STAFF REPORT

Date: November 18, 2010 **File No.:** TH/04-1.3

To: Thetis Island Local Trust Committee

For meeting of November 29, 2010

From: Courtney Campbell, Island Planner

CC: Chris Jackson, Regional Planning Manager

Re: Shoreline Management

1. BACKGROUND:

This staff report assesses the recent shoreline classification conducted by Archipelago Marine Research Ltd dated October 8, 2010 and discusses next steps in this Thetis Pilot Project for shoreline management, referring to the March 31, 2010 Archipelago Marine Research Ltd report and the "Thetis Island Pilot Study" by UBC in 2009.

2. ISSUES SUMMARY:

a) Types of shoreline classification data
b) ShoreZone data
c) UBC "Thetis Island Pilot Project"
d) Local government tools for shoreline management
e) Development considerations for different shore types
f) Considerations for different development types
g) Next steps

3. STAFF COMMENTS:

a) Types of shoreline classification data: We have three sources of data for classifying Thetis Island shorelines:

- Field observation for the UBC "Thetis Island Pilot Project"
- 1979 ShoreZone data
- 2004 ShoreZone data

The mapping produced for UBC's "Thetis Island Pilot Project" was reviewed by Archipelago Marine Research Ltd and compared to the Provincial standard ShoreZone data. The UBC project was evaluated as providing excellent background material for the development of shoreline management guidelines or regulations. It was noted, however, that the "hill slope" and "cliff" categories need to be clarified.

The ShoreZone data refers to the Province of British Columbia's ShoreZone program that systematically collected aerial video imagery of the marine shoreline in BC for geological and biological classification. Imagery for Thetis Island was collected in 1979 and in 2004.

The 2004 imagery was not classified or mapped at the time, and this was the purpose of the second contract with Archipelago Marine Research Ltd.

The 2004 ShoreZone data provides more accurate and up-to-date information for Thetis Island; since 1979 changes have been made to the ShoreZone classification system and to the Thetis Island shoreline as well.

b) ShoreZone data: The 2004 ShoreZone data identifies numerous attributes, and the four selected for classification by Archipelago Marine Research Ltd are:

- Shore units
- Shore types
- Shore modifications
- Wave exposure

Details are found in the October 8, 2010 report, but the following summary is provided here:

- Shore units are based primarily on uniform physical characteristics and include the following four categories: rock, rock and sediment, sediment, and man-made. For Thetis Island, the majority of the coastline was classified as a mixture of rock and sediment.
- Shore types takes the four shore units a step further, and the classifications are based on a combination of substrate, sediment, width and slope.
- Shore modifications refer to human-made modifications to the shoreline and include shore protection features and coastal access structures. Approximately 8% of the Thetis Island shoreline, or 2,200m has shoreline modifications. The number of boat ramps, piers, wharves or docks and slips at docks are listed in the report.
- Wave exposure can be based on physical or biological attributes. In this report biological attributes are used (i.e. observing the presence and abundance of biota) as they are considered to be a better index for wave exposure. For Thetis Island, two categories of exposure were used: protected and semi-protected. 47.6% of the shoreline is protected, and 52.4% is semi-protected.

In summary, the ShoreZone data we have is the science essential to creating management guidelines and regulations for shoreline protection, but the data needs to be clustered into fewer categories with simple descriptions that can be more readily understood by planning staff, trustees, and an average member of the public. Planning staff is working with the mapping department to this end.

c) UBC "Thetis Island Pilot Project": In contrast to the ShoreZone data, the UBC Pilot Project presents shoreline data using 6 categories that are relatively easy to understand:

- Estuary
- Sand/cobble
- Low rock/boulder
- Hill slope
- Cliff
- Altered

These categories are based on broader scale coastal processes with less detail than the ShoreZone data. The purpose of the March 31, 2010 report from Archipelago Marine Research Ltd was to assess the UBC Pilot Project in comparison to the ShoreZone data,

and provide comment on the utility of the information for shoreline management. The categories used in the UBC Pilot Project correspond with the ShoreZone data, with the exception of the hill slope and cliff categories which are unclear. The March 31, 2010 report provides recommendations on clarification of these categories.

The only other critique of the UBC Pilot Project is that the sketches of building siting appear to under emphasize setback requirements for some of the shore types.

d) Local government tools for shoreline management: Local governments have the ability to manage shorelines in three main ways:

- Official community plan (OCP) policies and objectives
- Land use bylaw (LUB) zone and setback regulations
- Development permit areas

The Thetis OCP already has objectives and policies addressing the foreshore, and the LUB has a setback of 7.6 metres from the natural boundary of the sea. Water zones in the LUB regulate foreshore for such things as docks and floats and boat ramps.

The LTC should consider adopting a development permit area to further manage shoreline development.

e) Development considerations for different shore types: The UBC Pilot Project identified development considerations for each of the shore types. These are a good starting point for determining what local government tools should be used for different shore types, and what the regulations should be. The information below is somewhat modified from the UBC Pilot Project based on Archipelago Marine Research Ltd's review.

Estuary:

- Protect systems that maintain natural sediment balance – (i.e. coastal systems, watershed systems, sediment-forming ecosystems, especially eelgrass)
- Prevent pollution by identifying contaminant sources and mitigation at source
- Ensure development does not impede or negatively alter system flows – (i.e. improper siting disrupting sediment flows, contamination via sewage/other pollutants, obtrusive access disrupting wildlife patterns)
- Restrict human activity (especially in nesting areas, etc.)

Sand / Cobble:

- Because sand and gravel shores are highly sensitive to human interference and interruption of sediment processes, development in these areas must consider the following:
    - Establish setbacks in accordance with seasonal/characteristic sediment dynamics of the specific site
    - Maintain existing backshore vegetation to mitigate destabilization/erosion
    - Avoid measures (locally, or upstream) that could cause imbalances in natural sediment dynamics
    - For previously developed areas, soft erosion control measures will be the least invasive to natural ecosystems and processes and generally the least expensive to install and maintain. These include: beach nourishment, bioretention/vegetation, and other constructed sediment accreting systems.

Low rock / Boulder

- Because rocky shores are generally very stable and not formed by large amounts of sediment, they are generally considered good areas for upland development.
- Intertidal and shallow subtidal biotic communities can be diverse and very susceptible to certain types of disturbances (i.e. impacts that scrape/abrade the rocky surface, like trampling from high impact human use).
- Even bedrock cliffs can be subject to faults, so structures should be set back far enough from the crest of the slope to ensure geotechnical stability.

Hill Slope (to be re-named Coastal banks and bluffs)

- Ensure appropriate septic system design (to prevent contamination of marine ecosystem)
- Specific guidance should be provided for building setbacks, slope stability and means of managing erosion at the toe of the bank or bluff.
- More information is needed on management guidelines for this shore type.

Cliff

- Development considerations similar to low rock / boulder but with the added consideration of slope stability

f) Considerations for different development types: In addition to thinking about management considerations in terms of shore type, it is also important to consider the type of development. Below is a summary list of different types of shoreline development and considerations that can be included in development permit area guidelines. These are taken from the Green Shores Project "Review of Shore Management Policy & Bylaw Language" which is not attached to this staff report but can be viewed on their website at: http://www.greenshores.ca or requested from the Islands Trust office. Selected development types that are relevant to Thetis Island are listed below:

- **Shoreline stabilization measures:**
  - include actions taken to address erosion impacts to property and dwellings or structures caused by natural processes such as current, flood, tides, wind or wave action
  - include structural and non-structural methods
  - include a range from "hard" to "soft" measures.
  - In general the harder the construction measure, the greater the impact on the shoreline process
  - DPA guidelines could
    - require non structural stabilization measures for new construction
    - list criteria for the replacement of existing stabilization measures
    - list criteria for structural stabilization measures for existing buildings
    - require a geotechnical report to describe options and impacts.

- **Docks, piers and ramps:**
  - Guidelines for docks, piers and ramps could include:
    - criteria for considering different types of structures
    - avoiding critical habitats and impacts to shoreline processes (this may require an environmental assessment)
    - limits on the size and/or number of structures (i.e. encouraging private landowners to share docks or use local public facilities)

- criteria for replacing existing docks, piers or ramps
- design preferences for these types of structures

- **Fill**
- **Breakwaters, jetties, groins and weirs**
- **General land development**
- **Dredging**
- **Public access**

g) **Next steps:** Moving forward with shoreline management can be divided into two parts: mapping data and regulatory measures (i.e. creating a development permit area for shorelines).

Planning staff has worked with the mapping department to develop a simpler shoreline classification map from the 2004 ShoreZone data to repeat the categories used in the UBC Pilot Project, with the recommended changes for the Cliff and Hill Slope categories. The map is shown in Attachment B of this report. It is preliminary, as staff still needs to make a detailed comparison to the UBC Pilot Project posters.

Working towards creating a development permit area, staff needs to draft development permit area guidelines for consideration of the community and the LTC.

Staff recommends taking the opportunity at the next community information meeting to check in with the community on the direction taken with shoreline management. Staff proposes to present, in general terms, what a development permit area would accomplish for shoreline protection. We would be interested in the feedback from the community, hoping for broad community support for the need for more management of Thetis Island shorelines. It also may be a good approach to bring this to the community in a conceptual form rather than coming with draft bylaws. Although the topic was at the community information meeting in August 2009, there was little discussion or direct reference to creating a development permit area; it was more focused on displaying the material from the UBC Pilot Project.

RECOMMENDATIONS

Based on the above considerations, Staff recommends that te Local Trust Committee:

- direct staff to present the information in this staff report regarding shoreline types, shoreline development types, their associated management considerations, and the concept of a development permit area, to the next community information meeting; and
- direct staff to draft development permit area guidelines based on the feedback at the next community information meeting, and to develop mapping of shoreline types based on both the 2004 ShoreZone data and the UBC Pilot Study.

Respectfully submitted by:

Courtney Campbell	November 24, 2010
Island Planner	Date of signature

Concurred in by:

Chris Jackson, MCIP	***November 23, 2010***
Regional Planning Manager	Date of signature

Attachments:

1. Classification of Thetis Island Shoreline from ShoreZone Aerial Video Imagery Collected in 2004, report by Hearther Anderson, Archipelago Marine Research Ltd., October 8, 2010
2. Draft Thetis Island Shorezones Map

Classification of Thetis Island Shoreline from ShoreZone Aerial Video Imagery Collected in 2004

October 8, 2010

Prepared by: Heather Anderson B.Sc.
Coastal Marine Biologist
Archipelago Marine Research Ltd.
525 Head Street
Victoria, BC
V9A 5S1

Prepared for: Courtney Campbell
Island Planner
Islands Trust, Northern Office
700 North Road
Gabriola Island, BC
V0R 1X3

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Courtney Campbell, Island Planner, Islands Trust, Northern Office.

