MARINE RESERVE IMPLEMENTATION:
WA SOUTH COAST & EUCLA

ESTABLISHING A MARINE PROTECTED AREA IN THE RECHERCHE ARCHIPELAGO REGION. YEAR 1: THE PHYSICAL AND BIOLOGICAL INFORMATION REQUIREMENTS

Final Report: MRI/WSC,EUC/RAR,SIN-59/2002

A collaborative project between the Department of Conservation and Land Management's Marine Conservation Branch and Esperance District office

A project partially funded through the Natural Heritage Trust's Coast and Clean Seas Marine Protected Area Programme

Prepared by K P Bancroft
Marine Conservation Branch

October 2002

Marine Conservation Branch
Department of Conservation and Land Management
47 Henry St
Fremantle, Western Australia, 6160

Government of Western Australia
Department of Conservation and Land Management
Conserving the nature of WA
Natural Heritage Trust
Helping Communities Helping Australia
Coasts & Clean Seas

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This report may be cited as "*Establishing a Marine Protected Area in the Recherche Archipelago region: Year 1, the physical and biological information requirements*". Copies of the report may be borrowed from the library:

Environment Australia
Biodiversity Group
GPO Box 787
CANBERRA ACT 2601
AUSTRALIA

Or

The Librarian
Science and Information Division
Department of Conservation and Land Management
PO Box 51
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AUSTRALIA

Cover photo: Islands of the Recherche Archipelago

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SUMMARY

This report summarises the major activities and outcomes of a one-year project entitled "*Establishing a marine protected area in the Recherche Archipelago region. Year 1: The physical and biological information requirements*". This project was partially funded by a grant of $100,000 obtained through the Coast and Clean Seas Marine Protected Areas Programme, an initiative of Environment Australia's Natural Heritage Trust. The Department of Conservation and Land Management contributed further resources to the project, valued at approximately $52,000.

The project involved:

- A review of existing ecological information of the area;
- A review of the climate and physical oceanography;
- The collation of existing biological resource information layers;
- The development of a preliminary understanding of the broadscale water movements;
- Preliminary habitat mapping and development of a conceptual model for further mapping;
- The development of a marine wildlife distribution map;
- The verification of preliminary habitat mapping and the collection of further ground truth data, and;
- The development of a broadscale map of marine ecological communities.

The outcomes of specific action items detailed in the project specifications have been reported on.

In summary, the outcomes of the project were achieved and the information layers developed will be used in the planning process for a marine protected area in the Recherche Archipelago region.

ACKNOWLEDGEMENTS

Department of Conservation and Land Management

Direction

- Gordon Wyre, Acting Director, Nature Conservation Division.
- Dr Chris Simpson, Manager, Marine Conservation Branch

Collaboration

- John Watson, Manager, South Coast Region
- Klaus Tiedermann, Manager, Esperance District
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External collaboration

- Dr Gary Kendrick, Marine Botany, University of Western Australia
- Dr Euan Harvey, Marine Botany, University of Western Australia
- Katrina Baxter, University of Melbourne

Resources and funding

- This project was partially funded by through the Natural Heritage Trust's Coast and Clean Seas Marine Protected Area Programme.
- The Marine Conservation Branch, Department of Conservation and Land Management provided funds, staff and equipment.
- The Esperance District, Department of Conservation and Land Management assisted with this project by providing office resources, vehicles and field station/accommodation.

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1. INTRODUCTION

This report summarises the major activities and outcomes of a one-year project entitled "*Establishment of a Marine Protected Area in the Recherche Archipelago region. Year 1: The physical and biological information requirements*." This project was partially funded by a grant of $100,000 obtained through the Coast and Clean Seas Marine Protected Areas Programme, an initiative of Environment Australia's Natural Heritage Trust. The Department of Conservation and Land Management contributed further resources to the project, valued at approximately $52,000.

The outcomes of specific action items detailed in the project specifications (Appendix A) have been reported on.

1.1. BACKGROUND

The Recherche Archipelago and the Stokes Inlet areas were recommended in the *Report of the Marine Parks and Reserves Selection Working Group* (MPRSWG) (Department of Conservation and Land Management, 1994) as worthy of consideration for reservation as a marine conservation reserve under the *Conservation and Land Management Act (1984)*. The *Conservation and Land Management Act (1984)* allows for the establishment of multiple-use marine conservation reserves for the purposes of conservation of marine flora and fauna and public recreation. Commercial activities, such as fishing, aquaculture and petroleum exploration and production, are also acceptable within specific zones of multiple-use marine conservation reserves.

The Marine Parks and Reserves Authority (MPRA) was created in 1997, in accordance with amendments to the *Conservation and Land Management Act (1984)*. One of the roles of the MPRA was to prioritise the 70 MPRSWG recommended areas. The Jurien Bay, Dampier Archipelago/Cape Preston, Montebello/Barrow Islands, Recherche Archipelago and the Walpole-Nornalup inlet regions were identified as being of highest priority, with the Recherche Archipelago/Stokes Inlet region being identified in the "second tier" of high priorities. Currently, there is no marine conservation reserve in the "Western Australian South Coast" or the "Eucla" bioregions (Interim Marine and Coastal Regionalisation for Australia Technical Group, 1998).

The *Conservation and Land Management Act (1984)* specifies the statutory process for the reservation of marine conservation reserves, including a public planning process for the development of management zoning schemes that allow for the spatial separation of incompatible activities in a marine park. In anticipation of the State Government initiating the planning process, the major marine resources and current uses of a number of the areas in the Recherche Archipelago region recommended in the MPRSWG report (Department of Conservation and Land Management, 1994), are being identified.

As part of the statutory marine conservation reserve planning process, it is required that the biological, economic, social and cultural resources of a proposed marine conservation reserve be assessed before the Notice Of Intent (NOI) is issued. This process has been designed improve the community's awareness of the issues concerned with the creation of a marine conservation reserve prior the release of the NOI. The information layers provide the basic information required in the consultative process, which results in the determination of preliminary boundaries and zonings, so that current users have a clear appreciation of how the proposed marine reserve will affect their current and future usage of the area.

This project was coordinated by Marine Conservation Branch (MCB) of the Department of Conservation and Land Management (the Department) as part of the MCB's Marine Reserve Implementation function, in collaboration with the Department's Esperance District Office, South Coast Region.

