Review of Thetis Island Shoreline Classification and Recommendations for Shoreline Development

Rev A

March 31, 2010

Prepared by: Pam Thuringer M.Sc., R.P.Bio
Brian Emmett M.Sc., R.P.Bio
Archipelago Marine Research Ltd.
525 Head Street
Victoria, BC
V9A 5S1

Prepared for: Chris Jackson M.C.I.P.
Regional Planning Manager
Islands Trust, Northern Office
700 North Road
Gabriola Island, BC
V0R 1X3

ARCHIPELAGO
MARINE RESEARCH LTD.

REVISION HISTORY

Version	Date	Author	Notes
Rev A	March 31, 2010	P. Thuringer B. Emmett	Prepared as a discussion document for Islands Trust

DISTRIBUTION

Chris Jackson, Regional Planning Manager, Islands Trust, Northern Office.

Table of Contents

1.0 INTRODUCTION AND OBJECTIVES

Islands Trust and the Thetis Island Local Trust Committee are conducting a review of the Official Community Plan (OCP) and Land Use Bylaws for Thetis Island. An aspect of this review is the adequacy of shoreline inventory information and management guidance within the OCP and associated bylaws. To inform this review process Islands Trust engaged Archipelago Marine Research Ltd. to review existing coastal inventory datasets for Thetis Island and provide comment on the utility of this information for shoreline management purposes. The specific objectives of this assignment were to:

1. Review existing aerial video shoreline survey and classification (ShoreZone) datasets conducted by the Province of BC and subsequently Parks Canada.
2. Review recently completed Shorelands mapping of Thetis Island conducted by the UBC School of Landscape Architecture and provide a comparison of this information with the ShoreZone dataset.
3. Provide comment and recommendations on potential use of this information for shoreline management purposes, including reference to other local government experience with using this type of information for Development Permit Area designations.
4. Provide comment on the potential for Thetis Island or other Islands Trust regions to participate in the Green Shores for Homes program currently proposed for the City of Seattle and San Juan Country in Washington State.

2.0 SHOREZONE REVIEW

2.1 GENERAL

The Province of British Columbia, through the RIC standard ShoreZone program, has systematically collected 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 and, at that time, there was no biotic mapping component (i.e., no commentary on the aerial survey providing real time descriptions of biobands[1] and no oblique aerial 35mm slide imagery or photographs of the shoreline were collected) Therefore only the physical aspects were mapped. Appendix Table 1 summarizes the physical attributes available from the 1979 ShoreZone database.

The bioband data was added in 1998 following a review of the 1979 imagery as well as shore station data from 100 stations collected from 1996 to 1998 in the southern Strait of Georgia Shore and modelling of intertidal species assemblages, habitat types and oceanographic characteristics of the Strait of George (Morris 2000). Appendix Table 2 summarizes the biotic attributes available from the 1979 ShoreZone database for the Strait of Georgia.

[1] Bioband is defined as an observed assemblage of coastal biota, which grows in a typical across-shore elevation, and at characteristic wave energies and substrate conditions. Bands are spatially distinct, with alongshore and across-shore patterns of color and texture that are visible in aerial imagery. Biobands are named for the dominant species or group that best represents the entire band

New aerial video imagery of the Thetis Island shoreline was collected in 2004 as part of the Southern Strait of Georgia National Marine Conservation (NMCA) initiative. Although the imagery for Thetis Island has not been classified, 78 high resolution geo-referenced digital photos of Thetis Island are available online (http://www.shim.bc.ca/gulfislands/atlas.htm; Appendix Figure 1). The video imagery (DVD format) and original digital photos with GPS locations can be made available pending permission from Parks Canada.[2]

2.2 SHORE UNITS AND SHORE TYPES

A **shore unit** is defined as an association of one or more across shore components or processes that are continuous alongshore within a unit. A shoreline 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.

A total of 29 **shore units** (total shoreline length approximately 27 km) were classified for the 1979 imagery for Thetis Island, with the unit shoreline length varying between 150 and 3,200 m (average = 930 m). Subunits were identified within four of the units. Table 1 provides a breakdown of **shore units** by shoreline length. The majority of units (66%) are <1.0 km in length and, of those, 58% are <0.5 km in length. For comparison, the average unit length for 782 km of mapped shoreline in the southern Strait of Georgia NMCA mapping project for Parks Canada in 2004/2005 (Vancouver Island from Gonzales Island to Crofton and southern Gulf Islands from Saltspring Island south) was 187m (CORI and AMR 2005).

Table 1. Number of units mapped by unit length.

Unit Length	# of Units
<1 km	19
1- 2 km	7
2 -3 km	0
>3 km	3

Table 2 summarizes the shoreline types (= coastal class) classified for Thetis Island. The coastal class is defined by substrate, sediment, width and slope. Of the 34 shore types[3] used in the classification system (see Appendix Table 3), 11 were identified for Thetis Island. Table 2 summarizes shore type by units. Figure 1 shows the units and associated coastal classes.

[2] Video imagery can be classified to RIC (Resource Inventory Committee) standards for $100/km by a geologist from Coastal and Ocean Resources Inc. and biologist from Archipelago Marine Research Ltd.
[3] In 1979, there were 33 coastal classes identified. The data from 1979 was updated to match the coastal classes currently used as shown in Appendix Table 2.

