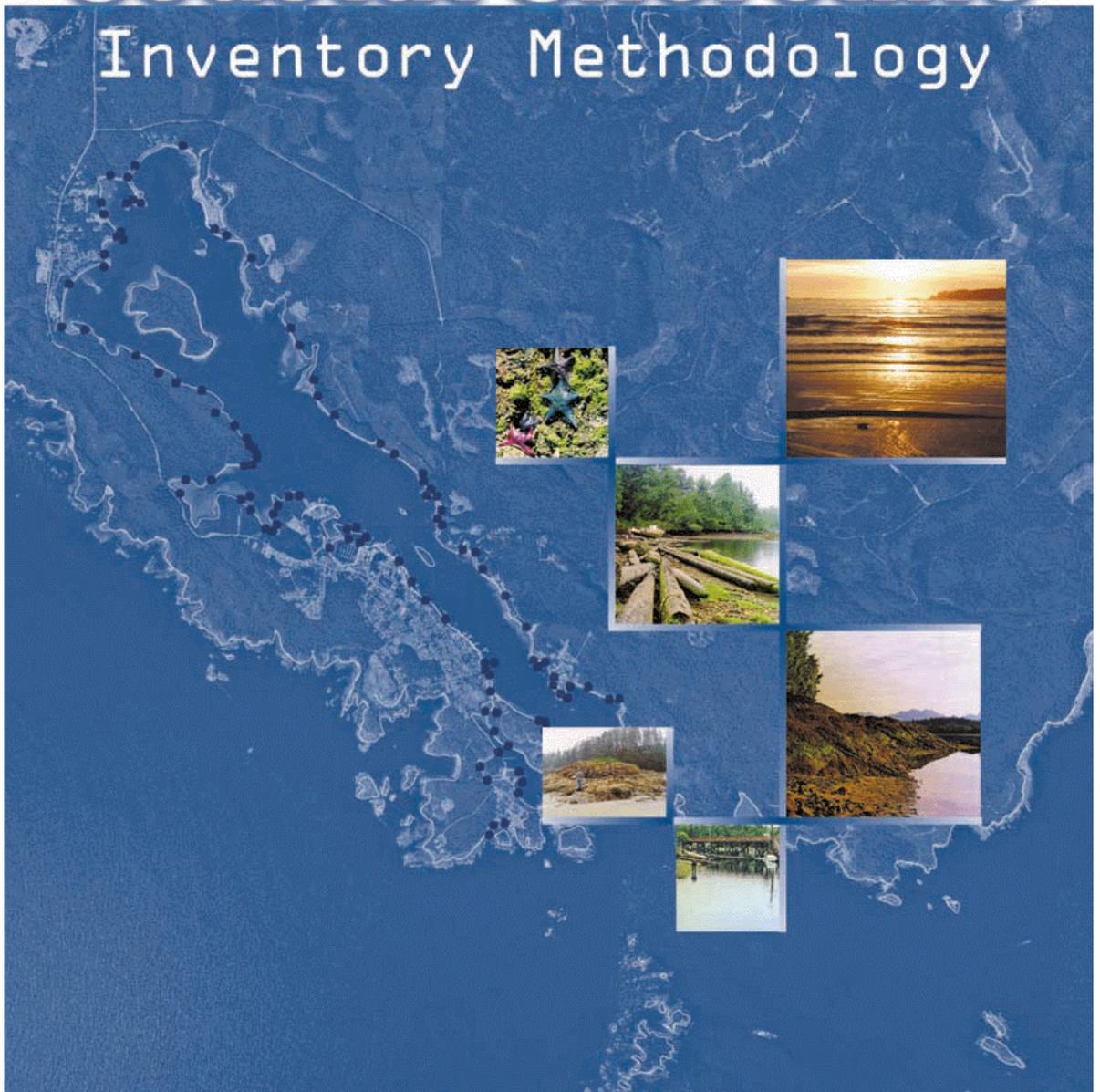


DRAFT

Coastal Shoreline

Inventory Methodology



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COMMUNITY MAPPING NETWORK

COASTAL SHORELINE INVENTORY AND MAPPING ABSTRACT

This manual is a standardized methodology for mapping coastal shoreline areas, including intertidal (foreshore), backshore and coastal shoreline riparian areas of British Columbia. The data collected is intended to provide valuable information for use by local and regional planners, resource managers, and community stakeholders, marine researchers, environmental biologists and others who are interested in using spatially accurate data to assist in making development and resource-related decisions.

This methodology follows the approach and standards used by the Sensitive Habitat Inventory Methodology (SHIM) for mapping watercourse features and positions. The Coastal Shoreline Inventory Methodology was initially developed as a data inventory project piloted in Ucluelet Inlet, on the west coast of Vancouver Island. The general objectives of this pilot were to develop and test a standard methodology for coastal shoreline mapping that can be applied across British Columbia. Important considerations for this pilot project included use of local knowledge and development of capacity by local people and groups to organise and complete these methods.

The use and application of CSIM is intended to:

- Map spatially accurate data that can be linked to cadastral maps and plans for municipalities and regional districts;
- identify and map sensitive coastal habitats and resources;
- provide detailed habitat information for foreshore planning and impact assessment;
- ground truth assigned shoreline types and LUCO units from provincial government Land Use Coordination Office (LUCO) inventories.

CSIM collects four principal types of information including:

- Verification of the boundaries and classification of the Provincial physical shoreline type;
 - Across shore profiles of the physical and biological characteristics of the intertidal and backshore portions of those physical shoreline types;
 - Intertidal and backshore areas of sensitive habitat
- Locations of significant intertidal and backshore physical, biological, anthropogenic and cultural features;
- biological (flora and fauna) features and characteristics;

This manual provides procedures for mapping and inventory in coastal shorelines, and methods for data management and analysis using a spatial database.

ACKNOWLEDGEMENTS

This manual was prepared over five years through consultation with many coastal communities within British Columbia. The authors recognise contributions from many local government planners and engineers, volunteers, community groups, fishers, First Nations, fisheries and environmental biologists. Special recognition is given to Adrienne Mason of Raincoast Communications, Project Watershed in the Comox Valley, Friends of Semiahmoo Bay, Nanaimo Community Fisheries Development Centre (CFDC), Alberni Clayoquot Regional District (ACRD), Regional Aquatic Management Society (RAMS), Pacific Rim National Park Reserve, Ucluelet First Nation, Nuu-chah-nulth Tribal Council and many other groups that piloted methods and promoted use of the information in municipal and regional planning processes. Thanks is given to Mark Johannes, Josie Cleland and Leila Hanslit of the Northwest Ecosystem Institute for building a GIS based atlas using the CSIM methods for Ucluelet, and for designing the front cover of the CSIM manual and for assistance in coordinating and promoting the initiative from the beginning.

Direction for the development of this manual was provided by an ad hoc steering committee including Brad Mason of Fisheries and Oceans Canada, Jacqueline Booth, Jacqueline Booth and Associates and Mark Johannes, Northwest Ecosystem Institute. Further guidance and support was provided by Don Chamberlain, Cynthia Durance, Mike Berry, Marci Leighton, and Josie Cleland.

Local user input was contributed through ongoing consultation, extensive field trials, intensive user need assessments, focus groups, working sessions and workshops. The participation of numerous individuals from the municipal, provincial and federal governments, as well as stewardship groups and First Nations is appreciated.

Developing a coastal shoreline mapping standard and data system using global positioning system (GPS) and geographic information system (GIS) to meet the needs of different coastal communities and groups has been an interesting and challenging experience. We hope this methodology will continue to develop to meet the needs of local planners, biologists and managers. The development of this mapping standard is intended to promote the protection and sustainable development of fisheries, wildlife and aquatic habitat resources in coastal British Columbia.

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Coastal Shoreline Inventory Mapping

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INTRODUCTION

The Coastal Shoreline Inventory Mapping (CSIM) method was developed to provide a standardized method for collecting detailed information in support of local planning, stewardship and environmental protection of coastal shorelines in British Columbia. The coastal shorezone in this manual has been interpreted as including intertidal (foreshore), backshore and coastal shoreline riparian areas. The method focuses on those biological and physical coastal features that may be directly or indirectly impacted by human activities or which are critical in protecting shorezone ecosystems. The method is also designed to document anthropogenic modifications of the shorezone. The mapping scale specified by the methods is large enough to collect the detail required for local and site planning and assessment. The spatial data collected will provide valuable information for use by local and regional planners, resource managers, and community stakeholders, marine researchers, environmental biologists and others who require spatially accurate data to assist in making decisions related to shorezone planning and development.

CSIM methods use Global Positioning System technology interfaced with geographic information system tools to support the precise mapping and inventory of shorelines at detailed mapping scales. CSIM builds on the existing provincial physical shoreline classification by ground truthing and refining it at larger mapping scales and adding the explicit mapping of significant coastal features.

The key objectives of CSIM are to:

- Ground truth and thereby verify and validate existing shorezone information.
- Correctly georeference both the high and low tide shorelines at a scale of at least 1:5,000.
- Map and describe the location and extent of physical, biological and anthropogenic features within the shorezone units. This system identifies those features that are relevant to coastal zone stewardship and management and defines the format for classifying and mapping them.

The Coastal Shoreline Inventory Mapping (CSIM) method was developed with the interest, cooperation and participation of many individuals and groups within British Columbia. The method development is ongoing and represents at least three years of experience and consultation with specialists, local community groups and agencies within the Georgia Basin and West Coast of British Columbia. The CSIM method is intended for distribution and use as a standard and is comprised of a series of modules describing tools to inventory, precisely map and compile data for BC coastal shorelines.

CSIM was initiated through the federal/provincial Fish Habitat Inventory and Information Program (FHIIP). The British Columbia Ministry of Water, Lands and Air Protection and Fisheries and Oceans Canada along with others are partners in fisheries inventory and information systems in BC. Activities of FHIIP include the development of the Fisheries Information Summary System (FISS), Sensitive Habitat Inventory Mapping, Coastal Shoreline Inventory Mapping, participation in the provincial Resources Inventory Committee (RIC) and many other regional and community driven initiatives. The CSIM methodology follows the approach and standards used by the Sensitive Habitat

Inventory Methodology (SHIM) for mapping watercourse features and positions. CSIM was designed to incorporate the existing Provincial RIC standard for "Physical Shoreline Mapping" and compliment the Fisheries and Oceans Canada "Shorekeepers" monitoring method.

The use and adoption of CSIM as a standardized method for mapping coastal shorelines will greatly assist managers, planners and communities alike in the successful resource inventory, land use planning, restoration, enhancement and assessment of BC's coastal shorelines.

OVERVIEW AND CONTEXT OF CSIM

The Shorezone Ecosystem

The Shorezone is the boundary between the land where we live and the ocean. It is the area most impacted by human use with impacts from backshore activities such as urban and rural development, intertidal activities such as shellfish culture and harvesting and from offshore impacts such as oil spills and marinas. It is also an area that is subject to human controls such as municipal zoning or granting of foreshore leases. As such it is important that we have information on the ecosystems and features that are found there.

CSIM considers the shorezone to extend offshore to the point at which influence from foreshore activities ceases to be significant. For convenience this is taken as the 20 m contour surrounding the shoreline. Within this, the shorezone can be divided into a number of across-shore zones. CSIM divides the across shore profile of the shorezone into a number of zones:

- The backshore: The upper or inner, usually dry, zone of the shore lying between the high-water line of mean spring tides and the upper limit of shorezone processes; it is acted upon by waves or covered by water only during exceptionally severe storms or unusually high tides.
- The splash zone: The region that is sprayed by salty mist from crashing waves during high tide. This area is seldom covered by the ocean but is watered by sea mist and rain. The splash zone is mostly inhabited by terrestrial organisms that can tolerate some salt.
- The intertidal zone: The area between the mean, ordinary high tide mark and the mean ordinary low tide mark.
- The shallow subtidal zone: Areas below the mean ordinary low tide mark and about 20 depth. The 20 m depth was chosen as it is roughly the point at which light becomes limiting for marine algae.
- The pelagic zone: The water column of the ocean.

The shorezone characteristics or features of interest include physical features (substrate, slope, sediments), vegetative cover (trees, shrubs, grasses in the backshore and marine algae in the intertidal and subtidal), benthic animals (marine invertebrates and tide pool fishes), pelagic fish (herring, salmon, groundfish) and wildlife (birds, marine mammals and terrestrial mammals which feed along or otherwise use the shorezone). The nature of these features will dictate the way we survey and record them but all are important components of the shorezone.

CSIM Mapping Products

CSIM provides you with a method to georeference and describe ecosystems and physical, biological and anthropogenic features of the shorezone in your project area. It provides a snapshot of what is present at one point in time. CSIM will help you gather the following georeferenced information for the shorezone in your project area:

- **Shoreline and datum:** The shoreline and datum are defined as the upper and lower limits respectively of the intertidal zone.
- **Shorezone Linear Physical Units:** The linear delineation of the shorezone into alongshore units based on the exposure to wave energy, intertidal substrate and sediment and intertidal slope and width.
- **Shorezone Ecosystem Polygons:** Polygons or areas of uniform physical, biological, land use and tidal zone characteristics mapped from air photos and/or existing data sources and verified using field reconnaissance.
- **Shorezone Transects:** The information of the distribution of the physical shorezone substrate and physical, biological and anthropogenic features across a shorezone unit at designated points. This information is used to characterize the across shore characteristics of a shorezone unit.
- **Shorezone Features:** Biological, physical and anthropogenic features mapped using GPS within the shorezone. These may include data of different representational formats (polygon, line and point data).

The data are designed to reside in a Geographic Information System (GIS). A standard database structure allows you to compare the data for your project area with that of other areas where CSIM methods have been applied. The CSIM methods have been developed to ensure that the way information is collected and stored is standardized so that it can be integrated and compared with existing local and regional geographic information.

CSIM Applications

CSIM was designed to collect information that can be used at the local level for local planning, or designing stewardship and remediation projects. The shorezone is a critical component of both urban and rural landscapes providing the link between freshwater, terrestrial and marine ecosystems. Shorezones are also under more pressure than any other ecosystem from development, recreation and pollution. Mapping of the shorezone is the first, critical step towards managing and protecting this boundary zone. Some of the suggested uses of the database resulting from a CSIM project include:

- Provide the detailed information needed for local shorezone planning and background needed for informed policies in Official Community Plans.
- Guide decisions in locating and establishing shorezone habitat restoration and enhancement or stewardship projects.
- Identify areas with potential problems with erosion.

