Islands Trust Shoreline Mapping

Project Methodology

September, 2011

Prepared for the Islands Trust by:

Paul de Greeff
Murdoch de Greeff Inc.
Victoria, BC

Brian Emmett
Archipelago Marine Research Ltd.
Victoria, BC

John Harper
Coastal and Ocean Resources Inc.
Victoria, BC

Alison Mewett
Land & Water Inc.
Comox, BC

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1 Introduction

The Islands Trust Shoreline Mapping Project (ITSMP) is part of ongoing Islands Trust planning initiatives designed to broaden appreciation and understanding of natural features and systems across the Gulf Islands region. The Trust's mapping projects are considered fundamental to the preserve and protect mandate of the organization, as developing a general appreciation of the value and beauty of landscape is central to long term landscape preservation (Nelson & Phelps, 1966; Bimonte, 2002; Farzin & Bond, 2006). One physical product helpful in achieving heightening awareness and understanding of landscape values is interpretive mapping.

Mapping products developed as part of this project communicate vital coastal information, like shoreline types, valued shoreline features and ecologically sensitive shorelines. Interpretive maps are intended to be easy to understand and appealing to a wide audience by using simple language, vivid colours and descriptive annotations and graphics. Still, they are based on defensible, standardized information from reliable sources, like the provincial ShoreZone data system which will be described in detail in this report. The mapping products developed under this project provide the Islands Trust with a new communication tool designed to expand appreciation of shorelines within island communities.

The ITSMP evolved out of a 2009 pilot study completed by the UBC School of Architecture and Landscape Architecture (UBC-SALA) for Thetis Island, BC. The Thetis Island Pilot Project received broad support from political leaders, Islands Trust staff, and community members. This support base spurred the Islands Trust to expand the mapping program to other Trust-area islands. The primary objective of the Thetis Island Pilot Project was to provide islanders, planners and politicians with basic landscape, land use planning and alternative (green) development information in an easy to read format, depicting natural features and processes that make Thetis Island's shoreline special or helped to shape its character. The information presented in a series of six graphic interpretive boards was largely educational in its purpose. With the Thetis Island Pilot Project used as a starting point, the shoreline mapping products completed for this project have been revised extensively and project objectives broadened from the work completed by UBC-SALA.

Although receiving broad acclaim, a shortcoming of the Thetis Island Pilot Project mapping, identified by the ITSMP consulting team, involved the absence of a map data collection protocol and a clear project methodology. Since the initial Thetis Island interpretive boards were intended to be an educational product, data collection was based on casual field observation, with more emphasis placed on graphic communication and appearance of the products than documented protocols and mapping accuracy. By expanding shoreline mapping to additional islands as part of the ITSMP, establishment of a mapping protocol was deemed critical to clarify map reliability for specific uses and to ensure that limitations of mapping would be clear to an expanded user group.

Objectives of the ITSMP have broadened since the Thetis Island Pilot Project was completed. In addition to serving as a communications tool, the new mapping products are intended to serve as a ready base for future shoreline management initiatives and island planning work. Shoreline management options available to the Islands Trust include further educational initiatives, shore protection guidelines, low-impact development incentives programs, and/or regulations on land use and development near shorelines. Use of the ITSMP products for these kinds of planning initiatives is better facilitated with the establishment of a clear, defensible mapping methodology. This report is intended to clarify mapping methods and elaborate on design rationale for the specific mapping products.

2 Project Rationale and Methodology

The ITSMP products evolved out of early work completed by UBC-SALA on the Thetis Island Pilot Project, and subsequent workshops and discussions between Islands Trust planners and the ITSMP consulting team. The ITSMP consulting team has been lead by Murdoch de Greeff Inc. (MDI), with Archipelago Marine Research Ltd. (AMR), Coastal and Ocean Resources Inc. (CORI), and Water Land Consulting Ltd. (WLC) providing invaluable services. The project was split into two components:

1) Thetis Island Map Prototype Development; and,
2) Map Prototype application to 11 additional Trust Area Islands.

Since the UBC-SALA Pilot Project used Thetis Island, it was felt that a revised Thetis Island prototype mapping product would provide opportunity for direct comparison between the pilot and the new prototype in order to evaluate proposed mapping improvements. Prior to development of the new prototype mapping product, a one day intensive workshop or *charrette* was held to discuss the UBC-SALA pilot products, to review proposed mapping objectives, to explore available data sources proposed for inclusion in the mapping products, and to discuss with Islands Trust planners the intended product uses. This workshop helped to inform the design objectives and overall form of the Thetis Island shoreline mapping prototype. Subsequent critical reviews and comments from Island Trust staff were also provided to the consulting team that further influenced product development. Only after completion of the exhaustive prototype development process was the mapping project expanded to eleven additional islands, including:

1) Denman Island;
2) Hornby Island;
3) Lasqueti Island;
4) Gambier Island;
5) Gabriola Island;
6) Saltspring Island;
7) Galiano Island;
8) Mayne Island;
9) Saturna Island;
10) North Pender Island; and,
11) South Pender Island.

