NINGALOO MARINE PARK MONITORING PROGRAM

A collaborative project between CALM and AIMS

CALM involvement includes Marine Conservation Branch, Karratha Regional Office and Exmouth District Office

INITIALISATION OF LONG-TERM BENTHIC MONITORING SITES: MAY 1998

Field Programme Report MMSP/MW/NMP-10/1998

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AIMS collaboration

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Funding for the May 1998 field survey - $20 000 from Marine Conservation Branch budget.

Budget:	$ 20 000
'In kind' CALM resources	
CALM people:	142 (MCB) 40 (Regions) person days; includes field survey and pre and post survey
CALM volunteers:	300 days field survey and pre and post survey
CALM equipment:	trailers, diving gear, cameras, underwater videos etc.
AIMS people	40 person days
AIMS equipment	vehicle, videos, diving gear

1 INTRODUCTION

1.1 General

This field program report presents details of the first field survey of the *Ningaloo Marine Park Monitoring Program* (NMPMP). The main aim of the NMPMP is to determine the health of the key benthic habitats of the Ningaloo Marine Park and the proposed southern extension of the marine park. The locality and boundaries of Ningaloo Marine Park and surrounds are shown in Figure 1. The first survey will be conducted in May 1998 and will involve the establishment of approximately 18 long-term monitoring sites in coral communities. Areas identified as having a high level of human usage and being biologically unique will also be visited to assist in selecting permanent monitoring sites for the next survey.

The field survey will be coordinated by CALM in collaboration with the Australian Institute of Marine Science (AIMS). The Marine Conservation Branch (MCB) of CALM will co-ordinate the program (Principle contact: Dr. Chris Simpson) which will be conducted in collaboration with the Pilbara Regional Office (Contact: Fran Stanley) and the Exmouth District Office (Contact: Doug Myers).

Jennie Cary of the Marine Conservation Branch is the Field Team Leader and will coordinate all activities in the field.

Other CALM field staff will include Chris Simpson, Tim Daly, Mike Lapwood, Ian Gales, Jeff Myers, Tim Grubba and Glen Jarmaine and Justin Parker from the MCB and Peter Moore and Alan Shields from the Pilbara Regional Office. AIMS field staff include Andrew Heyward and Stuart Fields. Kim Brooks is a CALM/AIMS volunteer.

1.2 Background

The successful management of the marine environment is contingent upon comprehensive long-term monitoring programs that provide information on natural variability and long-term trends in key biological communities, determine the status of important natural attributes at regular intervals and identify undesirable trends resulting from human activities in time for remedial management action to be implemented effectively. Monitoring programs generally comprise one or more of the following complementary objectives: (i) local scale impact and/or *compliance monitoring* that examines the effects of human activities in a localised area(s); (ii) temporally-constrained, broadscale *surveillance monitoring* to assess the impact of episodic regional physical and biological processes (eg the effect of cyclones and predators) and (iii) spatially-constrained, long-term monitoring of key biological parameters to determine the extent and cause of *natural variation* (eg seasonal and inter-annual variability) of key ecosystem attributes.

The aim of the *Ningaloo Marine Park Monitoring Program* (NMPMP) is to assess the 'health' of major benthic habitats of the marine park and its southern extension. This report describes the first of a number of field surveys which will be conducted as part of the NMPMP. The spatial and temporal scale of on-going monitoring will determine the type of monitoring; i.e. surveillance, compliance or natural variability. As the coral communities are the most dominant benthic habitat, the major focus of the field program will be to monitor the coral communities. As the majority of human activities in the marine park occur within the easily accessible lagoon and back-reef reef (on the sea-ward edge of lagoon) the majority of monitoring sites will be established in these areas. In this survey long-term monitoring sites will be established on back-reef coral communities. Quantitative biological information to assess the 'health' of the coral communities will be obtained using video footage from re-locatable permanent transects. Long term monitoring sites will be established to provide baseline ecological data from which the impacts from human activities can be monitored and managed to ensure that all activities are ecologically sustainable.

The NMPMP is linked to the recommendations of the *Ningaloo Marine Park Management Plan 1989-1999;*

- Monitoring of marine flora and fauna be carried out to gain an understanding of factors which influence the stability of marine communities in the Park.
- Monitoring and periodic surveys of recreational and commercial use in and adjacent to the park be carried out to determine the effect of human usage on marine communities in the Park.

1.3 Aims

The main aim of the NMPMP is to determine the 'health' of the major benthic habitats of the Ningaloo Marine Park and the southern extension. Primary objectives of the May 1998 field survey include:

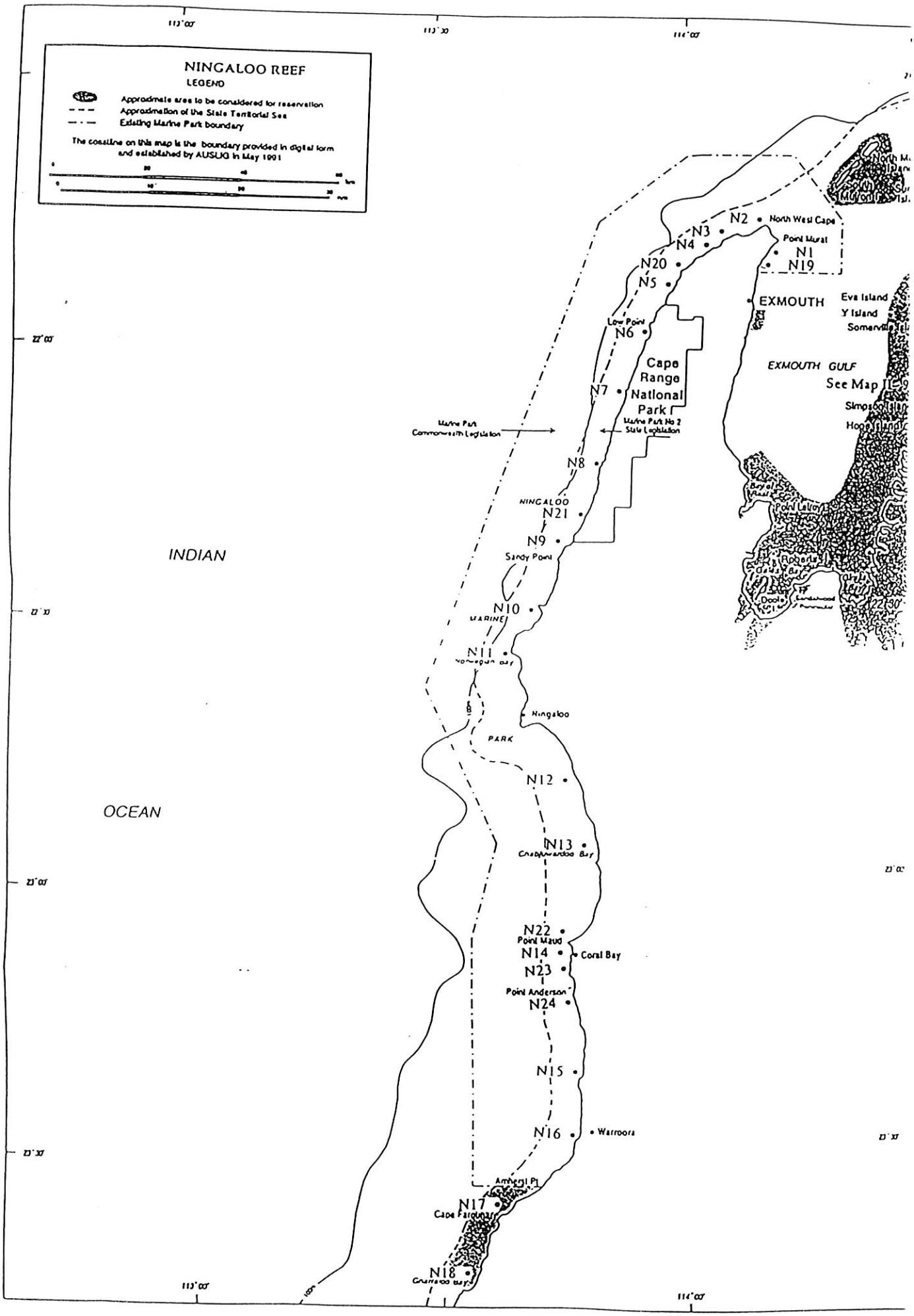

Figure 2: Approximate locations of proposed long-term monitoring sites to be established in May 1998

- The establishment of re-locatable long-term monitoring sites on back-reef coral communities that are *representative* of the Ningaloo Marine Park and the proposed southern extension.

- Familiarization of areas identified as having a *high human usage* (generally in the lagoon) to assist in site selection for the next field survey.

- Familiarization of areas identified as *biologically unique* to assist in site selection for the next survey.

- The opportunistic collection of still photographs and video footage of major habitat types and visually dominant flora and fauna.