- Identify areas with potential point source and non-point source pollution and ensuing nearshore contamination.
- Assist with the design of stormwater / surface runoff management plans.
- Identify and prioritize shorezone areas for protection or restoration (e.g. fish and wildlife habitat, clam beds, eelgrass beds or other sensitive ecosystems).
- Locating occurrences of rare species for protection and monitoring or invasive species for designing control and removal programs.
- Identify areas for more intensive monitoring and assessment programs.
- Provide a base line for flagging significant changes in biophysical or anthropogenic shoreline features.

CSIM is also a method to build awareness of the shorezone in your community and can help develop a group of citizens who will map, monitor and care for your shorezone.

Ownership of the shorezone

In B.C., the Province of British Columbia owns all land in the intertidal zone – except in cases of federal harbours and aboriginal lands. Above the high tide, in the splash zone and backshore, the land may be publicly or privately owned. The seabed below the mean ordinary high tide mark (the subtidal) is owned either by the Provincial Government (in the case of the Strait of Georgia) or by the Federal Government (off the West coasts of Vancouver and the Queen Charlotte Islands). In some areas such as Hecate Strait, the ownership of the seabed is disputed between the two governments and in some cases First Nations as well. In the Strait of Georgia, most of the backshore is privately owned while in other parts of the province most of the backshore is public or “Crown” land.

Shorezone Regulation, Planning and Stewardship

On both public and private land, laws and regulations can protect the shorezone to some extent by limiting the types of human activities that may occur there. The Provincial government regulates all shorezone activities or uses that require a foreshore lease including:

- The construction of foreshore structures such as docks and boathouses;
- Marine fish, shellfish or algal culture sites;
- Log handling sites (dumps, booms);
- Floating structures used for sport fishing or other commercial recreational purposes.

Local governments can guide the Provincial Government in zoning where these foreshore leases may be issued and in requiring set backs for other activities from the

shoreline. However laws and regulations can only go so far; Shorezone stewardship, the voluntary conservation of the natural shorezone habitat, also plays an important role. Shorezone planning and stewardship both require information on the marine habitats and features to be effective. Maps of habitats and habitat features produced by CSIM provide the background information municipalities, regional districts or the Islands Trust need to assign shorezone zoning. Community groups need the information to design local shorezone monitoring, stewardship and rehabilitation projects.

Inventory Limitations

CSIM is designed to provide the information on shorezone habitats and features that is needed to prevent and, if that is unsuccessful, record human impacts. CSIM maps the exact location of shorezone habitats and features at the point in time the mapping is undertaken. It can record impacts of human activity human such as erosion, disruption of benthos, and aquatic discharges, but it does not monitor them. Rather, CSIM provides the information needed to design a monitoring program such as "Shorekeepers" or the "GSA Quadrat system" (see Appendix 1).

Who should use this manual?

While the CSIM system is rigorous and scientifically sound, it can be used by motivated, non-professional community members. A basic understanding of coastal ecology and ecological principles is needed as a starting point for users of this manual. The goal of developing CSIM methods is to make the methods versatile and usable by both professionals and trained community groups. All CSIM projects would benefit by having at least one person with provincial Resource Inventory Committee (RIC) certification in the use of global positioning systems (GPS).

Training requirements

Training is required for groups in the use of CSIM methods. Not every person in a project group needs to be capable of every task, although it is of benefit if they understand what is involved at all stages of the CSIM project. Each module has specific training requirements and will draw on the different strengths of the project team.

Module 1, where the scope and scale of the project are determined, requires someone who has a good understanding of how the information will be used. An understanding of how the shorezone ecosystem functions is also useful at this point.

In Module 2, where existing information is identified and assembled, requires someone who understands (or is willing to take the time to learn) about baseline topographic, cadastral and natural resource mapping. This module can be done by a team with someone with strong organizational skills to keep track of and collate the data teamed up with someone with knowledge of what information is useful and where it is located.

Module 3 involves the interpretation of Air Photos to pre-type the shorezone, and if a digital orthophoto is not available for your region will also require someone with strong image analysis skills.

Modules 4 and 5, data collection from the field, require RIC trained GPS technician and biologists or other field crew how are familiar with the local flora and fauna. Other skills required for these modules can be quickly learned during a CSIM training course.

Finally Module 6 requires someone with GIS and database management skills.

Relationship of CSIM to Other Coastal Habitat Inventory Methods

In British Columbia and Washington State there already exist a number of methods for used classifying and mapping physical, biological and or anthropogenic attributes of the shorezone. Each method was developed with a specific scale and objective in mind. While each method is a valuable tool for its purpose, none of these systems provide the level of detail and coverage required by local planners, stewardship groups or similar local users. In developing CSIM, most of these existing methods were reviewed and where appropriate used to form the basis of CSIM. In the case of other methods, CSIM was designed to compliment or supplement the information derived from applying their methodology.

The list of methods currently used to map the B.C. shorezone is presented in the table below; details of these methods and their relationship to the CSIM is given in Appendix 1. Your study area will already have been surveyed using one or more of these other coastal habitat inventory methods. It is important that you identify and gather any data collected from these surveys for your project area as part of your CSIM mapping project (see Module 2 of this method).

Method Objective	Method
Classification and mapping of alongshore shoreline units	BC Physical and Biological Shorezone mapping system*
	Victoria and Esquimalt Harbours Ecological Inventory and Rating
	People for Puget Sound Rapid Shoreline Inventory
Classification and mapping of coastal ecosystems	BC Terrain Classification System*
	BC Terrestrial Ecosystem Mapping*
	Sensitive Ecosystems Inventory
	BC Estuary Mapping System*
	BC Wetland and Riparian Mapping System*
	BC Marine Ecological Classification*
Shoreline Monitoring	Shorekeepers**

	Reefkeepers**
	Georgia Strait Alliance Quadrat System
	Field Methods for Mapping and Monitoring Eelgrass Habitat in BC***
	Photo Point Monitoring
<p>*Standard method approved by BC Resource Inventory Committee (RIC) **Method developed and supported by DFO *** Method developed and supported by Environment Canada</p>	

Broad scale mapping of fisheries and fish habitat based on the personal knowledge of those intimately familiar with these marine resources (e.g. DFO staff, commercial and recreational fishermen) can be found in the Pacific Coastal Resources Atlas on the Community Mapping Network site:

http://www.shim.bc.ca/Coastal/Coastal_entry.htm

Schematic Overview of Shorezone Mapping Modules

The CSIM methodology has been organized into a series of six tasks or modules and seven appendices which provide additional “tools” to support these modules. The following flow chart illustrates the sequence and connectivity between tools and modules used to complete a Coastal Shoreline Inventory Mapping project.

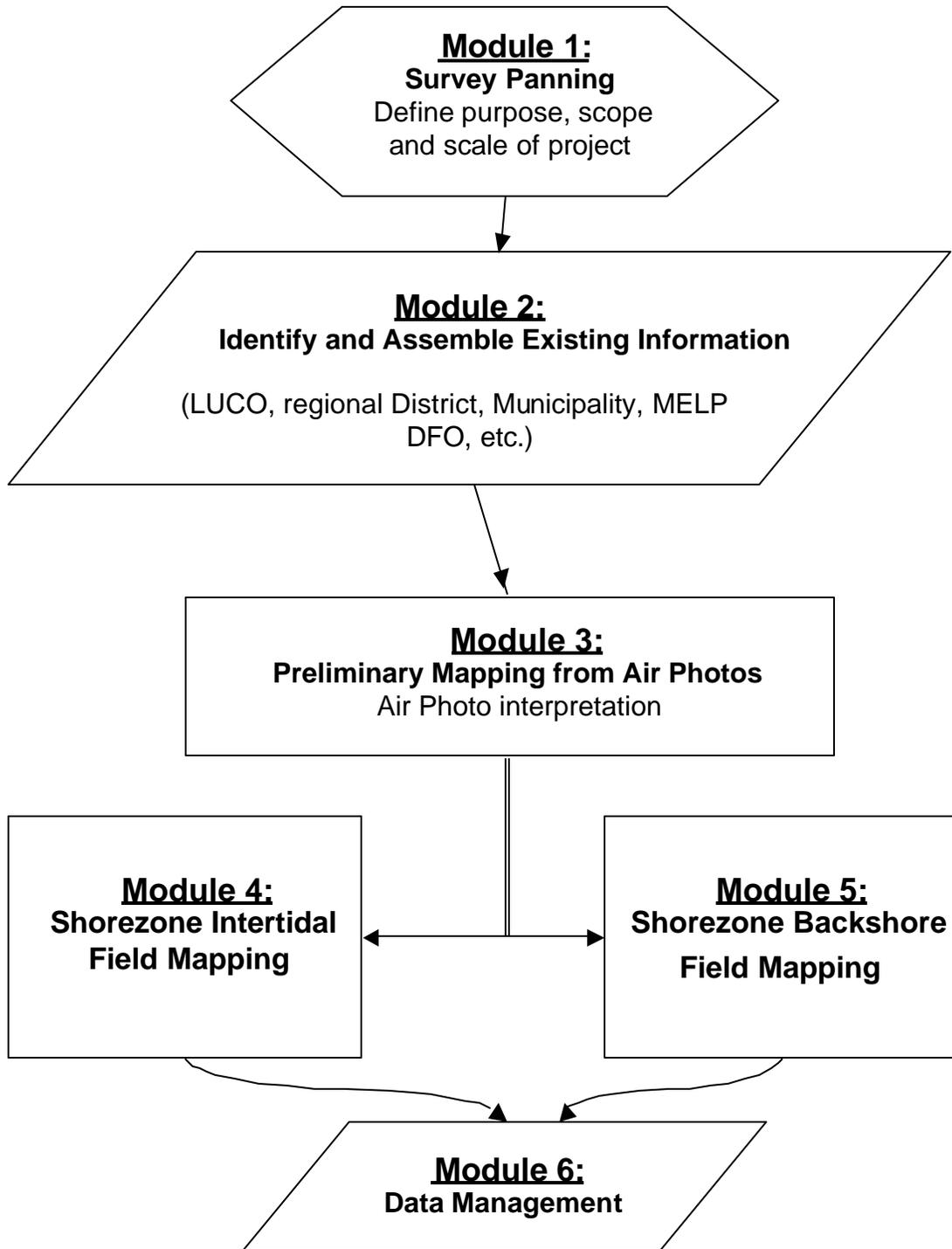


Figure 1: Schematic flow chart of CSIM modules

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MODULE 1: CSIM PROJECT PLANNING

The Coastal Shoreline Inventory Mapping (CSIM) method has been developed to provide a standardized method for providing the detailed information of the coastal shoreline in support of local planning, stewardship and environmental protection of coastal shoreline areas. The method provides a means of integrating detailed GPS mapping of coastal features with existing coastal habitat and human use information. The system includes the ability to map a wide variety of coastal features, however the selection of features that a user will map for an area will depend on:

- a) The nature of the area being mapped (e.g. protected soft substrate bay or rocky steep sided fjord);
- b) The purpose of the mapping (e.g. local zoning for foreshore use, regional planning for oil spill response, identification of areas in need of habitat restoration or protection, inventory of coastal resource, etc.);
- c) The resources available to the mapping team. (i.e. personnel, GPS, air photos, bathymetry, other existing information).

The process of planning your CSIM project should consist of the following steps:

Step 1: Decide on the Purpose(s) the CSIM Project

CSIM mapping can be used for a number of purposes: shorezone planning, designing stewardship or restoration projects, baseline inventory or designing shorezone monitoring projects. By stating the principle use for which the CSIM data is being collected, you can better determine the scope and scale of your CSIM project. Note that you may decide that the information you collect will be put to more than one use; however usually there is one purpose more pressing than others that will help in designing your CSIM project.

Step 2: Set the Scale and Scope of the CSIM project

The *scale* of the CSIM project is what determines how large and area you will map and the size of the smallest feature you will map as a polygon. The *scope* of the project determines how many features you will map and how much information you will collect on those features. CSIM allows the user to select as many or as few features as meets their needs and define those features with as much detail as is necessary for their purpose. Appendix 4? lists the features included in the CSIM data dictionary and indicates why those features are important and what concerns a coastal planning or stewardship group might have for them. These lists should be reviewed, and those features that you want to map selected along with the associated amount of detail. For example, if you are gathering information for creating shorezone zoning for an OCP you might want to map only those features that might influence your zoning such as eelgrass beds, clam beds and evidence of erosion. If you are looking at potential

sources of coastal pollution, you might want to record information on point discharge sites. Along with mapping the location of these discharge sites, the CSIM data dictionary allows you to record information on 17 additional features of a discharge site; It is up to the project planning team to decide how much detail to collect give the area you wish to cover and the time available.

Another trade off that you might want to make is in the amount of across shore detail you collect. Extensive features such as eelgrass or clam beds can be mapped as linear, along-shore features instead of as polygons. This might be a good choice if you are collecting data for creating a coastal zone plan where the presence of these features along a shore would influence zoning regardless of their across shore extent. Mapping these features as lines or points instead of polygons greatly speeds up the mapping process, however it does not provide you with the information that might be required to approve a foreshore structure.

Depending on the resources available a trade off between the scope of the project and its scale may have to be worked out. This compromise will be influenced by the urgency of information and the immediate purpose for which it is being collected. Prior to mapping, you should decide on the level of detail needed; it is recommended that a minimum mapped polygon size will be 25 m in the longest dimension. Based on this criterion, an isolated eelgrass patch 25 x 3 m would be mapped as a polygon, while an isolated patch 10 x 2 m would not be mapped or only mapped as a point.

Step 3: Set a Project Timetable

CSIM has been set up as a series of *modules* (see Figure 1: Schematic flow chart of CSIM modules). The modules have to be completed in a logical sequence. The main factor that will determine timing of the project is the GPS mapping of coastal features (Module 4), which is dependent on low daytime tides which are most frequent during the late spring and summer months. Information on tides can be obtained from hard copy tide tables available at chandlers, marinas, many book stores and most libraries.

Alternatively you can plot tide tables from the following Internet web sites:

<http://tbone.biol.sc.edu/tide/index.html>

<http://www.lau.chs-shc.dfo-mpo.gc.ca/english/Canada.shtml>

Timing may also be influenced by the availability of the project team, especially if it includes volunteer help.

