MARINE MANAGEMENT SUPPORT

A collaborative project between CALM Marine Conservation Branch, CALM Gascoyne District (Midwest Region) and Murdoch University

A project funded through the Commonwealth World Heritage Property fund

Baseline water quality survey of the Cape Peron-Monkey Mia region of the Shark Bay World Heritage Area: Autumn 1998

Field Programme Report: MMSP/MW/SBMP - 08/1998

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Direction

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- Dr Chris Simpson - Manager, Marine Conservation Branch (MCB), Nature Conservation Division.
- Kelly Gillan - Manager, Midwest Region.

CALM Collaboration

- Nick D'Adamo, Project Leader, MCB.
- Paul Brown, Manager, Gascoyne District, Midwest region.

External Collaboration

- Dr Eric Paling, Murdoch University, School of Environmental Science.
- Mike Steber, Department of Land Administration, Remote Sensing Applications Centre, Perth.

Funding and resources

- Funding of $25000 has been obtained through the Commonwealth Government's World Heritage Property management funds.
- Resources including scientific supervision, technical assistance, logistical support and instrumentation are being provided by the MCB.
- The study is being conducted in collaboration between CALM and Murdoch University, School of Environmental Science.
- Resources including technical input, administrative assistance and logistical/operational support are being provided by CALM's Gascoyne District office, Midwest Region.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

This report presents details of a baseline water quality survey to be undertaken during 4 March to 6 May 1998, in the eastern gulf of Shark Bay within the coastal zone off the Peron Peninsula between Cape Peron and Monkey Mia. Measurements at nine sites will comprise; total nitrogen, total inorganic nitrogen, total phosphorus, total inorganic phosphorus, chlorophyll-a, total suspended solids, salinity, temperature and light attenuation.

The study aims to provide a comprehensive quantitative baseline description of the physical, chemical and biological characteristics of this region and to also establish and initialise long-term water quality monitoring sites. The information is required to provide a relevant ecological context from which to assess the impacts of any future changes in the water quality of the area that may be attributed to increases in human activity, such as aquaculture and tourism. Past water quality data (Trayler & Shepherd, 1993; Kendrick, *Pers. Comm.*) indicate that seasonal inorganic nutrient levels are most probably at their highest during the autumn period and also that re-suspension of sediments during strong bottom shear may lead to elevated nutrient concentrations in the water column. This information has been used to help structure the temporal and spatial characteristics of the field program.

The autumn period was chosen for the survey on the basis of historical water quality data which suggested that key water quality parameters exhibit their greatest seasonal variation at this time of the year. The survey has been structured to include a bi-daily (i.e., every second day) data set over the first two weeks (to encompass a complete neap/spring tidal cycle) and thence once per week for the following seven weeks. The historical data sets have indicated that spring tidal flows may be correlated with relatively high nutrient levels in the water column and the intensive bi-daily monitoring has been designed to investigate this hypothesis.

The study will be conducted as a collaboration between the Department of Conservation and Land Management's Marine Conservation Branch and Gascoyne District office and Murdoch University's School of Environmental Science.

1 INTRODUCTION

1.1 Background

Shark Bay (Figure 1) was included on the World Heritage List in 1991, in recognition of the international significance of the environmental values of the area. The Shark Bay Marine Reserves Management Plan 1996-2006 was completed in 1996 (CALM, 1996).

The coastal region off the Cape Peron Peninsula, including the Monkey Mia lagoon, is an important visitor destination in this World Heritage Area and in recent years has experienced rapid growth in tourism and associated coastal infrastructure. In addition, there is now increasing interest from the aquaculture industry to site sea-farms in the area. However, the coastal environment is poorly understood in terms of background water quality. These waters therefore have a high conservation value and are likely to come under increasing pressure in the future from both tourism and commercially-based activity (e.g., recreational and commercial fishing, aquaculture, boating and ecotours). This juxtaposition of ecological values with potential threats means that it is timely to instigate baseline monitoring to define background water quality ahead of likely increases in potentially threatening activities in order to ensure that development proceeds in an ecologically sustainable manner.

The importance of having sound technical information for the management of human activities, that have the potential to threaten the environmental values of these waters, is emphasized in the recommendations of the Shark Bay Marine Reserves Management Plan 1996-2006 (CALM, 1996) and related environmental reports (Environmental Protection Authority, 1989; Trayler & Shepherd, 1993; Wilson, 1994). In a recent report (titled *Review of Environmental Impacts of Water Based Tourism at Monkey Mia*) Wilson (1996) concluded that there is significant potential for eutrophication in these nearshore waters, particularly within relatively poorly flushed areas such as the Monkey Mia lagoon. The current management plan (CALM, 1996) and Wilson (1996) recommend a quantitative baseline water quality survey of the Monkey Mia lagoon and adjacent waters off the cape.

The planned survey will partly address these recommendations by providing the first spatially and temporally comprehensive data set of water quality in the coastal region between Cape Peron and Monkey Mia with the objective of capturing water quality variations in response to typical autumn conditions and neap/spring tidal cycles.

The study aims to provide a comprehensive quantitative baseline description of the physical, chemical and biological characteristics of this region and to also establish and initialize long-term water quality monitoring sites. The information is required to provide a relevant ecological context from which to assess the impacts of any future changes in the water quality of the area that may attributed to increases in human activity, such as aquaculture and tourism. Past water quality data (Trayler & Shepherd, 1993; Kendrick, *Pers. Comm.*) indicated that seasonal inorganic nutrient levels are most probably at their highest during autumn and also that re-suspension of sediments during strong bottom shear may lead to elevated nutrient concentrations in the water column. This information has been used to set the temporal and spatial characteristics of the field program.

The measurements, planned for 4 March to 6 May 1998, have been structured to include a bi-daily (i.e., every second day) data set over the first two weeks (to encompass a complete neap/spring tidal cycle) and thence once per week for the following seven weeks to provide data over a typical autumn period. The historical data sets have indicated that spring tidal flows may be correlated to relatively high nutrient levels in the water column and the intensive bi-daily monitoring has been designed to investigate this hypothesis. It is also likely that occasional strong wind events will be encountered during the survey, particularly during the initial two-week intensive phase, thereby providing an opportunity to measure any possible changes in water column nutrient levels that may be induced by re-suspension due to wind-generated turbulence.

The nine sites chosen (Table 1 and Figure 2) have been selected to provide a logistically manageable, broad spatial coverage in terms of returning water quality data that will represent a naturally occurring range in the respective parameters monitored.

