British Columbia Biological Shore-Zone Mapping System

Prepared by
Land Use Coordination Office
for the Coastal Task Force
Resources Information Standards Committee

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Preface

This report is submitted to the Resources Inventory Committee (RIC) by the Coastal Task Force.

The Resource Inventory Committee members re resources inventory specialists from a wide variety of professional disciplines and representing provincial, federal, aboriginal and private sector agencies and other resource interests. RIC's objective is to develop a common set of standards and procedures for provincial resource inventories.

The Coastal Task Force has identified a number of projects to develop a common set of inventory mapping standards for the coast of British Columbia. This manual provides documentation of the Biotic Mapping System developed as a component of the Shore-zone Mapping System which has been under development by the Province of British Columbia since the early 1980's.

Funding of the Resources Inventory committee work, including preparation of this report, is provided by the Canada-British Columbia Partnership Agreement on Forest Resources Development: FRDA II. This is a five-year (1991-1996) $200 million program cost-shared equally by the federal and provincial governments.

Funding from FRDA II does not imply acceptance or approval of any statements or information contained herein by either government. This document is not official policy of Forestry Canada or any British Columbia government ministry or agency. For additional copies and/or further information about the Committee and its task forces, please contact the *Secretariat, Resources Inventory Committee, 840 Cormorant St., Victoria, BC V8W 1R1, phone (604) 381-5661 or fax (604) 384-1841*.

Abstract

A database and mapping system for the descriptive biota of the British Columbia shoreline has been designed and includes the following details:

The system integrates directly with the physical shore-zone mapping system for British Columbia by linking data tables in the biological database with data tables in the physical database.

The boundaries for units and components in the physical system, based on geomorphological parameters, are used to define boundaries for species assemblages (bands) in the biological system.

The biological database is designed to accept data collected by a range of sampling methods and levels of effort. This is accomplished without the loss of information by the inclusion of a methods code.

The biological database intentionally does not include a hierarchical structure above the shore unit level so that users can summarize shore unit data within areas of their choosing. Summary areas can be added to a digital map at any time.

A hierarchical coding system for biota is included and is based on taxonomic groupings. A more versatile code which includes other groupings requires further development and user consultation.

Two new fields, freshwater influence and land use, are suggested for inclusion in the physical database. Also, modifications and additions are suggested for the physical database to compliment the biological database.

Acknowledgments

The biotic mapping system was developed for the Coastal Task Force of the British Columbia Resource Committee. The idea for developing a biotic mapping system originated with the scientific authority, Mr. Don Howes, who provided administrative, technical and financial support. John Harper of Coastal and Oceans Resources Inc. helped considerably in the integration of the biotic and physical shore-zone mapping systems. We would also like to thank Peter Wainwright of LGL Limited and Brian Emmett of Archipelago Marine Research for their contribution to the initial conceptual design and development of the system. Mary Morris kindly allowed us to include the species codes she compiled. Contributions were also made by workshop participants including: Barron Carswell, British Columbia Ministry of Agriculture, Food and Fisheries, Michael Dunn, Canadian Wildlife Service, Christine Hodgson, British Columbia Ministry of Agriculture, Food and Fisheries, Brad Mason, Canada Department of Fisheries and Oceans, Kenneth Warhei, Washington State Department of Wildlife, and Maureen Wayne, British Columbia Ministry of Environment, Lands and Parks.

The Government of British Columbia provides funding of the Resources Information Standards Committee work, including the preparation of this document. The Resources Information Standards Committee supports the effective, timely and integrated use of land and resource information for planning and decision making by developing and delivering focused, cost-effective, common provincial standards and procedures for information collection, management and analysis. Representatives to the Committee and its Task Forces are drawn from the ministries and agencies of the Canadian and the British Columbia governments, including academic, industry and First Nations involvement.

The Resources Information Standards Committee evolved from the Resources Inventory Committee which received funding from the Canada-British Columbia Partnership Agreement of Forest Resource Development (FRDA II), the Corporate Resource Inventory Initiative (CRII) and by Forest Renewal BC (FRBC), and addressed concerns of the 1991 Forest Resources Commission.

For further information about the Resources Information Standards Committee, please access the RISC website at: http://ilmbwww.gov.bc.ca/risc/index.htm.

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1. Introduction

1.1 Purpose

The purpose of this manual is to standardize the methodology for recording and mapping biological characteristics of the marine shoreline of British Columbia and to provide a clear and concise description of the database structure. From the outset of development of this system, the objectives were to design a flexible system that would meet the requirements of a broad spectrum of potential users and be compatible with the physical shore-zone mapping system developed by the province (Howes et al. 1994). This manual provides the conceptual framework used in developing the mapping system, the methods of data collection, an interface with the physical shore-zone mapping system, and the mapping procedures.

1.2 Background

Eleven habitat classification systems developed for North America and elsewhere were reviewed (Frith et al. 1993) and some common characteristics of established classification systems of biological communities operating at a similar scale to that desired for the British Columbia coastline were identified. In summary, the review concluded that a coastal habitat mapping classification system for British Columbia should contain the following elements:

1. a truly hierarchical design thus facilitating application at a variety of scales;
2. a global perspective where the higher levels of the classification system are defined by global processes;
3. a process-driven classification system where the criteria defining each level are functional determinants of community structure;
4. selection of habitat classification parameters that can be monitored by remote sensing techniques (e.g., aerial video, satellite imagery) at least at the higher and intermediate levels of the hierarchy;
5. quantitative assessment of general measures of biological community structure (e.g., relative abundance of key species), their distribution in space within the coastal zone and linkages with habitat classification parameters.

Given the interest of the Land Use Coordination Office of the British Columbia Ministry of Environment, Lands and Parks in a physical shoreline classification system (i.e., Howes et al. 1994) and the desire to extend this system to include biotic communities, it was deemed essential to make the two systems compatible wherever possible. For the most part, the biological database structure has been designed to interface with the physical system and a common base map.

In order to be useful and informative for most required applications, a biotic mapping or habitat classification system must be predictive rather than simply descriptive. A functional predictive system consists of a series of key species together with physical habitat data which can be used to predict the probable biological community present in the area (Figure 1). Nevertheless, in the absence of suitable data on which to develop a predictive mapping system, few alternatives remain. Through the process of elimination, the descriptive option was chosen for the biotic mapping system. However, this approach is a "stop-gap" measure only until further research is directed at developing a predictive tool. Some field studies have already been conducted toward this end. Harper et al. (1993) has field tested an earlier, but similar, approach on the Queen Charlotte Islands and developed a workable prototype. Further work by Harper and others on the

West Coast of Vancouver Island in 1994 tested a draft version of the shoreline biotic mapping system which led to revisions contained in this manual. Throughout the development of the biotic mapping system, the probable requirements of a predictive model have been anticipated and information that is likely to be required in the future development of a predictive model has been included.

1.3 Format

The biotic mapping system presented in this manual is intended to provide a structure for the description and mapping of the marine shore zone of British Columbia. It has been developed as a means of recording the distribution of biological resources along the coast and as a tool for identifying biological communities and community-based relationships with physical and oceanographic processes. As with the physical shore-zone mapping system, the biotic mapping system is essentially independent of scale and lends itself to data collected at all levels of detail. It is intended to meet a wide-ranging need for resource information including land-use planning, oil-spill response and management, resource conservation and management and environmental impact assessment.

2. **Philosophy and Approach**

The information contained in a biological database in support of a biotic mapping system for the British Columbia shoreline will better serve potential government, private industry and public users if:

1. the spatial boundaries for information collected and recorded in the biological database describe real boundaries for the distribution and abundance of species;
2. species of value to users are a mandatory inclusion in the database where the abundance and distribution of species of interest are recorded directly, or physical and biological information known to affect the distribution of these species are collected;
3. the database structure is flexible in its ability to display data on a local, regional or provincial scale; and
4. the database structure allows for the collection of information at a variety of map scales and levels of effort such that detailed field surveys required for the development of a predictive habitat model and more general information from aerial surveys or low effort field surveys can be included in the same database.

The use of the physical shoreline classification system for British Columbia (Howes et al. 1994) to define boundaries for the distribution and abundance of species is probably realistic for many species. The physical classification system sub-divides shore units into zones (backshore, intertidal and sub-tidal). Zones are further sub-divided into across-shore components based on physical characteristics. The distribution and abundance of species or species assemblages are described within components. This approach assumes physical parameters of substrate, elevation and wave energy, taken from the physical database for each component are the main determinants of species distribution (Kozloff 1976). Components are divided across the shoreline into bands of common biotic assemblages. These bands are visible in aerial video and slide imagery.

While physical parameters can be determinants of the distribution of species, biotic factors are equally important, and may dominate in some cases (Connell 1961). The definition of shore unit boundaries based on discontinuities in biotic composition would be preferred over physical boundaries for the biological database. However, the independent collection of biological information on the distribution and abundance of shoreline species contains significant practical constraints. The major advantage of this approach is the identification of boundaries for the distribution of species independent of the physical characteristics of the shoreline. The simultaneous, but independent, collection of biological and physical data and a subsequent spatial analysis to characterize associations between species and physical features is an unbiased approach. However, given that very few detailed surveys for the British Columbia coastline presently exist, significant time and effort would be required to collect the necessary information for the biological database. Although geomorphologists can identify materials and forms of physical components from the air, biologists are not able to view the distribution and abundance of most intertidal or subtidal species from the air. However, across-shore bands of color are visible from the air and appear to be indicative of common species assemblages (Harper et al. 1993). Ground and underwater surveys would be necessary for the collection of the majority of biological data to establish distributional boundaries. This would further prolong the data collection process and delay integration of the biological and physical databases. Therefore, for practical reasons, the boundaries of the biological database are defined by physical parameters.

The goal of the biotic mapping system is to develop a classification methodology similar to the physical shoreline system but based on biological criteria. A summary classification, referred to as "shoreline type" in the physical shore unit database, defines shore units based on substrate,

sediment type, unit width, and slope. Harper et al. (1993) used substrate classes from the physical shore unit database and a measure of wave exposure to predict the presence of key indicator species in the intertidal and subtidal zones for each shore unit. The results were seven combinations of substrate and exposure characterized by one to five species in each of four intertidal zones and one subtidal zone. Further division of shore units based on biological information should be possible, and is probably necessary to adequately describe the distribution of biological assemblages or species in the coastal zone of British Columbia.