Step 4: Compile a Project Team

Early on you will need to compile a project team and assign project tasks to each team member. Tasks should be assigned by module so that team members can see when they have to be prepared to undertake and complete their task(s). Certain tasks require specific skills and certification while other tasks require skills that can be quickly learned during a CSIM training course. Specific skills required are given below::

Task	Modules	Skills or certification needed
Decide on purpose and scope of project	1	Understanding of goals of group or organization that will use CSIM data
Gather existing information	2	Familiarity with government data sources and types of coastal information
Compile existing information	2	Use and management of a GIS and database
Air photo interpretation – creation of orthophoto mosaic	3	Familiarity with image processing software (only if existing digital orthophoto is not available)
Air photo interpretation – mapping of shorezone features and ecosystems	3	Familiarity with the project area, experience in looking at air photos, understanding and knowledge of coastal ecosystems and features
GPS field mapping	4 and 5	RIC certified in GPS mapping
Mapping of shorezone features	4 and 5	Ability to identify shorezone features
GIS data management	6	Use and management of a GIS and database

Step 5: Obtain Land Owner Permission

While the intertidal (below mean highest tide) and subtidal zones are all public lands in Canada, you may have to traverse private land to get to the shore or to traverse areas at high tide or when the topography is very steep or rugged. Where possible landowners of properties you expect to have to traverse should be contacted prior to conducting field surveys. This saves valuable “low tide” field time and also provides a greater probability of contacting the landowner. Your local government planning office can often provide contact information for specific addresses or alternatively tell you the address of a specific property. Alternatively you can use internet resources such as Infospace¹ to look up the name and phone number of the person at a specific street address. The importance of gaining landowner permission well before the field survey cannot be underestimated and is a key task for the project organizers in Module 1. See Appendix 7 for a sample copy of a letter that could be sent to property owners.

¹ http://www.infospace.com/canada/reverse_ca.htm

MODULE 2: **COMPILE EXISTING INFORMATION**

A key part of the initial preparation for actual mapping in the field is compilation of a preliminary GIS database that includes all of the existing information. This database can help you plan your fieldwork, put your information into context and provide initial reference points and features to verify the information you collect during field surveys. As pointed out in the overview section of this report, there are a number of shorezone mapping standards in BC. A description of these methods and how they relate to the CSIM method is covered in Appendix 1. Some of these methods have been used to map the shorezone in all regions of BC; others may have been applied for specific purposes in your area. These existing data sources are discussed in Step 1 of this module.

Step 2 of this module takes you through the steps to use the existing information to create a working GIS database that you can then use to:

- Delineate your initial project boundaries;
- Verify the positions of your field data;
- Provide a first cut at delineating backshore coastal ecosystems and intertidal shorezone units;
- Select locations for across-shore transects.

Step 1: Identify and Collect Existing Information

The existing information falls into 4 categories:

1. Topographic and bathymetric maps – coastline, river networks, road networks, elevations, depth contours, and topographic / hydrographic features.
2. Land Status maps – property lines, crown lands and protected areas, right of ways.
3. Shorezone classification maps – linear sections of the shoreline with uniform physical or biological characteristics.
4. Ecosystem classification maps - coastal and backshore regions classified according to Vegetation or Terrain, marine substrates, soils maps.
5. Coastal Features maps – maps with coastal features individually mapped as points, lines or polygons.
6. Wildlife information – nesting sites for raptors, herons, colonial nesting species and other marine birds, seal or sealion haulout or loafing areas, Cetacean migration routes or travel corridors, other areas of bird or mammal concentrations.

The relevant information currently exists in many different locations with various agencies. The Community Mapping Network (CMN) is working to assemble as much coastal and marine baseline and resource information as possible on their web site² for on-line viewing. Your first step should be to view what data is available for your area of interest on the CMN web site and contact the CMN to assemble what digital data is available for your region. You will still need to search for and collect local information. All of the existing information should then be assembled in your own GIS database. The sections below take you through the most relevant types of background data that you should assemble for your project.

Topographic and bathymetric maps

Together the topographic and bathymetric information form the “base map” for all other map layers. A base map of your project area is required before you start any fieldwork or compilation of features from existing sources. The base map provides an initial shoreline, the location of roads, harbours, marinas and certain large permanent structures such as hydro-transmission lines, towers or large buildings. The base map enables you to:

- Provide control points for interpreting aerial photos;
- Provide geodetic control for ground surveys.

Currently in BC, there is no systematic base map coverage at scales greater than 1:20,000. In addition, coastlines have been variably interpreted in the existing base maps. As a general guideline, you should seek out the most accurate base map available for your coastal study area. The standard alternatives available in BC are shown below in Table 1. All of these base maps can be viewed on the CMN web site.

Table 1: Existing base maps for the BC shorezone

Base Map series	Source	Scale	Comments
Hydrographic charts	Canadian Hydrographic Service (CHS)	Variable: 1:2,500 to 1:200,000	Hard copy charts only. Accurate coastline, few landward features required for aerial photo control; may provide high and low tide coastlines but usually at small scales. Provides depth contours.
	Nautical Data International (NDI)	Variable: 1:2,500 to 1:200,000	Source in Canada for digital raster or vector versions of the CHS charts.
TRIM and TRIM 2	Provincial Government	1:10,000 to 1:20,000	Acquired at 1:63,000 and 1:40,000 scale respectively; provides considerable topographic and planimetric control; shoreline is less accurate than other sources. TRIM 2 is available for only a small portion of the BC coastline.
BC Watershed Atlas	MWLAP	1:50,000	Shoreline river systems and watersheds. At smaller scale than TRIM.

² <http://www.shim.bc.ca/> or <http://www.cmNBC.ca>

The optimal choice for a base map is a combination of the CHS charts and TRIM 2 (if available) or TRIM base maps. Newer hydrographic charts show chart datum as a dotted line and in some areas such as harbours and passages may be of a scale (1:5,000 to 1:20,000) useful for mapping high and low tide lines.

Land Status Maps

Cadastral Information

The Cadastral information is the official registry of the ownership of land. (The word comes from the Latin root *capita*, heads for the Roman land tax). These maps show all property boundaries and right-of-ways. These maps Attributes associated with parcels include information on the current owner and the status of the land for tax purposes. Your local government³ should have digital cadastral maps for your region. This layer will also include boundaries of Provincial and Federal protected areas (National Parks, Provincial Parks, Ecological Reserves, Recreation areas) and Federal and provincial crown land parcels.

Marine Protected Areas

While the legislation exists for creating federal and provincial marine protected areas (MPAs), to date several areas have been proposed but no areas have been officially designated. When MPAs have been established they will be part of the dataset on the CMN site.

Land Tenures and Foreshore Leases

Although the land below the mean high tide mark is all public land, the provincial government can issues leases in both the intertidal and subtidal. The digital file of leases contains information on the location, purpose and status of all foreshore leases. While this database is maintained by the Provincial Government it may be viewed and obtained for your study area on the CMN.

Other jurisdictional areas that may be of interest for your region include Shipping Lanes, Department of National Defence testing areas, and ocean dumping sites. Most of these sites are offshore; all should be indicated on recent CHS charts for your region. The Department of Fisheries and Oceans (DFO) has the authority to close areas to harvest of marine species. The most relevant closures for community mapping purposes are clam harvesting closures, usually in response to local contamination. Areas may also be closed for commercial and sport fisheries but these can change over time in response to management practices.

³ municipality, regional district or Islands Trust

Shorezone Classification Maps

The entire coast of British Columbia has been mapped using the BC Provincial Physical and Biological Shorezone Classification System. This information is posted on the CMN web site and the GIS layer containing physical shorezone units and associated biological banding.

The Physical Shorezone mapping system has been used to divide the coast into alongshore segments (units) based on the exposure regime and general physical form and texture of the shorezone. This system provides an overview of the main physical characteristics of the shorezone which can then be integrated with more detailed biotic and physical information collected at much large scales from GPS field surveys using the CSIM methodology.

The Physical Shorezone Classification was intended for regional planning purposes and was therefore completed at a scale of 1:40,000 for most of the province. While the system can be applied at larger scales, the boundaries need to be reviewed and in some cases "sub-units" defined. For example, in most instances small islets and reefs are included in the units of the adjacent shorelines. These can be reclassified as sub-units at the 1:5,000 map scale and the physical attributes modified as appropriate. Identification of sub-units should be done during the field mapping of shorezone features (Module 4).

The Biological Shorezone Classification system adds information on the biological "bands" present in each shorezone unit in the Physical shorezone classification database. The classification of vegetative communities applies to the entire physical shorezone unit and is therefore only to be taken as an indication of what might be there. This information can, however, be useful in interpreting air photos and selecting locations for shoreline transects.

In a few isolated areas other methods may also have been used to classify shorezone units. The Harbour Ecological Inventory and Rating System (HEIR) has been applied in Victoria and Esquimalt Harbours and some BC communities have looked at applying the People For Puget Sound Rapid Shoreline Inventory Method, although none have applied it locally at this point in time (2004). Your local government office should know what local shorezone linear mapping has been completed for your region.

Ecosystem Classification maps

Terrestrial Ecosystem Mapping and Terrain mapping have been applied in a few areas of the province although few of these sites are on the coast and much of the mapping has been done for forestry applications at regional scales (1:250,000). Where they do exist in your region at detailed scale (<1:10,000), these products can be used to replace your own photo interpretation of backshore ecosystems (Module 3). Sensitive Ecosystems Inventory mapping has been completed for most of the east coast of

Vancouver Island, including the Gulf Islands. This ecosystem classification mapping only maps specific “sensitive ecosystems” but can be used as a starting point for photo interpretation.

Coastal Features and Species Records

As indicated in the overview section of this manual, most of the other coastal mapping systems applied in BC have mapped coastal features only as an attribute of a shorezone unit or ecosystem polygon. There are however a number of potential sources for maps of coastal features or detailed descriptions of coastal ecosystems or species occurrence. These are listed below.

Shorekeeper Records

If there has been a Shorekeepers project in your area this will give you some indication of the species and habitats you may expect to encounter in your survey. The location of the Shorekeeper transects should be part of your database and can be used to help pre-type air photos in Module 3.

First Nations

First Nations may have information they are willing to share on traditional use or other knowledge of the coastal ecosystems. The contact number for the local Band or Tribal Council can be obtained by contacting the Ministry of Aboriginal Affairs through Enquiry B.C., or looking in local phone directories. Traditionally First Nations’ families had stewardship/ownership of intertidal shellfish (mostly clams) and in the backshore of certain parts of the Strait of Georgia maintained coastal meadows for *Camus* harvesting by using fire to prevent succession into forest ecosystems.

Local Resource Mapping (clam beds, eelgrass beds, kelp beds)

Stewardship and conservation organisations may also have valuable information on local coastal shorelines and other aquatic habitats. The contact number for your local stewardship group can be obtained through the Community Advisor, or Stewardship Coordinator at the regional Fisheries and Oceans Canada office (consult the blue pages of the telephone directory for this phone number) or the Stewardship Advisor/Coordinator at the regional Ministry of Water, Land and Air Protection office (consult the blue pages of the telephone directory for this phone number). The following types of data may be available through local stewardship groups:

- Local use for recreational clam or crab harvesting;
- Riparian backshore, intertidal – foreshore, subtidal reef habitat survey results;
- Maps or anecdotal information on the locations of eelgrass or kelp beds;
- Descriptions of habitat restoration and enhancement projects.

Other Data Sources

Historical air photos, reports, maps and other existing inventory data for the study area can indicate features for the mapping team to look out for when mapping. They also permit an assessment of the relative stability of the features over time and seasons. This procedure also facilitates investigation of the influence of anthropogenic impacts on the estuary and may assist in explaining conditions that are difficult to interpret in the field.

Other types of data, including ground or air 35 mm photography, aerial video imagery, and any other existing relevant sources may be useful. While georeferencing is not possible from these media, they can provide invaluable assistance in characterizing shorelines, especially in recognizing features more apparent from a profile rather than a vertical image.

Wildlife Inventory Data

Wildlife (birds, small mammals and marine mammals) are somewhat different than other shorezone features in that they tend to be more mobile and their distribution along the shorezone can change dramatically diurnally, seasonally and between years. Some features such as nest sites or sea haul outs tend to be more consistent in their locations and easier to map, however the presence of a killer whale travel route or an intertidal roosting site for Harlequin ducks can be just as important to capture.

Red and Blue Listed Species

Sightings and occurrence records for red and blue listed species are maintained by the B.C. Conservation Data Centre (CDC). The CDC archives information on location, known presence, species, and species status for listed species of plants and animals (i.e. den or nesting sites).

Marine and Coastal Birds

The Canadian Wildlife Service maintains an inventory of seabird and heron colonies as well as individual nest sites of raptors (eagles, falcons). Other bird concentrations of interest are migratory stopovers of species such as western sandpipers, late summer marine concentrations of moulting sea ducks (Scoters and Harlequin Ducks), and large concentrations of over wintering waterfowl. Sources for locating these kinds of bird concentrations include CWS and local naturalist groups.

Seal and Sealion Haulout and Rafting Sites

The Marine Mammal Research Unit at the Department of Fisheries and Oceans routinely surveys the BC coast for seals and sea lions. They survey about every 5 years selected areas of the coast – not all areas are surveyed. Local fishermen (sport or commercial) are one of the best sources of information on these species.

Step 2: Create a GIS database with all existing information

Once you have identified and collected all of the existing information the next step is to combine it into GIS with a base map for your project. All data must be converted into a common projection so that it can be overlaid together. It is recommended that you convert all data to a UTM projection in the zone most applicable to your region using the to North American Datum 1983 (NAD83). This projection minimizes distortion at large (detailed) mapping scales. Most of the province wide information you may obtain will be in an Albers Equal Area Conic projection; other data may be referenced as geographic co-ordinates (Latitude and Longitude). The data sets will have to be transformed. Also note the datum of your digital data. Recent data sets will be referenced to NAD83 while older data will be referenced to North American Datum 1927 and will have to have a datum shift applied.

One of the most important components of your GIS database will be the base map of your project area. This base map should include those layers that provide the background information for planning and preliminary mapping of your project area. These should include:

- A preliminary coastline at the most detailed scale you can find,
- Bathymetry (depth contours) for the nearshore areas,
- Roads and right-of-ways,
- Property boundaries,
- Physical Shorezone Units,
- Any existing information on shorezone marine vegetation (e.g. eelgrass beds),
- Existing Information on backshore land use or land cover (e.g. SEI, TEM, Forest cover mapping)

MODULE 3: PRELIMINARY MAPPING FROM AIR PHOTOS

While rigorous interpretation of air photos is beyond the capabilities of most community groups, a great deal of useful information can be derived from good quality air photos. Air photos can provide an overview of your study area and boundaries useful in logistical planning of your field survey. They can also be used to derive a preliminary high tide line; in areas of steep or otherwise inaccessible coastline the air photos may be your only method of obtaining a high tide coastline accurate at the CSIM mapping scale (<1:5,000). Air photos can also be used to identify and map polygons representing basic categories of shorezone cover and land use. The classification and boundaries of these polygons can be later verified using Shorezone field mapping methods (Modules 4 & 5). If professionally prepared ecosystem maps exist for your area these can help you delineate polygons meaningful to you purpose. The accepted ecosystem classification systems that have been applied at detailed mapping scales (<1:10,000) include *Terrestrial Ecosystem Mapping* and *Sensitive Ecosystems Inventory Mapping*.

