SOUTH COAST TERRESTRIAL AND MARINE RESERVE INTEGRATION STUDY

A collaborative project between CALM Marine Conservation Branch and South Coast Region

Project No: N713 - National Reserves System Cooperative Program
Environment Australia

PROGRESS REPORT: MRIP/SC - 12/96

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- Kelly Gillen, Nature Conservation Officer, South Coast Region.
- Gilles Monty - CALM Volunteer, MCB.
- Heidi Oswald - CALM Volunteer, MCB.
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External collaboration
- Dave Deeley & Kevin Bancroft, Estuarine Health Indicators Project, Murdoch University, WA.
- Dr Hugh Kirkman, CSIRO Division of Fisheries and Oceanography, WA.
- Dr Karen Edyvane, SARDI Aquatic Sciences Centre, SA.
- Dr Graham Edgar, Zoology Department, University of Tasmania.

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SUMMARY

This report presents details progress achieved in the South Coast Terrestrial and Marine Reserve Integration Study from 1/10/96 to 31/12/96.

This project is being coordinated by the Marine Conservation Branch (MCB) of the Department of Conservation and Land Management (CALM) as part of the MCB's Marine Reserve Implementation Programme (MRIP), and is being conducted in collaboration with CALM's South Coast Region in Albany.

The primary objective of the project is to facilitate a regional classification of the marine environment along the south coast of Western Australia between Broke Inlet and Israelite Bay, according to ecological, economic and cultural criteria, and to establish an information base for proposed marine reserve areas identified in the Wilson Report. The project will also provide recommendations that will facilitate the integrated management of adjacent terrestrial and marine reserves and will ensure that the potential impacts of terrestrial and estuarine ecosystems upon their marine counterparts are understood prior to the creation of any marine reserves.

1. INTRODUCTION

1.1 Work schedule

Following discussions with the Environment Australia (formerly ANCA) Reserve Systems Unit in October 1996, it was agreed to revise the deadlines and reporting schedule for this project. The duration of the work schedule is 12 months from 30/09/96. Three reports will be completed during this period - Progress (31/12/96), Interim (31/03/97) and Final (30/09/97). The production of a final report, with recommendations on integrated management of terrestrial and marine reserves along the south coast of Western Australia, will be finished and submitted to the Reserve Systems Unit prior to the World Conservation Union (IUCN) mid-term meeting to be held in Albany in November 1997. This conference will include a visit to the Fitzgerald Biosphere Reserve.

A summary Gantt chart, showing the revised work schedule for the project, is included in Appendix I

1.2 Management Plans

An initial review of existing Management Plans for terrestrial reserves along the south coast has been carried out. Management Plans have been produced and are current for D'Entrecasteaux/Shannon National Park, West Cape Howe National Park, Two Peoples Bay Nature Reserve, and the Fitzgerald River National Park.

1.3 Geographical boundaries

After discussions at the inaugural meeting of the project Advisory Committee (see section 7) it was agreed to define the western boundary of the project as Broke Inlet, rather than Denmark. Broke Inlet, a seasonally barred estuary with similar characteristics to Wilson Inlet, is in relatively pristine condition, largely because its catchment lies wholly within the boundaries of the D'Entrecasteaux/Shannon National Park. By comparison, Wilson Inlet, with its catchment lying within land cleared for agriculture, is severely impacted with periods of very poor water quality following nutrient enrichment.

2. OVERVIEW OF TERRESTRIAL RESERVES

The CALM South Coast Region, primarily drawing on information already compiled for reserve Management Plans, is undertaking a review of the existing terrestrial reserves from Broke Inlet to Israelite Bay. A report of this review will be produced by 28 February 1997, and the information generated will be incorporated into the interim report. This review will consist of a broad overview of physical/biological resources, cultural/historical values, social/economic usage and management issues in existing coastal terrestrial reserves. This will be limited to resources and activities that could influence integrated management of estuaries/inlets and of the nearshore marine environment adjacent to these reserves. The review will also consider the current and potential impacts on terrestrial flora and fauna from activities that gain access to water-based resources through terrestrial reserves.