The species chosen to characterize the biotic shoreline is restricted to benthic, sessile species. In this way, problems associated with short-term fluctuations in species abundance and distribution are minimized. Even so, spatial patchiness and temporal fluctuations are still common in stable, benthic populations. The date of data collection is a necessary inclusion in the dataset. The identification of species may not always be practical; therefore, the classification system is designed to accept a species name or a more general biotic category such as phylum, family, class, or common group (e.g., kelp, barnacles, infauna, attached vegetation, trees). An indication of the level of detail (in this case for the identification of organisms in the field) is important to database users. A sample list of species codes, species names and common names from intertidal areas of British Columbia is given in Appendix 1.

The accuracy and precision of a unit boundary and the amount of detail collected on substrate composition or species abundance and distribution depends on the field survey methodology (i.e., aerial or ground survey). In order to accommodate a range of collection methods employed by a potential variety of field researchers with varying objectives, the database does not place any restrictions on the methods used. However, a code is included which combines the survey method and level of effort. The database user can use the methods code to select data at a similar resolution for analysis where appropriate.

The biological mapping system for the British Columbia shoreline is designed to accommodate polygon data for resources mapped explicitly. The linkage of resource polygons and their attributes with shoreline units for descriptive or analytical purposes can be easily accomplished within a GIS (geographic information system) environment.

3. General Approach

The biotic mapping system is based on physical information and maps of the shore zone, and biological maps and information of the nearshore and shore zone areas. The physical and biological information is contained in a series of linked databases which are in turn linked to the physical and biological maps. Figure 1 portrays the components of the biotic mapping systems. The maps and databases are supported by "raw" information contained in video, transparencies and field sketches, notes and diagrams.

31. Field Methods

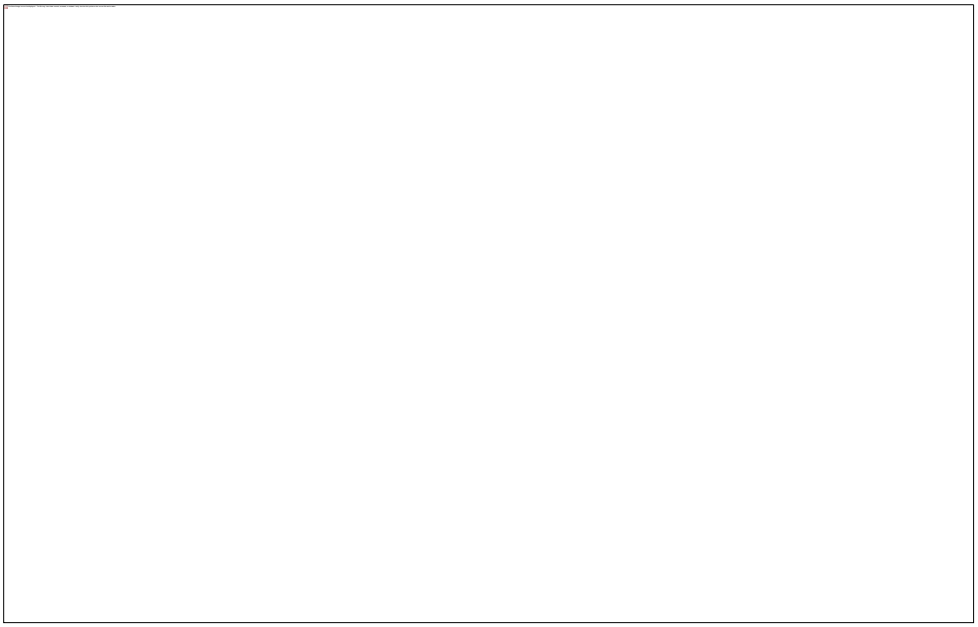


Figure 1 Basic components and interrelationships of a habitat model for the marine shorezone

The collection of physical and biological data for mapping shorelines based on along-shore and across-shore divisions demands two levels of data collection. Broad-scale mapping is accomplished through data collected from aerial surveys. Both physical information and some biological data can be collected from the air. More detailed information is collected by ground surveys.

3.2.1 Aerial Surveys

A biological survey of a shoreline from a fixed-wing aircraft or helicopter should include:

* in-flight commentary by one or more scientists;

* video tape records and analysis; and/or

* still photographic records and analysis.

Fixed-wing or helicopter overflights at 200 m ASL allow for the coverage of large areas of a shoreline with information collected for individual shore units. Across-shore bands of vegetation or substrate in the intertidal and backshore zones (components) are often visible from the air, but measurements of component widths and identification of species are limited. However, across-

shore zones and components and across-shore bands of biota can be identified and recorded. The form and material of the backshore and intertidal substrate can be identified from the air and boundaries for shore units determined where transitions in these parameters occur. Colour bands that are indicative of species assemblages and are general indicators of wave exposure can be identified from aerial videography of the shoreline.

Video tape records and photos supplemented by in-flight commentary are essential for the interpretation and recording of physical and biological data. The level of detail that can be resolved with certainty includes the establishment of physical shore units and across-shore zones for the backshore and intertidal. The sub-tidal substrate and most associated species are not visible from the air; only conspicuous biotic characteristics can be noted (e.g., presence of kelp beds and urchin barrens). High-quality video tape records or photos may be sufficiently clear to resolve substrate and biota components within the backshore and intertidal zones. Two levels of detail are therefore possible from aerial overflight surveys; general aerial surveys (zone data) and detailed aerial surveys (component data). The level of effort required for describing components is greater than for describing zones only.

3.2.2 Ground Surveys

On-site surveys are carried out in order to:

* collect more detailed information on physical and biological characteristics of a site than is available from aerial over-flights;

* supplement other field sampling programs (e.g., dive surveys, water quality studies); or

* ground-truth extensive or remote data collection methods.

The amount of detail attained from a field survey can vary widely with the level of effort and the survey techniques employed. Three levels of effort encompassing the most common field survey techniques are described and defined.

The most cursory ground survey is termed a field survey. This is the lowest level of information collection and entails a quick visual scan of each band. The data collected would include identification of the most common and conspicuous species or biotic group within bands. The most common species or biotic group would refer to key species of conspicuous assemblages where the species identified would be the dominant plant or animal species in that band (e.g., seagrass, barnacles, mussels). Video tape records and photographs from a boat would be a potentially useful method of data collection.

A more detailed survey, which would involve a foot survey of each component, is termed a general site survey. A survey of this intensity would identify key species in each band, similar to the general visual survey, but rare and common species would also be recorded and their abundance noted. The next level of effort in a field survey is termed a detailed site survey. In addition to a thorough foot survey to identify the distribution, cover and species identification of the more conspicuous species in each association, quadrants or transects are sub-sampled within each assemblage to identify the less common or conspicuous species. In this way, a greater number of species are identified within a species assemblage and the description of species distribution is more quantitative.

3.3 Definitions

Areas of the shoreline are defined by a combination of common physical and biological characteristics. There are four levels in the hierarchical structure. The top level divides the shoreline into along-shore units based on physical properties of the substrate (shore unit). The middle levels (zones and components) divide shore units into across-shore areas of common physical type (form

and material). The bottom level further divides components into across-shore areas of common species assemblages (bands). Each subsequent level, starting from the top, divides the previous level into smaller units where unit boundaries are always contained within the boundaries of the previous level.

Shore Units -- The largest division at the top of the hierarchy involves partitioning the shoreline into lengths called shore units. Shore units are defined based on physical morphology (form and material) of the shoreline where unit boundaries identify a change from one physical class to another. For example, a change from a beach to a rocky platform would define a boundary between two shore units. Shore units described for the Southern Strait of Georgia where applied at a scale of 1:15000 and result in shore unit lengths ranging from 30 m to 20 km with a median of 485 m.

Zones -- Shore units are divided into three across-shore zones; the backshore, intertidal and sub-tidal. The divisions between these zones are based on physical and biological characteristics within a shore unit that define the landward limit of marine processes, the high water line and the low water line.

Components -- Each zone is divided further across-shore into components based on the material composition and form of the substrate. Primary, secondary and tertiary material and form are described within components and provide descriptors of the variability in geomorphology within a component. For example, when there is a rock outcrop that makes up less than 50% of a component dominated by sand, the rock is defined as the secondary level and the sand as the primary level (see Howes et al. 1994 for details).

Bands -- Components are sub-divided into across- shore areas of common species assemblages termed bands. Bands are defined by the dominant cover species and the color and texture of that band visible from aerial videography, photography, or from ground surveys.

Species - Although species data do not at present provide a further sub-division of bands, they are essential for characterizing the species composition within a shore zone, and for assessing the significance of physical boundaries to the distribution of species.

4. Biotic Mapping Database

Because the biotic mapping system is based on the shore units, zones and components of the physical shore-zone mapping system, the physical mapping system and databases described in Howes et al. (1994) are a required starting point for the biotic mapping system. Four databases are required for recording biological data: the shore unit, component, band and biota databases. The shore unit database (see Appendix 2 for descriptions of terminology) includes physical parameters that are characteristic of the entire shore unit. The component database contains information on the physical characteristics of across-shore divisions of a shore unit. The band database includes information on sub-divisions of components based on species assemblages. The biota database contains information on species abundance and distribution within a band.

4.1 Shore Unit Database

The shore unit database (Table 1) contains physical parameters which characterize the physical environment for a shore unit. Some shore unit parameters define environmental conditions which may constrain the distribution of organisms alongshore. Fields for Intertidal Width and Shoreline Type are in this category. Exposure Category and Tide Range are also relevant to species distribution. These data are contained in the Wave Exposure database of the physical shore-zone mapping system and are used without change by the biotic mapping system. Four exposure categories are used based on maximum fetch and effective fetch. The Unit Length field is present in each unit record and is an essential parameter, especially when the quantitative contribution of characteristics of all units for a region is desirable. For a detailed description of the parameters in the physical database see Howes et al. (1994).

The shore unit database can be linked with the digital map, other tables in the physical database including the component database, the band database and the biota database for the same shore unit with the combination of unit ID, zone, component and band codes.

The shore unit database requires the addition of fields for Land Use and Freshwater Influence in support of the biotic mapping system. Land use defines the dominant activity on land that is apt to influence the coastal communities of a shore unit. General land use activity categories should include industrial use, recreational use, residential use, harvested, cultural/historic use, multiple use, no use and unknown use. However, the method of assessing the influence of land use in the vicinity of a shoreline unit (e.g., area of influence) has not been determined and requires development. Freshwater influence describes the frequency and degree of freshwater influence on the salinity of coastal waters adjacent to a shoreline unit. The freshwater influence may be characterized as continuous, episodic, freshet only, none, or unknown.