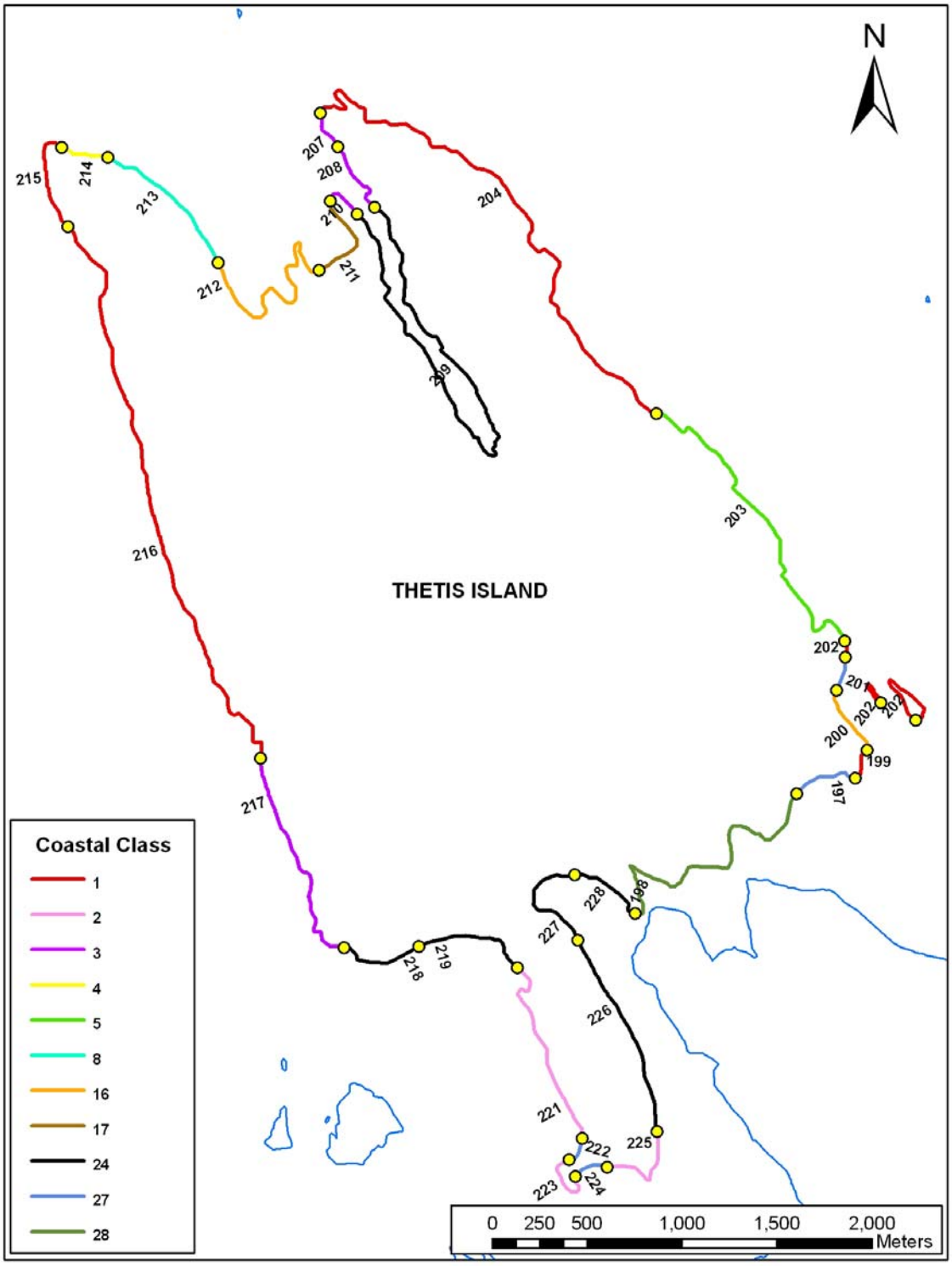


Figure 1. Map of Thetis Island showing the shore units (numbered on map) and their coastal class classification from the 1979 ShoreZone database (see Table 2 for a description of the coastal classes).

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

Coastal Class	Substrate	Shoreline Type (Class)	# Units Identified
1	Rock	Rock Ramp >30m	5
2	Rock	Rock Platform, wide >30m	3
3	Rock	Rock Cliff, narrow <30m	4
4	Rock	Rock Ramp, narrow <30m	1
5	Rock	Rock Platform, narrow <30m	1
8	Rock + Sediment	Rock Cliff with Gravel Beach, narrow <30m	1
16	Rock + Sediment	Rock Ramp with Sand Beach, wide >30m	2
17	Rock + Sediment	Rock Platform with sand Beach, wide >30m	1
24	Sediment	Sand or Gravel Flat or Fan, wide >30m	6
27	Sediment	Sand beach, wide >30m	4
28	Sediment	Sand Flat, wide >30m	1

Detailed information on form[4] and material[5] are available for each unit. If an anthropogenic structure is present within a unit, presence but not precise location is noted. Within the 1979 ShoreZone data for Thetis Island one unit with an anthropogenic form (ferry terminal) and nine units with anthropogenic material (logs, man-made debris) were identified.

The bio-mapping attributes added to each unit at an across shore component level in 1998 are shown in Appendix Table 2. For Thetis Island, eight biobands[6] were identified and 15 of 29 units had between one and four classified biobands.

2.3 EXPOSURE

The exposure category in the physical attribute dataset provides a summary indicator of wave exposure for each unit. Six exposure categories have been utilized (exposed, very exposed, semi-exposed, semi-protected, protected and very protected) and they are derived from the knowledge of maximum fetch and modified effective fetch which are calculated using the fetch categories listed in Appendix Figure 1. The same matrix is used for definition of the biological exposure categories however those are defined by the biobands observed in the unit. Higher confidence is given to the observed biological exposure categories and this classification is used to determine the final exposure for the unit. Appendix Table 4 shows the exposure matrix used to determine the exposure categories summarized below.