2 SITE SELECTION, METHODS AND EQUIPMENT

2.1 Site selection

2.1.1 Representative sites (including control sites)

Sites will be selected to represent the ecological attributes of *back-reef* coral communities along approximately 300km of coastline from Bundegi reef in the north (Exmouth Gulf) to Gnarraloo in the south. Approximately 18 representative sites will be selected approximately every 15 km of coastline. These sites can be used for *surveillance monitoring* and a sub-set to monitor *natural variability*.

Site selection was further influenced if historical information of the 'health' of the coral communities from previous surveys was available. Historical data will assist in determining temporal changes. Studies reviewed to assist in site section included:

- Ayling AM and AL (1987). Ningaloo Marine Park: Preliminary fish density assessment and habitat survey; with information of coral damage due to *Drupella cornus* grazing. A report of CALM.
- Forde MJ (1994). Ecology of the Muricid gastropod *Drupella cornus* and its significance as a corallivore on Ningaloo Reef, Western Australia. Master of Science degree from University of Western Australia.
- Osborne S and Williams (in preparation). Status of *Drupella cornus* outbreak at Ningaloo Reef. CALM report.
- Simpson *et al* (1993). Destruction of corals and other reef animals by coral spawn slicks on Ningaloo Reef, Western Australia. *Coral Reefs* **12**:185-191.
- Australian Institute of Marine Science - studies undertaken in Coral Bay.

Representative sites will be located in Sanctuary Zones where possible. In general, sites located in Sanctuary Zones will be used as control sites as no extractive activities are permitted in these zones. The results of long-term monitoring at sites subjected to recreational and/or commercial pressures will be assessed in the context of natural variation at the control sites. This is a fundamental requirement for effective management.

Approximately 18 long-term monitoring sites representative of the backreef coral communities will be established during this survey (Tables 1 and 2; Figure 2). Historical site information and data from Osborne and Williams (in preparation) was key in site selection (Tables 3 and 4). Table 3 summarises historical site information. Table 4 summarises historical data on percentage cover of live coral, and substrate type, and *Drupella* density.

2.1.2 Areas of high human usage

Areas identified as having high level of human usage will be visited during this survey and observations of the types of impacts observed will be recorded (Table 1). This information will be used to assist in the selection of monitoring sites for the next field survey. No permanent transects will be established in areas of high human usage visited during this field survey.

To assist in identifying areas of high human usage a spreadsheet identifying all human activities occurring in the marine park was developed. The spreadsheet divided the Ningaloo Marine Park into 23 sectors and the types of activities occurring in each sector were identified by the CALM Exmouth office (Appendix 1). The spreadsheet highlighted Bundegi Reef, Tantabiddi and Coral Bay as the areas with the highest number of human activities and to a lesser extent Mangrove Bay, Yardie Creek, Stanley Pool and Turquoise Bay. Most areas of high human usage are located in the lagoon.

Specific information on human activities in the area were provided by CALM Exmouth staff and other people with a high degree of local knowledge. This information was used to assist in site selection. The CALM dive and snorkel book (by Carolyn Thompson) was also used to identify popular shoreline dive sites.

2.1.3 Biologically unique areas

Areas identified as being biologically unique will also be visited during this survey and information gathered will be used to assist in selection of monitoring sites for the next field survey. No permanent transects will be established in areas identified as being biologically unique during this field survey.

To assist in the selection of biologically unique sites information was gathered from

- WA Museum surveys of 1977-1980
- CALM Exmouth staff and people with a high degree of local knowledge.

2.1.4 Survey grid details

Approximately 18 long-term monitoring sites are planned to be established during the survey (Figure 2). These sites will be representative sites of back-reef coral communities. The areas identified as having a high level of human activity and being biologically unique will be visited and *in situ* information gathered to aid in site selection for a follow-up field trip (Table 1). A list of the long-term monitoring sites and broad time frame for their establishment is given in Table 1. Table 1 also contains a brief description of the major habitat type and the dominant factor considered in the selection of the sites. Table 2 summarizes each site: referring to aerial photographs, previous studies, current management status (sanctuary/non-sanctuary), site description and access information.

2.1.5 Contingency for adverse conditions

In the event of adverse weather, sea conditions or road (track) conditions the Field Team Leader may choose to re-evaluate the day's field programme and change the schedule if necessary. This would primarily involve the abandonment of a site at which conditions are unsuitable and the replacement of the site with a site that is sheltered from the wind and/or offers better sea conditions for underwater work, and/or is accessible by road.

2.2 Methods

At each long-term monitoring site in this survey, the coral community will be surveyed and three permanent 50 m transects will be established to monitor spatial and temporal changes in benthic composition. The transects will be set along the back reef at a depth contour of approximately 2m. The transects will be set in a line along the depth contour one after the other, however transect start and end points will be separated by a 10 m space. The distance between the start of the first transect and the end of the last transect will be 50+10+50+10+50=170m. The transects are to be permanently set using star pickets at the start and end points, with a 50 m scaled (every 10cm) and weighted transect line following the contour of the seabed. The position of the start of each transect is recorded using differential GPS, providing an accuracy of better than 3 m. The sessile benthic composition along each transect is then recorded at a set height and speed, using a high quality video camera in an underwater housing, resulting in a strip transect 50 m long and 1 m in width being sampled.

The video sampling method was developed by the Australian Institute of Marine Science (AIMS) to monitor the status of coral dominated benthic communities by detecting and quantifying major spatial and temporal changes in the percentage cover of sessile benthos (Christie *et al.* 1996). This survey technique provides a permanent record of benthic habitats which can be later analysed in a variety of different ways. A visual record is a very compelling method for identifying change and for highlighting impacts that may result from recreational and commercial usage.

At all sites recordings of benthic composition using the video transect technique will be complemented with general information on the major benthic community types (e.g., coral and seagrass meadows etc.) the visually dominant species and the nature and extent of impacts (if present) will be recorded either by direct observation from the boat (i.e. by viewfinder), or by divers taking general video footage and still photographs.

Table 1 Description of sites scheduled to be visited. Week 1 (4-9 May), week 2 (11-16 May), week 3 (18-23 May) and week 4 (25-30 May)

Site number	Site name	Dominant factor in site selection	Habitat	Human Usage Sector
WEEK 1				
N1	Bundegi	Representative	Coral/backreef	Sector 1
N2	Mildura Wreck	Representative	Coral/backreef	Sector 2
N3	Vlamingh Head	Representative	Coral/backreef	Sector 3
N4	Torpedo Bay	Representative	Coral/backreef	Sector 3
N5	Tantabiddi	Representative	Coral/backreef?	Sector 3
N6	Neds Camp/ Mesa	Representative	Coral/backreef	Sector 4/5
Additional Sites (time permitting)				
N19	Bundegi (Sanctuary)	Representative	Coral/backreef	Sector 1
N20	Jurabi Point	Representative	Coral/backreef	Sector 3

Visit areas identified as having a high level of human activity or special areas to assist in site selection for follow-up survey e.g. Bundegi, Tantabiddi and Neds Camp

WEEK 2				
N7	Turquoise Bay	Representative	Coral/backreef	Sector 7
N8	Osprey Bay	Representative	Coral/backreef	Sector 9
N9	Bunderra	Representative	Coral/backreef	Sector 11
N10	Lefroy Bay	Representative	Coral/backreef	Sector 12
Additional Site (time permitting)				
N21	Yardie Creek	Representative	Coral/backreef	Sector 10

Visit areas identified as having a high level of human activity or special areas to assist in site selection for follow-up survey e.g. Turquoise Bay, Mandu and Yardie Creek

WEEK 3				
N11	Pt. Cloates	Representative	Coral/backreef	Sector 13I
N12	Dugong Sanctuary	Representative	Coral/backreef	Sector 13III
N13	Bruboodijoo Pt	Representative	Coral/backreef	Sector 14
N14	Coral Bay/Bill's Bay	Representative	Coral/backreef	Sector 16/17
Additional Sites (time permitting)				
N22	Outer Reef Bills Bay	Representative	Coral/backreef	Sector 16
N23	South Coral Bay	Representative	Coral/backreef	Sector 18
N24	Pt. Anderson	Representative	Coral/backreef	Sector 19

Visit areas identified as having a high level of human activity or special areas to assist in site selection for follow-up survey e.g. Dugong Sanctuary for seagrass; 10 mile; Coral Bay

WEEK 4				
N15	Pelican Sanctuary	Representative	Coral/backreef	Sector 21
N16	Alison Pt.	Representative	Coral/backreef	Sector 22

N17	Cape Farquhar	Representative	Coral/backreef	N/A
N18	Gnarraloo Bay	Representative	Coral/backreef	N/A

Visit areas identified as having a high level of human activity and special areas to assist in site selection for follow-up survey e.g. Gnarraloo,

Table 2 Summary of Representative Sites: site location, site description, transect location and historical information.

