the benthic video equipment being used in a Western Australia tropical reef environment (Montebello Islands region, 2006).

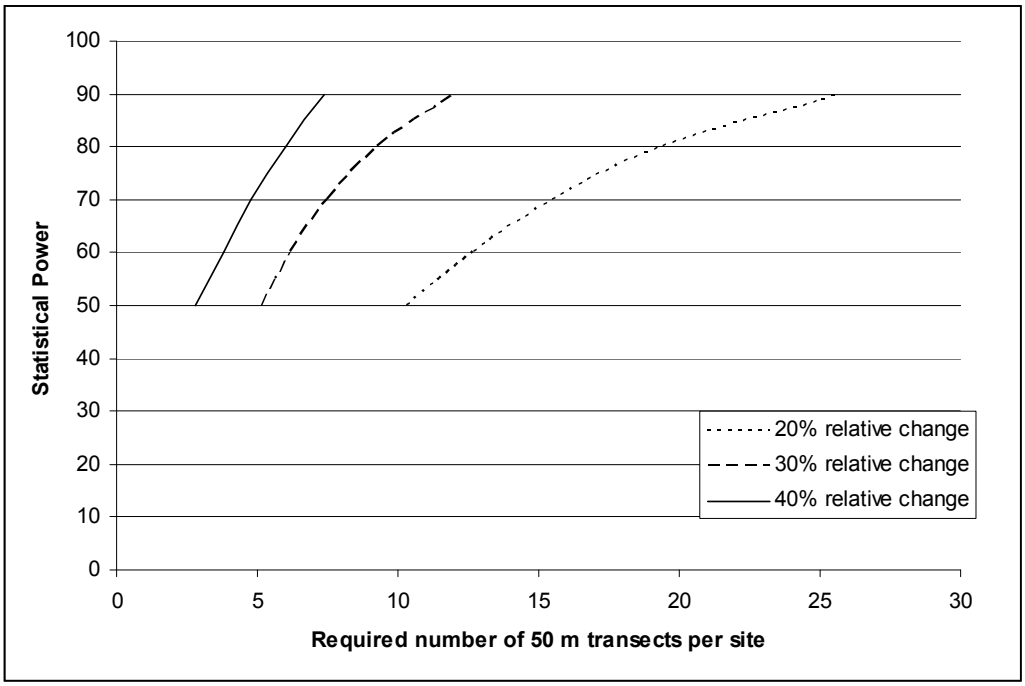


Figure 6. Resultant statistical power for detecting a relative 20, 30 and 40% change in live coral cover. Data from three outer-reef sites in the Dampier Archipelago were used in the analysis (data sourced from AIMS). Alpha was set to 0.05.

Tropical rock lobster and crown of thorns density and size

This section of the survey will be treated as a pilot study of which the methods will be tested at only one location reserve status (i.e. at three sites in total). This will be undertaken once the main fish and benthic cover surveys have been completed. We will also pilot the logistics of conducting the rock lobster and crown of thorns starfish sampling in conjunction with the fish and benthic cover sampling.

The density and size of tropical rock lobsters and crown of thorns starfish will be estimated by visual search within five m either side of each 50 m transect (50 x 10 m). At the start of each transect 10 meters of twine will be run out on right angles to the transect line (five meters either side of the transect line) to provide the divers with an estimate of the belt transect width. If the cotton twine is not easily visible then we will use fibreglass measuring tapes instead of the twine. This will be conducted at three sites. At one site we will try conducting this method in conjunction with the fish and benthic cover sampling. The maximum diameter to the nearest 10 mm of each *A. planci* will be estimated using the pre-marked ruler on the data sheet clipboard. The type of coral that each *A. planci* is observed on will also be recorded. If the starfish is located on substrate other than coral, the type of substrate will be recorded. The species of each rock lobster will be recorded and the carapace length of each lobster will be estimated visually to the nearest 10 mm and recorded. Divers will be trained to identify tropical rock lobster species and to estimate lobster size prior to sampling. Calibration of diver visual estimates will be undertaken by estimating the carapace length of a lobster visually, then capturing it and measuring the carapace length with vernier callipers. This will be undertaken for each diver several times. Calibration data obtained in this way will be used to correct size estimates for any bias. This is the same size calibration method used by Babcock *et al.* 2007 during a study on rock lobster size and abundance at Rottnest Island, Western Australia.

The choice of the 50 x 10 m transect size was based on pilot studies conducted by Pitcher *et al*. (1992) during a study on the abundance and distribution of the tropical rock lobster *Panulirus ornatus* in Torres Strait and by MacDiarmid (1991) during a study on patterns of abundance and movement of the spiny lobster *Jasus edwardsii* at coastal reefs of New Zealand.

Pitcher *et al.* (1992) compared the precision of several sized transects: lengths of 500, 1000, 1500 and 2000 m combined with widths of 1, 2 and 4 m with the number of replicates of each twelve width/length combinations needed to give 6000 m^2 of survey area. The mean and precision of *Panulirus ornatus* density estimates did not vary greatly between the different sample sizes. The most cost-efficient combination of sample size/number replicates was therefore chosen: three replicates of the 4 x 500 m transect (6000 m^2). A second pilot study looked at the level of variation in lobster density at the three spatial scales of sampling: location, site and transect levels. A negative value of variance was associated with the site level, and sites were subsequently dropped from the sampling strategy. Further analysis indicated that the most efficient sampling strategy for a full-scale study (25, 000 km^2 area of the Torres Strait) would be to survey two (4 x 500 m) transects at each location. The full scale survey was undertaken using this design (giving a 4000 m^2 sample area at each location). At Dampier we will pilot six 50 x 10 m transects per site which equates to a 3000 m^2 sample area per site and a 9000 m^2 sample area per location. The variable cover and patchiness of hard substrate within the Dampier Archipelago will restrict the length and width of transects and the need for a high level of replication of transects will further restrict transect size.

MacDiarmid (1991) compared the precision of three different sized transects: 10 x 10 m, 25 x 10 m and 50 x 10 m and also found the precision of different sample sizes to be similar in all cases. The 50 x 10 m transect was therefore selected to permit at least one transect per dive to be completed in areas of high lobster abundance, and limit the number of zero counts in areas of low lobster abundance. Kelly *et al.* (2000) used the results of the pilot study by MacDiarmid (1991) and chose 5 replicates of the 50 x 10 m transect size during a study that looked at the recovery of *Jasus edwardsii* in marine reserves in north-eastern New Zealand. Babcock *et al.* (2007) also used 50 x 5 m transects for estimating rock lobster size and density at Rottnest Island in Western Australia.

Brief outline of survey site activities

Upon arrival at each site, time will be invested in locationg a length of reef that is at least 350 m long or the width/length equivalent in order to fit six 50 m transects with an average space of 15 m between each transect. As each site will be stratified by depth and habitat, effort will be made to locate an area of suitable size that has a depth/habitat combination comparable to that of other sites.

Two divers are required for sampling at each site. One diver will record the abundance and length of fishes using the stereo-video UVC method, and the second diver will record benthic cover. Both divers will enter the water together. The fish diver will proceed along the transect first. The transect line will be laid by the fish diver using a modified Chainman©. This device measures distance by spooling out biodegradable twine and displaying the length of twine leaving on a counter easily viewed by the diver. On reaching the seabed, the diver wraps a coil of twine around a solid structure then begins the 50 m transect. Upon reaching the end of the transect, the twine is wrapped around a structure, broken off, then left on the benthos to biodegrade within a few days. This method greatly increases the efficiency of the transect method since a line does not need to be laid or retrieved as would be necessary using the traditional tape measure approach (Babcock *et al.* 2007). The fish diver will commence videoing along the transect whilst the twine unravels, effectively laying the transect line as they sample. The fish diver will remain

within predefined depth range and coral reef habitat (including similar coral cover, coral type and rugosity) comparable to that of other sites. The depth range and coral reef habitat will be confirmed on the first day in the field. The transect line does not need to be a straight but more importantly should stay within the predefined coral reef habitat and depth range. Shortly after the fish diver has commenced filming the second diver can commence videoing the benthos whilst following the transect line identified by the twine. The twine does not need to stay in the field of view of the camera, but the diver must video the benthos along the line of the transect. On completion of each transect both divers will meet at the end of the transect and then swim a random distance (between 10 and 20 m to enable independence between transects) before establishing the start of the next transect (the fish diver will lead). The UVC video camera will remain recording for the duration of sampling each site even between transects. On completion of the 6 transects the divers will meet and surface together. A GPS coordinate of the start and end of each transect will be taken by field personnel on the vessel for reference purposes.

We will work with two pairs of divers. One pair will survey the six transects at one site in one dive, then return to the vessel. The second pair of divers will be ready for their dive when the first pair returns to the vessel. The second pair of divers will then survey the six transects at the second site in one dive. We will rotate like this throughout the day with the aim of achieving 3 sites per day when the tides are most variable, and 6 sites per day when the tides are more stable, i.e. three to six short dives per day, with a maximum of three short dives per diver per day. We will rotate divers to limit the number of dives done per day per diver (a maximum of three dives per day per diver). The dive supervisor and the project leader will work closely together to devise a daily dive plan that will optimize both diver safety and survey time. The dive plan will be in accordance with the Departmental Diving Code of Practice and will be incorporated into this project plan at a later date.

Note that the first day or two will be used to trial different ways of undertaking the sampling. It may turn out that it is too difficult for either the fish or benthic diver to carry the cotton spool. In this case we will use a third diver who will lay the cotton spool (i.e. the sampling team will consist of three divers).

It is possible that some of the sampling may be able to be undertaken by snorkeling opposed to SCUBA. For planning purposes we will expect that all sampling will be undertaken by SCUBA.

PART E DATA MANAGEMENT AND REPORTING

23. Estimated number of vouchered specimens: n/a

24. Data management including data custodian:

DEC's Marine Science Program will be the custodian of the data.

Data Management

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

1. Marine Science Program, Science Division, Department of Environment and Conservation, 17 Dick Perry Avenue, Western Australia, 6152. Ph: (08) 9334 0333.

2. Woodvale Library, Science Division, Department of Environment and Conservation, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641.

3. Archives, Woodvale Library, Science Division, Department of Environment and Conservation, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641 (CD also attached).

4. Pilbara Region, Department of Environment and Conservation, Lot 3 Anderson Road, Karratha Industrial Estate, Karratha, Western Australia, 6530. Ph: (08) 9143 1488 Fax: (08) 91441118.

5. Serials Section, State Library of Western Australia. Alexander Library Building, Perth Cultural Centre, Perth, Western Australia, 6000.

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

1. The Science Division Server:
T:\529-CALMscience\Shared Data\Marine Science Program\MSP_REPORTS\msp_2006-03.pdf

2. CD-ROM [MSP_2006-03]

The benthic habitat data collected during the survey will be entered into the Habitats Database, which is located on the Science Division Server:

T:\529-CALMscience\Shared Data\Marine Science Program\MSP_DATABASES\Habitat database\MSP Habitats.mdb

All mini digital video (MDV) footage collected during the survey will be held at two locations:

1. MDV masters will be archived in a Dampier Archipelago Video Archive file held at the Information Management Branch, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0392.

2. Digital copies on DVDs will be stored at the Marine Science Program, Science Division, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0299 Fax: (08) 9334 0327.

All digital still photographs taken during the survey will be archived on the Science Division Server:

T:\529-CALMscience\Shared Data\Marine Science Program\MSP_COMMUNICATION\image library\images

PART F BUDGET

25. Budget Estimate:

Consolidated Funds (DEC)

	Year 1 ($)	Year 2 ($)	Year 3 ($)
FTEs – Scientist	Planning: DEC MSP ~$4,358, DEC Pilbara Region ~ $245 In field component: DEC MSP ~$2,821 DEC Pilbara Region ~$4,576 UWA ~$2, 251(in-kind) Data analysis: DEC MSP ~$2,179, UWA (fish data) ~$4919 Report writing: DEC MSP ~$4,358	TBD	TBD
FTEs – Technical	DEC MSP~$2,549 DEC Karratha ~$6,540 DEC Exmouth ~$3, 185, plus travel rate =$711		
Equipment	Hire of stereo-video UVC survey kit from UWA =$1,300 (in-kind), insurance, maintenance =$1000		
Vehicle/Vessel	Vessel: Fuel for the Biddy ~$1,125, plus tender ~$300 Vehicle: Fuel ~$200		
Travel	Flights: $2,988 Accommodation: $5,945 (Pilbara Holiday Park)		
Other	Meals: ~$1,500 Consumables (video tapes, water proof paper etc): ~$200 SCUBA tank fills: ~$600 SCUBA tank hire: ~$200 Freight: (Perth to Karratha return) ~$500		
TOTAL	~ $52,299		

PART G OPERATIONAL SCOPE

26. **Maps (if not already provided):** In addition to maps in Figures 1 and 2, see Appendix 3 for the tide charts relevant to the period of the field trip. Wind, swell and weather forecasts for the period of the field survey will be included in the daily field equipment but are not available at this stage. See Appendix 3 for the wind and swell forecast for the Dampier Archipelago area from the 4th to the 10th of September 2007, as an indication of what it may be like for the period of the survey.

27. **Mode of field operations (will operations will be vessel- or land-based? Camping or town accommodation? What kinds of vehicles/vessels will be required?):** Accommodation will be land based at Karratha (including the Pilbara Holiday Park and accommodation at other DEC Karratha staff members' houses). All survey operations will be vessel based. The vessel is the RV Bidthangara based in Dampier and the tender is the Iddy Biddy also based in Dampier (see photos below). A DEC Exmouth 4wd vehicle will be used for land based logistics for the duration of the field trip.

Figure 7. Photo of the RV Bidthangara.

Figure 8. Photo of the Iddy Biddy (in foreground).

28. Approximate duration of field operations (days per field trip if multiple operations):

The field trip will run from approximately the 17th of September to the 28th of September. Please note that the best tides for surveying occur over the weekend and we will need to make use of these tides. This means we will be working over the weekend that occurs in the middle of the field trip.

29. Approximate number of personnel that will be in the field for this project, and their roles (e.g. Dive Supervisor, Coxswain, Project Leader, Field Assistant):

Shannon Armstrong, DEC MSP – Project Leader
Geoff Kregor, DEC Karratha – Main Vessel Skipper/ field assistant
Brad Daw, DEC Exmouth – Dive Supervisor/ 2nd Vessel Skipper/ field assistant
Dr Alan Kendrick, DEC Pilbara Region – field assistant
Alicia Edwards, DEC MSP – field assistant
Dr Suzanne Long – field assistant
Dr Dianne Watson, UWA – field assistant
Adam Williams, DEC Karratha – field assistant
Marissa Speirs, DEC Karratha – field assistant

Dr Dianne Watson will be attending the first week of the survey to supervise correct use of the stereo-video UVC equipment.

30. Safety (indicate how relevant DEC boating, diving and communications policies/codes will affect field operations):

To ensure the safety of all survey personnel, a dive plan will be developed by the project leader and the dive supervisor for the survey, and approved by the Departmental Dive Officer. A field trip advice form containing preferred methods and details of communication contact will be lodged with the DEC Karratha, Exmouth and MSP offices and will be made available to all relevant DEC Karratha, Exmouth and MSP staff. See the end of this document for a copy of the field trip advice

form that will be lodged with the DEC Karratha and MSP offices and a copy of the search and rescue (SAR) working arrangements (Pilbara Region) guideline.

Boating
The skipper of the vessel will be responsible for boating and navigation in accordance with the 'Safe Marine Operations in Calm Procedure Guidelines (2002)'.

Diving and snorkeling
Diving and snorkeling undertaken during the survey will be in accordance with the 'CALM Diving Code of Practice (2005)'. A Dive Supervisor will be present during the duration of the field trip and will be responsible for all diving activity.

Other Safety Issues
All other safety issues shall be in accordance with the CALM Occupational Health and Safety Procedures Manual (1995) and will be the responsibility of the project leader, Shannon Armstrong.

31. Preliminary Field Itinerary:

Survey Location/ Other	Activity	Logistics	Personnel Required	Date/time
Perth to Karratha (flight) Exmouth to Karratha (drive)	Travel to Karratha	Shannon, Suzanne and Dianne fly Perth to Karratha (depart 1130, arrive 1330) Alan and Brad drive Exmouth to Karratha	Shannon, Suzanne and Dianne Alan and Brad	Sunday 16th
Sailfish 1	Undertake survey	three short dives	Shannon, Suzanne, Geoff, Alan, Dianne, Brad, Adam	Monday 17th
Legendre Island 1	Undertake survey	three short dives	Shannon, Suzanne, Geoff, Alan, Dianne, Brad, Adam	Tuesday 18th
Legendre Island 2	Undertake survey	three short dives Bring Suz to airport by 1745 Suzanne to fly Karratha to Perth (depart 1845, arrive 2040) Pick Alicia up from airport at 1805 Alicia to fly Perth to Karratha (depart 1605, arrive 1805)	Shannon, Suzanne, Geoff, Alan, Dianne, Brad, Adam Suzanne, Shannon Alicia, Shannon	Wednesday 19th
Delambre Island 1	Undertake survey	three short dives	Shannon, Alicia, Geoff, Alan, Dianne, Brad,	Thursday 20th

			Adam	
Delambre Is 2	Undertake survey	three short dives	Shannon, Alicia, Geoff, Alan, Dianne, Brad, Adam	Friday 21st
Kendrew Is and Sailfish 2	Undertake survey	six short dives (at least two teams of divers)	Shannon, Alicia, Geoff, Alan, Brad, Adam	Saturday 22nd
Hamersley Shoals 1 + 2	Undertake survey	six short dives (at least two teams of divers)	Shannon, Alicia, Geoff, Alan, Dianne, Brad, Adam	Sunday 23rd
Travel Karratha to Perth	Travel to Perth	Dianne to fly Karratha to Perth (depart 1850, arrive 2045)	Dianne	
TBD (for position and GPS coordinates of historical sites see Appendix 2)	Survey any sites unable to survey yet. Then re-survey additional historical survey sites (established by AIMS in 1993) and pilot rock lobster and COTS methods	Survey additional historic survey sites	Shannon, Alicia, Geoff, Alan, Brad, Adam, Marissa	Monday 24th
TBD	As above	Pilot the rock lobster and COTS methods		Tuesday 25th
TBD	As above	Survey additional historic survey sites or visit special interest sites		Wednesday 26th
TBD	Day dedicated to taking video footage and photographs for communication outputs	Likely to be two short dives (TBD)		Thursday 27th
Land-based day	Pack up and clean gear. Freight to be picked up by TOLL for couriering to Perth	TOLL to pick up freight to be couriered to Perth	Shannon, Alicia, Geoff, Alan, Brad, Adam	Friday 28th
Karratha to Perth (flight)	Travel to Perth	Shannon and Alicia fly Karratha to Perth (depart 1730, arrive 1925)	Shannon and Alicia	
Karratha to Exmouth (Drive)	Travel to Exmouth	Alan and Brad drive Karratha to Exmouth	Alan and Brad	

32. Equipment List

Survey equipment
1 Sony HDR-HC1/E digital video camera, Amphibico underwater housing plus 1 spare of each, battery packs and chargers
Nikon Digital D200 SLR still camera, underwater housing, battery packs and charger
Leads, pelican cases, o-ring kits and cleaning kits for camera gear
100 mini DV cassettes
1 calibration cube for re-calibrating stereo-video UVC cameras
1 handheld GPS plus 1 spare, spare batteries
In field tub for camera gear
Cotton spools 10, 000 m worth (need ~ 350 - 400 m per site at most)
Marine Research banner
Callipers (x 2) for measuring rock lobster carapace length
1 stereo-video UVC kit plus 2 spare cameras (see brake down below):

ITEM	#	UWA / DEC	NOTES
Diver-operated stereo-video systems	2	UWA	Approx 40 kg to take on plane as hand luggage
TRV 900 video cameras	4	UWA	
Batteries (large)	10	UWA	
Battery chargers	4	UWA	
Head-cleaning tape	1	UWA	
Synchronising diode	4	UWA	
Diode arm	2	UWA	
Cotton spools	4	DEC	Need to remove glass from the dial otherwise they float
Cotton	12 km	DEC	calculated using 420 m per dive (6 x 50 m transects)
Tapes	60	DEC	60-minute mini DV tapes – can be labeled prior to trip. Require tow tapes per site, i.e. one for the left cam and one for the right cam.
Tags	12	DEC	Numbered 1 through 6 to indicate transect #
Underwater slate	2	DEC	For checklist for camera operation
Tools		DEC	cable ties, duct tape, wrenches, screwdrivers etc.