In the 1979 ShoreZone dataset for Thetis Island, 12 of the units were classified as protected and 17 were classified as semi-protected based on the biology observed and the exposure matrix (Figure 2). Imagery classified for other areas from the southern Strait of Georgia for the NMCA project included a category (Habitat Class) that combines the biophysical characteristics observed for a particular shoreline unit (presence of biobands, exposure category, geomorphology) to provide a single attribute describing typical intertidal biota together with the

[4] Defined as morphological character or surface expression; includes primary codes and secondary modifiers; e.g. anthropogenic, ferry terminal or beach, storm ridge or cliff, eroding
[5] Defined as a physical descriptors; five primary codes plus modifiers; e.g. clastic, cobbles or biogenic, coarse shell
[6] Biobands include VER, SAL, BAR, BRE, FUC, OYS, ULV, SBR2, ZOS.

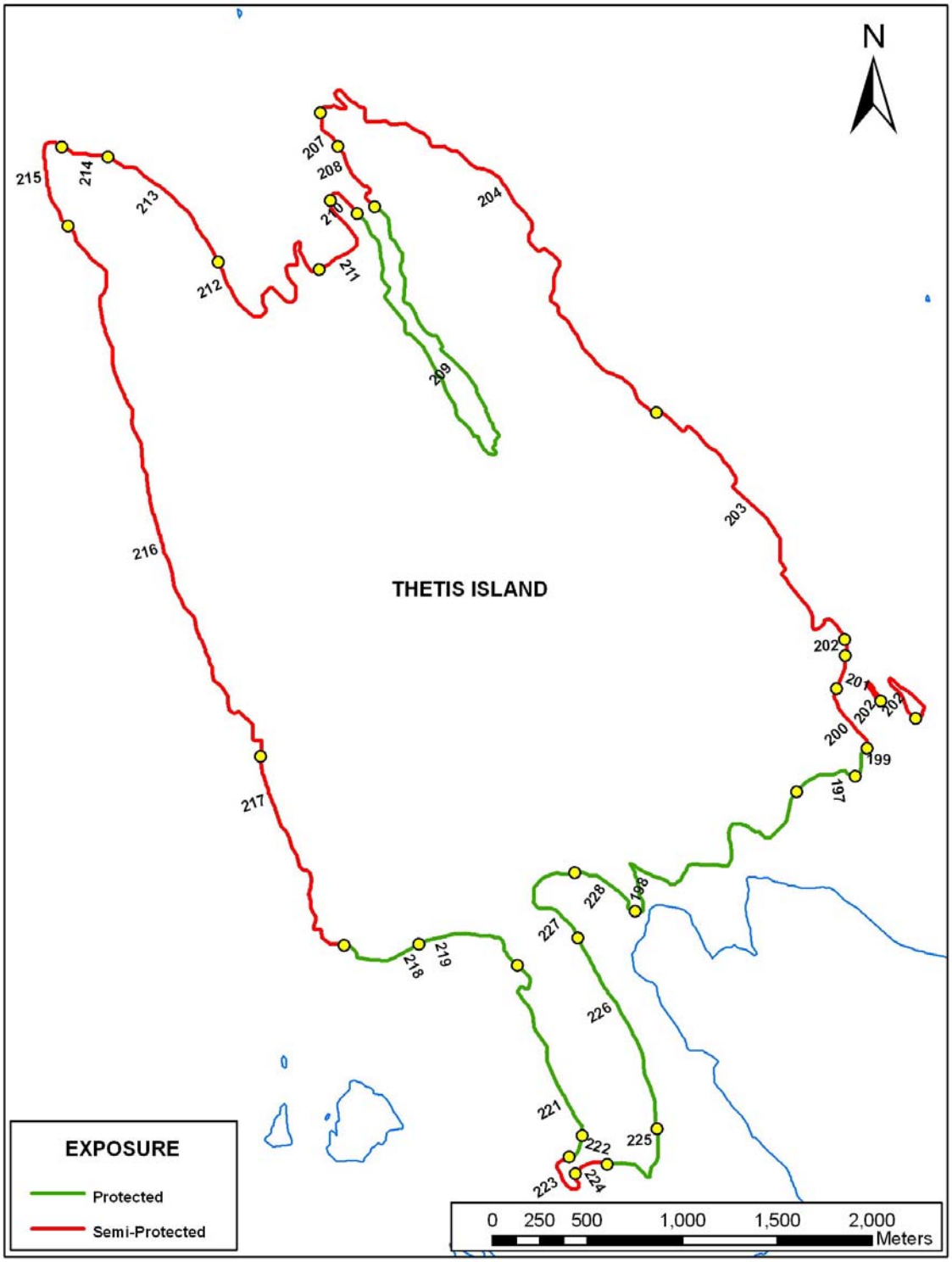


Figure 2. Map of Thetis Island showing the exposure category for each shore unit (numbered on map) from the 1979 ShoreZone database.

physical features of the shoreline (which includes substrate mobility classification and identification of structuring process, e.g., wave energy, current energy, fluvial/estuary process).

2.4 SEDIMENT TRANSPORT

As shown in Appendix Table 1, there are three sediment transport descriptors with secondary coding (source, abundance and direction[7]) that are classified by the geologist and are based on geomorphological indicators and/or published information on the general area. Although some locations in the Strait of Georgia from 1979 data set have data in those fields, none of the fields related to sediment transport are completed for Thetis Island. These fields have been completed for the southern Strait of Georgia NMCA imagery classified in 2004/2005. The same is true for the field identified as shoreline change (coded as accretional, erosional or stable) which is defined as an interpretative index of the shoreline stability based on an interpretation of geomorphology within the unit.

[7] Source is defined as the probable internal or external sources of unconsolidated material in the shore unit; abundance is defined as a qualitative index of sediment abundance within the shore unit; direction is defined as the dominant alongshore direction of sediment transport expressed as one of eight Cardinal compass points and indicating direction towards which sediment is transported.