Table 1 - Shore unit database

Unit ID
Region
Area
Unit
Subunit
Unit Type
Shoreline Type
Note Number

Associated Exposure Unit
Unit Location
Start Latitude
Start Longitude
End Latitude
End Longitude
Unit Length
Intertidal Width
Sediment Transport
Source
Abundance
Direction
Shoreline Change
Type
Rate
Data Sources
Airphoto Flightline
Airphoto Frame No.
Ground Truthing
NTS Map Sheet
Chart Number
Videotape Number
Tape Time
Land Use
Freshwater Use

4.2 Component Database

The component database (Table 2) contains a unit ID which is a number common to the shore unit database and, therefore, can be used to link the component database, the band database and the biota database with the physical data and the digital map. Zone and component data in the component database divide each shore unit into across shore sections; the zone divides the unit into backshore, intertidal and subtidal areas and the components further divide zones into across-shore sections. Zone and component divisions are based on physical characteristics of the shoreline. The material and form fields in the component database contain information on primary, secondary and tertiary composition of the physical substrate within a component.

Table 2 - Component database

Component ID	Zone	Component No.	Form			Material			Width (m)
			1	2	3	1	2	3	

4.3 Band Database

The band database (Figure 2 is a schematic of the banding concept and its relationship to the physical classification. Figure 3 is a photograph that shows the across-shore banding. The distribution code is used to describe the general distribution (patchy or continuous) of the biotic assemblage defining a band. Data on the elevation at the top of a band (elevation-top) and elevation at the bottom of a band (elevation-base) and the measured width for each band are also recorded.

The accuracy and resolution of the data depend mainly on the method of data collection although the field conditions at the time of survey may also influence data quality. A field has been included in the band database for method of data collection that indicates the level of effort and thus provides a measure of resolution. This allows a database user to avoid problems of differing resolution by selecting data records for analysis with a common survey method.

At present, there is no indicator of data quality due to conditions, but presumably when conditions are sufficiently poor and data quality is in jeopardy, the survey would not be conducted.

Fields for date collected and name are included for maintenance of tables. Date refers to the date the component record was first completed and the name field should be used for the name of the key person/firm responsible for the original data record.

TABLE 3 - Band database

Unit ID	Zone	Comp.	Form	Mat.	Band	Dist. Code	Width	Ele. Top	Ele. Base	Method	Date Coll.	Name

Figure 2 Banding schematic

Figure 3 Typical banding pattern on bedrock substrate

4.4 Biota Database

Each band in the biota database (Table 4) contains information on the abundance and microhabitat of each species observed within a band. The unit ID, zone, component, and band codes allow linkage of species information with the band, component and shore unit databases and the digital map. A numeric code is used to define each species where the number defines a species or a higher phyllogenetic group if the species is not known. For the convenience of the user, a field for the species or group name is also included in the biotic database. The numerical coding system also allows for flexibility in the analysis and display of biota data. The distribution of biota can be summarized or incorporated into an algorithm based on any combination of the number codes.

The recording of data at the species level provides a high level of detail and thus allows for flexibility in the analysis of biota among shore units. Species data can be grouped by taxonomic similarity, feeding guilds or other associations, although an additional field would be required to group species into guilds. Data analysis for defining biological and physical habitat characteristics preferred by common shore-zone species can be attempted after the development of a suitable data set. The identification of habitat characteristics at a later date may justify the inclusion of a habitat field. The hierarchical structure allows for flexibility in the level of information entered on the biota type as well as flexibility in the level of detail used for summary and analysis. Species can be grouped based on many criteria during or after the creation of the database.

The abundance code for species identifies general categories of abundance at the general site survey level and quadrat counts at the detailed site survey level. Species are given a microhabitat code when they occur in specific habitats (e.g., tide pools, crevices, under rocks). Otherwise, species which occur on the common substrate are not given a microhabitat code, except when species occur on both the general substrate and in a microhabitat.

Table 4 - Biota database

Unit ID	Zone	Component	Band	Species Code	Species Name	Abundance	Micro Habitat

5. Mapping Example

The following example uses the same mapping example from the physical shore-zone mapping manual (Howes et al. 1994) and extends the mapping process to the biotic mapping requirements. The intention is to depict the integration between the physical and biological mapping methods and the specifics of the biotic mapping process. For convenience, the physical mapping example is reproduced in this report as Appendix 3.

5.1 Project Data and Exposure Information

Information in the project data and exposure databases (Appendix 3) are contained entirely and without change in the physical shore-zone mapping system. It is expected that the biotic mapping occurs in concert with the physical mapping. Therefore, these dataforms are filled out by the physical mapper and used directly by the biotic mapper.

5.2 Shore Unit Information

Data collection specific to the biotic mapping database begins at the shore unit level. The physical mapper will complete the shore unit data base with the exception of the land use and freshwater influence fields (Table 5). In this example, the land use category is none (N) and there is no freshwater influence (N).

Table 5 - Shore Unit Database Example

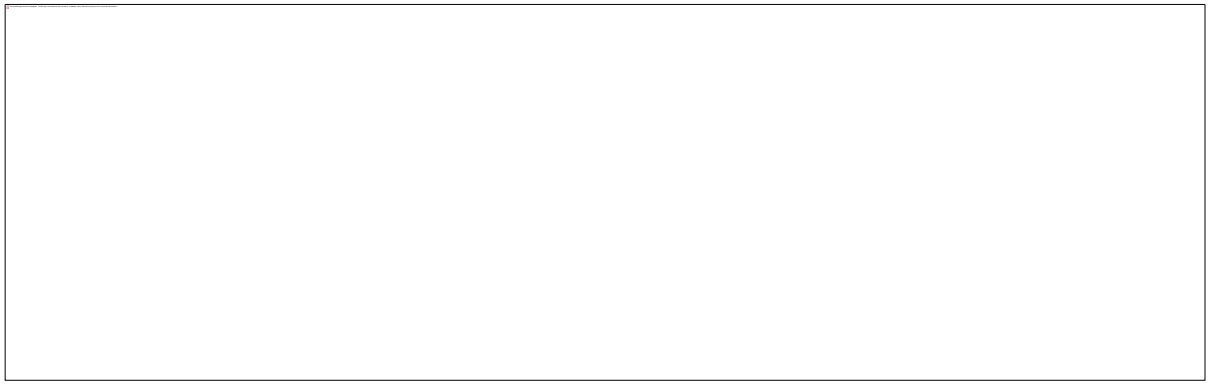
5.3 Across-shore Component Information

Information contained in the component data base (Appendix 3) is used directly from the physical shore-zone mapping system. This form is completed by the physical mapper.

5.4 Band Information

Information on banding is unique to the biotic mapping system. Bands are identified from aerial video, aerial transparencies or from the ground. The band database entries are presented in Table 6 and are schematically represented in Figure 4. In this example, there are no bands associated with Zone A and Component 1, the cliff face. In Zone B, Component 1, the inclined beach, there are two bands, a continuous (C) grey-white band consisting primarily of barnacles (BAR) at the upper extent of the beach, and a lower continuous (C) band of golden brown made up primarily of Fucus sp. (FUC). Still in Zone B, Component 2, the irregular high tide rock platform, has a continuous (C) single band of bright green colour made up mostly of Ulva sp. (ULV). The third component in Zone B also has a single continuous (C) band soft brown in colour (SBR) which is dominated by Laminarians, Agarum sp., Sargassum sp., and other non-stalked brown algae.

Table 6 - Band Database Example



5.5 Biota Information

The major organisms associated with each band, their relative abundances and any microhabitat associations of more abundant and conspicuous species are compiled in the biota database (Table 7). The first four fields in this database serve only to link this database with other databases in the physical and biotic mapping systems. Ideally each major organism in each band is identified to species, but the mapping system accommodates more general levels of classification such as genus, order, etc.

Note that within the spray zone, the abundance of Verrucaria is simply referred to as the width of the entire band containing this algae. For all other species, the abundance is referred to as rare (R), few (F), common (C), or abundant (A). Most species are generally distributed, except for Petrolithes cinctripes which occurred only in mussel beds.

Table 7 - Biota Database Example

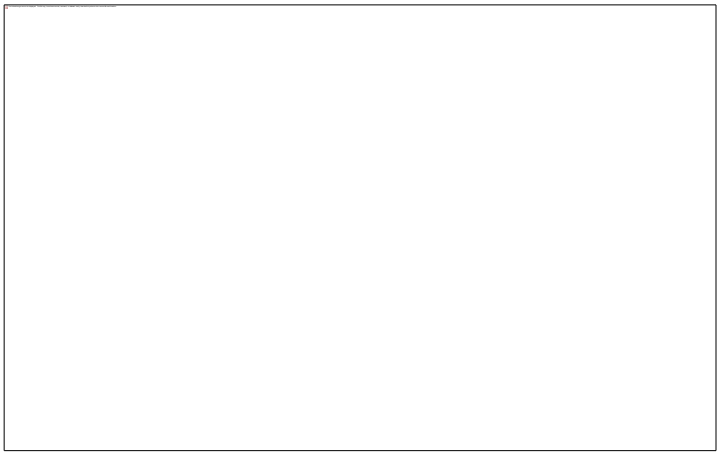


Figure 4 Banding schematic

5.6 Explicitly Mapped Information

The information mapped so far in this example has been for relatively sedentary intertidal or subtidal organisms. More mobile, nearshore species such as most fish, birds and mammals do not lend themselves to this type of mapping treatment. For many of the mobile species, the preferred approach is to map their distribution as a polygon which can then be linked to adjacent shore units if desired. In addition, polygons have been used by many individuals to map the distribution of many sessile species (e.g., clams, geoducks, kelp). In other cases, the data base for each species or group of species would vary and no attempt is made in this manual to develop or design databases for all possible explicitly mapped resources. For most resources, a minimum database would include information on abundance and timing of presence. The example shown in Figure 5 depicts herring fishery areas. As many copies of maps as necessary should be used in order to keep the information being mapped clear and distinct. An example data base for the polygon data are presented in Table 8.