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INTRODUCTION AND PROJECT DESCRIPTION

The Province of British Columbia, through the RIC standard ShoreZone program, has systematically collected aerial video imagery of the marine shoreline in BC for geological and biological classification. The video imagery has been obtained from low altitude aerial surveys conducted during low tide cycles in the summer months. Imagery of the shoreline for Thetis Island was collected in 1979, with physical and biological aspects mapped. Imagery was collected again in 2004 as part of the Southern Strait of Georgia National Marine Conservation Area (NMCA) initiative, but the Thetis Island portion was not classified or mapped at that time.

The objective of this project, conducted for Islands Trust, was to review the 2004 imagery to classify and map the shoreline of Thetis Island. The results of this work are presented in the following summary report. The deliverables include an Access database populated with all of the data; a data dictionary, with definitions for all fields and attributes in the database; and a copy of the aerial video imagery and digital photographs taken during the aerial survey. The data dictionary is included in Appendix B at the end of this report (from Harney *et al* 2008).

2.0 SUMMARY OF DATA

There are a number of physical and biological attributes used in the ShoreZone classification system. Based on the information from the review of the 1979 ShoreZone classification of Thetis Island, the following attributes have been selected as the focus of this summary report and are discussed in more detail below:

- Shore units
- Shore types
- Shore modifications
- Wave exposure

2.1 SHORE UNITS

A shore unit is delineated primarily on the basis of uniform physical characteristics, including geomorphology, sediment texture and degree of wave exposure. A shore unit is further subdivided into across-shore components (A Zone = supratidal or backshore (limit not defined), B Zone = Intertidal zone, C Zone = shallow subtidal zone). Subunits may also be identified within a unit and are used to map point features, such as streams or rivers.

The shoreline of Thetis Island (approximately 27 km) was divided into 124 shore units based on observations made from review of the 2004 aerial imagery. These shore units are shown in Figure 1[1]. Subunits were identified within three of the units. Table 1 provides a breakdown of shore units by shoreline length, which varies between 30 and 650 m (average = 220 m). The majority of units (71%) are <250 m in length.

[1] The shore units have been uniquely numbered so that the corresponding data can be easily added to the existing ShoreZone data mapped from the 2004 imagery for the Gulf Islands.

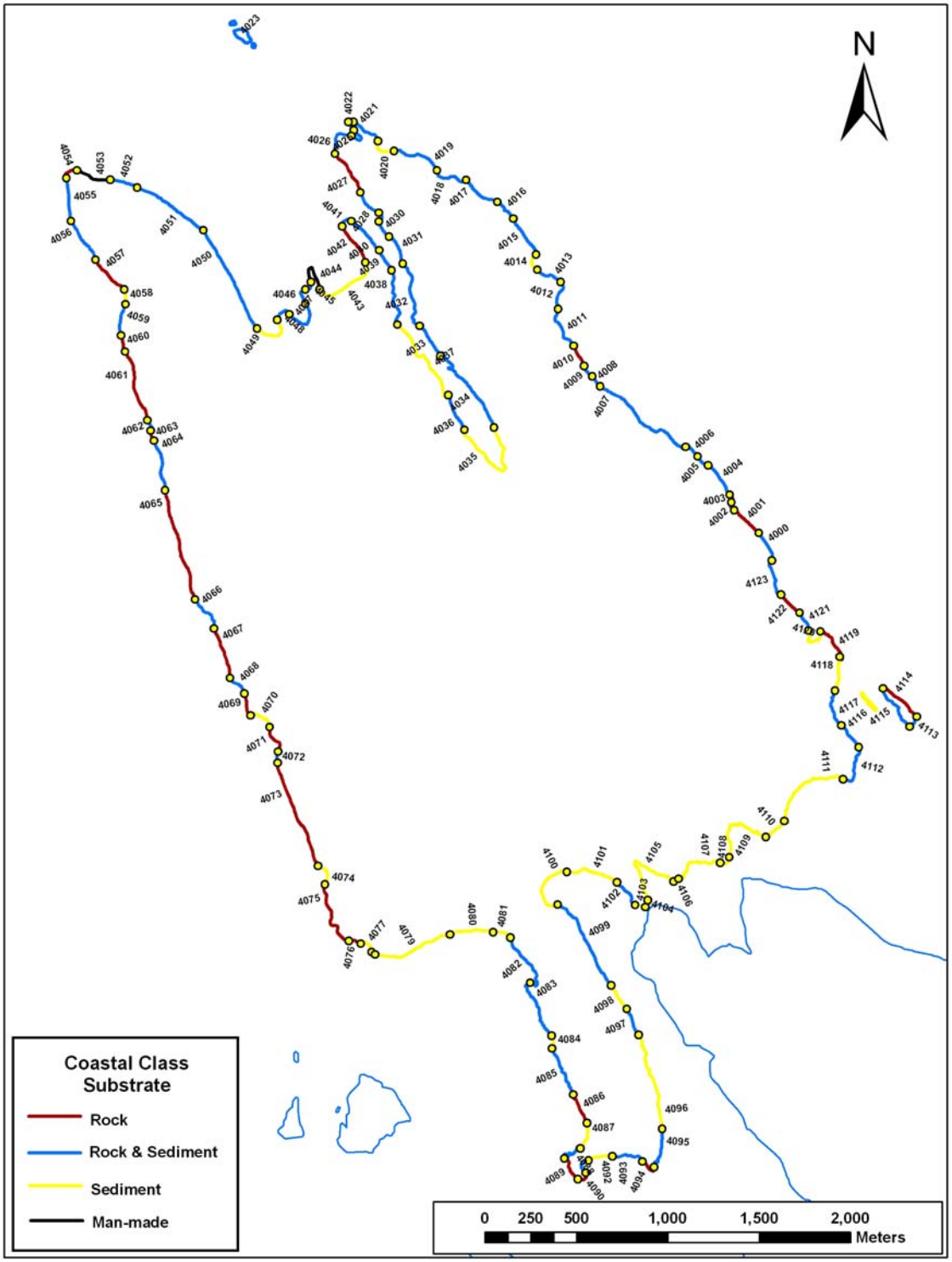

Figure 1. Map of Thetis Island showing the shore units (numbered on map) and associated coastal class substrate groupings (refer to Table 2 and Appendix Table B-2 for definitions of coastal classes).

Table 1. Number of shore units mapped by unit length for Thetis Island.

Unit Length	# of Units
<100 m	27
100-249 m	61
250-500 m	27
>500	9

2.2 SHORE TYPES

The collective attributes of each shore unit are used to assign an overall unit classification, or shore type representative of the unit as a whole. The shore type (= coastal class) is determine based on substrate, sediment, width and slope.

Table 2 summarizes the shore type classified for Thetis Island. Of the 34 coastal classes used in the classification system (see Appendix Table B-2 for complete list of classes), 18 were identified for Thetis Island. The majority of the shoreline along Thetis Island was classified as a mixture of rock and sediment (51% of the total shoreline length, or 13.9 km). The distribution of coastal classes grouped by substrate is shown in Figure 1. The rock and sediment coastal classes observed on Thetis Island are typically bedrock cliffs or platforms with pockets of overlying sand or gravel. Three shore units were assigned a coastal class of man-made permeable, which can be described as units with an area greater than 50% altered by humans, and would include areas of rip rap or fill. One shore unit was classified as organics, which denotes a section of shoreline with marsh grasses. Figure 2 shows the shore units and distribution of associated coastal classes.

Table 2. Summary of shore types (coastal class) classified for Thetis Island.

Substrate	Code	Shore Type (Coastal Class)	# of Units	Total Shoreline Length (m)	% Occurrence (by length)	Cumulative Shoreline Length & % Occurrence
Rock	1	Rock Ramp, wide	1	90.3	0.3	5.2 km 19.1%
	2	Rock Platform, wide	2	168.0	0.6	
	3	Rock Cliff	6	1329.7	4.9	
	4	Rock Ramp, narrow	15	3630.6	13.3	
Rock & Sediment	6	Ramp with gravel beach, wide	2	348.0	1.3	13.9 km 51.0%
	8	Cliff with gravel beach	14	3312.6	12.2	
	9	Ramp with gravel beach	10	1737.6	6.4	
	10	Platform with gravel beach	1	70.6	0.3	
	11	Ramp with gravel and sand beach, wide	23	4749.4	17.4	
	12	Platform with gravel and sand beach, wide	2	275.0	1.0	
	13	Cliff with gravel and sand beach	4	1160.3	4.3	
	14	Ramp with gravel and sand beach	11	2243.8	8.2	
Sediment	24	Sand and gravel flat or fan	22	5121.8	18.8	7.7 km 28.2%
	25	Sand and gravel beach, narrow	2	292.9	1.1	
	28	Sand flat	3	1024.3	3.8	
	29	Mud flat	2	802.4	2.9	
	31	Organics	1	437.6	1.6	
Man-made	32	Man-made, permeable	3	461.8	1.7	0.5 km 1.7%