2.1 Thetis Island Pilot Project (UBC-SALA)

Much of the design intent of the Thetis Island Pilot Project maps has been retained in the ITSMP products. As a graphic product, the UBC-SALA work was exemplary, and attracted wide-spread approval from community members and other users when on display at public meetings. Capitalizing on the UBC-SALA pilot project's successes was a key project objective. However, two primary design distinctions between the original Thetis Island Pilot Project products and the current shoreline mapping products emerged through the product development process.

2.1.1 Deviation from UBC-SALA Pilot - Guidelines Graphic Display Boards

At the time of issuing the request for consulting services to undertake this project, it was clear that three interpretive mapping products were desired per island (mapping products are described in detail in Sections 2.2 to 2.4 below). In contrast, the Thetis Island Pilot Project completed by UBC-SALA consisted of a set of six interpretive boards, three of which were mapping products and three of which were supporting illustrative development guidelines display boards. The three guidelines-oriented illustrative display boards provided background information in text and graphic form on how to develop in proximity to shorelines in a manner that would better protect shoreline values and avoid typical building and infrastructure problems in shoreline environments. The information on the guidelines boards was developed specific to Thetis Island. Although important to helping round out the story of how to protect shorelines and develop sensitively near them, the supporting three guidelines graphic boards were not critical to the mapping product development process, and therefore not included in the ITSMP Request for Consulting Services (see recommendation in Section 4.1 on supporting materials).

2.1.2 Deviation from UBC-SALA Pilot - Values and Vulnerability Map

The UBC-SALA Thetis Island Pilot Project contained three maps with the following titles:

1) Distribution of Shoreline Types;
2) Sediment Transport and Related Ecosystems; and,
3) Coastal Energy Zones.

The first map in the new ITSMP products set has remained largely unchanged from the UBC-SALA Pilot; with the exception of some classification adjustments (see Section 2.5.1). The second and third map products from the UBC-SALA pilot project have been merged into a new ITSMP map entitled “Energy and Sediment Movement”. The third ITSMP map is an entirely new map entitled “Shoreline Values and Vulnerability”. The intent of this new map is to identify sections of island shoreline and landscape that are either vulnerable to human and natural disturbances (i.e.: effects of sea level rise) or are especially valued in some way (i.e.: high recreational or ecological value). Sections 2.2 through 2.4 describe the three ITSMP maps in more detail.

2.2 Map 1 – Shoreline Classification

The shoreline classification map is the core map of the ITSMP (labelled as Map 1 of 3 for each island). It provides a verifiable and reliable indication of what type of shoreline exists where; much like a zoning map in a city shows where residential, commercial or industrial land uses are located. This basic, foundational information is critical to helping communities and land use planners map out what to expect in the landscape, and plan accordingly. For example, bluff shorelines are generally critical sediment sources to beaches in proximity to bluffs. Knowing the location of bluffs allows communities, regulators or land use planners to launch education programs in neighbourhoods near bluffs, to assign development controls near bluffs, or to provide incentives for improved management.

Shore classes on Map 1 are assigned on the basis of broad, easily understood and non-technical criteria. Classes loosely subscribe to those defined in Chapter three of *Coastal Shore Stewardship: A Guide for Planners, Builders and Developers*, a document published by the Province of BC, as well as to the shore classes defined by UBC-SALA in the Thetis Island Pilot project. However, slight adjustments were made to classes (as compared to both of these sources) to render new classes more consistent with the ShoreZone data system. A 'cross-walk' comparison matrix (described in Section 2.5.1 below) was used to reduce or 'lump' the 35 shoreline classes that exist in the ShoreZone data system into the six classes presented on Map 1.

One of the key differences between the classes defined in this project and previously referenced systems is the removal of the modified or "structurally altered" shoreline type from the classification system. This move was made because even where a structural alteration to a shoreline exists, that particular piece of shoreline still belongs to a specific natural shoreline type. For example, a structural alteration comprised of a riprap wall positioned along the natural boundary may still have a boulder/cobble or pebble/sand beach in front of it. Rather than showing altered shorelines as a separate class, they are represented as a modifier to existing shoreline types and are displayed on the maps in an inset.