Figure 5 Herring fishery in the Copper Island area

Table 8 - Fisheries coding sheet

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APPENDIX 1 - SPECIES CODES

I.D.#	Scientific Name	Common Name	Zone
1.000	Cyanobacteria	blue green algae	
1.010	Various spp		"S,H"
2.000	Bacillariophyta	diatoms	
2.010	Loose skeins on mud		M
2.020	"On rocks, on seaweeds"		M
3.000	Chlorophyta	green algae	
3.010	Acrosiphonia spp	green rope weed	M
3.020	Blidingia spp		"S,H"
3.030	Cladophora spp	branching green filament seaweed	"H,M"
3.040	Codium fragile	dark green finger seaweed	M
3.050	Codium setchellii	dark green spongy seaweed	L
3.060	Enteromorpha spp	wrinkled green tube seaweed	"S,H,M"
3.070	Monostroma spp	mono-layer sea lettuce	"M,L"
3.080	Prasiola spp	green guano seaweed	S
3.090	Rhizoclonum spp	tangled drk grn filament on mud	
3.100	Ulva teaniata	sea lettuce	M
3.110	Ulva fenestrata	perforated sea lettuce	L
3.120	Ulva spp	sea lettuce	"H,M,L"
3.130	"Various planktonic, pools"		H
3.140	Unbranched filaments	green sea hair	"H,M"
3.150	unidentified spp		
4.000	Phaeophyta	brown algae	
4.010	Var. encrusting		

4.020	Agarum spp	solid broad kelp	L
4.030	Alaria marginata	short stipe alaria	M
4.040	Alaria nana	small alaria	M
4.050	Alaria spp	long stipe alarias	M
4.060	Analipus abietina	yellow bottle brush	M
4.070	Coilodesme bulligera	flat sac	L
4.080	Colpomenia spp	globose sac	M
4.090	Costaria costata	multi-ribbed searsucker	L
4.100	Cymothere triplicata	multi-ribbed smooth blade	L
4.110	Desmarestia aculeata	fine branched brown	L
4.120	Desmarestia ligulata	broad branched brown	L
4.130	Egregia menziesii	feather boa	L
4.140	Fucus gardneri	common brown rock weed	"H,M"
4.150	Fucus spp	hairy pit rock weed	H
4.160	Haplogloia andersonii	furry soft branch	L
4.170	Hedophyllum sessile	sea cabbage	M
4.180	Laminaria groenlandica	flaccid dissected laminaria	
4.190	Laminaria saccharina	sugar kelp	L
4.200	Laminaria setchellii	stiff laminaria	L
4.210	Leathesia difformis	convoluted yellow sac	M
4.220	Lessoniopsis littoralis	knarled tough root weed	L
4.230	Macrocystis integrifolia	branching giant kelp	L
4.240	Melanosiphon intestinalis	yellow spagetti weed	H
4.250	Nereocystis luetkeana	bull kelp	L
4.260	Ralfsia spp	yellow-brown thin crust	M
4.270	Sargassum muticum	japanese weed	L

4.280	Scytosiphon lomentaria	mini-sausage links	M
4.290	unidentified spp		
4.300	Postelsia palmaeformis		
4.310	Pelvetiopsis limitata		
4.320	Heterochordaria abientina		
4.330	Pleurophycus gardneri		
4.340	Eisenia arborea		
4.350	Desmarestia spp.		L
4.360	Pterygophora Californica		
5.000	Rhodophyta	red algae	
5.010	Ahnfeltia spp	thick wiry dark weed	L
5.020	Antithamnion spp	red branching fluff	"M,L"
5.030	Bangia vermicularis	red sea hair	H
5.040	Bonnemaisonia nootkana	delicate red feather	L
5.050	Bossiella spp		
5.060	Calliarthron spp		
5.070	Calliarthron/Bossiella spp	broad joint corallines	M
5.080	Callithamnion pikeanum	dark elongate seamoss	M
5.090	"Callophyllis, spp"	non-veined red leafy	L
5.100	Ceramium spp	micro-cross bands	L
5.110	Corallina vancouveriensis	bushy cylindrical coralline	"H,M"
5.120	Corallina pilulifera		
5.130	Cumagloia andersoni	gelatinous spiny fat branches	H
5.140	Cryptopleura ruprechtiana	ruffled net vein	L
5.150	Cryptosiphonia woodii	dark branching knob tip	M
5.160	Delessaria decipiens	veinless leaflet edged	L

5.170	Endocladia muricata	thin dark spiny wires	H
5.180	Erythrophyllum delesserioides	tattered veined leaf	L
5.190	Gastroclonium subarticulatum	narrow neck branching cylinders	L
5.200	Gelidium coulteri		
5.210	Gelidium purpurescens	blunt-tip candelabra	L
5.220	Gigartina corymbifera	broad turkish towel	L
5.230	Gigartina exasperata	elongate turkish towel	L
5.240	Gigartina spp		
5.250	Gloiopeltis furcata	small gelatinous sparse branching	H
5.260	Gracilaria spp	large gelatinous irregular branching	M
5.270	Gymnogongrus leptophyllus	short bifurcated-tip straps	L
5.280	Gymnogongrus linearis	long bifurcated-tip straps	L
5.290	Halosaccion glandiforme	fine spray sea sacs	M
5.300	Hildenbrandia occidentalis	dark red thin crust	H
5.310	Hymenena spp		
5.320	Iridaea cordata	purple iridescent broad blades	M
5.330	Iridaea cornucopiae	yellow-brown flaring small blades	H
5.340	Iridaea heterocarpa	brownish iridescent broad blades	L
5.350	Iridaea lineare	"purple, rubbery elongate blades"	L
5.360	Laurencia spectabilis	flat stiff pinnate branches	L
5.370	"Lithothamnion/Lithophyllum, etc"	red calcareous crust	M
5.380	Mastocarpus papillatus	small papillate straps	H
5.390	Membranoptera dimorpha	veined leaflet edged	L
5.400	Microcladia borealis	one sided round branches	H
5.410	Microcladia coulteri	alternate sided round branches	L
5.420	Neorhodomela larix	black tufted bottle brush	H

5.430	Nemalion helminthoides	brown spagetti	M
5.440	Nienburgia andersoniana	spiny lateral bladelets	L
5.450	Odonthalia spp	dark dense knob-tip branches	M
5.460	Opuntiella californica	ovoid & lateral bladelets	L
5.470	"Petrocelis' stage"	thick tarspots	H
5.480	Phycodrys setchellii	veined blades on stolon	L
5.490	Pikea californica	pointed-tip candelabra	L
5.500	Plocamium cartilagineum	alternate sided outcurved flat branches	M
5.510	Plocamium violaceum	alternate sides incurved flat branches	M
5.520	Polyneura latissima	smooth net vein	L
5.530	Polysiphonia spp	tier-celled fine tufts	
5.540	Porphyra spp	translucent steel grey/purplish green	"H,M"
5.550	Prionitis lanceolata	small lateral blades on lance	H
5.560	Prionitis linearis	wiry spiny tips	L
5.570	Prionitis lyalli	lateral lances on lance	M
5.580	Ptilota spp	serrate edged blades	L
5.590	Rhodochorton purpureum	light red shaded crust	"S,H"
5.600	Rhodoglossum affine	short dichotomous twisted branches	M
5.610	Rhodomenia pertusa	perforated red broad blades	L
5.620	Sarcodiotheca gaudichaudii	large one-plane pink branching	L
5.630	Schizymenia pacifica	broad soft slippery blades	L
5.640	Stenogramme interrupta	broad bifurcate straps	L
5.650	unidentified filamentous spp		
5.660	unidentified leafy spp		
5.670	unidentified red algae spp		
5.680	unidentified spp		

5.900	Corallina foliose spp. unident		
6.000	Fungi/lichens		
6.010	"Verrucaria"	high black crust	S
6.020	unidentified spp		
7.000	Angiosperms	flowering plants	
7.010	Phyllospadix scouleri	surf grass	M
7.020	Salicornia virginica	pickle weed	S
7.030	Zostera marina	common eel grass	L
7.040	unidentified grasses/rushes		
8.000	Porifera	sponges	
8.010	Acarnus erithaceus	thick crimson sponge	
8.020	Adocia spp	flake top mauve sponge	
8.030	"Aplysilla ""glacialis"""	pink slippery sponge	M
8.040	Cliona spp	yellow boring sponge	M
8.050	Craniella villosa	spiny tennis ball sponge	L
8.060	"Halichondria ""bowerbanki"""	yellow midtide encrusting sponge	M
8.070	Halichondria panicea	green midtide sponge	H
8.080	"""Haliclona permollis"""	purple midtide sponge	M
8.090	Halisarca spp	slippery yellow tan sponge	
8.100	Hymeniacidon spp	"yellow in,purple out sponge"	
8.110	Laxosuberites spp	ivory thin nipple sponge	
8.120	Leucandra spp	small tufted pear sponge	
8.130	Leucilla nuttingi	stalked vase sponge	L
8.140	Leucosolenia eleanor	white anastomosing sphere sponge	L
8.150	Myxilla incrustans	"thick, dull yellow sponge"	
8.160	Ophlitaspongia pennata	red midtide sponge	M

8.170	Reneira sp B	stell blue	
8.180	"""Scypha"" spp"	unstalked whte vase sponge	L
8.190	Stelletta clarella	thick white prickly sponge	L
8.200	Suberites sp A	thick yellow dense sponge	M
8.210	Tethya aurantium	orange textured ball sponge	L
8.220	Red sponge species	unidentified	
8.230	Rust brown species	unidentified	
8.240	Sticky brown soft species	unidentified	
8.250	Wavy red species	unidentified	
8.260	unidentified spp		
9.000	Coelenterata - Hydrozoa + Hydroids		
9.010	Abietinaria spp	regular branched hydroids	L
9.020	Aglaophenia spp	stiff feather hydroids	L
9.030	Eudendrium spp	brown annulated hydroids	L
9.040	Garveia spp	orange hydroids	L
9.050	Obelia spp	plumose hydroids	M
9.060	Plumularia spp	soft feather hydroids	M
9.070	Sertularia	irregular branched yellow hydroids	L
9.080	Sertularella	no/few branched yellow hydroids	M
9.090	Stylantheca petrograpta	red/violet hydrocoral crust	L
9.100	Stylantheca porphyra	purple hydrocoral crust	L
9.110	Tubularia spp	large pink headed hydroids	L
9.120	unidentified hydroid spp		
10.000	Coelenterata - Anthozoa + Sea Anemones & Allies		
10.010	Anthopleura artemisia	drab column tentacled burrowing anenome	M
10.020	Anthopleura elegantissima	small aggregating green anemone	M