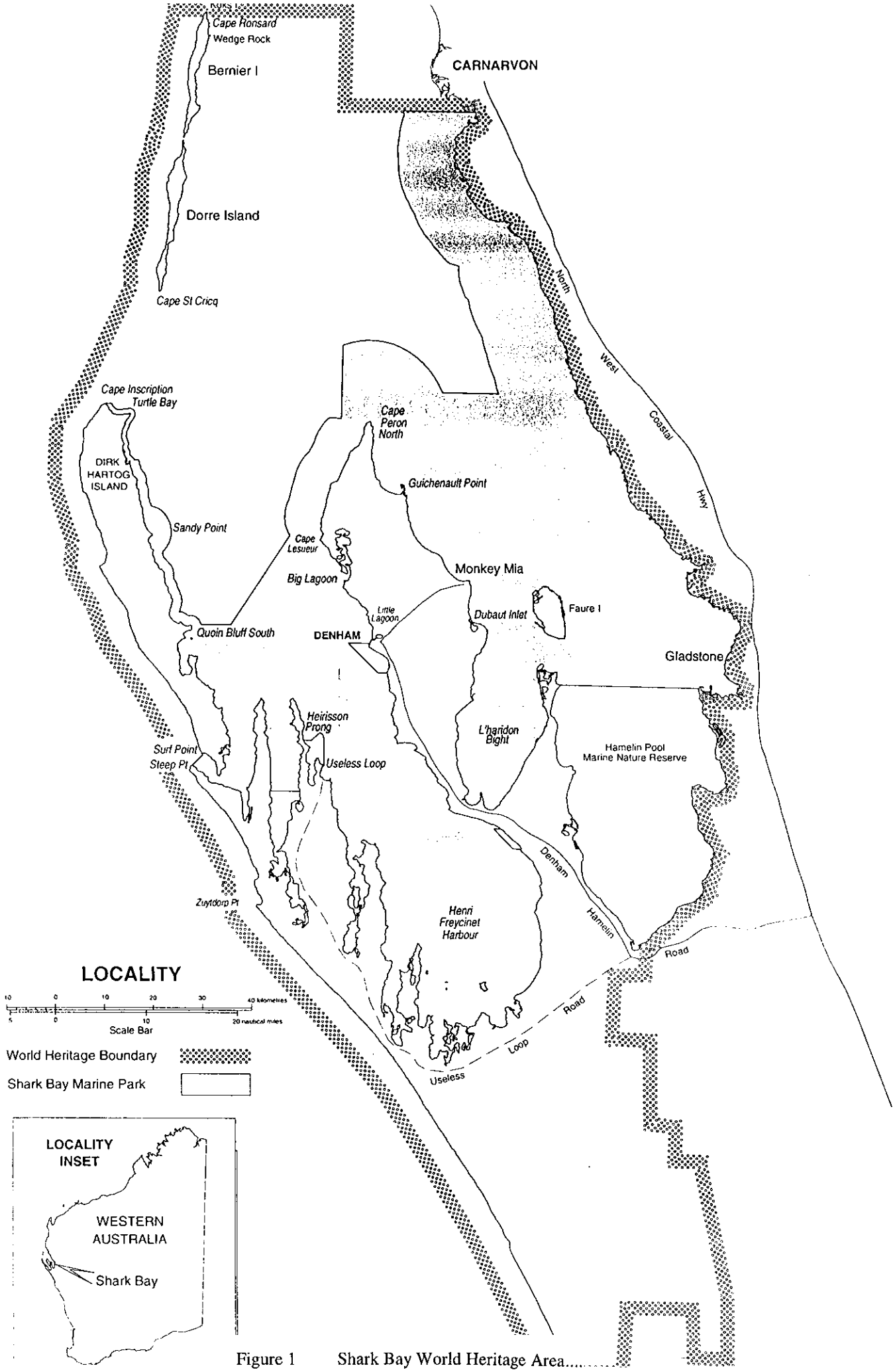

Figure 1 Shark Bay World Heritage Area.....

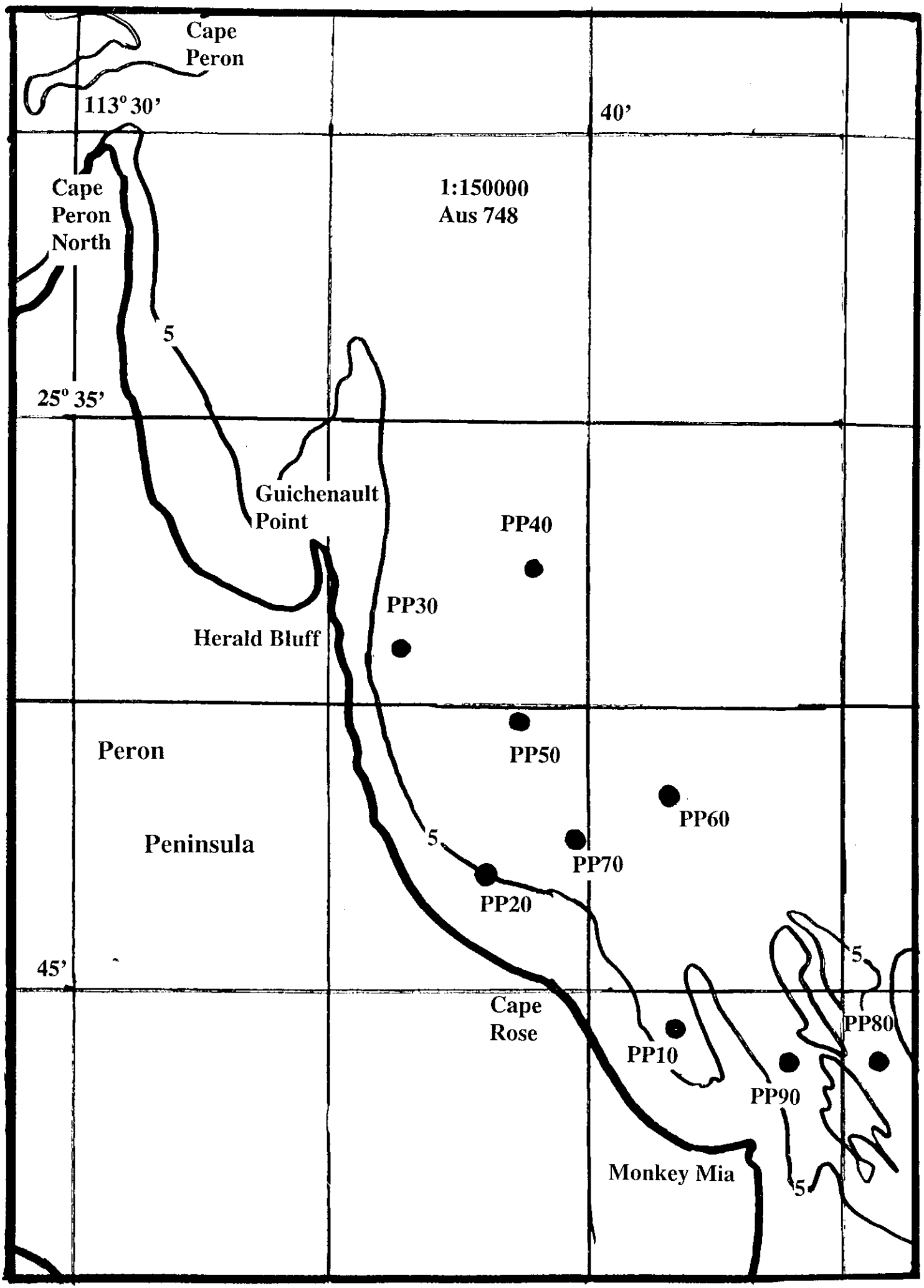

Figure 2 Site locations

1.2 Aims

- To provide a comprehensive quantitative baseline description of the physical, chemical and biological characteristics of the nearshore waters off the Peron Peninsula between Monkey Mia and Cape Peron.

- To establish and initialize long-term water quality monitoring sites in the nearshore waters off the Peron Peninsula between Monkey Mia and Cape Peron.

2 METHODS

2.1 Site selection

The nine sites for the survey are located within the coastal waters off the Peron Peninsula between Cape Peron and Monkey Mia (Figure 2). Access to the sites is from the launching area at Monkey Mia.

The approximate site coordinates are listed in Table 1. The MCB DGPS will be used to accurately record the site locations in the field.