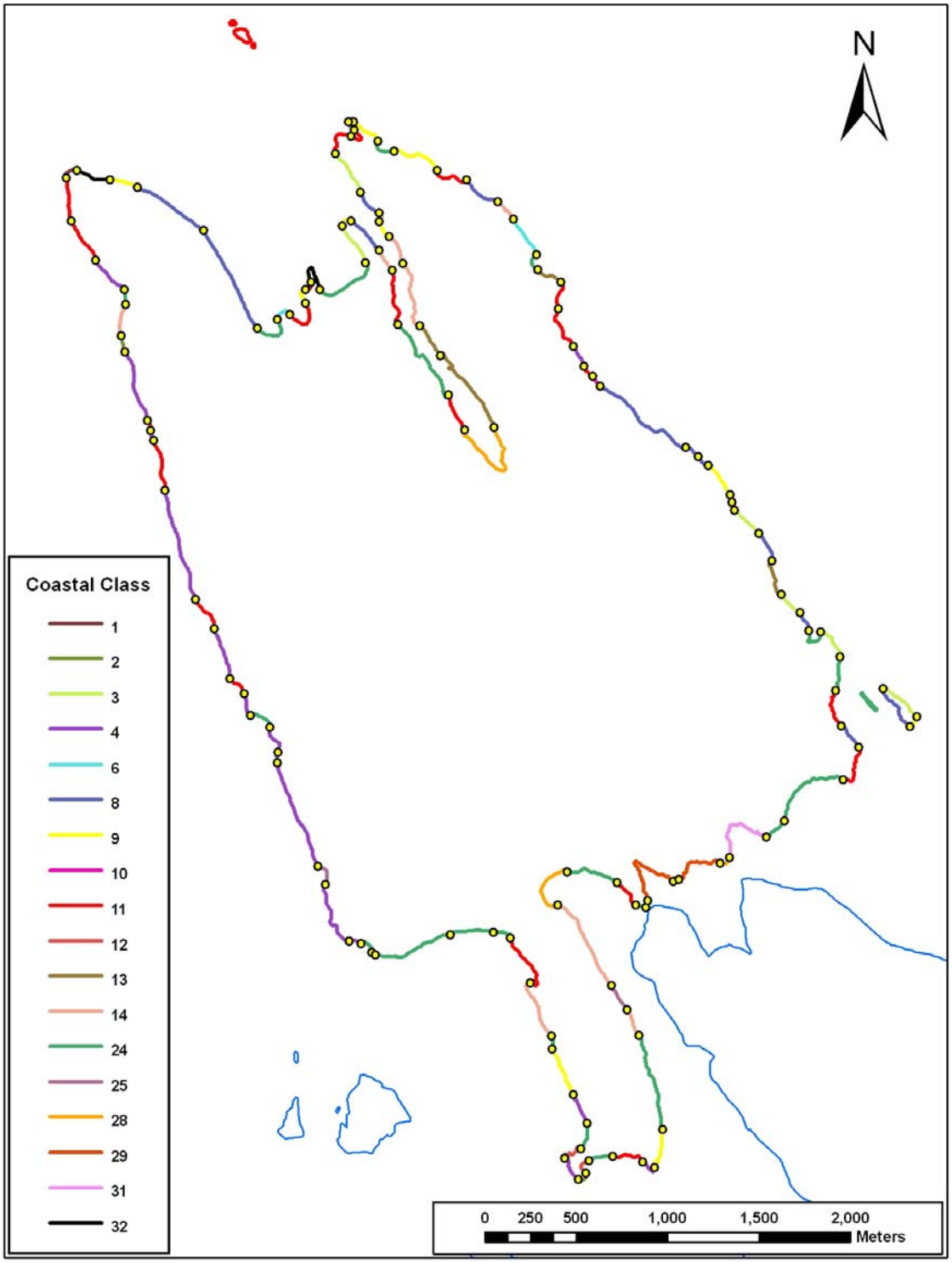

Figure 2. Map of Thetis Island showing the shore units and associated coastal classes (refer to Table 2 and Appendix Table B-2 for definitions of coastal classes).

2.3 SHORE MODIFICATIONS

Modifications to the shoreline, including shore protection features and coastal access constructions, are noted within the shore unit. The type of shore modification and the relative proportion of the intertidal zone modified are recorded, as well as the number of features observed (refer to Appendix Table B-1 for database field definitions for shore modifications). The exact location of the shore modification type or feature is not mapped.

A summary of the shore modifications along the shoreline of Thetis Island is shown in Table 3 (refer to Appendix Table A-1 for complete list of shore modifications by unit). Five different types of shore modifications were observed, including boat ramps, wooden and concrete bulkheads, landfill and rip rap. The length of shoreline representing the modifications on Thetis Island was estimated to be 2,200 m, which is approximately 8% of the total shoreline. Photos A and B show examples of two types of shore modifications observed on Thetis Island. The number of boat ramps, piers, wharves or docks and slips at docks observed is shown in Table 4 (refer to Appendix Table A-2 for complete list of features by unit). Photos C and D show examples of recreational boat slips and the ferry terminal observed on Thetis Island.

Table 3. Summary of shore modifications for Thetis Island.

Type of Shore Modification	Total Shoreline Length (m)
Boat ramp	253.5
Wooden bulkhead	159.4
Concrete bulkhead	585.0
Landfill	487.4
Rip rap	714.9

Intertidal swimming pool (classified under concrete bulkhead)

Shore unit 4017

Photo GIAVI04_0634.jpg

Rip rap

Shore unit 4053

Photo GIAVI04_0653.jpg

Table 4. Number of boat ramps, piers, wharves or docks and slips at docks for Thetis Island.

Feature	# of Features
Boat ramp	13
Pier, wharf or dock	31
Recreational boat slip[2]	185
Ferry terminal	1

	
Many recreational boat slips at one dock	Ferry terminal
Shore unit 4102	Shore unit 4082
Photo GIAVI04_0682.jpg	Photo GIAVI04_0672.jpg

2.4 WAVE EXPOSURE

There are two classifications for wave exposure, one based on physical attributes and the other on biological attributes. The categories of exposure are the same for both: exposed, very exposed, semi-exposed, semi-protected, protected and very protected. The difference between the two is how the classifications are derived. The physical wave exposure is an estimate of the exposure as a function of the maximum fetch, or length of water over which a given wind has blown (refer to Appendix Table B-4 for exposure matrix). The biological wave exposure is determined from observations of the presence and abundance of biota (refer to Appendix Table B-9 for definitions of exposure by species assemblage). Because wave energy tolerances for species assemblages have been assigned from scientific literature and expert knowledge, the assemblages of species present can be used as proxy indicators for energy conditions at the site. It is for this reason that the biological wave exposure category is considered to be a better index of exposure than are scores derived from fetch measurements and why this classification is used to determine the final exposure for the unit.

[2] Number of spaces at that a boat could occupy at a dock.

Of the six wave exposure categories, only two were used to classify the shoreline of Thetis Island based on the assemblages of biota observed. Out of 124 shore units mapped, 53 were classified as protected and 71 as semi-protected (Table 5). The percent occurrences by shoreline length were close to equal, with 47.6% classified as protected, and the other 52.4% classified as semi-protected. Figure 3 shows the units and distribution of associated biological wave exposure categories.

Table 5. Summary of biological wave exposure categories classified for Thetis Island.

Biological Wave Exposure	# of Units	Total Shoreline Length (km)	% Occurrence (by length)
Protected	53	13.0	47.6
Semi-protected	71	14.3	52.4

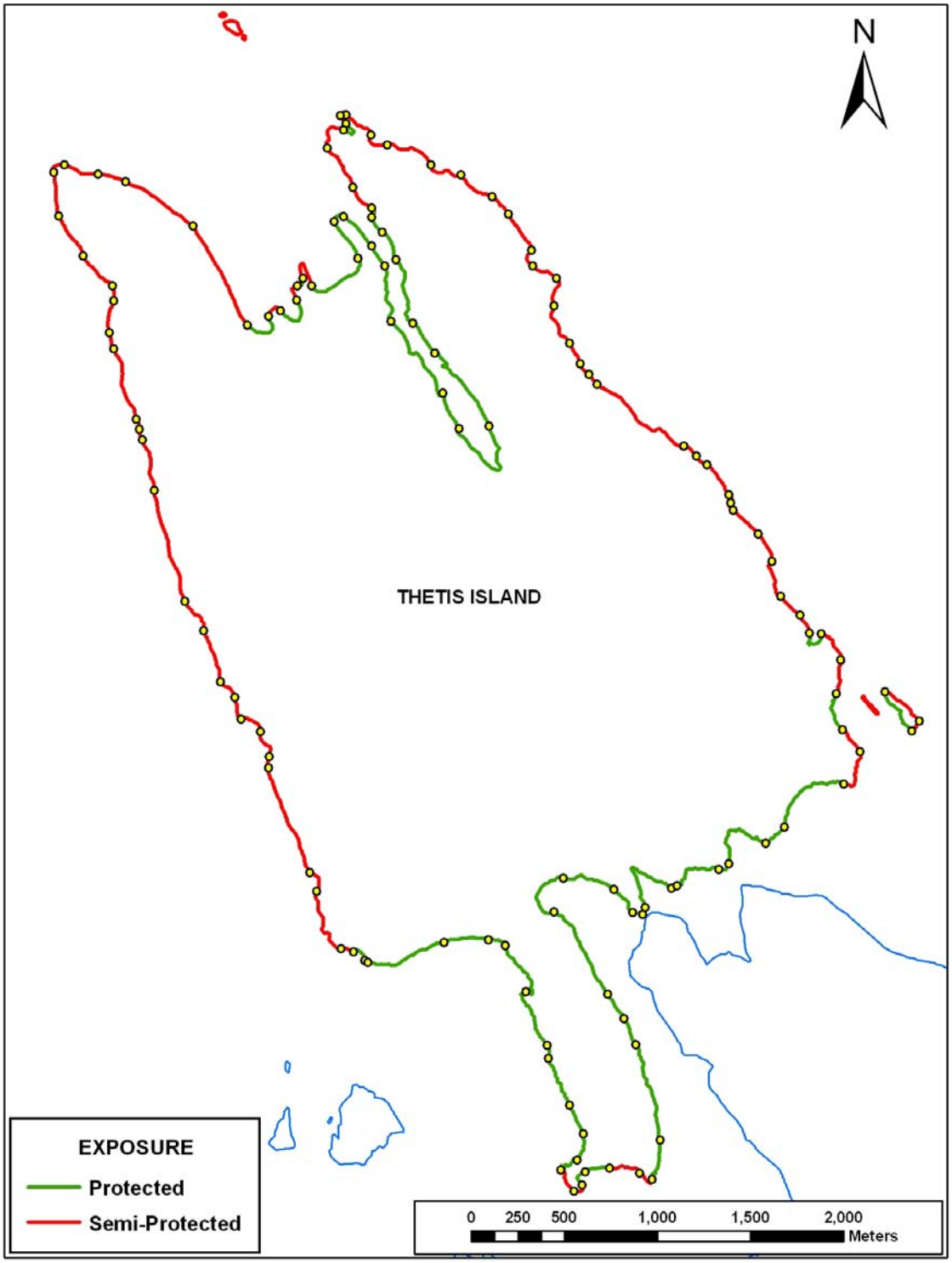

Figure 3. Map of Thetis Island showing the shore units and associated biological wave exposures (refer to Appendix Table B-9 for definitions of biological wave exposures).

3.0 DIFFERENCES BETWEEN THE 1979 AND 2004 DATASETS

ShoreZone mapping data for Thetis Island classified from imagery collected in 1979 was reported in Morris (2000) and then reviewed in Thuringer and Emmett (2010). Now that the classification and mapping has been completed from the 2004 imagery, the datasets can be compared. The following differences were noted:

- The number of shore units mapped from the 2004 imagery is higher (124) than that from the 1979 imagery (29), and, as a consequence, the average unit length is smaller.
- With smaller shore units mapped, the distribution of shore types is not the same, but the distribution of wave exposure categories is similar.
- There are three shore units mapped from the 2004 imagery with a coastal class of man-made, but none from the 1979 imagery.

The differences between these datasets may be attributed to changes in or alterations to the shoreline, but may also be a result of refined protocols resulting in current mapping being done at a finer level of detail.

4.0 RECOMMENDATIONS FOR FURTHER USE OF THE DATASET

The dataset provided includes attributes not discussed in this report and can be furthered queried to make use of the different attributes available. Attributes of interest include:

- Coastal processes (e.g., sediment transport)
- Oil residency
- Environmental sensitivity
- Valued habitat and biota (e.g., salt marsh vegetation, eelgrass)

Refer to the data dictionary included in Appendix B at the end of this report for definitions of *all* attributes included in the dataset. More information can also be found on these attributes, including classification guidelines, definitions and photo examples, in the ShoreZone Mapping Protocol (Harney *et al* 2008) available online.