3.0 UBC SHORELANDS REVIEW

3.1 GENERAL

In August 2009, students from the School of Landscape Architecture at the University of British Columbia under contract with Islands Trust completed a shoreline mapping pilot project for Thetis Island. Results were presented at an open house in the fall of 2009 as part of the review process for the Thetis Island OCP. The presentation material included poster boards with maps that include the following topics:

- description of coastline types, shoreline characteristics and development considerations,
- identification and distribution of coastline types,
- relative energy zones and shoreline dynamics,
- coastal and watershed systems (sediment sources, movement, sinks and ecosystems),
- coastal design strategies, and,
- coastline types and sighting in response to systems.

3.2 COASTAL TYPES

A total of six coastal types were identified for the Thetis Island shoreline. Five of the six coastal types are similar to those described in the Coastal Shore Stewardship Guide (http://www.stewardshipcentre.bc.ca/cdirs/st_series/index.php/17) with the sixth coastal type, hill slope, defined as ranging in angle from 10 to 60^0. Coastline types are generally classified as soft (estuary and sediment), hard (low rock/bolder, hill slope, cliff) or altered (the 7 options are depicted graphically but not defined). A total of 92 discrete units were identified with an additional 21 altered features[8] noted within those units. Table 3 provides a summary of coastline types identified. Data on the length of each unit was not included in the presentation material.

Table 3. Summary of coastal types classified for Thetis Island.

Coastal Type	# Identified
estuary	2
sediment	26
low rock/boulder	38
hill slope	9
cliff	17
altered	21

A description for each of the coastline types is provided, with the exception of the altered features, along with a representative photograph with the name of the geographic location. The descriptions include a summary of the characteristics of the coastline type such as information on the physical form and materials, shoreline dynamics, sediment processes, and sensitivity to disturbance. The descriptions include limited information on biological attributes of the shoreline.

[8] One altered feature identified in North Cove was identified as a stand alone unit.

3.2 EXPOSURE

Three exposure categories were identified for the Thetis Island shoreline; low (sheltered), medium and high (exposed) energy. These exposure categories are not defined however it appears that they are relative to each other and that the interpretation of each category (referred to as a "Zone") is based on a combination of wave energy and shoreline dynamics. A total of 35 along shore energy zones are identified with an additional six, very small, low energy zones identified shoreward of the 35 energy zones. The low energy zones are on the north and south side of the island and the six very small areas of low energy are on the east and west side of the island. Arrows are used to indicate shoreline change over time (shoreline accretes, "wobbles", or erodes) within some of the energy zones.

3.3 SEDIMENT TRANSPORT

The main graphic in the coastal and watershed system poster shows that the predominant along shore sediment flow is south to north around Thetis Island. In addition to the identification of the predominant sediment flow, arrows also depict localized sediment flow from coastal and watershed systems. A total of twelve areas have been identified as sediment sinks from watershed systems. A total of 21 areas have been identified as sediment sinks from coastal systems. There are no coastal system sediment sources identified on Thetis Island. Although discrete drift cells have not been identified, the data presented could be used to determine these areas (e.g., Washington State: http://www.kitsapgov.com/dcd/gis/maps/Standard_Maps/Environmental/Drift%20Cells2.pdf).

4.0 COMPARISON BETWEEN SHOREZONE AND SHORELANDS

Below is a comparison of the ShoreZone and Shoreland data:

1. ShoreZone classification encompasses the backshore and intertidal zone (with identification of some shallow subtidal features such as *Nereocystis* beds and urchin barrens) and Shorelands includes more of the uplands in some of the descriptions (e.g., hill slope). As a result, there is no shoreline type classification in ShoreZone that would be equivalent to the 'hill slope' coastal type from Shorelands, therefore it is difficult to directly compare the two[9]. However, aside from areas classified as 'hill slope' (which represents 10% of shoreline), there is general agreement between shoreline type and coastal type on a broader scale (e.g., areas with a sediment shoreline versus areas with rock).
2. Although there is a difference in how the exposure category in ShoreZone and the exposure zones in Shorelands is determined (e.g., wave exposure on a unit basis only, use of biological attributes in determination), generally the data shows that the protected areas on Thetis Island are on the north and south side of the island and the higher exposure ratings are on the east and west side of Thetis Island.
3. The sediment transport and shore stability data classification was not completed for ShoreZone so there is no data to compare to Shorelands. However, if the classification of the 2004 imagery included the unit based sediment transport and change categories discussed, this information could build on the Shorelands data and inform the designation of drift cells.

[9] For example, the shoreline shown in the photo of North Cove under the 'hill slope' coastal type in Shorelands was classified as a narrow rock cliff in ShoreZone.

5.0 APPLICATION TO SHORE GUIDANCE AND MANAGEMENT

Both ShoreZone and Shorelands provide relevant and important sets of information which can, and should, be applied to shoreline management. The following summarizes the strengths and weaknesses of each data set with respect to specific application for shore management.

5.1 SHOREZONE

ShoreZone is a coastal shore inventory dataset, providing information on a shore unit by shore unit basis. Information on larger scale coastal processes such as longshore drift, zones of accretion and erosion are not directly addressed but, in many cases, can be inferred from the shore unit information. Specifically ShoreZone provides detailed information on physical and biological features across the entire backshore and foreshore (to just below the low tide mark) in a classification system which can be analysed quantitatively. However the classified data set for Thetis Island is old (1979) and does not reflect changes to the shoreline over the last 30 years changes. The data set also does not fully reflect modifications to the ShoreZone classification system made since 1979. The ShoreZone data set, because it is detailed, can be challenging to summarize and interpret, making it difficult to use for management guidance or in an "over the counter" context.