No.	SITE	PHOTO #1	ZONE	PREVIOUS STUDIES	SITE DESCRIPTION #2	LAUNCH SITE	SI
N1	**Bundegi**	5156-5157 (1985)	Non Sanctuary	1) Osborne 1991/1994. Transects located on back reef	Reef structure not typical. Note: scattered offshore reef.	Launch site ~1800m south of point. Access from wide gravel track over sandy beach.	Tr ree Os ~4
N2	**Mildura Wreck**	5068	Non Sanctuary	No previous studies	Reef structure not typical. Note: scattered reef extending offshore to shelves.	Launch site ~550m south of study area. Access from sandy track over sandy beach. If too shallow rocky alternative site ~2000m south (refer photo 5066)	Tr sca off
N3	**Vlamingh Head**	5064	Non Sanctuary	No previous studies	Reef structure not typical. Note: scattered reef out to surf zone approximately 750m offshore.	Launch site adjacent to transect site. Access from sandy track across sandy beach adjacent to caravan park.	Tr sca lin
N4	**Torpedo Bay**	5057	Non Sanctuary	No previous studies	Reef structure not typical. Note: scattered offshore reef.	Launch site at any of three points 1)Trial access; 2) Brook access; 3) Baudin access. Access from track across sandy beach.	Tr sca Ba
N5	**Tantabiddi**	5031	Non Sanctuary	1) Osborne 1991/199494. Transects located in midlagoon ~1200m offshore.	Reef structure typical. Note: numerous channels through barrier reef to the north.	Launch site at Tantabiddi boat ramp	Tr ree sit
N6	**Ned's Camp/Mesa**	5045-5047	Sanctuary	1) Osborne 1991/1994. Transects located on back reef ~1400m off Low Pt. 2) Ayling 1987. Transect extends from shore to outer reef crossing lagoon ~2200m in length.	Reef structure typical. Note: major channel through barrier reef south of Low Pt	Launch site at Mesa. Access across wide sandy beach	Tr ree of ~1 ~4

Table 2 continued.

No.	SITE	PHOTO [#1]	ZONE	PREVIOUS STUDIES	SITE DESCRIPTION [#2]	LAUNCH SITE	SI
N7	**Turquoise Bay**	5028	Sanctuary	1) Osborne 91/94. Transects located on back reef ~1800m south of launch site.	Reef structure typical. Note: broad barrier reef.	Launch site on north side of point across wide sandy beach	Tr ree Os of lau
N8	**Osprey**	5018-5022	Sanctuary	1) Osborne 1991/1994. Transects located on back reef south of main channel and ~800m offshore 2) Ford 1988. Transects either side of the channel ~800m offshore	Reef structure typical. Note: major channel through barrier reef adjacent to launch site.	Launch site ~800m south of Sandy Bay	Tr ree Os an sit
N9	**Bunderra**	5009	Non Sanctuary	1) Osborne 1991/1994. Transects located on back reef ~1800m offshore.	Reef structure typical. Note: broad barrier reef and lagoon.	Launch site ~1200m south of sandy Pt. Access from small tracks across narrow sandy beach	Tr ree Os 22
N10	**Lefroy Bay**	5120	Non Sanctuary	1) Osborne 1991/1994. Transects located on back reef ~2000m from launch site.	Reef structure typical	Launch site ~5200m south of Winderabandi Pt. Access via track across sandy beach.	Tr ree Os ~2
N11	**Pt. Cloates**	5128-5132	Sanctuary	1) Osborne 1991/1994. Transects on back reef ~2600m from launch site.	Reef structure typical. Note: broad lagoon.	Launch site ~2600m north of Pt. Cloates. Access via track across narrow sandy beach.	Tr ree Os ~3 lau
N12	**Dugong Sanctuary**	5191 & 5142	Sanctuary	No previous studies	Reef structure typical. Note: broad lagoon.	Launch site ~1400m north of southern border of sanctuary (refer photo 5191). Access from track across narrow sandy beach	Tr ree ~8 sit

Table 2 continued.

No.	SITE	PHOTO #1	ZONE	PREVIOUS STUDIES	SITE DESCRIPTION #2	LAUNCH SITE	SI
N13	**Bruboodijo Pt.**	5186	Non Sanctuary	1) Osborne 1991/1994. Transects on back reef ~4800m offshore.	Reef structure typical. Note: broad lagoon.	Launch site ~6000m north of Bruboodijoo Pt. Access from track across narrow sandy beach	Tr ree Os ~4
N14	**Coral Bay/Bill's Bay**	5169-5167	Sanctuary	1) Osborne 1991/1994 Transects on mid lagoon ~600m from launch site. Transects also on back reef ~2200m from launch site. 2) Ford 1988. Transects on back reef at areas a) ~2200m off launch site and b) ~2900m to north of launch site.	Reef structure typical. Note: broad lagoon with extensive coverage of coral.	Launch site at Coral bay boat ramp.	Tr ree Os ~2
N15	**Pelican Sanctuary**	5128	Sanctuary	No previous studies	Reef structure typical.	Launch site on north side of Pelican Pt. Access from track across narrow sandy beach.	Tr ree lau
N16	**Alison Pt.**	5136	Non Sanctuary	No previous studies	Reef structure not typical. Note: scattered exposed reef.	Launch site near study sites uncertain possible access from small sandy track across sand dunes and beach. Alternative launch site ~5000m north at Maggies.	Tr ree be
N17	**Cape Farquhar**	5150	Non Sanctuary	No previous studies	Reef structure not typical. Note: small barrier reef extending north and south	Launch site adjacent to study site. Access from track across sandy	Tr off no

					of the cape.	beach.	ba

Table 2 continued.

No.	SITE	PHOTO #1	ZONE	PREVIOUS STUDIES	SITE DESCRIPTION #2	LAUNCH SITE	SI
N18	**Gnarraloo Bay**	5162	Non Sanctuary	No previous studies	Reef structure not typical. Note: reef extending north and south of the southern point of Gnarraloo Bay..	Launch site on southern shore of Gnarraloo Bay. Access from track across narrow sandy beach.	Tr off

Additional Sites

No.	SITE	PHOTO #1	ZONE	PREVIOUS STUDIES	SITE DESCRIPTION #2	LAUNCH SITE	SI
N19	**Bundegi**	5156-5157 (1985)	Sanctuary	1) Osborne 1991/1994. Transects located on back reef	Reef structure not typical. Note: scattered offshore reef.	Launch site ~1800m south of point. Access from wide gravel track over sandy beach.	
N20	**Jurabi Pt.**	5055-5057	Non Sanctuary	No previous studies	Reef structure typical. Note: barrier reed to south and scattered reef to the north.	Launch site ~4500m north of Jurabi Pt. Access from track (first track south of Baudin access) across sandy beach. Alternative launch site ~1200m south of Jurabi Pt across very wide sandy beach.	Tr ree Pt. ba
N21	**Yardie Creek**	5013-5015	Non Sanctuary	No previous studies	Reef structure typical. Note: major channels to immediate north of Yardie Creek, and major break in	Launch site at Yardie Creek. Access from track across extensive sand dune/beach	Tr ree a) of

					barrier reef to south		off an lau
N22 (a)	**Outer Reef Bill's Bay**	5165	Sanctuary	No previous studies	Reef structure typical. Note: northern tip of barrier reef extending north from Billis Bay.	launch site at Coral Bay boat ramp	Tr ree Fo ~7 sit

Table 2 continued.

No.	SITE	PHOTO #1	ZONE	PREVIOUS STUDIES	SITE DESCRIPTION #2	LAUNCH SITE	SI
N22 (b)	**Outer Reef Bill's Bay**	5165	Sanctuary	1) Ford 1988. Transects on back reef.	Reef structure typical.	launch site at Coral Bay boat ramp	Tr ree tra lau
N23	**South Coral Bay**	5173	Non Sanctuary	No previous studies	Reef structure typical.	launch site approximately 8000m to north at Coral Bay boat ramp. Alternatively 3200m north of site and approximately 4200 south of coral bay , track over narrow sandy beach	Tr ree
N24	**Pt Anderson**	5126	Non Sanctuary	1) Osborne 1991/1994. Transects on back reef ~1500m from launch site.	Reef structure typical. Note: broad lagoon. Channel to north	launch site ~500m south of Pt Anderson, track over narrow sandy beach	Tr ree Os ~1

Notes: [#1] Photographs referred to in table were all taken in 1994 with the exception of site 1 where the photograph is dated 198
[#2] An area was described as having a typical structure (barrier reef) as defined by Ayling '87.

Table 3 Historical Site Information from Osborne and Willams (in preparation).