Selection of Air Photos

The preferred inventory base for shorezone mapping are high-resolution colour aerial photos collected during low tide. Scales of 1:5,000 to 1:10,000 are preferred. Alternatively, black and white high resolution, vertical low tide photos can be used. There is some loss of resolution with these photographs, although they are less expensive to obtain. All photos must be orthorectified – this is where the air photo has been digitally referenced and corrected to fit specified projection co-ordinates. Orthophotos photos, which must be taken vertically downwards, are also corrected to remove distortions caused by vertical relief, atmospheric refraction, camera lens distortion and aircraft movements. If possible it is best to obtain an orthophoto mosaic⁴ of your study area.

Sources of digital orthophotos or air photos for BC include:

- The Community Mapping Network (CMN) Website: <http://www.shim.bc.ca> has digital orthophotos for the southeast coast of Vancouver Island the lower mainland regions. The Community Mapping Network (CMN) Website: also provides on-line mapping tools where you can digitize shorelines, features and polygons on-line and have the information provided back to you as a digital shape file (ESRI format).
- McElhanney (Distributors for BC government air photos used to create TRIM base maps: http://www.mcelhanney.com/products/prod_bco_details.html These digital orthophotos in 2004 cost \$200 per map sheet.

⁴ **Orthophoto mosaics** are produced by merging several orthophoto images with image tone and geometry maintained over the entire project thus producing seamless images and data.

- Regional Districts, Islands Trust or Municipalities. Availability will vary from region to region but this should be your first stop as digital orthophotos will generally be free from this source if you are working with your local government.

Air Photo Interpretation Procedures

Preliminary Mapping of the Shoreline And Datum

Both the shoreline (high tide line) high and datum (low tide line) can be mapped with a certain accuracy from 1:5,000 colour air photos taken at or near to a time when the tide level is at, or close, to datum. Datum can be digitized from the position of the land/water interface and the shoreline from visible deposits of seaweed and other beached flotsam. Having digital base layers with existing shorelines, datum and bathymetric/elevation contours to overlay on the air photos greatly helps in the interpretation of these boundaries.

Shorelines with low slopes and a large Intertidal region will likely be the least accurately mapped using existing small scale base maps (>1:5,000) and air photo interpretation. These areas of shoreline will be priority sites for field mapping of the coast and datum (Module 4). Shoreline areas with moderate slopes will probably be identified with moderate levels of position and accuracy (2.5 to 10m) and should also be prioritized for mapping. Reliance on existing digital base maps alone or combined with interpretation of air photos may be the only means you have to get a shoreline and datum in steep and / or inaccessible regions of your project area.

Shorezone Ecosystem Delineation

Air photos provide you with an overview of your project area that can be hard to achieve on the ground. Some basic ecosystem land cover types can be recognised and mapped from good quality orthophotos including:

- backshore land use polygon types (forest, agricultural, grasslands, bare rock, residential and industrial areas, paved areas, waterbodies)
- intertidal polygon types (components as defined by RIC physical shorezone mapping method – beaches, tidal flats, rock platforms, cliffs, offshore islands...)
- subtidal polygons (pick out shallow subtidal platforms/reefs, eelgrass, kelp)

A basic familiarity of your project area helps in interpretation of the different cover types in your region. Keep the interpretation simple and only try to map large features, easily visible on the orthophotos. A minimum polygon size of 0.5 cm² is recommended, following the TEM guidelines (RIC 1998). This corresponds to an area of 0.125 ha at a scale of 1:5,000, and 0.5 ha at 1:10,000. Items smaller than the minimum polygon size may be included as point or line features (e.g. plot locations or some man-made features).

Creating a Working Base Map

Once all of the existing information has been compiled you can create a working base map that you can use in your field surveys. It is suggested that you create a separate map for each of the following themes:

- Shoreline Units,
- Ecosystem polygons and low and high tide shorelines,
- Shoreline features

If your study is large you may require more than one map for each theme in order to obtain a detailed enough map scale. All maps should have a scale bar and compass bearing added. Any maps based on air photo interpretation should also have indicated on them all of the control points used to georeferenced the photos.

Ground Truthing of Results

You are now ready to ground truth your maps using the GPS. Ground truthing will verify both the spatial position and the characteristics of features you have mapped from existing data sources and the air photos. Some features (notably wildlife features) may be seasonal and will have to be ground truthed over a period of time. Other information may be historic such as areas where birds used to nest in a certain location, structures that have been torn down or even formerly pristine coastlines that are now built up. This historic information cannot always be ground truthed but can be useful information to archive and refer to when examining trends in shorezone structure and function.

Ground truthing methods are dealt with in Module 4 for the intertidal and Module 5 for the Riparian zone.

MODULE 4: SHOREZONE INTERTIDAL FIELD MAPPING

Shorezone Intertidal mapping uses GPS technology to collect five distinct types of information:

1. The position of the shoreline. This is represented by mapping an accurate high and low tide line. This information should be collected for the entire project area for all CSIM projects.
2. A general characterization of the shoreline's physical characteristics in an along shore direction. This is done by verification of the classification for the alongshore Physical Shorezone Units mapped by the province and the verification of break points between units. Sub-units may be created where applicable. This information should be collected for the entire project area for all CSIM projects.
3. A characterization of the shoreline's biophysical structure and features in an across shore direction. Across shore transects are completed to document the across shore variation in biophysical characteristics of each shorezone unit or sub-unit. Across shore transects can be prioritised for the more sensitive shorezone units or those under the greatest stress from human activities and later completed for other units as time permits.
4. Verification of intertidal polygons of shorezone land cover that were mapped in Module 3 of this manual. The location of "edges" of polygons should be verified as well as the interpretation of their general characteristics.
5. Identification of distinctive shorezone features relevant to the purpose of the CSIM project. Points, lines or polygons representing the locations of specific shorezone features are georeferenced and described. If time is a constraint a decision can be made to prioritize which features should be mapped and in which shorezone units. For example, it may be decided to complete the mapping of all eelgrass in the first year during the period of low daytime tides and then selecting less sensitive features or features at higher tide level in subsequent years. Features such as discharge outlets which tend to be near the high tide mark can be mapped at times of day or year when low daytime tides are not common.

The methods to collect these information types are outlined in the steps below.

Pre-field Work Planning

Survey Logistics and Safety Considerations

Prior to going into the field, the crew should develop a plan to optimize the use of time in the field and take the best advantage of the low tide cycle. If necessary, anticipate areas that must be mapped at the lowest tide (e.g. rocky headlines) and plan the day's mapping accordingly. Other logistical details to consider are:

- Access to and from the site. Ideally, access points should be from both ends of the mapping area so that the crew does not have to backtrack through an area when tides may make the terrain impassable,
- Location for safely parking vehicles at either end of the day's mapping areas,
- Whether private property will be crossed in the foreshore or backshore transect. If this is the case you will need to obtain permission from the landowners. (This should have been covered in Module 1: Step 5)

Survey Timetable

Since intertidal mapping must work within the restrictions of the tide heights, it is important to make a survey timetable before going into the field. The GPS technician will often have to back-track over the study area several times to pick up all of the features within the area. The most critical features (as determined by the goals of the study) should be mapped at the lowest tide and other features, and those higher up on shore, can be mapped as the tide rises. Your project planning (Module 1) should have ensured that there are reasonable daytime times during the survey period. Check the tide tables to plan your day - It is reasonable to work in the intertidal zone approximately two to three hours before and after the lowest tide of the day. High tide lines and the transect points can be collected at a later date as long as access is not restricted to tide height.

The amount of time spent collecting data may be adjusted due to the low tide window of availability or the complexity of the target shoreline. On a zero tide you may only have about two hours for collecting information in the lower intertidal, while four hours might be available on tides that are -3.0 or better. If the project shoreline is complex, such as those with many shoreline structures or a great diversity of biology, data collection may take longer per section than it would on a more basic area of shoreline. Note that because of the time-consuming nature of GPS and the fact that the GPS technician will have to walk certain shore sections several times, the GPS technician may take two low-tide cycles to complete any given unit.

Backshore data collection can occur whenever it is safe to walk the shoreline. Depending on the speed and proficiency of the mapping crews, as well as the terrain of the backshore, backshore mapping could take place immediately after each intertidal

transect or at a different time. For example, if the backshore is fairly uniform and straightforward to map, backshore transects could be completed quickly after the across shore transect. However, because of the limited time available to do intertidal mapping due to rising tides, this should be a decision made in the field.

Length of the surveys will vary depending on the terrain, tide height and variety in the foreshore. When conditions are good, it will take the GPS technician approximately 20 minutes to walk a kilometre of the low tide line.

Survey Equipment

The following equipment will be needed for all shorezone field mapping.

- Trimble Pathfinder GPS unit or Garmen GPS with data logger and differential antenna. The CSIM data dictionary must have been loaded into the data logger,
- Pathfinder Office software,
- Field notebook (waterproofed) and pencil for recording notes,
- Base maps of your project area showing cadastral boundaries, breakpoint of Physical shorezone units, any pre-typed shorezone polygon boundaries in addition to the database providing the physical shorezone unit and pre-typed polygon characteristics. This should be protected against the weather in a plastic or acrylic cover,
- Surveyors tape measure capable of measuring from 1 cm to 100 m,
- Camera,

When undertaking the intertidal and backshore transects the following additional equipment will be needed.

- Flagging tape and survey stakes for making start and end of transect,
- Data sheets (one/transect), preferably copied onto waterproof paper and mounted on a clip board – don't forget the pencils and select soft lead for writing on waterproof paper,
- Compass for taking bearings,
- Clinometer and stake as tall as the field crew who will be using the clinometer,
- Appropriate field guides (see Appendix A),
- "Ziploc" bags or other clear sample bags that will seal,
- Flagging tape,
- Black marker with permanent ink,

General GPS survey methods

In the field, the biologist and GPS technician should visually survey and discuss the overall site (if possible) to get a general sense of what features should be noted. For example, large marshes, eelgrass beds, anthropogenic features, etc. are features that should be captured on GPS. Other features will become more apparent as the site is mapped in detail and the crew travels through the site. As noted in the GPS mapping protocol below, the crew biologist will flag particular features to be mapped with the GPS unit as he or she moves through the transect. The field person handling the GPS should be RIC certified and general methods used to collect GPS data should follow the RIC manual which can be downloaded from the RIC web site at: <http://srmwww.gov.bc.ca/risc/pubs/other/index.htm>

Georeferencing

In order to verify the accuracy of your GPS, it is recommended that you record the positions of monuments, property line pins and other fixed locations or benchmarks. This will help to verify the georeferencing of layers such as cadastral maps as well helping you verify changes in your project area over the years. The data dictionary format for recording these reference points is shown in the table below.

Field	Field Value
Point_number	An auto-generated consecutive point number
Reference_Point	Location Point
	Reference Point
	Bench Mark
	Monument
Select one of	Map Tie Point
	Lot pin or marker
Distance	Distance to last reference point
Bearing	Compass bearing to last reference point
Gradient	Gradient to last reference point
PtComments	Comments concerning the reference point
PhotoNum	Roll and print number of photograph (roll.photonumber)

Step 1: Determine and digitize the high and low water shorelines and verify Physical Shorezone Units

Your first tasks should be to verify the breakpoints of the existing Physical Shorezone Units in your project area and to break those units into subunits where appropriate. While mapping these Shorezone Units you will simultaneously record the linear position of the high tide shoreline. We recommend that you walk the high tide line while you record the physical shorezone characteristics. The low tide line should be recorded separately when tides are optimal and you can rapidly record its position. Appendix 2

includes background information on the nature of tides in BC and provides definitions for high and low tide lines.

Mapping and Identification of high and low water shorelines

You should by this time have a working high and low tide line taken from existing digital base maps (Module 2) and/or large scale air photos (Module 3). Ultimately, the high and low water coastlines should be mapped using a GPS ground survey. In instances such as remote areas or inaccessible coastal regions this may not be possible and your high and /or low tide lines will have shoreline will have to be based on existing data or interpretation of air photos. Where you can get close enough to see the tide lines but cannot access them due to terrain or water barriers, it may be possible to walk a line parallel to the tide line and apply offsets to your line.

Where the shoreline is accessible, the high tide line can walked and mapped using the GPS at virtually any tide, provided that access is possible. A number of visual clues can be used to determine the location of the high tide line.

Shoreline Type	Evidence for Higher High Water line
Platforms or gentle ramps	A tide line of algal debris or other flotsam such as beach logs
Cliffs or steep ramps	A dark biological band of blue-green algae (eg. <i>Calothrix</i>) or lichen (<i>Verrucaria</i>) on rocky shores is indicative of the splash zone and can used as the highest high tide line. A barnacle band (<i>Chthamalus dalli</i> and/or <i>Balanus glandula</i>) is indicative of the top of the upper Intertidal zone.
Marshes	Upper extent of salt marshes species A tide line of algal debris or other flotsam

Verification of Physical Shorezone Unit Boundaries

While the physical shorezone units have been classified by a professional geomorphologists, that mapping process was done using aerial video photography and was fitted to a shoreline that was taken from air photos at random tide heights. CSIM allows you to correct the boundaries of the units using a GPS, verify the classification and if you feel that a unit is sufficiently different, it also allows you to create subunits. While you may lack the geomorphological and geological skills of the provincial mapper, you do have the advantage of a highly accurate georeferencing tool (the GPS) and a much closer look at the sediment, slope and structure of the shoreline.

The details on how the physical shorezone units are assigned, along with illustrations of different shorezone types can all be found in the RIC standard "Physical Shore-zone Mapping Methods" which can be found at the web site:

<http://srmwww.gov.bc.ca/risc/pubs/coastal/pysshore/index.htm>

The CSIM attribute database associated with Physical Shorezone units is provided below. It allows you not only to verify and fine tune the information provided by the

province for the Physical Shorezone Unit, but it also allows you enter information on backshore or riparian land use and cover, flora, and fauna. While all these features can be mapped explicitly using the CSIM methods, the shorezone unit data provides an overview and if you do not have the time or resources to complete the feature mapping portion of the method will give general information that is useful for planning purposes.