Recommendation – Use of data categories such as shore type and exposure are very useful to verify and possible augment the ShoreLands information. The 1979 data set should be interpreted with caution and it is recommended that the more recent 2004 imagery be classified if this information is to be used for shoreline management or guidance purposes.

5.2 SHORELANDS

Shorelands also provides information on a shore unit basis, in less detail than ShoreZone, but also includes information on broader scale coastal processes as well as development considerations for the different shore (coastline) types. The following points are made with respect to application of Shorelands for shoreline management:

1. It addresses broader scale coastal processes and identifies areas of accretion and erosion, an important category of information for shore management guidance.
2. The small number (7) of coastline type categories are appropriate for management guidance, however the definition of the "Hill Slope" and "Cliff" categories are unclear and possibly not ideally suited for management guidance (see Point 5 below).
3. The emphasis of the Shorelands classification is on the backshore zone and physical features. An updated ShoreZone data set could be used to augment physical and biotic information for the intertidal zone.
4. It provides shoreline development considerations by coastline type, appropriate for management guidance from an environmental perspective, as sensitivity and vulnerability varies by shore type. See comments below on the development guidance for each specific coastline type.
5. In general, the "Development Considerations" address the key shore management issues; specifically impacts to (A) coastal processes, (B) sediment and water quality and (C) habitat sensitivity and conservation. The associated "Shoreline Dynamics" illustrations are useful to

demonstrate to property owners the time scale of change for the different shore types. However the colour bars below the time scale axis require definition and the time scales for "Hill Slope" and "Cliff" coastlines will be clearer if they are re-defined as recommended below. Specific comments on the "Development Considerations" given for each coastline type follow:

- *Estuary* – The development considerations provided identify key habitat sensitivities of estuaries. It is also important to point out that these areas are generally low lying and located in protected shores. As such vertical elevation requirements for built structures are an important shore management condition. Projected sea level rise is also an important consideration for these areas.
- *Sand/Cobble* – the development considerations identify sediment dynamics as a key management consideration for these shores. Specific development guidance for these shores is necessary with respect to permissible types and design of shore protection works as well as building setbacks
- *Low Rock/Boulder* - the development considerations given for this coastline type indentify the key issues and only require more specific detail for management guidance.
- *Hill Slope* – as discussed above the definition of this coastal type is ambiguous. This coastline type is defined by slope angle ($10\text{-}60^0$) but it is unclear if the definition applies to both unconsolidated *and* rocky slopes. Slopes formed of unconsolidated material (coastal banks and bluffs) have far greater development sensitivities that bedrock slopes or cliffs. The Hill Slope category should be re-defined as coastal banks and bluffs[10] and specific guidance provided for building setbacks, slope stability and means of managing erosion at the toe of the bank or bluff.
- *Cliff* – as with Hill Slopes the Cliff coastline type is defined by slope angle ($>60^0$) and appears to apply to both rock and unconsolidated slopes. The term cliff should apply only to rock slopes, which have management considerations similar to Low Rock/Boulder above with the added consideration of slope stability.

6. The "Coastal Design Strategies" provided are excellent graphical illustrations of key design issues, broadly applicable to the BC coast. They will be a valuable illustrative tool for shore management guidance.
7. The "Sighting in Response to Systems" figures are also informative, although more difficult to follow that the "Coastal Design Strategies" diagrams. In addition, the building siting sketches appear to underemphasize setback requirements, particularly for the Estuary, Sand/cobble and Hill side shore types.

[10] **Coastal Banks or Bluffs** – Steep coastal slopes formed of unconsolidated material (sand and gravels) which may conceal underlying rock formations, in contrast to a cliff where rock formations are exposed. Coastal banks are generally less then 5m in height and coastal bluffs greater that 5m in height.

Recommendation – the ShoreLands information provides excellent background material for the development of shoreline management guidance or regulation. The concept of providing this guidance on a shore (coastline) type basis is sound from an environmental perspective. It may be challenging to operationalize as varying setbacks and other development rules may be difficult for waterfront property owners to accept (a feeling of unequal development opportunity). If Shorelands is used for shoreline management purposes the following should be addressed:

- Ensure that the "Hill Slope" category applies only to coastal banks and buffs and the Cliff" category applied only to rock cliffs. The coastline type mapping shore should then be modified accordingly.
- More specific guidance or rules will have to be developed for each coastline type such as defined setbacks (or formula for determining a setback) and specific guidance for shore protection works (see the Robert's Creek and District of Central Saanich examples provided below).

6.0 REVIEW OF SHORE DEVELOPMENT GUIDENCE INITIATIVES

6.1 GENERAL

In 2006, Green Shores (www.greenshores.ca), a project of the Stewardship Centre of British Columbia (www.stewardshipcentre.bc.ca), undertook a review of local government shore management bylaw and policy language[11]. This review focused on language for Official Community Plans (OCPs) and Development Permit Areas, drawing from existing OCPs, DPAs and zoning bylaws in BC coastal communities as well as federal, state and country policy directives in Washington State. The report provides example OCP policy language and DPA development language from these sources, including language related to shore protection, docks and piers, fill and dredging. Section 4.10 and Appendix A of this report provides examples of local governments (District of Metchosin and District of North Saanich) which, at the time, had developed DPA guidelines based on shore types. Updates to this report are planned but, to date, have not been undertaken.

6.2 ROBERT'S CREEK – SUNSHINE COAST REGIONAL DISTRICT (SCRD)

The community of Robert's Creek (SCRD Area D) was an early Green Shores project case example[12]. The shoreline of Robert's Creek is predominately sand/cobble beach. Historically the area was a waterfront cottage community for Lower Mainland residents. Over the past several decades many of these older cottages have been converted to larger, year round residences, often in conjunction with modifications (including seawalls and rip rap protection works) to the shore. To inform the revision of the Robert's Creek OCP, the case example (A) documented and mapped the various coastal shore types (beach, bedrock and estuary), (B) outlined coastal processes and environmental sensitivities by shore type and (C) proposed shore management considerations by shore type. This work was very similar in scope and outcome to the Thetis Island Shorelands project.