10.030	Anthopleura xanthogrammica	large solitary green anemone	M
10.040	Balanophyllia elegans	orange cup coral	M
10.050	Clavularia spp	tan/ivory thin crust soft coral	L
10.060	Epiactis spp	white radial lines on tentacles/oral disc anenome	M
10.070	Epizoanthus scotinus	colonial tan zoanthid	L
10.080	Gersemia rubiformis	sea strawberry soft coral	M
10.090	Haliplanella lineata	small orange striped anemone	H
10.100	Metridium giganteum	solitary giant plumose anemone	L
10.110	Metridium senile	aggregating small plumose anemone	L
10.120	Paracyathus stearnsi	tan cup coral	L
10.130	Peachia quinquecapitata	twelve tentacled burrowing anemone	L
10.140	Urticina lofotenis	red-olive green-variegated anemone	M
10.150	Urticina coriacea	red column blunt tentacled burrowing aenemone	M
10.160	Urticina crassicornis	white tubercle red anemone	L
10.170	unidentified spp		
10.180	Urticina spp.		
11.000	Platyhelminthes	flat worms	
11.010	Polycladida spp	unidentified spp	
12.000	Nemertea	ribbon worms	
12.010	Amphiporus spp	v-neck ribbon worm	
12.020	Amphiphorus formidabilis	dirty white ribbon worm	M
12.030	Amphiporus imparispinosus	flesh ribbon worm	M
12.040	Cerebratulus albifrons	brown white tipped flat ribbon worm	
12.050	Cerebratulus longiceps	narrow neck flat ribbon worm	
12.060	Cerebratulus marginatus	light margined flat ribbon worm	
12.070	Paranemertes peregrina	purple top cream bottom ribbon worm	M

12.080	Tublanus sexlineatus	white ringed and white line ribbon worm	L
12.090	unidentified nemertean spp	unidentified spp	
13.000	Mollusca		
13.000	Polyplacophora	chitons	
13.010	Cryptochiton stelleri	gumboot chiton	M
13.020	Katharina tunicata	black katy chiton	M
13.030	Lepidozona mertensi	red scaled chiton	L
13.040	Leptochiton rugatus	minute white chiton	L
13.050	Mopalia ciliata	spiny strap haired chiton	M
13.060	Mopalia cirrata	sparse haired chiton	L
13.070	Mopalia lignosa	white spotted hairy chiton	M
13.080	Mopalia muscosa	mossy chiton	M
13.090	Mopalia spp		
13.100	Placiphorella velata	carnivorous chiton	M
13.110	Tonicella lineata	wavy lined yellow spot chiton	M
13.120	unidentified chiton spp		
14.000	Gastropoda: prosobranchia	snails & allies	
14.010	Acmaea mitra	white capped limpet	L
14.020	Alia carinata	"smooth-top, dented aperature snail"	
14.030	Amphissa columbiana	wrinkled dove snail	L
14.040	Astrea gibberosa	red turban snail	L
14.050	Bittium eschrichti	threaded bittium	L
14.060	Calliostoma annulatum	purple ringed top shell	L
14.070	Calliostoma canaliculatum	channeled top shell	L
14.080	Calliostoma ligatum	brown & blue top shell	L
14.090	Ceratostoma foliatum	leafy hornmouth	M

14.100	Crepidula adunca	hooked brown slipper snail	M
14.110	Crepidula perforans	western white slipper snail	L
14.120	Diodora aspera	rough keyhole limpet	L
14.130	Fissurellidae bimaculatus	large key-hole limpet	
14.140	Fusinus harfordi	red spindle	L
14.150	Fusitriton oregonensis	oregon triton	L
14.160	Haliotis kamtschatkana	northern abalone	L
14.170	Homalopoma lacunatum	open umbilicus dwarf turban	L
14.180	Homalopoma luridum	ridged dwarf turban	L
14.190	Homalopoma subobsoletum	smooth dwarf turban	L
14.200	Lacuna spp	chink shells	L
14.210	Lirularia spp		
14.220	Littorina sitkana	sitka periwinkle	S
14.230	Littorina scutulata	checkered periwinkle	S
14.240	Lottia digitalis	ribbed limpet	S
14.250	Lottia pelta	shield limpet	H
14.260	Margarites marginatus	smooth margarite	L
14.270	Margarites pupillus	little margarite	L
14.280	Marsenina spp	pseudoflatworm snail	
14.290	Nitidiscala indianorum	indian wentletrap	L
14.300	Nucella canaliculata	channeled dogwinkle	M
14.310	Nucella emarginata	emarginate dogwinkle	M
14.320	Nucella lamellosa	frilled dogwinkle	M
14.330	Nucella lima	rough purple dogwinkle	M
14.340	Ocenebra interfossa		
14.350	Ocenebra/Trophonopsis spp	rock snails	L

14.360	Olivella biplicata	purple olive	L
14.370	Opalia spp	wentletraps	L
14.380	Polinices lewisi	lewis's moon snail	L
14.390	Lirabuccinum	dire whelk	M
14.400	Tectura persona	mask limpet	H
14.410	Tectura scutum	plate limpet	M
14.420	Tegula pulligo	dusky turban	L
14.430	Trichotropis cancellata	checkered hairy snail	L
14.440	Vermetus compactus	little tube-worm snail	M
14.450	unidentified spp		
14.460	unidentified spp.	little brown limpets	
14.470	Tegula funebralis		
14.480	Calliostoma spp.		
14.490	Nucella spp.		
14.500	Amphissa spp.		
15.000	Gastropoda: opisthobranchia	sea slugs	
15.010	Aeolidia papillosa	shag rug nudibranch	L
15.020	Anisodoris nobilis	orange fragrant seaslug	L
15.030	Archidoris montereyensis	monterey dorid	M
15.040	Cadlina luteomarginata	yellow edged cadlina	M
15.050	Diaulula sandiegensis	ring spotted dorid	M
15.060	Dirona albolineata	chalk lined dirona	M
15.070	Haminoea virescens	green bubble snail	L
15.080	Haminoea vescicula		
15.090	Hermissenda crassicornis	blue-lined aeolid	M
15.100	Onchidoris bilamellata	barnacle dorid	M

15.110	Rostanga pulchra	red sponge dorid	M
15.120	Tochuina tetraquetra	tochni	L
15.130	Triopha catalinae	sea clown triopha	L
15.140	unidentified spp		
16.000	Gastropoda: pulmonata	lunged snails	
16.010	Onchidella borealis	leather sea-slug	M
16.020	Siphonaria theristes	limpet-like pulmonate	M
16.030	unidentified spp		
17.000	Bivalvia	bivalves	
17.010	Clinocardium nuttalli	basket cockle	M
17.020	Crassadoma gigantea	purple-hinged rock scallop	L
17.030	Glans carpenteri	little heart clam	L
17.040	Glans subquadrata	eccentric ridged clam	
17.050	Hiatella arctica	nestling saxicave	M
17.060	Kellia suborbicularis	nestling clam	M
17.070	Macoma calcerea		
17.080	Macoma nasuta	bent-nose clam	M
17.090	Macoma secta	sand clam	M
17.100	Macoma spp	baltic clam	M
17.110	Modiolus flabellatus	giant horse mussel	L
17.120	Musculus taylori	tiny bearded mussel	M
17.130	Mya arenaria	soft-shell clam	H
17.140	Mya truncata	blunt soft-shell clam	L
17.150	Mytilimeria nuttalli	sea-squirt clam	L
17.160	Mytilus californianus	california mussel	M
17.170	Mytilus edulis	blue mussel	M

17.180	Panope abrupta	geoduck	L
17.190	Pododesmus cepio	jingle shell	L
17.200	Protothaca staminea	native little-neck clam	M
17.210	Saxidomus giganteus	butter clam	M
17.220	Semele rubropicta	red-painted semele	L
17.230	Tellina nuculoides	walking clam	L
17.240	Tresus capax	fat horse clam	L
17.250	unidentified spp		
17.260	Crassostren gigas	japanese oyster	
18.000	Cephalopoda	"octopods, squids"	
18.010	Octopus dofleini	giant pacific octopus	L
19.000	Annelida	segmented worms	
19.000	Polychaeta	bristle worms	
19.010	Arabellidae	red irridescent burrowing worms	"M,L"
19.020	Arenicolidae	lug worms	"M,L"
19.030	Capitellidae	thread worms	"M,L"
19.040	Cirratulidae	filamentous body tentacles	
19.050	Docecaceria concharum	small black u worm	
19.060	Dodecaceria fewkesi	large black u worm	
19.070	Eudistylia spp	giant feather-duster worms	M
19.080	Glyceridae	blood worms	M
19.090	Idanthyrus armatus	cemented tube worm	L
19.100	Maldanidae	bamboo worms	"M,L"
19.110	Mesochaetopterus taylori	long parchment tube worm	L
19.120	Myxicola spp	jelly house fan worm	L
19.130	Neanthes brandti	giant nereid worm	M

19.140	Nephtyidae	flat head worms	"M,L"
19.150	Nereis vexillosa	green mussel worm	M
19.160	Opheliidae	twitching worms	L
19.170	Orbinidae	"bush, pointed snout worms"	
19.180	Owenia collaris	writhing tile worm	L
19.190	Phyllochaetopterus prolifica	colonial parchment tube worm	L
19.200	Phyllodocidae	leafy cirri worms	L
19.210	Pista spp	shaggy tube worm	L
19.220	Polynoidae	scale worms	M
19.230	Sabellaria cementarium	honeycomb worm	M
19.240	Salmacina tribranchiata	tangled white tubes worm	L
19.250	Schizobranchia insignis	feather duster worm	M
19.260	Serpula vermicularis	red calcarious tube worm	M
19.270	Spionidae	palp worms	"M,L"
19.280	"""Spirorbis"" spp"	tiny white tube worms	M
19.290	Syllidae	showy cirri worms	"M,L"
19.300	Terebellidae	medusa worms	"M,L"
19.310	unidentified spp		
20.000	Sipunculida	peanut worms	
20.010	Phascolosoma agassizi	banded peanut worm	M
21.000	Arachnida	"spiders, mites, & allies"	
21.010	Neomolgus littoralis	red shore mite	S
23.001	Crustacea		
23.000	Copepoda		
23.010	Tigriopus californicus	red spray pool copepod	S
24.000	Cirripedia	barnacles	