Field	Data to enter or choose from pick list
Organization	Organization completing survey
Tide Level	Tide level at time break point is recorded
Date	Date unit is mapped (if no date stamp on GPS)
Time	Time unit is mapped (if no time stamp on GPS)
Crew	names or initials of field crew/mappers
Weather	Weather at time of survey (Light Rain, Heavy Rain, Snow/Sleet, Over cast, Clear, Partly Cloudy, Other)
PS_Unit	Provincially assigned shorezone unit number
ShoreLine	Shoreline break point is referenced to (Mean_High_Tide, High_High_Tide, Low_Tide)
Shore_type	See RIC manual for shorezone classes and their descriptions; additional anthropogenic classes have been added
Antho_Material	Material from which anthropogenic shorelines are constructed (if they exist) Concrete, metal, rubble, fiber, logs
Comments	General comments about unit
UnitPhotoNum	Roll and frame number of photo taken of unit (roll.frame)
PS_SubUnit	Unique sequential subunit number (if appropriate) If no subunits then leave as "0"
Sub_type	See RIC manual for shorezone classes and their descriptions
SubUnitPhotoNum	Roll and frame number of photo taken of subunit (roll.frame)
ComtSubUnit	General comments about subunit
Clams	Is species present in unit (or subunit if defined) (Yes/No)
Oysters	
Urchins	
Butter clams	
Native Littleneck	
Manila clams	
Horse clams	
Geoduck clams	
Sand Dollars	
Eel Grass	
Surf Grass	
Canopy_kelp	
Salt Marsh	
Fish_spawning	
Other_Bio	
Other_Bio_	Name of "Other_bio" species present
CmmntFlora	Comments on the Flora in the intertidal zone of unit/subunit
CmmntFauna	Comments on the Fauna in the intertidal zone of unit/subunit

ComtIntertidal	General comments on the intertidal zone
Land_Use	Main backshore land use in backshore of unit/subunit (Park, Vacant, Natural, Disturbed, Forestry, Commercial, Residential, Industrial, Agriculture, Aquaculture, Transportation, Institutional, Recreation, Unknown)
RipClass	Main land cover in backshore of unit/subunit (Row Crops, Broadleaf forest, Bryophytes, Coniferous forest, Planted Tree Farm, Disturbed wetland, Dug out pond, Exposed soil, Flood plain, Herbs/grasses, High Impervious, Medium Impervious, Low Impervious, Mixed forest, Natural wetland, Rock, Shrubs)
Qualifier	Qualify nature of land cover in backshore of unit/subunit (Agriculture, Natural, Recreation, Disturbed, Unknown)
Cover	What is % cover by this land cover (<25%, 25-49%, 50-75%, >75%)
Stage	low shrubs <2m, tall shrubs 2-10m, sapling >10m, young forest, mature forest, old forest
Shrubs	<5%, 5-33%, 34-66%, 67-100%
Snags	Number of tree snags present in unit/subunit (<5, 5-25, 26-50, >50)
Veteran	Number of veteran trees present in the unit/subunit (<5, 5-25, 26-50, >50)
Material	Anthropogenic, Organic/Debris, Clay, Mud/Fines, Gravel, Sand_Mud, Sand, Shell_Hash, Pebble/Gravel, Cobble, Boulder, Bedrock, Other
ComtRiparian	Comments on the riparian zone of the intertidal zone of unit/subunit

Step 2: Across-shore transect mapping methods

The purpose of the across-shore transects is to give character to the shorezone units; they document a typical profile of the shape and biophysical characteristics in that unit or subunit. The transects should also be used to verify the validity of the character and boundaries of intertidal ecosystem polygons mapped in Module 3.

The bands mapped using the CSIM methods should be similar but not necessarily the same as those recorded in the biological banding database associated with the Provincial shorezone units. The Provincial bio-banding information was collected using oblique aerial video imagery and the classification of bands is based on what is visible using this method. The CSIM methods are based on ground surveys and so species not visible from the air can be recorded as well as the more conspicuous species. The CSIM methods also collect more detailed information on the slope and width of bands that is not present in the Provincial system.

A transect through the riparian habitat is also conducted for the 50m of habitat immediately landward of the foreshore transect (see Module 5). The exact locations of selected shorezone features are also mapped but in a subsequent step (see Module 4: Step 3).

Transect Preparation

Once in the field, the crew should determine the location of intertidal transects, however aerial photographs may be used to assist selection of intertidal transect locations. While this will be subjective depending on the complexity of each unit, intertidal transects should capture the general nature of the unit as well as any

significant features (e.g. *Zostera marina* bed). If the unit is fairly uniform, one transect every 50 – 100 metres or one in each Physical shorezone unit or sub-unit is sufficient.

The starting point for each transect is located at the shoreline (highest high water) at a location typical for a shorezone unit. A stake flagged with florescent tape should be placed at the start of the transect. The tape measure should be stretched from this point in a straight line to the water, perpendicular to shore. The measuring tape should be stretched taut and remain lying flat on the ground until the survey of that transect is complete. Preparation for mapping transects should be done as close to low tide as possible. Mapping can commence before low tide and work down the shore as the tide drops.

Transect Data Recording

Transect information is recorded using the CSIM data dictionary via your data logger. The point where you begin your transect (i.e. the location of the highest high tide) is recorded in the data dictionary of the data logger attached to the GPS under the menu item: "Intertidal_Transect". Each transect must be assigned a unique transect number by which it, and all the attribute data attached to it, can be identified. The system we suggest for identifying a transect is to attach to each transect record the Provincial code assigned to the Physical shorezone unit number, the date (DDMMYYYY)⁵, and a unique sequential transect number. If it takes more than one day to complete a transect it is still given the same transect number although the date for the resumed file would change. Other general information that should be entered for each transect includes:.

Field	Description
Transect_number	Unique transect identifier
PS_Unit	Physical Shorezone unit number from provincial database
PS_SubUnit	Physical Shorezone Sub-unit number if you have assigned one
Date	Date transect was begun (DD/MM/YYYY)
Start_time	When first measurements are taken
End_time	When last measurement is taken
Field_crew	Names or initials of all crew
Bearing	Using the compass determine the magnetic bearing of the transect following the line of the tape measure.
Transect_Width	Width of transect (highest high tide to low tide (datum))
Transect_Slope	Average slope of transect from top to bottom (see below for methods)
Comments	Comments that provide information on how the transect was mapped – e.g. if the transect is a steep cliff and distances are estimated from

⁵ Check if your data logger automatically date and time stamps all features mapped. This is true for the Trimble data loggers but may not be so for all others.

	the base or top or if the transect is done over several tide cycles.
PhotoNum	Roll and picture number of photos taken of transect (formatted as role.picture)

Measuring Slope

To measure the slope of the intertidal transect, one person stands at the lower edge of the transect, holding the stake. The person with the clinometer stands at the start point of the transect. As they look through the clinometer, they should line up the horizontal line with the height on the stake that they determined to be their eye height. It is easiest if a stake is the same height as their eye level. Read the slope in degrees from the scale in the clinometer.

Mapping Intertidal Bands

Once your transect has been registered you can commence moving seaward along the transect and record information for each biophysical band along the transect. The data logger will automatically carry forward all basic transect information and only the changes need to be recorded.

With the assistance of the crew biologist, the field crew should determine the location of intertidal bands. These may be physical features, such as a rock ramp or a sand/cobble beach or biological features such as a band of *Fucus*. Biological features may overlap one or two physical bands or they may be distinct bands in themselves. For example a distinct band of *Enteromorpha* over-lying a sand/cobble beach is *not* mapped as a separate band (because of the seasonal nature of *Enteromorpha*.) However, non-seasonal biological features such as a band of *Fucus*, or an oyster bed, are mapped as distinctive bands.

For each band along the transect the following information is recorded using the CSIM data dictionary loaded in your logger:

Field	Data to enter	pick list from menu
Transect_number	Unique transect number	N/A
Band_No	Consecutive number of the band starting from 1 at the start (high tide) point	N/A
Band_Width	Width (in meters) of the band as measured by the tape laid along the transect.	N/A
Band_Slope	Slope of the band as measured by the clinometer	N/A
Tidal_Zone	Tidal zone of the band	Backshore, Splash zone, Intertidal, High intertidal, Low intertidal, Subtidal
Substrate	Nature of the primary substrate of the band	Organic/Debris, Clay, Mud/Fines, Gravel, Sand_Mud, Sand, Shell_Hash, Pebble/Gravel, Cobble, Boulder, Bedrock, Other

Comt_Substrate	Comments related to the substrate	N/A
Flora	Main flora covering the band	Eelgrass, Eelgrass_native, Eelgrass_introduced, Surfgrass, Salt_marsh, Green_algae, Fucus, Other_brown_algae, Red_Algae, Bladed_kelps, Stalked_kelps, Macrocystis, Nereocystis, Laminaria, Sargassum, Mixed_Algae, No_Flora
Flora_Cover	Percent of band covered by flora	<25%, 25-49%, 50-75%, >75%
Comt_Flora	Comments related to the flora	N/A
Urchins	Abundance / distribution pattern of faunal type	none, few, patchy, common, even_abundant, clumped_abundant, dominant
Clams		
Oysters		
Native_Littleneck		
Manila_Clams		
Butter_Clams		
Horse_Clams		
Geoduck Clams		
Mussels		
Sand_Dollars		
Fish Spawning		
Other_species		
Comt_Other_sp	Enter name of "other species"	N/A
Comt_Fauna	Comments related to the fauna	N/A

If you cannot identify a plant or animal in the field, make a note in the comments section of the data sheet and give the species a temporary name or descriptor (e.g. brush like, black seaweed). Collect one or two individuals and put them into a Ziploc bag or take a photograph. Key the organism out later or freeze the specimen and seek appropriate assistance with identification. The bag should be labelled with the temporary name of the organism, the name of the study area, including physical shorezone unit number and transect number. Once a proper identification has been made, insert the correct information into your database.

The point where the first band ends and the next begins is recorded as the start point for band two and so on until all recognizable bands across the shore have been recorded. Each band will have a start point (recorded using the GPS), transect and band number associated with it along with the band attributes recorded using the CSIM data dictionary.

Step 3: Mapping of Shorezone Features

In the project planning stage (Module 1: steps 1 and 2) you should have identified what features are most critical for you to map. Mapping features does take time so you decide carefully whether knowing the exact location of a feature will help you in your immediate goals. This set of features will vary both with the type of shoreline that is

present in your project area and with the focus of your project (i.e. planning of conservation or stewardship projects, development of land use bylaws, foreshore stability or pollution assessment). Some of the features of interest may be identified from aerial photographs but many will not. Field surveys are required both to verify the boundaries drawn from the aerial surveys and to map new boundaries or point locations of features missed in the interpretation of air photos.

Common to the mapping of all features is assigning a unique feature number be it a point, line or polygon. In this way any "paper" field notes can be linked to the digital feature attributes. In addition, we recommend that all unique features should be photo documented and the photo roll and frame number recorded in the data dictionary. If you have a feature that is repeated many times such as a beach that is intersected along its length by groins, a single picture of one of the groins is sufficient.

Features have been divided up into sub-types based on the attributes that should be recorded with each and in order to keep the number of menus for a feature type manageable for field entry. Details of the data dictionary structure for each type of feature are included in the following section.

Physical Features

Physical Features are divided into 3 categories for mapping. These include:

1. Landforms: General shorezone landforms that describe the large features of a shorezone unit,
2. Streams: The location and flow characteristics of streams in the shorezone,
3. Erosion features: The location and characteristics of areas of obvious erosion in the shorezone,

Landforms

Physical landform features are described in detail in Appendix A of the *British Columbia Physical Shore-Zone Mapping Manual* (Howes *et. al.* 1994). The CSIM methods allow you to map the extent of these physical features (create a polygon of their boundaries) or locate their exact position (create a point in the centre of the feature) rather than just recording them as a component present somewhere in the Shorezone unit (as is done in the Physical Shorezone mapping system). The system used to describe these physical features is adapted from the Physical Shorezone mapping methods (Howe *et al.* 1994). Each feature is identified by its form (e.g. cliff) and a form modifier (e.g. eroding, passive or not eroding, cave, terraced). The tables below provide a list of physical forms and their associated modifiers. The slope and height of the feature are also recorded as is the material(s) that comprise it and recorded comments and the roll and picture number of photographs taken of the feature.

A complete list of the attributes recorded for each physical landscape feature is listed in the table below:

Attributes for Landform Features	Data to be entered or selected from pick list
ID	Unique polygon, line or point number
Form Descriptor	Choose from list of one of the "Form Descriptors" (Table "A" below)
Form Modifier	Choose from list of "Form Modifiers" developed for that primary form (see Table "A" below)
Map representation	Point, line, polygon
Slope	Flat; ramp (inclined surface with slope between 5° and 20°); inclined cliff (cliff with slope between 20° and 35°); steep cliff (cliff with slope > 35°)
Height/elevation	In meters from base (cliff) or datum (island, reef)
Tidal Zone	Main tidal zone of the feature
Primary Material	Choose from list of materials (Table "B") the most abundant, 2 nd most abundant, and 3 rd most abundant surface material of form
Secondary Material	
Tertiary Material	
Photo number	Enter roll and frame number (roll.frame) for photo takes of feature
Comments	Enter any relevant comments about form or field collection

Table A: List of Physical Feature Forms and Form modifiers

Form Descriptor	Possible Form Modifiers
Beach	Berm, washover channel, face, bars/ ridge, low tide terrace, washover fan
Cliff	cave, terraced, fan
Delta	fan, multiple channels, single channel, ebb tidal delta, flood tidal delta
Dune	Vegetated, unvegetated
Reef	Irregular (local relief > 1 m), smooth (local relief < 1 m)
Lagoon	Open, closed
Marsh	High tide, low tide, tidal creek, levee, pond
Offshore Island	table shaped, pillar/stack, whaleback
Platform	tide pool(s)
Tidal Flat	levee, tidal channels, tidal flats, tide pool

Table B: List of Materials for Physical Features

Primary Material	Material Descriptors
Biogenic	Coarse shell, fine shell hash, trees, organic litter, peat/organic sediment
Clastic	Blocks, boulders, cobbles, diamicton, fines, gravel, clay, pebbles, rubble, sand, silt, angular fragments
Bedrock	Igneous, metamorphic, sedimentary, volcanic

Note that a complete description of the various physical forms, form modifiers and materials is included in the manual for the RIC standard "Physical Shore-zone Mapping Methods" which can be found at the web site:

<http://srmwww.gov.bc.ca/risc/pubs/coastal/pysshore/index.htm>

Stream Features

Streams are mapped separately from other physical features because of their importance in the shorezone ecosystems and the number of attributes that can be recorded concerning streams. Streams can be mapped in one of three ways:

- As point features if you are marking the point where a narrow stream crosses the high tide shoreline or where a waterfall is located on a stream;
- As linear features if you are following the stream along its length before it enters the ocean; or
- As polygon features if you are mapping the mouth of a wider stream where it enters the shorezone.