The SCRD subsequently (2008) used this information to draft a Shore Development Permit Area Bylaw[13] based on the three designated shore types. The bylaw addressed setback requirements for new buildings, guidance for shore protection works and coastal riparian vegetation management. In response to waterfront property owners concerns, the draft DPA bylaw has been referred to Roberts Creek Greenshores Advisory Committee with the Committee mandated to make recommendations to SCRD as to how to proceed. First reading of the draft bylaw was planned for May, 2009. In response to waterfront property owners concerns, the draft DPA bylaw was referred to a Roberts Creek Greenshores Advisory Committee with the Committee mandated to make recommendations to SCRD as to how to proceed. An amended version passed third reading in December 2009 and is currently waiting provincial approval (Mark McMullen, SCRD, pers. comm.).

[11] The Green Shores Project (2006) Review of Shore Management Policy and Bylaw Language http://www.greenshores.ca/index.asp?type=single&section=Community%20Planning&sid=5&id=19

[12] The Green Shores Project (2007) Overview of Key Shore Management Issues and Green Shore Opportunities for Roberts Creek http://www.greenshores.ca/index.asp?type=single&section=Community%20Planning&sid=5&id=19

[13] http://www.scrd.ca/index.php?page_id=135

6.3 DISTRICT OF CENTRAL SAANICH MARINE SHORELINE DEVELOPMENT PERMIT AREA

The District of Central Saanich adopted a revised OCP (OCP bylaw 1600, http://www.centralsaanich.ca/Assets/Central+Saanich/Bylaws/OCP+Bylaw+1600.pdf) in January 2010. Section 11.2 of the OCP addresses the shore environment through designation of a Marine Shoreline Development Permit Area. The DPA applies to all development 15m inland *and seaward* of the natural boundary. The DPA provides shoreline protection guidance for new developments and subdivisions as well as changes to existing development. It also provides guidance by specific shore types (rocky, beach and marsh shore types). Much of the DPA language is drawn from the review of shore management policy and bylaw language referred to above as well as aspects of the draft Roberts Creek Shore DPA. The District of Central Saanich is the most recent and comprehensive example of a development permit area for marine shorelines, and should be comprehensively reviewed if a similar initiative is contemplated for Thetis Island or other Islands Trust Regions.

6.4 GREEN SHORES COASTAL DEVELOPMENT RATING SYSTEM

The Green Shores program has developed a pilot coastal development rating system for larger residential/commercial developments as well as waterfront park and recreational areas[14], modeled after the highly successful LEEDtm Green Building and LEEDtm for Neighbourhood rating systems. The Green Shores rating system prerequisites (building siting; conservation of critical/sensitive habitats; conservation of coastal processes; riparian area protection; and environmental management plan requirements) provide a relatively thorough overview of best management practices for sustainable shoreline management, and would be useful to review in developing shore management guidance. This draft rating system was recently piloted on two coastal development projects and two coastal rehabilitation projects in British Columbia, and has undergone recent revisions to an operational version. The revised rating system credits should be posted to the Green Shore website (www.greenshores.ca) by late April, 2010.

6.5 PROPOSED GREEN SHORES FOR HOMES PROGRAM

In January 2010 the City of Seattle and San Juan County, in partnership with Green Shores, submitted a funding proposal to the US Environmental Protection Agency (EPA) for the development and piloting of a "Green Shores for Homes" (GSH) assessment framework to incentivize low impact shoreline development for waterfront homes. Key aspects of this four year funding proposal are:

1. the development of a Green Shores for Homes assessment and rating system, based on the existing coastal development rating system;
2. evaluation of potential homeowner incentive programs targeted to specific GSH rating levels;
3. development of a GSH trainer assessor program to educate building professionals and conduct GSH assessments;
4. pilot testing the assessment and incentive program for Lake Washington (Seattle) and San Juan country; and
5. program evaluation.

[14] Available at www.greenshores.ca

In March 2010 this project was one of 16 selected for funding by EPA, although the final award decision is pending more detailed discussions with the City of Seattle. As Green Shores is envisioned as a BC/Washington transboundary initiative, it has always been considered desirable to have a BC counterpart within the GSCH program. The Islands Trust region is a well suited counterpart for San Juan County and a comparative, cross border initiative, particularly with respect to piloting and evaluating incentive programs, would greatly enhance the applicability of a GSCH program in Canada. The assessment system and associated incentives may be a way of extending the requirements and guidance provided by shore Development Permit Area designation more broadly among waterfront property owners (e.g. by incentivizing property owners to achieve designated GSCH rating levels). EPA cannot fund a Canadian pilot program, however, additional if funding can be secured, a Canadian pilot will be supported by the EPA funding through the development of the GSCH rating system and the framework for piloting and evaluating incentive options.

7.0 REFERENCES

Coastal and Ocean Resources Inc. and Archipelago Marine Research ltd. 2005. ShoreZone Mapping, Data Summary, Southern Strait of Georgia NMCA. Contract report for Parks Canada, Victoia BC.

Harper, J. and D. Reimer. 1992. Final Summary Report: Physical Shore-zone Mapping of the Southern Strait of Georgia for Oilspill Sensitivity Assessment. Contract report by Harper Environmental, Sidney BC for BC Ministry of Environment, Victoria, BC.

Howes, D., J. Harper and E. Owens. 1994. Physical Shore-zone Mapping System for British Columbia. Resources Inventory Committee (RIC) Report by the Coastal Task Force, Victoria, BC.