1998 SITE REF #	SITE	DEPTH	Latitude (S)	Longitude (E)
N1	Bundegi (transect 2)	4.0 m	21° 15.002'	114° 10.779'
N6	Ned's camp (transect 3)	1.0 - 1.5m	21° 58.560'	113° 55.280'
N7	Turquoise Bay (transects 1-3)	1.5 - 2.0m	22° 06.717' 22° 06.867' 22° 07.178'	113° 52.734' 113° 53.668' 113° 52.763'
N8	Osprey Sanctuary (transects 1-3)	1.0 - 1.5m	22° 14.884' 22° 15.336' 22° 14.644'	113° 49.731' 113° 49.481' 113° 49.718'
N9	Bundera (transect 1)	1.0 - 1.5m	22° 23.685'	113° 44.716'
N10	Lefroy Bay (transects 1-3)	2.0 - 3.0m	22° 31.598' 22° 31.615' 22° 31.679'	113° 40.628' 113° 40.685' 113° 40.646'
N11	Pt Cloates (transect 1)	1.5m	22° 40.817'	113° 38.525'
N13	Bruboodijoo (transect 2)	0.5 - 1.5m	22° 56.416'	113° 46.708'
N14	Coral Bay (transects 1-3 on back reef)	1.0m	23° 09.241' 23° 09.005' 23° 09.227'	113° 45.030' 113° 45.020' 113° 45.103'
N24[#1]	Pelican (Pt. Anderson) (Transect 2)	1.0 - 2.0m	23° 20.027'	113° 46.721'

Note: [#1] Site 14b Pelican Pt/Pt/Anderson is an additional site
Latitude and Longitude of transects are extracted from Osborne (in preparation) 1991 data collections. Listed coordinates correspond to the proposed locations of the 1998 long term monitoring sites.

Table 4 Historical Data on % cover of live coral, substrate type and Drupella density from Osborne and Williams (in preparation)

Site N1	**Bundegi: back reef**	**1991**	**1994**
	Live Hard Coral	52.0%	79.0%
	Soft Substrate	2.0%	1.0%
	Hard Substrate	46.4%	25.0%
	Drupella (live)	1.62	0.77
	Drupella (dead)	0.04	0.01
Site N5	**Tantabiddi: mid lagoon**	**1991**	**1994**
	Live Hard Coral	52.9%	38.0%
	Soft Substrate	2.6%	5.0%
	Hard Substrate	44.5%	56.0%
	Drupella (live)	3.04	2.72
	Drupella (dead)	0.26	0.30
Site N6	**Ned's Camp: back reef**	**1991**	**1994**
	Live Hard Coral	3.8%	6.0%
	Soft Substrate	20.8%	19.0%
	Hard Substrate	75.4%	74.0%
	Drupella (live)	0.30	0.05
	Drupella (dead)	0.38	0.11
Site N7	**Turquoise Bay: back reef**	**1991**	**1994**
	Live Hard Coral	11.1%	14.0%
	Soft Substrate	25.7%	32.0%
	Hard Substrate	63.3%	51.0%
	Drupella (live)	0.39	0.51
	Drupella (dead)	0.10	0.18
Site N8	**Osprey Sanctuary: back reef**	**1991**	**1994**
	Live Hard Coral	16.2%	31.0%
	Soft Substrate	20.3%	15.0%
	Hard Substrate	63.5%	54.0%
	Drupella (live)	0.05	1.56
	Drupella (dead)	0.04	0.21
Site N9	**Bunderra: back reef**	**1991**	**1994**
	Live Hard Coral	14.8%	9.0%
	Soft Substrate	13.1%	20.0%
	Hard Substrate	72.1%	71.0%
	Drupella (live)	2.01	1.00
	Drupella (dead)	0.18	0.09

Table 4 continued.

Site N10	**Lefroy Bay: back reef**	**1991**	**1994**
	Live Hard Coral	45.0%	41.0%
	Soft Substrate	3.7%	7.0%
	Hard Substrate	51.2%	55.0%
	Drupella (live)	3.49	3.30
	Drupella (dead)	0.32	0.30
Site N11	**Pt Cloates: back reef**	**1991**	**1994**
	Live Hard Coral	18.5%	14.0%
	Soft Substrate	22.2%	31.0%
	Hard Substrate	51.3%	55.0%
	Drupella (live)	0.02	1.01
	Drupella (dead)	0.06	0.08
Site N13	**Bruboodijoo: back reef**	**1991**	**1994**
	Live Hard Coral	19.7%	28.0%
	Soft Substrate	17.3%	18.0%
	Hard Substrate	63.0%	54.0%
	Drupella (live)	2.04	3.48
	Drupella (dead)	0.09	0.10
Site N14	**Coral Bay: back reef**	**1991**	**1994**
	Live Hard Coral	10.6%	9.0%
	Soft Substrate	9.4%	14.0%
	Hard Substrate	80.0%	77.0%
	Drupella (live)	3.93	1.60
	Drupella (dead)	0.27	0.91
Site N15	**Pelican: back reef**	**1991**	**1994**
	Live Hard Coral	80.0%	60.0%
	Soft Substrate	5.1%	3.0%
	Hard Substrate	15.1%	37.0%
	Drupella (live)	18.77	10.06
	Drupella (dead)	0.36	0.33

Note: Live Hard Coral, Soft Substrate and Hard Substrate data is mean % cover
Drupella data is mean estimated density (snails/m^2)

All habitat data and related observations will be recorded electronically onto standard data files which have been pre-formatted and stored on a laptop computer. Data sheets for written data recordings will be also be made available. All written data is to be transferred to the computer files during the field survey, and preferably on the day of collection. Examples of data recording sheets are presented in Appendix II.

2.2.1 Establishment of permanent transects

Each site will consist of three permanent 50 meter transect lines placed end to end in a straight line with a 10m space between ends. A star picket will be driven into the substrate at the start and end point of each transect. These will be temporally marked by a weighted marker float to enable DGPS coordinates to be obtained from the surface. Previous field trips have proven that transect deployment can be best achieved by using either procedures 1 or 2 below, or a combination of both depending on conditions, available vessels and personnel (sections 2.2.1.2 and 2.2.1.3).
The following section (section 2.2.1.1) describes the general procedures. The entire procedure should take between 2 and 4 hours, depending on *in situ* conditions. The number of sites established per day will depend on road/track conditions between sites, prevailing sea conditions and distance from vessel launch site to the area of operation. Changes to this procedure may be made by the Field Team Leader, Jennie Cary, and advised to the field crew in the field.

2.2.1.1 General Procedure

1. Personnel and equipment leave main camp and move to 'day camp' (a point on the beach as close as possible to the site).

2. Boats are launched, gear made ready.

3. Boat 1 leaves the beach followed by boat 2 about 15 minutes later.

4. Transect lines are set, filmed and retrieved as described in the methods below.

5. Boats 1 and 2 takes divers back to 'day camp' to change air tanks, camera batteries etc. and check video footage. Boat 2 also brings backs site data (start and end point coordinates, transect layout sketch, dive times, video times etc.) for shore person to enter onto data sheets.

6. Boats are retrieved and gear stored.

7. Personnel and equipment leave day base to either return to base camp or move directly to second site (if applicable) and setup second 'day camp'.

8. Steps 2 through 7 are then repeated.

2.2.1.2 Establishment of transect using boat.

To be used in calm conditions with low current and relatively flat bathymetry. The transect lines will be laid out and retrieved by boat rather than by divers.

<u>Boat 1 (2 persons: 1 boat operator, 1 field crew)</u>

1. Boat 1 will reconnoitre general area using pre-marked aerial photographs and GPS readings as guidance.

2. The site is viewed using a viewfinder or a snorkel diver to confirm suitability of the site.

3. The end of the transect line is clipped to the weight of the start point marker buoy as it is deployed.

4. The transect lines are run out by driving the boat in a straight line on a predetermined compass bearing.

5. When the end of each transect line is reached it is clipped to the weight of the end point marker buoy as it is deployed.

6. This process is repeated for the last two transects.

7. Boat 1 deploys a snorkeler to check that the transect line was laid straight. If possible the snorkeler straightens the transect line where necessary. If the snorkeler is unable to correct the transect line, that person informs one of the SCUBA equipped divers whom will make the necessary adjustments.

8. Boat 1 stands by as it waits for boat 2 divers to install star pickets and video the transects. Boat 1 then retrieves it's divers.

9. Boat 1 then takes DGPS readings at the marker buoys to determine the positions of the beginning of each transects and the end of transect 3.

10. Boat 1 then retrieves the transect lines, and in the event of the line becoming snagged a diver from boat 2 (or a snorkeller from boat 1) enters the water to unsnag the line.

Boat 2 (4 persons: 1 boat operator, 3 divers)

1. As soon as the first transect is set, boat 2 with three divers moves into position over the beginning of transect 1. The three divers are deployed. One diver has the role of video camera operator, the second divers is a data recorder, and the third diver installs the star pickets.

2. The three divers descend to the beginning of the first transect designated by the weight of the marker buoy.

3. The installation diver then hammers a star picket into the substrate at the beginning of the transect, attaches the polypipe extension and positions the weight adjacent to the picket.

4. The camera operator films the surrounding reef. Anything that is of significance is also taped. The site and transect details inscribed on the first picket are taped. Then the diver proceeds video taping along the transect line (Section 2.2.2).