5.0 REFERENCES

Harney, J.N., M. Morris and J.R. Harper 2008. ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska. Report prepared for The Nature Conservancy, NOAA National Marine Fisheries Service, and the Alaska State Department of Natural Resources (Juneau, AK). Coastal and Ocean Resources Inc. (Sidney, BC), and Archipelago Marine Research Ltd (Victoria, BC). 155 p.

Howes, D., J.R. Harper, and E.H. Owens. 1994. Physical Shore-Zone Mapping System for British Columbia. Report prepared by Environmental Emergency Services, Ministry of Environment (Victoria, BC), Coastal and Ocean Resources Inc. (Sidney, BC), and Owens Coastal Consultants (Bainbridge, WA). 71 p.

Morris, M. 2000. Georgia Strait Bio-mapping Final Report. Report prepared for the Land Use Coordination Office (Victoria, BC). Archipelago Marine Research Ltd. (Victoria, BC

Peterson, J., J. Michel, S. Zengel, M. White, C. Lord and C. Plank. 2002. Environmental Sensitivity Index Guidelines, Version 3. NOAA Technical Memorandum NOS OR&R11. 192 p.

Thuringer, P. and B. Emmett. 2010. Review of Thetis Island Shoreline Classification and Reccomendations for Shoreline Development. Report prepared for Islands Trust, Northern Office (Gabriola Island, BC). Archipelago Marine Research Ltd. (Victoria, BC). 22 p.

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APPENDIX A
Shore Modification Data

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Table A-1. Shore modifications by shore unit, classified from 2004 aerial imagery of Thetis Island (refer to Appendix Table B-2 for definitions of shore modification codes).

Shore Unit	Primary Shore Modification		Secondary Shore Modification		Tertiary Shore Modification	
	Type	Shoreline Length (m)	Type	Shoreline Length (m)	Type	Shoreline Length (m)
4002	BR	5.6				
4011	BR	51.2				
4016	WB	13.8	CB	13.8		
4017	BR	22.3				
4020	RR	41.3	LF	13.8		
4024	CB	5.5				
4025	CB	26.1				
4028	RR	48.0				
4036	BR	22.0				
4044	RR	220.8				
4049	BR	23.1				
4053	RR	98.6				
4055	RR	24.0				
4065	CB	63.4				
4067	CB	29.3	BR	29.3		
4069	CB	39.3				
4073	CB	62.1				
4077	BR	10.0				
4080	LF	148.5				
4081	LF	46.1	RR	11.5		
4082	RR	37.0				
4083	WB	35.8				
4084	WB	7.4				
4087	CB	31.3				
4088	CB	34.6				
4091	LF	40.9				
4092	CB	81.8	BR	13.6		
4096	WB	56.1				
4097	CB	158.7				
4100	LF	104.0				
4101	LF	90.3	RR	30.1	BR	30.1
4102	CB	17.2				
4104	LF	43.8				
4108	RR	15.2	CB	7.6		
4110	CB	14.3				
4111	RR	97.6				
4117	RR	44.5				
4118	RR	46.3	WB	46.3	BR	46.3

Table A-2. Number of boat ramps, piers, wharves or docks and slips at docks by shore unit, classified from 2004 aerial imagery of Thetis Island (refer to Appendix Table B-2 for definitions of features).

Shore Unit	Boat Ramp	Pier, Wharf or Dock	Recreational Boat Slip	Ferry Terminal
4002	1	0	0	0
4011	2	0	0	0
4017	3	0	0	0
4024	0	1	1	0
4027	0	2	4	0
4028	0	0	3	0
4031	0	2	1	0
4033	0	1	1	0
4035	0	1	0	0
4036	1	1	0	0
4044	0	1	4	0
4049	1	0	0	0
4050	0	1	6	0
4053	0	1	4	0
4067	1	0	0	0
4069	0	1	10	0
4072	0	1	0	0
4077	1	0	0	0
4080	0	1	6	0
4082	0	2	4	1
4089	0	1	0	0
4092	1	0	0	0
4096	0	1	4	0
4097	0	1	70	0
4099	0	1	3	0
4100	0	2	0	0
4101	1	1	0	0
4102	0	1	60	0
4107	0	3	0	0
4110	0	1	0	0
4115	0	1	2	0
4116	0	1	2	0
4118	1	0	0	0
4121	0	1	0	0

APPENDIX B
Data Dictionary[3]

[3] From Harney *et al* 2008.

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Table B-1. Definitions for Fields and Attributes in the UNIT table.

Field Name	Description
UnitRecID	**Unit Record ID:** An automatically-generated number field; the database "primary key" for unit-level relationships
PHY_IDENT	**Physical Ident** is a unique code to identify each unit, assigned by physical mapper; defined as an alphanumeric string determined by the codes for: Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0), where '12' is Region 12, '03' is Area 3, '0552' is the Unit number, and '0' is the Subunit number.
REGION	**Region:** assigned during mapping, makes up first two digits of the PHY_IDENT. (See PHY_IDENT description for example.)
AREAS	**Area:** assigned during mapping, makes up the third and fourth digits of the PHY_IDENT. (See PHY_IDENT description for example.)
PHY_UNIT	**Unit:** Four digit **along-shore unit number**; assigned during mapping, unique within Region/Area mapping section. (See PHY_IDENT description for example.)
SUBUNIT	**Subunit:** assigned during mapping, is '0' for unit line features. Subunit field is used to identify Point features (if any, also called 'Variants') within Units, and are numbered sequentially (1, 2, 3…) according to the order occurring within the unit. (See PHY_IDENT description for example.)
TYPE	**Unit Type:** A single-letter description for Unit as either: a (L)ine (linear unit) or (P)oint feature (variant). Related to SUBUNIT attribute, where each numbered SUBUNIT 'variant' would be TYPE 'P'
BC_CLASS	**BC Coastal Class:** Code number for Coastal Class classification for the unit. Definitions of codes in Table B-2. Determined by the Physical mapper and based on: overall substrate type, sediment size (if sediment is present), across-shore width, and across-shore slope for the unit; derived from the Howes *et al* (1994)
ESI	**Environmental Sensitivity Index** Classification for the shore unit, using unit-wide interpretation of ESI. Definitions in Table B-3, after Peterson *et al* [2002].
LENGTH_M	**Unit Length**: Along-shore unit high waterline, in meters; calculated in ArcGIS, from digitized shoreline
GEO_MAPPER	**Physical Mapper Name:** Last name of the physical mapper
GEO_EDITOR	**Physical Mapper Reviewer:** Last name of the physical mapper who QA/QCs the work (10% of all units are reviewed by a different Physical mapper than did original mapping)
VIDEOTAPE	**Videotape Name:** Unique code for title of the videotape used for mapping; Naming convention example is SE07_SO_08, where first four characters identify the main survey region and year, (where SE07 is 'Southeast Alaska 2007'), two letter code for survey team (where SO is 'Sockeye') and two digit code '08' is for consecutively numbered tape.
HR	**Hour**: From the first two digits of the 6-digit UTC time burned on video image, identifying video frame at which the unit starts; with the unit start frame at center of viewing screen
MIN	**Minute**: From the third and fourth digits of the 6-digit UTC time burned on video image at which unit starts; with the unit start frame at center of viewing screen
SEC	**Seconds**: From the last two digits of the 6-digit UTC time burned on video image at which unit starts; with the unit start frame at center of viewing screen
EXP_OBSER	**Physical wave exposure:** Estimate of wave exposure as observed by the physical mapper, estimated from observed fetch and coastal processes; categories listed in Table B-4.

[continued]

Table B-1. Definitions for Fields and Attributes in the UNIT table. (continued)

Field Name	Description
ORI	**Oil Residency Index:** Code indicating the potential persistence of oil within the shore unit. Based on unit substrate type and biological wave exposure categories. Definitions and lookup matrix in Tables B-5 and B-6
SED_SOURCE	**Sediment Source:** Code to indicate estimated sediment source for the unit: (A)longshore, (B)ackshore, (F)luvial, (O)ffshore, (X) not identifiable
SED_ABUND	**Sediment Abundance:** Code to indicate the relative sediment abundance within the shore-unit: (A)bundant, (M)oderate, (S)carce
SED_DIR	**Sediment Transport Direction:** One of the eight cardinal points of the compass indicating dominant sediment transport direction (N, NE, E, SE, S, SW, W, NW). (X) Indicates transport direction could not be discerned from imagery.
CHNG_TYPE	**Change Type:** Code indicating the estimated stability of the shore unit, reflecting the relative degree of "measurable change" during a 3-5 year time span: (A)ccretional, (E)rosional, (S)table
SHORENAME	**Shorename:** Name of a prominent geographic feature near the unit (from nautical chart or gazetteer)
UNIT_COMMENTS	**Unit Comments**: Text field for comments and notes during physical mapping
SM1_TYPE	**Primary Shore Modification:** 2-letter code indicating the primary type of shore modification occurring within the unit: BR = boat ramp; CB = concrete bulkhead; LF = landfill; SP= sheet pile; RR = rip rap and WB = wooden bulkhead
SM1_PCT	**Primary Shore Modification Percent Unit Length:** Estimated % occurrence of the primary shore modification type in tenths (i.e. "2" = 20% occurrence with the unit alongshore)
SM2_TYPE	**Secondary Shore Modification:** 2-letter code indicating the secondary type of shore modification occurring within the unit
SM2_PCT	**Secondary Shore Modification Percent Unit Length:** Estimated % occurrence of the secondary type of shore modification occurring within the unit
SM3_TYPE	**Tertiary Shore Modification:** 2-letter code indicating the tertiary type of shore modification occurring within the unit
SM3_PCT	**Tertiary Shore Modification Percent Unit Length:** Estimated % occurrence of the tertiary seawall type in tenths (i.e., "2" = 20% occurrence within the unit)
SMOD_TOTAL	**Total Shore Modification % Unit Length:** Total % occurrence of shore modification in the unit in tenths
RAMPS	**Boat Ramps:** Number of boat ramps that occur within the unit; ramps must impact some portion of the shore-zone and generally be constructed of concrete, wood or aggregate
PIERS_DOCK	**Piers or Wharves:** Number of piers or wharves that occur within the unit; piers or docks must extend at least 10 m into the intertidal zone; does not include anchored floats
REC_SLIPS	**Dock Slips:** Estimated number of recreational slips at docks or marinas within the unit; based on small boat length ~<50'
DEEPSEA_SLIP	**Ship Dock Slips:** Estimated number of slips for ocean-going vessels within the unit; based on ship length ~>100'
ITZ	**Intertidal Zone Width:** Sum of the across-shore width of all the intertidal (B Zone) components within the unit
SLIDE	Still Photo in Unit: **Yes/No tick box** to indicate if high resolution photo is available for the Unit.
EntryDate ModifiedDate	**Date/Time Mapped or Modified:** Date and time the unit was physically mapped (or modified)

Table B-2. Definitions of the Shore Type (Coastal Class or BC_CLASS) attribute, in the UNIT table (after Howes *et al* 1994).