Safety equipment
Dive flag, plus one spare
Oxy-viva kit for vessel
Comprehensive diving first aid kit
Sunscreen, hats, plenty of water, sunglasses
SAR emergency guideline procedure
Field trip advice form
Device that enables communication device with Karratha Office at all times (CDMA, DEC VHF)
Dive Plan, NASDS DCIEM Tables (decompression flow chart), DEC dive logs
Mermaid line

Dive equipment
12 SCUBA cylinders
BC and regs for all survey personnel
Mask and fins for all survey personnel
Full wetsuit, booties and gloves for all survey personnel
Dive knives for all survey personnel

Dive weights
(As no portable compressor is available, all fills will be land based. We will have enough tanks so that fills do not hold up survey time)

Information
Data sheets
Field not books
Field reference books (identification guides for marine fauna and flora)
Survey and safety equipment checklist (to be checked off before leaving base)
Habitat maps
Zoning maps and GPS coordinates of zone boundaries
All GPS coordinates on Aussie Map for Biddy GPS
GPS coordinates of all survey sites
Aerial photographs of sites
DAMPA Draft Management Plan

PART H MARINE SCIENCE COMMUNICATION/EDUCATION

32. What science communication products/activities will be associated with this project (specify audience in each case)?

Further communication avenues will be explored and used. At this stage the following two communication outputs have been confirmed:

- DEC Conservation News article (October issue, 2007)
- DEC LANDSCOPE magazine article (Autumn edition, 2008)
- Local Newspaper article (one article before the survey and one after) - Pilbara News
- Further communication avenues to be determined

REFERENCES

Abdo, D., Burgess, G., Coleman, G., & Osborne, K. (2004). *Surveys of benthic reef communities using underwater video: Long-term monitoring of the Great Barrier Reef, Standard Operational Procedure Number 2*. Australian Institute of Marine Science, Townsville, Australia.

Anderson, M.J. (2001). *A new method for non-parametric multivariate analysis of variance.* Austral Ecology, 26: 32–46.

Anderson, M.J. and Willis, T. (2003). *Canonical analysis of principal coordinates: A useful method of constrained ordination for ecology.* Ecology, 94: 511-525.

Anderson, M.J., and Robinson, J. (2003). *Generalized discriminant analysis based on distances.* Australian and New Zealand Journal of Statistics. 45: 301-318.

Babcock, R., Vanderklift M., Haywood, M., Clapin G., Murphy, N., Pillans, R., Limbourn A. (2007). *Ecosystem Effects of Recreational Fishing: Ningaloo Underwater Visual Census 2007: Data Report.* CSIRO Marine and Atmospheric Research.

CALM and MPRA 2005, *Indicative management plan for the proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area*, Department of Conservation and Land Management and Marine Parks and Reserves Authority, Perth, Western Australia, p. 121.

Fletcher W J and Head F (eds) 2006, *State of the Fisheries Report 2005/06*. Department of Fisheries, Perth, Western Australia, p. 284.

Harvey, E. S., Fletcher, D., and Shortis, M. (2001*). Improving the statistical power of visual length estimates of reef fish: A comparison of estimates determined visually by divers with estimates produced by a stereo-video system.* Fishery Bulletin, 99(1): 72-80.

Harvey, E.S, Fletcher, D., and Shortis, M.R. (2002). *Estimation of reef fish length by divers and by stereo-video: A first comparison of the accuracy and precision in the field on living fish under operational conditions.* Fisheries Research, 57/3: 255-265.

Hutchins, B, J. (2004). *Fishes of the Dampier Archipelago, Western Australia.* In: Marine Biodiversity of the Dampier Archipelago Western Australia 1998 – 2002. Records of the Western Australian Museum Supplement No. 66: pp 343 – 398.

Hutchins, J.B. 1978. *The report of a reef fish survey conducted in the Dampier Archipelago during August, 1978.* In: Western Australian Museum. 1978. Report on the marine fauna and flora of the Dampier Archipelago. Unpublished reports submitted to Meagher and LeProvost Consultancy, Western Australia.

Morrison, P. (2004). *A general description of the subtidal habitats of the Dampier Archipelago, Western Australia.* In: Marine Biodiversity of the Dampier Archipelago Western Australia 1998 – 2002. Records of the Western Australian Museum Supplement No. 66: pp 51 – 59.

Osborne S, Bancroft K P, D'Adamo N and Monks L 2000, *Dampier Archipelago/ Cape Preston Regional Perspective*, Department of Conservation and Land Management, Perth, Western Australia, p. 74.

Sinclair and Knight Merz. (2007). *Dredging Program for the Cape Lambert Port Upgrade.* Sinclair and Knight Merz, Perth, Western Australia.

Stoddart, J.A., & Stoddart, S.E. (2005). *Corals of the Dampier Harbour: Their survival and reproduction during the dredging programs of 2004.* MScience Pty Ltd, Dampier Port Authority, Western Australia.

Tourism Western Australia 2006, *Tourism Western Australia Submission to State Infrastructure Strategy*, Tourism Western Australia Industry Development and Visitor Servicing Division, p. 36.

Westera, M., Harvey, E., & Kendrick, G. (2006). *Benchmark study on marine communities of the south-west (Capes) region for long-term monitoring including the proposed Capes Marine Reserve.* School of Plant Biology, Faculty of Natural & Agricultural Sciences. University of Western Australia.

APPENDIX 1: FISHERY INFORMATION

Commercial fisheries	Spatial operation	Recreational fisheries - key target species		Charter fishing operations - key target species
Beche-de-mer Fishery	No extraction occurs	Blackspot Tuskfish - *Choerodon schoeleinii*	Green Mudcrab - *Scylla serrata*	Narrow-barred Spanish mackeral - *Scomberomorus commerson*
Mackerel Interim Managed Fishery	Troll fishery with sites throughout	Blacktip Reef Shark - *Carcharhinus melanopterus*	Tropical Rock Lobsters - *Panulirus versicolor* and *P. ornatus*	*Lutijanus* Spp. Red Emperor - *Lutjanus sebae,* Seaperch, Saddle-tailed (Scarlet) - *Lutjanus malabaricus*
Marine Aquarium Fishery	Sites throughout	Blue Swimmer Crab - *Portunus pelagicus*	Rockcod, Rankin's (White-Blotched) - *Epinephelus multinotatus*	Emperor Spp. Spangled Emperor - *Lethrinus nebulosus*, Emperor, Sweetlip (Red Throat) - *Lethrinus miniatus*
Nickol Bay Prawn Managed Fishery	Operates to the east of the Burrup Peninsula	Coral Trout - *Plectropomus leopardus*	Red Emperor - *Lutjanus sebae*	Coral Trout - *Plectropomus leopardus*
Onslow Prawn Managed Fishery	Operates to the west of the Burrup Peninsula	Estuary Cod - *Epinephelus coioides*	Snappers - *Lutjanus* spp.	Trevally, Gold-Spotted/Turrum - *Carangoides fulvoguttatus*
Oyster Fishery	Zone 1, not main fishing area	Golden travally - *Gnathanodon speciosus*	Spangled Emperor - *Lethrinus nebulosus*	Rockcod, Rankin's (White-Blotched) - *Epinephelus multinotatus*
WA North Coast Shark Fishery	Did not operate within close proximity, closed since 2006.	Grass Emperor -*Lethrinus laticaudis*	Spanish Mackerel - *Scomberomorus commerson*	Chinaman Fish - *Symphorus nematophorus*

* *No trawling for fish occurs within the Dampier Archipelago*
** *No commercial fishing for tropical rock lobsters has occurred since June 1997*

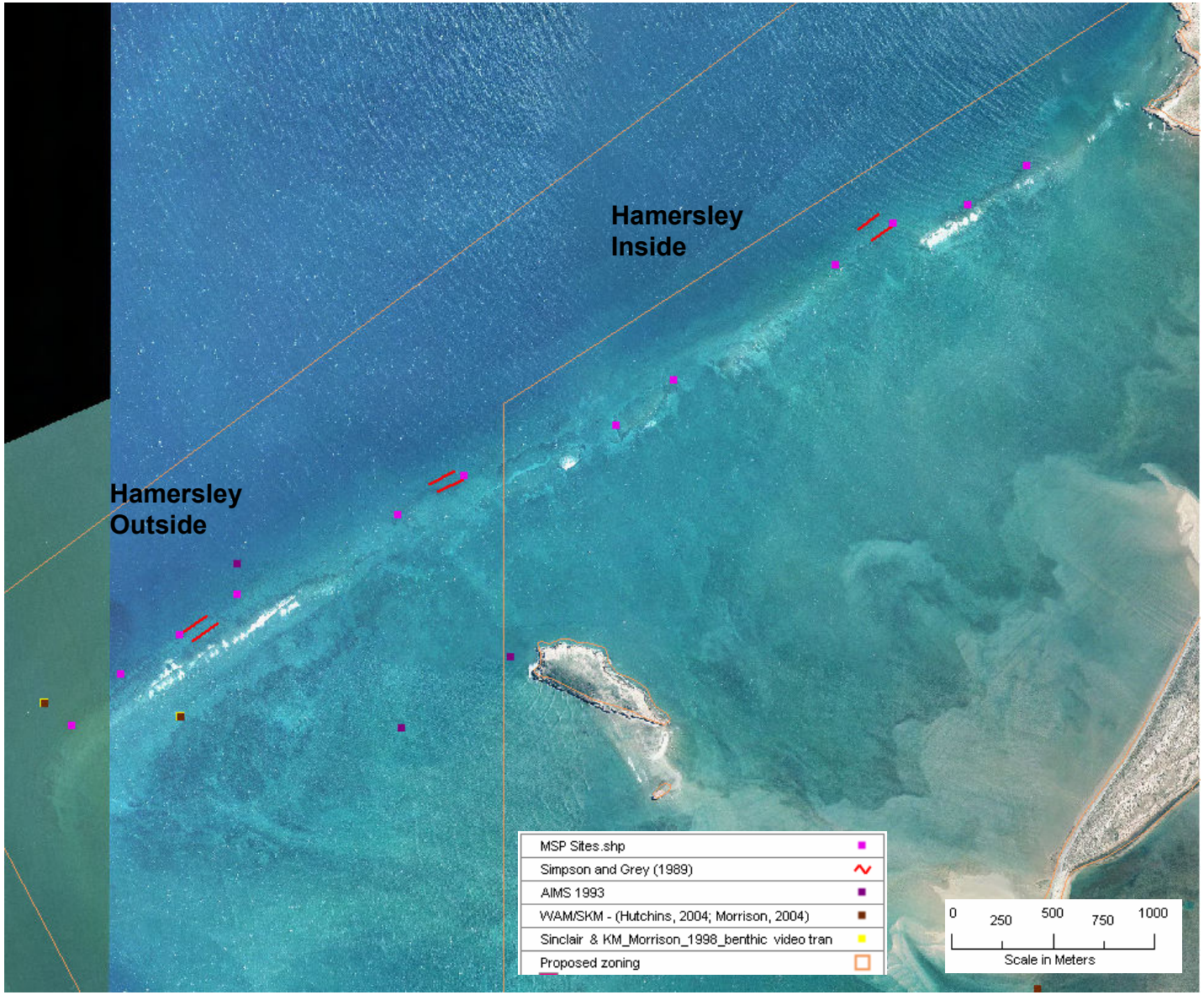
Table complied by Peter van Schoubroeck (MSP)