1.2. STUDY AREA

The study area (Figure 1) for this project is defined as the marine waters from Stokes Inlet to Israelite Bay and extending seaward to the Limit of Western Australian Coastal Waters, described as 3 nm seawards from the territorial sea baseline.

1.3. OBJECTIVES

The objective for the project was to compile ecological information layers for the Recherche Archipelago/Stokes Inlet region.

2. PROJECT TASKS

The project details are outlined in the work schedule (*see* Appendix A) and includes nine specific action items:

Action 1. A review of existing ecological information of the area;

Action 2. A review of the climate and physical oceanography;

Action 3. Collation of existing information layers;

Action 4. Prepare and submit a progress report;

Action 5. Develop a preliminary understanding of the broadscale water movements;

Action 6. Preliminary habitat mapping and development of a conceptual model for further mapping;

Action 7. Develop a marine wildlife distribution map;

Action 8. Verification of preliminary habitat mapping, and;

Action 9. Develop the broadscale map of marine ecological communities.

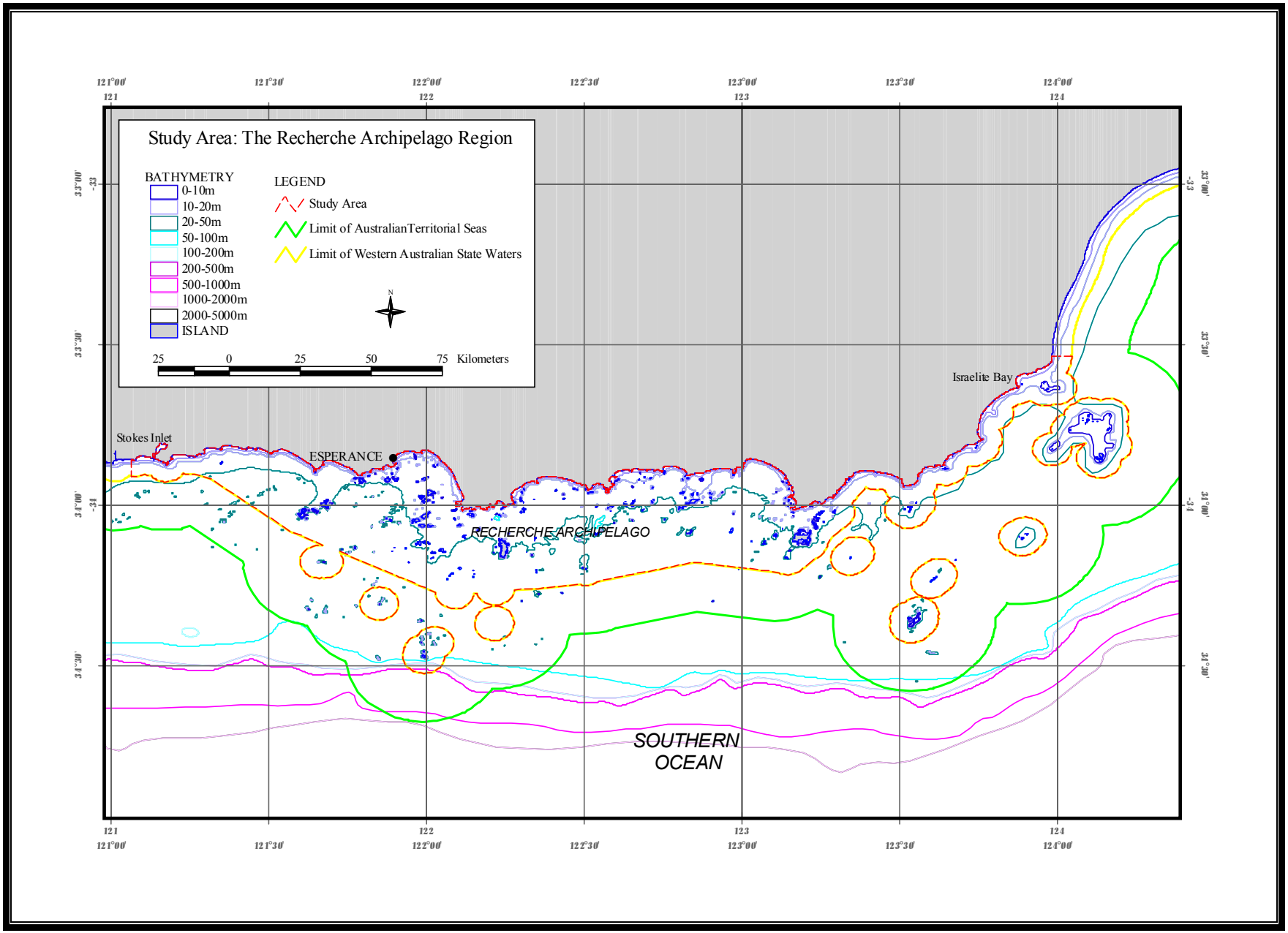

Figure 1. The study area: The Recherche Archipelago region (Stokes Inlet to Israelite Bay)

ACTION 1. Review of existing ecological information

A review of existing ecological information for the Recherche Archipelago region was completed in December 2001 (Lee & Bancroft, 2001) and is incorporated in the progress report (Bancroft, 2001). The progress report was provided to Environment Australia in December 2001.

The review presents a general description of the physical characteristics and summarises the biological resources of the region. The information that has been compiled in the review was collected predominantly through literature searches, review of published information, examination of Department data for marine mammals and stranding events, and from anecdotal information from scientists, natural resource managers, commercial operators and knowledgeable community members.

The review collates information available for benthic habitats, marine flora and fauna, estuarine and coastal wetlands, and coastal terrestrial biota. It highlights the gaps in ecological information for the region, particularly:

1. the poor coverage of existing benthic habitat mapping, and;

2. the lack of information on the abundance and distribution of marine flora and fauna in general.

This review will be utilised as a resource document when the planning process for a possible marine conservation reserve in the Recherche Archipelago region is initiated.