2.3 Map 2 – Energy and Sediment Movement

Where Map 1 is largely about the physical characteristics of shorelines, Map 2 is about the systems and processes that determine why certain physical characteristics exist where they do along the shoreline. In some locations, wind works on the ocean surface to build waves over long distances (or long fetch), and when waves that are built up by winds intersect with the shoreline, energy is available to erode shoreline banks or to move material along the shoreline. In other more sheltered locations, less energy is available for sediment movement and sediment may be deposited in these locations. This system of erosion, sediment movement and deposition (accretion) is called *longshore drift*. Depending on the exposure of shorelines, the amount of energy from wind and waves available to work on the shoreline varies appreciably. Also, watersheds further influence the shoreline system by contributing sediment, nutrients and, potentially, pollutants.

The energy system working along shorelines represents only one component controlling the longshore drift system. Shoreline type also influences how much sediment is eroded, transported along its length, or deposited. For example, bluffs along high exposure shorelines will generally contribute far more sediment than rocky or cliff shorelines in high exposure areas. In this way, Map 1 and Map 2 are integrally linked – the distribution of shoreline types influence the longshore drift system by locally limiting or increasing sediment supply, but the distribution of shoreline types is also largely determined by the energy systems moving materials along the shoreline.

Energy is also very important in controlling the coastal habitat (that is, the plants and animals that inhabit a particular section of shoreline). In addition, wave energy levels are important in the dispersal of pollutants, where high energy shorelines have relatively rapid dispersal rates and low energy shores have much lower rates; as such low-energy shores are more likely to be sensitive to pollutant accumulation.

2.4 Map 3 – Values and Vulnerability

Map 3 provides a value-based assessment of shorelines from the perspective of the project consulting team (i.e.: consisting of design and science professionals). This map is not intended to be a comprehensive description and inventory of valued and vulnerable shoreline features, but a means of highlighting key forms, features and system processes that may affect potential future land use planning issues along island shorelines. It is envisioned that further community-derived, value-based assessment of island shorelines might result in additions or deletions to this map or emphasis on different shoreline features in future – in fact, the maps contain a window within which community members can contribute to identifying valued shoreline features and to build on the effectiveness of this map.

Some of the key shoreline values and vulnerabilities identified on Map 3 are:

- **Connection between watersheds and sensitive shorelines** – Sensitive shorelines are defined as those that have sensitive ecological features such as salt marshes, or those that have poor circulation and might be vulnerable to pollutant discharge from land-based activities. Island surface areas draining to these shoreline types are cross-hatched to identify them as areas contributing to shorelines with particular sensitivity or value associated with them. This connection highlights the link between management of land-based activities far from the shore and protection of shoreline values.

- **Bluff shorelines** – Bluffs are highlighted to indicate their importance to the longshore system. Bluffs often provide sediment that nourishes beaches some distance from the bluffs. Without bluff erosion, some of our most treasured sand beaches would become rocky or over-steepened and lose their recreational or habitat value. Buildings sited above bluffs are also at risk from receding bluff faces – it follows that if bluff erosion is important to maintaining shoreline values, then bluffs should be allowed to continue eroding (or values would have to be maintained in some other fasion – i.e.: beach nourishment) necessitating careful management of building and facility siting/setbacks above and below bluffs. Identifying bluffs as a valued and vulnerable shoreline type helps to draw attention to the management issues pertaining directly to them.

- **Vulnerability to sea level rise –** Low-lying coastal areas are indicated to draw attention to a regionally significant land use planning and resource management issue. Indeed, there are some locations on the Gulf Islands that will be radically affected by sea level rise over time, either directly through flooding, or through increased exposure to storm waves that can increase shoreline erosion rates, driftwood throw up onto properties (endangering structures near the shore), salt effects to low-lying agricultural or forested soils, and other related effects. Structures and facilities like sea walls, building foundations, infrastructure or other hardened, immovable installations are particularly susceptible to the effects of sea level rise since they cannot be adjusted over time to respond to slow, incremental changes in water levels. As well, some important recreational amenities, such as natural beaches and/or modified shorelines may be affected significantly as sea level rises. As a result, sea level rise is a critical land use planning issue and is identified as part of this mapping program.

2.5 Data Source - ShoreZone

2.5.1 The ShoreZone Data System

ShoreZone is a coastal habitat mapping system that was developed by the Province of British Columbia to provide a systematic inventory of coastal habitats and features for planning within the province (Howes 2001). Some portions of the Strait of Georgia were mapped in the early 1980s and some of these locations have been updated in the lat 10 years (e.g., CORI and AMRL 2005). ShoreZone subdivides the shoreline into segments of more or less uniform morphology and substrate and also provides a description of key habitat features within each along-shore unit. This existing data provided the base information used in the ITSMP.