This will be comprised of:

- **A review of physical/biological resources**

  Coastal landscapes and aesthetic values
  Review of flora and fauna on offshore island nature reserves
  Listings of terrestrial flora and fauna of the Fitzgerald Biosphere Reserve

- **A review of cultural/historical values**

  Aboriginal and European sites in coastal areas, estuaries/lagoons and on offshore islands

- **A review of social and economic usage**

  Recreational: *water-based activities, including:*
  recreational fishing, spearfishing, marroning
  yachting, canoeing, power-boating, water & jet ski-ing
  surfing, sailboarding
  swimming, wading, snorkelling, scuba diving
  marine mammal and seabird watching
  other

  land-based activities, including:
  4x4 beach driving, boat launching, beach camping
  hang gliding, rock climbing, sand boarding
  other

  Commercial: fishing and aquaculture
  tourism
  other

- **A review of management issues**

  Coastal rehabilitation
  Aerial deposition of soil to the marine environment
  Access to estuarine/marine environments and visitor safety
  Community liaison and education
  Marine mammal stranding planning
  Oil spill contingency planning
  Ocean discharges
  Coastal recreational facilities
  Other

3. OVERVIEW OF ESTUARIES AND CATCHMENTS

The Marine and Freshwater Research Laboratory (MAFRL) of the Institute of Environmental Science, Murdoch University, is undertaking the review of all the estuaries and associated catchments along the south coast from Broke Inlet and Israelite Bay, including those not surrounded by existing terrestrial reserves. A report of this review will be produced by 28 February 1997, and the information generated will be incorporated into the interim report. Particular attention will be given to aspects of catchment land use and characteristics of estuarine systems that could have a direct influence on integrated management of terrestrial, estuarine, and marine environments.

This review of estuaries and catchments will draw on the results of the Estuarine Health Indicators Project, being carried out by Dave Deeley and Kevin Bancroft from the MAFRL. Their detailed proposal for the review is included in Appendix II.

4. OVERVIEW OF MARINE ENVIRONMENT

4.1 Preliminary review

A preliminary review of information available for the marine environment along the south coast has been carried out

a 3 month period gathering information on the marine environment along the south coast. These volunteers are carrying out literature searches, developing inventories of marine wildlife and commercial/recreational usage, compiling a reference database, and accessing all unpublished reports and datasets for nearshore marine waters and benthic habitats. This has involved making contact with several internal CALM branches, including the Wildlife Protection Section and the WA Threatened Species and Communities Unit (WATSCU), plus a number of external state and federal government departments and organisations, including: WA Fisheries Department, WA Department of Transport, WA Tourism Commission, WA Maritime Museum, WA Department of Environmental Protection, WA Water and Rivers Commission, University of Western Australia, Murdoch University and CSIRO Division of Wildlife and Ecology.

4.2 Benthic habitat classification

Benthic habitat classification and bathymetric data, compiled by Dr Hugh Kirkman, CSIRO Division of Fisheries and Oceanography, have been obtained for the coast from Broke Inlet to Twilight Cove. Full details of the mapping project are given in Appendix III. The relevant digital data sets has been sourced through the Coastal Resource Atlas at the Western Australian Department of Transport (DOT), and transferred to the marine GIS currently being established at the MCB office in Fremantle. Preliminary maps showing benthic habitats for the whole of the south coast and for the area adjacent to the Fitzgerald Biosphere Reserve have been generated. It is apparent from these maps that the benthic habitats of the inshore marine environment from Denmark to Albany, including the areas adjacent to the William Bay, West Cape Howe and Torndirrup National Parks, have not been classified. It is hoped that during the course of this project it will be possible to carry out a short 5 day field survey to ground truth the benthic habitats in this area.

One of the project volunteers has databased additional information from field notes for surveys of the south coast, including GPS positions of ground-truthing sites, seagrass and seaweed species, water depth and codings for predicted and actual benthic habitat category.

5. FIELD SURVEY

A quantitative marine biological survey of the coastal waters adjacent to the Fitzgerald Biosphere Reserve will be carried out from 7-21 March 1997. This baseline survey of benthic communities will cover the area from Cheyne Bay (34°35'S 118°40'E) to Starvation Boat Harbour (33°55'S 120°35'E) and will include the opportunistic determination of the biological accuracy of existing benthic habitat maps and opportunistic collection of still photographs and video footage of the major habitat types and visually dominant flora and fauna. A live-aboard survey vessel will be chartered out of Esperance or Albany for a 15 day period. A systematic survey will provide quantitative biological data that can be analysed using multivariate techniques to provide information on biological zoning within this area, and also faciliate identification of bioregions and bioregional boundaries. A quantitative analysis of benthic community structure is an essential pre-requisite for zoning of a future marine reserve.