Table 1 Site coordinates

Site	Approximate coordinates (Reference: Chart Aus 748)		Comments
PP10	113^o 41.6’	25^o 45.6’	Weekly
PP20	113^o 38.0’	25^o 43.0’	Weekly; intensive (5-17 Mar)
PP30	113^o 36.4’	25^o 39.0’	Weekly
PP40	113^o 38.9’	25^o 37.6’	Weekly
PP50	113^o 38.6’	25^o 40.3’	Weekly
PP60	113^o 41.6’	25^o 41.6’	Weekly; intensive (5-17 Mar); continuous light and temperature loggers
PP70	113^o 39.7’	25^o 42.4’	Weekly
PP80	113^o 45.7’	25^o 46.2’	Weekly
PP90	113^o 43.9’	25^o 46.2’	Weekly; intensive (5-17 Mar); continuous light and temperature loggers

The eastern gulf has a number of physical characteristics that were considered in selecting the site locations. First, there is a characteristic strong north-south salinity gradient (Logan & Brown, 1986; Smith & Atkinson, 1983) with salinity ranging typically from about 38 pss at Cape Peron to about 45 pss in the vicinity of Faure Island. Hence, it was deemed pertinent to have a spread of sites in the north-south direction. Second, the prevailing wind climate in summer/autumn is strongly influenced by sea-breeze fields that blow from the southwest during which the eastern coastline of the Peron Peninsula is sheltered. Third, the shoreline shape is characterized by a series of semi-protected crenulate-shaped coastal embayments due to the presence of northward aligned sills that emanate from the main coastline, such as at Monkey Mia and Guichenault Point. Furthermore there is increasing interest for aquaculture development to be sited in the region.

The chosen grid will characterize the centre-most of the three repeating nearshore crenulate-shaped bays between Cape Peron and Monkey Mia and the sites have been spaced to provide a broad coverage of the bay and to capture any of the north-south and east-west gradients in environmental conditions discussed above.

Logistically, the chosen field grid falls within the boating safety requirement that the vessel operate within 5 nm of shore. The route is traversable within about 4 hours of boating time in calm to moderate conditions. If each site comprises 30 minutes of monitoring and sampling then a field day should have an approximate duration of 9 hours from launch to retrieval of the vessel at Monkey Mia.

All nine sites will be monitored once per week throughout a ten week period, yielding a total of ten sampling days. Additionally, a subset of three sites will be monitored during every second day of the first two weeks. The

sampling routines are described below.

2.2 Data collection

2.2.1 Weekly measurements

The ten weekly surveys will comprise monitoring of nutrient and chlorophyll-**a** concentrations, total suspended solids (TSS), salinity, temperature and light attenuation, at the sites detailed in Table 2, and according to the following methods.

Nutrient, chlorophyl- a and total suspended solids

Integrated sampling (sites PP10, 30, 50, 70, 80)

Water samples for total nitrogen (TN), total inorganic nitrogen (TIN), total phosphorus (TP) and total inorganic phosphorus (TIP), plus 2 spares (one for totals and one for inorganics) will be taken from depth-integrated water samples. These samples are comprised of a mixture of equal parts of surface and bottom water from sites PP10, 30, 50, 70, 80.

At each site, a five-litre surface volume (collected with a bucket) and five-litre bottom volume (collected with a Niskin bottle) will be mixed in a bucket. From this unfiltered integrated water sample, three 150 ml sub-samples (for TP and TN and an unfiltered spare) are to be placed in labelled polyethylene bags (Nasco "Whirlpak", Kansas, USA). At least two litres of the integrated water will be filtered, using the filter tower, through a 1.2 µm G/FC Whatman filter paper at a maximum negative pressure of 75 kPa. The filter paper is to be wrapped in aluminium foil, placed in a labeled envelope and retained for chlorophyll-a analyses. The volume of water filtered is to be noted and written on the envelope. A greater volume of water should be filtered through the filter paper if this is believed necessary by the field officer to provide a sufficiently dense chlorophyll-a mass on the filter paper. The filtered water will then be filtered through 0.45 µm micropore filter and individual 150 ml sub-samples for TIN, TIP and a spare for 'inorganics' are placed into labelled Whirlpaks.

The remaining unfiltered water (2 litres or more as determined in the field) is to be filtered through a pre-weighed a 1.2 µm G/FC Whatman filter for TSS analyses. Then 250 ml of de-ionized water is to be rinsed through the filter to remove excess salts. The filter paper is to be removed, wrapped in foil and placed in a labelled envelope. All samples are to be placed on ice in an esky and then quickly frozen on return from the day's sampling.

Surface and bottom sampling (sites PP20, 40, 60, 90)

In addition to the integrated measurements, surface and bottom sampling will be conducted at the remaining four sites (i.e., PP20, 40, 60 and 90). At these four sites data will be collected from **both** the surface and bottom water volumes. This will result in nutrient, chlorophyll-a and TSS samples taken from **both** the surface and bottom water volumes, rather than from just a depth-integrated water column sample. The complementary vertical salinity-temperature profiling at all sites will facilitate interpretations in the event that there are marked differences in the concentrations of water quality parameters between the surface and bottom due to say vertical stratification of the water column by local or advective influences.

Transport of samples from Denham to Murdoch University

Each week's set of frozen samples are to be packed with ice in polystyrene packs which will be transported to Perth Airport by Western Airlines. The flight departs Denham every Monday, Wednesday and Friday at 1400 hrs and arrives in Perth Airport at 1700 hrs. Arrangements have been made by Mike Lapwood of the Marine Conservation Branch for Western Airlines to place the samples in a freezer (supplied by the MCB) situated in the premises of Western Airlines at Perth Airport and on the following day Courier Australia will collect and deliver the samples to the Marine and Freshwater Research Laboratory (MAFRL), School of Environmental Science, Murdoch University.

Analyses will be conducted at MAFRL and the results faxed back to the field officer for ongoing data processing and data report production during the ten week survey.

Salinity and temperature

Salinity (S) and temperature (T) profiles will be acquired by manually profiling the water column with a Yeokal Hamon Model 602 Salinity-Temperature Bridge. Data will be recorded on field sheets and backed up by writing each profile data set to an EXCEL data file. Calibrations will be carried out as follows: three times per day a bucket of water will be collected from the surface and (i) a sample of the water placed in a clean sealed salinity bottle (ii) the salinity and temperature of the water in the bucket recorded with the ST meter, and (iii) quickly (within 60 seconds) thereafter its temperature recorded with a scientific thermometer. The calibration information (bottle number, ST meter readings and thermometer readings) are to be recorded on calibration sheets. The salinity bottle samples will subsequently be analyzed for true salinity (within 0.001 pss) at the Commonwealth Scientific and Industrial Research Organization (CSIRO) research laboratories, Marmion, Western Australia. All data will be backed up, by writing each profile data set to an EXCEL data file. Ongoing data processing of the ST data will be conducted throughout the survey.

Light attenuation

Light (i.e., Photosynthetically Active Radiation (PAR) profiles, from which attenuation coefficients will be determined, will be attained by manually profiling the water column with a 2π Li-Cor LI-188b meter. Data will be written to field data sheets and backed up by writing each profile data set to an EXCEL data file. Ongoing data processing of the light data will be conducted throughout the survey. The light meter will be calibrated prior to the survey at the MAFRL.

2.2.2 Intensive measurements

In addition to the weekly measurements, three sites (PP20, 60 and 90) will be visited every second day of the first two weeks of the field survey, at which the sampling routine and analyses will be almost similar to that for the weekly surveys, with the exception being that samples will be collected from both the surface and bottom of the water column. This will result in nutrient, chlorophyll-a and TSS samples taken from both the surface and bottom water volumes, rather than from a depth-integrated water column sample.

2.2.3 Light and temperature logging

Light logging

Four WESDATA light loggers will be deployed for the duration of the survey. The deployment will comprise two sites where at each site light loggers will be positioned near-surface and near-bottom. The light logging sites are PP60 and PP90. The loggers will be calibrated prior to the survey by the MAFRL, Murdoch University. The arrays will be designed and prepared prior to the survey by the MCB.