ACTION 2. Review of the climate and physical oceanography

A comprehensive review of existing information on the physical oceanography of the Recherche Archipelago region was prepared for the Department by the Centre of Water Research, University of Western Australia (van Hazel *et al.*, 2001) and is incorporated in the progress report (Bancroft, 2001). The progress report was provided to Environment Australia in December 2001. Van Hazel *et al.* (2001) presents a review of the climate and oceanography of the south coast of Western Australia, focussing on the Recherche Archipelago region and neighbouring Stokes Inlet.

The oceanography of the region is yet to be studied in any great detail, either through field, analytical or numerical modelling methods. Accordingly, this review provides a significant contribution to furthering the understanding of the broadscale oceanography and in turn, provides insight into physical factors that may have an influence and control on the biology.

This review provided a platform from which to undertake more detailed investigations of the broadscale water movements in the Recherche Archipelago region (*See* Action 5; van Hazel, 2001).

ACTION 3. Collation of existing information layers

A comprehensive search was undertaken by the MCB Marine Information section, which resulted in a comprehensive set of existing GIS data layers (Table 1). The result highlighted the lack of high-resolution bathymetric data and the absence of sediment or substrate/geology data for the study area.

All data and GIS information layers are stored in the MCB Marine Information System.

Table 1: List of existing GIS information layers for the Recherche Archipelago region

DESCRIPTION	TYPE OF DATA	DATA LAYER NAME
CSIRO habitat ground truth	Point data with ground truth information stored in the MCB marine habitats database (*see* Appendix C)	Habitats.mdb
CSIRO marine habitats	ArcView 3.2 shape file of classified broadscale marine benthic habitats developed by CSIRO.	macsiro_poly_ll_agd84.shp
DOLA coastline	ArcView 3.2 shape file	coastline_rar_28022001_utm51_gda94.shp
Australian Maritime Boundaries Information System - AMBIS 2001 (Version 1.1)	ArcView 3.2 shape file of latest spatial information on the territorial boundaries. AMBIS 3, 12, 24, 200 nautical mile datasets and treaty boundaries in a single coverage. Dataset aus_zones.e00 copied from AMBIS 2001 CD-rom.	ambis_aus_20010930_ll_wgs84.shp
DOLA bathymetry	ArcView 3.2 shape file	Bathym_WA_DOT_ll_agd84.shp
RAN bathymetry	ArcView 3.2 shape file of high-density point data covering offshore areas. This datalayer omits the greater part of the Archipelago.	bathymetry-groundtruth-corrected_rar_20011206_ll_gda94.shp
CALM seabird nesting islands	ArcView 3.2 shape file of islands where sightings of nesting seabirds have been recorded.	seabirds_rar_20020219_ll_gda94.shp
Esperance orthophoto Feb 1999	Colour ortho-mosaic 1:25000 photography. focal=152.98. 0.5m resolution. Scanned at 21 micron (1200dpi)	Esperance1.ecw Esperance1.ers
Esperance orthophoto Feb 1999	Colour ortho-mosaic 1:25000 photography. focal=152.98. 0.5m resolution. Scanned at 21 micron (1200dpi)	Esperance2.ecw Esperance2.ers
Esperance orthophoto Feb 1999	Colour ortho-mosaic 1:25000 photos. 0.5m resolution. Scanned at 21 micron (1200dpi)	EsperanceW.ecw EsperanceW.ers
Esperance Landsat Images	Landsat 7 images of the Esperance region. 30m res.	cape_arid_dual_gda94.bil esperance_dual_gda94.bil mondrain_island_dual_gda94.bil malcolm_dual_gda94.bil
Drainage of the Esperance region	extract from the Water and Rivers Commission WA hydrography dataset in ArcView format.	draft_hydrography_wrc.shp
Recherche Archipelago Geo-referenced aerial photography	scanned images of 1:25,000 aerial photos (Unrectified) (roughly geo-referenced) 453 dpi = 1.2m ground res Job No 950027 Job No 950030 Job No 970005 Job No 980023 Job No 980031 Job No 980032 Job No 980038	Numerous *.tif and *.tifw files

ACTION 4. Prepare and submit a progress report

A progress report was submitted to Environment Australia in December 2001 (Bancroft, 2001). The progress report addresses all scope items and referred to progress against the Work Schedule (Appendix A).

The progress report incorporates:

(i) the review of existing ecological information for the Recherche Archipelago region. (Lee & Bancroft, 2001);

(ii) the review of existing information on the physical oceanography of the Recherche Archipelago region (van Hazel *et al.*, 2001), and;

(iii) the preliminary broadscale map of the marine benthic habitats of the Recherche Archipelago region.

ACTION 5. Develop an understanding of the broadscale water movements

Further to undertaking the review of the climate and physical oceanography of the Recherche Archipelago region (van Hazel *et al*. 2001), van Hazel undertook an Honours project, value adding to the investment expended by the Department and the National Heritage Trust. A copy of Mr van Hazel's unpublished Honours thesis has been included in this report (*see* Appendix B; van Hazel, 2001).

This study provides a significant contribution to furthering the understanding of the broadscale oceanography and, in turn, provides insight into physical factors that may have an influence on the biology. The study analysed and discussed the meteorological, water level and surface temperature data and used chlorophyll images from the SeaWiFS and CZCS satellites as well as acoustic doppler current profiler (ADCP), conductivity, temperature, depth (CTD), and hydrology data collected by CSIRO, to corroborate the findings. The data has been further supported with the use of a three-dimensional hydrodynamic model (HAMSON), for the simulation of broadscale currents throughout the region (van Hazel, 2001).

This research will provide a platform from which to plan more detailed investigations into the oceanography of the Recherche Archipelago region.

ACTION 6. Preliminary habitat map and development of a conceptual model for further mapping

A preliminary habitat map was produced by the MCB using existing CSIRO data (*by courtesy* CSIRO).

The metadata for this data layer did not clearly state the reliability of the data or the methodology involved in producing it. Therefore, it was necessary to verify the polygons and their classification by using CSIRO ground-truth data that were available for 223 sites in the Recherche Archipelago region (*by courtesy* CSIRO, Appendix C).

The preliminary habitat map was utilised as a start point for understanding the spatial distribution of marine benthic habitats in the Recherche Archipelago region and was improved upon by the collection of further data during a habitat survey in April 2002 (*see* ACTION 8).