This survey will be undertaken by staff from the Marine Conservation Branch and from external organisations. It is hoped that a total of 10 people will be involved and a number of key people have been invited to join the survey. External participants will include marine ecologists with considerable experience of quantitative surveys of benthic communities in the temperate waters of southern Australia - Dr Karen Edyvane, Chief Scientist from the South Australia Research and Development Institute (SARDI) Aquatic Sciences Centre, and Dr Graham Edgar from the Zoology Department, University of Tasmania. It is hoped that a number of marine taxonomists from the Aquatic Zoology Department of the WA Museum will also be able to participate in this survey.

6. CONSULTATIVE PROCESS

Strategies for the public consultative process were discussed at the inaugural meeting of the project Advisory Committee (see section 7). It was agreed that the first stage in initiating a consultative process to inform local community/key user groups about the project would be the publication of a comprehensive article in local newspapers across the south coast, including the Albany Advertiser and the Esperance Express. This article will be drafted by the Marine Conservation Branch, sent to the Advisory Committee for comment, reviewed by CALM Corporate Relations, and then sent on to CALM South Coast Region for distribution to the appropriate newspapers.

7. ADVISORY COMMITTEE

An informal project Advisory Committee has been formed, comprised of representatives of organisations involved in research and management of terrestrial, estuarine and marine environments along the south coast, as well as from key user groups. The Advisory Committee is comprised of:

Dr Jeremy Colman, Project Leader CALM Marine Conservation Branch
Dr Chris Simpson, Manager, CALM Marine Conservation Branch
Kelly Gillen, CALM South Coast Region

Dr Paddy Berry, Western Australian Museum
Geoff Bott, Western Australian Department of Environmental Protection (DEP)
David Deeley, Estuarine Health Indicators Project, Murdoch University
Dr Ian Eliot, Geography Department, University of Western Australia
Dr Hugh Kirkman, CSIRO Division of Fisheries & Oceanography
Dr Paul Lavery, Ernvironmental Management Department, Edith Cowan University
Guy Leyland, Western Australian Fisheries Industry Council (WAFIC)

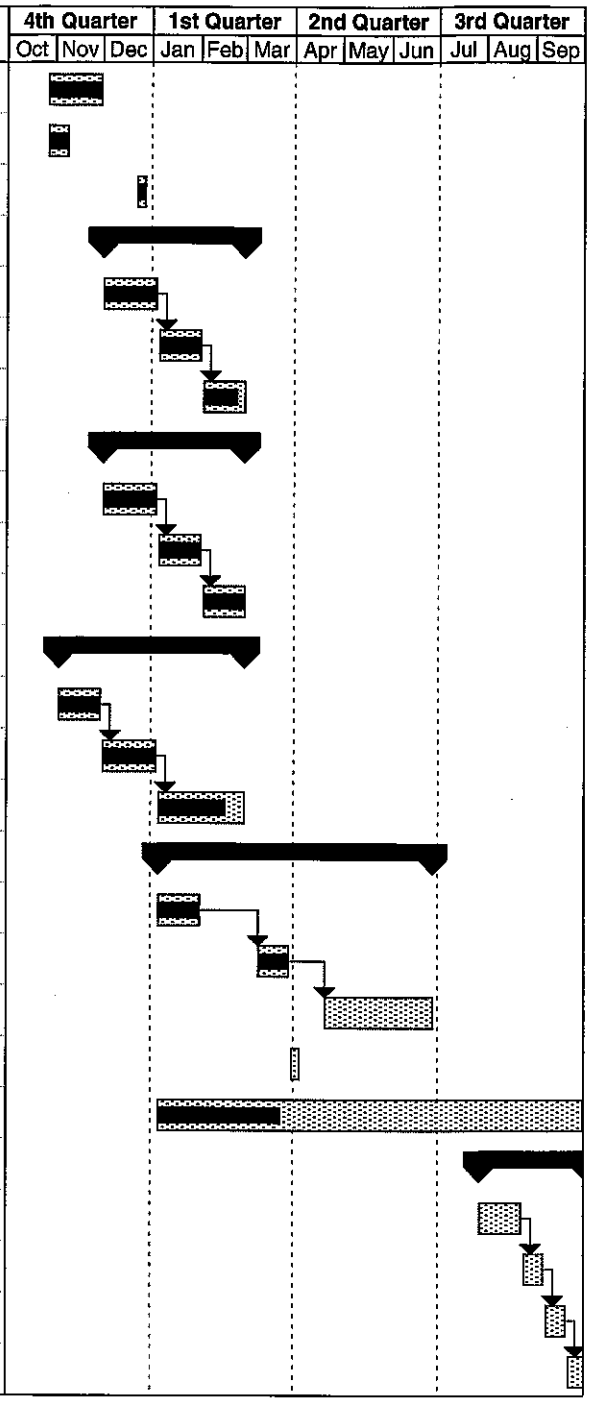
An inaugural meeting of the committee was held on 7 November 1996. It is expected that the committee will meet for half a day every two months. The next meeting is scheduled for 20 January 1997.