The attributes that can be entered into the data dictionary for shorezone streams include:

Attributes for Stream Features	Data to be entered or selected from pick list
ID	Unique polygon, line or point number
Stream_name	Gazetted name of stream (or local if none gazetted)
Form	Waterfall, multiple channels, single channel
FW_Influence	Continuous, Episodic, Freshet, None, Unknown,
Width	Width of stream in meters
Depth	Max depth of stream as it crosses shoreline
Flow	Flow of stream in centre in cubic feet per second
Comments	Comments specific to stream

Erosion Features

Documenting areas of erosion in the shorezone is an important role for CSIM. The methods allow you to map where erosion takes place and also to record, where possible, what form that erosion takes and possible or known causes of the erosion.

The fields in the data dictionary that describe erosion features include:

Attributes for Erosion Features	Data to be entered or selected from pick list
ID	Unique polygon, line or point number
Erosion Cause	Culvert, lack of riparian vegetation, livestock access, public access/path, wave action, alongshore drift, foreshore structure, other
Erosion Type	Bank erosion, debris flow, eroding cliff, landslide, point erosion, sloughing
Severity	Low (<5 m ²), moderate (5-10m ²) severe (>10 m ²)
Length	Measurement in meters of erosion feature
Width	"
Height	"
Slope	Flat; ramp (inclined surface with slope between 5° and 20°), inclined cliff (cliff with slope between 20° and 35°), steep cliff (cliff with slope > 35°)
Material Exposed	Anthropogenic, Organic/Debris, Clay, Mud/Fines, Gravel, Sand/Mud, Sand, Shell Hash, Pebble/Gravel, Cobble, Boulder, Bedrock, Other

Biological Features

Shorezone intertidal biological features that can be mapped using CSIM fall into one of six classes:

- Marine Vegetation (both vascular and algae)
- Intertidal Invertebrate Fauna
- Invasive species
- Wildlife trees
- Coastal and Marine Birds
- Coastal and Marine Mammals, Reptiles and Amphibians

Other features can be added by modifying the CSIM data dictionary, however it is important not to get too detailed if time is limiting. Most intertidal algae on rocky shores fall into bands which will be characterized using the intertidal transect methods outlined in Module 4: Step 2. Again, there are other methods developed for monitoring bird and mammal population that are designed for monitoring; nests and large concentrations can be noted but as noted in the Introduction, CSIM is not an ongoing monitoring method and these highly mobile species are better suited to other inventory and monitoring methods.

Marine Vegetation

While you could record all types of marine vegetation from the common *Fucus* and *Enteromorpha* to rare species of cryptic algae, the CSIM method is designed to map features that could be used in conservation planning and coastal zone management. As such the vegetation classes represent those vegetation types that are known play an important role in ecosystem function – sea grasses, kelps and *Salicornia*. Salicornia or Saltwort is an important food source for some waterfowl and is also under pressure from harvesters. The vegetation types that are included in the CSIM data dictionary include:

Attributes for Intertidal Flora	Data to be entered or selected from pick list
Map representation	Point, polygon
Feature name	Eelgrass native (<i>Zostera marina</i>), Eelgrass introduced (<i>Zostera japonica</i>), Eelgrass unspecified, Surfgrass (<i>Phyllospadix souteri</i>), Saltmarsh, Saltwort (<i>Salicornia</i> spp.), Kelp, <i>Macrocystis</i> , <i>Nereocystis</i> , <i>Laminaria</i>
Feature % cover	Sparse, low, moderate, dense

Intertidal Invertebrate Fauna

While we do not recommend that you try and map all intertidal invertebrates, you may want to map rare occurrences of species such as Sand Dollars, or the locations of species that are recreationally and/or commercially harvested.

Attributes for other Intertidal Fauna	Data to be entered or selected from pick list
Feature name	Mussels, Oysters, Urchins, Sand dollars
Feature abundance (#/m ²)	<1, 1-10, 11-100, >100
Feature % cover	Sparse, low, moderate, dense

As there may be more than one clam species present in a clam bed, the data dictionary allows you to indicate the presence/absence of each species along with the overall density of all clams.

Attribute for clam beds	Data to be entered or selected from pick list
Species present	Manila, Butter clam, Horse clam, Geoduck, Varnish clam, Razor clam, Other clam (presence/absence field for each species)
Feature abundance (#/m ²)	<1, 1-10, 11-100, >100 (of all species)

Invasive Species

There are a number of invasive marine species that are of high concern in British Columbia. Most of these have already become a problem in the Pacific NW states to the south of us and mapping their distribution is an important first step in controlling their spread. The main species of concern include Cordgrass (*Spartina alterniflora*, *S. densiflora*, *S. anglica*, and *S. patens*), the Varnish Clam (*Nuttalia obscurata*), the European green crab (*Carcinus maenas* Linnaeus), mussel species introduced for aquaculture (*M. edulis* and *M. galloprovincialis*) and the brown seaweed introduced from Japan (*Sargassum muticum*). There are many less common invasive marine species, and others like the Japanese oyster (*Crassostea gigas*) and Manila clam (*Tapes philippinarum*) that are so common now that we forget they are an introduced species!

Attribute	Data to be entered or selected from pick list
Tidal_Zone	Backshore, Splash zone, Intertidal, High intertidal, Low intertidal, Subtidal
Species	<i>Spartina</i> , Varnish Clam, Green Crab, non-native mussels, <i>Sagassum</i> , Other
Name_Other_sp	Name of other invasive species if selected above
Abundance	none, few, patchy, common, even_abundant, clumped_abundant, dominant
Comt_InvasivePoint	Comments about this invasive species point

Wildlife Trees

Municipalities have the ability to create bylaws for protecting wildlife trees. In order to implement such a bylaw these features must be inventoried and mapped. Even without a bylaw, stewardship and education efforts will benefit from such an inventory, The attributes that can be recorded for wildlife trees include:

Attribute	Data to be entered or selected from pick list
Species utilizing wildlife tree	Cormorant, Eagle, Woodpecker, Woodduck, Osprey, Marbled Murrelet, Great Blue Heron, Black Bear, Grizzley Bear, Other
Species name	Add species name if not listed above
Type_Tree	Coniferous, Deciduous, Unknown
Veteran_tree	Is this a veteran tree? Yes/No (default)
DBH	Diameter Breast Height of tree (in meters)

Mast_tree	Is this a mast tree? Yes/No (default)
Nest	Are nests present in tree? Possible_nest, Large_nest, Small_nest
State	What is state of tree? Living, Dead, unknown
Denning	Is there evidence that tree has been used as animal den? Yes/No (default)
Perches	Does tree have perches? Yes/No (default)
Cavities	Number of cavities in tree (1, 2, 3, 4+)

Coastal and Marine Birds

While CSIM is not the ideal method for recording locations of concentrations of coastal and marine birds, this feature is provided as a method of augmenting other bird inventory methods. Ideally birds should be monitored seasonally over time to document the various concentration they form over the year. The list of attributes below include information on how the birds were "sighted", what species was present and the type of concentration "sighted":

Attributes	Data to be entered or selected from pick list
Type of evidence	Calls, Nest, Sighted, Droppings, Other
Bird species	Songbird, Raptor, Bald Eagle, Shorebirds, Black Oystercatcher, Great Blue Heron, Waterfowl, Ducks, Dabbling Ducks, Diving Ducks, Swans, Geese, Brant Geese, Loons, Cormorants, Double Crested Corm, Pelagic Cormorant, Brandt's Cormorant, Alcid, Pigeon Guillemot, Gulls, Glaucous Winged Gull, Terns, Other
Concentration type	Single nest, Colony, Overwintering Conc, Migrating Flock, Summer Moulting Conc, Summer feeding conc
Species name	Enter species name if not in pick list
Bird_Numbers	Approximately how many birds of species are present in concentration

Coastal and Marine Mammals, Reptiles and Amphibians

Sightings of small animals – mammals, reptiles and amphibians can also be recorded using CSIM. While the Department of Fisheries and Oceans does monitor major seal and sea lion haulout and rafting areas, smaller ones may be missed and over time even large haulouts may change in location. Other mammals may be locally abundant such as Grizzlet bears in the North coast estuaries and sea otters in the Kyuquot Sound region. Amphibians and reptiles are not exclusive to the coastal zone but the endangered status of many of these species is a good reason for mapping their occurrence where possible. The data dictionary allows you to enter information on what species is present, your evidence for the species presence (direct sightings or indirect evidence such as noise, scat or tracks), and the nature and size of the species concentration:

Attributes	Data to be entered or selected from pick list
Type of evidence	Sounds, Sighted, Scat/Droppings, Tracks, Other
Mammal species	Amphibian, Reptile, Large Land Mammal, Small Land Mammal, River Otter, Sea Otter, Harbour Seal, Sea Lion, Steller Sealion, California Sealion, Other
Concentration type	Haulout, Rafting, Other
Species name	Enter species name if not in pick list
Mamal_number	Approximately how many individuals are present in concentration

Anthropogenic Features

Anthropogenic features include those features of the shore that are man-made. We have divided these features into two groups:

- Shoreline armouring or other structures
- Shorezone point discharge

The shorezone armouring and structures include any feature that replace or overlay the natural shoreline with a man-made shoreline. The type of feature and material from which is constructed are both recorded along with the tidal zone in which the majority of the structure resides. Trails can be recorded as single access points where they transect the shore or as linear features where they run parallel to the shore.

Attributes	Data to be entered or selected from pick list
Feature name	Dolphin, Breakwater, Float, Log dump, Log sort storage, Seawall, Boat ramp, Wharf, Gov Dock, Ship wreck, Marina, Jetty, Groin, Dyke, Ferry Terminal, Port Facility, Bottom Shellfish Cult, Hanging Shellfish Cult, Salmon Farm, Mooring Buoy, Trail, Landfill/tailing, Revetment, Rip rap, Other
Tidal Zone	Backshore, Intertidal, Shallow subtidal, Deep subtidal
Material	Metal, concrete, wood, stonework, sandbags, rubble

Point source discharges such as culverts have been kept in a separate category from other anthropogenic features as there are a large number of attributes that you may wish to record about these features. Depending on your project goals you may or may not want to record all of these attributes:

Attributes	Possible values
Discharge Type	Box Culvert, Gated Inlet, Gated Outlet, Gated Multiple Inlet, Gated Multiple Out, Inlet, Inlet Stacked, Multiple Inlet, Multiple Outlet, Outlet, Outlet Stacked
Discharge Source	Agricultural , Domestic, Industrial, Pulp Mill/Effluent, Storm Drain, Other
Comments	Comments on discharge type
Flow	none, intermittent, seasonal, visible flow
Owner	Municipal, Private
Condition of Culvert/Pipe	Good, Partially Collapsed, Collapsed/Plugged
Material	concrete, steel, wood, iron, PVC, asphalt, corrugated steel, other
Substrate in Culvert/Pipe	Boulders, Cobbles, Fines, Gravels, Mixed, Same as Culvert
Form	Circular, Rectangular, Arch, Vertical Ellipse, Horizontal Ellipse, Other
Width or diameter	Where applicable, measurement in cm of pipe/culvert diameter
Temperature	Temperature (Celsius) of discharge
Screen Size	If there is a screen on outlet note mesh size in mm
Headwall	Concrete, Concrete Block, Gabion, Sand bag, Wood
Apron	Yes/No (default)
Baffles	Yes/No (default)

Cultural Features

Cultural features are recorded separately from other anthropogenic features. Cultural features are usually features that we wish to protect. They are often already inventoried in an existing government database but probably not with the spatial precision that is possible with CSIM. Government inventories of archaeological sites such as middens for instance record only a point location for that site which may extend for 100s of meters along the shore. On the other hand, the government inventories which are usually collected by professional archaeologists may have far more information on the nature of the site which you may wish to access if site preservation is your goal. Note that information on some of these sites, such as first nations burial sites, may be considered confidential.

Attributes	Data to be entered or selected from pick list
Cultural Feature	Midden, CMT, Ship Wreck, Other
Other_type	Enter other type of cultural feature
ComtCultural	Comments on cultural feature

MODULE 5: SHOREZONE BACKSHORE FIELD MAPPING

Shorezone backshore mapping for CSIM focuses on the verification of the backshore land use polygons created from interpretation of orthophotos in Module 3 of this manual. The mapping method relies on transects surveyed perpendicular to the shore extending back from the high tide line. The location of transects should be chosen from the backshore land use / land cover maps created in Module 3 such that they transect all of the polygon classes that you have created.

The ultimate goal of CSIM Module 5, is to identify land cover and land use categories that provide enough information to allow an assessment of the potential quality and quantity of runoff and potential for creation of coastal erosion. The classes of land cover and land use that are used by CSIM include:

Land Cover Classes	Land Use Classes	Substrate	
Row Crops	Park	Anthropogenic	<p>It is acceptable to add other land cover or land use classes as long as you are consistent. You must also be able to differentiate the classes on the orthophotos and verify them during the field surveys.</p> <p>In addition to verifying land cover and land use, during your field mapping you may wish to add information on backshore polygons that cannot be obtained from orthophotos. Currently the additional polygon attributes in the CSIM database include:</p>
Broadleaf forest	Vacant	Organic/Debris	
Bryophytes	Natural	Clay	
Coniferous forest	Disturbed	Mud/Fines	
Planted Tree Farm	Forestry	Gravel	
Disturbed wetland	Commercial	Sand/Mud	
Dug out pond	Residential	Sand	
Exposed soil	Industrial	Shell Hash	
Flood plain	Agriculture	Pebble/Gravel	
Herbs/grasses	Aquaculture	Cobble	
High Impervious	Transportation	Boulder	
Medium Impervious	Institutional	Bedrock	
Low Impervious	Recreation	Other	
Mixed forest	Unknown		
Natural wetland			
Rock			
Shrubs			

Structural Stage	% Cover by Shrubs	# Snags present	# Veteran trees present
low shrubs <2m	<5%	<5	<5
tall shrubs 2-10m	5-33%	>=5	>=5
sapling >10m	34-66%		
young forest	67-100%		
mature forest			
old forest			

Both the structural stage of the vegetation and the % cover by shrubs can influence backshore processes such as erosion and runoff as well provide an indication of potential habitat for coastal fauna. Snags and veteran trees provide roosting and nesting opportunities for shorezone birds such as eagles and herons and as such may also be something you may wish to map.