CONCEPTUAL MODEL FOR MAPPING THE RECHERCHE BENTHIC HABITATS

After a comparison between the existing CSIRO ground-truth data (see Appendix C) and further ground-truth data acquired during the collaborative habitat survey (*see* ACTION 8, Appendix F), the following conceptual model was developed for mapping the marine benthic habitats in areas of Recherche Archipelago that have a lack or no ground-truth data.

Rule 1 The existing preliminary habitat map classifications are to be aligned with the latest shallow-water marine habitat classification scheme (Bancroft, *in prep*). These reclassifications are listed in Table 2:

Table 2. Re-assignment of marine habitat classifications

Existing CSIRO assigned classifications	**Shallow-water marine habitat classification** (Bancroft, *in prep*)
Bare	Mobile sand (subtidal)
Sparse seagrass	Perennial seagrass (sparse)
Patchy seagrass	Perennial seagrass (medium)
Medium seagrass	Perennial seagrass (medium)
Dense seagrass	Perennial seagrass (dense)
Granite	Macroalgae (subtidal, high relief)
Heavy limestone reef	Macroalgae (subtidal, high relief)
Low profile reef	Reef pavement (subtidal)

Rule 2 The preliminary habitat map polygons classified as perennial seagrass (dense), perennial seagrass (medium), perennial seagrass (sparse) or macroalgae (subtidal, high relief) in areas <50 m bathymetry have a high level of confidence and are to remain.

Rule 3 Areas with >50 m bathymetry are to be classified as pelagic.

Rule 4 Between the 20 m and 50 m isobath, except where rule 2 is applied, all other existing classifications and polygons are to be ignored.

Rule 5 The area between the 20 m and 50 m isobath is to be classified as mobile sand/reef pavement (subtidal) with the exception of where rule 2 is applied.

Rule 6 In the areas of <20 m bathymetry, all existing polygons are to remain.

Rule 7 The leeward sides of inshore islands are to be classified as perennial seagrass (medium) or perennial seagrass (dense) where ground-truth data is available.

Rule 8 Where offshore islands have a <10 m isobath, the area between 0-10 m is to be classified as macroalgae (subtidal, high relief).

Rule 9 Where offshore islands have only the 20 m isobath (where rule eight cannot be applied), the area between 0-20 m is to be classified as macroalgae (subtidal, high relief).

Rule 10 Where offshore islands have 10 m–20 m bathymetry, in addition to where rule 8 is applied, the area is to be classified as macroalgae (subtidal, low relief).

Rule 11 Where islands have no related 10 m or 20 m isobath, a 50 m buffer is to be applied and classified as macroalgae (subtidal, high relief) with the exception of where Rule 2 and rule 7 has been applied.

Rule 12 The areas where the DOLA coastline high water and low water marks are shown with no associated island, are to be classified as offshore intertidal reef, if the Royal Australian Navy (RAN) navigational charts or RAN point bathymetry data layer show these areas as having <5 m in depth. Areas having >5 m depth are to be classified as macroalgae (subtidal, high relief).

Rule 13 Shallower bathymetry (<10 m) in areas of <50 m bathymetry, are to be classified as macroalgae (subtidal, high relief).

Rule 14 The shallow water areas (<20 m) in the Eastern Group of islands, are to be classified as mobile sand/reef pavement (subtidal).

Rule 15 Interpolative methods are to be used where there were three or more juxtaposed ground-truth sites classified as pebble/rubble (subtidal).

The above conceptual model was utilised to revise the preliminary broadscale map (original developed by CSIRO) of the major marine benthic habitats in the Recherche Archipelago region (*see* ACTION 9)

ACTION 7. Develop a marine wildlife distribution map.

Distribution maps of the major marine wildlife of the Recherche Archipelago region were completed in June 2002 (Bancroft *et al.*, 2002; *see* Appendix D).

Anecdotal and scientific information on the seasonal distributions, including particular important sites of various species of marine wildlife, including whales, sea lions, fur seals and seabirds, has been compiled and incorporated into maps, which delineate areas of high conservation value, in relation to marine wildlife. These data layers will contribute to the information base required for marine conservation reserve planning process for the region.

A list of GIS information layers that were developed for the marine wildlife distributions of the Recherche Archipelago region is presented in Table 3.

Table 3: List of GIS information layers for the wildlife distribution in Recherche Archipelago region.

DESCRIPTION	TYPE OF DATA	DATA LAYER NAME
Southern right whales breeding/nursery/milling areas	ArcView 3.2 shape file	whales-southern-right-poly_rar_20020221_ll_gda94.shp
Southern right whale migratory paths	ArcView 3.2 shape file	whales-southern-right-line_rar_20020221_ll_gda94.shp
Australian sea lion breeding and haul-out islands	ArcView 3.2 shape file	sealions_rar_20020219_ll_gda94.shp
Seabirds nesting islands	ArcView 3.2 shape file	seabirds_rar_20020219_ll_gda94.shp
New Zealand fur seals breeding and haul-out islands	ArcView 3.2 shape file	furseals_rar_20020219_ll_gda94.shp

ACTION 8. Verification of preliminary habitat mapping

As presented in Action 6 above, habitat verification data were collected through a collaborative marine benthic habitat survey, to which the Department and the Natural Heritage Trust (NHT) project contributed funds ($5,390 and $26,235 respectively, see Appendix E).

As part of the collaboration, the NHT project received:

1. Survey vessel time through the Fisheries Research and Development Corporation (FRDC) project to collect transect data suitable for modelling broadscale habitats in the Recherché Archipelago.

2. Data obtained from the above transects, some in the form of DBF and some as TXT files (Appendix F).

3. The Department has access to all habitat data collected, either in the form of DBF or TXT files, during the whole survey (approximately 3500 data points). At the date of writing this report, delivery of all collected data was yet to be finalised.

In return for the above data, the FRDC project will receive the revised broadscale map of the major marine habitat and the associated GIS data layers that have been developed.

The collaborative marine benthic habitat survey was undertaken in April to June 2002. Approximately 3500 data points were recorded with associated video footage. Of these, the Department has received 884 data points. These data were utilised in the development of a conceptual model for mapping marine benthic habitats in the region (*see* ACTION 6) and utilised for the revision of the broadscale map of the marine habitats (*see* ACTION 9).