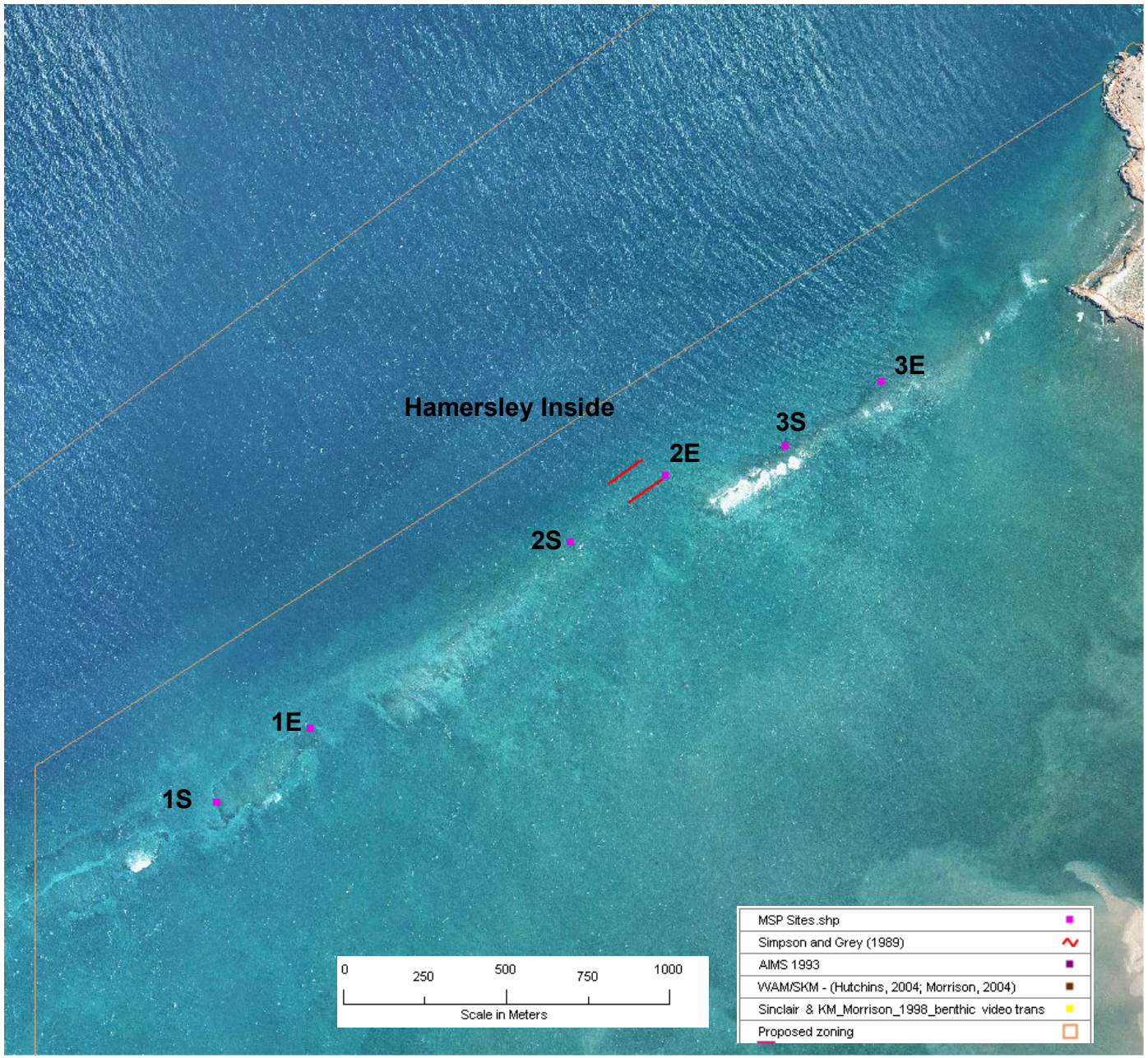
APPENDIX 2: STUDY SITE INFORMATION

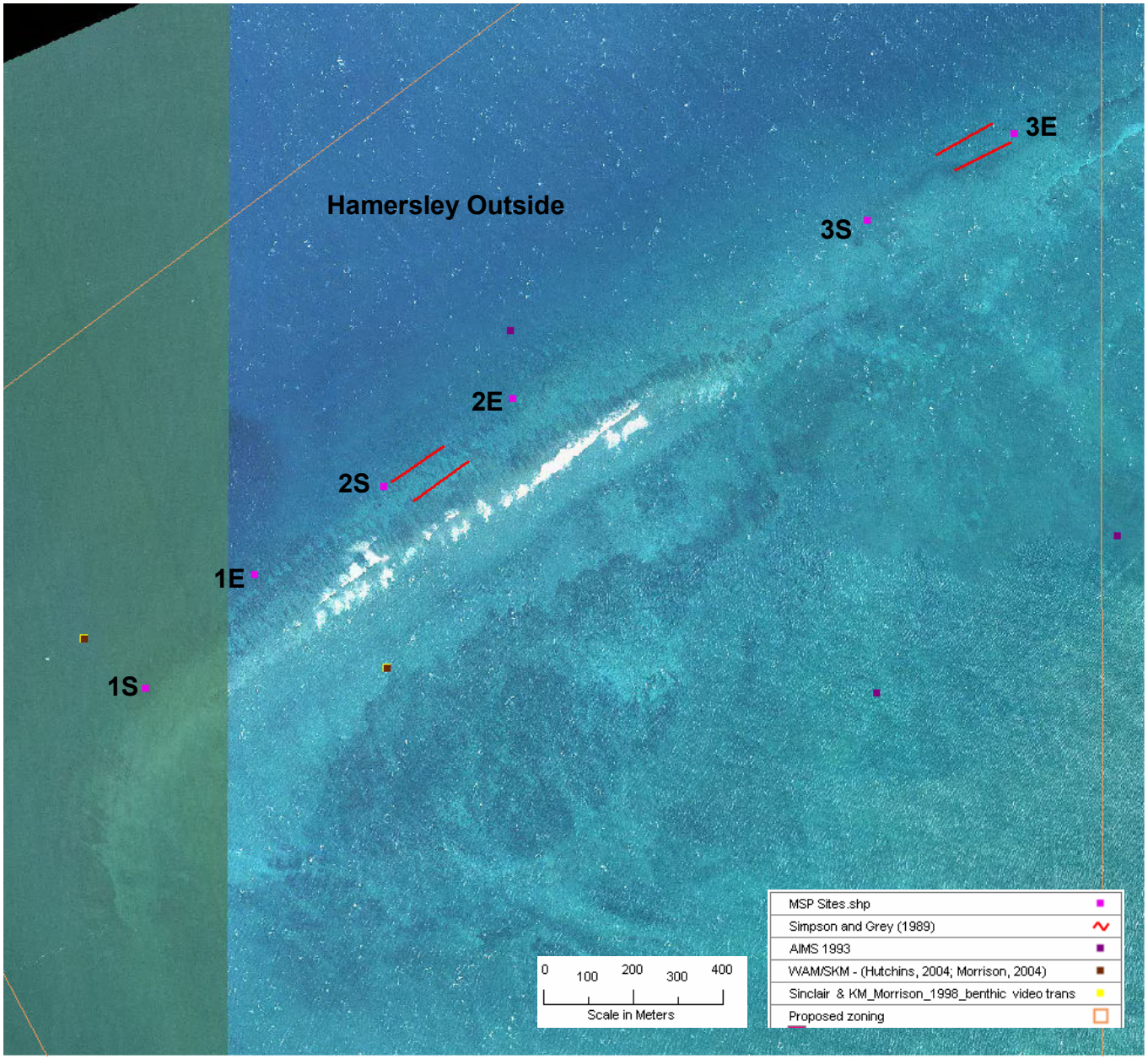
PRELIMINARY POSITIONS OF DEC DAMPA LONG-TERM MONITORING SITES

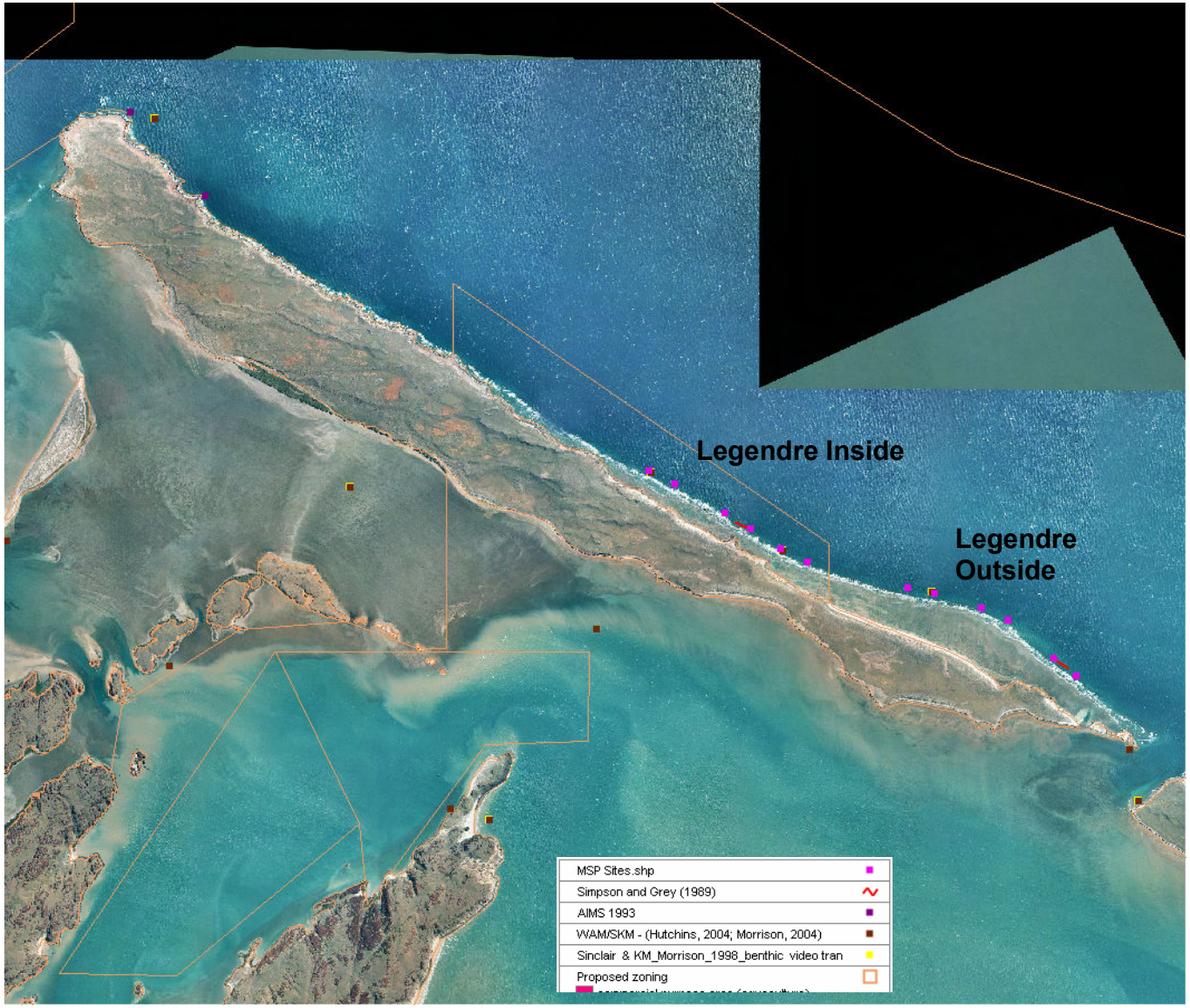
Preliminary GPS coordinates of our long-term monitoring sites. Coordinates are given for the start and end of each site. Between the start and end of each site we will establish and survey six 50 m transects. The following maps show the position of the start and end of each site.

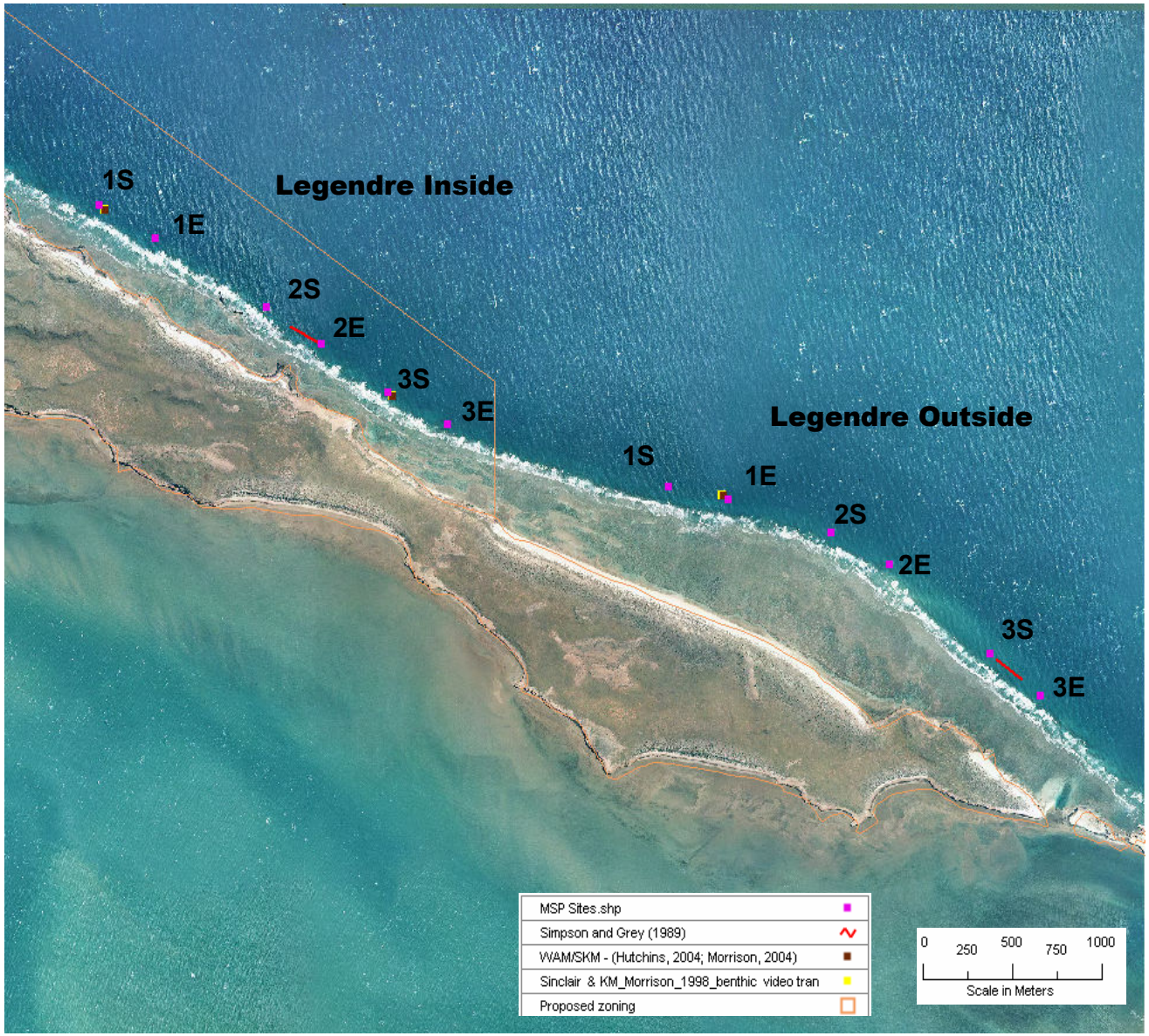
MSP Site	Longitude Decimal degress	Latitude Decimal degress	Longitude Deg/min/dec	Latitude Deg/min/dec
Hamersley Outside 1 start	116.7795	-20.3877	116˚46.770	20˚23.262
Hamersley Outside 1 end	116.7818	-20.3854	116˚46.908	20˚23.124
Hamersley Outside 2 start	116.7846	-20.3837	116˚47.076	20˚23.022
Hamersley Outside 2 end	116.7874	-20.3819	116˚47.244	20˚22.914
Hamersley Outside 3 start	116.795	-20.3783	116˚47.700	20˚22.698
Hamersley Outside 3 end	116.7981	-20.3765	116˚47.886	20˚22.590
Hamersley Inside 1 start	116.8053	-20.3743	116˚48.318	20˚22.458
Hamersley Inside 1 end	116.8081	-20.3723	116˚48.486	20˚22.338
Hamersley Inside 3 start	116.8221	-20.3645	116˚49.326	20˚21.870
Hamersley Inside 3 end	116.8249	-20.3627	116˚49.494	20˚21.762
Hamersley Inside 2 start	116.8158	-20.3671	116˚48.948	20˚22.026
Hamersley Inside 2 end	116.8185	-20.3653	116˚49.110	20˚21.918
Legendre Inside 2 end	116.9135	-20.3983	116˚54.810	20˚23.898
Legendre Inside 2 start	116.9105	-20.3965	116˚54.630	20˚23.790
Legendre Inside 1 end	116.9046	-20.3933	116˚54.276	20˚23.598
Legendre Inside 1 start	116.9015	-20.3918	116˚54.090	20˚23.508
Legendre Inside 3 start	116.9171	-20.4005	116˚55.026	20˚24.030
Legendre Inside 3 end	116.9203	-20.402	116˚55.218	20˚24.120
Legendre Outside 3 end	116.9522	-20.4147	116˚57.132	20˚24.882
Legendre Outsdie 3 start	116.9495	-20.4127	116˚56.970	20˚24.762
Legendre Outside 1 start	116.9322	-20.4049	116˚55.932	20˚24.294
Legendre Outside 1 end	116.9354	-20.4055	116˚56.124	20˚24.330
Legendre Outside 2 start	116.9409	-20.4071	116˚56.454	20˚24.426
Legendre Outside 2 end	116.9441	-20.4086	116˚56.646	20˚24.516
Delambre Inside 1 start	117.1048	-20.4367	117˚06.288	20˚26.202
Delambre Inside 1 end	117.1037	-20.4336	117˚06.222	20˚26.016
Delambre Inside 2 start	117.1023	-20.4323	117˚06.138	20˚25.938
Delambre Inside 2 end	117.0991	-20.4311	117˚05.946	20˚25.866
Delambre Inside 3 start	117.0966	-20.4308	117˚05.796	20˚25.848
Delambre Inside 3 end	117.0933	-20.4308	117˚05.598	20˚25.848
Delambre Outside 1 start	117.0558	-20.4397	117˚03.348	20˚26.382
Delambre Outside 1 end	117.0551	-20.4364	117˚03.306	20˚26.184
Delambre Outside 2 start	117.0591	-20.4337	117˚03.546	20˚26.022
Delambre Outside 2 end	117.062	-20.4335	117˚03.720	20˚26.010
Delambre Outside 3 start	117.0634	-20.4329	117˚03.804	20˚25.974
Delambre Outside 3 end	117.0668	-20.4323	117˚04.008	20˚25.938
Sailfish Nrth 3 start	116.5957	-20.4523	116˚35.742	20˚27.138
Sailfish Nrth 3 end	116.5989	-20.4519	116˚35.934	20˚27.114
Sailfish Nrth 1 start	116.5866	-20.457	116˚35.196	20˚27.420
Sailfish Nrt 1 end	116.5891	-20.4556	116˚35.346	20˚27.336
Sailfish Sth 3 end	116.5803	-20.4609	116˚34.818	20˚27.654
Sailfish Sth 3 start	116.5772	-20.4624	116˚34.632	20˚27.744
Sailfish Sth 1 end	116.5687	-20.4657	116˚34.122	20˚27.942
Sailfish Sth 1 start	116.5655	-20.4669	116˚33.930	20˚28.014
Sailfish Sth 2 start	116.5713	-20.4642	116˚34.278	20˚27.852
Sailfish Sth 2 end	116.5747	-20.4632	116˚34.482	20˚27.792
Sailfish Nrth 2 start	116.5914	-20.4541	116˚35.484	20˚27.246
Sailfish Nrth 2 end	116.5944	-20.4526	116˚35.664	20˚27.156
Kendrew 3 start	116.5362	-20.4755	116˚32.172	20˚28.530
Kendrew 2 end	116.535	-20.476	116˚32.100	20˚28.560
Kendrew 3 end	116.5398	-20.4761	116˚32.388	20˚28.566
Kendre 2 start	116.5332	-20.4787	116˚31.992	20˚28.722
Kendrew 1 end	116.5325	-20.4824	116˚31.950	20˚28.944
Kendrew 1 start	116.5295	-20.4842	116˚31.770	20˚29.052

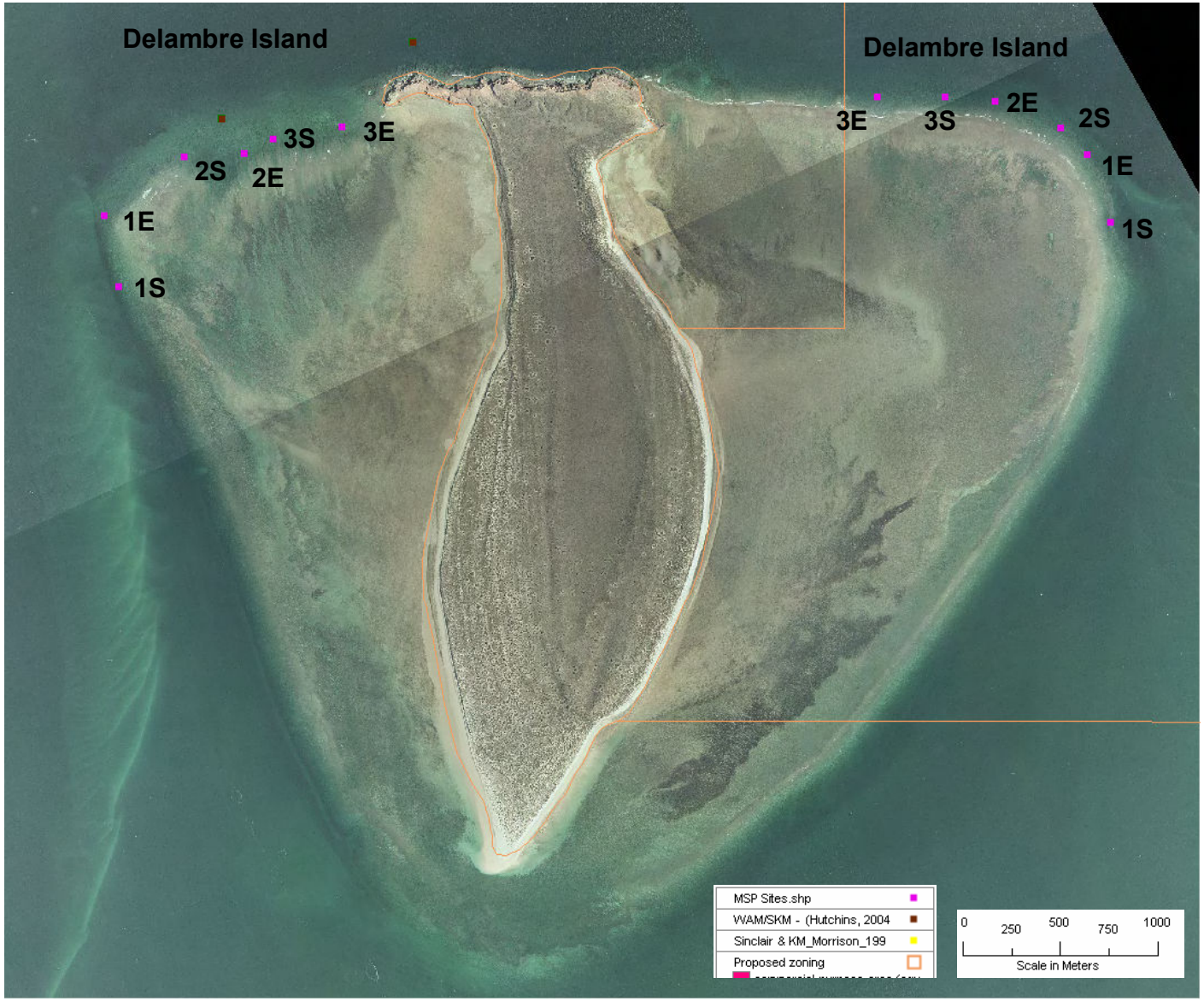

Hamersley
Inside
Hamersley
Outside
MSP Sites.shp
Simpson and Grey (1989)
AIMS 1993
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video tran
Proposed zoning
0
250
500
750
1000
Scale in Meters