5. The data recorder diver follows the diver video taping the transect. This diver is making general observations about the reef, any visual impacts etc. This diver can also draw mud-maps of the location of the star picket in relation to coral/sand landmarks.

6. The diver installing the pickets, after securing the first picket swims to the end of the first transect plus the 10m extension and hammers another picket into the substrate to define the start point of the second transect. This process is continued for the third transect and a final picket is driven in at the end of the third transect.

7. The other two divers collecting data repeat steps 4 through 5 for the remaining transects.

8. The divers then return to the boat 2 which will be waiting at the end of transect 3. Boat 2 stands by as boat 1 takes a DGPS fix and completes the retrieval of the transect lines. Boat 2 deploys a diver if the transect line becomes snagged during retrieval. Both boats then return to the launch site.

2.2.1.2 Establishment of transect by divers.

To be used when adverse wind, current or irregular bathymetry make the previous procedure impractical.

Boat 1 (3 persons, boat person and 2 divers)

1. Boat 1 will reconnoiter general area using pre-marked aerial photographs and GPS readings as guidance.

2. The site is viewed using a viewfinder or a snorkel diver to confirm suitability of the site.

4. Boat 1 deploys divers with pickets, hammer and transect line (still on reel) at transect 1 start point.

5. Divers hammer star picket in substrate, attach the polypipe extension and position weighted marker float adjacent to picket.

6. Divers clip the transect line to the marker weight and run it out on a predetermined compass bearing.

7. At the end of the transect the divers hammer a star picket into the substrate, and attach the polypipe extension.

8. Divers continue to run transect line out for 10m (unmarked colored line). At the end of 10m the star picket marking the start of transect 2 is driven into the substrate and polypipe extension attached. Another marker buoy attached to a weight is positioned adjacent to the star picket.

9. The divers then repeat steps 5 through 8 for the last two transects and place a marker buoy at the end of transect 3

10. Divers then surface and are retrieved by boat 1. Boat 1 willstandby until boat 2 has retrieved it's divers.

11. Boat 1 then takes DGPS coordinates of the transect start points. Boat 1 then retrieves the transects lines. In the event of the transect line becoming snagged a snorkeller from boat 1 re-enters the water to un-snag the line.

Boat 2 (3 persons: 1 boat operator, 2 divers)

1. As soon as boat 1 has completed the laying of transect 1, the two video divers are deployed. One diver has the role of video camera operator, and the second is data recorder. Diver 1 descends with the video camera, diver 2 with underwater slates.

2. The divers descend to the beginning of transect 1. The camera operator films the surrounding reef. Anything that is of significance is also taped. The site and transect details inscribed on the first picket are taped. Then the diver proceeds video taping along the transect line (Section 2.2.2).

3. Diver 2 removes the end of the transect line from the star picket and then follows diver 1 who is video taping the transect. Diver 2 also records general observations about the reef, any visual impacts etc. Diver 2 will also draw mud-maps of the location of the star picket in relation to coral/sand landmarks.

4. Steps 2 through 3 are repeated for transects 2 and 3 .

5. The divers then return to boat 2and standby as boat 1 completes the retrieval of the transect lines. Then both boats return to the launch site.

2.2.2 Sampling methodology for the collection of benthic hab itat video imagery

This sampling technique is adapted from the AIMS Standard Operating Procedure No. 2 (Christie *et al.*, 1996). The steps required for preparation of the underwater housing and video camcorder are included in Appendix III. The recording of data for each transect should be carried out according to the following steps:

1 Fill out the details on the in-water data sheet (located on the top of the housing) identifying the transect. Record the site number, date, transect number, and recorder's name.

2 Set the camcorder to **autofocus**, press REC and video a panoramic shot of the start of the transect. Start at the star picket, hold the camera in a horizontal position and turn slowly clockwise, videoing the immediate surroundings and ending at the initial view. Move in on the top of the star picket to record the site number and transect number written on the white plastic cap. Press STBY.

3 Record the start time code on the data sheet. Press REC and video the base of the star picket for a few seconds and then move along the tape or scaled rope, keeping it approximately 10 cm in from the right hand side of the field of view. Keep the housing lens parallel to the substrate at a distance of 30 cm.

4 Follow the transect line keeping the housing at the set height of 30 cm, ensuring that the screen image is in focus. Adjust your swimming speed so that it is constant and you cover approximately 10 m every minute, and

not faster. This is important to ensure a high quality of image. The entire transect should take between 5 and 6 minutes in total. At the end of the transect video the base of the star picket for a few seconds and then press STBY.

5 Record the finish time code on the data sheet.

6 If video recording along a transect has to be aborted for any reason, or if there is considerable variation in the height or speed of the recorder, then the entire transect should be re-sampled, beginning again from the start point of the transect. It is important that the new start and finish time codes for any repeated transects are clearly recorded on the data sheets.

7 Proceed to the next transect. Once all three transects at a site have been completed and the tape has been viewed and checked back on the vessel, full details must be recorded on the main video transect data sheet (Appendix II). Any repeated or incomplete transects, or situations where transects were recorded out of order or with false starts should be noted on the data sheets.

8 A total of three sites should be recorded on each 90 min Hi8 tape. The tape and tape cover should be clearly labeled (using a permanent marker) with the designated tape number (Appendix III), the site number and date of recording. The red copy protect switch on the tape should be switched on to prevent accidental recording over any data, and the tapes should be stored in a waterproof case at all times.

9 At the end of the field trip and before data analysis the tapes must be duplicated, either in Hi8 or VHS format, and the originals archived and stored separately from the duplicates.

2.3 Equipment

2.3.1 Video system

- Blaupunkt CC894 Hi 8 video camcorder, with battery pack (2), battery charger (1), battery discharger (1), yellow and orange filters
- StingRay SR-700 underwater video housing with colour monitor back, super wide-angle and zoom-macro lenses, and built-in red filter
- SunRay underwater lighting system with battery pack (3), battery charger (1), and spare lamps (2).
- Instruction manuals
- Monitor for video camera
- Video transect data sheets
- Sony professional 90 min Hi 8 video tapes (15)
- Housing O-ring kit and silicone grease
- Cleaning kit
- Back-up underwater video system (Sony VHS system)

2.3.2 Still photography

- Camera 1: Nikonos V, 35mm lens and close up kit
- Camera 2: Nikonos V, 15mm lens and SB102 strobe unit
- Land Camera
- 5 rolls of 36 exposure print film
- 15 rolls of 36 exposure slide film
- Log books for cameras 1 and 2
- Kit of camera spares

2.3.3 Safety

- Comprehensive diving first aid kit
- Emergency response flowsheet
- Emergency contact flow chart
- Patient information log
- Accident log sheets

- Spare oxygen D cylinder and regulator
- 4 wet weather jackets
- Sunscreen
- Spare sunglasses
- Vinegar and flask hot water per vessel

2.3.4 Information

- Marine Charts: Satellite photos, coastal maps, sanctuary zone maps with latitudes and longitudes
- Maps with historical data
- Reference books for the identification of corals, fish, birds, marine mammals and marine fauna
- Scientific reference file
- Landsat imagery of Ningaloo Marine Park and southern extension
- Full set of aerial photographs of Ningaloo Marine Park
- Laminated scanned copies of aerial photographs of the sites for field use.
- Habitat data sheets
- Long-term monitoring site data sheets
- Transect data sheets
- Video data sheets
- 1 laptop computer plus 20 floppy discs

2.3.5 Diving

SCUBA

- Personal dive gear
- 10 scuba tanks
- 6 BCD's
- 6 regulators with alternate airsource and gauges
- 2 masks and snorkels
- 2 spare pairs of fins
- 2 dive computers
- 7 weight belts, each with 24 lb of weight (plus 3 spare weight belts)
- 4 compasses
- 2 boat dive flags
- 1 personal dive flag
- 2 dive spare parts and repair kits
- 6 pocket size underwater slates, grips and pencils
- 4 large underwater slates, grips and pencils
- 4 catch bags

Accessories

- 100 sheets underwater paper
- box graphite sticks
- box elastic bands
- printed underwater paper for recording video codes
- 4 field notebooks
- 1 box of pencils
- 1 stationary box
- 1 viewfinder
- equipment log book
- Scuba log book

Vessels (inflatables)

- CALM MCB 12'6" zodiac (C401)with all safety equipment for survey exempt vessel, fitted with 35hp Yamaha

- CALM (Karratha) 4.2 . inflatable with all safety equipment for survey exempt vessel, with 30 hp Evinrude outboard.
- AIMS 4.2 rigid hull inflatable may also be used plus 40 hp motor.
- Bags, repair kit, ropes, oars and lines, and fuel tanks

Vehicles

- MCB Landcruiser with full length roof rack (hired from Jaram P/L Ph 9362 6899) and extra spare wheel
- MCB heavy duty trailer with 2 spare wheels/tires, bracket to hold 2 outboards and racks for inflated zodiac.
- AIMS vehicle with trailer
- CALM Karratha vehicle
- Vehicles to have full tool kit, battery jumper leads, tyre inflator coupled to scuba cylinder valve.