Temperature logging

Six DATAFLOW temperature loggers will be deployed as vertical arrays at the two light logger sites PP60 and PP90 (3 loggers per site; top, middle and bottom at each site) to provide continuous measurements of water column temperature. The data will be used to indicate the formation and destruction of vertical temperature stratification in response to daytime heat fluxes, wind mixing, tidal stirring and penetrative convection. The temperature loggers will be calibrated prior to the survey by the MCB. The arrays will be designed and prepared prior to the survey by the MCB.

2.3 Analyses and data retrieval

Nutrients and chlorophyll-a

Orthophosphate is to be analyzed by the single solution method (Major *et al*., 1972); nitrate-nitrite after copper-

cadmium reduction with a Technicon Auto-analyser; and ammonia by the phenol-prusside method (Dal Pont *et al*., 1974). Total nitrogen and total phosphorus are to be determined from sulphuric and perchloric digests respectively followed by analyses for ammonia and phosphate, as described above. Chlorophyll-a is to be analyzed after 24 hours in 90 % acetone at 750 nm, 664 nm and 630 nm according to the methods to Jeffrey and Humphrey (1975).

The samples will be transported in a frozen state (*see* Section 2.2.1) to the Marine and Freshwater Research Laboratory (MAFRL), School of Environmental Science, Murdoch University. Analyses will be conducted at MAFRL and the results faxed back to the field officer ASAP for data processing and data report production.

Total Suspended Solids

Suspended solids are the portion of material retained by a filter paper when a solution is passed through it. In the field a well-mixed sample is filtered through a pre-weighed standard glass fibre filter paper (Whatman GF/C 25mm diameter). In the laboratory the retained residue and filter are dried to a constant weight at 105°C.

$$\text{Total Suspended Solids (mg/L)} = \frac{10^6 \times (A - B)}{V}$$

where A = weight of crucible + residue (g).
B = weight of crucible (g).
V = volume of sample (mL)

The samples will be transported in a frozen state (*see* Section 2.2.1) to the Marine and Freshwater Research Laboratory (MAFRL), School of Environmental Science, Murdoch University. Analyses will be conducted at the MAFRL and the results faxed back to the field officer for data processing and data report production.

Salinity and temperature profiles

Each ST profile data set is to be written to EXCEL file and density calculated.

For each site's data set, vertical plots of salinity versus depth, temperature versus depth and density versus depth are to constructed using the EXCEL plotting options.

In addition, time series curves of surface and bottom salinity, surface and bottom temperature and surface and bottom density are to be constructed for the ten survey dates.

The data processing is to be conducted during the field survey.

Temperature and light logger time series

The data from the six temperature and four light loggers are to be retrieved at the end of the fifth and tenth weeks of the survey. Downloading the data at the end of the fifth week will enable a check to be made on the performance of the loggers mid-term during the survey and allow any required maintenance to be performed on the loggers. Data will be calibrated using pre-determined calibration files and written to an EXCEL data file. Time series plots are to be constructed from the six time series.

The data processing is to be conducted during the field survey.

Light attenuation

Light profiles are to be plotted as PAR versus depth and $\log_{10}$PAR versus depth. The attenuation coefficient is to be calculated as the slope of the $\log_{10}$PAR versus depth plot, expressed in units of m^{-1}.

The data processing is to be conducted during the field survey.

2.4 Field summary

2.4.1 Work timetable and personnel

Table 2 presents a summary of the field activities.

Table 2 Field itinerary: 3 March to 8 May 1998

Date	Tide	Sites	Activity	Depth	Personnel
3 Mar 98 (Tues)			Travel to Shark Bay by car (MCB Landcruiser) (Depart 6 AM from 70 Jones Street, Balcatta)		K Bancroft N D'Adamo Y Pedretti
4 (Wed)		PP10, 20, 30, 40, 50, 60, 70, 80, 90 PP60, 90 PP60, 90	• Field preparation • Establishment of stations (GPS plus buoy markers) • Deployment of light loggers • Deployment of temperature loggers		K Bancroft N D'Adamo Y Pedretti
5 (Thur)		PP20, 60, 90 PP20, 60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light	Surface Bottom	K Bancroft N D'Adamo Y Pedretti
6 (Fri)			Travel to Perth by Air Dep M Mia 0850 AN6571 Arr Carn 0905 Dep Carn 0935 AN6572 Arr Per 1135		N D'Adamo
7 (Sat)	Neap	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light	Integrated Surface Bottom	K Bancroft Y Pedretti
8 (Sun)	Neap		Analysis, documentation MCB work		Y Pedretti K Bancroft
9 (Mon)	Neap	PP20, 60, 90 PP20, 60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light	Surface Bottom	K Bancroft Y Pedretti
10 (Tues)		PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light	Integrated Surface Bottom	K Bancroft Y Pedretti
11 (Wed)			Travel back to Perth (charter flight - privately arranged) MCB work		Y Pedretti K Bancroft
12 (Thur)		 PP20, 60, 90 PP20, 60, 90	Travel to Monkey Mia Airport arriving at 0900 (charter flight - privately arranged) K Bancroft to meet Y Pedretti at Airport Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light	 Surface Bottom	Y Pedretti K Bancroft K Bancroft Y Pedretti

Date	Tide	Sites	Activity	Depth	Personnel
13 (Fri)	Spring		Analysis, documentation MCB work		Y Pedretti K Bancroft
14 (Sat)	Spring	PP20, 60, 90 PP20, 60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light	Surface Bottom	K Bancroft Y Pedretti
15 (Sun)	Spring		Travel back to Perth by car (MCB Landcruiser)		K Bancroft
16 (Mon)	Spring	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light De-foul light loggers	Integrated Surface Bottom	Gascoyne Y Pedretti

Date	Tide	Sites	Activity	Depth	Personnel
24 (Tues)	Neap	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90 PP60, 90 PP60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light De-foul light loggers Download and check light and temperature loggers	Integrated Surface Bottom	Gascoyne Y Pedretti
31 (Tues)	Spring	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90 PP60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light De-foul light loggers	Integrated Surface Bottom	Gascoyne Y Pedretti
7 Apr 98 (Tues)	Neap	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90 PP60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light De-foul light loggers	Integrated Surface Bottom	Gascoyne Y Pedretti
14 (Tues)	Spring	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90 PP60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light De-foul light loggers	Integrated Surface Bottom	Gascoyne Y Pedretti
21 (Tues)	Neap	PP10, 30, 50, 70, 80 PP20, 40, 60, 90 PP20, 40, 60, 90 PP60, 90	Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light Nutrients, Ch a, TSS, ST, Light De-foul light loggers	Integrated Surface Bottom	Gascoyne Y Pedretti

Date	Tide	Sites	Activity	Depth	Personnel
28 (Tues)	Spring	PP10, 30, 50, 70, 80	Nutrients, Ch a, TSS, ST, Light	Integrated	Gascoyne Y Pedretti
		PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light	Surface	
		PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light	Bottom	
		PP60, 90	De-foul light loggers		
5 May (Tues)	Neap	PP10, 30, 50, 70, 80	Nutrients, Ch a, TSS, ST, Light	Integrated	Gascoyne Y Pedretti
		PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light	Surface	
		PP20, 40, 60, 90	Nutrients, Ch a, TSS, ST, Light	Bottom	
		PP60, 90	De-foul light loggers		
6 (Wed)		PP10, 20, 30, 40, 50, 60, 70,80,90	De-commission all sites (including light arrays)		Gascoyne Y Pedretti
		PP60, 90	download and check light and temperature loggers		
7 (Thurs)			Pack and arrange road transport of equipment to MCB Fremantle		Y Pedretti
8 (Fri)			Travel back to Perth by Air Dep M Mia 0850 AN6571 Arr Carn 0905 Dep Carn 0935 AN6572 Arr Per 1135		Y Pedretti

Definition of terms in table:
Bottom: Water collected from the bottom with a Niskin bottle.
Ch a: Filter paper containing Chlorophyll-a sample.
GPS: Geographical Position System
Integrated: A mixture of equal parts of water from the surface and bottom.
Light: Vertical profile of Photosynthetically Active Radiation.
Light loggers: Wesdata light loggers for fixed long-term deployments
Nutrients: Water samples (150 ml in Whirlpaks) for total nitrogen (TN), total inorganic nitrogen (TIN), total phosphorus (TP) and total inorganic phosphorus (TIP), plus 2 spares (one for totals and one for inorganics).
ST: Vertical profile of salinity and temperature.
Surface: Water collected from the water surface (skimmed with a bucket).
Temperature loggers: DATAFLOW temperature loggers for fixed long-term deployments.
TSS: Filter paper containing Total Suspended Solids sample.
Y Pedretti: Murdoch University post-graduate student.