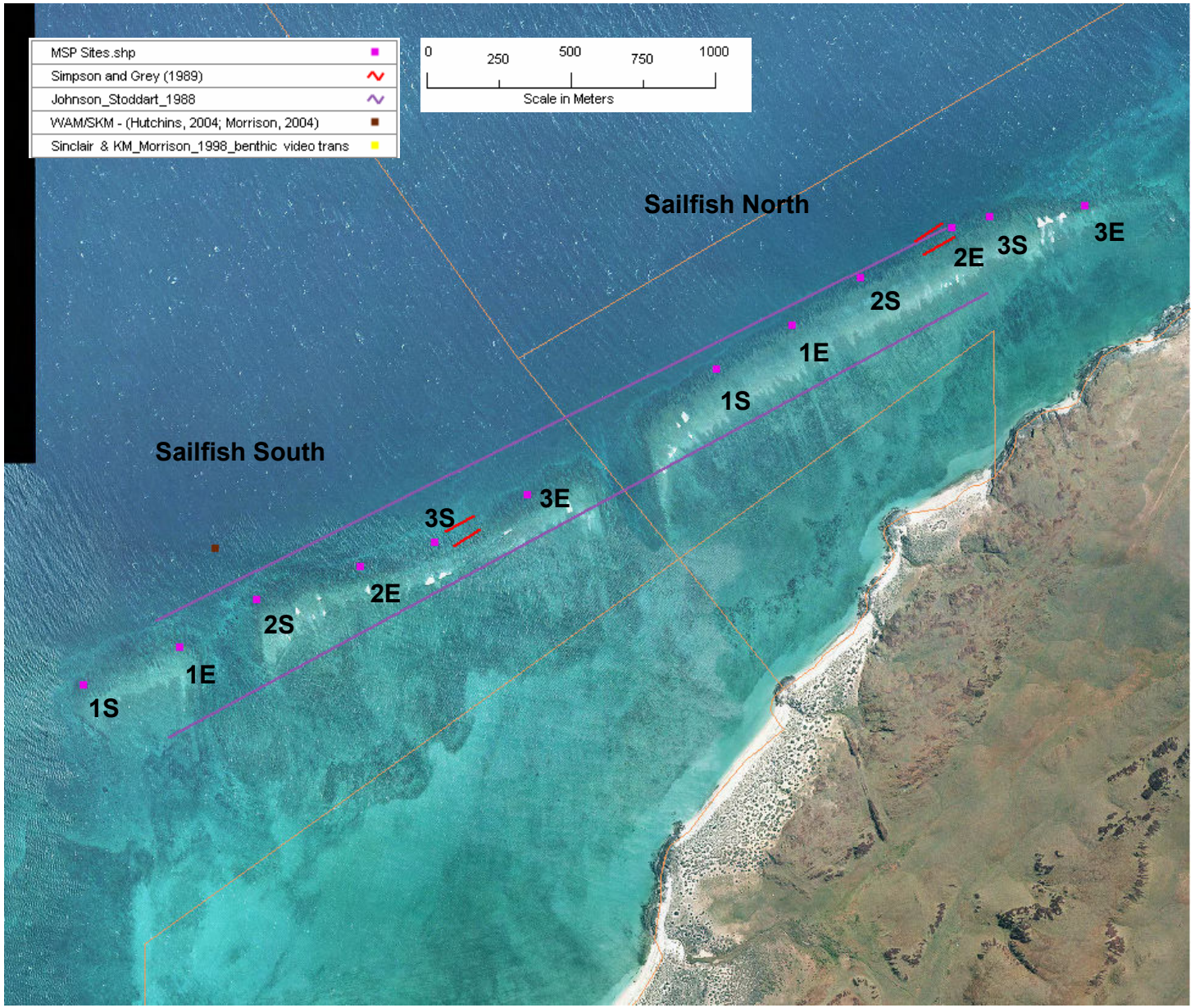

Hamersley Inside
3E
3S
2E
2S
1E
1S
0
250
500
750
1000
Scale in Meters
MSP Sites.shp
Simpson and Grey (1989)
AIMS 1993
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video trans
Proposed zoning

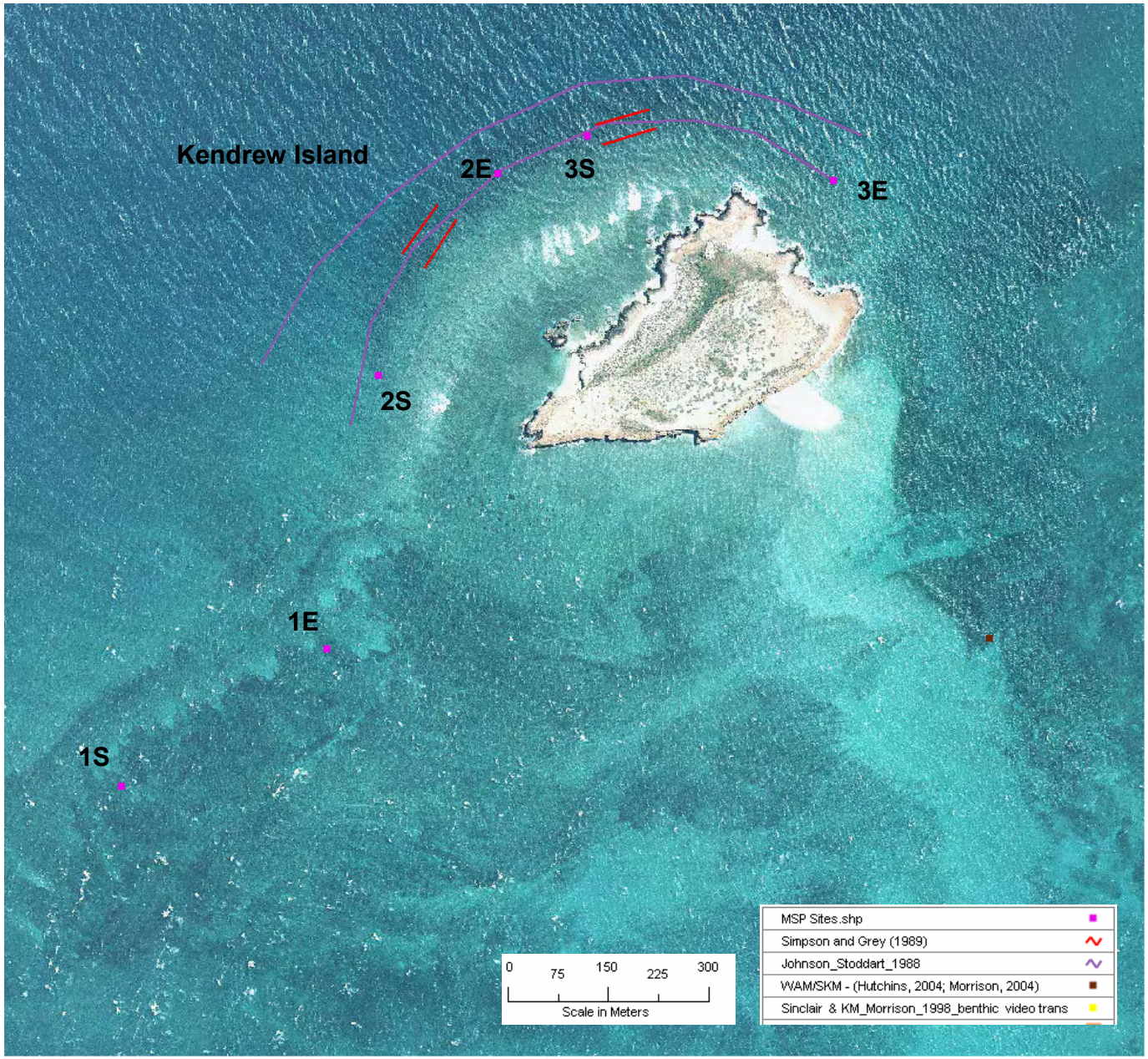

Hamersley Outside
3E
3S
2E
2S
1E
1S
0
100
200
300
400
Scale in Meters
MSP Sites.shp
Simpson and Grey (1989)
AIMS 1993
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video trans
Proposed zoning


Legendre Inside
Legendre Outside
MSP Sites.shp
Simpson and Grey (1989)
AIMS 1993
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video tran
Proposed zoning


1S
1E
Legendre Inside
2S
2E
3S
3E
Legendre Outside
1S
1E
2S
2E
3S
3E
MSP Sites.shp
Simpson and Grey (1989)
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video tran
Proposed zoning
0
250
500
750
1000
Scale in Meters


Delambre Island
Delambre Island
3E
3S
2E
2S
1E
1S
3E
3S
2E
2S
1E
1S
MSP Sites.shp
WAM/SKM - (Hutchins, 2004
Sinclair & KM_Morrison_199
Proposed zoning
0
250
500
750
1000
Scale in Meters


MSP Sites.shp
Simpson and Grey (1989)
Johnson_Stoddart_1988
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video trans
0
250
500
750
1000
Scale in Meters
Sailfish North
Sailfish South
1S
1E
2S
2E
3S
3E


Kendrew Island
2E
3S
3E
2S
1E
1S
0
75
150
225
300
Scale in Meters
MSP Sites.shp
Simpson and Grey (1989)
Johnson_Stoddart_1988
WAM/SKM - (Hutchins, 2004; Morrison, 2004)
Sinclair & KM_Morrison_1998_benthic video trans

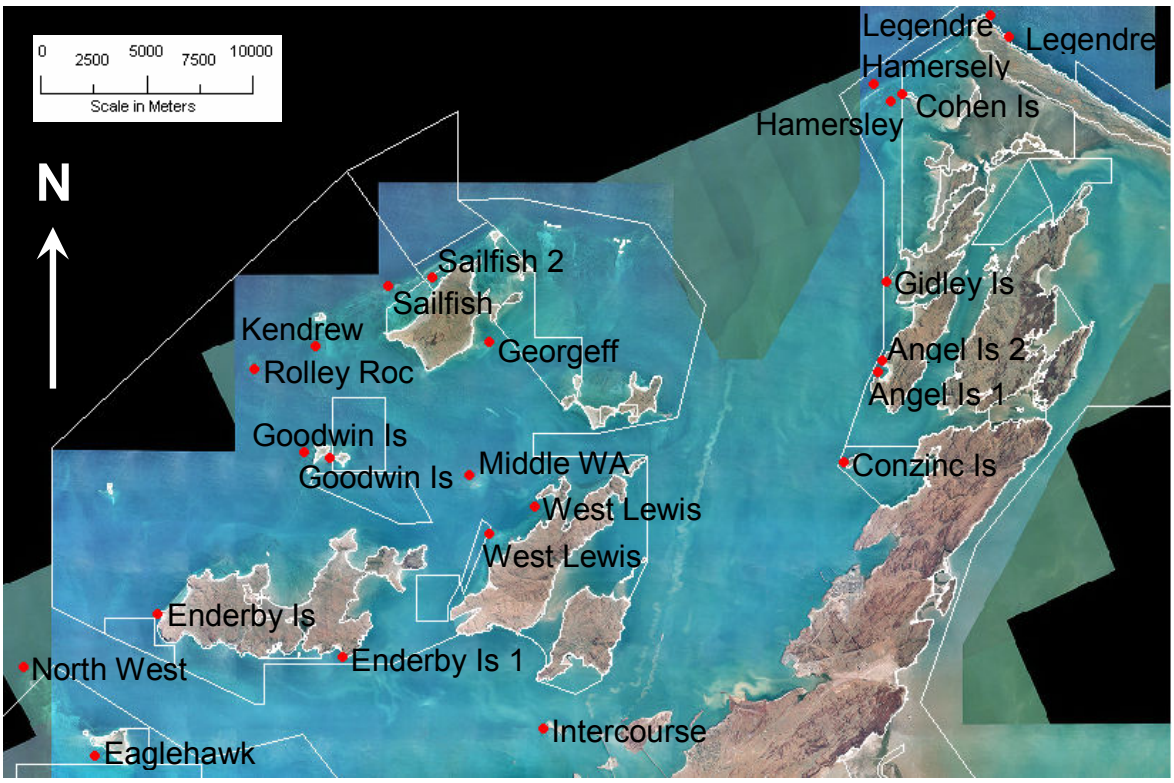
POSITIONS AND INFORMATION REGARDING HISTORICAL SURVEY SITES

Summary of historic Dampier Archipelago marine surveys. Note this is not a complete list of research that has been conducted in the Dampier Archipelago to date.

Agency	Who	Contact details	When	What	Method	Technical notes	Sites GPS availability	Why	Reports	Completed /Ongoing
Mscience	Dr David Blakeway	dave@mscience.net.au	2007	Coral monitoring			22 sites (GPS)	Monitoring for Industry	Personal correspondance of site locations	Ongoing
	Travis Hurley	travis_h@mscience.net.au	2004	Coral monitoring	Video transect - random point analysis	Permenantly marked 10 m transects, 5 per site. Video ~70 cm above betho, ~4 min per transect. Video analysis: 10 frames per transect selected at even intervals assessed at 50 random points per frame	19 sites (no GPS)	Monitoring for Industry	Stoddart J A, Blakeway D R, Grey K A and Stoddart S E 2004, Rapid high precision monitoring of coral communities to support reactive management of dredging in Mermaid Sound, Dampier, Western Australia, pp. 35-51. (In) Stoddart J A and S E Stoddart (Eds) 2005. Corals of the Dampier Harbour: Their Survival and Reproduction During the Dredging Programs of 2004. MScience Pty Ltd, Perth WA, 78pp.	Report completed
	Jim Stoddart	jim@mscience.net.au	2004	Coral monitoring			11 sites (GPS)	Monitoring for Industry	Hamersely Iron Pty. Ltd 2003, Dampier dredging project: coral monitoring and management plan, Hamersely Iron Pty. Ltd, Western Australia, p. 17.	Report completed
							9 sites (GPS)	Monitoring for Industry	Mscience 2003, Dampier Port Authority derdging project: benthic coral community monitoring baseline data report, Mscience, Perth, Western Australia, p. 28.	Report completed
							19 sites (no GPS)	Monitoring for Industry	Stoddart J A and S E Stoddart (Eds) 2005. Corals of the Dampier Harbour: Their Survival and Reproduction During the Dredging Programs of 2004. MScience Pty Ltd, Perth WA, 78pp.	Report completed
Environmnetal Protection Authority	Dr Chris Simpson	Chris.Simpson@dec.wa.gov.au	1985	Coral monitoring and Crown of Thorns	Line intercept dive transects	13 sites, 100 m transects at the 3 m and 7 m depth contours, coralsurvey transects 100x10 m (Loya 1978), COT surveys; 100x10 m transects divided into 8 x 125 m2 sections.	13 sites (maps available, GPS evaluated)	To determine Acanthaster planci abundance and live coral cover at selected sites in the Dampier Archipelago as baseline data for future reference	Simpson C J and Grey K A 1989, Survey of Crown-of-Thorns starfish and coral communities in the Dampier Archipelago, Western Australia, Environmental Protection Authority, Perth, Western Australia, p. 24.	Report completed
Western Australian Museum	Diana Jones	Diana.Jones@museum.wa.gov.au	1998-2002	Biodiversity survey	Video transect - random point analysis and biological survey	1998: 19 stations, no replicates. 1999: 26 stations, 3 replicates per station. 25 m transects (Carelton and Done 1995), recording speed of ~ 0.2 m/sec at 0.5 m from the substrate (swath width 0.6 m). Sinclair Kinght and Merz Video Transect Analysis System: 200 random frames per 25 m transect, one random dot per frame is indentified.	GPS all: 35 sites 1998, 35 sites 1999, plus additional sites from 2000	To document species diversity	Jones 2004, Report on the results of the Western Australralian Museum/Woodside Energy Ltd. Perteership to explore the marine biodiversity of the Dampier Archipelago, Western Australia, 1998-2002, Records of the Western Australian Museum Supplement No. 66, Western Australian Museum, Perth, Western Australia, p. 401.	Report completed

Summary of historic Dampier Archipelago marine surveys, continued.