Substrate	Sediment	Width	Slope	BC_CLASS	
				Description	CODE
Rock	n/a	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Rock Ramp, wide	1
			Flat (<5°)	Rock Platform, wide	2
		Narrow (<30 m)	Steep (>20°)	Rock Cliff	3
			Inclined (5-	Rock Ramp, narrow	4
			Flat (<5°)	Rock Platform, narrow	5
Rock & Sediment	Gravel	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Ramp with gravel beach,	6
			Flat (<5°)	Platform with gravel beach,	7
		Narrow (<30 m)	Steep (>20°)	Cliff with gravel beach	8
			Inclined (5-	Ramp with gravel beach	9
			Flat (<5°)	Platform with gravel beach	10
	Sand & Gravel	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Ramp w gravel & sand	11
			Flat (<5°)	Platform with G&S beach,	12
		Narrow (<30 m)	Steep (>20°)	Cliff with gravel/sand beach	13
			Inclined (5-	Ramp with gravel/sand	14
			Flat (<5°)	Platform with gravel/sand	15
	Sand	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Ramp with sand beach, wide	16
			Flat (<5°)	Platform with sand beach,	17
		Narrow (<30 m)	Steep (>20°)	Cliff with sand beach	18
			Inclined (5-	Ramp with sand beach,	19
			Flat (<5°)	Platform with sand beach,	20
Sediment	Gravel	Wide (>30	Flat (<5°)	Gravel flat, wide	21
		Narrow (<30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Gravel beach, narrow	22
			Flat (<5°)	Gravel flat or fan	23
	Sand & Gravel	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	n/a	-
			Flat (<5°)	Sand & gravel flat or fan	24
		Narrow (<30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Sand & gravel beach, narrow	25
			Flat (<5°)	Sand & gravel flat or fan	26
	Sand/Mud	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Sand beach	27
			Flat (<5°)	Sand flat	28
			Flat (<5°)	Mudflat	29
		Narrow (<30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Sand beach	30
			Flat (<5°)	n/a	-
	Organics	n/a	n/a	Organics	31
Anthropogenic	Man-made	n/a	n/a	Man-made, permeable	32
			n/a	Man-made, impermeable	33
Channel	Current	n/a	n/a	Channel	34
Glacier	Ice	n/a	n/a	Glacier	35

Table B-3. Definitions of the ESI (Environmental Sensitivity Index) attribute, from the UNIT table (after Peterson *et al* 2002).

Environmental Sensitivity Index (ESI)	
CODE	**Description**
1A	Exposed rocky shores; exposed rocky banks
1B	Exposed, solid man-made structures
1C	Exposed rocky cliffs with boulder talus base
2A	Exposed wave-cut platforms in bedrock, mud, or clay
2B	Exposed scarps and steep slopes in clay
3A	Fine- to medium-grained sand beaches
3B	Scarps and steep slopes in sand
3C	Tundra cliffs
4	Coarse-grained sand beaches
5	Mixed sand and gravel beaches
6A	Gravel beaches; Gravel Beaches (granules and pebbles
6B	Gravel Beaches (cobbles and boulders)
6C	Rip rap (man-made)
7	Exposed tidal flats
8A	Sheltered scarps in bedrock, mud, or clay; Sheltered rocky shores (impermeable)
8B	Sheltered, solid man-made structures; Sheltered rocky shores (permeable)
8C	Sheltered rip rap
8D	Sheltered rocky rubble shores
8E	Peat shorelines
9A	Sheltered tidal flats
9B	Vegetated low banks
9C	Hypersaline tidal flats
10A	Salt- and brackish-water marshes
10B	Freshwater marshes
10C	Swamps
10D	Scrub-shrub wetlands; mangroves
10E	Inundated low-lying tundra

Table B-4. Definitions for estimating the OBSERVED PHYSICAL EXPOSURE attribute, (EXP_OBSER) in the UNIT table.

Maximum Fetch (km)	**Modified Effective Fetch (km)**				
	<1	**1 - 10**	**10 - 50**	**50 - 500**	**>500**
<1	very protected	n/a	n/a	n/a	n/a
<10	protected	protected	n/a	n/a	n/a
10 – 50	n/a	semi-protected	semi-protected	n/a	n/a
50 – 500	n/a	semi-exposed	semi-exposed	semi-exposed	n/a
>500	n/a	n/a	semi-exposed	exposed	exposed

Codes for exposures: Very Protected = **VP;** Protected = **P;** Semi-Protected =**SP;** Semi-Exposed = **SE;** Exposed = **E;** Very Exposed = **VE**

Table B-5. Definition of the OIL RESIDENCE INDEX (ORI) attribute in the UNIT table.

Persistence	Oil Residence Index (ORI)	Estimated Persistence
Short	1	Days to weeks
Short to Moderate	2	**Weeks** to Months
Moderate	3	Weeks to **Months**
Moderate to Long	4	**Months** to Years
Long	5	Months to **Years**

Table B-6. OIL RESIDENCE INDEX (ORI) Component lookup matrix based on exposure (columns) and substrate type (rows).

Component Substrate	VE	E	SE	SP	P	VP
rock	1	1	1	2	3	3
man-made, impermeable	1	1	1	2	2	2
boulder	2	3	5	4	4	4
cobble	2	3	5	4	4	4
pebble	2	3	5	4	4	4
sand with pebble, cobble or boulder	1	2	3	4	5	5
sand without pebble, cobble or boulder	2	2	3	3	4	4
mud	999	999	999	3	3	3
organics/vegetation	999	999	999	5	5	5
man-made, permeable	2	2	3	3	5	5

Table B-7. Definitions of the attributes in the BIOUNIT table.

Field Name Code	Description
UnitRecID	**Unit Record ID:** Automatically-generated number field; the database "primary key" required for relationships between tables
PHY_IDENT	**Physical_Ident** is a unique code to identify each unit, assigned by physical mapper; defined as an alphanumeric string determined by the codes for: Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0), where '12' is Region 12, '03' is Area 3, '0552' is the Unit number, and '0' is the Subunit number.
EXP_BIO	**Biological Wave Exposure:** A classification of the wave exposure category within the Unit, assigned by the Biological mapper, based on observed indicator species and biobands (Table B-8 and Table B-9)
HAB_CLASS	**Habitat Class**: Code for a classification of overall habitat category within the Unit, assigned by the biological mapper. Based on the Biological Exposure (EXP_BIO) and the geomorphic features of the shoreline (Table B-10 and B-11).
HAB_CLASS_LTRS	**Habitat Class** in alphabetic code: translation from number codes in the HAB CLASS lookup table (Table B-11)
HAB_OBS	**Habitat Observed**: Original Habitat code categories used to classify Habitat Type; not used in current protocol but kept for backward-compatibility with earlier projects; replaced by HAB_CLASS
BIO_SOURCE	**Biomapping Source:** The source data used to interpret coastal zone biota: (V)ideotape, (V2) - lower quality video imagery, (S)lide, (I)nferred
HAB_CLASS2	**Secondary Habitat Class**: Code for a classification of secondary Lagoon-type habitat within the Unit, assigned by the biological mapper. Based on the Biological Exposure (EXP_BIO) and lagoon habitat types (Table B-10 and B-11)
HC2_SOURCE	**Secondary Habitat Class Source:** Source used to interpret the Secondary Habitat Class (HAB_CLASS2) "lagoon": OBServed as viewed from video, LooKUP referring to 'Form' Code (Table B-10 and Table B-11) Lo or Lc in across-shore physical component table (Table B-12 and B-13)
HC2_Note	**Secondary Habitat Class Comment:** comment field for Secondary Habitat Class ((HAB_CLASS2))
RIPARIAN_PERCENT	**Riparian Percent Overhang:** Estimate of the percentage of alongshore length of the intertidal zone, in which the shoreline is shaded by overhanging riparian vegetation; all substrate types (Expanded definition in Table B-10)
RIPARIAN_M	**Riparian Overhang Meters:** Calculated portion of the unit length, in meters, of riparian overhang in the intertidal (B) zone, using LENGTH_M field of UNIT table, and RIPARIAN_PERCENT of BIOUNIT table; all substrate types;
BIO_UNIT_COMMENT	**Biological Comments**: regarding the along-shore unit as a whole. Included as deliverable data, as note format.
BIO_MAPPER	**Biological Mapper:** The initials of the biological mapper that provided the biological interpretation of the imagery
PHOTO	Still Photo in Unit: **Yes/No tick box** to indicate if high resolution photo is available for the Unit. (see BIOSLIDE table)
DateAdded DateModified	**Date/Time Mapped or Modified:** Date and time the unit was physically mapped (or modified)

Table B-8. List of the BIOLOGICAL WAVE EXPOSURE codes, in BIOUNIT table.

Biological Wave Exposure	
Name	**Code**
Very Exposed	VE
Exposed	E
Semi-Exposed	SE
Semi-Protected	SP
Protected	P
Very Protected	VP

Table B-9. Definitions of BIOLOGICAL WAVE EXPOSURES, by bioband, and by indicator and associate species assemblages (EXP_BIO attribute in BIOUNIT table).