ACTION 9. Develop a broadscale map of the marine ecological communities

A revised broadscale map of the major marine benthic habitats was developed (Appendix G), using the preliminary habitat map as the base layer and applying the conceptual model developed for mapping marine benthic habitats (*see* ACTION 6). The methods used and the data reliability are stated in the metadata (Appendix H) for the revised marine habitat GIS information layers (Table 4).

The shoreline habitats of the Recherche Archipelago Region were also mapped (Appendix I) and the associated GIS information layer was developed (Table 4). This data was incorporated into the broadscale map of the marine habitats. The development methods used and the reliability of the data is stated in the metadata (Appendix J) for the shoreline habitats GIS information layer.

The revised broadscale map of the major marine benthic habitats, the shoreline habitats and their associated GIS information layers, will contribute to the information base required in the planning process for establishing a marine conservation reserve in the Recherche Archipelago region.

Table 4: List of GIS information layers for the marine and shoreline habitats of Recherche Archipelago region.

DESCRIPTION	TYPE OF DATA	DATA LAYER NAME
Marine benthic habitats	ArcView 3.2 shape file	habitat_rar_20020916_ll_gda94.shp
Shoreline habitats	ArcView 3.2 shape file	Habitat_shoreline_rar_20000330_ll_gda94.shp

3. STATEMENT OF EXPENDITURE

The project had a total cost of $152,400. Of this, $52,400 was contributed by the Department and $100,000 was contributed by the Marine Protected Areas Program (MPAP) of Coast and Clean Seas, a Natural Heritage Trust initiative. A statement of expenditure is presented below (Table 5).

Table 5. Statement of expenditure

Item	MPAP Funding ($)	MPAP Expenditure ($)	CALM Expenditure ($)	Total Expenditure ($)
NHT funding received initially	80,000			
NHT final payment received June 2002	20,000			
Expenditure to 30 June 2002		82,900	41,000	**123,900**
Expenditure to Aug 2002		17,100	11,400	**28,500**
Totals	**$100,000**	**$100,000**	**52,400**	**152,400**

4. FUTURE DIRECTION OF THE PLANNING PROCESS

- The Jurien Bay, Dampier Archipelago/Cape Preston, Montebello/Barrow Islands, Recherche Archipelago, Geographe Bay/Capes/Hardy Inlet and the Walpole-Nornalup Inlet regions were identified by the MPRA as being of highest priority out of the 70 MPRSWG recommended areas. The Recherche Archipelago/Stokes Inlet region was also identified as a priority area to be considered for reservation in the future.

The status of the planning process for the first group of high priorities is as follows:

- The proposed Jurien Bay Marine Park is in its final stages (MPRA and Government endorsement, and gazettal) as the public comment phase has been completed.

- The Montebello/Barrow islands proposal is currently at the finalising of the draft indicative management plan phase.

- The Dampier Archipelago/Cape Preston Advisory Committee is still finalising its recommendations to the proposed management zoning and the proposed reserve classification.

- The proposal for the Geographe Bay/Capes/Hardy Inlet proposal is currently in the pre-Advisory Committee phases of the planning process.

- The Walpole-Nornalup Inlet planning process is yet to begin.

Currently, there are no plans to initiate the planning process for the implementation of a marine conservation reserve in the Recherche Archipelago region, other than the resource assessment, which was facilitated by this NHT supported project.

Once the State Government supports the consideration of the Recherche Archipelago region for reservation as a marine conservation reserve, the research and information layers developed by this project will provide a platform from which to initiate the planning process for its implementation. The planing process for a marine conservation reserve under the *Conservation and Land Management Act (1984)* is broadly outlined below highlighting:

1. the preparatory public education phase (Table 6);

2. the resource assessment and establishment of advisory committee phase (Table 7);

3. the preparation of an indicative management plan phase (Table 8);

4. the public review and refinement of indicative management plan phase (Table 9), and;

5. the gazettal process (Table 10).

Table 6. Planning process for new marine conservation reserves in Western Australia: Preparatory public education phase.

PLANNING PHASES & TASKS	COMMUNITY INVOLVEMENT
Preparatory Public Education *OBJECTIVE: To increase community knowledge and understanding of the marine conservation reserve program and the coastal region under consideration.*	
1. Identify stakeholder groups with interest in the coastal region under consideration.	The community currently assists with this process and there is scope for community involvement to increase.
2. Train coastal CALM staff and other key community members with educational roles.	Training the educators will involve community members as both deliverers and recipients of course material.
3. Produce and distribute educational materials to explain the values of the coastal region, the need for and how to care for our marine and coastal environments, the marine conservation reserve concept and planning process.	The community currently assists with this task and there is scope for community involvement to increase.
4. Community driven information gathering and monitoring.	This task is driven primarily by the community with the frameworks for gathering information being developed jointly by Government and the community.
5. Endorsement of high priority marine reserve proposals by MPRA.	MPRA membership is community based.
6. Ministerial agreement to commence planning process within defined study area.	

Table 7. Planning process for new marine conservation reserves in Western Australia: Resource assessment and establishment of advisory committee phase.

PLANNING PHASES & TASKS	COMMUNITY INVOLVEMENT
Resource assessment and establishment of advisory committee. *OBJECTIVE: To gather the information required and to establish the framework for the development of community advice relating to planning the proposed marine conservation reserve.*	
1 Gather environmental information in accordance with the attached inventory of resource information requirements.	Community participation in this task has the potential to be extensive and relates directly to the amount of relevant information that was gathered during task 4 in phase II.
2 Gather historical and current cultural and social information in accordance with the attached inventory of resource information requirements.	Community participation in this task has the potential to be extensive and relates directly to the amount of relevant information that was gathered during task 4 in phase II.
3 Undertake an analysis of community issues to determine community aspirations for the future, attitudes towards the proposed marine conservation reserve, levels of knowledge and understanding of the proposed area, reserve concept and planning process and key issues relating to the development of the proposed reserve.	This task involves the summarisation of a large number of discussions with community members. The participation of community is there essential for this task.
4 Notify the broad community of the immanent commencement of the planning process and invite nominations for the community planning advisory committee.	The community could assist greatly by disseminating these messages.
5 Minister appoints community planning advisory committee.	
6 Establish consultation partnerships and sector reference groups with key sectors of the community.	Extensive community involvement in this task is essential.