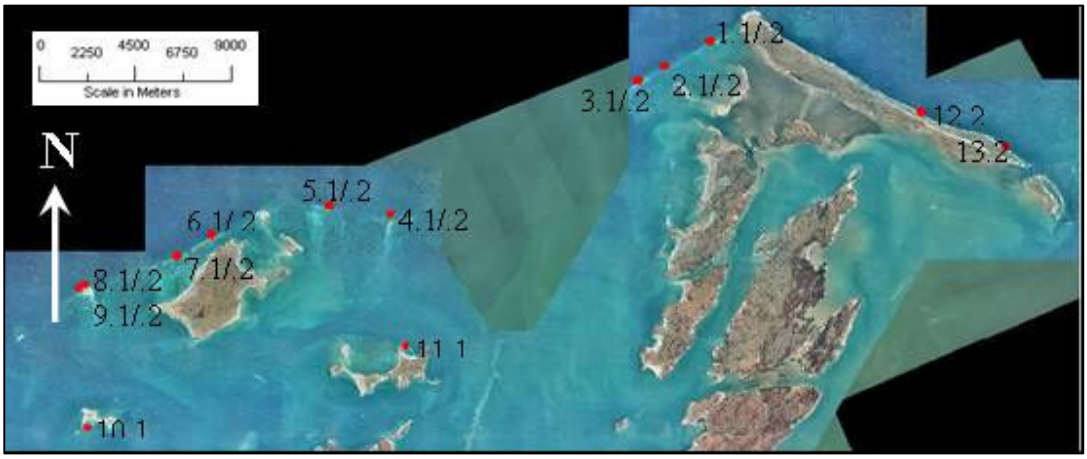
Agency	Who	Contact details	When	What	Method	Technical notes	Sites GPS availability	Why	Reports	Completed /Ongoing
Sinclair Knight and Merz	Dr Peter Morrison (surveyed with WA Museum - Jones 2004)	Pmorrison@skm.com.au	1998-99	Benthic habitats	Video transect - random point analysis	1998: 19 stations, no replicates. 1999: 26 stations, 3 replicates per station. 25 m transects (Carelton and Done 1995), recording speed of ~ 0.2 m/sec at 0.5 m from the substrate, swath width ~0.6 m. Sinclair Kinght and Merz Video Transect Analysis Sys	GPS all: 35 sites 1998, 35 sites 1999	To provide a descrition of the subtidal habitats of the Dampier Archipelago	Morrison 2004, A general description of the subtidal habitats of Dampier Archipelago, p. 51-59, (In Jones 2004), Report on the results of the Western Australralian Museum/Woodside Energy Ltd. Perteership to explore the marine biodiversity of the Dampier A	Report completed
Departmnet of Conservation and Land Management	Kevin Bancroft	Kevin.Bancroft@dec.wa.gov.au	1999-2000	Benthic habitats	Drop down video	Video lowered from side of survey vessel capturing 30 seconds of footage per drop	GPS all: 1999 84 sites, 2000 166 sites	To develop habitat maps and assess the biological context of the region	Bancroft et al. 2000, Developing a broadscale habitat map of the Montebello/Barrow Islands and the Dampier Archipelago/Cape Preston regions, Marine Conservation Branch, Department of Conservation and Land Management, Perth, Western Australia, p. 59.	Report completed
Australian Institute of Marine Science	Johnson and Stoddart 1988		1987	Crown of Thorns	Manta towa and subsequent dives	Qualitative survey of COT abundance and coral cover via manta tows at ~2 knots for ~2 min intervals. Dives at target sites for COT collection, measurement and samples taken	4 sites (maps available, GPS evaluated)	To collect COT samples for genetic and morphomentric analysis	Johnson and Stoddart 1988, Report on surveys of the distribution, abundance and impact of Acanthaster planci on reefs within the Dampier Archipelago (Western Australia) April 1987, Townsville, Queensland, p. 15.	Report completed
Dampier Port Authority, Woodside, Pilbara Iron, Mermaid Marine (Mscience)	Peter Smith (DPA), David Gordon (Woodside)	Peter.Smith@dpa.wa.gov.au DAVID.GORDON@woodside.com.au	2003 - present	Benthic habitats	Multiple	Report of use of Mscience monitoring locations in Dampier Archipelago	Multiple (Maps available, GPS re: Mscience)	Monitoring and surveys in response to industrial activity	Mscience 2007, Dampier Port Authority Environmental Monitoring GIS, Mscience Pty. Ltd, Perth, Western Australia, p. 32.	Ongoing
Australian Institute of Marine Science	Felicity McAllister	f.mcallister@aims.gov.au	1993	Fish and coral survey	Quantitative		24 sites (GPS supplied)		No report produced (raw data sourced)	
ROBE (Rio Tinto)				Water quality and coral monitoring	Video transects	Video transect benthic habitat analysis by Sinclair Knight and Merz	10 sites (GPS supplied)	Monitoring and surveys in response to industrial activity	Pending	Ongoing



Positions of the AIMS sites established in 1993. Benthic video transects and UVC fish surveys were undertaken along five 50 m transects at each site.

GPS coordinates of the AIMS 1993 sites.

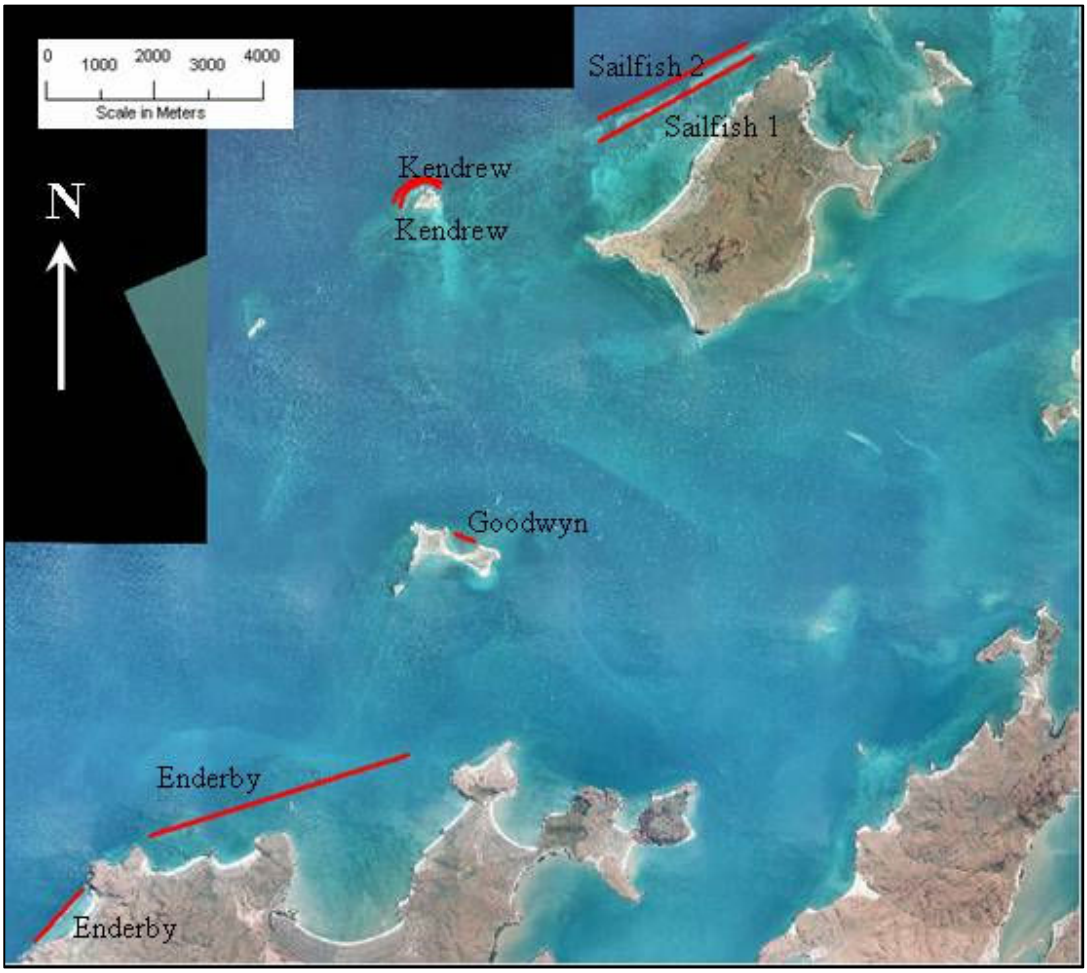
Site Name	Longitude (dec deg)	Latitude (dec deg)	Longitude (deg/min/dec)	Latitude (deg/min/dec)
Angel Is 1	116.7895	-20.5025	116°47.37	-20°30.15
Angel Is 2	116.791	-20.497166	116°47.46	-20°29.82996
Cohen Is	116.800333	-20.384666	116°48.01998	-20°23.07996
Conzinc Is	116.773666	-20.540333	116°46.41996	-20°32.41998
Eaglehawk	116.435833	-20.663333	116°26.14998	-20°39.79998
Enderby Is 1	116.547333	-20.622166	116°32.83998	-20°37.32996
Enderby Is 2	116.4645	-20.603833	116°27.87	-20°36.22998
Georgeff	116.614166	-20.489333	116°36.84996	-20°29.35998
Gidley Is	116.793333	-20.464166	116°47.59998	-20°27.84996
Goodwin Is 1	116.5305	-20.535333	116°31.83	-20°32.11998
Goodwin Is 2	116.542	-20.538166	116°32.52	-20°32.28996
Hammersley 1	116.787333	-20.3805	116°47.23998	-20°22.83
Hammersley 2	116.795166	-20.387833	116°47.70996	-20°23.26998
Intercourse	116.638	-20.652833	116°38.28	-20°39.16998
Kendrew Is	116.536	-20.491	116°32.16	-20°29.46
Legendre 1	116.84	-20.351666	116°50.4	-20°21.09996
Legendre 2	116.848833	-20.361	116°50.92998	-20°21.66
Middle WA	116.605	-20.545166	116°36.3	-20°32.70996
North West	116.403833	-20.626166	116°24.22998	-20°37.56996
Rolley Roc	116.508166	-20.5005	116°30.48996	-20°30.03
Sailfish 1	116.568833	-20.465666	116°34.12998	-20°27.93996
Sailfish 2	116.588333	-20.462166	116°35.29998	-20°27.72996
WestLewis 1	116.613833	-20.570333	116°36.82998	-20°34.21998
WestLewis 2	116.634333	-20.5585	116°38.05998	-20°33.51



Positions of the Simpson & Grey (1989) sites established in 1985 for the Environmental Protection Authority.

GPS coordinates of the Simpson & Grey (1989) sites.

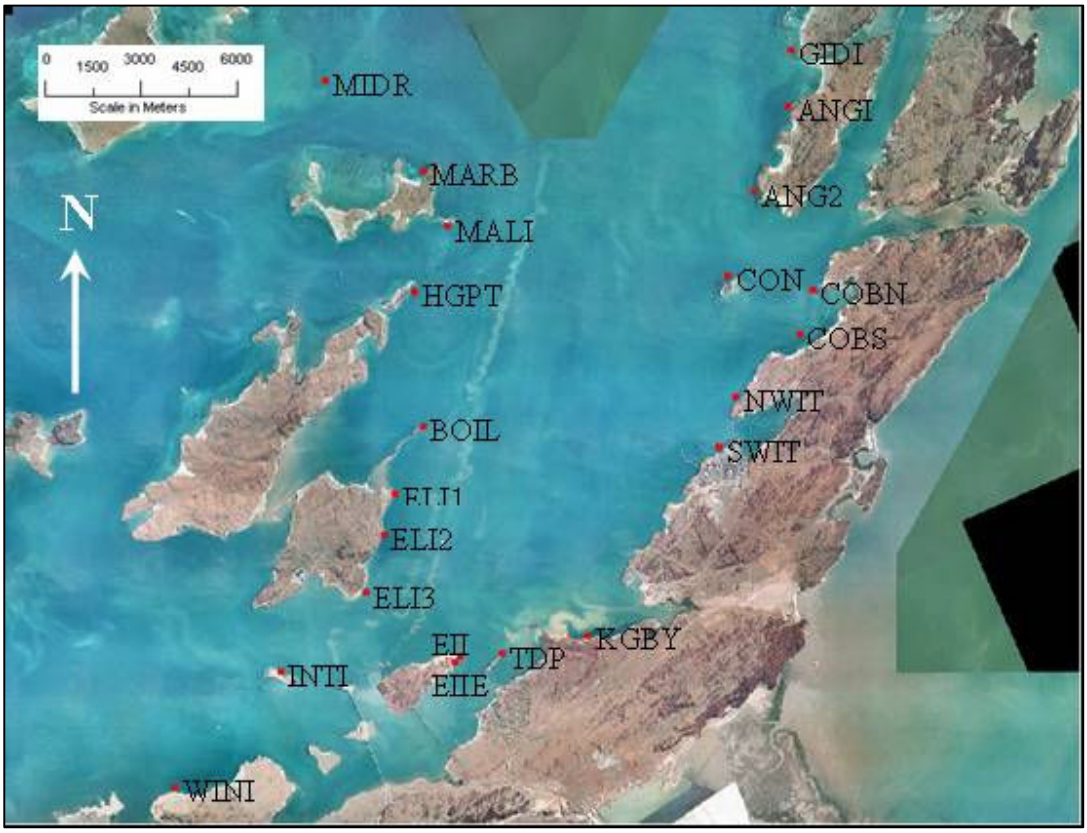
Transect location	Transect length	Start (western most) point		Finish (eastern most) point		Start (western most) point		Finish (eastern most) point	
		Longitude (dec deg)	Latitude (dec deg)	Longitude (dec deg)	Latitude (dec deg)	Longitude (deg/min/dec)	Latitude (deg/min/dec)	Longitude (deg/min/dec)	Latitude (deg/min/dec)
Goodwyn Island - transect 10.1	~100 m	116.5374	-20.53995	116.53835	-20.53995	116˚32.244	20˚32.397	20˚32.397	116˚32.301
Hamersley Shoal - transect 1.1	~125 m	116.81475	-20.36600	116.81845	-20.36540	116˚48.885	20˚21.960	20˚21.924	116˚49.107
Hamersley Shoal - transect 1.2	~130 m	116.81685	-20.36550	116.81785	-20.36480	116˚49.011	20˚21.930	20˚21.888	116˚49.071
Hamersley Shoal - transect 2.1	~140 m	116.79685	-20.37725	116.79805	-20.37670	116˚47.811	20˚22.635	20˚22.602	116˚47.883
Hamersley Shoal - transect 2.2	~140 m	116.79645	-20.37693	116.79765	-20.37630	116˚47.787	20˚22.616	20˚22.578	116˚47.859
Hamersley Shoal - transect 3.1	~155 m	116.78523	-20.38393	116.78642	-20.38312	116˚47.114	20˚23.036	20˚22.987	116˚47.185
Hamersley Shoal - transect 3.2	~145 m	116.78475	-20.38355	116.7859	-20.38280	116˚47.085	20˚23.013	20˚22.968	116˚47.154
Kendrew Island - transect 8.1	~85 m	116.53645	-20.47560	116.5372	-20.47535	116˚32.187	20˚28.536	20˚28.521	116˚32.232
Kendrew Island - transect 8.2	~85 m	116.53635	-20.47530	116.53712	-20.47510	116˚32.181	20˚28.518	20˚28.506	116˚32.227
Kendrew Island - transect 9.1	~85 m	116.5339	-20.47723	116.53435	-20.47660	116˚32.034	20˚28.634	20˚28.596	116˚32.061
Kendrew Island - transect 9.2	~90 m	116.53357	-20.47705	116.53408	-20.47638	116˚32.014	20˚28.623	20˚28.583	116˚32.045
Legendre Island - transect 12.2	~185 m	116.91177	-20.39745	116.91338	-20.39820	116˚54.706	20˚23.847	20˚23.892	116˚54.803
Legendre Island - transect 13.2	~180 m	116.9498	-20.41295	116.95123	-20.41390	116˚56.988	20˚24.777	20˚24.834	116˚57.074
Malus Island - transect 11.1	~100 m	116.6807	-20.50283	116.6809	-20.50375	116˚40.842	20˚30.170	20˚30.225	116˚40.854
Miller Rocks - transect 5.1	~100 m	116.64633	-20.44000	116.6473	-20.44000	116˚38.780	20˚26.400	20˚26.400	116˚38.838
Miller Rocks - transect 5.2	~100 m	116.6463	-20.43965	116.64725	-20.43965	116˚38.778	20˚26.379	20˚26.379	116˚38.835
Nelson Rocks - transect 4.1	~100 m	116.67368	-20.44415	116.67448	-20.44373	116˚40.421	20˚26.649	20˚26.624	116˚40.469
Nelson Rocks - transect 4.2	~90 m	116.67355	-20.44380	116.67427	-20.44340	116˚40.413	20˚26.628	20˚26.604	116˚40.456
Sailfish Reef - transect 6.1	~125 m	116.59345	-20.45345	116.5945	-20.45288	116˚35.607	20˚27.207	20˚27.173	116˚35.670
Sailfish Reef - transect 6.2	~120 m	116.59315	-20.45300	116.59412	-20.45245	116˚35.589	20˚27.180	20˚27.147	116˚35.647
Sailfish Reef - transect 7.1	~115 m	116.5778	-20.46255	116.5787	-20.46200	116˚34.668	20˚27.753	20˚27.720	116˚34.722
Sailfish Reef - transect 7.2	~115 m	116.5775	-20.46210	116.5785	-20.46160	116˚34.650	20˚27.726	20˚27.696	116˚34.710



Positions of the Johnson and Stoddart (1988) transect sites established during a survey undertaken by AIMS in 1987.

GPS coordinates of the Johnson and Stoddart (1988) transect sites.

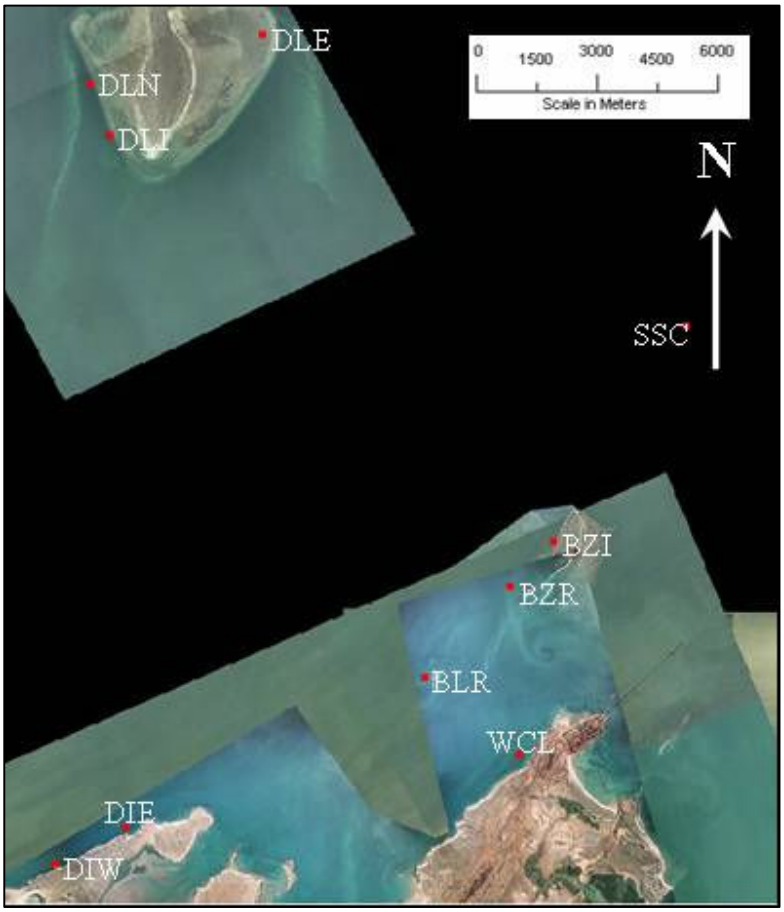
Transect location	Transect length	Start (western most) point		Finish (eastern most) point		Start (western most) point		Finish (eastern most) point	
		Longitude (dec deg)	Latitude (dec deg)	Longitude (dec deg)	Latitude (dec deg)	Longitude (deg/min/dec)	Latitude (deg/min/dec)	Longitude (deg/min/dec)	Latitude (deg/min/dec)
Goodwyn north	0.36 km	116.54253	-20.53342	116.54582	-20.53445	116˚32.5518	20˚32.0052	116˚32.7492	20˚32.067
Sailfish 1	~3 km	116.56828	-20.46854	116.59559	-20.45465	116˚34.0968	20˚28.1124	116˚35.7354	20˚27.279
Sailfish 2	~3 km	116.5679	-20.46484	116.59422	-20.45261	116˚34.074	20˚27.8904	116˚35.6532	20˚27.1566
Enderby west	1.3 km	116.4679	-20.60025	116.47605	-20.59175	116˚28.074	20˚36.015	116˚28.563	20˚35.505
Enderby north	5 km	116.4881	-20.58275	116.53395	-20.56967	116˚29.286	20˚34.965	116˚32.037	20˚34.1802
Kendrew north 1	~1 km	116.53284	-20.47936	116.53979	-20.47608	116˚31.9704	20˚28.7616	116˚32.3874	20˚28.5648
Kendrew north 2	~1 km	116.53155	-20.4785	116.54018	-20.47547	116˚31.893	20˚28.71	116˚32.4108	20˚28.5282



Position of the MScience sites.