24.010	Balanus balanoides	false common barnacle	M
24.020	Balanus crenatus	smooth acorn barnacle	L
24.030	Balanus glandula	common pacific acorn barnacle	H
24.040	Balanus nubilus	giant acorn barnacle	L
24.050	Chthamalus dalli	small brown barnacle	M
24.060	Pollicipes polymerus	goose neck barnacle	M
24.070	Semibalanus cariousus	thatch acorn barnacle	M
24.080	unidentified spp		
25.000	Leptostraca	hooded shrimp	
25.010	Nebalia pugettensis	mud flat hooded shrimp	L
26.000	Mysidacea	possum shrimp	
26.010	unidentified spp		L
27.000	Isopoda	pill bugs & allies	
27.010	Cirolana harfordi	carnivorous grey isopod	M
27.020	Gnorimosphaeroma insulare	estuarine roll-up isopod	M
27.030	Gnorimosphaeroma oregonensis	common roll-up isopod	M
27.040	Idotea aculeata	pink idotea	L
27.050	Idotea montereyensis	monterey idotea	L
27.060	Idotea resecata	concave telson idotea	
27.070	Idotea spp	unidentified spp	
27.080	Idotea stenops	fat idotea	M
27.090	Idotea urotoma	no telson point idotea	M
27.100	Idotea wosnesenskii	kidney eye idotea	M
27.110	Limnoria spp	wood boring gribble	L
27.120	Liaia occidentalis	speedy shoreline isopod	S
27.130	unidentified spp		

28.000	Amphipoda - gammaridea	side swimmers & allies	
28.010	Talitridae	beach hoppers	S
28.020	unidentified gammarids spp	side swimmers	"S,L"
28.030	unidentified caprellids spp	skeleton shrimp	L
29.000	Decapoda	10-legged crustaceans	
29.010	Cancer gracilis	purple legged graceful crab	L
29.020	Cancer magister	dungeness crab	L
29.030	Cancer oregonensis	ovoid nestling crab	M
29.040	Cancer productus	red rock crab	M
29.050	Crangonidae	in-bottom shrimps	L
29.060	Cryptolithodes sitchensis	wide snoot turtle crab	L
29.070	Discorsopagurus schmitti	tube dwelling hermit crab	L
29.080	Hapalogaster mertensi	orange fingered hairy lithode crab	L
29.090	Hemigrapsus nudus	purple shore crab	H
29.100	Hemigrapus oregonensis	drab mud-flat crab	H
29.110	Hyas lyratus	lyre crab	L
29.120	Lophopanopeus bellus	black clawed straight margined crab	L
29.130	Mimulus foliatus	winged shell crab	L
29.140	Neotrypaea californiensis	bay ghost shrimp	M
29.150	Oedignathus inermis	tuberculate nestling lithode crab	L
29.160	Oregonia gracilis	long snoot decorator crab	L
29.170	Pachycheles pubescens	hairy porcelain crab	M
29.180	Pachycheles rudis	knob-on-claw porcelain crab	M
29.190	Pandalus danae	coon striped shrimp	L
29.200	Pagurus armatus	oval eyed long ant. hermit	L
29.210	Pagurus beringanus	orange banded leg hermit crab	L

29.220	Pagurus granosimanus	blue granular legged hermit crab	M
29.230	Pagurus hemphilli	yellow eye circled hermit crab	M
29.240	Pagurus hirsutiusculus	hairy hermit crab	M
29.250	Pagurus ochotensis	oval eyed short ant. hermit crab	L
29.260	Pagurus samuelis	blue/white banded leg hermit	M
29.270	Pagurus spp	unidentified hermit crab	
29.280	Petrolisthes cinctipes	red jawed porcelain crab	M
29.290	Petrolisthes eriomerus	blue jawed porcelain crab	L
29.300	Phyllolithodes papillosus	leafy lithode crab	L
29.310	Pugettia gracilis	naked graceful kelp crab	L
29.320	Pugettia producta	naked olive backed kelp crab	L
29.330	Pugettia richii	red decorator kelp crab	L
29.340	Scyra acutifrons	broad sharp nosed decorator crab	L
29.350	Telmessus cheiragonus	yellow horse crab	L
29.360	Upogebia pugettensis	blue mud shrimp	M
29.370	unidentified spp		
30.000	Brachiopoda	lamp shells	
30.010	Terebratalia transversa	wavy wide lamp shell	L
31.000	Phoronida	lophophore worms	
31.010	Phoronopsis harmeri	sand lophophore worm	L
31.020	Phoronis ijimae	colonial rock lophophore worm	L
31.030	unidentified spp		
32.000	Bryozoa	moss animals	
32.010	Alcyonidium spp	gel crust bryozoan	M
32.020	Bowerbankia spp		
32.030	Bugula californica	orange spiraled bryozoan	L

32.040	Crisia spp	"branched tubes, white joints"	
32.050	Dendrobeania lichenoides	flexible leaf bryozoan	L
32.060	Diaperoecia spp	rough yellow rigid finger bryozoan	L
32.070	Eurystomella bilabiata	orange with red semicircle crust bryozoan	L
32.080	Filicrisia spp	"branched tubes, black joints"	
32.090	Flustrellida corniculata	spiny flexible leaf bryozoa	L
32.100	Heteropora magna	smooth yellow rigid finger bryozoan	L
32.110	Hippodiplosia insculpta	rigid orange sinous pallisa bryozoan	L
32.120	Phidolopora labiata	yellow lace bryozoan	L
32.130	Schizoporella unicornis	orange encrusting bryozoan	L
32.140	Scrupocellaria spp	"bushy, whip bryozoan"	
32.150	unidentified spp		
33.000	Echinodermata	spiny skinned animals	
33.000	Holothuroidea	sea cucumbers	
33.010	Cucumaria lubrica	grey scattered tube feet sea cucumber	L
33.020	Cucumaria miniata	orange sea cucumber	M
33.030	Cucumaria piperata	speckled sea cucumber	L
33.040	Cucumaria pseudocurata	grey aligned tube feet sea cucumber	M
33.050	Eupentacta pseudoquinquesemita	white slender feet sea cucumber	L
33.060	Eupentacta quinquesemita	yellow-ivory broad feet sea cucumber	L
33.070	Leptosynapta clarki	papillated pink burrowing sea cucumber	L
33.080	Leptosynapta transgressor		
33.090	Parastichopus californicus	red & white spiny sea cucumber	L
33.100	Pseudonchus astigmatus	pale yellow sea cucumber	L
33.110	Psolus squamatus	red sole attached sea cucumber	L
34.000	Echinoidea	sea urchins	

34.010	Dendraster excentricus	excentric sand dollar	M
34.020	Strongylocentrotus droebachiensis	green sea urchin	M
34.030	Strongylocentrotus franciscanus	giant red sea urchin	L
34.040	Strongylocentrotus purpuratus	purple sea urchin	M
35.000	Asteroidea	sea stars	
35.010	Asterina miniata (patiria)	bat star	L
35.020	Crossaster papposus	rose star	L
35.030	Dermasterias imbricata	leather star	M
35.040	Evasterias troscheli	mottled star	M
35.050	Henricia leviuscula	blood star	M
35.060	Leptasterias hexactis	six-armed star	M
35.070	Mediaster aequalis	mediaster aequalis	L
35.080	Pisaster brevispinus	giant pink star	L
35.090	Pisaster ochraceous	purple/ochre star	M
35.100	Pteraster tesselatus	slime star	L
35.110	Orthasterias koehleri	red & white banded star	L
35.120	Pycnopodia helianthoides	sunflower star	L
35.130	Solaster dawsoni	morning sun star	L
35.140	Solaster stimpsoni	purple band sun star	L
35.150	Stylasterias forreri	long armed black star	L
35.160	unidentified spp		
36.000	Ophiuroidea	brittle stars	
36.010	Amphiodia occidentalis	sand burrowing brittle star	L
36.020	Amphipholis pugetana	tiny banded brittle star	L
36.030	Amphipholis squamata	brooding brittle star	M
36.040	Ophiopholis aculeata	daisy brittle star	L

37.000	Tunicata:ascidacea	sea squirts	
37.010	Aplidium solidum	translucent orange slab seasquirt	L
37.020	Archidistoma molle	globose white with red dots seasquirt	L
37.030	Archidistoma psammion	leathery sandy slab seasquirt	L
37.040	Archidistoma purpuropunctatum	lavender	
37.050	Archidistoma ritteri	pale yellow	
37.060	Ascidia callosa	brown hemisphere solitary seasquirt	M
37.070	Ascidia paratropa	glassy spiny seasquirt	L
37.080	Boltenia villosa	orange stalked hairy seasquirt	L
37.090	Botryllus sp	yellow/orange sunburst array seasquirt	L
37.100	Chelyosoma productum	translucent brown flat-top seasquirt	L
37.110	Clavelina huntsmani	neon lightbulb seasquirt	L
37.120	Cnemidocarpa finmarkiensis	orange solitary hemisphere seasquirt	M
37.130	Corella spp	soft translucent solitary seasquirt	L
37.140	Cystodytes lobatus	spiculated slab seasquirt	L
37.150	Didemnum carnulentum	pink thin seasquirt	L
37.160	"Didemnum, Tridemnum"	pink/white thin seasquirt	L
37.170	Diplosoma macdonaldi	thin sheet salt & pepper seasquirt	L
37.180	Distaplia occidentalis	variegated colour sponge	
37.190	Halocynthia aurantium	sea peach	L
37.200	Halocynthia igoboja	large drab spiny seasquirt	L
37.210	Metandrocarpa dura	red-orange crowded social seasquirt	L
37.220	Metandrocarpa taylori	red-orange spaced social seasquirt	M
37.230	Perophora annectens	green mini sea grapes	M
37.240	Pycnoclavela huntsmani	orange tipped elongate sand-covered seasquirt	L
37.250	Pyura haustor	orange siphon wrinkled seasquirt	M

37.260	Ritterella pulchra	orange flat-top lobes	
37.270	Ritterella rubra	crimson lobed colonial seasquirt	L
37.280	Styela montereyensis	narrow stalked grooved solitary seasquirt	L
37.290	Styela spp	broad stalked solitary seasquirt	L
37.300	Synoicum parfustis	"sandy-red zooid, orange tunicate"	
37.310	unidentified compound ascidians		
37.320	unidentifed spp		
38.000	Vertebrata	backboned animals - fish	
38.010	Anoplarchus insignis	slender cockscomb	M
38.020	Anoplacrchus purpurescens	high cockscomb	M
38.030	Apodichtys flavidus	penpoint gunnel	L
38.040	Artedius harringtoni	scalyhead sculpin	
38.050	Clinocottus globiceps	mosshead sculpin	
38.060	Gobiesox maeandricus	northern clingfish	M
38.070	Jordania zonope	longfin sculpin	
38.080	Leptocottus armatus	pacific staghorm sculpin	
38.090	Myxocephalus polyacanthocephalus	great sculpin	
38.100	Oligocottus maculosus	tidepool sculpin	M
38.110	Oligocottus rimensis	saddleback sculpin	L
38.120	Pholis laeta	crescent gunnel	L
38.130	"Sculpinidae, other"	sculpins	"M,L"
38.140	Syngnathus griseolineatus	pipefish	L
38.150	Xererpes fucorum	rockweed gunnel	M
38.160	Xiphister atropurpureus	black prickleback	M
38.170	Xiphister mucosus	rock prickleback	M
38.180	unidentified spp		

H High Intertidal

M Mid Intertidal

L Low Intertidal

S Spray Zone

APPENDIX 2 - CODES AND DEFINITIONS FOR BIOLOGICAL SURVEY PARAMETERS

A2.1 Shore Unit Data

The shore unit table is part of the physical database. The following fields should be appended to the shore unit database.