Table 8. Planning process for new marine conservation reserves in Western Australia: Preparation of an indicative management plan phase.

PLANNING PHASES & TASKS	COMMUNITY INVOLVEMENT
Preparation of an indicative management plan. *OBJECTIVE: For the community planning advisory committee to forward its recommendations for endorsement by the MPRA and Government in the form of an indicative management plan for the proposed marine conservation reserve.*	
1. Undertake and document a broad community education program.	There is potential for extensive community involvement in this task.
2. Undertake and document a broad public participation program focusing on sector reference groups.	This task requires extensive community involvement in the development and communication of sector viewpoints and the dissemination of planning decisions and rationales back to members of the community.
3. Community planning advisory committee to identify agreed values, agreed pressures, agreed targets and agreed strategies, including reserve type, boundaries and zoning. All decisions to be made using an open process with clear rationales for decisions.	The community planning advisory committee relies on the dedication of its community members.
4. Preparation of draft indicative management plan.	
5. MPRA endorsement of draft indicative management plan.	The MPRA is a community advisory body.
6. Ministerial approval to release Notice of Intent (NOI) to create reserve (including release of indicative management plan).	
7. Cabinet approval for NOI	
8. Release of NOI	

Table 9. Planning process for new marine conservation reserves in Western Australia: Public review and refinement of indicative management plan phase.

PLANNING PHASES & TASKS	COMMUNITY INVOLVEMENT
Public review and refinement of indicative management plan. *OBJECTIVE: To finalise and seek endorsement of a final management plan giving due consideration to public submissions.*	
1. Release of NOI and indicative management plan for statutory 3 month public submission period.	
2. Facilitation of broad community participation in submission process.	Community participation in this task is essential.
3. Preparation of public submissions summary.	
4. Community planning advisory committee consideration of submissions and proposed changes to indicative management plan.	The work of this committee relies on the dedication of its community members.
5. MPRA consideration of submissions and proposed changes to indicative management plan.	Membership of the MPRA is drawn from the community.
6. Preparation of resource estimates for establishing and implementing the indicative management plan.	
7. Ministerial consideration of submissions and proposed changes to indicative management plan.	
8. Cabinet approval for final management plan and consideration of resources for management.	

Table 10. Planning process for new marine conservation reserves in Western Australia: Gazettal process.

PLANNING PHASES & TASKS	COMMUNITY INVOLVEMENT
Gazettal Process *OBJECTIVE: To declare the marine conservation reserve in accordance with the management plan.*	
1. Gazettal notice tabled in Parliament.	Opportunities for Parliamentary debate on reserve gazettal.
2. Gazettal	Once gazetted, the management plan is implemented and many of the management strategies within the management plan require community participation, eg establishment of a management advisory committee, establishment of a friends group, development of a community monitoring program, etc.

5. REFERENCES

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van Hazel, J. (2001). The climate and physical oceanography of the Recherche Archipelago and adjacent waters. Honours Thesis, Department of Environmental Engineering, University of Western Australia, Perth, Western Australia. October 2001. 87p.

van Hazel, J., Pattiaratchi, C. & D'Adamo, N. (2001) Review of the climate and physical oceanography of the Recherche Archipelago and adjacent waters. Reference WP 1614 CP. Centre for Water Research, University of Western Australia, Perth, Western Australia.

APPENDICES

APPENDIX A. WORK SCHEDULE

Tasks	Dec 2000	Jan 2001	Feb 2001	Mar 2001	Apr 2001	May 2001	Jun 2001	Jul 2001	Aug 2001	Sept 2001	Oct 2001	Nov 2001	Dec 2001	Jan 2002	Feb 2002	Mar 2002	Apr 2002	May 2002	Jun 2002	Jul 2002
The review of existing ecological information																				
The review of the climate and physical oceanography																				
Collation of existing information layers																				
Progress reporting																				
Develop a preliminary understanding of the broadscale water movements																				
Preliminary habitat mapping and conceptual model development																				
Develop a marine wildlife distribution map																				
Verification of preliminary habitat mapping																				
Develop the broadscale map of marine ecological communities																				
Year 1 final report																				

APPENDIX B. THE CLIMATE AND PHYSICAL OCEANOGRAPHY OF THE RECHERCHE ARCHIPELAGO AND ADJACENT WATERS.

van Hazel, J. (2001). The climate and physical oceanography of the Recherche Archipelago and adjacent waters. Honours Thesis, Department of Environmental Engineering, University of Western Australia, Perth, Western Australia. October 2001. 87p.

APPENDIX C. CSIRO GROUND-TRUTH DATA FOR THE RECHERCHE ARCHIPELAGO REGION.

APPENDIX D. MARINE WILDLIFE DISTRIBUTIONS IN THE RECHERCHE ARCHIPELAGO REGION (STOKES INLET TO ISRAELITE BAY).

Bancroft, K.P., Davidson, J.A. & Lamb, B (2002) Marine wildlife distributions in the Recherche Archipelago region (Stokes Inlet to Israelite Bay) Report: MRI/WSC/RAR-61/2002. Marine Conservation Branch, Department of Conservation and Land Management, Perth, Western Australia. Unpublished report. 37p.

APPENDIX E. CORRESPONDENCE FOR THE COLLABORATIVE MARINE BENTHIC MAPPING SURVEY

APPENDIX F. HABITAT VERIFICATION AND GROUND-TRUTH DATA COLLECTED DURING THE COLLABORATIVE MARINE BENTHIC MAPPING SURVEY

APPENDIX G. REVISED BROADSCALE MAP OF THE MARINE ECOLOGICAL COMMUNITIES OF THE RECHERCHE ARCHIPELAGO REGION.

APPENDIX H. METADATA FOR THE OF THE MARINE BENTHIC HABITATS OF THE RECHERCHE ARCHIPELAGO REGION GIS INFORMATION LAYER.

APPENDIX I. MAP OF THE SHORELINE HABITATS OF THE RECHERCHE ARCHIPELAGO REGION.