A table (cross-walk matrix) was used to generalize the 35 shore types used in ShoreZone into the six shore types used in the ITSMP. While some of these generalizations are straightforward, the cross walk was checked using previously collected low-tide, aerial videography. The cross-walk matrix is shown in Table 1 below.

Table 1. Shore Classes Related to ShoreZone Classification.

Substrate	No	Type	Features	Concerns	Examples	ShoreZone Cross Walk
Rock (hard shorelines)	1	Sea Cliffs/(Hillslopes)	rocky shore with steep slopes (>20°)	generally stable in terms of erosion; some rock cliffs may be susceptible to failure	common on Gulf Islands	3, 8, 13, 18
	2	Low Rock/ Boulder	rocky shore with low slopes (<20°)	generally stable in terms of erosion; very low ramps may be sensitive to occasional storm surge/sea level rise	common on Gulf Is	1, 2, 4, 5 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 19, 20, 33
Sediment(soft shorelines)	3	Bluffs	moderate to high slopes of loose deposits/sediment	generally erosional (bare or grassy); sometimes stable (treed); important sediment sources	eastern shore Denman Is	will require video review
	4	Boulder-cobble beach	boulder-cobble covers on surface of beach; may be pebble sand on upper beach	Boulder-cobble beaches often are associated with erosional shorelines	common in Baynes Sound	21, 22, 23, 24 25, 26, 32
	5	Pebble-sand beaches	pebble-sand (shell) beaches are generally stable to accretional.	beach stability sensitive to sediment supply; beaches are dynamic and may exhibit long-term cycles (e.g., 20yr storm cycle)	mostly occur as pocket beaches in Gulf Is (often shell fragments) but some large beaches (Tribune Bay, Hornby Is; Walker Hook, Saltspring Is)	27, 28, 30
	6	Estuaries-Tidal flats	estuaries and flats, often have salt marsh in upper intertidal; sand and mud in lower intertidal; usually low energy; associated rivers and streams are often significant sediment sources.	low energy areas are sensitive to disturbance and are slow to recover. Fine sediments may trap pollutants and accumulation of organics often leads to anoxic sediments; sensitive to sediment supply	Clam Bay, Thetis Is	29, 31

2.5.2 Modified shoreline

The modified shoreline map inset on Map 1 provides some statistics generated from the ShoreZone data system (in some cases for older ShoreZone mapping, aerial videography was reviewed to create this estimate) and a graphic depiction of ShoreZone shore units that have significant modifications along them. The statistic for percent modified shoreline in the inset is the measured length of observed shoreline modifications, divided by the total shore unit, for a specific island. For the purposes of the map inset graphic, 30% was selected as the minimum alteration within a given ShoreZone shore unit as the criterion for inclusion of shore units on the inset map ("30% modified" means that for the shoreline units illustrated, more than 30% of a given shoreline unit's length has been structurally altered in some way, generally through the installation of riprap walls, groynes, breakwaters, seawalls, wharf or other typical shoreline modifications). The 30% criterion provided an effective graphic representation of areas along the shoreline that had the most intensive shoreline development. A higher percentage eliminated significant shore modifications from displaying, and a lower percentage resulted in the display of a larger number of insignificant alterations at an island scale.

Newer ShoreZone mapping in the Strait of Georgia includes specific documentation on shore modifications such as the extent of seawalls, rip-rap shoreline and areas of landfill but older areas of ShoreZone mapping (e.g., Denman Is., Hornby Is., Lasqueti Is.) do not. For the older areas of mapping, mapping technicians reviewed low-tide, aerial video to provide estimates of shore modification. Previous studies have shown that vertical aerial photos are less suitable for documenting shore modification as the overhang of tree canopies obscures shore modifications.
For this project, shore modification includes estimates of length for wooden, concrete and steel seawalls. These are usually in the supra-tidal zone but sometime extend into the lower intertidal zone.

2.5.3 Salt marsh

Salt marshes are a sensitive shoreline ecotype that has high habitat value, is sensitive to trampling and development impacts and is an indicator of very low energy levels. Salt marsh areas are typically vulnerable to pollutant accumulation. Newer ShoreZone mapping identifies salt marsh (CORI and AMRL 2005) but older ShoreZone mapping does not, so aerial videography was reviewed to identify locations of salt marsh in those areas.