MODULE 6: DATA MANAGEMENT

Organization of Data

This mapping system is composed of project overview data, shoreline ecosystem/land use data, shoreline feature data, data from transects characterizing the shoreline ecosystems and data collected to reference the project area. This information is organized into individual files (digital map layers). All mapped data is referenced to the project area and Physical shorezone unit/subunit in which it is recorded. These files include:

- **Project Overview:** Administrative data on who, when, why and how the mapped data were collected,
- **Shorezone Ecosystem Polygons:** Polygons or areas of uniform physical, biological, land use and tidal zone characteristics mapped from air photos and/or existing data sources and verified using field reconnaissance,
- **Shoreline:** The corrected high and low tide shorelines for your project area,
- **Shorezone Linear Physical Units:** The linear delineation of the shorezone into alongshore units and possibly subunits based on the exposure to wave energy, physical form and material. These are based on the existing Provincial shorezone mapping units with the end points refined and sub-units created using the CSIM methods,
- **Shorezone Intertidal Transects:** The information of the distribution of the physical shorezone substrate and physical, biological and anthropogenic features across a shorezone at characteristic point within the unit or subunit,
- **Shorezone Riparian Transects:** The information of the distribution of the physical shorezone substrate and physical, biological and anthropogenic features in a transect extending from the high tide shoreline landward for 50 m at characteristic point within the unit or subunit.
- **Shorezone Features:** Biological, physical and anthropogenic features mapped using GPS within the shorezone. These may include data of different representational formats (polygon, vector and point data).
- **Reference Points:** These are monuments and points easily identifiable in air photos and subsequent field surveys that are recorded during field surveys to verify your georeferencing.
- **Photograph Points:** This records the location of photographs taken to generally characterize your project area. These are in addition to photographs taken and recorded during mapping of transects or features.

Project Overview

The **project database** contains administrative information on the project that can be easily accessed for those interested in the project details. It includes the details of who managed the project, when it was done, what the purpose of the project was, what existing data was incorporated and where did it come from, what new data was collected and who collected it, when and how. Methods for setting up the project database and the rationale for the data included in it are included in Module 1 of this report. When you register your project with the CMN they will have assigned a three-digit numeric project code to your CSIM mapping project. If this is the second year of data collection, unless the scale or scope of the project has changed, the project code should be maintained. The same would hold true for subsequent years.

Shorezone Ecosystem Polygons

The shorezone polygon database stores information on polygons of uniform:

- physical form and material,
- biological banding or species association,
- land use,
- and tidal zone.

These polygons are initially identified from 1:5,000 air photos and then verified using field reconnaissance. If existing TEM or estuary mapping exists the polygons from these coverages can be included in the shorezone polygon database. Existing data may have to be adjusted if the scale of existing mapping is coarser than 1:5,000. The polygons should be nested within the shorezone units and high and low water tide marks. They are included as GIS coverage with unique polygon tags for each polygon. All shoreline areas should be included in a shorezone polygon.

Physical Shorezone Units

The physical shorezone units are the highest level of classification in CSIM. All information is linked to these linear shorezone units (vectors) with a unique identifier for each unit linked to a database of the physical attributes of that shore unit. The attribute database for shorezone units is described in Appendix 3 of this manual. In the GIS database table associated with the shorezone units you will find the unique identifier in the field called PS_UNIT. There are no subunits in the database as it comes from the Provincial Government, however as discussed in Module 4, you may wish to assign one if you find significant changes in the alongshore physical shorezone type within a shorezone unit.

Shorezone Transects

The Intertidal and Riparian transect files store information collected from across shore transects. These transects are done to document the across shore characteristics of shorezone units/sub-units based on profiles, and physical, biological and anthropogenic characteristics. Transects are represented as a series of start points which represent the upper tidal level of an intertidal band or the point closest to the shore of a riparian band. Each point is associated with a length and bearing and from this the transect can be reconstructed. By laying this information over the Shorezone ecosystem polygons created by interpretation of orthophotos you can confirm or reject your classification and confirm polygon boundaries.

Shorezone Features

The features layers include the position and characteristics of physical, biological and anthropogenic features that are recorded during GPS field surveys. A shorezone polygon may include more than one feature. These features are coded as points, lines or polygons depending on their size and the mapping scale. A preliminary list of features that could be recorded is provided in this manual. The system can be modified to include additional features depending on the objective of the mapping and the nature of the shoreline. It is more likely however that you will use only a small sub-set of the features provided for.

Data Management in the Field

Data Collection

While in the GPS field data for features within each Physical Shorezone unit should be stored in its own individual data file. Regardless of where you are in your survey, a new file should be made approximately once every hour to reduce the possibility of data loss. Each file should be labelled sequentially, using the unique identification number for the unit being sampled.

Downloading and Checking of Data

Data should be downloaded after every day of data collection. At this time it is also important to preview the data to identify any abnormalities in the data collection or features that may have to be recaptured.

The data for each area surveyed should be combined into one file for each data type (polygon, point or line data). It is helpful to print out and review a hard copy of the features mapped to ensure that all features were captured. This is also a good time to ensure that the numbering system used by the GPS technician and the field crew, are synchronized.

GLOSSARY

Coastal Resources	What constitutes the coastal zone? For the purpose of this project, a relatively narrow definition of the coastal zone or coastal resources was used: coastal resources are defined as those resources falling between the normal limit of the highest high tides (effectively the storm log line limit) and the 30m isobath; the 30m isobath was chosen as this reflects the normal limit of kelp beds and associated nearshore habitat.
Coastal Habitat	What is meant by the term coastal habitat? Habitat is a term used widely in this report and requires a definition in that it has a wide range of meanings to a wide range of users. We believe that the vast majority of users consider "coastal habitat" as the physical framework and associated "fixed" biological communities that determine the biological use of the coastal zone by more mobile terrestrial (including humans), coastal and marine species. Habitat is a general term that refers to a collection of attributes such as: coastal morphology, substrate, wave exposure, tidal range, water quality and intertidal biota.
Urban	Aquatic features (watercourses, lakes, wetlands, streams, aquifers ditches etc.) that fall within regional / municipal boundaries and are typically affected by urban development pressures such as culverting, channelization, riparian clearing, flow diversion and enclosure, and hydrological and water quality changes associated with impervious surfaces.
Rural	Aquatic features located within agricultural / forest land and are affected by riparian clearing, livestock access, irrigation withdrawal, channelization, impoundment and point source water quality impacts.
Urban/Rural Interface	Aquatic features located at the edge of expanding urban settlement, where there is growing pressure to convert land from rural to urban use which may affect freshwater habitat values.
Less Disturbed	While this manual does not apply to rural forested watersheds that are relatively undisturbed, many urban or rural watersheds remain undisturbed in their headwater areas. In these instances, this manual would apply to these less disturbed areas of watershed.
Watercourse	A well defined channel containing flowing water for at least part of the year, which supports a community of plants and animals within the channel and its associated riparian zone. Watercourses can be <u>ephemeral</u> (watercourse that flows briefly in direct response to precipitation in the immediate locality and whose channel is at all times above the water table), <u>intermittent</u> (watercourse that flows in contact with the groundwater table only at certain times of the year when the groundwater table is high and/or when it receives water from springs or from some surface water source such as melting snow in mountainous areas), or <u>permanent</u> (watercourse that flows continuously throughout the year). Watercourses do not include features lacking a well defined channel i.e., lakes and some wetlands.

Inventory	The collection of information. In the context of natural resources, inventory requires measurement of objects and features, but no interpretation regarding their importance or value (see assessment below). Inventory data are typically derived from field surveys, and minimal professional judgement is required other than interpretation of inventory data descriptions and definitions.
Assessment	To determine the importance, value or condition of what has been inventoried. In the context of natural resources, assessment requires interpretation of data collected through an inventory method. Assessment can sometimes be derived during field surveys, although in these professional judgement and experience is applied.
Fish Habitat	Spawning grounds and nursery, rearing, food supply and migration and holding areas on which fish depend directly or indirectly to continue their life history cycle.
Backshore	Area from the higher high water line landward to (50m distance) past the top of a coastal cliff or limit of marine processes
Foreshore	Same as intertidal.
Intertidal zone	Area between the higher high water line and the lower low water line (chart datum)
Nearshore Subtidal	The region between the 0 and 30m isobath. The 30m isobath is taken as a reasonable outer limit for coastal benthic resources. (this definition is from Standard Methods for Sampling Resources and Habitats in Coastal Subtidal Regions of British Columbia: Part 1 – Review of Mapping with Preliminary Recommendations, 1996, p2).
Ecosystem	Broad, geographically contiguous regions of similar climate, physiography and biota. "Each area can be considered a discrete system which has resulted from the mesh and interplay of the geological, landform, soil, vegetative, climatic, wildlife, water and human factors that may be present" (Environment Canada 1994)
Habitats	Repetitive physical or biophysical types found within ecosystems. The same habitat type may be found in several ecosystems. The definition of biophysical habitats may include key species which impact on the physical structure of the habitat
Communities	Groups of biological species which are associated with each other and with a physical habitat type. Communities are assumed to functionally interact.
Biological features	Specific biota that may be mapped independently of habitat or communities.
Anthropogenic features	Include tenures, contaminants and existing use.
Cultural Features	Include historic or archaeological sites.

Appendix 1 RELATIONSHIP OF CSIM TO OTHER COASTAL HABITAT INVENTORY METHODS

BC Physical and Biological Shorezone Mapping

The Provincial Government has mapped the entire coastline of BC using the Physical Shorezone Mapping System (Howes *et al.* 1994). The inventory method for the BC Physical Shorezone mapping System is designed to be used by professional biologists and geomorphologists at medium map scales of 1:15,000 to 1:40,000. The system is based on interpretation of oblique aerial video photography supplemented by spot-checking in the field. The inventory resulting from this method however is intended to be used for regional planning purposes at a scale of 1:40,000.

The BC Physical Shorezone mapping System divides the coast into alongshore segments based on the exposure regime and general physical form and texture. This information allows an overview of the main physical characteristics of the shorezone, which can then be integrated with more detailed biotic and physical information collected at much larger scales from GPS field surveys.

The biological component of the Shorezone Mapping System classifies the intertidal "bands" of marine plants and animals and then assigns them as an attribute of the Physical shorezone units. The CSIM incorporates the shorezone units mapped using the Physical Shorezone Mapping methods into its database along with information on the biological bands present. Because of the small map scale used for the CSIM some Physical Shorezone unit boundaries may have to be moved while others may need to be divided into sub-units. The system differs from CSIM in that CSIM also provides exact locations and boundaries of significant shoreline features using GPS field surveys. In the Biological and Physical Shorezone Mapping systems features are only treated as attributes of shorezone units and are not explicitly mapped.

Victoria and Esquimalt Harbours Ecological Inventory and Rating (HEIR) System

The Harbour Ecological Inventory and Rating System (HEIR) was developed for Victoria and Esquimalt harbours as part of the Victoria and Esquimalt Harbours Ecological Environmental Action Program (VEHEAP). This system is based on the Physical and Biological Shorezone classification systems with four significant enhancements:

1. It is done at a larger scale (more detail) than the Physical and Biological Shorezone classification systems (<1:5,000) and hence will often divide shorezone units defined by these classification systems into smaller subunits.
2. There is finer detail in the classification of shorezone anthropogenic structures and land use as well as some additional codes for wildlife features.

3. The shoreline high tide line is digitized from 1:5,000 scale orthorectified air photos. The photos are taken at a 2 m tide, just below the 2.5 m tide typically accepted as high tide. In the Physical and Biological Shorezone classification systems the coastline is typically the standard TRIM coast and the position is not corrected – only the alongshore break in the shorezone unit boundaries is mapped.
4. Most significantly a rating system is applied to each shorezone unit which rates the unit according to species diversity, habitat diversity, natural habitat value, presence of “key life cycle” areas, ecological value and vulnerability to development. From these units the priority of units for protection and remediation are assigned. This system is somewhat specific to the Victoria and Esquimalt harbour region although it could be adapted to other regions.

CSIM uses a similar approach to HEIR in applying the Physical shorezone units at a larger scale than the original classification system. It also has incorporated the more detailed anthropogenic and wildlife codes. CSIM does not use the rating system developed by HEIR, although there is no reason why a rating system could not be applied to information collected by using CSIM. Unlike CSIM, the HEIR system does not explicitly map features within the shorezone units.

People For Puget Sound Rapid Shoreline Inventory Method

The Rapid Shoreline Inventory (RSI) is an approach designed to produce a fast systematic inventory of physical and biological information about shoreline and nearshore habitats on contiguous 150-foot sections of beach. As with the Physical and Biological shorezone mapping, Shorezone features are not mapped explicitly but, are recorded as attributes of alongshore coastal units. In the RSI system however, the coastal units are pre-defined 150m sections of the coast and break points are based on distance rather than changes in the physical shoreline type.

Features that are recorded for each section using RSI methods include:

- Dominant substrates of intertidal and backshore zones
- Physical characteristics of intertidal and backshore zones (presence of bluffs, banks, spits, tombolos, marshes etc.)
- Bluff/bank characteristics (height, vegetation, erosion)
- Presence of invasive species
- Adjacent land use and trails
- Streams, outfalls, and other freshwater discharges
- Artificial shoreline structures (type, size, condition)
- Presence/absence of eelgrass, kelp and vegetation overhanging the intertidal

- Wildlife and Vegetation – main species present, tidal level and rough abundance
- Vegetation

Plants and animals are sometimes identified to the species level, but often are only identified to the level of family or genus or order. In addition, to taking the GPS coordinates of the start and end points of the 150 m shoreline sections or units, GPS coordinates are also taken of stationary shoreline characteristics, such as trails/access points, outfalls, and structures including bulkheads, seawalls, docks, piers, and boat launches. The width of the intertidal and backshore zones are measured for each 150 m coastal section at the mid-point of the section.

BC Terrain Classification System

The Terrain Classification System is a descriptive mapping system involving the identification and delineation of terrain units based on geologic processes, landforms and surficial materials (Howes & Kenk 1997). The effective level of mapping is about 1:20,000 scale although it has been used for larger and smaller scale mapping projects. The major focus of terrain mapping has been in the terrestrial environment above the higher, high water line or log line. Standards for Terrain mapping in BC are outlined in Terrain Classification System (Howes and Kenk 1997). These standards are highly detailed, requiring a trained geographer, geomorphologist or geologist to complete the mapping.