Exposure	Zone	Indicator Species	Associated Species	Bioband Name	Bioband Code
Very Exposed (VE) & Exposed (E)	Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
		Verrucaria		Splash Zone	VER
			Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
		Semibalanus cariosus		Barnacle	BAR
		Mytilus trossulus		Blue Mussel	BMU
	Lower Intertidal & Nearshore Subtidal		*Mytilus californianus*	California Mussel	MUS
		Coralline red algae		Red Algae	RED
		Alaria 'nana' morph		Alaria	ALA
		Lessoniopsis littoralis		Dark Brown Kelps	CHB
		Laminaria setchellii		Dark Brown Kelps	CHB
		Nereocystis luetkeana		Bull Kelp	NER
Semi-Exposed (SE)	Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
		Verrucaria		Splash Zone	VER
			Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
			Fucus distichus	Rockweed	FUC
		Semibalanus cariosus		Barnacle	BAR
		Mytilus trossulus		Blue Mussel	BMU
	Lower Intertidal & Nearshore Subtidal	mixed filamentous and foliose red algae		Red Algae	RED
		Alaria 'marginata' morph		Alaria	ALA
		Phyllospadix sp.		Surfgrass	SUR
		Laminaria setchellii		Dark Brown Kelps	CHB
		Saccharina subsimplex		Dark Brown Kelps	CHB
		Saccharina sessile smooth morph		Dark Brown Kelps	CHB
		Alaria fistulosa		Dragon Kelp	ALF
			Strongylocentrous fransciscanus	Urchin Barrens	URC
			Macrocystis integrifolia	Giant Kelp	MAC
		Nereocystis luetkeana		Bull Kelp	NER

[continued]

Table B-9. Definitions of BIOLOGICAL WAVE EXPOSURES, by bioband, and by indicator and associate species assemblages (EXP_BIO attribute in BIOUNIT table). (continued)

Exposure	Zone	Indicator Species	Associated Species	Bioband Name	Bioband Code
Semi-Protected (SP)	Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
			Carex spp.	Sedges	SED
			Puccinellia sp.	Salt Marsh	PUC
			Plantago maritima	Salt Marsh	PUC
			Glaux maritima	Salt Marsh	PUC
		Verrucaria		Splash Zone	VER
	Lower Intertidal & Nearshore Subtidal		*Balanus glandula* *Semibalanus balanoides*	Barnacle	BAR
		Semibalanus carriosus		Barnacle	BAR
			Fucus distichus	Rockweed	FUC
		Mytilus trossulus		Blue Mussel	BMU
			Ulva spp.	Green Algae	ULV
		Bleached mixed red algae		Bleached Red Algae	HAL
		Mixed red algae including *Odonthalia*		Red Algae	RED
		Alaria 'marginata' morph		Alaria	ALA
		Zostera marina		Eelgrass	ZOS
		Saccharina latissima		Soft Brown Kelps	SBR
			Nereocystis luetkeana	Bull Kelp	NER
		Macrocystis integrifolia		Giant Kelp	MAC
Protected (P) & Very Protected (VP)	Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
			Carex spp.	Sedges	SED
			Puccinellia sp.	Salt Marsh	PUC
			Plantago maritima	Salt Marsh	PUC
			Glaux maritima	Salt Marsh	PUC
		Verrucaria		Splash Zone	VER
			Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
			Fucus distichus	Rockweed	FUC
		Mytilus trossulus		Blue Mussel	BMU
	Lower Intertidal & Nearshore Subtidal	*Ulva* spp.		Green Algae	ULV
		Zostera marina		Eelgrass	ZOS
		Saccharina latissima		Soft Brown Kelps	SBR

Table B-10. Expanded descriptions for HABITAT CLASS, SECONDARY HABITAT CLASS, and RIPARIAN fields of the BIOUNIT table.

Attribute	Description
HAB_CLASS	**Habitat Class** attribute is a classification of the biophysical characteristics of an entire unit, and provides a single attribute that describes the typical intertidal biota and the associated biological wave exposure together with the geomorphology. That is, a typical example of a Habitat Class includes a combination of biobands, and their associated indicator species (which determine the Biological Exposure category) and the geomorphological features of the Habitat Class. The biological mapper observes and records the biobands in the unit, if any, and determines the Biological Exposure Category (EXP_BIO). The Habitat Class is determined on the basis of presence/absence of biobands, exposure category, geomorphology, and spatial distribution of biota within the unit. Within the database, both a numeric code and an alpha code are used. Both codes for Habitat Class are listed in Table B-11, in which the matrix includes all combinations of Dominant Structuring Process, with associated substrate mobility and general geomorphic type on the vertical axis, and Biological Exposure on the horizontal axis.
HAB_CLASS2	The '**Secondary Habitat Class**' was added as an attribute in the BioUnit Table during biological mapping of the Kodiak Archipelago in order to specifically identify lagoon habitats. Many backshore lagoons were observed in the Kodiak region, and they represent an unusual coastal habitat that differs from other estuaries and marshes. Units classified as lagoons contain brackish or salt water contained in a basin with limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal. Single units classified as lagoons often have the lagoon form in the A zone; however, some lagoons are large and may encompass several units when the lagoon form is mapped as the C zone.
RIPARIAN_PERCENT	As an attribute in the BIOUNIT table, the **Riparian_Percent** value is intended to be an index for the potential habitat for upper beach spawning fishes. The value recorded in the **Riparian_Percent** field is an estimate of the percentage of the unit's total alongshore length in which riparian vegetation (trees and shrubs) shades the upper intertidal zone. Shading of the highest high water line is a good estimate of riparian shading; therefore, shading of wetland herbs and grasses is not included in the estimate, nor is any shading of the splash zone alone. Shading must be visible in the upper intertidal zone, and the shading vegetation must be woody trees or shrubs. Riparian overhanging vegetation is also an indicator of lower wave exposures, in which the splash zone is narrow. Shading may occur in on sediment-dominated or in rocky intertidal settings.

Table B-11. Codes for HABITAT CLASS and SECONDARY HABITAT CLASS attributes, in the BIOUNIT table.

Dominant Structuring Process	Substrate Mobility	Coastal Type	Description	Biological Exposure Category					
				Very Exposed (VE)	Exposed (E)	Semi-Exposed (SE)	Semi-Protected (SP)	Protected (P)	Very Protected (VP)
Wave energy	Immobile	Rock or Rock & Sediment or Sediment	The epibiota in the immobile mobility categories is influenced by the wave exposure at the site. In high wave exposures, only solid bedrock shorelines will be classified as 'immobile'. At the lowest wave exposures, even pebble/cobble beaches may show lush epibiota, indicating an immobile Habitat Class.	10 VE_I	20 E_I	30 SE_I	40 SP_I	50 P_I	60 VP_I
	Partially Mobile	Rock & Sediment or Sediment	These units describe the combination of sediment mobility observed. That is, a sediment beach that is bare in the upper half of the intertidal with biobands occurring on the lower beach would be classed as 'partially mobile'. This pattern is seen at moderate wave exposures. Units with immobile bedrock outcrops intermingled with bare mobile sediment beaches, as can be seen at higher wave exposures, could also be classified as 'partially mobile'.	11 VE_P	21 E_P	31 SE_P	41 SP_P	51 P_P	61 VP_P
	Mobile	Sediment	These categories are intended to show the 'bare sediment beaches', where no epibenthic macrobiota are observed. Very fine sediment may be mobile even at the lowest wave exposures, while at the highest wave exposures; large-sized boulders will be mobile and bare of epibiota.	12 VE_M	22 E_M	32 SE_M	42 SP_M	52 P_M	62 VP_M
Fluvial/ Estuarine processes		Estuary	Units classified as the 'estuary' types always include salt marsh vegetation in the upper intertidal, are always associated with a freshwater stream or river and often show a delta form. Estuary units are usually in lower wave exposure categories.	13 VE_E	23 E_E	33 SE_E	43 SP_E	53 P_E	63 VP_E
Current energy		Current-Dominated	Species assemblages observed in salt-water channels are structured by current energy rather than by wave energy. Current-dominated sites are limited in distribution and are rare habitats.	14 VE_C	24 E_C	34 SE_C	44 SP_C	54 P_C	64 VP_C
Glacial processes		Glacier	In a few places in coastal Alaska, saltwater glaciers form the intertidal habitat. These Habitat Classes are rare and include a small percentage of the shoreline length.	15 VE_G	25 E_G	35 SE_G	45 SP_G	55 P_G	65 VP_G
Anthropogenic		Anthropogenic – Impermeable	Impermeable modified Habitats are intended to specifically note units classified as Coastal Class 33. These Habitat Classes are rare and include a small percentage of the shoreline length.	16 VE_X	26 E_X	36 SE_X	46 SP_X	56 P_X	66 VP_X
		Anthropogenic – Permeable	Permeable modified Habitats are intended to specifically note shore units classified as Coastal Class 32. These Habitat Classes are rare and include a small percentage of the shoreline length.	17 VE_Y	27 E_Y	37 SE_Y	47 SP_Y	57 P_Y	67 VP_Y
Lagoon		Lagoon	Units classified as Lagoons in the Secondary Habitat Class contain brackish or salty water that is contained within a basin that has limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal.	18 VE_L	28 E_L	38 SE_L	48 SP_L	58 P_L	68 VP_L

Shaded boxes are not applicable in most regions

Table B-12. Definitions of fields and attributes in the XSHR (Across-shore) component table (after Howes *et al* 1994).

Field Name	Description
UnitRecID	**Unit Record ID:** An automatically-generated number field; the database "primary key" for unit-level relationships
XshrRecID	**Across-shore Record ID:** Automatically-generated number field; the database "primary key" for across-shore relationships
PHY_IDENT	**Physical Ident** is a unique code to identify each unit, assigned by physical mapper; defined as an alphanumeric string determined by the codes for: Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0
CROSS_LINK	**Crosslink code:** Unique identifier for each across-shore record, consisting of an alphanumeric string comprised of the PHY_IDENT followed by the Zone and Component separated by slashes (e.g. 12/03/0552/0/A/1)
ZONE	Across-shore **Zone:** Code indicating the across-shore position (tidal elevation) of the Component: (A) supratidal, (B) intertidal, (C) subtidal
COMPONENT	Across-shore **Component:** a subdivision of Zones, numbered from highest to lowest elevation in across-shore profile (e.g. A1 is the highest supratidal component; B1 is the highest intertidal; B2 is lower intertidal)
Form1	**Form1:** The principal geomorphic feature within across-shore Component, described by a specific set of codes (Table B-10)
MatPrefix1	**Material Prefix:** Veneer indicator field; blank = no veneer; "v" = veneer
Mat1	**Material** (substrate and/or sediment type) that best characterizes Form1, described by a specific set of codes (Table B-11)
FormMat1Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form1 and Mat1 into text
Form2	**Form2:** Secondary geomorphic feature within across-shore Component, described by a specific set of codes (Table B-10)
MatPrefix2	**Material Prefix:** Veneer indicator field; blank = no veneer; "v" = veneer
Mat2	**Material** (substrate and/or sediment type) that best characterizes Form2, described by a specific set of codes (Table B-11)
FormMat2Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form2 and Mat3 into text
Form3	**Form3:** Tertiary geomorphic feature within each across-shore component, described by a specific set of codes (Table B-10)
MatPrefix3	**Material Prefix:** Veneer indicator field; blank = no veneer; "v" = veneer
Mat3	**Material** (substrate and/or sediment type) that best characterizes Form3, described by a specific set of codes (Table B-11)
FormMat3Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form3 and Mat3 into text
Form4	**Form4:** Fourth-order geomorphic feature within each across-shore component, described by a specific set of codes (Table B-10)
MatPrefix4	**Material Prefix:** Veneer indicator field; blank = no veneer; "v" = veneer
Mat4	**Material** (substrate and/or sediment type) that best characterizes Form4, described by a specific set of codes (Table B-11)
FormMat4Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form4 and Mat4 into text
WIDTH	**Width:** Estimated mean across-shore width of the component (e.g. A1) in meters
SLOPE	**Slope:** Estimated across-shore slope of the mapped geomorphic Form in degrees; must be consistent with Form codes (Table B-10)
PROCESS	**Coastal Process** dominant in affecting the morphology: (F)luvial, (M)ass wasting (landslides), (W)aves, (C)urrents, (E)olian (wind, as with dunes) (O)ther
COMPONENT_ORI	**Component Oil Residence Index** on the basis of substrate type; 1 is least persistent, 5 is most persistent (Tables B-5 and B-6)

Table B-13. Definitions of FORM attributes, in XSHR (Across-shore) table (after Howes *et al* 1994).