Salt marsh consists of assemblages or various salt-tolerant vascular plants that typically form a band in the upper intertidal zone and may extend from the tree line to the mid-intertidal zone. They are uncommon in the Strait of Georgia, typically comprising about 5-10% of the shoreline. Salt marsh usually occurs in low energy areas and is often associated with sandflats and mudflats

2.5.4 Wave exposure

ShoreZone catalogues the wave exposure levels along the shore based on observed assemblages of biota. Most intertidal species have preferred exposure preferences and by carefully observing these biota on aerial videography, different wave energy classes can be assigned to each shore unit. Where the biota has not been systematically observed, wave fetch distances provide an estimate of wave exposure levels. The entire Strait of Georgia ShoreZone mapping data set includes a wave exposure classification as follows:

- Semi-Exposed (ITSMP exposure: high) – this is the highest wave exposure class that occurs within the Strait of Georgia and occurs on the open coasts of Hornby, Galiano, Mayne and Saturna Islands where maximum wave fetches are greater than 50 km. Large waves generated during south easterly storms are capable of moving cobbles and small boulders.

- Semi-Protected (ITSMP exposure: medium) – this is the most common exposure category within the Gulf Islands where wave fetches are limited (maximum wave fetch of 10 – 50 km). Waves generated by storms may move cobbles but generally cobbles are sufficiently stable that attached algae and fauna are common.

- Protected (ITSMP exposure: low) – protected shores occur where maximum wave fetches are 1-10 km; on these low energy shores pebbles are typically stable enough that they can support attached algae and faunal communities (e.g., stable enough that barnacles may grow on the pebbles).

- Very Protected (ITSMP exposure: very low) – this is the lowest wave exposure category where maximum wave fetch is less than 1 km. Such locations are favoured locations for anchorages and marinas. The low energy levels allow deposition of muds and sand and often include areas of salt marsh.

2.5.5 Eroding/accreting shorelines

Shoreline stability is of concern for long-range planning of human activities along the shoreline where eroding shorelines may be a potential hazard to land owners. Eroding shorelines provide an important constituent (sediment) for shoreline habitats and accreting shorelines often include mudflats, salt marsh and dunes. Delineating these areas is important to understanding the sources and sinks of the longshore drift system, and the *flow* of sediments around an island. Some of the ShoreZone mapping includes categorization of shoreline stability but many areas do not. Aerial videography was reviewed to categorize the shoreline stability.

- Eroding Shorelines – technically, almost all “cliffed” shorelines are eroding but where the cliff is rock, the erosion rate is almost imperceptible. Shorelines were classified as eroding “where there would likely be measureable shoreline change over a one year period” or >15 cm/year shoreline change. Bluffs or unconsolidated cliff shores are the most common shore type of eroding shorelines. Eroding shorelines are important sources of sediment for the longshore sediment transport system.

- Accreting Shorelines – accreting shorelines are where sediment accumulation is causing a seaward migration of the high water line. Dune and storm-berm formation are sometimes an indicator of accretionary shores. Accreting shorelines are often the sediment sinks for the alongshore sediment transport. Accretionary shores also have the potential to accumulate pollutants.

2.6 Data Source - Other

2.6.1 Sea Level Rise Vulnerability Areas

Sea level rise vulnerability mapping criteria were determined by evaluating Shoreline Sea Level Rise Sensitivity Index (SSLRSI) methodology developed by Howes et al. (2010) for the BC Ministry of Environment. Like the Howes et al. approach, the methodology chosen for the ITSMP was influenced by two factors: 1) sea level projections widely accepted in the scientific community; and 2) available mapping data.

Of particular interest in the Howes et al. Report was the flood index methodology. The proposed SSLRSI method for a flood index is described by Howes et al. as follows:

> "The potential 2100 water levels applied in this index for the Strait of Georgia study area is based on an estimated "normal" upper limit of marine processes including the elevation of highest spring tides (astronomical tides) and typical high water levels generated by oceanographic process (meteorological tides) and potential wave heights. For this study, a normal upper limit is estimated to be 3.0 m ± 1m above the HWL (R. Thomson, pers. comm., February 2010). This 3-m value is based on estimates of a 1.0 m sea level rise through 2100, an annual storm surge water elevation event on the order of 1.0 m, and a higher water elevation of 0.75 to 1.0 m during an El Niño year. In addition, more exposed shorelines could have higher water levels due to storm waves and local conditions." (Howes et al., 2010, pg. 14).

Howes et al. mapped the 5m contour line (interpolated from the 20m TRIM contour) to represent areas vulnerable to the effects of flooding from sea level rise, and then rated areas as having a low to high vulnerability based on horizontal distance inland of the 5m contour line.