APPENDIX J. METADATA FOR THE OF THE SHORELINE HABITATS OF THE RECHERCHE ARCHIPELAGO REGION GIS INFORMATION LAYER.

DATASET	
Title	*Onshore Coastline Habitats of the Recherche Archipelago*
Custodian	*Department of Conservation and Land Management (CALM)*
Jurisdiction	*Western Australia*
DESCRIPTION	
Abstract	*This dataset consists of linework detailing the onshore coastline habitats of Southern Western Australia's Recherche Archipelago and covers approximately 983km of coastline extending from stokes inlet (121°E) eastward to Isrealite Bay (124°15'E).* *The coastline is delineated into areas of* ***beach, rocky shore, N/A*** *or* ***beach + rocky shore*** *and are further attributed with the direction the habitat is facing, habitat length (metres), beach width (maximum and average in metres). The base coastline linework was provided by DOLA. A source attribute has been added to each line based on the coastline source and/or method used to derive the coastline in any area.* *Habitats were identified from digital orthophoto mosaics, unrectified hardcopy and digital aerial photography and local knowledge of the physical characteristics of the islands in the area. Beach widths were measured from the digital orthophoto mosaic and aerial photography using ArcViews measure tool and using a scaled adjustable magnifying glass for the hardcopy photography. Habitat facing directions were determined using an avenue script to compute a bearing from North. The dataset was compiled by Ben Lamb in March-June 2002.*
Search Word(s)	
Geographic Extent Name(s)	*WA South Coast (WSC) and Eucla (EUC) IMCRA regions*
DATA CURRENCY	
Begin Date	*22 February 1991*
End Date	*30 March 2000*
DATASET STATUS	
Progress	*In Progress*
Maintenance & Update Frequency	*As required*
ACCESS	
Stored Data Format	*DIGITAL ArcView shapefile, projected to Map Grid of Australia Zone 50 from the Geocentric Datum of Australia 1994 (GDA94).*
Available Format Type	*DIGITAL ArcView 3.2 shapefile*
Access Constraint	*Data available for external use subject to transfer fee and license conditions.* *Data is not to be distributed without authorisation from CALM.* *Contact CALM's database administrator for further details.*
DATA QUALITY	
Lineage	*The classification was undertaken in three stages Stage 1 was the classification of the coastline using three digital orthophoto mosaics supplied by DOLA and the selection of existing photography to be supplied by DOLA in a digital form. Stage 2 involved the basic georeferencing of the unrectified digital aerial photography supplied by DOLA and using this as the base for habitat classifications. Stage 3 was the classification of the remainder of the coastline from older B&W hardcopy aerial photography and the classification of offshore islands using Kevin Bancrofts local knowledge of the physical characteristics of the islands. Details for all stages are supplied below.* *A standard broad scale marine habitat classification system was developed by CALM Marine Conservation Branch (see T:\144-Marine Conservation Branch\Shared Data\Current_papers\Habitat Classification\SMECCS_291101.doc).* *NOTE: The classification system is being refined on an on-going basis.* ***STAGE 1 (Carried out by Ben Lamb in March 2002)*** ***1.*** *The dataset 'coastline_wa_20010228_ll_gda94' was clipped to the cover the extent of the proposed study area for the proposed Recherche Archipelago marine park. As there*

	was no High Water Mark only the line representing Mean High Water Mark was required for the classification so the Low Water Mark lines were removed. This coastline was used as the base linework for the coastline habitats to be 'split' and attributed as necessary. ***2.*** *This shoreline was then projected to MGA Zone 51 coordinates using the projection functionality of the extension 'calm_add_funk_2001.avx' in Arcview3.2 to facilitate overlaying the orthophotos with the shoreline.* ***3.*** *The digital orthophoto mosaics (esperanceE1.ecw, esperanceE2.ecw and esperanceW.ecw) were then used as a spatially rectified reference to delineate habitat boundaries on the base coastline.* *Habitat identification was determined visually from the digital orthophoto. Habitat boundaries were delineated (according to CALM's standardised habitat classification system) into areas of* ***beach, rocky shore, N/A*** *or* ***beach + rocky shore*** *and attributed accordingly. Delineation was done using the 'split line' functionality of Arcview 3.2 and was done where there was a change in habitat or a significant change in direction of the coastline.* *Lines containing beach habitats were then attributed with beach width (average and maximum). This was measured on the digital orthophoto using Arcviews measure tool functionality. The lines were all split whilst moving from East to West along the coast or in the case of an island in an anti-clockwise direction. This systematic splitting of the coast was done to enable the used of scripts to automate the facing direction calculations.* *The digital orthophoto mosaics were the attribute source for 272.7 km of the total 983.1 km of shoreline.* ***STAGE 2 (Carried out by Ben Lamb in March 2002)*** ***1.*** *DOLA supplied 215 colour aerial photos scanned at 453 dpi. These photos were taken from February 1996 to March 2000. These digital photos then underwent basic georeferencing by Ben Lamb. The georeferencing was done by cropping the image to the actual picture area and recording the size in pixels of the cropped image. The true scale of each photo was calculated using the focal length of the camera and the flying height, this was then used to calculate the ground dimensions of a pixel separately for each frame. This equared to approximately 1.43m. The coordinate for the upper left pixel was calculated by using the photo centre supplied by DOLA in AGD84 Zone 51 coordinates, half the number of pixels in the x and y directions and the ground size of the pixels. A world file in the required Arcview format was then generated using this information to allow the display of the photos in Arcview and overlaying the shoreline.* *NOTE: The images have been georeferenced only and have not undergone any rectification. The accuracy of the georeferencing is low and the georeferenced photos should only be used for applications where the high spatial accuracy is not required* ***2.*** *Habitat identification was determined visually from the digital aerial photography and inaccuracies in the georeferenceing were accounted for in the classification. Habitat boundaries were delineated (according to CALM's standardised habitat classification system) into areas of* ***beach, rocky shore, N/A*** *or* ***beach + rocky shore*** *and attributed accordingly. Delineation was done using the 'split line' functionality of Arcview 3.2 and was done where there was a change in habitat or a significant change in direction of the coastline.* *Lines containing beach habitats were then attributed with beach width (average and maximum). This was measured on the digital orthophoto using Arcviews measure tool functionality. The lines were all split whilst moving from East to West along the coast or in the case of an island in an anti-clockwise direction. This systematic splitting of the coast was done to enable the used of scripts to automate the facing direction calculations.* *The digital aerial photography were the attribute source for 229.4 km of the total 983.1 km of shoreline.* ***STAGE 3 (Carried out by Ben Lamb in May/June 2002)*** ***1.*** *Hardcopy B&W aerial photography (Job no. 900401 runs 49 and 50 flown Feb1991) supplied by the Department for Planning and Infrastructures Marine Division and used as the base for the shoreline habitat classification for the Stokes Inlet area.* ***2.*** *Habitat boundaries were delineated (according to CALM's standardised habitat classification system) into areas of* ***beach, rocky shore, N/A*** *or* ***beach + rocky shore*** *and attributed accordingly. The classifications were made by correlating the shoreline onscreen to the hardcopy photos. Delineation was done using the 'split line' functionality of Arcview 3.2 and was done where there was a change in habitat or a significant change*