2.4.2 Accommodation, food and incidental expenses

Accommodation

Field crew will be based at the Shark Bay Caravan Park, Denham: Ph. 08-99481387. The accommodation roster is as follows.

3-16 March 98	Y Pedretti, K Bancroft, N D'Adamo	Shark Bay Caravan Park - 2 bedroom Chalet
16 Mar - 8 May 98	Y Pedretti	Shark Bay Caravan Park - En-suite cabin

Food and incidental expenses

An account for food is to be set up with the supermarket in Denham upon arrival. The supermarket manageress is Jackie (Ph: 08-99481351). Y Pedretti and K Bancroft will have the authority to purchase on this account. All purchases are to be accompanied by receipts and receipts are to kept and handed to the MCB at the end of the

survey.

A cash 'kitty' of $500 will be held by Y Pedretti and K Bancroft for incidental expenses. All purchases are to be accompanied by receipts and receipts are to kept and handed to the MCB at the end of the survey.

2.4.3 Travel

- Car to and from Denham: MCB Landcruiser 3-14 March 1998
- Car during field surveys: By arrangement with Paul Brown, Manager, CALM Gascoyne District office.
- Air travel from Monkey Mia to Perth for N D'Adamo (6 March) and Y Pedretti (8 May): Ansett Airlines departing from Monkey Mia (see Table 2). Tickets at collection counter, Monkey Mia airport.

2.4.4 Equipment list

Note, this equipment list is to used to confirm all field requirements and group all equipment ready for packing in the MCB Fremantle field station by Wednesday 25 February 1998.

CALM vessel

The CALM vessel will be the MCB "EX63" 4.7m Westerberg aluminium runabout with 40hp Johnson outboard. The vessel is equipped with:

- 9hp auxiliary motor from Gascoyne District Office
- VHF marine radio
- CALM HF radio
- Safety equipment: life jackets, flares, fire extinguisher, oars & rowlocks, tool box, 2 anchors, anchor rope and first aid kit.
- Trailer with winch, spare wheel, wheel brace, spare bearings
- 2x 25 litre fuel tanks

Technical equipment

- MCB DPGS: Trimble Scoutmaster coupled with Omistar demodulator
- Li-Cor LI-188b with Li-Cor 2π light sensor
- Yeo-kal Salinity Temperature Bridge 602 MkII, serial no ST384
- Scientific thermometer
- Digital thermometer
- 6 Wesdata data loggers with thermisters
- 4 Wesdata data loggers with Li-Cor 2π light sensors
- Equipment instruction manuals
- Laptop computer (discs, communication cable)
- Silicon grease, 'O' rings, desiccant drysacks
- Esky for temperature logger calibrations

Stationary

- Salinity/temperature profile sheets
- Light profile sheets
- Field report sheets
- 6 x HB pencils
- 2 x erasers
- pencil sharpener
- 4 x black permanent markers
- 250 numbered waterproof labels
- 400 small envelopes for chlorophyll-a & TSS filters

Sundry equipment

- 2x 5 l Niskin sampler (one as a spare)
- Rope, weights & 2x messanger for Niskin samplers
- Secchi disc and graduated drop line
- gantry, winch and depth indicator pulley wheel
- 3x 5 l filter tower with vacuum pump and 12 volt leads
- 4 x 9 volt batteries (spares)
- back-up spare 12 volt battery
- back-up spare 12 volt vacuum pump
- 2x20 l plastic buckets
- 2x5 l plastics buckets
- 2 l graduated beaker
- 10 l graduated beaker
- Acid (diluted HCl)
- 20 l de-ionized water
- 2 x 500 ml squeeze bottles for de-ionized water
- box of tools eg forceps, aluminium foil, etc.
- Esky & icepacks
- 66 x 250 ml salinity bottles
- 10 polystyrene boxes and plastic liners
- 30 large plastic bags.
- 1000 150 ml Whirlpaks
- 200 1.2 µm Whatman GF/C filters
- 200 preweighed 1.2 µm Whatman GF/C filters
- 200 0.45 µm Micropore filters

Loggers, mooring arrays

- 5x 10kg ballast for light loggers
- 10 x 5kg ballast for marker floats
- assorted shackles
- 100m x 7mm polypropylene rope
- 4 float apparatus for light loggers
- clips, ties for temperature loggers
- 10 x 8" polystyrene floats, painted orange with "CALM. please leave" on them

3 SAFETY AND RESPONSIBILITIES

3.1 General

Field operations shall be carried out in accordance with departmental procedures and protocols. During the survey safety will be the responsibility of the skipper. Decisions relating to navigation, sea, weather etc rest with the skipper.

3.2 Boating

All boating operations shall be carried out in accordance with Department of Transport regulations. Furthermore, boating operations should also conform to CALM's Draft Departmental Boating Policy and Procedures Manual (BPPM). The skipper is responsible for this aspect of safety.

3.3 Communications and emergency contacts

3.3.1 General

Shark Bay Nursing Post: Ph. 08-99481213

CALM, Marine Conservation Branch: Ph. 08 9432 5100, Fax 08 94305408
Mobile: 041 904 5285

CALM, Denham: Ph. 08 99481208, Fax 08 99481024

CALM, Monkey Mia Visitor Centre: Ph. 08 99481366, Fax 08 99481512
This centre monitors radio Channel 20 from 0800 to 1700 hrs. This is likely to be the best option for radio contact during the field surveys. The skipper has the responsibility to report to the centre prior to departure and to provide details of the planned day's activities (planned field run, planned return time). Notification upon return from the day's field activities is to be given to the centre.

CALM Peron Homestead: Ph: 08-99481429

Shark Bay Caravan Park: Ph. 08-99481387

Volunteer Marine Rescue (VMR) Shark Bay: Ph. 08 9948 1727 or 08 0048 1113
Shark Bay VMR monitors Marine VHF ch 16.

CALM, Geraldton: Ph. 08-99215955, Fax 08-99215713

Denham Police Station: Ph. 08-99481201

3.3.2 Radio

The CALM vessel EX63 is equipped with both marine VHF and CALM VHF. Both the Gascoyne District CALM office in Denham and the Monkey Mia Visitor Centre (MMVC) monitor CALM VHF channel 20.

For the purpose of complying with Section 12.2 of the BPPM, the MMVC should be notified prior to departure, of the intended voyage plan and estimated time of return. This can be done in person or via CALM radio (channel 20). Similarly the MMVC should be notified of any changes to the voyage plan or time of return. It is essential to notify the MMVC upon safe arrival back at the launch ramp to avoid an unnecessary search being implemented. Vessel to vessel communication and emergency/distress calls can be made using channel 16 on the marine VHF.