APPENDIX I

SUMMARY GANTT CHART

South Coast Terrestrial and Marine Reserve Integration Study
ANCA National Reserves System Cooperative Program
Project No: N713

ID	Task Name
1	Project Planning
2	Establish Advisory Committee
3	Prepare PROGRESS REPORT
4	**1. OVERVIEW OF TERRESTRIAL RESERVES**
5	Review natural attributes & socio-economic data
6	Review management issues
7	Identify impacts on adjacent marine areas
8	**2. OVERVIEW OF ESTUARIES AND CATCHMENTS**
9	Review catchment and estuary characteristics
10	Classify individual estuaries
11	Identify impacts on adjacent marine areas
12	**3. OVERVIEW OF MARINE ENVIRONMENT**
13	Review existing information
14	Compile inventories
15	Acquire/develop GIS layers
16	**4. FIELD SURVEY**
17	Design sampling methodology
18	Undertake field survey
19	Prepare data report
20	Prepare Progress Report
21	**5. CONSULTATIVE PROCESS**
22	**6. PRODUCTION OF FINAL REPORT**
23	Develop regional classification of marine areas
24	Identify issues related to integrated management
25	Formulate recommendations
26	Prepare FINAL REPORT



Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Project Manager: Jeremy Colman
Date: 20/10/97

Collaborative Partners: CALM South Coast Region

APPENDIX II

REVIEW OF ESTUARIES AND CATCHMENTS

Marine and Freshwater Research Laboratory, Murdoch University

South Coast Terrestrial and Marine Reserve Integration Study

Review of Estuaries and Catchments between Broke Inlet and Israelite Bay

A proposal by the Marine and Freshwater Research Laboratory, Murdoch University

OVERVIEW

The project will review the available information on the water quality of all estuaries and associated catchments between Broke Inlet and Israelite Bay, including those not surrounded by existing terrestrial reserves. Particular attention will be given to aspects of catchment land use, clearing status and runoff quality. The review will also comment on characteristics of estuarine systems that could have a direct influence on integrated management of terrestrial, estuarine, and marine environments.

This proposal is in seven sections. Section 1, 2 and 3, describes in detail the work that will be undertaken by the Marine and Freshwater Research Laboratory (MAFRL), specifically to meet the terms of the project brief issued by CALM Marine Conservation Branch. These include a review of catchment characteristics, a review of estuaries and coastal lagoons and a classification of individual estuaries. Section 4 addresses the review outcomes, Section 5 lists the personnel undertaking this review, Section 6 outlines the budget and the final section relates to the project completion.

1. A review of catchment characteristics

There is considerable existing information on the status of southcoast catchments. There are active Land Care District Committees (LCDCS) associated with the Manjimup, Denmark, Albany, Jerramungup, and Esperance Shires, covering the catchments of most estuaries in the review area. The Jerramungup Soil Conservation District has been active in promoting the Fitzgerald Biosphere Project, with its focus on protecting the Fitzgerald River National Park, and its unique flora, fauna and estuaries. Soil Conservation handbooks, and summary documents will be obtained and used as a basis for providing an overview of mass transport of substances to the land margin.

Along with LCDCS, there are a number of Statutory local area management authorities that have been established along the south coast including Albany Waterways Management Authority and Wilson Inlet Management Authority, covering the management of Albany Harbours and Wilson Inlet (WWC 1992, AWMA 1995, Seal 1995). An advisory committee (Walpole and Nornalup Inlet Systems Advisory Committee), based around the Walpole-Nornalup Inlet has been established and has provided advice on a range of issues to the Manjimup Shire. Contact will be made with local management authorities and advisory committees to obtain available information on issues influencing quality of runoff waters.

The Water and Rivers Commission has recently completed a draft review of catchments in the Busselton to Walpole region (Muirden 1995), and this will provide hydrological information for the western portion of the review area. Hydrological information has not been summarized for catchments east of Walpole, although limited summaries have been provided in the EPAWA Estuarine Study Series (Hodgkin & Clark 1987, 1988a, b & c, 1989a & b, 1990a & b).