Compressor and generator

- MCB compressor
- AIMS compressor (back-up) will be left at Exmouth
- Tool and repair kits
- Fuel container (20l)
- Generator

2.3.6 Position fixing, communications and habitat data recording

Position fixing

- 1 hand held GPS units and accessories
- 1 Omni star differential GPS unit, antennae and accessories

Communications

- 2 calm hand-held radios and chargers
- 2 waterproof bags for radios
- 1 HF CALM radio
- CALM vehicle equiped with CALM VHF
- Satellite phone

Mechanical and electrical repair kits

- Comprehensive mechanical tool kit
- Comprehensive electrical repair kit

Transect establishment

- 9x pre cut marker buoys (6 x 5m, 3 x 10m)
- 4 x 50m weighted transect lines, marked at 10cm increments
- 3 x 10m lines marked at 1m increments
- 180 x 600mm galvanised steel pickets
- 100 x 1800mm galvanised steel pickets
- 280 x 600m PVC caps for pickets
- 400 x 250mm stainless steel for fixing caps
- 3 x permanent markers for marking caps
- 2 x 15lb sledge hammers
- 3 x picket drivers
- 2 x driver extensions
- 10 x 8lb weights
- 2 x 100 m rope

Other items

- 20 D batteries
- 12 C batteries
- 2 motorbike batteries and chargers

2.3.7 Camping equipment

- MCB Engels 12/240v fridge/freezer with connections
- 3 x 4 person dome tents
- 1 x portable generator with 2 fluoro lights, cables and power boxes
- 2 x kitchen fly's with poles, guys and stakes
- 2 x petrol lights
- 1 x gas light
- 4 x gas bottles
- 2 x tarps (ground sheets)
- 1 x gas ring burner
- 1 x 3 ring stove
- 1 x MCB 2 ring stove
- 2 x tables with legs
- 3 x bench seats with legs
- 1 x kitchen box
- crockery and cutlery for 7 people
- pots and pans
- 7 x folding chairs
- 1 x MCB esky
- 5 Air-mattresses
- 2 swags
- 1 bush shower
- 100 l drinking water

3 FIELD PROGRAMME

3.1 Field itinerary

The field itinerary for the field survey period 27 April to 29 May 1998, including travel details, is given in Table 3.

3.2 Equipment suppliers and relevant contacts

The following list gives contact details of the suppliers of major items of equipment.

Aerial photos: DOLA, Gary Caporn, Ph. 92737209
Ansett: Flights, Ph. 131644
Calm, Exmouth: Ph. (08) 99 491676 (fax) (08) 99 491580
Transport: Cape Transport (Mick & Jane Stamp, or Shane) Ph. 08 99491041
Car: Budget, Todd Maskiell, Ph. 4791919
Compressor: Serviced by Australian Safety Engineers, Ph. (08) 9 527 9211
Drop-down camera: Cunard Technologies, Mark Harris (014 884 006/458 4022
Exmouth automotive and marine Alan Waddingham; (08) 99492795
John Houghton (Courier Service Exmouth to Mildura via Coral Bay): 08 99491020
Omnistar differential GPS: Fugro Pty Ltd, Gary Allen, Ph. 93225295
Padbury Scout Group: (camping equipment), John Maher, Ph 9401 2884
Pickets: supplied by: Whites wires, Lindsay, Ph 9353 2771 fax 9353 2776
galvanising: Lyons Galvanising, Paul, Ph 9356 1797
PVC picket extensions: Swan Irrigation, Steve Carrie, Ph 9446 9966
Scoutmaster GPS: Benchmark, Rob Fergusen, Ph. 08 2325405
Transport: cape Transport, Mick Stamp, Ph (08) 99 491041
Underwater scooter: Dolphin Dive, 3532488
Underwater video system: Sea Optics, David Hull, Ph. 08 3626161
Zodiac inflatable vessel: Wiltrading, Geoff Jordan, Ph. 3359155

Warroora gate key: Leonie Horrick (Gate Key): Exmouth Wk. Ph. (08) 9 949 1144, Exmouth Hm. Ph. (08) 9 949 2727
Warroora homestead:
Exmouth Tourist Bureau: (08) 9 949 1176

3.3 Emergency contacts

General
CALM, Exmouth: Ph.(08) 9 949 1676 and (08) 9 949 2113, Fax (08) 9 949 1580
CALM, Marine Conservation Branch, Fremantle: Ph (08) 9 432 5100; Fax (08) 9 430 5408
Fisheries Department, Exmouth: Ph (08) 9 949 2755
Coral Bay Nursing Post: Ph. (08) 9 942 5828 (Maureen Woodhams private Ph. (08) 9 942 5825)
Exmouth Dive Centre: Coral Bay Ph (08) 9 942 5824; Exmouth Ph (08) 9 949 1201
Exmouth Hospital/Ambulance: Ph.(08) 9 949 1011, fax (08) 9 949 1017
Exmouth Police: Ph. (08) 9 949 2444
Fremantle Hyperbaric/Diving Service: (08) 9 431 2233 or (08) 9 431 3333
Royal Flying Doctor Service: Admin., Ph (08) 9 414 1200
Coral Bay Volunteer Rescue Group: Ph. (08) 9 942 5933 , Call Sign: VMR679, Channel 90 (UHF,VHF)
Emouth Sea Rescue Group: Ph. (08) 9 949 2382, Call Sign: VMR682, Channel 90 (UHF, VHF)

AIMS Satellite Phone: Ph. 014 110476

Radio
CALM VHF Radio: Monitored at Exmouth office, use channel 11 (north of Yardie Creek) and channel 17 (south of Yardie Creek).
Marine HF - channel 2182, 4620. These channels will establish contact with:
Royal Flying Doctor Service: HF radio frequencies monitored 24 hrs are :
4045,4030,4010,5300,5360,6880,6890,6960 from Operations Centre, Jandakot.

4 SAFETY

Safety issues relating to:

- the field work is the responsibility of the Field Team Leader, Jennie Cary (May 3-19), Tim Daly (May 20-29)
- diving is the responsibility of the Diving Supervisor, Tim Daly or Mike Lapwood and have taken into account CALM's departmental safety procedures and protocols
- boating and navigation is the responsibility of the boat skipper.

5 BUDGET

A budget of $20 000 has been allocated for this survey.

1	VESSELS/COMPRESSOR/GENERATOR:		
	fuel	1100	
	40 tank fills @ $5.00 each	200	
2	TRANSPORT		
	2800 km Ningaloo to Perth; then $100 /day at Ningaloo		
	=5300km/car/day @45c/km=$2385		2385
	Airfare (Exmouth/Perth	1037	
	Bus trip (2) (Coral Bay/ Perth)	500	
	transport of equipment by road	500	
3	EQUIPMENT		
	starpickets plus extensions		2648
	making transects	150	
4	SUNDRY CONSUMABLES		
	20*@20 Hi 8 videos and VHS	460	
	extras - batteries, waterproof paper, dubbing	600	
5	ACCOMMODATION AND FOOD		
	Tantabiddi chalet for 7 people/10 days	1100	
	Coral Bay $500/week for 2 weeks	1000	
	Camping - equipment hire/allowance etc.	900	
	Gnaraloo station -2 nights	400	
	food	3150	
6	OTHER		
	Preliminary and final report	400	
	diving allowance		750
	aerial photos	400	
	Volunteers medicals	460	
TOTAL		18140	
CONTINGENCY (@10%)		1814	
		19 954	

Table 5 Field itinerary for the period 29 April to 29 May1998.

Date	day	Site number location	Activity
29 April	W		Bulk equipment leaves Perth via truck
30	T		Truck delivers equipment: 3 crates to Yardie Caravan Park and 1 crate to CALM rangers house at Coral Bay.
2 May	S		Lapwood, Myers, Grubba, Gale and Rowen depart Perth by vehicle at approximately 0800 hrs and arrive Yardie Homestead Caravan Park at approximately 2000 hrs
3	S		Equipment set up; Heyward and Fields arrive from Dampier (car) with AIMS boat and motor plus equipment and CALM Karratha boat and motor; Cary arrives Learmouth airport 6.45pm. Six people based at Caravan Pk (chalet #6) and 3 at Milyering.
4	M	Site 1: Bundegi	Field work Field crew: Cary, Lapwood, Myers, Grubba, Gale, Fields, Heyward
5	T	Site 2: Mildura Wreck	Field work; Heyward leaves by plane at 5.35pm; Moore arrives from Karratha by car.
6	W	Site 3 : Vlamingh Head a	Field work
7	T	Sites 4&5: Torpedo Bay & Tantabiddi &	Field work;
8	F	Site 6: Ned's Camp	Field work
9	S	Site 7: Turquoise Bay	Field work
10	S		Rest day;
11	M	Site 8: Osprey	Field work (field crew: Cary, Lapwood, Myers, Grubba, Gale, Fields, Moore)
12	T	Additional site/s	Field work
13	W		Pack up and move camp- set up camp-site at Winderabandi for 3 or 4 days
14	T	Site 9: Bunderra	Field work
15	F	Site 10: Lefroy Bay	Field work
16	S	Site 11: Pt Cloates	Field work
17	S		Pack up and move camp to Coral Bay -House (No 26) booked at Coral Bay for 2 weeks (from Saturday 16); If problems Contact Frank and Cynthia Smith (Bay 183 Bayview Park)
18	M		Rest day; Gale catches bus back to Perth; Lapwood takes vehicle to Learmouth and flies back to Perth and Daly arrives from Perth. Justin Parker and Glen Jarmaine arrive by bus from Perth. Kim Brooks arrives from Karratha.
19	T	Site 14: Coral Bay	Field work; Field team: Daly, Myers, Grubba, Jarmaine, Parker, Moore, Fields and Brooks. Shields arrives in Learmouth at 5.05pm; Moore leaves Learmouth for Karratha at 5:35pm. Vehicle goes to Carnarvon for shopping and drops Fields off. Cary talks with locals about usage of area.
20	W	Site 12: Dugong Sanctuary	Field work
21	T	Site 13: Bruboodjioo Pt	Field work; Cary flies back to Perth