3.4 Personnel and responsibilities

MCB

Nick D'Adamo	Project Leader, Ph (w): 08-94325104 or 08-94325100 or (h) 08-93490879 Fax (w) 08-94305408
Kevin Bancroft	Ph (w): 08-94325102 or 08-94325100 or (h) 08-94488192
Yvette Pedretti	Ph: 08-93284621

CALM Gascoyne District Office, Denham

Paul Brown	Manager, CALM, Denham: Ph. 08 99481208, Fax 08 99481024
Brad Barton	CALM, Denham: Ph. 08 99481208, Fax 08 99481024

CALM, Monkey Mia Visitor Centre

Roxane Shadbolt	Manager, CALM, Monkey Mia Visitor Centre: Ph. 08 99481366, Fax 08 99481512

Overall responsibility for the field survey rests with the Project Leader, Nick D'Adamo. During the survey minor decisions relating to scientific issues (data collection techniques, grid alterations etc) are to be assessed and decided upon by Kevin Bancroft (3-16 march) and Yvette Pedretti (17 March to 8 May). Major changes to the field program are to be considered and decided upon after consultation with the Project Leader, Nick D'Adamo.

Safety issues are the responsibility of the skipper (see Sections 3.1 and 3.2, above).

4 BUDGET

Budget Item		WHA funds	CALM (in kind)	total cost
Contingency (administration, overuns)				
10% of funding		2500		2500
		2500		**2500**
Travel				
Airfares	2 x Denham –Perth @ $241	482		482
MCB Landcruiser	3000km @ 15c/km	450		450
Return of vessel to Perth post field survey (nominal)		900		900
		1832		**1832**
Accommodation and provisions				
Accommodation	1st-16th Mar 2 wk @ $200	400		400
Accommodation	16th Mar – 15th May 8 wk @ 120	960		960
Provisions	Allow $200/wk for 10 wk	2000		2000
		3360		**3360**
Staff				
N. D'Adamo	15 days (in kind)		8800	8800
Dr Eric Paling	10 days (in kind)			*
K. Bancroft	15 days (field/prep) @ $415/day	3100	3100	6200
T. Daly	5 days (prep) @ $340/day	850	850	1700
M. Lapwood	5 days (prep) @ $340/day	850	850	1700
Y. Pedretti	40 days (field/prep/reporting) (in kind)			*
Local CALM	20 days (field/prep/assistance) (in kind)		6800	6800
		4800	20400	**25200**
Vessels and other equipment				
CALM EX63	23 days @ $100/day	2300	*	2300
EX63 fuel	21 days @ $50/day	1050	*	1050
DGPS	3 day @ $95/day	285	*	285
Sal/Temp meter	21 days @ $40/day (in kind)	*	840	840
Light meter	21 days @ $40/day (in kind)	*	840	840
Light meter calibration	(Murdoch University) $50/hr (in kind)	*	*	0
Temp/light loggers	6 loggers for 10 wk @ $25/day	250	*	250
		3885	1680	**5565**
Chemistry costs				
Water quality (excluding TSS)	770 samples @ $10	7700	*	7700
Preweighed filters	200 @ $0.50	100	*	100
Trans to Perth	1st week 252 samples	175	*	175
	2nd week 288 samples	200	*	200
	3rd –10th week 54 samples ($64) x 7 wk	448	*	448
		8623	*	**8623**
	TOTAL EXPENDITURE	**$25000**	**$22080**	**$47080**

*** not assessed**

5 REFERENCES

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Wilson, B. (1994): Review of dolphin management at Monkey Mia. Unpublished report to the Executive Director, Department of Conservation and Land Management. 37 p.

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APPENDIX 1

Salinity-Temperature Data Sheet

SALINITY-TEMPERATURE DATA SHEET

Project	FITZGERALD MARINE BIOLOGICAL SURVEY				Field Survey	MARCH 1997
Site No.		Site Name		Date	Recorder	
Time	GPS Latitude		GPS Longitude		Differential	
	° ' S		° ' E		Yes ☐	No ☐

ST meter details		Salinity calibration sample bottle no.		Meter salinity reading of calibration sample	
Thermometer details		Thermometer reading of calibration sample		Meter temperature reading of calibration sample	

Depth (m)	Salinity (pss)	Temperature (℃)
0		
0.5		
1.0		
2.0		
3.0		
4.0		
5.0		
6.0		
7.0		
8.0		
9.0		
10.0		
11.0		
12.0		
13.0		
14.0		
15.0		

Depth (m)	Salinity (pss)	Temperature (℃)
16.0		
17.0		
18.0		
19.0		
20.0		
21.0		
22.0		
23.0		
24.0		
25.0		

Notes:

APPENDIX 2

NOAA-AVHRR Satellite Overpass Times
Western Australia, 1st March-15th May 1998

DOLA Remote Sensing Applications Centre

Sat	Orbit	Date (WST)	Equator Cross Time	Equator Cross Long	Start Time	Azim	Lat	Long	Max Elev	Min
12	35287	1/ 3/1998	552	304.740	645	346.38	-8.08	110.27	31	14
12	35294	1/ 3/1998	1740	127.550	1906	175.44	-56.86	119.44	51	15
12	35301	2/ 3/1998	529	310.290	622	1.14	-5.47	116.40	52	15
12	35308	2/ 3/1998	1718	133.100	1844	168.55	-55.98	124.48	85	15
12	35315	3/ 3/1998	507	315.840	600	13.36	-6.40	121.75	83	15
12	35351	5/ 3/1998	1753	124.430	1918	178.90	-57.64	116.79	39	15
12	35358	6/ 3/1998	542	307.180	634	354.69	-4.69	113.46	39	15
12	35365	6/ 3/1998	1730	129.980	1856	172.39	-56.76	121.81	65	15
12	35372	7/ 3/1998	519	312.730	612	6.53	-5.61	118.80	65	15
12	35379	7/ 3/1998	1708	135.530	1834	165.51	-55.88	126.86	77	15
12	35422	10/ 3/1998	1743	126.860	1908	175.97	-57.57	119.17	48	15
12	35429	11/ 3/1998	532	309.610	624	359.93	-4.81	115.86	48	15
12	35436	11/ 3/1998	1720	132.410	1846	169.39	-56.69	124.19	81	15
12	35443	12/ 3/1998	509	315.160	602	11.89	-5.73	121.21	77	16
12	35479	14/ 3/1998	1755	123.750	1920	179.26	-58.34	116.52	37	15
12	35486	15/ 3/1998	544	306.490	637	351.00	-7.56	112.14	36	14
12	35493	15/ 3/1998	1733	129.300	1858	173.06	-57.43	121.52	61	15
12	35500	16/ 3/1998	521	312.040	614	5.21	-4.95	118.26	60	16
12	35507	16/ 3/1998	1710	134.850	1836	166.45	-56.51	126.53	81	15
12	35550	19/ 3/1998	1745	126.180	1910	176.51	-58.12	118.83	46	15
12	35557	20/ 3/1998	534	308.930	627	356.70	-7.72	114.53	45	15
12	35564	20/ 3/1998	1723	131.730	1848	170.17	-57.21	123.82	75	15
12	35571	21/ 3/1998	511	314.480	604	10.48	-5.12	120.66	71	16
12	35578	21/ 3/1998	1700	137.280	1826	163.56	-56.29	128.84	65	15
12	35614	24/ 3/1998	546	305.810	639	349.91	-6.98	111.59	34	14
12	35621	24/ 3/1998	1735	128.610	1900	173.71	-57.91	121.14	57	15
12	35628	25/ 3/1998	524	311.360	617	2.52	-7.91	116.93	56	15
12	35635	25/ 3/1998	1713	134.160	1838	167.30	-57.01	126.14	81	15
12	35678	28/ 3/1998	1747	125.500	1912	177.02	-58.64	118.48	43	15
12	35685	29/ 3/1998	536	308.240	629	355.45	-7.17	113.98	43	15
12	35692	29/ 3/1998	1725	131.050	1850	170.90	-57.74	123.47	69	15
12	35699	30/ 3/1998	514	313.790	607	8.38	-8.11	119.32	70	15
12	35706	30/ 3/1998	1702	136.600	1828	164.50	-56.85	128.48	67	16
12	35742	2/ 4/1998	548	305.130	641	348.80	-6.48	111.02	32	15
12	35749	2/ 4/1998	1737	127.930	1902	174.31	-58.45	120.79	53	15
12	35756	3/ 4/1998	526	310.680	619	1.13	-7.42	116.36	54	15
12	35763	3/ 4/1998	1715	133.480	1840	168.11	-57.56	125.79	77	16
12	35806	6/ 4/1998	1749	124.810	1914	177.47	-59.20	118.17	40	15
12	35813	7/ 4/1998	538	307.560	631	354.22	-6.68	113.41	40	15
12	35820	7/ 4/1998	1727	130.360	1852	171.58	-58.32	123.15	64	16
12	35827	8/ 4/1998	516	313.110	609	6.89	-7.62	118.76	67	15
12	35834	8/ 4/1998	1705	135.920	1830	165.40	-57.44	128.15	69	16
12	35870	11/ 4/1998	550	304.450	643	347.78	-5.94	110.47	31	15
12	35877	11/ 4/1998	1739	127.250	1904	174.84	-59.09	120.52	49	16
12	35884	12/ 4/1998	528	310.000	621	359.80	-6.87	115.81	51	15
12	35891	12/ 4/1998	1717	132.800	1842	168.89	-58.20	125.51	76	16
12	35934	15/ 4/1998	1751	124.130	1917	180.14	-56.46	115.79	37	14
12	35941	16/ 4/1998	540	306.880	633	353.08	-6.12	112.86	38	15
12	35948	16/ 4/1998	1729	129.680	1854	172.21	-58.97	122.88	61	16
12	35955	17/ 4/1998	518	312.430	611	5.46	-7.05	118.20	64	15
12	35962	17/ 4/1998	1707	135.230	1832	166.26	-58.09	127.86	75	16
12	35998	20/ 4/1998	552	303.760	645	346.82	-5.36	109.91	29	15
12	36005	20/ 4/1998	1741	126.560	1906	175.31	-59.73	120.26	47	16
12	36012	21/ 4/1998	530	309.310	623	358.53	-6.29	115.26	48	15
12	36019	21/ 4/1998	1719	132.120	1844	169.61	-58.85	125.23	76	16
12	36026	22/ 4/1998	508	314.860	601	11.11	-7.22	120.60	81	15
12	36062	24/ 4/1998	1754	123.450	1919	180.53	-57.10	115.48	35	14
12	36069	25/ 4/1998	542	306.200	635	351.99	-5.53	112.31	36	15
12	36076	25/ 4/1998	1731	129.000	1857	173.82	-56.21	120.51	59	15
12	36083	26/ 4/1998	520	311.750	613	4.08	-6.46	117.66	61	15
12	36090	26/ 4/1998	1709	134.550	1834	167.06	-58.72	127.58	82	16
12	36133	29/ 4/1998	1743	125.880	1909	177.52	-56.96	117.83	44	15
12	36140	30/ 4/1998	532	308.630	625	357.33	-5.69	114.71	45	15

12 36147	30/ 4/1998	1721	131.430	1847	170.67	-56.07	122.87	74	15
12 36154	1/ 5/1998	510	314.180	603	9.63	-6.70	120.04	76	15
12 36161	1/ 5/1998	1659	136.990	1825	163.50	-55.10	127.89	67	15
12 36197	4/ 5/1998	545	305.510	637	350.92	-5.01	111.75	34	15
12 36204	4/ 5/1998	1733	128.320	1859	174.50	-56.73	120.14	55	15
12 36211	5/ 5/1998	522	311.070	615	2.74	-5.93	117.10	57	15
12 36218	5/ 5/1998	1711	133.870	1837	167.56	-55.84	125.18	88	15
12 36261	8/ 5/1998	1746	125.200	1911	178.05	-57.47	117.46	42	15
12 36268	9/ 5/1998	535	307.950	627	356.14	-5.16	114.15	42	15
12 36275	9/ 5/1998	1723	130.750	1849	171.45	-56.58	122.49	70	15
12 36282	10/ 5/1998	512	313.500	605	8.20	-6.08	119.50	71	16
12 36289	10/ 5/1998	1701	136.300	1827	164.52	-55.69	127.53	72	15
12 36325	13/ 5/1998	547	304.830	640	346.82	-7.91	110.42	32	14
12 36332	13/ 5/1998	1736	127.640	1901	175.12	-57.32	119.80	52	15
12 36339	14/ 5/1998	524	310.380	617	1.47	-5.30	116.55	53	16
12 36346	14/ 5/1998	1713	133.190	1839	168.43	-56.43	124.83	86	15
12 36389	17/ 5/1998	1748	124.520	1913	178.51	-58.06	117.14	39	15
12 36396	18/ 5/1998	537	307.270	629	355.05	-4.51	113.61	39	15
12 36403	18/ 5/1998	1726	130.070	1851	172.17	-57.17	122.15	65	15
12 36410	19/ 5/1998	514	312.820	607	6.83	-5.43	118.96	65	16
12 36417	19/ 5/1998	1703	135.620	1829	165.48	-56.28	127.18	76	15
12 36453	22/ 5/1998	549	304.150	642	345.90	-7.25	109.89	30	14
12 36460	22/ 5/1998	1738	126.950	1903	175.68	-57.90	119.48	49	15
12 36467	23/ 5/1998	527	309.700	619	0.27	-4.63	116.02	49	16
12 36474	23/ 5/1998	1716	132.500	1841	169.25	-57.01	124.49	79	15
12 36517	26/ 5/1998	1750	123.840	1915	178.93	-58.64	116.82	37	15
12 36524	27/ 5/1998	539	306.580	632	351.43	-7.36	112.29	37	15
12 36531	27/ 5/1998	1728	129.390	1853	172.84	-57.75	121.81	61	15
12 36538	28/ 5/1998	517	312.130	609	5.52	-4.75	118.42	60	16
12 36545	28/ 5/1998	1705	134.940	1831	166.38	-56.85	126.83	78	15
12 36581	31/ 5/1998	551	303.470	644	345.04	-6.56	109.35	28	14
12 36588	31/ 5/1998	1740	126.270	1905	176.21	-58.47	119.15	45	15