GPS coordinates of the MScience sites.

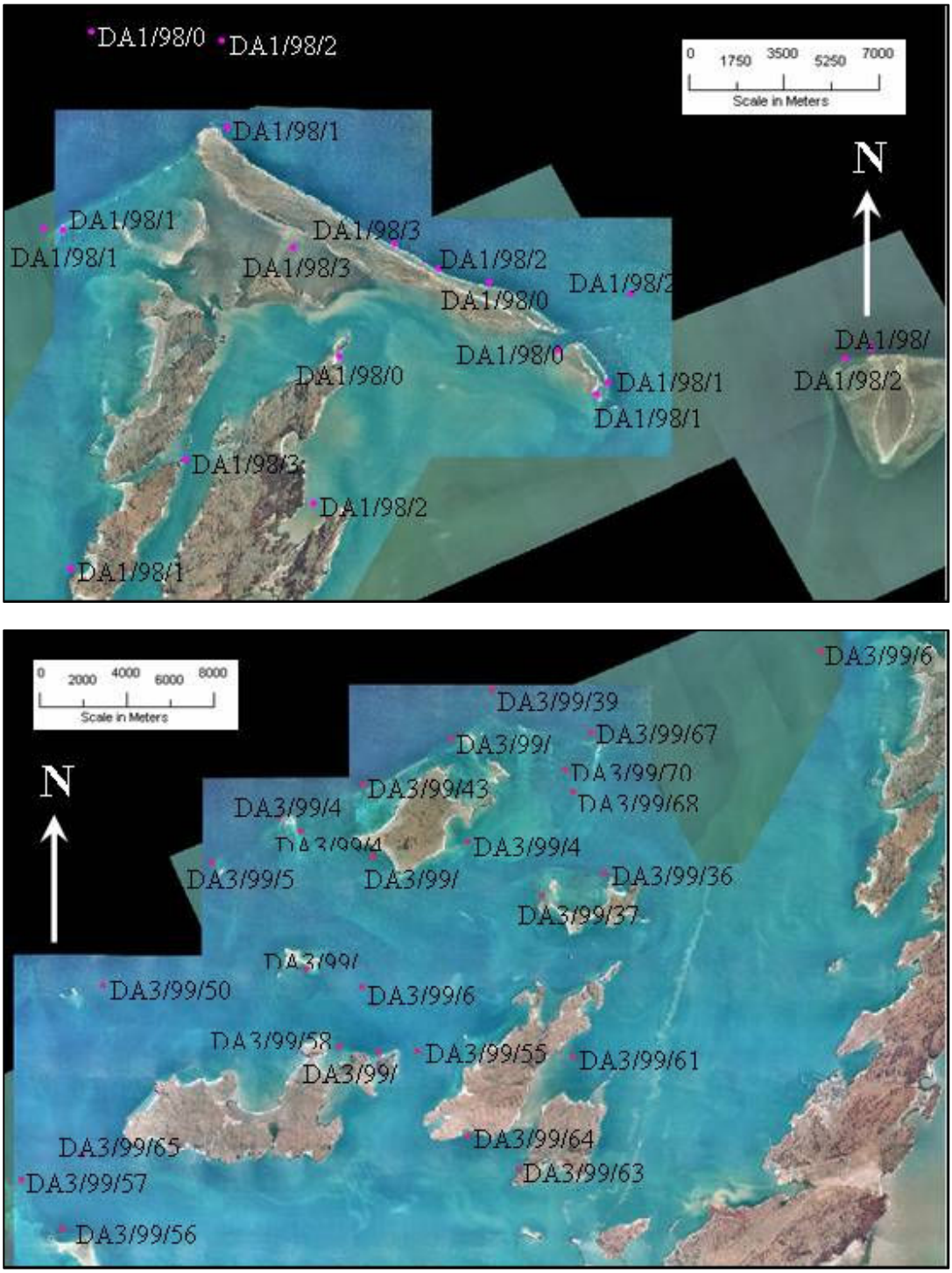
ID	Latitude	Longitude	Latitude	Longitude
ANG2	S20°30.7110'	E116°47.1274'	-20.51185000	116.78545670
ANGI	S20°29.2409'	E116°47.7508'	-20.48734833	116.79584667
BOIL	S20°34.7834'	E116°41.2229'	-20.57972333	116.68704833
COBN	S20°32.4174'	E116°48.1927'	-20.54029000	116.80321167
COBS	S20°33.1874'	E116°47.9415'	-20.55312333	116.79902500
CONI	S20°32.1743'	E116°46.6684'	-20.53623833	116.77780667
EII	S20°38.7617'	E116°41.8611'	-20.64602833	116.69768500
EIIE	S20°38.8613'	E116°41.7698'	-20.64768833	116.69616333
ELI1	S20°35.9525'	E116°40.6948'	-20.59920833	116.67824667
ELI2	S20°36.6547'	E116°40.5091'	-20.61091167	116.67515167
ELI3	S20°37.6451'	E116°40.1666'	-20.62741833	116.66944333
GIDI	S20°28.2617'	E116°47.7935'	-20.47102833	116.79655833
HGPT	S20°32.4605'	E116°41.0458'	-20.54100833	116.68409667
INTI	S20°39.0062'	E116°38.6362'	-20.65010333	116.64393667
KGBY	S20°38.4002'	E116°44.1321'	-20.64000333	116.73553500
MALI	S20°31.3100'	E116°41.6351'	-20.52183333	116.69391833
MARB	S20°30.3580'	E116°41.2150'	-20.50596667	116.68691667
MIDR	S20°28.7857'	E116°39.4605'	-20.47976167	116.65767500
NWIT	S20°34.2813'	E116°46.7926'	-20.57135500	116.77987667
SWIT	S20°35.1370'	E116°46.4861'	-20.58561667	116.77476833
TDPL	S20°38.7214'	E116°42.6087'	-20.64535667	116.71014500
WINI	S20°41.0268'	E116°36.7332'	-20.68378000	116.61222000



Position of the ROBE (Rio Tinto) sites.

GPS coordinates of the ROBE (Rio Tinto) sites.

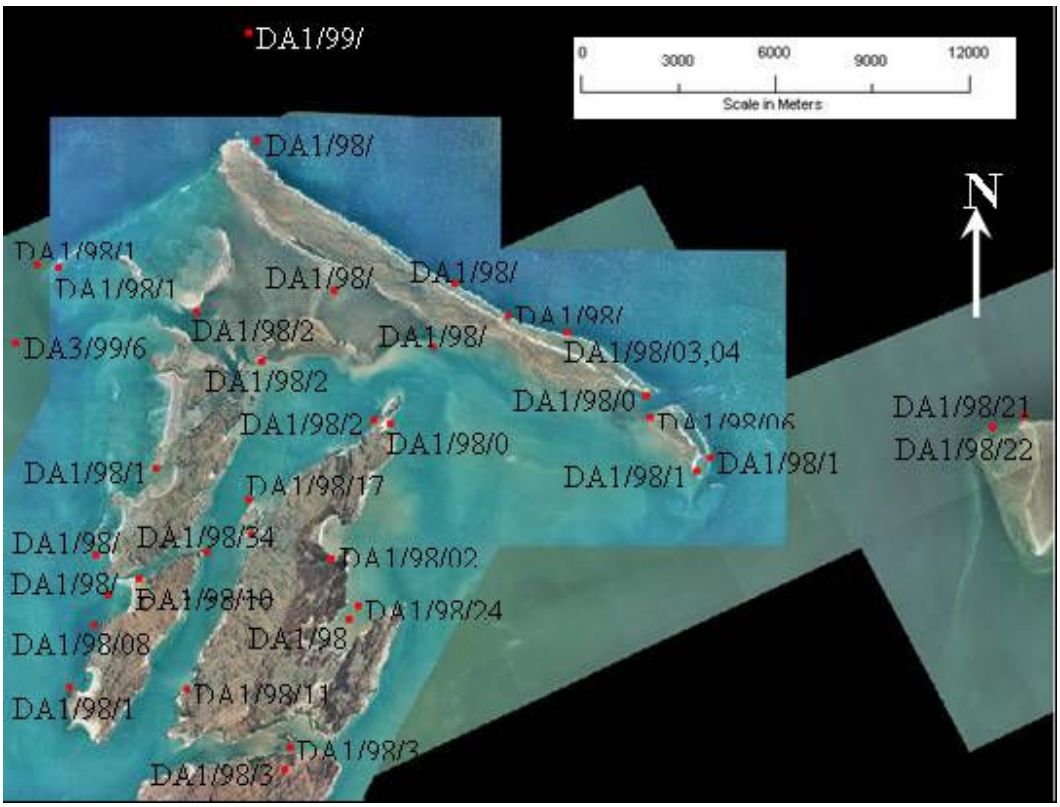
Site Name	Longitude (dec deg)	Latitude (dec deg)	Longitude (deg/min/dec)	Latitude (deg/min/dec)
BZI	117.17185	-20.55355	117°10.311'E	20°33.213'S
BZR	117.1613667	-20.56371667	117°09.682'E	20°33.823'S
BLR	117.1409333	-20.5842	117°08.456'E	20°35.052'S
WCL	117.1634167	-20.60168333	117°09.805'E	20°36.101'S
DIE	117.06905	-20.61806667	117°04.143'E	20°37.084'S
DIW	117.0523167	-20.62623333	117°03.139'E	20°37.574'S
DLI	117.0652667	-20.46226667	117°03.916'E	20°27.736'S
DLN	117.0608167	-20.45065	117°03.649'E	20°27.039'S
DLE	117.1018	-20.43935	117°06.108'E	20°26.361'S
SSC	117.2034167	-20.50508333	117°12.205'E	20°30.305'S



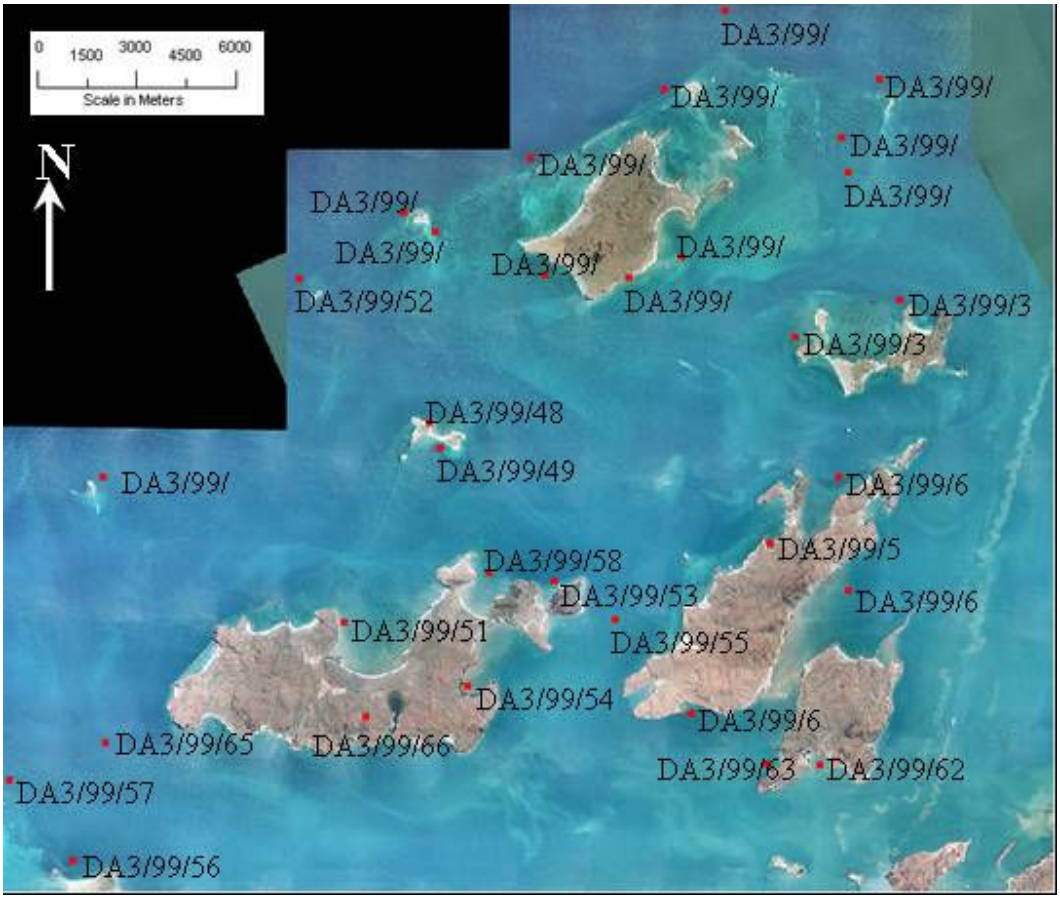
Positions of the Sinclair Knight and Merz (SKM) sites surveyed in 1998 (top map) and 1999 (bottom map). This survey was lead by Dr Peter Morrison and undertaken in conjunction with the Western Australian Museum.

GPS coordinates of the SKM 1998 and 1999 sites.

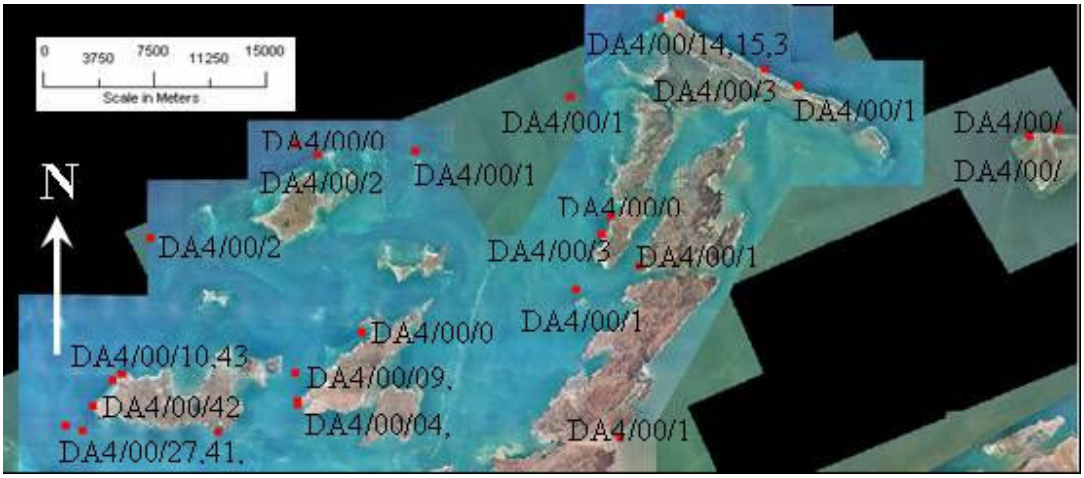
Site Name	Longitude (dec deg)	Latitude (dec deg)	Longitude (deg/min/dec)	Latitude (deg/min/dec)
DA1/98/01	116.88255	-20.430867	E116˚52.953	S20˚25.852
DA1/98/03	116.935133	-20.405333	E116˚56.108	S20˚24.320
DA1/98/06	116.959667	-20.42875	E116˚57.580	S20˚25.725
DA1/98/08	116.795183	-20.319667	E116˚47.711	S20˚29.180
DA1/98/12	116.787483	-20.503333	E116˚47.249	S20˚30.200
DA1/98/13	116.778183	-20.386717	E116˚46.691	S20˚23.203
DA1/98/15	116.842983	-20.352367	E116˚50.579	S20˚21.142
DA1/98/16	116.784667	-20.387333	E116˚47.080	S20˚23.240
DA1/98/18	116.977233	-20.44	E116˚58.634	S20˚26.400
DA1/98/19	116.973167	-20.443667	E116˚58.390	S20˚26.620
DA1/98/21	117.070333	-20.428333	E117˚04.220	S20˚25.700
DA1/98/22	117.060917	-20.431917	E117˚03.655	S20˚25.915
DA1/98/24	116.873	-20.481167	E116˚52.380	S20˚28.870
DA1/98/26	116.840917	-20.322383	E116˚50.455	S20˚19.343
DA1/98/27	116.91735	-20.400733	E116˚55.041	S20˚24.044
DA1/98/29	116.985233	-20.409433	E116˚53.714	S20˚24.566
DA1/98/32	116.901833	-20.392	E116˚54.110	S20˚23.520
DA1/98/33	116.8282	-20.466083	E116˚49.692	S20˚27.965
DA1/98/35	116.866	-20.393667	E116˚51.960	S20˚23.620
DA3/99/36	116.676317	-20.500933	E116˚40.579	S20˚30.056
DA3/99/37	116.648633	-20.5102	E116˚38.918	S20˚30.612
DA3/99/39	116.626883	-20.4235167	E116˚37.613	S20˚25.411
DA3/99/40	116.6087	-20.4441333	E116˚36.522	S20˚26.648
DA3/99/41	116.616233	-20.4873833	E116˚36.974	S20˚29.243
DA3/99/43	116.569867	-20.4635666	E116˚34.192	S20˚27.814
DA3/99/44	116.5741	-20.4931666	E116˚34.446	S20˚29.590
DA3/99/46	116.533183	-20.4772333	E116˚31.991	S20˚28.634
DA3/99/47	116.542483	-20.4827833	E116˚32.549	S20˚28.967
DA3/99/49	116.544717	-20.54055	E116˚32.683	S20˚32.433
DA3/99/50	116.455083	-20.5474833	E116˚26.705	S20˚32.849
DA3/99/52	116.503067	-20.4956833	E116˚30.184	S20˚29.741
DA3/99/53	116.576233	-20.575466	E116˚34.574	S20˚34.528
DA3/99/55	116.593667	-20.5751833	E116˚35.620	S20˚35.111
DA3/99/56	116.436967	-20.6489833	E116˚26.218	S20˚38.939
DA3/99/57	116.418817	-20.62845	E116˚25.129	S20˚37.707
DA3/99/58	116.5593	-20.5731	E116˚33.558	S20˚34.386
DA3/99/60	116.56905	-20.5482333	E116˚39.513	S20˚32.894
DA3/99/61	116.662017	-20.5775833	E116˚39.721	S20˚34.655
DA3/99/63	116.638133	-20.6245667	E116˚38.288	S20˚37.474
DA3/99/64	116.615717	-20.6109833	E116˚36.943	S20˚36.659
DA3/99/65	116.445333	-20.6182667	E116˚26.720	S20˚37.096
DA3/99/67	116.670417	-20.44175	E116˚40.225	S20˚26.505
DA3/99/68	116.662217	-20.4663167	E116˚39.733	S20˚27.979
DA3/99/69	116.771633	-20.4077667	E116˚46.298	S20˚24.466
DA3/99/70	116.659567	-20.4574667	E116˚39.574	S20˚27.448



Position of the Western Australian Museum sites surveyed in 1998.