23	S	Additional Site(s)	Field work
24	S	.	Rest day
25	M	Site 16: Alison Pt	Field work
26	T		Pack up and move to campsite near Gnarraloo
27	W	Site 17: Cape Farquhar	Field work completed
28	T	Site 18: Gnarraloo Bay	Field work and pack up drive to Coral Bay
29	F		AIMS car drops gear at Coral Bay to be transported back to Perth. Brooks and Daly stay in Coral Bay for AIMS Coral Taxonomy course (accommodation still available). Shields drives back to Karratha. Grubba, Myers, Jarmaine, Parker and Rowen drive CALM MCB car back to Perth.

6 REFERENCES

Christie C A, Bass D K, Neale S J, Osborne K and Oxley W G (1996). Surveys of sessile benthic communities using the video technique. Long-term monitoring of the Great Barrier Reef. Standard Operational Procedure Number 2. Australian Institute of Marine Science, Townsville, Queensland.

Department of Conservation and Land Management (1989). Ningaloo Marine Park Management Plan 1989-1999. Management Plan No. 12. Department of Conservation and Land Management, Perth, Western Australia.

APPENDIX I

SPREADSHEET AND MAP OF HUMAN USAGE IN NINGALOO MARINE PARK

APPENDIX II

DATA RECORDING SHEETS

TRANSECT DATA SHEET

Project	NINGALOO MARINE PARK MONITORING PROGRAM				**Field Survey**		MAY 1998
Site No.	N	**Site Name**		**Date**		**Recorder**	
Time		**Video tape no.**	NMPMP/bvt/ /#		**Video operator**		

T1	**Length (m)**	**50**	**Compass bearing (°)**		**Distance to T2 (m)**	
Transect	**DGPS Lat**	**DGPS Long**	**Depth (m)**	**Picket type**	**Picket ht (m)**	
Start	° ' S	° ' E				
Finish	° ' S	° ' E				

Notes: (eg. description of habitat and dominant species along transect)

T2	**Length (m)**	**50**	**Compass bearing (°)**		**Distance to T3 (m)**	
Transect	**DGPS Lat**	**DGPS Long**	**Depth (m)**	**Picket type**	**Picket ht (m)**	
Start	° ' S	° ' E				
Finish	° ' S	° ' E				

Notes:

T3	**Length (m)**	**50**	**Compass bearing (°)**		**Distance to T1 (m)**	
Transect	**DGPS Lat**	**DGPS Long**	**Depth (m)**	**Picket type**	**Picket ht (m)**	
Start	° ' S	° ' E				
Finish	° ' S	° ' E				

Notes:

Project	NINGALOO MARINE PARK MONITORING PROGRAM				Field Survey		MAY 1998
Site No.	N	Site Name		Date		Recorder	

GPS Latitude	GPS Longitude	Differential			
° ' S	° ' E	Yes	☐	No	☐

Habitat type						
Location of nearest transect from GPS position	Transect No.	T	Compass bearing (°)		Distance (m)	

Site Map (include north indicator, scale, vessel location, water depth, transect locations & other features of interest):

Notes:

HABITAT DATA SHEET

Project	NINGALOO MARINE PARK MONITORING PROGRAM				**Field Survey**		MAY 1998
Site No.	N	**Site Name**		**Date**		**Recorder**	
Vessel		**Time**		**Weather**			
Sea		**Water depth (m)**		**Water visibility (m)**			
GPS Latitude		**GPS Longitude**		**Differential**			
° ' S		° ' E		**Yes**	☐	**No**	☐
Site location							

Habitat Description

Dominant Species

Seagrass	
Macro-algae	
Coral	
Fish	
Invertebrates	

Other Features

Impact or Activity

Video reference	NMPMP/bvt/ /#	**Aerial reference**	/WA /RUN /
Slide reference		**Print reference**	

VIDEO DATA SHEET

Project	NINGALOO MARINE PARK MONITORING PROGRAM				**Field Survey**		MAY 1998
Site No.	N	**Site Name**		**Date**		**Recorder**	
Start time		**Finish time**		**Depth (m)**		**Visibility (m)**	

Underwater Video System	Blaupunkt CC894 camcorder in StingRay SR-700 housing

Focus mode				**Exposure mode**				**Program mode**				**White balance mode**			
Auto	☐	Manual	☐	Auto	☐	Manual	☐	Sports	☐	High-speed	☐	Auto	☐	Outdoor	☐

Lens system				**Filters**								**Lights**			
Wide-angle	☐	Zoom-macro	☐	None	☐	Red	☐	Yellow	☐	Orange	☐	On	☐	Off	☐

Video operator		**Tape no.**	NMPMP/bvt/ /#	**Height above substrate (cm)**	50
Time coding for all video footage at site:		**From:**	: : :	**To:**	: : :

Transect time coding	**Start**	**Finish**	**Total time (mins/secs)**
T1	: : :	: : :	.
T2	: : :	: : :	.
T3	: : :	: : :	.

Notes:

APPENDIX III
UNDERWATER VIDEO SYSTEM

Preparation of underwater housing and video camcorder

Step-by-step instructions on preparing the StingRay SR-700 housing and Blaupunkt CC894 camcorder are given below. This procedure is adapted from the AIMS Standard Operational Procedure Number 2: "Surveys of sessile benthic communities using the video technique" (Christie *et al.,* 1996).

Where possible, store and prepare the equipment at room temperature to prevent condensation on the lenses of the camcorder and housing. Carry out these preparations in a dry, dust and spray-free environment. For more details refer to the relevant instruction manual.

Housing

1) Open the housing by simultaneously releasing and rotating the two black plastic catches at the rear of the housing. Carefully remove the monitor back and place to one side. Remove the camera tray by depressing the small black plastic catch on the left hand side and simultaneously sliding out the tray. Check the inside of the housing for any dust or other particulate matter, and clean out using a lens cloth and blower brush if necessary. Check the inside of the lens and the red filter and clean using blower brush, lens tissues and lens cleaning fluid if necessary. Check which lens is attached to the housing - super wide-angle (the shorter of the two available optics) or zoom-macro. **For transect work the super wide-angle lens is required.**

2) If using the SunRay lighting system, install a fully charged battery in each of the battery pods mounted on both sides of the housing (see StingRay instruction manual).

3) Remove the two O-rings from the monitor back, clean them with lens tissues and check for any cracks or scratches. If there is any damage to the O-rings, discard and replace with new ones. Apply a small amount of silicone grease (2-3 mm) between thumb and index finger and run the O-ring through several times to spread this evenly. Repeat with the second O-ring. **Ensure that you do not use too much grease as this could cause the seal to leak!** Remember that the grease is there to keep the O-rings supple and not to actually form a seal.

4) Clean out each O-ring groove with a cotton bud, and carefully replace the clean and greased O-rings back into the grooves without twisting them. Ensure that there is no particulate matter sticking to the O-rings. The housing is now ready for the camcorder to be inserted.

Camcorder

5) Place the camcorder on a clean, dry, flat surface and attach the StingRay battery adapter to the rear. Attach a fully charged Sony NP-78 battery pack to the battery adapter. Remove the lens cap, check the lens and clean if necessary. Attach a yellow or orange filter if required (see point No. 24).

6) If the housing zoom-macro lens system is being used, attach the zoom-macro adapter to the front of the camcorder. This accessory lens pushes on in front of the camcorder lens, so that it lies flush with the manual focusing ring.

7) Press the eject switch (small switch with blue button on top of camcorder) and insert a blank Hi 8 video tape into the cassette holder, ensuring that the red copy protection switch is switched off. Close the cassette holder by gently pressing the 'PUSH' mark on the right side - the top section of the cassette holder will then close down automatically. **Do not push it down manually.**

8) Switch the camcorder on by sliding the OPERATE switch (front left side with green button) to CAMERA. Turn the REC switch (rear left side with red button) to STANDBY.