A = Anthropogenic
- a pilings, dolphin
- b breakwater
- c log dump
- d derelict shipwreck
- f float
- g groin
- i cable/ pipeline
- j jetty
- k dyke
- m marina
- n ferry terminal
- o log booms
- p port facility
- q aquaculture
- r boat ramp
- s seawall
- t landfill, tailings
- w wharf
- x outfall or intake
- y intake

B = Beach
- b berm (intertidal or supratidal)
- c washover channel
- f face
- i inclined (no berm)
- m multiple bars / troughs
- n relic ridges, raised
- p plain
- r ridge (single bar; low to mid intertidal)
- s storm ridge (occas marine influence; supratidal)
- t low tide terrace
- v thin veneer over rock (also use as modifier)
- w washover fan

C = Cliff
stability/geomorphology
- a active/eroding
- p passive (vegetated)
- c cave

slope
- i inclined (20°-35°)
- s steep (>35°)

[continued]

Cliff continued
height
- l low (<5m)
- m moderate (5-10m)
- h high (>10m)

modifiers (optional)
- f fan, apron, talus
- g surge channel
- t terraced
- r ramp

D = Delta
- b bars
- f fan
- l levee
- m multiple channels
- p plain (no delta, <5°)
- s single channel

E = Dune
- b blowouts
- i irregular
- n relic
- o ponds
- r ridge/swale
- p parabolic
- v veneer
- w vegetated

F = Reef
(no vegetation)
- f horizontal (<2°)
- i irregular
- r ramp
- s smooth

I = Ice
- g glacier

L = Lagoon
- o open
- c closed

M = Marsh
- c tidal creek
- e levee
- f drowned forest
- h high
- l mid to low (discontinuous)
- o pond
- s brackish, supratidal

O = Offshore Island
(not reefs)
- b barrier
- c chain of islets
- t table shaped
- p pillar/stack
- w whaleback

elevation
- l low (<5m)
- m moderate (5-10m)
- h high (>10m)

P = Platform
(slope <20°)
- f horizontal
- g surge channel
- h high tide platform
- i irregular
- l low tide platform
- r ramp (5-19°)
- t terraced
- s smooth
- p tidepool

R = River Channel
- a perennial
- i intermittent
- m multiple channels
- s single channel

T = Tidal Flat
- b bar, ridge
- c tidal channel
- e ebb tidal delta
- f flood tidal delta
- l levee
- p tidepool
- s multiple tidal channels
- t flats

Table B-14. Definitions of the MATERIALS attributes, in XSHR (Across-shore) table (after Howes *et al* 1994).

A = Anthropogenic

a	metal (structural)
c	concrete (loose blocks)
d	debris (man-made)
f	fill, undifferentiated mixed
o	concrete (solid cement blocks)
r	rubble, rip rap
t	logs (cut trees)
w	wood (structural)

B = Biogenic

c	coarse shell
f	fine shell hash
g	grass on dunes
l	dead trees (fallen, not cut)
o	organic litter
p	peat
t	trees (living)

C = Clastic

a	angular blocks (>25cm diameter)
b	boulders (rounded, subrounded,>25cm)
c	cobbles
d	diamicton (poorly-sorted sediment containing a range of particles in a mud matrix)
f	fines/mud (mix of silt/clay, <0.0.63 mm diameter)
g	gravel (unsorted mix pebble, cobble, boulder >2 mm)
k	clay (compact, finer than fines/mud, <4 μm diameter)
p	pebbles
r	rubble (boulders>1 m diameter)
s	sand (0.063 to 2 mm diameter)
$	silt (0.0039 to 0.063 mm)
x	angular fragments (mix of block/rubble)
v	sediment veneer (used as modifier)

R = Bedrock

rock type:

i	igneous
m	metamorphic
s	sedimentary
v	volcanic

rock structure:

1	bedding
2	jointing
3	massive

SEDIMENT TEXTURE
(Simplified from Wentworth grain size scale)

GRAVELS

boulder	> 25 cm diameter
cobble	6 to 25 cm diameter
pebble	0.5 cm to 6 cm diameter

SAND

very fine to very coarse:
0.063 mm to 2 mm diameter

FINES ("MUD")

includes silt and clay

silt	0.0039 to 0.063 mm
clay	<0.0039 mm

TEXTURE CLASS BREAKS

sand / silt	63 μm (0.063 mm)
pebble / granule	0.5 cm (5 mm)
cobble / pebble	6 cm
boulder / cobble	25 cm

SHORE MODIFICATIONS

WB	wooden bulkhead
BR	boat ramp
CB	concrete bulkhead
LF	landfill
SP	sheet pile
RR	riprap

% are 0-10 (default value 0)

Note: The 'Material' descriptor consists of one primary term code, followed by codes for associated modifiers (e.g. Cbc). If only one modifier is used, indicated material comprises 75% of the volume of the layer (e.g. Cb), if more than one modifier, they are ranked in order of volume. A surface layer can be described by prefix *v* for veneer (e.g. vCs/R).

Table B-15. Definitions for fields in the BIOBAND table. *

Field	Description
UnitRecID	Automatically-generated number field; the database "primary key" required for relationships between tables
XshrRecID	Automatically-generated number field; the database "primary key" required for relationships between tables
PHY_IDENT	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0)
CROSS_LINK	Unique alphanumeric identifier of component made up of: REGION, AREA, PHYS_UNIT, SUBUNIT, ZONE and COMPONENT fields
VER	Bioband for Splash Zone (black lichen **VER***ucaria*) in supratidal (Table B-16)
GRA	Bioband code for Dune **GRA**ss in supratidal (Table B-16)
SED	Bioband for **SED**ges in supratidal (Table B-16)
SAL	Bioband for Salt Marsh grasses, including **SAL***icornia* and other salt tolerant grasses, herbs and sedges, in supratidal (Table B-16)
BAR	Bioband for **BAR**nacle (*Balanus/Semibalanus*) in upper intertidal (Table B-16)
FUC	Bioband for Rockweed, the **FUC***us*/barnacle in upper intertidal (Table B-16)
ULV	Bioband for Green Algae, including mixed filamentous and foliose greens (**ULV***a* sp*., Cladophora, Acrosiphonia*) in mid-intertidal (Table B-16)
BMU	Bioband for **B**lue **MU**ssel (*Mytilus trossulus*) in mid-intertidal (Table B-16)
OYS	Bioband for **OYS**ters (*Crassostrea gigas*) in mid-intertidal (Table B-16)
HAL	Bioband for Bleached Red Algae, including mixed filamentous and foliose reds (*Palmaria, Odonthalia*, **HAL***osaccion*) in mid-intertidal (Table B-16)
RED	Bioband for **RED** Algae, including mixed filamentous and foliose reds (*Odonthalia, Neorhodomela, Palmaria*) in lower intertidal (Table B-16)
SBR	Bioband for **S**oft **BR**own Kelps, including unstalked large-bladed laminarians, in lower intertidal and nearshore subtidal (Table B-16)
CHB	Bioband for Dark Brown Kelps, including stalked bladed dark **CH**ocolate-**B**rown kelps in lower intertidal and nearshore subtidal (Table B-16)
SUR	Bioband for **SUR**fgrass (*Phyllospadix*) in lower intertidal and nearshore subtidal (Table B-16)
ZOS	Bioband for **ZOS***tera* (Eelgrass) in lower intertidal and subtidal (Table B-16)
URC	Bioband for **URC**hin Barrens (*Strongylocentrotus fransicanus*) in nearshore subtidal (Table B-16)
MAC	Bioband for Giant Kelp (**MAC***rocystis integrifolia*) in nearshore subtidal (Table B-16)
NER	Bioband for Bull Kelp (**NER***eocystis luetkeana*) in nearshore subtidal (Table B-16)

* Occurrences code for biobands observed are listed in Table B-17.

Table B-16. Definitions for BIOBAND attribute for Southeast Alaska, in BIOBAND table.

Zone	Bioband		Color	Indicator Species	Physical Description	Biological Wave Exposure	Associate Species
	Name	Code					
A	**Splash Zone**	**VER**	Black or bare rock	*Verrucaria* sp. Encrusting black lichens	Visible as a dark stripe, on bare rock, marking the upper limit of the intertidal zone. This band is observed on bedrock, or on low energy boulder/cobble shorelines. This band is recorded by width: Narrow (N), Medium (M) or Wide (W)	VP to VE	*Littorina* sp.
A	**Dune Grass**	**GRA**	Pale blue-green	*Leymus mollis*	Found in the upper intertidal zone, on dunes or beach berms. This band is often the only band present on high-energy beaches.	P to E	
A	**Sedges**	**SED**	Bright green, yellow-green to red-brown.	*Carex lynbyei*	Appears in wetlands around lagoons and estuaries. Usually associated with freshwater. This band can exist as a wide flat pure stand or be intermingled with dune grass. Often the PUC band forms a fringe below.	VP to SP	*Carex* spp.
A	**Salt Marsh**	**SAL**	Light, bright, or dark green, with red-brown	*Salicornia virginica*	Appears around estuaries, marshes, and lagoons. Usually associated with freshwater. Often fringing the edges of GRA and SED bands. SAL can be sparse *Salicornia* on coarse sediment or a wetter, peaty meadow with assemblage of herbs and sedges.	VP to SE	*Carex* spp. Other salt tolerant grasses and herbs
upper B	**Barnacle**	**BAR**	Grey-white to pale yellow	*Balanus glandula* *Semibalanus cariosus*	Visible on bedrock or large boulders. Can form an extensive band in higher exposures where algae have been grazed away.	P to E	*Endocladia muricata* *Gloiopeltis furcata* *Porphyra* sp. *Fucus distichus*
upper B	**Rockweed**	**FUC**	Golden-brown	*Fucus distichus*	Appears on bedrock cliffs and boulder, cobble or gravel beaches. Commonly occurs at the same elevation as the barnacle band.	P to SE	*Balanus glandula* *Semibalanus cariosus* *Ulva* sp. *Pilayella* sp.
B	**Green Algae**	**ULV**	Green	*Ulva sp.* *Monostroma sp.* *Cladophora sp.* *Acrosiphonia sp.*	Found on a variety of substrates. This band can consist of filamentous and/or foliose green algae. Filamentous species often form a low turf of dark green.	P to E	*Filamentous red algae*