	in direction of the coastline. *Lines containing beach habitats were then attributed with beach width (average and maximum). This was measured on the aerial photos using an adjustable scaled magnifying glass.Due to difficulty in accurately identifying beach widths for individual segments of beach the beach widths generated from this photography were calculated over the total length of the beach and applied to the individual segments. All other attribution has been performed to the same standards as was used in previous stages. The lines were all split whilst moving from East to West along the coast or in the case of an island in an anti-clockwise direction. This systematic splitting of the coast was done to enable the used of scripts to automate the facing direction calculations.* ***3.** The shoreline which comprised of the offshore islands that was not covered by any of the aerial photography was identified by Kevin Bancroft as being all rocky shore with the exception of beaches on Sandy Hook Island and Middle Island. The habitat boundaries were delineated (according to CALM's standardised habitat classification system) into areas of **beach or rocky shore** and attributed accordingly. The lines were all split whilst moving in an anti-clockwise direction. This systematic splitting of the coast was done to enable the used of scripts to automate the facing direction calculations.* *The hardcopy photography was the attribute source for 51.2 km and evin Bancroft was the attribute source for 359.7 km of the total 983.1 km of shoreline* ***4.** Habitats were further attributed with direction the habitat is facing. This was determined using an avenue script to calculate the direction of the line, which was then converted to a facing direction eg. **North, South, East, West, North East, North West, South East** or **South West.** See 'Attribute Accuracy' below for further details.* ***5.** The dataset was then rationalised to merge adjacent polylines with identical attributes and reduce the size of the dataset. This was done by creating a grouping field by concatenating all the other fields. A script (autounion.ave) was then used to union all the polylines based upon their group attribute being identical. This polylines were then converted back to a single part shapes using the Xtools 'convert multipart to single part' functionality. This resulted in in a reduction in the number of polylines from 9112 to 6869. Manual verification was undertaken on numerous samples of the dataset to ensure that the integrity of the dataset had been maintained.* ***6.** Habitat length was calculated using the CALM added functionality extension (Calc length). The dataset was then converted to GDA94 Lat/Long coordinates using the Change Projection funcionality of the CALM Added Functionality Extension 2001 extension.*
Positional Accuracy	*Habitat extents were delineated as accurately as is possible to determine from the available digital and hardcopy sources. Further Ground-truthing would need to be undertaken to determine them with greater accuracy.* *Accuracy of DOLA's coastline linework is not stated. DOLA has compiled this dataset from a number of sources of best available information including 1:2 000, 1:50 000 and 1:100 000 scale datasets. These source datasets were collected at various levels of positional accuracy, and as such each individual line is as accurate as its source data. The source attribute in the shapefile identifies these sources.*
Attribute Accuracy	*- Habitat classifications were determined visually from digital orthophoto mosaics, digital georeferenced aerial photography and hardcopy aerial photography, and while every effort has been made to assign these correctly, there may be some errors. The habitats are accurate as best determined at the time of aerial photography (Feb 1991 to Mar 2000). Coastlines by their very nature are dynamic and subject to change due to natural and man-made forces. This is particularly the case with the movement of sand up and down the coast, and as such beaches may form and dissappear with the passing of time.Ground-truthing needs to be undertaken to determine habitats with greater accuracy.* *- Beach widths estimated from the digital and hardcopy aerial photography are estimated to be accurate to within 10 metres. Beach widths estimated from the digital orthophotomosaics are estimated to be accurate to within 5 metres. Ground-truthing needs to be undertaken to determine them with greater accuracy.* *- Habitat directions were determined using an avene script to calculate the bearing between the first and last points of the individual polylines. All polylines were split in a uniform direction so as the polyline direction placed the sea to the right of the line and the land to the left. Directions were assigned based on the seaward direction the habitat was*

	facing. The following domain was used based on the seaward perpendicular of the bearing of the habitat. *east = 337.5^o- 22.5^o* *south-east = 22.5^o - 67.5^o* *south = 67.5^o - 112.5^o* *south-west = 112.5^o - 157.5^o* *west = 157.5^o - 202.5^o* *north-west = 202.5^o - 247.5^o* *north = 247.5^o- 292.5^o* *north-east = 292.5^o - 337.5^o* *- Habitat lengths were determined based on the arc length of the DOLA coastline (after splitting) and calculated automatically using the CALM extension for Arcview3.2. Lengths were rounded to the nearest metre.*
Logical Consistency	*Attribute names have been checked and validated for consistency across all shoreline habitat datasets.* *Attribute values have been checked and validated for consistency, and checked for logic in relation to attribute names. All attributes that require values have had values assigned.* *The shapefile has been compiled carefully to avoid overlaps or duplication of points.*
Completeness	*The dataset will be upgraded as priorities, time and resources permit. Further work needs to be undertaken on ground-truthing.*
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METADATA DATE	
Metadata Date	*5 June 2002*
ADDITIONAL METADATA	
Additional Metadata	*- See accompanying habitat classification documentation further describing the classification system(see T:\144-Marine Conservation Branch\Shared Data\Current_papers\Habitat Classification\SMECCS_291101.doc).* *NOTE: This system is still in development. Any feedback would be appreciated.* *- See DOLA coastline Metadata report for further details on the coastline.*