9) Select the camcorder settings. Turn the IMAGE STABILIZER switch (below the AUTO MODE cover on left side) to ON. Open the AUTO MODE cover and set the functions as follows:

FOCUS- the focus mode can be selected when the camcorder is inside the housing.

EXPOSURE - leave the exposure mode in automatic setting (no exposure indicator on the left side of the LCD display).

PROGRAM - select the desired shutter speed by pressing the PROGRAM button. The SPORTS setting (indicated by a running figure on the LCD display) gives a shutter speed of 1/50 to 1/500 of a second. **This will be suitable for**

moving subjects such as marine mammals or fish it would probably be better to select the HIGH SPEED setting (indicated by a golfing figure on the LCD display), giving a shutter speed of 1/4000 sec.

WHITE- the white balance setting can be selected when the camcorder is inside the housing (see point No. 18).

10) Ensure the viewfinder lens is removed, and the viewfinder is locked in the down position (see camcorder instruction manual for details).

11) Ensure that the timecode function is switched on (TC displayed on the top right side of the LCD display). If it is off, press the COUNTER/TIMECODE button below the LCD display so that TC is displayed.

12) Mount the camcorder on the StingRay camera tray, ensuring that the camcorder is correctly aligned and that the screw on the bottom of the tray is tightened firmly. Attach the cables from the tray to the camcorder, in the following order:

    i) attach the video cable (yellow label) to the VIDEO OUT plug (front right side), ensuring that it is routed snugly under the base of the battery and inside the camcorder grip strap (otherwise it will not reach the plug);

    ii) attach the power-out cable (green label) from the battery adapter to the DC power jack on the camera tray;

    iii) attach the remote cable (blue label) to the blue REMOTE plug (back right side);

    iv) attach the microphone cable (red label) to the red MIC plug (front right side),ensuring that it is routed under the lens and clear of the camera tray.

13) Slide the camera tray assembly into the grooves in the housing and push forward gently until it will not go in any further. Check that the assembly is locked in place and cannot be withdrawn without depressing the small black plastic locking button at the rear left hand side of the camera tray.

14) Ensure that the two black plastic catches on the outside of the housing are in the vertical position with the slots facing towards you. Place the monitor back onto the rear of the housing, ensuring that the two black plastic guide pins go into the guide holes on the camera tray. Simultaneously rotate the locking catches towards you, ensuring that the stainless steel guide pins on the monitor back enter the slots on the catches. Continue to rotate the catches until they lock in the horizontal position. Inspect around the circumference of the monitor back to ensure that it is properly seated.

15) Assemble the monitor back screen shade and place it in the tracks of the monitor back. Slide it down until it locks in place.

Pre-filming checks

16) Power up the camcorder by sliding the PWR switch (right side rear) towards you and holding it in place for 2 seconds. A green LED comes on at the bottom centre of the monitor back, and the screen display will come on. Check the screen display to ensure that all the camcorder functions are set correctly. At the top right side of the display there should be Hi8 and SP (indicating that the tape is Hi8 format and record mode is set for short play), and STBY (indicating that the camcorder is in standby mode). Underneath these symbols the time code indicator and the remaining tape indicator, will be displayed. At the bottom right side the battery indicator will be displayed. At the top left side there will be a hand symbol (indicating that the image stabilization system is on), and a running figure symbol (indicating that the shutter speed is set to SPORTS mode), and a hand symbol with the letter F inside (indicating that the manual focus mode is on). Check the manual focus by holding the focus switch (left side front) to both N (near) and F (far) positions.

17) To switch to autofocus mode, toggle (push and immediately release) the PWR switch towards you. Do not hold the switch in place or the camcorder will turn off. To return to manual focus mode, toggle the AF switch away from you. Use automatic focus for panoramic shots and manual focus for filming the transects.

18) Toggle the WB switch (left side) towards you repeatedly to change the white balance mode (as indicated by symbols in the top left side of display). The settings available are:

AUTO MODE - (no symbol): automatic white balance setting.

HOLD MODE - (HOLD): the last automatic white balance setting is locked and maintained, even if lighting conditions change.

OUTDOOR MODE - (sun symbol).

INDOOR MODE - (light bulb symbol).

For video transect work the most suitable settings are AUTO or OUTDOOR. Use the OUTDOOR mode in shallow (<3 m) water, on bright sunny days when the water visibility exceeds 8 m. Otherwise, leave the white balance in AUTO mode.

19) If there are any other symbols displayed on the screen check the camcorder instruction manual to determine what they represent.

20) Ensure that the zoom function is set to full wide-angle. Move the zoom switch (right side front) to the W position and hold it there. Check the zoom indicator on the left side of the screen display. (*Note: When using the super wide-angle lens and the auto focus mode, the camcorder will only zoom in and stay in focus for about 50 % of the full range before going out of focus. To zoom in closer than 50 % the zoom-macro lens system should be fitted).*

21) Turn the power off by moving the power/record switch to PWR and holding it there for 5 seconds. the screen display and the green LED will turn off.

22) Check that there is no condensation on the camcorder lens or housing lens. If condensation is present, delay filming until it disappears (approximately 10 minutes). The housing should be kept out of the sun during transport.

23) Once in the water, if visibility is good (>8 m) and transects are in water >3 m deep, slide the red filter down over the lens by turning the knob on the front plate of the housing. If transect is in water <3 m deep, or if the visibility is poor it will probably be necessary to use a yellow or orange filter that screws on to the camcorder, directly in front of the lens.

24) Check the housing for leaks. This may be indicated by a moisture condensation symbol on the screen display (refer to camcorder instruction manual), bubbles coming from the housing, or water droplets visible inside the housing when you look through the housing lens.

25) Before starting to film, check the front of the housing lens for small air bubbles. Gently wipe away any that are present with your hand. Check for air bubbles regularly.

26) If lighting conditions are poor, switch on both SunRay lamps.

27) Turn the power on (move the power/record switch to PWR position and hold it there for 2 seconds) and commence recording (toggle the switch to the REC/STBY position. A red LED will come on at the bottom centre of the monitor back, and the REC symbol will appear at the top left side of the screen display.

Post-dive procedure

28) After every dive immerse the housing in fresh water. Leave it there for 10-15 minutes and wash the controls and monitor back with running water. Remove the monitor back screen shade.

29) Wipe the housing with a clean, dry towel and leave in a clean, dry, airy and salt-free environment to dry completely.

30) Wipe carefully around the rear seal of the housing before opening so that no water gets onto the camcorder. Open the housing by simultaneously rotating the black plastic catches at the rear of the housing. Remove the camera tray assembly by depressing the small black plastic locking button at the rear left side and sliding the tray out. Detach the cables and remove the camcorder from the tray. Attach caps to both housing and camcorder lens. **Do not open the housing where salt spray is present.**

31) Switch the camcorder to video by sliding the OPERATE button to VTR. Rewind the tape using the either the controls on the top of the camcorder or the remote commander. Connect the camcorder to the TV monitor (refer to camcorder instruction manual) and view the footage. Transcribe the system settings and time code information onto the main Video Transect Data Sheet (Appendix II). Label the tape clearly (using a permanent marker pen)

Tape numbering

The video tapes should be consecutively numbered according to the following coding system:

Project acronym (SBMRMP)/Sampling method (bvt - benthic video transect)/Date (07.04.97)/Tape number (#1 onwards).

Thus, the first tape would be labeled as: **SBMRMP/bvt/07.04.97/#1**

If the tape contains footage spanning more than one day the tape number should indicate this (e.g. **SBMRMP/bvt/07-08.04.97/#1).**

32) A total of three sites should be recorded on each 90 minute Hi8 tape. Before commencing filming at another site, ensure that the tape is wound forward to the end of the footage recorded at the previous site. This will ensure that no data is recorded over accidentally. Once a tape is complete the red copy protect switch on the tape should be switched on to prevent any loss of site data. The tapes should be stored in a waterproof container and duplicated at the end of the field trip.

33) Clean the video heads with the head cleaning cassette after approximately 10 hours of use. Follow the instructions carefully to avoid damage to the video heads. Refer to the camcorder instruction manual for more details.

Recharging the battery packs

34) New batteries should be fully charged and discharged several times before use to prolong their life. The Sony NP-78 batteries should last between 75 and 90 mins, when using the monitor back. Before recharging a used battery, make sure it is fully discharged first (use the REFRESH function on the battery charger or a battery discharger). Once the battery is totally discharged, slide the indicator switch on the top of the battery so that a red dot is visible. This serves as a reminder that the battery is totally discharged. Connect it to a battery charger and charge it completely. This will take approximately 2 hours and 20 minutes for a Sony NP-78 battery. Once it is charged, slide the indicator switch to hide the red dot, indicating that the battery is fully charged and ready to be used. At the end of the field trip, leave all batteries discharged.

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