[continued]

Table B-16. Definitions for BIOBAND attribute for Southeast Alaska, in BIOBAND table. (continued)

Zone	Bioband		Color	Indicator Species	Physical Description	Exposure	Associate Species
	Name	Code					
B	**Blue Mussel**	**BMU**	Black or blue-black	*Mytilus trossulus*	Visible on bedrock and on boulder, cobble or gravel beaches. Appears in dense clusters that form distinct black patches or bands, either above or below the barnacle band.	P to VE	*Fucus distichus* *Balanus glandula* *Semibalanus cariosus* Filamentous red algae
B	**Oyster**	**OYS**	White	*Crassostrea gigas*	Appears in dense clusters on bedrock that form distinct white patches, often amidst the rockweed band.	P to SP	*Fucus distichus*
B	**Bleached Red Algae**	**HAL**	Olive, golden or yellow-brown	*Bleached foliose red algae* *Palmaria* sp. *Odonthalia* sp.	Common on bedrock platforms, and cobble or gravel beaches. Distinguished from the RED band by color. The bleached color usually indicates lower wave exposure than where the RED band is observed, and may be caused by nutrient deficiency.	P to SE	*Halosaccion glandiforme* *Mazzaella* sp. Filamentous green algae
B	**Red Algae**	**RED**	Corallines: pink or white Foliose or filamentous: Dark red, bright red, or red-brown.	*Corallina* sp. *Lithothamnion* sp. *Neoptilota* sp. *Odonthalia* sp. *Neorhodomela* sp. *Palmaria* sp. *Mazzaella* sp.	Appears on most substrates except fine sediments. Lush coralline algae indicates highest exposures; diversity of foliose red algae indicates medium to high exposures, and filamentous species, often mixed with green algae, occur at medium and lower exposures.	P to VE	*Pisaster* sp. *Nucella* sp. *Katharina tunicata* Large brown kelps of the CHB bioband
B & C	**Soft Brown Kelps**	**SBR**	Yellow-brown, olive brown or brown.	*Sargassum muticum* *Saccharina latissima* *Agarum* sp.	This band is defined by non-floating large browns and can form lush bands in semi-protected areas. The kelp fronds have a ruffled appearance and can be encrusted with diatoms and bryozoans giving the blades a 'dusty' appearance.	VP to SE	*Saccharina sessile* (bullate)

[continued]

Table B-16. Definitions for BIOBAND attribute for Southeast Alaska, in BIOBAND table. (continued)

Zone	Bioband		Color	Indicator Species	Physical Description	Exposure	Associate Species
	Name	Code					
B & C	**Dark Brown Kelps**	**CHB**	Dark chocolate brown	*Alaria* spp. *Pterygophora* sp.	Found at higher wave exposures, these stalked kelps grow in the lower intertidal. Blades are leathery, shiny, and smooth. A mixture of species occurs at the moderate wave exposures, while single-species stands often occur at high exposures.	SE to VE	Filamentous and foliose red algae
B & C	**Surfgrass**	**SUR**	Bright green	*Phyllospadix* sp.	Appears in tide pools on rock platforms, often forming extensive beds. This species has a clearly defined upper exposure limit of Semi-Exposed and its presence in units of Exposed wave energy indicates a wide across-shore profile, where wave energy is dissipated by wave run-up across the broad intertidal zone.	SP to SE	Foliose and coralline red algae
B & C	**Eelgrass**	**ZOS**	Bright to dark green	*Zostera marina*	Commonly visible in estuaries, lagoons or channels, generally in areas with fine sediments. Eelgrass can occur in sparse patches or thick dense meadows.	VP to SP	*Pilayella* sp.
C	**Urchin Barrens**	**URC**	Coralline white, underwater	*Strongylocentrotus franciscanus*	Shows rocky substrate clear of macroalgae. Often has a pink-white color of encrusting coralline red algae. May or may not see urchins.	SP to SE	Encrusting invertebrates
C	**Giant Kelp**	**MAC**	Golden-brown	*Macrocystis integrifolia*	Canopy-forming giant kelp, long stipes with multiple floats and fronds. If associated with NER, it occurs inshore of the bull kelp.	P to SE	*Nereocystis luetkeana* *Alaria fistulosa*
C	**Bull Kelp**	**NER**	Dark brown	*Nereocystis luetkeana*	Distinctive canopy-forming kelp with many long strap-like blades growing from a single floating bulb atop a long stipe. Can form an extensive canopy in nearshore habitats, usually further offshore than *Alaria fistulosa* and *Macrocystis*. Often indicates higher current areas if observed at lower wave exposures.	SP to VE	*Alaria fistulosa* *Macrocystis integrifolia*

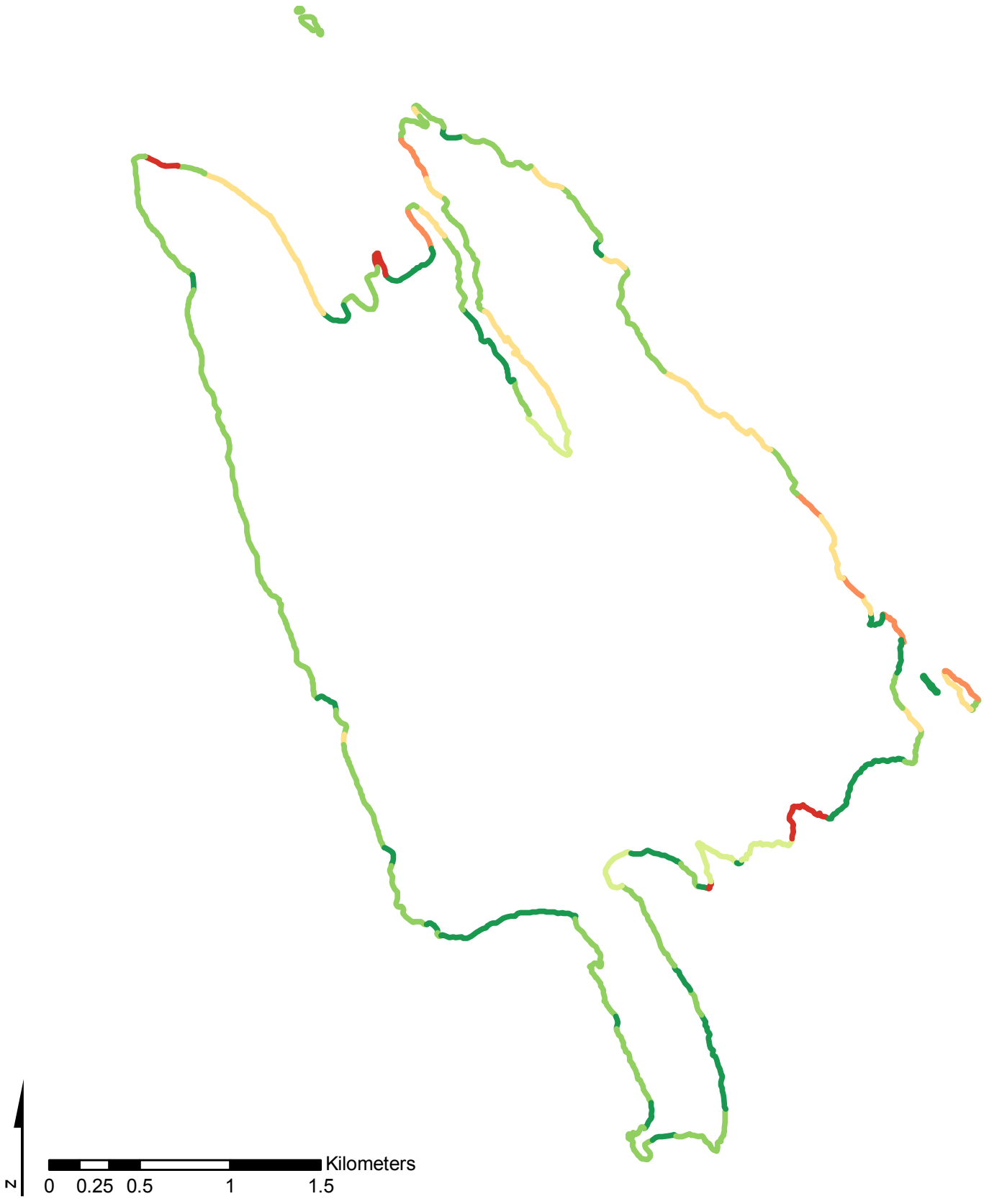
Table B-17. Definitions for Occurrences of Biobands, in the BIOBAND table. *

Value		Applicable Bioband	Definition
Name	**Code**		
Patchy	P	All biobands *except* VER	Bioband visible in less than half (approximately 25 – 50%) of the along-shore unit length
Continuous	C	All biobands *except* VER	Bioband visible in more than half (approximately 50-100%) of the along-shore unit length
Narrow	N	VER *only*	Bioband visible at an across-shore width of up to 2 meters
Medium	M	VER *only*	Bioband visible at an across-shore width of between 2 and 5 meters
Wide	W	VER *only*	Bioband visible at an across-shore width of greater than 5 meters

* Note that a Blank or Null value for the bioband indicates that band was not observed within the unit.

Table B-18. Definitions for fields in the PHOTOS table.

Field Name	Description
SlideID	**SlideID**: A unique numeric ID assigned to each slide or photo
UnitRecID	**Unit Record ID**: Automatically-generated number field; the database "primary key" required for relationships between tables, links to Unit table
SlideName	**Photo Name:** A unique alphanumeric name assigned to each slide or photo
ImageName	**Full Photo Name:** Full image name with .jpg extension (required to enable "PhotoLink")
TapeTime	**Photo Time:** Exact time during aerial video imaging (AVI) survey when digital image was collected; used to link photo to digital trackline and position
SlideDescription	**Photo Comment:** Text field for biological comments regarding the digital photo or slide
Good Example?	**Yes/No** field, which when set to "Yes," indicates the photo is good representative of a particular biological feature or classification type
ImageType	**Photo Image Type:** Media type of original image: "Digital" or "Slide"
FolderName	**Photo Folder Name:** Name of the folder in which digital images are stored (required to enable "PhotoLink")
PhotoLink	**Photo Hyperlink:** Enables linkage to photos placed in directories near the database
PHY Good Example?	**Yes/No** field, which when set to "Yes," indicates the photo is representative of a particular geomorphic feature or classification
PHY SlideComment	**Physical Photo Comment:** Text field for geomorphological comments regarding the digital photo or slide



Thetis Island Shore Zones

Shore Zone updates as provided by Archipelago Marine Research Ltd.

- Altered
- Cliff
- Coastal Banks or Bluffs
- Estuary
- Low Rock / Boulder
- Sand / Cobble