The Estuarine Health Indicators project currently being completed by MAFRL has investigated water quality for Broke, Walpole-Nornalup and Wilson Inlet, Oyster Harbour and Stokes Inlet (Deeley & Paling in preparation, Deeley et al. in preparation). The available historical infortnation becomes increasingly scarce as one moves eastward. None-the-less, some runoff quality data are available, and regression analysis will be used to make some speculative judgments about the magnitude and frequency of runoff events in the eastern portion of the review area.

The review will use the available information to review catchment processes including;

Catchment boundary and area, catchment slope/erosive conditions, drainage & riparian buffers
Geology: soil type, topography, water features, vegetation type and community
Rainfall and discharge patterns
Hydrology
Land use
Water quality and pollutant loads

It should be pointed out that the basic philosophy of land management throughout the region has been on agricultural productivity on-site, and not on minimization of off-site impacts. The Western Australia Government has until recently, advocated the use of natural and artificial drainage lines for disposal of both saline runoff from salt

reclamation works and paddock runoff from low-lying coastal pastures. Both these practices promote the passage of sediment and nutrients, particularly during periods of high flow.
Much of the available information still follows this basic philosophy with an emphasis on the paddock not the estuary, and may be of marginal relevance for the review.

2. A review of estuaries and coastal lagoons

The Estuarine Study Series of eight reports by Hodgkin and Clark (1987, 1988a, b & c, 1989a & b, 1990a & b), cover all the estuaries in the study area. These reports will form the basis of the review of estuarine status. There have been a number of studies undertaken in several of the estuaries in the review area. These include investigations into heavy metal contamination of sediments in Princess Royal Harbour, and seagrass and macroalgal distribution in Princess Royal Harbour and Oyster Harbour (EPAWA 1990a, 1990b, Masini et al. 1995, Bastyan et al. 1996). There have also been investigations into sediments, hydrodynamics and macrophyte communities in Wilson Inlet. These investigations will be reviewed and relevant findings summarized.

The Fisheries Department may hold information on stock taken by commercial fishermen along south coast estuaries. These data, if standardized to catch per unit effort, and species composition, may provide an indication of longer term trends in estuarine health. The Fisheries Department will be contacted and any relevant information that is provided will be summarized.

The Estuarine Health Indicators Project has collected physical, chemical and biological data for Broke, Walpole-Nornalup and Wilson Inlet, Oyster Harbour and Stokes Inlet. The project involved two years of sampling of water and sediment chemistry, phytoplankton, zooplankton and benthic macro-invertebrate communities at five sites in each estuary. This quantitative information will compliment the qualitative information presented in the Estuarine Study Series (Hodgkin & Clark 1987, 1988a, b & c, 1989a & b, 1990a & b), and will form the basis of the regional assessment.

There are few data on the water quality, sediment or biota for most other estuaries on the southcoast. An assessment of estuarine trophic status will be undertaken, using regression analysis and information from other regional estuaries, but it must be seen as being subjective in the absence of site specific data. Although speculative, the analysis of status and susceptibility of south coast estuaries will undoubtedly identify priority issues requiring more detailed assessment in the future.

The review will use the available information to summarize estuarine;

Physical characteristics: estuary surface area and volume
hydrodynamics
bathymetry and geomorphology
sediments: chemical and physical characteristics, distribution and accretion rates
water quality: nutrient and particulate pollutants, salinity

Biological characteristics: trophic status
vegetation diversity, abundance and distribution
fauna diversity, abundance and distribution

3. A classification of individual estuaries

There have been a number of classification schemes published for estuaries (Heath 1975, Roy 1984). These have been based on geomorphology, evolutionary stage, hydrological processes, climate, water quality, habitat, land use, aesthetic and eutrophication risk assessment.

Availability of relevant information for catchments and estuaries in the review area, will govern the nature of the classification scheme. Elements of several published classification schemes will be used to analyze risks to receiving waters and to identify priority issues. This review will use the available information to undertake a risk assessment examining causes and effects, to aid long-term management of southcoast receiving waters:

- catchment land use and management practices
- long-term nutrient and sediment loads
- degree of marine flushing

4. Review outcomes

The outcome of this review will supply information that will assist the Marine Conservation Branch of CALM to address the estuarine aspects of the Southcoast Terrestrial and Marine Reserve Integration Study Scope Items N' 1, 4, 7, and 8. This review will provide information for:

- The provision of a report identifying potential impediments to the long term conservation of estuaries and potential marine reserves along the south coast of Western Australia between Broke Inlet and Israelite Bay.