Sat	Orbit	Date (WST)	Equator Cross Time	Equator Cross Long	Start Time	Azim	Lat	Long	Max Elev	Min
14	16314	1/ 3/1998	146	312.180	239	5.01	-5.46	118.13	60	16
14	16321	1/ 3/1998	1340	133.620	1506	167.29	-58.55	127.23	84	16
14	16328	2/ 3/1998	135	315.000	228	11.14	-6.12	120.80	76	16
14	16335	2/ 3/1998	1329	136.430	1455	164.25	-57.87	129.61	69	16
14	16342	3/ 3/1998	124	317.810	217	17.33	-6.73	123.47	79	16
14	16420	8/ 3/1998	1404	127.830	1530	173.89	-57.82	120.96	54	15
14	16427	9/ 3/1998	159	309.210	252	357.54	-6.82	114.84	46	15
14	16434	9/ 3/1998	1353	130.640	1519	170.69	-57.27	123.42	70	16
14	16441	10/ 3/1998	147	312.020	240	5.17	-3.94	118.32	60	16
14	16448	10/ 3/1998	1342	133.460	1508	167.37	-56.71	125.89	84	16
14	16455	11/ 3/1998	136	314.840	229	11.00	-4.57	121.00	75	16
14	16462	11/ 3/1998	1331	136.280	1457	163.96	-56.10	128.33	71	16
14	16469	12/ 3/1998	125	317.660	218	16.90	-5.21	123.67	78	16
14	16547	17/ 3/1998	1406	127.670	1531	173.52	-59.32	121.81	53	16
14	16554	18/ 3/1998	200	309.050	253	358.10	-5.26	115.04	46	16
14	16561	18/ 3/1998	1354	130.490	1520	170.62	-58.75	124.23	67	16
14	16568	19/ 3/1998	149	311.870	242	4.12	-5.92	117.71	59	15
14	16575	19/ 3/1998	1343	133.310	1509	167.61	-58.10	126.61	79	16
14	16582	20/ 3/1998	138	314.690	231	10.35	-6.60	120.37	76	16
14	16589	20/ 3/1998	1332	136.120	1458	164.50	-57.53	129.06	69	16
14	16596	21/ 3/1998	126	317.500	220	16.66	-7.18	123.05	83	16
14	16674	26/ 3/1998	1407	127.520	1533	174.39	-57.56	120.46	53	15
14	16681	27/ 3/1998	201	308.890	255	356.50	-7.24	114.42	45	15
14	16688	27/ 3/1998	1356	130.330	1522	171.15	-56.92	122.88	69	15
14	16695	28/ 3/1998	150	311.710	243	4.34	-4.38	117.90	57	16
14	16702	28/ 3/1998	1345	133.150	1511	167.74	-56.27	125.30	87	15
14	16709	29/ 3/1998	139	314.530	232	10.25	-5.01	120.57	71	16
14	16716	29/ 3/1998	1333	135.970	1500	164.21	-55.62	127.73	74	15
14	16723	30/ 3/1998	128	317.350	221	16.24	-5.65	123.24	75	16
14	16815	5/ 4/1998	1406	127.730	1531	173.36	-59.28	121.95	54	16
14	16822	6/ 4/1998	201	309.100	253	358.60	-5.23	115.26	47	16
14	16829	6/ 4/1998	1355	130.520	1520	170.45	-58.87	124.46	69	16
14	16836	7/ 4/1998	149	311.890	242	4.66	-5.67	117.96	60	16
14	16843	7/ 4/1998	1344	133.320	1509	167.49	-58.45	126.98	83	16
14	16850	8/ 4/1998	138	314.690	231	10.82	-6.12	120.66	76	16
14	16857	8/ 4/1998	1333	136.120	1458	164.51	-58.04	129.50	71	16
14	16864	9/ 4/1998	127	317.490	220	16.98	-6.56	123.36	78	16
14	16942	14/ 4/1998	1408	127.400	1533	173.76	-59.13	121.52	52	16
14	16949	15/ 4/1998	203	308.770	255	357.74	-5.49	114.89	46	16
14	16956	15/ 4/1998	1357	130.200	1522	170.82	-58.72	124.04	67	16
14	16963	16/ 4/1998	151	311.570	244	3.85	-5.94	117.59	59	16
14	16970	16/ 4/1998	1346	133.000	1511	167.82	-58.31	126.56	81	16
14	16977	17/ 4/1998	140	314.370	233	10.07	-6.38	120.28	75	16
14	16984	17/ 4/1998	1335	135.800	1500	164.81	-57.90	129.09	72	16
14	16991	18/ 4/1998	129	317.170	222	16.30	-6.82	122.98	82	16
14	17069	23/ 4/1998	1410	127.080	1535	174.17	-58.99	121.10	51	16
14	17076	24/ 4/1998	205	308.450	257	356.88	-5.74	114.52	44	15
14	17083	24/ 4/1998	1359	129.880	1524	171.20	-58.58	123.62	64	16
14	17090	25/ 4/1998	153	311.250	246	3.03	-6.18	117.21	57	16
14	17097	25/ 4/1998	1348	132.670	1513	168.17	-58.17	126.14	79	16
14	17104	26/ 4/1998	142	314.040	235	9.30	-6.62	119.91	74	16
14	17111	26/ 4/1998	1337	135.470	1502	165.12	-57.76	128.67	73	16
14	17118	27/ 4/1998	131	316.840	224	15.60	-7.06	122.61	85	16
14	17182	1/ 5/1998	1413	126.900	1538	174.15	-59.86	121.41	50	16
14	17189	2/ 5/1998	207	308.280	300	356.59	-4.95	114.35	43	16
14	17196	2/ 5/1998	1401	129.720	1527	171.36	-59.26	123.80	64	16
14	17203	3/ 5/1998	156	311.100	249	2.52	-5.59	117.02	55	16
14	17210	3/ 5/1998	1350	132.540	1516	168.45	-58.66	126.21	80	16
14	17217	4/ 5/1998	145	313.920	238	8.67	-6.23	119.69	71	16
14	17224	4/ 5/1998	1339	135.360	1505	165.44	-58.06	128.62	76	16
14	17231	5/ 5/1998	133	316.740	227	14.94	-6.86	122.36	85	16
14	17245	6/ 5/1998	122	319.560	216	21.21	-7.50	125.03	70	16
14	17309	10/ 5/1998	1414	126.750	1540	175.13	-57.97	119.95	50	15

14	17323	11/ 5/1998	1403	129.570	1529	171.99	-57.37	122.38	63	15
14	17330	12/ 5/1998	157	310.950	250	2.81	-4.09	117.21	54	16
14	17337	12/ 5/1998	1352	132.390	1518	168.68	-56.76	124.82	80	16
14	17344	13/ 5/1998	146	313.770	239	8.66	-4.72	119.88	68	16
14	17351	13/ 5/1998	1340	135.200	1507	165.26	-56.15	127.27	78	16
14	17358	14/ 5/1998	135	316.580	228	14.62	-5.35	122.55	78	16
14	17365	14/ 5/1998	1329	138.020	1456	161.77	-55.54	129.73	61	15
14	17372	15/ 5/1998	124	319.400	217	20.59	-5.99	125.22	68	16
14	17450	20/ 5/1998	1404	129.410	1530	171.81	-58.80	123.17	61	16
14	17457	21/ 5/1998	159	310.790	252	1.59	-6.07	116.59	54	16
14	17464	21/ 5/1998	1353	132.230	1519	168.80	-58.19	125.58	76	16
14	17471	22/ 5/1998	147	313.610	241	7.84	-6.70	119.26	70	16
14	17478	22/ 5/1998	1342	135.050	1508	165.69	-57.59	128.00	75	16
14	17485	23/ 5/1998	136	316.430	230	14.21	-7.33	121.93	89	16
14	17492	23/ 5/1998	1331	137.870	1457	162.51	-56.98	130.43	60	16
14	17499	24/ 5/1998	125	319.250	219	20.61	-7.96	124.60	72	16
14	17577	29/ 5/1998	1406	129.260	1532	172.51	-56.89	121.77	62	15
14	17584	30/ 5/1998	200	310.640	253	1.94	-4.52	116.79	52	16
14	17591	30/ 5/1998	1354	132.080	1521	169.09	-56.28	124.21	80	15
14	17598	31/ 5/1998	149	313.460	242	7.87	-5.15	119.46	65	16
14	17605	31/ 5/1998	1343	134.900	1510	165.56	-55.67	126.67	81	15