For the ITSMP, the Islands Trust provided the consulting team with a data set that is substantially more accurate than the provincial TRIM data. 2m and 4m contours, based on either a photogramatically acquired DEM (+/- 0.5m accuracy over open ground; ½ tree height accuracy in treed areas) or Lidar acquired DEM (+/- 0.5m accuracy throughout) were made available for use by the Islands Trust mapping department. These contours are based on a 0m elevation set at the mean sea level (MSL). The following tidal statistics are for Chemainus (approximate centre of mapping area):

- Range, Large tide: 4.4 m
- MSL: 2.5 m
- Minimum LWL 0.3 m

- Maximum HWL 4.7 m
- Natural boundary Approx. 5.2 m

Therefore, assuming an estimated sea level rise of 1.13m by 2100 (Thomson et. al., 2008), the 4m contour would fall about 0.4m elevation higher than the projected 2100 natural boundary (i.e.: the 4m contour would fall very close to the projected 2100 new natural boundary).

Shorelines that have steep rock benches or high cliffs are less vulnerable to flooding from sea level rise than low-lying areas. To more easily identify areas most vulnerable to the effects of sea level rise, areas where the 4m contour had a horizontal distance from MSL of at least 50m were mapped. As with the modified shoreline inset map, the 50m criteria was selected on the basis that it provided an appropriate level of inclusion for areas most at risk to sea level rise. It should cautioned that the exclusion of some low-lying areas from maps (i.e.: areas with less than 50m of horizontal distance between the zero and four metre contours, but still low-lying) does not mean that they are not vulnerable to sea level rise – again, the 50m criterion was selected on the basis that it provided the most reasonable graphic product at the scale of the mapping, rather than providing the most comprehensive coverage.

It should also be noted here that sediment shorelines, particularly bluff shorelines, are likely to be prone to increased erosion as rising sea levels potentially soften sediment shorelines. This is one of the reasons that sediment shorelines are included as a vulnerable feature on Map 3.

2.6.2 Fetch diagram

The fetch diagram is provided on Map 2 to help explain the concept of wave fetch. Wave fetch is defined as the distance of water over which a given wind has blown. Fetch is generally used as a measure to determine the expected magnitude of waves and, in the case of this project, the exposure rating of shorelines (see Section 2.5.4 above).

2.6.3 Watersheds, Conveyance Zones & Areas Draining to Sensitive Shorelines

Watersheds and conveyance zones are displayed prominently on all maps. The source of this data is the Islands Trust's Riparian Areas Regulation (RAR) Watershed Mapping Project completed in 2009. Watersheds are considered one of the key driving systems on the Gulf Islands. Water flowing through watersheds delivers sediment and nutrients to the shoreline system, and also potentially contributes pollutants.

In addition to simply displaying watersheds, particular watershed areas that drain to sensitive shorelines and/or areas with expected poor circulation in the marine environment have been identified in Map 3 as cross-hatched areas. Shorelines with poor circulation and sensitive features like salt marsh, are considered particularly vulnerable to accumulation of pollutants from land based activities delivered to the marine environment by watersheds, so identifying these watersheds as contributing areas to sensitive environments helps to draw attention to an important land management issue.

2.6.4 Watershed pour-points

Watershed pour-points are points at which identified areas of concentrated water flow (drainage conveyance zones – derived from the Islands Trust's Riparian Areas Regulation (RAR) Watershed

Mapping Project) exit to the marine environment, either in the form of a seasonal or permanent creek (overland flow) or as seepage (interflow). Note that land-based activities in non-basin drainage areas (i.e.: areas outside of watersheds) may also contribute nutrients, sediment and/or pollutants to the marine environment. However, it is more likely that these sources would be less concentrated than at pour-points.

2.6.5 Predominant Wave Energy & Localized Sediment Movement Arrows

Predominant wave energy and localized sediment movement arrows are provided to indicate the general patterns of energy and material flow around the islands. Shorelines are dynamic, with sediment, nutrients and organics (ie: logs, debris, etc) flowing along them. Generally, prevailing storm winds push materials along the shoreline is a relatively uniform direction – in our region, prevailing storms flow from southeast to northwest, so materials generally move north and west along shorelines. However, some beaches are exposed to north-westerly outflow winds in the winter, and localized reversals in sediment movement and energy exposure exist as a result. The precise movement of sediment can be complicated by rock outcrops or watershed sediment inputs and can be very site specific, but the arrows do provide the reader with a general impression of how the energy system works.

2.6.6 Very Protected Shorelines

Very protected shorelines are derived from the ShoreZone data system. They represent areas most protected from wave energy (i.e.: areas with very low fetch). For Map 3, very protected shorelines are highlighted as a vulnerable shoreline type because these areas are typically associated with areas of limited water circulation and are therefore susceptible to pollutant accumulation. They are also often areas of high ecological value, with fine sediment accumulation and salt marsh habitats.