Position of the Western Australian Museum sites surveyed in 1999.



Position of the Western Australian Museum sites surveyed in 2000.

GPS coordinates of the Western Australian Museum sites.

Site	Latitude	Longitude	Latitude	Longitude
DA1/98/01	20˚25.852	116˚52.953	-20.43087	116.88255
DA1/98/02	20˚28.090	116˚51.910	-20.46817	116.86517
DA1/98/03	20˚24.320	116˚56.108	-20.40533	116.93513
DA1/98/04	20˚24.320	116˚56.108	-20.40533	116.93513
DA1/98/05	20˚25.380	116˚57.510	-20.42300	116.95850
DA1/98/06	20˚25.725	116˚57.580	-20.42875	116.95967
DA1/98/07	20˚28.010	116˚47.720	-20.46683	116.79533
DA1/98/08	20˚29.180	116˚47.711	-20.48633	116.79518
DA1/98/09	20˚28.692	116˚47.950	-20.47820	116.79917
DA1/98/10	20˚28.410	116˚48.480	-20.47350	116.80800
DA1/98/11	20˚30.249	116˚49.335	-20.50415	116.82225
DA1/98/12	20˚30.200	116˚47.250	-20.50333	116.78750
DA1/98/13	20˚23.203	116˚46.691	-20.38672	116.77818
DA1/98/14	20˚26.581	116˚48.790	-20.44302	116.81317
DA1/98/15	20˚21.142	116˚50.579	-20.35237	116.84298
DA1/98/16	20˚23.240	116˚47.080	-20.38733	116.78467
DA1/98/17	20˚27.090	116˚50.438	-20.45150	116.84063
DA1/98/18	20˚26.400	116˚58.634	-20.44000	116.97723
DA1/98/19	20˚26.620	116˚58.390	-20.44367	116.97317
DA1/98/20	20˚24.812	116˚50.678	-20.41353	116.84463
DA1/98/21	20˚25.700	117˚04.220	-20.42833	117.07033
DA1/98/22	20˚25.915	117˚03.655	-20.43192	117.06092
DA1/98/23	20˚29.100	116˚52.220	-20.48500	116.87033
DA1/98/24	20˚28.870	116˚52.380	-20.48117	116.87300
DA1/98/25	20˚23.975	116˚49.520	-20.39958	116.82533
DA1/98/26	20˚19.343	116˚50.455	-20.32238	116.84092
DA1/98/27	20˚24.044	116˚55.042	-20.40073	116.91737
DA1/98/28	20˚25.771	116˚52.680	-20.42952	116.87800
DA1/98/29	20˚24.566	116˚53.714	-20.40943	116.89523
DA1/98/30	20˚31.586	116˚51.088	-20.52643	116.85147
DA1/98/31	20˚31.230	116˚51.182	-20.52050	116.85303
DA1/98/32	20˚23.520	116˚54.110	-20.39200	116.90183
DA1/98/33	20˚27.965	116˚49.692	-20.46608	116.82820
DA1/98/34	20˚27.684	116˚50.486	-20.46140	116.84143
DA1/98/35	20˚23.620	116˚51.960	-20.39367	116.86600
DA3/99/36	20˚30.050	116˚40.594	-20.50083	116.67657
DA3/99/37	20˚30.632	116˚38.788	-20.51053	116.64647
DA3/99/38	20˚30.632	116˚38.788	-20.51053	116.64647
DA3/99/39	20˚25.411	116˚37.578	-20.42352	116.62630
DA3/99/40	20˚26.657	116˚36.507	-20.44428	116.60845
DA3/99/41	20˚29.339	116˚36.798	-20.48898	116.61330
DA3/99/42	20˚29.339	116˚36.798	-20.48898	116.61330
DA3/99/43	20˚27.757	116˚34.193	-20.46262	116.56988
DA3/99/44	20˚29.629	116˚34.425	-20.49382	116.57375
DA3/99/45	20°29.670	116°35.890	-20.49450	116.59817
DA3/99/46	20°28.630	116°31.990	-20.47717	116.53317
DA3/99/47	20˚28.936	116˚32.519	-20.48227	116.54198

DA3/99/48	20˚32.000	116˚32.420	-20.53333	116.54033
DA3/99/49	20˚32.397	116˚32.606	-20.53995	116.54343
DA3/99/50	20˚32.841	116˚26.733	-20.54735	116.44555
DA3/99/51	20˚35.196	116˚30.914	-20.58660	116.51523
DA3/99/52	20˚29.696	116˚30.166	-20.49493	116.50277
DA3/99/53	20˚34.528	116˚34.575	-20.57547	116.57625
DA3/99/54	20˚36.222	116˚33.063	-20.60370	116.55105
DA3/99/55	20˚35.152	116˚35.631	-20.58587	116.59385
DA3/99/56	20˚38.985	116˚26.210	-20.64975	116.43683
DA3/99/57	20˚37.702	116˚25.089	-20.62837	116.41815
DA3/99/58	20˚34.398	116˚33.443	-20.57330	116.55738
DA3/99/59	20˚33.947	116˚38.334	-20.56578	116.63890
DA3/99/60	20˚32.878	116˚39.518	-20.54797	116.65863
DA3/99/61	20˚34.693	116˚39.698	-20.57822	116.66163
DA3/99/62	20˚37.499	116˚39.182	-20.62498	116.65303
DA3/99/63	20˚37.469	116˚38.246	-20.62448	116.63743
DA3/99/64	20˚36.658	116˚36.956	-20.61097	116.61593
DA3/99/65	20˚37.111	116˚26.780	-20.61852	116.44633
DA3/99/66	20˚36.700	116˚31.293	-20.61167	116.52155
DA3/99/67	20˚26.511	116˚40.256	-20.44185	116.67093
DA3/99/68	20˚27.998	116˚39.707	-20.46663	116.66178
DA3/99/69	20˚24.484	116˚46.310	-20.40807	116.77183
DA3/99/70	20˚27.441	116˚39.588	-20.45735	116.65980

GPS coordinates of the Western Australian Museum sites continued.

Site Name	Longitude (dec deg)	Latitude (dec deg)	Longitude (deg/min/dec)	Latitude (deg/min/dec)
DA4/00/01	116.79717	-20.484167	116˚47.830	20˚29.050
DA4/00/03	116.63683	-20.55867	116˚38.210	20˚33.520
DA4/00/04	116.59568	-20.60278	116˚35.741	20˚36.167
DA4/00/06	116.59517	-20.4375	116˚35.710	20˚26.250
DA4/00/08	116.59493	-20.605167	116˚35.696	20˚36.310
DA4/00/09	116.59382	-20.58525	116˚35.629	20˚35.115
DA4/00/10	116.4762	-20.58975	116˚28.572	20˚35.385
DA4/00/12	116.67102	-20.441767	116˚40.261	20˚26.506
DA4/00/13	116.77163	-20.407467	116˚46.298	20˚24.448
DA4/00/14	116.84065	-20.353433	116˚50.439	20˚21.206
DA4/00/15	116.84065	-20.353433	116˚50.439	20˚21.206
DA4/00/16	116.91798	-20.400417	116˚55.079	20˚24.025
DA4/00/17	116.77477	-20.5317	116˚46.486	20˚31.902
DA4/00/18	116.81583	-20.516667	116˚48.950	20˚31.000
DA4/00/19	116.8025	-20.627	116˚48.150	20˚37.620
DA4/00/21	116.60845	-20.444283	116˚36.507	20˚26.657
DA4/00/22	116.59367	-20.585167	116˚35.620	20˚35.110
DA4/00/23	116.50083	-20.498	116˚30.050	20˚29.880
DA4/00/27	116.44535	-20.618267	116˚26.721	20˚37.096
DA4/00/32	116.79133	-20.496083	116˚47.480	20˚29.765
DA4/00/33	116.82965	-20.356683	116˚49.779	20˚21.401
DA4/00/37	116.84262	-20.3545	116˚50.557	20˚21.270
DA4/00/38	116.8967	-20.389233	116˚53.802	20˚23.354
DA4/00/39	116.08515	-20.428417	117°05.109	20˚25.705
DA4/00/40	116.06695	-20.432267	117°04.017	20˚25.936
DA4/00/41	116.45635	-20.621683	116˚27.381	20˚37.301
DA4/00/42	116.46313	-20.605817	116˚27.788	20˚36.349
DA4/00/43	116.4818	-20.585317	116˚28.908	20˚35.119
DA4/00/44	116.54372	-20.622833	116˚32.623	20˚37.370

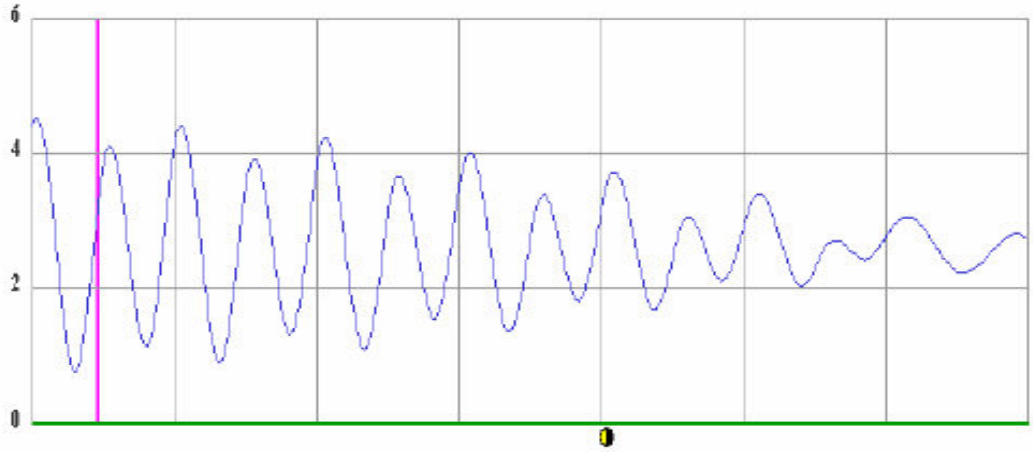
APPENDIX 3: ENVIRONMENTAL CONDITIONS

DAMPIER (KING BAY)

Local Standard
Timezone: -8:00 U.T.

20° 38' S 116° 45' E

PREDICTION DATUM: 2.73 (m)



Sep 16 Su		17 Mo		18 Tu		19 We		20 Th		21 Fr		22 Sa	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0041	4.5	0101	4.4	0123	4.2	0146	4.0	0210	3.7	0239	3.4	0349	3.1
0710	0.8	0733	0.9	0758	1.1	0824	1.4	0855	1.7	0945	2.0	1242	2.2
1301	4.1	1324	3.9	1347	3.7	1412	3.4	1441	3.1	1533	2.7	2206	2.8
1910	1.1	1929	1.3	1947	1.5	2005	1.8	2022	2.1	2029	2.4		

DAMPIER (KING BAY)

Local Standard
Timezone: -8:00 U.T.

20° 38' S 116° 45' E

PREDICTION DATUM: 2.73 (m)

Sep 23 Su		24 Mo		25 Tu		26 We		27 Th		28 Fr		29 Sa	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0235	2.6	0323	2.2	0356	1.7	0428	1.2	0500	0.8	0534	0.4	0610	0.2
0757	3.1	0907	3.5	0948	3.9	1024	4.2	1057	4.5	1130	4.6	1204	4.6
1511	1.9	1545	1.5	1615	1.2	1644	0.9	1714	0.7	1745	0.7	1815	0.7
2145	3.2	2159	3.6	2218	4.0	2243	4.4	2309	4.7	2337	4.9		

7 DAY FORECAST – DAMPIER ARCHIPELAGO

	Tue 4 12am	Tue 4 6am	Tue 4 12pm	Tue 4 6pm	Wed 5 12am	Wed 5 6am	Wed 5 12pm	Wed 5 6pm	Thu 6 12am	Thu 6 6am	Thu 6 12pm	Thu 6 6pm	Fri 7 12am	Fri 7 6am	Fri 7 12pm	Fri 7 6pm	Sat 8 12am	Sat 8 6am	Sat 8 12pm	Sat 8 6pm	Sun 9 12am	Sun 9 6am	Sun 9 12pm	Sun 9 6pm	Mon 10 12am	Mon 10 6am	Mon 10 12pm	Mon 10 6pm
WIND RANGE (knots)	11	7	3	12	10	5	9	13	10	9	7	19	19	19	21	18	10	5	8	10	14	11	8	7	9	7	6	9
GUST	8	5	3	9	8	4	7	10	7	7	5	14	14	14	15	14	7	3	6	7	10	8	6	5	7	5	4	6
WIND DIRECTION	SE	ENE	NE	SW	SSE	ENE	N	WSW	SSW	SW	WSW	SW	SSW	SW	WSW	SW	S	WSW	WSW	WNW	NW	WNW	NW	NW	NNW	N	NW	NW
WAVE HEIGHTS (m)	1.2	1.2	1.1	1	0.9	0.9	0.9	0.9	0.9	1	1.1	1.3	1.7	1.8	2	1.9	1.8	1.7	1.7	1.6	1.6	1.8	1.6	1.5	1.3	1.2	1.2	1.2
MAX	1	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.9	1	1.3	1.4	1.5	1.5	1.4	1.3	1.3	1.2	1.2	1.4	1.3	1.2	1	1	1	0.9
AVG																												
PERIOD	14	13	13	13	12	12	12	12	11	11	11	12	4	12	5	5	11	16	16	15	15	14	14	13	13	12	12	12
PRIMARY DIRECTION	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	SW	WSW	SW	SW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW	WSW

APPENDIX 4: FIELD TRIP SAFETY

Department of Environment and Conservation

FIELD TRIP ADVICE FORM

A field trip is defined as an excursion involving leaving their normal work place before SOB or returning to the office after COB or an overnight stay away from your normal home. This notification form should be worked through and given to the appropriate Region or District BASE contact 24 hrs prior to field trip departure and copies given to the designated after hours contact person/s.

TRIP LEADER name/title/call sign	Shannon Armstrong/ DEC MSP Research Scientist/ MSP Shannon			
OFFICE Contact Person.	Kerry Jankowski by radio VHF channel 16 (or phone 91822000) (Karratha) Ian Walker (on the weekend) 0428 441 118			
PREFERED METHOD OF CONTACT FOR SCHEDULED	**0915hr**	Radio (Kerry) Ph (Ian)	**1645hr**	Radio (Kerry) Ph (Ian)

COMMUNICATIONS and VEHICLE INFORMATION									
HF		**SEL CALL No**		**UHF**		**CHANNEL**		**VHF:**	**16**
SATELITE PHONE NUMBER			0424 210 304			**EPIRB**	Yes		
VEHICLE REGO, TYPE & COLOUR	1QAY 314, Land Cruiser, White (DEC Exmouth vehicle)								

AFTER HOUR CONTACT DETAILS FOR GROUP MEMBERS (including Trip Leader)			
NAME	TITLE AND COMPANY	EMERGENCY CONTACT PERSON	EMERGENCY CONTACT NUMBER
Shannon Armstrong	DEC MSP 0427519622	Joseph Sholly	0418 926 908
Alicia Edwards	DEC MSP 0402727905	Trudy Edwards	0417 936 488 9448 7721
Dianne Watson	UWA 0402842601	Steve McLean	0416287865
Alan Kendrick	DEC Pilbara Region (Exmouth) 0427387606	Pete Kendrick	91431488
Brad Daw	DEC Exmouth 0400 937103	Michelle Dawson	93647896
Geoff Kregor	DEC Karratha 0424210304	Pat Kregor	91431405
Adam Williams	DEC Karratha 0403 804 051	Marissa Speirs - (preferred) Gordon Williams – (back-up)	0401 223 022 0419 485 471
Marissa Speirs	DEC Karratha	Adam Williams -	0403 804 051

	0401 223 022	(preferred) Gordon Williams – (back-up)	0419 485 471
Suzanne Long	DEC MSP 0427999642	Robert Wocheslaender	0416 813 492

ITINERARY (Attached with map)

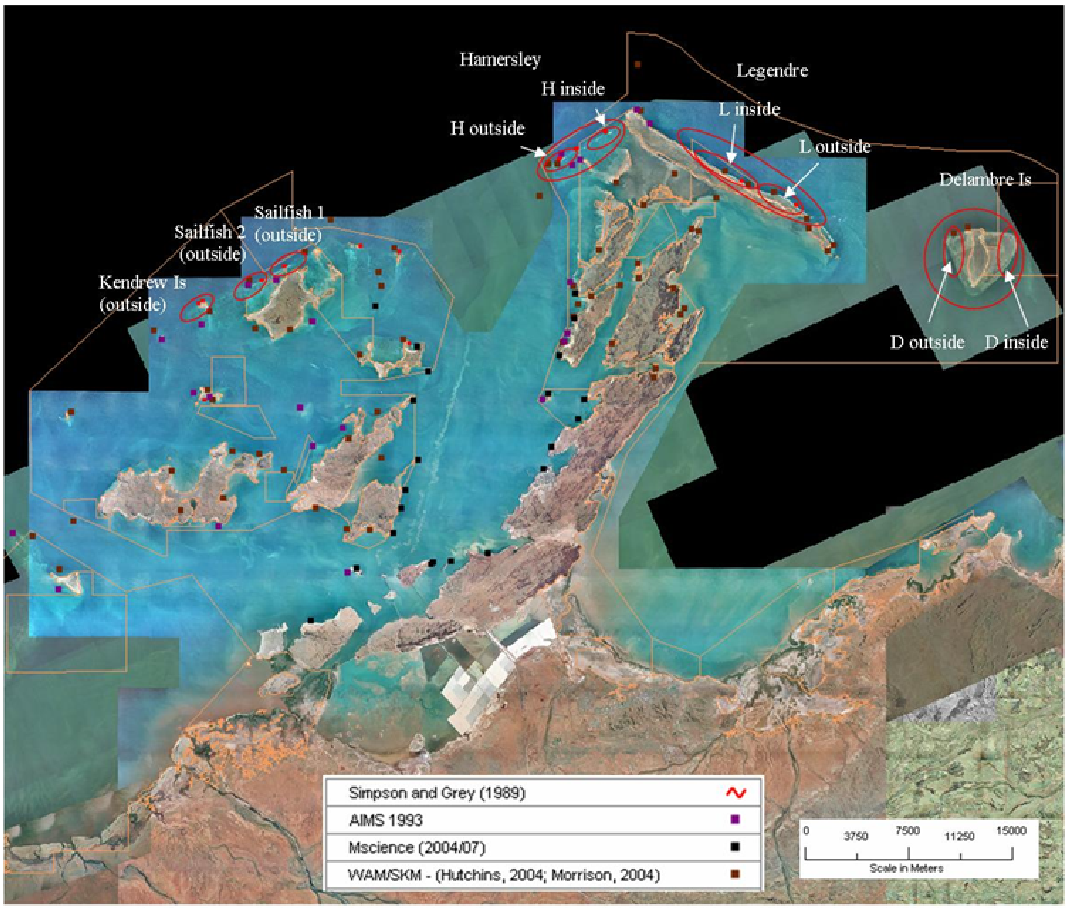
*I will contact BASE by 0915 hrs and 1645 on a daily basis Monday to Friday and organize after hours Schedule Calls with a nominated Departmental person. I understand that **SAR Phase 1** will be initiated if contact has not been made 1 hour after scheduled call and **SAR Phase 2** will be initiated if I haven't contacted BASE or nominated contact within 4 hours.*
I've read the attached SCHEDULE CALL & SAR procedure documents (Attachment 2).