McMullen, M. personal communication, March 2010. Sunshine Coast Regional District.

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

APPENDIX

Appendix Table 1. Physical shoreline attributes from the 1979 ShoreZone database (from Harper and Reiner 1992).

Linked Database #1 (General)

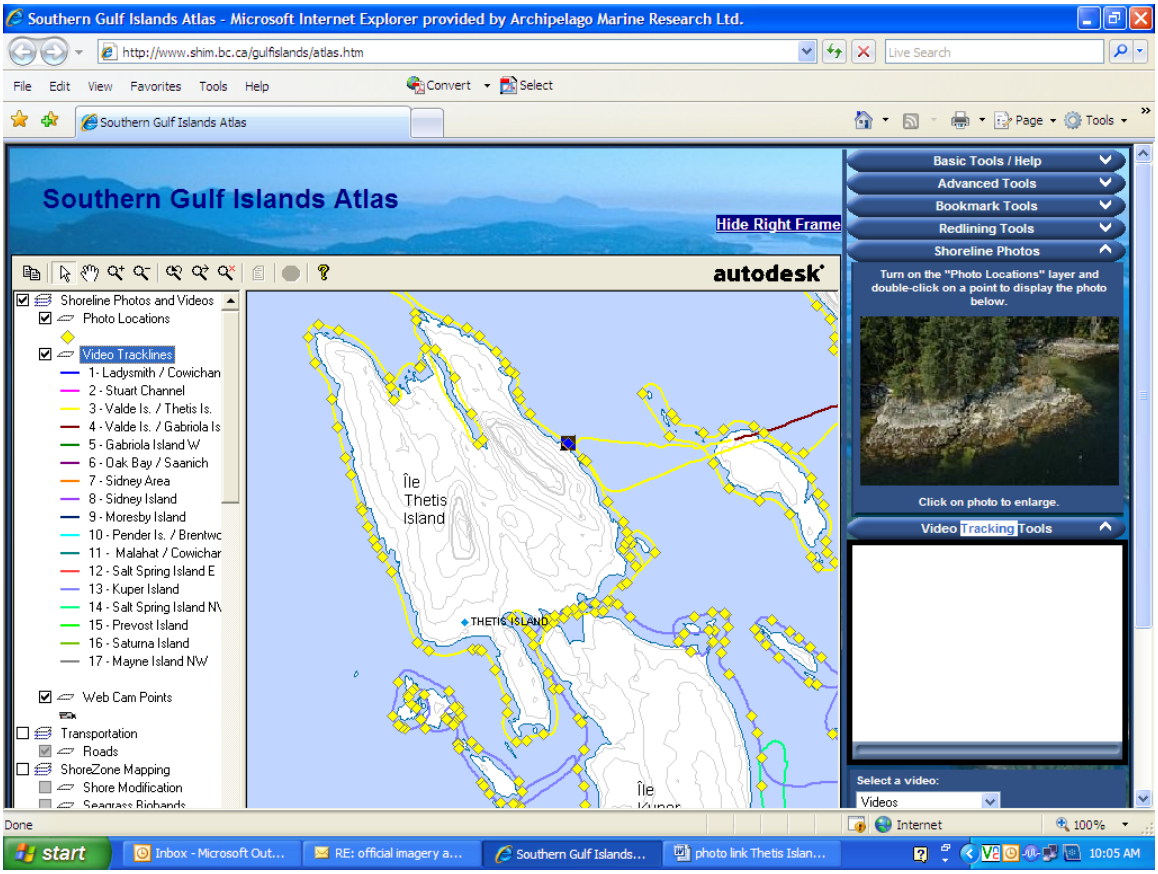
- REGION*
- AREA*
- UNIT*
  - LENGTH
  - NTS*
  - SCALE*
  - START LOCATION
  - END LOCATION
  - MAPPERS*
  - DATE MAPPED*
  - EDITORS*
  - DATE EDITED*
  - DATA SOURCES*
  - GROUND TRUTH
  - TIDES*
    - TYPE*
    - LARGE RANGE*
    - MEAN RANGE*
  - FETCH
    - MAXIMUM DIRECTION
    - MAXIMUM LENGTH
    - SHORE NORMAL
    - LEFT 45
    - PERPENDICULAR
    - RIGHT 45
    - EFFECTIVE FETCH
    - WAVE EXPOSURE
  - REFERENCES
    - VIDEOTAPE NUMBER*
    - AIRPHOTO NUMBER

Linked Database #2 (Shoreline)

- SUB-UNIT* (along shore physical units from data sets)
  - CLASS* (see section 3.0)
  - TYPE* (original coded type: primary, secondary, etc.)
  - LENGTH
  - SEDIMENT TRANSPORT
    - SOURCE
    - ABUNDANCE
    - DIRECTION
  - SHORELINE CHANGE
    - TYPE
    - RATE
  - FORESHORE USE
  - ZONE* (across shore, back-shore, intertidal)
    - COMPONENT*
      - FORM* (descriptive morphology)
      - MATERIAL* (sediment description)
      - WIDTH* (where included in the data set)
      - SLOPE
      - PROCESS
  - OIL RESIDENCE INDEX

Appendix Table 2. Data Dictionary for the database summarising the bio-mapping attributes (from Morris 2000).