3 Limitations

3.1 Data accuracy

Detailed descriptions of data components and data sources are provided in Section 2.5 and Section 2.6. Three principal data sources were used in the production of the ITSMP maps and the expected accuracy of each source data set is described below.

- ShoreZone: The ShoreZone data system is a provincial mapping system that was designed for oil spill response preparedness and for marine resource management. This dataset varies in age, ranging from the mid 1980s when imagery collection began (Gambier Is) to 2006 when the last ShoreZone imagery was collected by Parks Canada within the southern Gulf Islands. Some areas of the Gulf Islands (Galiano Is, Gabriola Is, Lasqueti Is, Denman Is and Hornby Is) did not originally include biotic mapping and were "retrofit" in the mid 1990s; the quality of biotic mapping is lower than that for the islands surveyed in 2006. Older imagery was reviewed to check for biota and for shore modification in attempt to bring the mapping to 2006 standards. The 2006 imagery is available on the web at: http://www.shim.bc.ca/gulfislands/atlas.htm.

- Islands Trust DEM: The Islands Trust purchases Digital Elevation Models (DEM) and aerial photography from McElhanney Geomatics. Depending on the specific island, DEMs and aerial photos were produced between 2005 and 2009. DEMs for Saltspring Island, Galiano Island, Thetis Island and Gabriola Island were photogrammetrically derived and have an expected accuracy of +/- 0.5m, except in treed areas where accuracy is reduced to ¼ to ½ of tree height. DEMs for remaining islands are LIDAR derived and have an expected accuracy of +/- 0.5m throughout. 2m contours are developed from the DEMs. Contour accuracy is typically represented in cartography as ½ of the contour interval, so for a 2m contour interval, accuracy would be expressed as +/- 1m. The accuracy range of the DEMs should be added to the contour accuracy, so overall contour accuracy for this project is expected to be +/- 1.5m, (except in treed areas for islands with photogrammetrically derived DEMs).

- Watersheds & Conveyance Zones: The Islands Trust contracted Water Land Consulting Ltd. and Murdoch de Greeff Inc. in partnership with UBC-SALA in 2008/2009 to define watershed boundaries, areas of concentrated drainage (i.e.: wetlands, creeks, moist soil areas, etc) and non-basin drainage areas for the entire Islands Trust area. Watersheds boundaries were interpreted from 1:7,500 hardcopies of Islands Trust DEM-derived contours. Both the accuracy of the base data and further error introduced in the watershed boundary interpretation process contributed to reductions in the expected accuracy of the watershed boundaries. However, since the scales of maps in this project are smaller than those used during the interpretation process and since the DEM accuracy is relatively high (less so for forested areas), watershed boundary accuracy is considered appropriate for the purpose of this project.

3.2 Intended Use

The maps and graphics developed as part of the ITSMP have been designed to serve a useful purpose in an educational context, as a general guide to land use planning decisions and as background for the formulation of Development Permit Guidelines or incentives programs. However, the maps and diagrams do not have a level of accuracy or representational detail sufficient for analysis of shoreline conditions at the scale of individual properties. Individual property owners can use these maps to help identify concerns, to provide an estimation of what type of shoreline might be expected in front of their property and to explore issues they might expect to encounter on their section of shoreline, but the maps should not be used for detailed analysis without input from qualified building or environmental professionals. They should also not be considered a comprehensive inventory of risk factors at the site level.

3.3 Data Gaps

The ShoreZone mapping system has been in development for near 30 years. Over that time, mapping protocol has been expanded and refined. Much of the BC shoreline has been mapped, but the precise procedures and protocol used for specific areas varies depending on the date of data collection. In order to build a consistent mapping product for this project, ShoreZone technicians at Coastal and Ocean Resources Inc. used a shoreline low-angle videography review procedure to update or verify some areas with older shore data to be consistent with new ShoreZone mapping standards.

There were two islands – Lasqueti and Gambier Islands – where the videography review procedure was not possible to complete, simply because the original video tapes were no longer available from the provincial government archives. For these two islands, high resolution orthophotos provided by the Islands Trust were used to confirm ShoreZone data collected for these islands in the 1980's. There are two key limitation in using orthophotos instead of low angle videography. These include the following:

1) Salt marsh areas are difficult to verify from orthophotos – as such, salt marsh areas have not been mapped for Gambier and Lasqueti Islands;

2) Modified shorelines are difficult to verify from orthophotos in some locations because of overhanging trees and vegetation – although some shoreline modification information was available in the ShoreZone data for Lasqueti and Gambier Islands, the videography review procedure was not used for verification of the older data.