- The classification of seaward-draining catchments associated with the review area on the basis of existing and future land-use and degree of alteration to the natural surface water and groundwater systems which enter the marine environment

5. Personnel

Dr. E.1. Paling	Director, Marine and Freshwater Research Laboratory, Institute of Environmental Science. Murdoch University.
Mr. D.M. Deeley	Principal Environmental Officer, Water and Rivers Commission Project Leader, Estuarine Health Indicators Project, Murdoch University.
Mr. K.P. Bancroft	Professional Officer, Estuarine Health Indicators Project, Murdoch University.

6. Resource Requirements

Salaries	
Project Professional Officer KP Bancroft (22 days)	
Project Supervision DM Deeley, El Paling (2 days)	
(Including salary on-costs of 23.44%)	$6,800
Information Sourcing	
Photocopy, Library & Phone, and Travel	$1,000
Sub-Total	**$7,800**
Murdoch Administration Costs (15%)	$1,170
Total	**$8,970**

7. Completion Date

A draft report (not exceeding 15,000 words) will be provided by the end February 1997. It is anticipated that the Final Report with alterations will be resubmitted by the end of March 1997.

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APPENDIX III

BENTHIC HABITAT MAPPING

CSIRO Division of Fisheries and Oceanography

MAPPING AUSTRALIA'S UNDERWATER FEATURES

HUGH KIRKMAN
CSIRO DIVISION OF FISHERIES
PO BOX 20
NORTH BEACH
WA 6020

ABSTRACT

Australia's coastline was first mapped at the beginning of the 19th century. Now the underwater features are being mapped with extensive ground truth, satellite technology and computer mapping and digitising techniques. Landsat TM imagery is processed to enhance underwater features. The enhanced imagery is then taken into the field for strategic ground truth verification of features seen in the imagery. GPS position fixing is used to find a position of interest or to position a site where verification takes place. Once an image has been verified the ground truth points are placed on an outline of the coast and these points placed on the image. Eight categories of habitat are used in the map but these may vary depending on where in Australia the mapping is done. The features are traced onto the image and digitised and the map presented, at 1:100,000 on Arc Info. The success of this project relies on the collaboration and cooperation of State Government departments, so far, most of South Australia and Western Australia from Exmouth Gulf to the border of South Australia has been completed, the Victorian government has bought the satellite images and preliminary interpretations have been done. New South Wales has bought the first of about ten images and Tasmania has made a commitment to assist in mapping that state. The aim is to complete all of Australia within three years.

OBJECTIVE

To prepare a map at a scale of 1:100,000 of underwater features of the Australian coastline and separate those features into categories that can be used for coastal management and making decisions on choices of marine protected areas.

BACKGROUND

The underwater features of the Australian coastline are poorly known apart from areas around centres of population. Underwater features are seagrass meadows, reefs of different morphology and geology, unvegetated sand and, in the tropics, coral reefs, coral debris and muddy deltaic areas. There are a number of reasons that underwater features should be mapped.

- Selection of Marine and Estuarine Protected Areas (MEPA's). Once the features of the offshore coast have been mapped and an estimate of the biodiversity made, decision makers have an informative baseline upon which to choose bioregions or areas of biological similarity and hence select marine parks or reserves.
- Assist with decisions concerning coastal development - where to put marinas, harbours, effluent outfalls and exploratory. mining. Seagrass meadows are particularly vulnerable to above ambient nutrient concentrations caused by effluent discharges. Coral reefs are also affected by high sediment concentrations caused by land clearing. If the extent of these biological features is known decision makers can protect them or decide to sacrifice parts of them.
- Location of vulnerable areas if an oil spill occurs. Reefs and coral reefs are particularly vulnerable to oil pollution, if these habitats are well defined the clean up of oil can concentrate around these areas and limited resources can be deployed at strategic places to reduce impact.
- Assist with decisions as to the location of mariculture development. Aquaculture cages release nutrients into the sea and shade the underlying substrate. The positioning of these cages should be planned to have as little impact as possible on the benthic biota.
- Assist with locating where heavy machinery can approach the water/land interface for pollution clean-up and military purposes. Cliffs, exposed beaches and shallow offshore reefs are places that are difficult to approach for clean-up whereas shallow estuaries and gently sloping beaches are more suitable.
- Assist with coastal management. Once an atlas of resources has been prepared, strategic monitoring will help detect changes to the various ecosystems that have been distinguished.

METHODS

The maps are being prepared at a scale of 1:100,000 using the blue band or band 1 of the Landsat TM satellite. The key to mapping these areas is obtaining satellite imagery that has penetrated the water and then enhancing the raw imagery so that the best is made of the benthic features in the scene. The high water clarity in southern Australia has allowed us to identify features to 50m depth, but in many cases because of poor light penetration, this depth is much reduced. Completed maps, therefore, do not have an offshore limit, but rather a line exists at the extremity of what can be seen through the water by the Landsat TM imagery.