Field Name	Type	Description
SOGindex	autonumber	index number, Not part of Standard bio-mapping database
UNITKEY	number	unit number from atlas, Not part of Standard bio-mapping database
HAB_CALC	number	a calculated field from the Physical Mapping Database, prediction of intertidal biota from CLASS and EXP_CALC
PHY_IDENT	text	mapped original physical ident number, unique for each unit and subunit, used to cross-reference to previous physical mapped database with cross-shore form and material details
VER	text	VERrucaria bio-band, N-narrow, M-medium, W-wide
SAL	text	SALicornia bio-band P-patchy (<50% cover), C-continuous (>50%cover)
BRE	text	BRE for extensive mud/sand flats only NOT STANDARD IN OTHER COASTAL BIO-MAPPING. IS STANDARD FOR BC ESTUARY DESCRIPTION
FUC	text	FUCus bio-band
BAR	text	BARnacle bio-band
MUS	text	bio-band for California MUSsel/barnacle bio-band
OYS	text	OYSter bio-band
ULV	text	ULVa bio-band
DIA	text	DIAtom bio-band
HAL2	text	HALosaccion bio-band for SOG
RED	text	bio-band for mixed REDs of WCVI and SJdF
RED2	text	bio-band for mixed REDs in SOG
BMU	text	bio-band for blue mussels
SBR	text	bio-band for soft brown SBR of WCVI and SJdF
SBR2	text	bio-band for soft brown SBR2 in SOG
CHB	text	bio-band for chocolate browns of WCVI and SJdF
CHB2	text	bio-band for chocolate browns2 in SOG
SUR	text	bio-band for SURfgrass - not used in SOG
ZOS	text	bio-band for ZOStera
URC	text	bio-band for URChin barrens
NER	text	bio-band for NEReocystis bull kelp
MAC	text	MACrocystis bio-band - not seen in SOG
EXP_BIO	text	letter code, wave exposure shown by biota, P-protected, SP-semi-protected, SE-semi-exposed, E-exposed
HAB_OBS	number	number code, bio-habitat type observed, see details in substrate/wave exposure/indictator spp table
BIO_SLIDE	text	slide number, collected during aerial video - not used in SOG
BIO_MAPPER	text	name of bio-mapper
BIO_DATE	text	date of bio-mapping
BIO_SOURCE	text	source of bio-mapped information: (I)nferred general HABOBS, V1-high quality video, V2-med quality video, G-ground station in the unit, highest confidence in bio-mapping, G2-observations from boat (Victoria&Esq.Hbr), C – HAB_CALC only available, no video. See also Table 1.
BIO_SITE	text	shore station number within unit, if any. Links shore-station database to bio-mapped database
CURRENT	text	estimate of current as observed by bio-mapper - not used in this SOG
CROSSLINK	text	not used in this SOG mapping



Appendix Figure 1. Snap shot of the 2004 video imagery trackline and photograph locations for Thetis Island from the Sensitive Habitat Inventory and Mapping (SHIM) Atlas on the Community Mapping Network (CMN) site (http://www.shim.bc.ca/gulfislands/atlas.htm).

Appendix Table 3. Rationale for the classification of BC shoreline types (from Howes et. al. 1994).

SUBSTRATE	SEDIMENT	WIDTH	SLOPE	Shore Type Code & Description
ROCK	n/a	WIDE (>30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(1) Rock Ramp, wide
			FLAT(<5°)	(2) Rock Platform, wide
		NARROW (<30m)	STEEP(>20°)	(3) Rock Cliff
			INCLINED(5-20°)	(4) Rock Ramp, narrow
			FLAT(<5°)	(5) Rock Platform, narrow
ROCK + SEDIMENT	GRAVEL	WIDE (>30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(6) Ramp w gravel beach, wide
			FLAT(<5°)	(7) Platform w gravel beach, wide
		NARROW (<30m)	STEEP(>20°)	(8) Cliff w gravel beach
			INCLINED(5-20°)	(9) Ramp w gravel beach
			FLAT(<5°)	(10) Platform with gravel beach
	SAND & GRAVEL	WIDE (>30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(11) Ramp w gravel & sand beach, wide
			FLAT(<5°)	(12) Platform w G&S beach, wide
		NARROW (<30m)	STEEP(>20°)	(13) Cliff w gravel/sand beach
			INCLINED(5-20°)	(14) Ramp w gravel/sand beach
			FLAT(<5°)	(15) Platform with gravel/sand beach
	SAND	WIDE (>30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(16) Ramp w sand beach, wide
			FLAT(<5°)	(17) Platform w sand beach, wide
		NARROW (<30m)	STEEP(>20°)	(18) Cliff w sand beach
			INCLINED(5-20°)	(19) Ramp w sand beach, narrow
			FLAT(<5°)	(20) Platform w sand beach, narrow
SEDIMENT	GRAVEL	WIDE (>30m)	FLAT(<5°)	(21) Gravel flat, wide
		NARROW (<30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(22) Gravel beach, narrow
			FLAT(<5°)	(23) Gravel flat or fan
	SAND & GRAVEL	WIDE (>30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	n/a
			FLAT(<5°)	(24) Sand & gravel flat or fan
		NARROW (<30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(25) Sand & gravel beach, narrow
			FLAT(<5°)	(26) Sand & gravel flat or fan
	SAND/MUD	WIDE (>30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(27) Sand beach
			FLAT(<5°)	(28) Sand flat
				(29) Mudflat
		NARROW (<30m)	STEEP(>20°)	n/a
			INCLINED(5-20°)	(30) Sand beach
			n/a	
	ORGANICS/FINES	n/a	n/a	(31) Organics/Fines (Estuaries)
ANTHRO-POGENIC	MAN-MADE	n/a	n/a	(32) Man-made, permeable
				(33) Man-made, impermeable
CURRENT-DOMINATED				(34) Channel

Appendix Table 4. Exposure matrix and exposure category codes.

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
500-1000	n/a	n/a	semi-exposed	exposed	exposed
>1000	n/a	n/a	n/a	very exposed	very exposed

Exposure Category Codes:		
	very protected	**VP**
	protected	**P**
	semi-protected	**SP**
	semi-exposed	**SE**
	exposed	**E**