TRIP LEADER SIGNATURE: _____ Date: _____

Preliminary Field Itinerary:

Survey Location/ Other	Activity	Logistics	Personnel Required	Date/time
Perth to Karratha (flight) Exmouth to Karratha (drive)	Travel to Karratha	Shannon, Suzanne and Dianne fly Perth to Karratha (depart 1130, arrive 1330) Alan and Brad drive Exmouth to Karratha	Shannon, Suzanne and Dianne Alan and Brad	Sunday 16th
Sailfish 1	Undertake survey	three short dives	Shannon, Suzanne, Geoff, Alan, Dianne, Brad, Adam	Monday 17th
Legendre Island 1	Undertake survey	three short dives	Shannon, Suzanne, Geoff, Alan, Dianne, Brad, Adam	Tuesday 18th
Legendre Island 2	Undertake survey	three short dives Bring Suz to airport by 1745 Suzanne to fly Karratha to Perth (depart 1845, arrive 2040) Pick Alicia up from airport at 1805 Alicia to fly Perth to Karratha (depart 1605, arrive 1805)	Shannon, Suzanne, Geoff, Alan, Dianne, Brad, Adam Suzanne, Shannon Alicia, Shannon	Wednesday 19th
Delambre Island 1	Undertake survey	three short dives	Shannon, Alicia, Geoff, Alan, Dianne, Brad,	Thursday 20th

			Adam	
Delambre Is 2	Undertake survey	three short dives	Shannon, Alicia, Geoff, Alan, Dianne, Brad, Adam	Friday 21st
Kendrew Is and Sailfish 2	Undertake survey	six short dives (at least two teams of divers)	Shannon, Alicia, Geoff, Alan, Dianne, Brad, Adam	Saturday 22nd
Hamersley Shoals 1 + 2	Undertake survey	six short dives (at least two teams of divers)	Shannon, Alicia, Geoff, Alan, Dianne, Brad, Adam	Sunday 23rd
Travel Karratha to Perth	Travel to Perth	Dianne to fly Karratha to Perth (depart 1850, arrive 2045)	Dianne	
TBD (for position and GPS coordinates of historical sites see Appendix 2)	Survey any sites unable to survey yet. Then re-survey additional historical survey sites (established by AIMS in 1993) and pilot rock lobster and COTS methods	Survey additional historic survey sites	Shannon, Alicia, Geoff, Alan, Brad, Adam, Marissa	Monday 24th
TBD	As above	Pilot the rock lobster and COTS methods		Tuesday 25th
TBD	As above	Survey additional historic survey sites		Wednesday 26th
TBD	Day dedicated to taking video footage and photographs for communication outputs	Likely to be two short dives		Thursday 27th
Land-based day	Pack up and clean gear. Freight to be picked up by TOLL for couriering to Perth	TOLL to pick up freight to be couriered to Perth	Shannon, Alicia, Geoff, Alan, Brad, Adam	Friday 28th
Karratha to Perth (flight)	Travel to Perth	Shannon and Alicia fly Karratha to Perth (depart 1730, arrive 1925)	Shannon and Alicia	
Karratha to Exmouth (Drive)	Travel to Exmouth	Alan and Brad drive Karratha to Exmouth	Alan and Brad	



Map of the survey area showing the general locations of the study sites (circled in red).

Department of Conservation and Land Management
Pilbara Region

Search and Rescue (SAR) Working Arrangements

Schedule calls

1) All staff must record their daily movements with ETA and vehicle being used on the destination board.

2.) Daily schedule calls are to be undertaken by all park staff based, staff who are working remote from their office, staff that are out before start of business or who are out after close of business (COB). This includes CALM volunteers and camp ground hosts.

Information included in Scheduled Calls
- Who is making the call(call sign),
- Current location,
- Intended travel movements,
- Next scheduled call, and
- Any other messages.

Base station staffs are to document and log all incoming scheduled calls.

Calls are to be made at 0915 -0930 hrs and 1645 – 1700 hrs. Exceptions can only be made by prior arrangement.
Schedule calls can only be made to CALM staff. USING SPOUSE AND FAMILY MEMBERS OTHER THAN CALM STAFF IS NOT APPROPRIATE. However, park based rangers may use family members if other park staff or other CALM staff are not available.

3.) Late returns from the field.
If you are unexpectedly retuning to your office after COB, you must contact your office prior to COB and establish a person and time to call in your safe return.

4.) Weekends and after hours
Appropriate contacts
- CALM staff, usually direct supervisor.
- CALM duty officer (Pilbara).
- Woodvale base HF radio cell call (Cell Call# 200). CALM staff check stored calls Sat, Sun at 0900.
- Park based rangers may use family members if this is the best alternative.

SEARCH AND RESCUE (SAR)

SAR is initiated with the assumption that CALM staff are in danger or need of assistance. The following procedures are to be followed if a scheduled call is missed.

1.) FIELD ACTIONS.
CALM staff working away from base must make all nominated schedule calls. If problems are encountered communication alternatives may include contacting one of the below and having them relay a message
- Other CALM staff, parks or mobiles.
- Pastoralists and other members of the public.
- Shift to a location that improves radio/telephone reception.
- WA Police FESA/SES
- Royal Flying Doctor Service

If no resolution has been achieved initiate SAR phase 1.

2.) SAR PHASE 1- 1 HOUR AFTER 0930 or 1700 hours Schedule Call Time.

- Nominated base contact person notifies manager immediately.
- Nominated BASE contact person (Admin) must;
  - Review field trip advice form and log book for details of contact, after hours contact expected location.
  - Check with nominated after hours contact.
  - Attempt to contact mobile by the nominated communication method on the field trip advice.
  - Check with other office based staff to confirm no other contact has been made and that mobile has missed scheduled call.
  - Check with emergency contacts or family members for contact.

No resolution, contact with mobile has not been established 4 HOURS after scheduled call (0930 or 1700) initiate **SAR PHASE 2.**

3.) SAR PHASE 2-

- Nominated base contact and/or manager to notify police of the situation.
- WA Police emergency response protocols will determine the necessary actions to be taken, eg State Emergency Service (SES) involvement, air and/or sea search, telephone communications, etc. The WA Police are likely to discuss the situation and possible actions with the manager or designated CALM contact.
- In SAR phase 2 Calm field based staff and volunteers can expect resources to be deployed for search and rescue purposes, if that mobile has not contacted base.

Departmental Dive Plan for the survey

Note that Attachment 1 and 2 mentioned in the Dive Plan relate to Appendix 2 and 3 of the Project Plan.

CALM DIVE PLAN

This form must be submitted to the Department Dive Officer for assessment/approval a minimum of 10 days before the first dive listed below is scheduled to occur.
Dive Supervisors should retain a copy of this form and provide copies to all divers involved in the planned dive operations prior to diving.
No diving is permitted unless the Dive Supervisor has an approved and signed copy of this plan.
*The dive plan **shall** comply with the procedures and requirements as presented in the CALM Diving Code of Practice.*
Where required Risk Assessments and Job Safety Analysis forms should be completed and attached to this form (Appendices 16 and 20)

Plan submitted by	SHANNON ARMSTRONG		
Phone:	08 93340228	**Email:**	SHANNON.ARMSTRONG@DEC.WA.GOV.AU
Dive supervisor/s:	BRAD DAW (EXMOUTH)		

TICK ACTIVITY TO BE CONDUCTED

SCUBA	x	**Snorkel**	x	**SSBA**		**Nitrox**	

Program name: ***(if applicable)***	ESTABLISHING A LONG-TERM MONITORING PROGRAM FOR THE PROPOSED DAMPIER ARCHIPELAGO MARINE PARK			
Program objective:	ESTABLISH AND SURVEY LONG-TERM MONITORING SITES IN THE PROPOSED DAMPIER ARCHIPELAGO MARINE PARK FOR DETERMINING LONG-TERM TRENDS DUE TO MANAGEMENT IN FISH ABUNDANCE AND LENGTH AND TROPICAL ROCK LOBSTER SIZE AND DENSITIES.			
Start Date	17/9/07	**Finish Date**	28/9/07	**Duration: (days)** 12 DAYS
Is this an ongoing program (if yes explain)	YES, THIS IS THE FIRST SURVEY OF A LONG-TERM MONITORING PROGRAM.			

SITE LOCATION

Latitude:	~20°20S - 20°40S	**Longitude:**	~116°30E - 117°00E

Site Description:	Dampier Archipelago region. See attachment 1 for detailed positions for each proposed survey site (maps and GPS coordinates).

TYPICAL WEATHER AND SEA CONDITIONS

See Attachment 2 for the tide charts for the period of the survey and wind and swell forecasts from the 4th to the 10th of September (just prior to the survey, as wind and swell forecasts are not yet available for the period of the survey).

Summer

Tide/current					

Winter

Tide/current (Spring/Neap):					

Best periods for access	

DIVE ACTIVITIES CARRIED OUT AT THE SITE

Activity	✓	**Risk level**	**Comments**
1. Sanctuary marker inspection			
2. Monitoring site	x	L - S	Significant due to possible strong currents and poor visibility
3. Mooring inspection			
4. Animal collection			
5. Site assessment	x	L	Site assessment prior to sampling will be done by snorkel
6. Habitat mapping			
7. Research	x	L - S	Significant due to possible strong currents and poor visibility
8. Training			

9. Diver assessment			
10. Other			

SITE ACCESS

	✓	Risk	Comments
1. Land			
2. Boat	x		All sites accessed by boat (RV “Bidthangara”, tender “Iddy
3. Jetty/Pier			

Risk level (H - High, M - moderate, S - significant, L - low)

PERSONNEL

Department divers	ROL	CA	CER	ACT	MED	AID	OXY	EXP	BOA
e.g. Diver Dan	*DS*	*A*	*R*	*Y*	*6/09/03*	*8/10/02*	*8/10/02*	*5*	*TL3*
1. Shannon Armstrong	PL	B	R	Y	12/6/06	14/6/06	30/5/07		-
2. Alan Kendrick	FT	B	R	Y	11/5/06	03/06	3/06		TL3
3. Suzanne Long	FT	B	R	Y	12/6/06	21/6/06	30/5/07		-
4. Brad Daw	DS	A	R	Y	5/07	5/07	5/07		COX
5. Adam Williams	FT	B	R, COMM L2	Y	25/06/07	05/2005	22/09/07		-
6. Alicia Edwards	FT	C	OW	Y	07/06/0	27/06/0	30/5/07		-
7. Marissa Speirs **	FT	B	R	n/a	10/05**	03/07	22/09/07		R/COX
8.									
9.									
Other divers									
10. Dianne Watson	FT	C	R	Y	8/5/07	12/05	18/8/06		REC (TL3)
11.									
12.									
Boat operator									
13. Geoff Kregor	SK	B	R	Y	28/03/07	03/07	22/09/07		COX/ MED 2

14. Brad Daw - See									
15.									
16.									

Legend

ROL	*Primary role*	***CAT***	*Department Dive Category*	***CER***	*Highest Certification*
ACT	*Active diver status*	***MED***	*Date of current dive medical*	***AID***	*Date of current first aid qual*
OXY	*Date of current oxygen resuscitation qual*	***EXP***	*Experience level*	***BOA***	*Highest boating qua*

OPERATIONAL

		Comments
1. Maximum water depth	20 m	
2. Maximum dive depth	15m	Likely to be under 10 m
3. Main working depth	3 -7m	
4. Number of dives /person/day	3	3 at max
5. Number of hours in the water	2.25 hr	max
6. Multi-day		
7. Repetitive		
8. Level of exertion (High/Moderate/Low)		Moderate
9. DCIEM Dive tables used	yes	
10. Air travel after flying	yes	>24hrs after last dive

WEATHER/SEA CONDITIONS UNDER WHICH DIVE OPERATIONS WOULD BE CANCELLED

Swell:	>2 m, 13 sec	**Wind**	> 18knts onshore, > 25knts offshore	Wind direction	W, NE for Ledendre and E Delambre (onshore)
Tide/current (Spring/Neap)	> 1knt current				

TYPE OF DIVE

	✓	Risk	Comments
1. Lagoon			
2. Inside reef	x	L-S	
3. Outside reef	x	L-S	Majority of dives will be along reef crest in less than 10 m
4. Open ocean			

5. In river			
6. In visibility <3			
7. After sunset			
8. Altitude			
9. Wreck			

ARE PERMITS REQUIRED IF YES PROVIDE DETAILS

No. Only DEC permits which I have.

Risk level (H - High, M - moderate, S - significant, L - low)

POSSIBLE HAZARDS

Strong currents	**x**	**Low visibility**	**x**	**Sharks**	**x**	**Stinging organisms**	
Marine traffic	**x**	**Other**		**Coral**	**x**		

COMMENTS

Strong currents: Diving will mainly be concentrated to times when tides are most stable. The survey has been planned to coincide with neap tides. Currents will be tested before commencing diving, if currents are too strong, the dive will be cancelled.
Low visibility: Visibility will be tested before commencing diving, if the visibility is less than 5 m the dive will be cancelled.
Sharks: Dangerous sharks are unlikely to be encountered. The skipper of both the main vessel and the tender will be on watch for sharks when any divers are in the water. Stand-by divers will act as additional look-outs for sharks.
Coral: All divers will be fully covered, including gloves, i.e. no spring suits will be allowed. If any abrasion does occur we will have adequate medical supplies on board to respond.
Marine Traffic: A dive flag will be visible on the main vessel and the tender when any divers are in the water. A “marine research” banner will also be displayed on the main vessel. Skippers of both vessels (main and tender) will be on look-out for marine traffic at all times. Stand-by divers will act as additional look-outs for marine traffic.

SITE MAP

SEE ATTACHMENT 1.

VESSELS TO BE USED

Vessel	✓	Risk	Comments
1. RV "Bidthangara" (Karratha)	x		fuel capacity of 1000lt
2. "Iddy Biddy" - tender (Karratha)	x		
3.			
4.			

VESSEL MOVEMENTS

Will vessels be anchored with motors off		The tender vessel will be used for most diving as it is more manoeuvrable and has a shallower draft than the main vessel. The tender will remain un-anchored with a skipper on board to ensure fast response time to any emergency. The Bidthangara will remain anchored or floating near-by with a skipper on board.

VESSELS ADDITIONAL INFORMATION

1. Live aboard vessel	no		
2. Remote location	yes		Max time to port is 4 hrs

EQUIPMENT TO BE USED

Equipment	✓	Risk	Comments
1. Underwater video	x		One video camera and one stereo-video UVC kit.
2. Underwater still	x		
3. Transect line	x		Biodegradable cotton twine will be used instead of the typical fibreglass measuring tape. This will improve sampling efficiency as there will be no need to return along transect line to collect the tape.
4. Quadrats			
5. Star pickets			

6. Sledge hammer			
7. Small tools			
8. Sample bags			
9. Others - list	x		Slates and tags for placing in front of video cameras to identify transect number.
10.			
11.			
12.			

EMERGENCY CONTACTS

	Contact	Comments
1. Mobile phone	0424 210 304	Geoff Kregor's mob (CDMA and SAT)
2. Satellite phone	0424 210 304	As above
3. Marine VHF	-	
4. Department VHF/HF	Channel 16	DEC VHF
5. Fremantle hyperbaric	08 94312233	First point of call for DCI incidents
6. HMAS Stirling **7.** LS Anita Rayner	08 9553 2555 0895535337 Mob: 0404097927	HMAS Stirling has two one man and one 10 man chambers. Use of these chambers is restricted.
8. Local hospital	08 91440330	
9. Local medical centre	As above	
10. Ambulance	08 91851222	
11. Police **12. Water Police** **13.** Water Police Coordination Centre	08 91442233 08 99428600 08 99428606	 24hr number Also contactable on HF radio frequencies 4125, 6215, 8291, and 8176
14. Flying Doctor Service	1800 625 800	
15. Local sea rescue	0439 870 995 0417 932 023	**- PORT WALCOTT VOLUNTEER MARINE RESCUE** **- WEST PILBARA VOLUNTEER SEA SEARCH & RESCUE GROUP**
16. Local Department office	08 9143 1488	DEC Karratha
17.		
18.		

Estimated time to get assistance to the site (under worst case conditions)	4.5 hrs by boat at max
Estimate time to get out of site	As above

SAFETY EQUIPMENT		**Comments**
Oxygen resuscitation equipment on site (hours of oxygen)	x	O2 at 16l/min for resuscitation for 5 hours
DCIEM tables	x	
Dive logs	x	
Marine first aid kit on site	x	
Additional medical supplies required	x	
Safe a dive kit	x	

ADDITIONAL INFORMATION

Water police are the lead responsible agency for life threatening marine emergencies in WA under "WESTPLAN". In the event of an emergency we should contact the Water Police 24hr number of 99428600 via sat phone stating we have a diving emergency. They will coordinate the emergency in the Water Police Coordination Center PH 99428606. They are also contactable on HF radio frequencies 4125, 6215, 8291, and 8176.
They have the contacts (choppers, ambulance and medical) and lists of resources (chambers etc) that will be required and they will coordinate an appropriate response based on information supplied to them and resources available. The water police vessel Delphinus operates in the area and the Dive Supervisor (Brad Daw)I will try to make contact with them to advise of our operation on arrival at Dampier.