Each image is selected from microfiche reproductions provided by the Australian Centre of Remote Sensing (ACRES), a division of the Australian Land Information Group (AUSLIG) situated in Canberra, as being on a cloud-free day and with a sun elevation above 45°. Because of the sun elevation restriction, only images taken between mid-October and April are chosen. The weather pattern for the previous three days is then examined from the Bureau of Meterology data to determine if storms or strong wind might have disturbed sediment in the target area. Even with these constraints it is difficult, because of water turbidity, to find a suitable image.

Once an image has been acquired it is rectified to level 9, ie rectified to the AUSLIG topographic map at a scale of 1:100,000, with Australian Map Grid positions and checks at every 10km on the photographic image. The position of any feature can then be determined for later field ground truthing. The photographic image is laminated in plastic so that it is waterproof for field work. The discernible underwater features are traced on the image, and these are verified in the field.

The ground truthing of the images, to verify the presence of underwater features, is a major operation on a scale as large as the coastline of Australia. In southern Western Australia and in South Australia this has been done from ocean going vessels capable of spending extended time at sea. In the case of Western Australia, a shark fishing vessel was chartered from Esperance on two occasions. On the first cruise from 9 - 13 March 1994 we concentrated on deep water features and the islands of the Archipelago of the Recherche. On the second cruise from 6 - 13 April. 1994 we moved along the coast from Two Peoples Bay near Albany to the western end of the cliffs of the Great Australian Bight. In South Australia all ground truth was accomplished from the research Vessel "Ngerin" courtesy of the South Australian Research and Development Institute (SARDI) on two cruises. The first, from 16 - 29 June 1994, of these was from the Head of the Bight to Ellison and the second, from 9 - 19 October 1994, was to Kangaroo Island and the adjoining mainland.

Ground truthing was done by either "bounce" diving, hanging a video camera from the ship or by using a small grab. For the "bounce" diving part of the work,. the crews take small inflatable dinghies to predetermined places of interest along the coast. These places are chosen on their representativeness of other areas or as being unusual in shape or position on the image. Before going into the water, an estimate of the bottom type expected is recorded on data sheets for each ground truth site. At the chosen site a GPS position is recorded and the field worker makes a dive, usually with scuba, to determine what is on the bottom. If a seagrass habitat is encountered a handful of seagrass with roots and rhizomes and fruiting parts, if available, is taken and the depth, density of seagrass, species and other observations are recorded on a field slate. If a reef is encountered, the depth and type of reef is recorded and the dominant seaweeds collected and returned for later pressing. If unvegetated sand is encountered, the diver may abort the dive and record "bare" on the field slate.

The bottom types are divided into eight categories: dense seagrass, medium seagrass,. sparse seagrass, patchy seagrass, bare sand, flat platform reef, heavy limestone reef and granite reef. Dense seagrass is seagrass that completely covers the bottom, medium seagrass is a density where two fingers held together can be placed between shoots and sparse is the density of seagrass where a hand can be placed between shoots. Flat platform reef is flat reef that is easily covered in mobile sand and therefore does not have a heavy growth of large seaweeds. In Western Australia this category often had *Scaberia or Dictyopteris* growing on it. Limestone reef has a cover of kelp *(Ecklonia radiata)* or other large brown seaweeds and granite reef also has kelp but has a smoother surface and has steeper edges.

The video camera and grab are usually used from the mother ship which, while the inflatables are engaged closer to the shore in shallower water, will be steaming to chosen sites where it may not be necessary to dive, is too deep or is thought to be unvegetated sand. At these sites a GPS position is recorded and the video or grab deployed. If scenes or samples of interest are found, a diver may collect a sample from the bottom.

Once the inflatables return to the mother ship, the data from the field slates are recorded on data sheets, and field note book, specimen plants are pressed and labelled and the actual bottom type compared with the estimated one.

After the cruise, the position of every ground truth site is plotted onto an AUSLIG, 1:100,000 outline of the coast as a number related to the data sheets and as a colour related to the category of bottom detected. Information from the field note book and data sheets are used to label pressed samples and these are stored for later use.