4 Recommendations

4.1 Supporting Graphics Boards

The ITSMP did not include the production of guidelines graphic boards like those produced as part of the Thetis Island Pilot Project completed by UBC-SALA. Although the maps produced by this project will be useful for the intended purposes described herein, part of the communication effectiveness of the Thetis Island Pilot project has been diminished by the exclusion of a product that addresses development strategies in proximity to shorelines. It is recommended that the Islands Trust draw on experience derived from the Thetis Island Pilot and expand communication materials beyond the maps produced as part of this project. Materials could take the form of display boards similar to those produced as part of the Thetis Island pilot that deal with guidelines for development, or materials might include a summary document specific to development along Gulf Island Shorelines. Other product ideas might include a green shoreline development incentives program that is linked to the maps (see Section 4.3), or a website and/or summary document used to elaborate on managing and preserving shoreline values and function for the Islands Trust area shorelines.

4.2 Completion of Islands within Trust Area

This project has resulted in the mapping of 12 Trust Area islands. There are numerous smaller islands within the Islands Trust's jurisdiction that may or may not have shoreline development pressures and sensitive or vulnerable shorelines that need special management consideration. Completion of the mapping exercise would help identify shorelines within the remaining Trust Area that have special sensitivities or require special management, or conversely, that are more appropriate for development. Also, in areas where low-angle videography is not available for verification and review of existing shoreline data (ie: Gambier and Lasqueti Islands), some collection of video footage of shorelines is recommended.

4.3 Green Shores for Homes

The Green Shores program website (www.greenshores.ca) describes the Green Shores for Homes program as follows:

> " In March 2010, the U.S. Environmental Protection Agency (EPA), under the Puget Sound Watershed Management Assistant Program, awarded the City of Seattle a four year grant of over $500,000 to research incentives for removing bulkheads and improving the ecological function of residential shorelines along Lake Washington. Green Shores for Homes will build on Seattle's existing Green Shorelines guidelines by developing and testing incentives to protect and improve ecosystem function and processes along shorelines of single-family waterfront homes. The assessment framework, Green Shores for Homes, will be based on the existing Green Shores for Coastal Development Rating System (CDRS) developed by the Stewardship Centre of British

Columbia. The Coastal Development Rating System provides a voluntary rating certification process for coastal developments modeled after the highly successful LEED Green Building rating system.

The City of Seattle proposes to pilot Green Shores for Homes credits and locally developed incentives on Lake Washington, building on previous multi jurisdiction efforts to facilitate alternatives to shoreline alteration. San Juan County will participate as a project partner and will pilot Green Shores for Homes in marine coastal locations. In September 2010, Islands Trust, a federation of local governments within the BC Gulf Islands, joined this initiative as a trans-boundary partner. Members of the Green Shores Technical Working Group, which oversaw the development of the Coastal Development Rating System, will coordinate the development of the Green Shores for Homes credit system."

The Green Shores for Homes program will provide the Islands Trust with a viable incentives program for promoting alternative shoreline management approaches – Green Shores for Homes is particularly relevant to the Islands Trust due to the predominant form of development along island shorelines consisting of private homes. The ITSMP is an important prerequisite to the Green Shores for Homes program as it will help to build understanding of the shoreline system, and it is expected that the two projects will complement each other in message and focus. It is recommended that the Islands Trust continue to support development of the Green Shores for Homes program and begin to consider how Green Shores for Homes will build upon the work completed as part of this project. Future shoreline planning projects should ensure consistency and relevance within the context of the ITSMP and Green Shores for Homes.

4.4 DPA Guidelines

Several local government jurisdictions in the province of BC have developed shoreline Development Permit Guidelines as part of their Official Community Plans. Section 919.1(1)(a) of *the Local Government Act* authorizes local government to designate development permits where protection of the natural environment, its ecosystems and biological diversity is desired and can be justified. Section 919.1(1)(b) authorizes local government to designate development permits for the protection of development from potentially hazardous conditions. Both of these sections can be used to justify development permit areas along Gulf Island shorelines.

Many of the provincial development permit guideline precedents use general shoreline classes, similar to those presented in Map 1, for basing specific guidelines on. For example, it may be desirable to specify more substantial setback requirements for bluff shorelines than for low-rock/boulder shorelines since bluffs are typically less stable, and preserving the active and ongoing erosion processes typical of bluff landscapes is critical to maintaining other shoreline values. Map 1 could conceivably form the basis of a schedule used to show where specific guidelines apply along the shoreline.

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