Land Use -- A single letter code is chosen for the land use activity in the vicinity of the shore unit which is apt to have an influence on the distribution and abundance of species in that unit. The selection of categories, category definitions, and the establishment of appropriate zones of influence by each land use category will require further development.

Code	Term	Definition
R	Recreational Use	Shore unit is in a park or other recreational zone and/or receives predominantly recreational use.
H	Harvested	Shore unit contains a clam bed or other resource which is cultured or harvested on a regular basis.
I	Industrial Use	Shore unit is commercially developed or is adjacent to industrial uses that significantly affect the unit.
S	Residential Use	Shore unit is bordered by residential development.
U	Unknown	Shore unit is known to be affected by human land uses, but the specific uses are unknown.
N	None	There are no known land use activities in the shore unit or which directly affect the shore unit.
C	Cultural and Historic Uses	Shore unit has previously been used by First Nations or other users and the remains of those uses or the activity still affect the shore unit (e.g., shell middens)

Freshwater Influence -- Intertidal and subtidal biota may be influenced by freshwater both temporally and spatially.

Code	Term	Definition
C	Continuous	Salinity remains below 25 ppt throughout the year.
E	Episodic	Salinity is normally above 25 ppt throughout a year, but occasionally goes below 25 ppt.
F	Freshet	Salinity is below 25 ppt during spring runoff only.
N	None	Salinity is rarely or never below 25 ppt.
U	Unknown	The salinity associated with the shore unit is unknown.

The choice of 25 ppt as a boundary for a change in biota is arbitrary. The selection of a more appropriate and meaningful value will require further research.

A2.2 Band Data

Table A2.1 shows the fields required for the band database.

Table A2.1 - Band database

Unit ID	Zone	Comp.	Form	Mat.	Band	Dist. Code	Width	Ele. Top	Ele. Base	Method	Date Coll.	Name

Table A2.2 - Biological colour band descriptions developed for the west coast of Vancouver Island

Zone	Colour Band Name	Code Name	Colour	Description	Exposure Category
Supratidal (A)	*Verrucaria*	VER	black or bare rock	splash zone: sometimes marked by black encrusting lichen & blue-green algae. May include "yellow lichen" in splash zone especially at higher exposures.	width can be an index of wave exposure
	grasses & *Salicornia*	SAL	light/bright green	marsh grasses, halophytes, *Salicornia*	P, SP, estuary
Inter-tidal (B)	*Fucus*	FUC	golden brown	dominated by *Fucus*; includes *B. gladula*. At high SE; this band includes *Pelvetiopsis* which is the same colour.	SE, SP, P
	upper barnacle	BAR	grey-white	continuous band of *B. glandula*; may also be bare rock, upper intertidal	SP,P
	barnacle mussel	MUS	grey-blue	dominated by *Mytilus californianus* - *Semibalanus carriosus* - with scattered *Pollicipes*	E, SE
	Ulva	ULV	bright green	*Ulva*/'Ulvaria' greens, filamentous greens; colour band is sometimes due to complex of bleached reds in lower intertidal.	

Distribution -- A code describes the distribution of bands in the shore unit.

Code	Term	Definition
P	Patchy	The band is distributed intermittently throughout the shore unit.
C	Continuous	The band occurs throughout the shore unit.

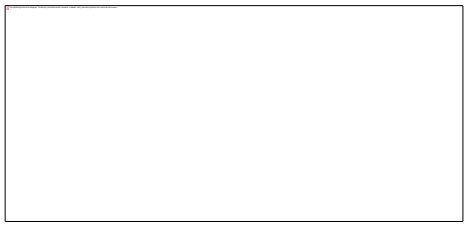

Figure A2. 1 Distribution codes and examples

Figure A2 1 shows the difference between patchy and continuous distribution. The one exception is the splash zone which is described as

W	Wide	Zone is less than 1 metre wide.
M	Medium	Zone is between 1 metre and 5 metres wide.
N	Narrow	Zone is greater than 5 metres wide.

Elevation-Top -- The elevation (in metres) of the component above or below lowest low water at the land edge.

Elevation-Base -- The elevation (in metres) of the component above or below lowest low water at the seaward edge.

Width -- This field records the average across-shore dimension (in metres) of each band. This measure will only be entered when a ground survey has been conducted.

Method -- The method of collecting visual records of the shoreline component are recorded in this field. The codes and categories are described in Table A2.3

Table A2.3 - Method of data collection: a measure of effort level and resolution

Code	Survey Method	Description	Level of Effort	Resolution
1	general aerial	in-flight commentary and data recording	<0.5 hr/unit	unit/zone
2	detailed aerial	in-flight commentary followed by analysis of video tapes and/or air photos	0.5-2 hs./unit	unit/zone/component
3	field	general visual survey to identify presence of cover species	<1 hr./unit	zone/component/ban /species groups
4	general site	systematic visual survey to determine relative abundance of common species	1-2 hr./unit	zone/component/band /10-20 species
5	detailed site	detailed analysis of distribution and abundance of species supplemented by transects and/or quadrats and/or infaunal sampling, replicated in each Bio-association.	>2 hr./unit	zone/component/band />20 species

Date Collected -- The date the biotic database records were created/collected is recorded as DDMMMYYYY.

Name -- Record the name of a key individual/firm responsible for the collection and recording of the initial data set used to create the biotic database.

A2.3 Biota Data

Table A2.4 shows the fields required for the biota database.

Table A2.4 - Biota database

Unit ID	Zone	Component	Band	Species Code	Species Name	Abundance	Micro Habitat

Unit ID, Zone, Component, Band -- These fields link the biota data with relevant information in other databases, specifically the band, component and shore unit databases.

Species Code -- A number code is assigned for species and genus (X.XXX). The integer portion of the number indicates the taxonomic group and the numbers after the decimal indicate the genus and species. Appendix 1 provides a provisional list of species names and species codes.

Species name -- This field records the genus and species name or a common name for a species or group of species. See Appendix 1 for examples.

Abundance Code -- The occurrence of each species is measured according to general categories of abundance.

Code	Term	Definition
R	Rare	Only one or two isolated individuals of the organism occur in the band.
F	Few	The organism occurs sporadically or in small patches in the band.
C	Common	The organism is present in moderate numbers throughout most or all of the band.
A	Abundant	The organism occurs in large numbers throughout most or all of the band.

Note the combinations of abundance and distribution may alter the appearance of organism abundance in the fields. Figure A2.2 provides several combinations to serve as reference points for assigning abundance values. The size of individual oganisms may also affect the visual estimate of abundance and should be compensated for.

Microhabitat -- When a species is found in a well defined habitat, a two letter code is used to define the location of species within a band. For example:

Code	Term	Definition
TP	Tide pool	The organism is found only in tide pools.
CR	Crevice	The organismis found only in rock crevices.
MB	Mussel bed	The organism is only found in association with aggregations of mussels.
UR	Under rock	The organisms are only found under rocks.
GS	General Substrate	This code is only entered when a species occurs both in a microhabitat and outside of a microhabitat on the common substrate. In most cases species do not occur in a microhabitat and the field is left blank.

Figure A2. 2 Abundance codes and examples under various distribution patterns

APPENDIX 3 - PHYSICAL SHORE-ZONE MAPPING EXAMPLE

This section has been reproduced from Howes et al. (1994: Section 5.0). Minor changes have been made to section, figure and table numbers and the text.

The following example shows the mapping and coding procedures along with appropriate reference within the text. The example is taken from the recently completed coastal physical mapping project of Gwaii Haanas National Marine Park in the southern Queen Charlotte Islands (Harper et al. 1994). The example shows East Copper and Jeffery Island from the Skincuttle Inlet area, bordering on Hecate Strait (Fig. A3.1).

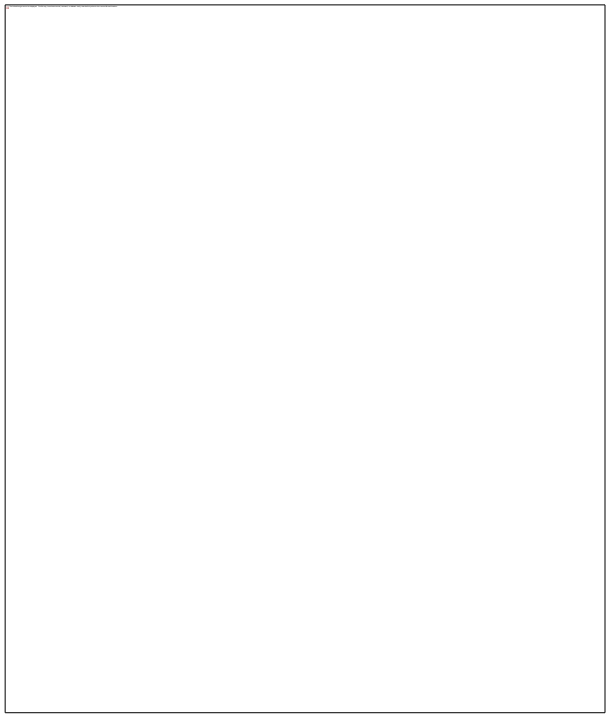

Figure A3.1 Location of the Queen Charlotte Islands (inset) and the Copper Islands

A3.1 Project Data

Information related to the entire project is included in the Project Data Fields (Table A3.1).