The coast outline is then laid over the satellite image (they are at the same scale) and a pin is pushed through at each ground truth point. The category of the bottom type is noted on the satellite image and the tracings are revised using the ground truth data. The satellite images with their tracings are then digitised and put into Arc lnfo for presentation as a map.
Each of the completed maps is accompanied by a statement as to the quality of the mapping. The quality control comes from a comparison of the expected bottom type compared to the actual bottom type. Currently the ground truth estimate of a particular area is about 80% accurate.

REQUIREMENTS FROM COLLABORATORS

A close liaison and co-operation with state government departments has been of vital importance to the whole project. Table 1 lists the collaborators in this project.

ORGANISATION	DEPARTMENT
Western Australian Government	Land Administration
	Fisheries
	Transport
	Environmental Protection
South Australian Government	SA Research and Development Institute.
	Environment and Natural Resources
CSIRO	Division of Fisheries
	Division of Wildlife and Ecology
Royal Australian Navy	Hydrographers

CSIRO does not have a large budget for this work, however with the collaboration and co-operation of a number of State Departments the mapping in South Australia and Western Australia has progressed quickly and economically. The state departments provided the satellite imagery (band 1 only) which was chosen by CSIRO from the catalogue at ACRES. The State Departments provided technical help in enhancing the imagery and producing a photograph with AMG and 10 km grid. The tracings were digitised and map produced by State Departments which provided the maps in digitised form to the CSIRO Division of Wildlife and Ecology for the CAMRIS GIS. The completed maps are owned by CSIRO and the state.

CURRENT STATUS

The southern coasts of Australia are in the process of being mapped. Arc Info maps have seen prepared from Perth to the cliffs of the Great Australian Bight. The underwater features of the coast from Perth to Exmouth Gulf and from the cliffs of the GAB to Victor Harbour are in preparation. Other areas of the Australian coastline eg. GBR, Moreton Bay, the estuaries of NSW and the Gulf of Carpentaria, have been mapped for various organisations for different purposes at different scales, but most of these maps can be brought to the scale required for this project and their categories made compatible with those of this project and then put into the underwater features data base.

The coast of Victoria has been mapped from satellite imagery but no ground truth has been done. For NSW satellite imagery seems inappropriate so that aerial photos are being scanned from which the maps will be prepared.

FUTURE DIRECTIONS

It is anticipated that during 1995/96 the current study will be extended to the ground truth of the Victorian coast, and Tasmania and NSW governments have shown some commitment to mapping their coastlines.

The northern parts of Australia are a different matter as far as obtaining satellite images with sufficient water penetration. The water in northern Australia generally contains enough sediment to prevent light penetration beyond a metre. This sediment comes from seasonal rivers and the very large tides of the Kimberley to Darwin coast and the Gladstone to Rockhampton coast of Queensland.

Although the plant communities will not be as deep as in southern areas of the continent because of the lower light

series of transects to determine the composition of the benthic habitats. These transects would be at right angles to the coast and to a distance where, either a continuous substrate is obvious or it is believed that further data would be of limited use. This form of mapping requires much more field work and relies on a statistically sound number of samples ie transects, being taken.

END PRODUCT

Completed mapping is in an Arc lnfo format on disc or on hard copy at a scale of 1;100,000. These maps are available to State Government Departments and institutions that have given assistance in preparing the maps.

MIILESTONES

Oral Presentations:
CZP meeting. Oct 1994
ANZECC committee meeting Nov 1994
Vic Govt Departments Nov 1994
Perth Dive Academy Dec 1994
Underwater World June 1995

Written Reports
CZP Report Oct 1994
Ecos article Autumn 1995
South Australian Fisheries article May 1995
Kirkman, H. and Kuo, J. 1996. Seagrasses of the southern coast of Westem Australia. Proceedings of the International Workshop on the Biology and Ecology of Seagrasses. Rottnest Island. Eds. Kuo, Kirkman, Phillips and Walker.
Hamdorf, I. and Kirkman, H. 1995. Status of Australian Seagrass. Issue Paper Fisheries Pollution and Marine Environment Committee 32pp.
Kirkman, H. In press. State of Environment Report on Seagrasses. National State of the Environment Reporting System. Commonwealth Environment Protection Agency. 43 pp.
Kirkman, H. In press. Baseline and monitoring methods for seagrass meadows. Journal of Environmental Management.

Presentations
Plenary Talk at the International Symposium of Remote Sensing, Seattle Washington. Held in Septernber 1995.
Talk at Estuarine Research Foundation Biannual International Meeting. Corpus Christi, Texas Nov 12-19.

Committee Responsibilities due to this project.
Advisory Committee of Western Australian Land Information System (WALIS)
Visiting Committee Department of Geography, The University of Western Australia