A3.2 Exposure Information

Once the resource materials are collected (in this project this included: aerial video imagery, vertical air photos, topographic maps, charts and oblique aerial photos), the **Exposure Units** were defined (Fig. A3.2). Three Exposure Units were defined in this case:

Exposure Unit 7/7 -- a general southerly orientation with limited fetches to the south within Skincuttle Inlet, but with maximum fetches exposed to the open Hecate Strait

Exposure Unit 7/8 -- mostly east-facing shore units and exposed to the extensive fetch window of Hecate Strait

Exposure Unit 7/9 -- generally north-facing shoreline with a fetch window open to northern Hecate Strait

Although there are small indentations and islets along the coast that have slightly different wave exposures, these exposure units provide a reasonable first approximation of the wave climate around the Copper Islands.

More detailed fetch measurements are then made for each exposure unit. The measurements made for Exposure Unit 7/7 are schematically shown in Figure A3.3 and summarized in Table A3.2.

The data show that the maximum fetch direction is to the east-southeast and extends across Hecate Strait for over 200km. The shoreline within the Exposure Unit is approximately south-facing; the shore perpendicular is just to the west of south at 192o. Fetches within Skincuttle Inlet are limited and all of the measured distances are less than 6km. The computed Effective Fetch is 3.8km , but the high Maximum Fetch Distance (219.6km) results in a Semi-Exposed categorization for the unit.

The wave fetch measurements provide a general indication of the wave climate for the unit. Under moderate wind conditions, the shoreline is relatively protected by islands to the south and west; however, extensive open water to the east can result in large waves being generated, especially during southeast storms.

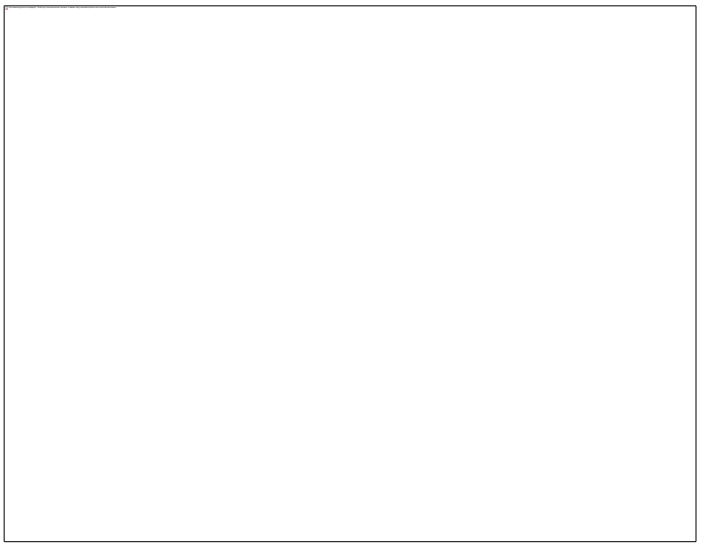

Figure A3.2 Wave Exposure Units of East Copper and Jeffrey Islands

A3.3 Shore Unit Information

The Exposure Unit is then subdivided into **Shore Units** which have more or less uniform geomorphology and substrate. Figure A3.4 shows the air photo of the island (scale approximately 1:20,000) and the base map (in this case, a photocopy of the nautical chart) used for recording the unit boundaries.

Four Shore Units are defined within the Exposure Unit and data for one (Shore Unit 7/7/01) are summarized in Table A3.3. The Unit type is linear (L) and is classified as a wide rock platform with a gravel beach (Class 7). An associated note (#277) is included in a separate database.

Unit Location and **Unit Length** information are normally computed by the GIS program but were manually measured in this case. The mean **Intertidal Width** is estimated at 80m.

There is no external **Sediment Source** to the unit or an indication of **Sediment Transport Direction**, so these fields have been left blank. Sediment Abundance is sparse (S).

The morphology of the unit (eroding cliff) indicates the shoreline is erosional (E) but the rate is unknown (?).

Data sources include: air photos, topgraphic maps, charts and aerial video imagery. No ground-truthing was conducted in the unit.

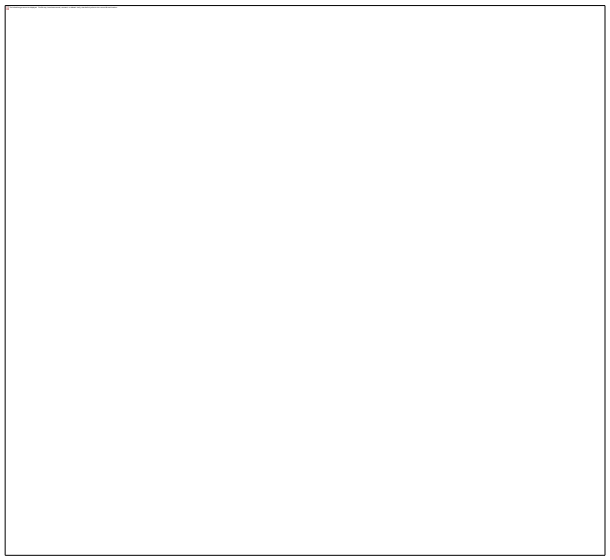

Figure A3.3 Wave fetch measurements for Exposure Units 7/7 showing direction of Maximum Wave Fetch (110 degrees at 219 km) and the Shore Normal(192 degrees) with associated fetch measurements.

Table A3.1 - Data entry fields - project information

Table A3.2 - Shore-zone data entry fields - wave exposure information

Figure A3.4 Vertical aerial photo of the Copper Islands and the working copy of associated shore units on East Copper Island

A3.4 Across-Shore Component Information

Each **Shore Unit** has associated across-shore components that provide a detailed characterization of morphology within the unit in an onshore to offshore progression. The Across-shore **Component** data are summarized in Table A3.4 and schematically represented in a sketch (Fig. A3.5).

The first **Zone** characterized is the supra-tidal zone (indicated by A). There is only one component (A1), a low ("l" indicates less than 5m high), inclined ("i" indicates a slope of 20-35o cliff (C)); the cliff includes anthropogenic or cut logs (At) over rock, sedimentary (Rs).

The next component (B1), located in the upper intertidal zone, is a beach, inclined (Bi) comprised of logs (At) over clastic cobbles (Cc) over rock, sedimentary (Rs); this beach is approximately 10m in width.

The second component (B2) lies seaward of the beach and consists of rock platform (P) which is a high-tide platform ("h") and has an irregular ("i") surface; it is comprised of sedimentary bedrock and is estimated at 70m in width.

The third component (B3) lies seaward of the platform and consists of two types of morphologies: offshore islet chains (Oc) and detached reefs with an irregular surface (Fi). Both the reefs and islets are comprised of sedimentary bedrock.

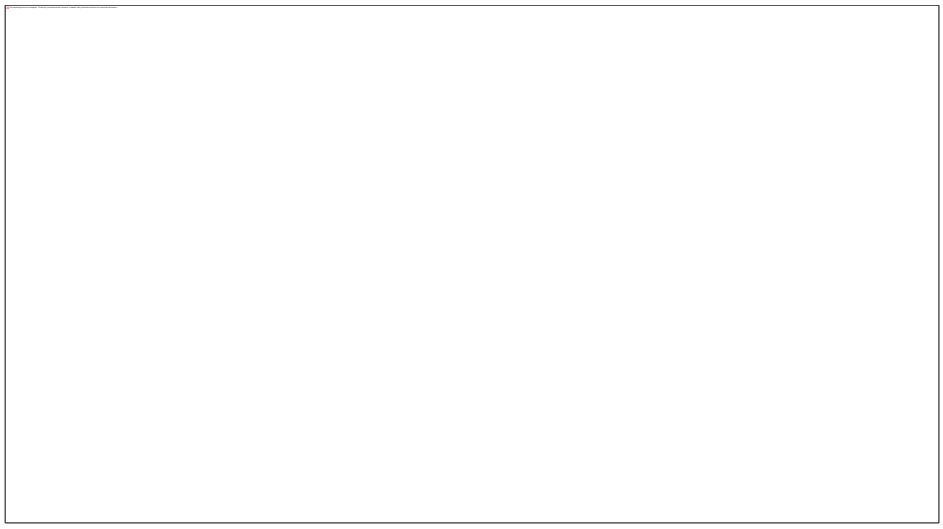

Figure A3.5 Sketch of Shore Unit 7/7/01 illustrating across-shore components of the Shore Unit. See Table A3.4 for detailed coding of across-shore components.

Table A3.3 - Shore-zone data entry fields - shore unit information

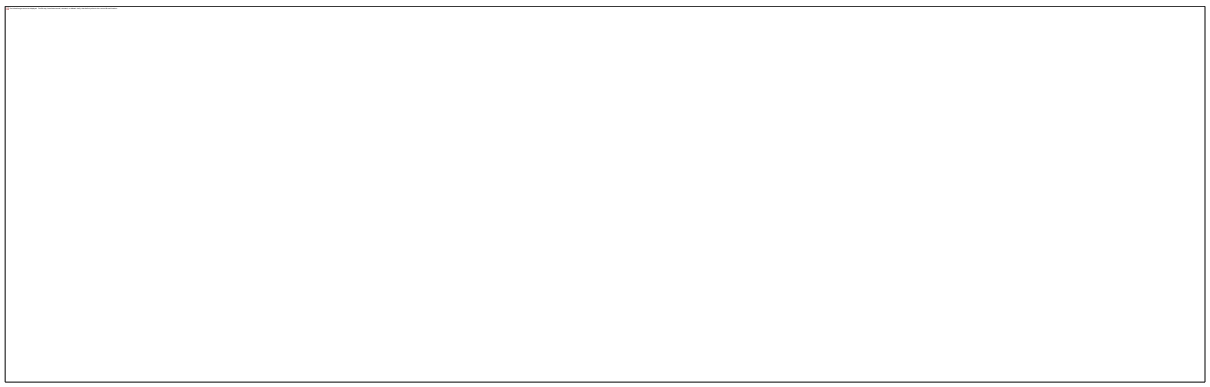

Table A3.4 - Shore-zone data entry fields - shore component information