The Terrain Classification System formed the basis of the BC Physical Shorezone Mapping System and as a result there are many similarities between the two systems. The two mapping systems include similar texture classifications for clastic sediments and the surface expression component in the Terrain Classification System is similar to the form of the BC Physical Shorezone Mapping System. However, the latter provides more variation and detail than the former. The Terrain Classification System provides information on the origin of surficial materials that is not explicitly done in the Physical Shorezone Mapping System and is not included in the CSIM. Where Terrain mapping has been completed it can be easily incorporated into the CSIM.

Terrestrial Ecosystem Mapping (Coastal Portion Only)

Terrestrial Ecosystem Mapping (TEM) is a documented RIC standard for mapping terrestrial ecosystems in BC at scales from 1:5,000 to 1:250,000 (Resource Inventory Committee 1998). Ecosystem mapping is the stratification of a landscape into map units according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil and vegetation. TEM defines the site associations found within terrain units mapped using the Terrain Classification system. The TEM includes a list of “approved” site associations – a dynamic list that is increasing as more TEM projects are completed. To date most ecosystems have mapped at the

small scale (1:250,000) and there are few coastal and wetland site associations described. TEM mapping is highly specialized and requires background knowledge of soils and vegetation as well as specific training in the specifics of the methodology; the latter is available through RIC training courses.

Ecosystem maps, along with associated interpretations, supply valuable information for many uses, particularly planning resource allocation. The maps are used, for example, to meet many Forest Practices Code related needs, including landscape unit planning, forest development planning, range use planning and development and application of biodiversity guidelines, riparian guidelines, and the Identified Wildlife Management Strategy.

TEM inventories are conducted by the private sector and provincial government with the government providing Quality Assurance (QA) and data custodian roles (BC Environment and Ministry of Forests). To assist government staff with QA and help contractors meet government standards, a complete suite of mapping tools have been developed. All individuals providing TEM mapping services must be certified; A RIC training course is offered to provide certification. More information is available through the TEM web site.

Sensitive Ecosystems Inventory Mapping SEI (Coastal Portions)

The purpose of the Sensitive Ecosystems Inventory (SEI) project is to identify remnants of rare and fragile terrestrial ecosystems and to encourage land-use decisions that will ensure the continued integrity of these ecosystems. The ecosystems inventoried by this system are designated as sensitive and/or endangered by the BC Conservation Data Centre. Only one of the currently designated Sensitive Ecosystems, "Coastal Bluffs" is primarily coastal. There are two categories of Coastal Bluff: vegetated rocky islets and shorelines (CB) and vegetated coastal cliffs and bluffs (CB:c1).

The majority of the sensitive ecosystem boundaries inventoried to date have been mapped from aerial photography at a map scale of 1:20,000 scale. The boundaries of an identified sensitive ecosystem polygon should be verified through a field check. We recommend a detailed ecological assessment by a professional plant ecologist for site-specific evaluations.

The existing inventory of Sensitive Ecosystem is restricted to the east coast Vancouver Island. Ecosystems were identified from interpretation of approximately 3000 air photos at scales of 1:10,000 to 1:15,000 (1993/94). Roughly 7400 sites were identified in an area of about 4120 sq. km. Approximately 30% of all of the sites identified were field checked to verify boundaries, classify, photograph and evaluate present conditions. The involved compiling and editing all data, digitizing sites outlined on the air photos and producing digital and hardcopy maps at a 1:20,000 scale.

SEI project staff are now working with local governments, landowners, developers and other to use existing tools and mechanisms to protect and conserve the sites identified.

Everyone of these sites is potentially a valuable component of the area's natural landscape.

BC Estuary Mapping System

The *British Columbia Estuary Mapping System* (Howes *et al.* 1999), like CSIM, is applied at a map scale of 1:5,000 and explicitly maps coastal features. The two significant differences between the two systems are that the *British Columbia Estuary Mapping System* is applicable only to estuaries and it requires a higher level of skill to apply than CSIM. The *British Columbia Estuary Mapping System* is designed as an ecological inventory rather than as a planning tool and as such places a strong emphasis on the vegetative plant associations and geomorphological features with a level of detail on species composition not relevant to local planners and conservation/stewardship groups.

Wetland and Riparian Ecosystem mapping systems

The *Wetlands and Riparian Ecosystem Classification* (WREC) System systematically classifies all wetlands (bogs, fens, estuaries) within a framework based on an *ecosystem* component (the biological state and associated biological community) and the *hydrogeomorphic* component (the hydrological processes and geomorphic forms). The system is applied to all freshwater and marine wetlands and riparian areas but has focused on the classification of areas where there is rooted vegetation and soil development. As such it is a useful tool for classifying the upper portions of estuaries but does not provide a detailed classification framework for the intertidal and shallow subtidal realms. The system follows the methodology of the TEM but adds the site associations and hydrology unique to wetlands.

BC Marine Ecological Classification: Marine Ecosections and Ecounits

The BC Provincial Marine Ecosystem Classification (BCMEC) system is designed for marine planning at a provincial scale. The BCMEC is a hierarchical classification consisting of four nested divisions based on physiographic and oceanographic properties, and a fifth division based on current, depth, substrate, bottom relief, salinity, temperature, stratification, and wave exposure. The fifth, and most detailed, division - termed ecounits - was created at a considerably larger scale (1:250,000) than the other divisions. The ecounits were developed to evaluate the boundaries and homogeneity of the four larger divisions, as well as for the application to coastal management and marine protected areas planning. Only data that was available province wide was used in this system which has little relevance to local planning or monitoring other than to put local regions into a province wide perspective. For more information on this system go to: <http://srmwww.gov.bc.ca/dss/coastal/bcmec/index.htm>.

Shorekeepers

The Shorekeepers' Guide (Jamieson *et al.* 1999) is a protocol for monitoring and assessing long-term changes in intertidal marine communities. Shorekeepers' is designed to be used by non-professionals in a manner that produces data of sufficient quantity and quality for use by resource managers, environmental biologists, and marine researchers. The goal is to enable interested non-professional individuals and community groups to obtain standardized, credible data over time from a specific physical site -- and from these data, to document and evaluate the nature of change, if any, that is occurring. The system is not designed to survey entire coastlines, but concentrates on one or more sites that are repeatedly sampled over time. The protocol uses both physical substrate characteristics (e.g. sand, mud, and rock boulders) and biological features (e.g. rockweed and eelgrass beds) to define and map habitats, which are then sampled for species diversity and abundance. The protocol can be used on both soft and hard intertidal substrates, and includes a descriptive method for backshore surveying within 20m of the intertidal zone.

The Guide is comprised of three modules: a mapping and survey procedure, a data management procedure, and a training curriculum to teach leaders about the survey protocol and data management procedures.

While the system is not GPS-based, the sites are permanently marked using survey pins that are then georeferenced using a GPS or known reference point. The transects extend from the backshore through the foreshore. Along the transects all habitat units over 25m² are identified, described and mapped. Up to 15 quadrats are laid out along the transects within the habitat units and the plants, animals and substrate within them are identified and quantified.

Reefkeepers

Developed by Fisheries and Oceans Canada, in collaboration with the Royal British Columbia Museum and PADI Project AWARE, the "Reefkeepers' Guide For Monitoring Subtidal Habitats of Canada's Pacific Waters" is the core of Reefkeepers. The guide is a protocol for non-professionals, certified and experienced in scuba diving, to survey and monitor subtidal habitats. The data collected should be of sufficient quantity and quality for use by resource managers, environmental biologists, and marine researchers, who are monitoring and assessing long-term changes in marine communities. Reefkeepers is about collecting detailed data at regular frequent intervals at the same site for 5 or more years. The goal is to enable interested non-professional individuals and community groups to obtain standardized, credible data over time from a specific physical site -and use these data to document and evaluate the nature of change, if any, that is occurring.

Georgia Strait Alliance Quadrat System

The Georgia Strait Alliance Quadrat system provides data on the number of organisms in the intertidal zone and the relative biodiversity within the intertidal zone. When repeated over time, quadrat studies provide long-term data on the changes occurring in natural marine communities. The system relies on local volunteers trained by the GSA and has a large stewardship component.

The intertidal quadrat studies that GSA has been developing use square frames (quadrats) that are 1m x 1m and are strung with string to form a grid with 36 intersections. These quadrats are put down on the beach along a transect line (a line that runs perpendicular to the shoreline) at 1.0m, 1.5m, 2.0m, 2.5m, 3.0m and 3.5m above the "0" tide line. Intertidal life within each quadrat frame is then identified and recorded, using a method to identify what is on top, and another method for what lives underneath the rocks.

Unlike the CSIM, the quadrat system does not provide spatial resource data for a coastline. Instead it provides a gage of temporal changes in a shoreline as well as a relative index of the biodiversity and abundance of organisms in a particular location. Information is stored by the Georgia Strait Alliance in an in-house database and can be accessed by contacting the GSA.

Field Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia

Field Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia was designed to provide a standardized set of methods to map, classify, and monitor eelgrass habitat on a local level. The mapping and monitoring system was designed to be used by both community groups and government agencies. Like the CSIM method this method uses GPS to map the outline of an eelgrass bed; The CSIM data collected for eelgrass could feed directly into the Mapping and Monitoring Methods for Eelgrass Habitat. Where the systems differ is in the non-spatial detail collected in the Mapping and Monitoring Methods for Eelgrass Habitat. This system measures variables such as stem density, maximum depth of eelgrass bed, and a leaf area index to assess the health of the eelgrass bed and water quality parameters to determine potential stressors on the bed. While CSIM can provide the information needed to see if overall eelgrass habitat is expanding or shrinking, the Mapping and Monitoring methods for Eelgrass Habitat provide the detail needed to understand what is happening to individual eelgrass beds.

Photo Point Monitoring

Photopoint Monitoring (PPM) is a standardised procedure for taking precise replicable photographs of sites that require long term monitoring and management. The method

was developed over a 45-year period by Frederick C. Hall, senior plant ecologist (now retired), U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. It has been primarily applied to monitoring forest and stream side ecosystems but could easily be adapted for the marine shorezone.

Using PPM, a photographic record of the shorezone unit that is taken from a set location and bearing at a specific tidal height that can be precisely replicated over time. Photos are taken in such a way that small changes can be detected or measured that wouldn't otherwise be obvious using field notes and casual photographs and is generally less subjective. A meter board is placed in the photograph to assist in both in orientating and focusing the camera as well as allowing you to measure the height of features. Photographs taken over a period of time are then "gridded" and analysed to measure change in the feature you wish to measure – shrub height, canopy cover, amount of erosion or extent of an eelgrass bed. A complete description of this methodology can be downloaded from the site: <http://www.fs.fed.us/pnw/pubs/gtr526/>

Photo Point Monitoring can build on your CSIM project by recoding images of features that you map and wish to monitor for change over time. Features suited to this method are those that change in 3D spatial extent such as erosion features, backshore vegetative cover, eelgrass beds and salt marshes. Other monitoring methods (Shorekeepers or the GSA Quadrat methods) are better suited for monitoring changes in species composition or abundance.

Appendix 2 TIDAL PATTERNS AND SHORELINE DEFINITIONS

Tidal patterns

Over a 24 hour and 50 min period (lunar day) the tides line moves up and down the shore in regular pattern that is predicted by the tide tables. Depending on your location the tidal cycle over a lunar day may consist of:

- One high water and one low water – diurnal tidal pattern
- Two high waters and two low waters of almost equal height - semi-diurnal tidal pattern
- Two high waters and two low waters of unequal height – mixed tidal pattern

The mixed tidal pattern is the most frequently found pattern on the coast. Along the BC coast the tidal range between low and high tides is typically 3-5 meters. The tidal range varies over a lunar month as well with a larger tidal range known as “Spring tides” occurring twice a month at full and change of moon and a smaller tidal range or “Neap” tides occurring halfway between the Spring tides. Tidal range also varies over the course of a year with the greatest range occurring around the equinoxes in June and December and smallest range mid-way between these in March and September.

Shoreline Definitions

In BC, the definition of the marine limit or “shoreline” taken from English common law and is defined as the ordinary high water line. This is defined as the higher high water mark of the medium tide between the spring tides and neap tides. These tides more frequently reach and cover the shore than they leave it uncovered. Practically you will be mapping the mean level of the highest high water over the lunar month in which you are mapping. This will typically be during periods of higher tidal ranges such as June or July.

Note that the ordinary high water line is not always the legal property boundary of the upland owner. The legal boundary of shoreline properties is determined by land surveyors and is registered in the property titles and should be (but is not always) reflected in the cadastral maps. Property owners whose seaward boundary is defined by the shoreline can take legal action to claim ownership of land that has accreted naturally. But, except in cases of extreme storm events where landowners seek to restore their property within one year of loss, the law provides no means for reclaiming eroded shoreline property.

The lower boundary of the intertidal is the chart datum, defined in BC as the level of the “lowest normal tide” and is commonly referred to as “zero tide”. This is the level to which low water can be expected to fall during normal tides. Some low waters can be expected to fall below datum but this is due to specific meteorological conditions or

astronomical conditions. Chart datum is what is mapped on Hydrographic charts as the shoreline.

Appendix 3 DESCRIPTION OF AND ATTRIBUTE DATABASE FOR PHYSICAL SHOREZONE UNITS AND BIOBANDING

The physical and biological shorezone classification systems are a building block of the CSIM method and discussed in detail in Module 2: Step 1 as well as in Appendix 1. The RIC manuals for these methods can be downloaded from the web at the sites:

"Physical Shore-zone Mapping Methods" manual:

<http://srmwww.gov.bc.ca/risc/pubs/coastal/pysshore/index.htm>

"Biological Shore-zone Mapping Methods" manual:

<http://srmwww.gov.bc.ca/risc/pubs/coastal/bioshore/index.htm>

For your convenience the rationale and description of the physical shorezone classes and the biological bands are reproduced in the tables below:

Rationale for the classification of physical shoreline types

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

Biological colour band descriptions (developed for the west coast of Vancouver Island)

BIOTYPE	CODE	DESCRIPTION
Salt Marsh	SMH	Salt tolerant plants, regularly covered during high tides. Includes sedge, saltgrass and <i>Salicornia</i> .
Green Algae	GA	Green algae, which may grow on bedrock and unconsolidated substrates. Primarily <i>Ulva</i> , but also include <i>Enteromorpha</i> , <i>Monostroma</i> and various forms of filamentous green algae.
Fucus	FUC	<i>Fucus</i> and <i>Pelvetiopsis</i> species. May include barnacles and blue mussels.
Other brown algae	OBA	<i>Sargassum</i> , <i>Leathesia</i> and other small (non-kelp), brown algae.
Bladed kelps	BK	Large laminarian bladed kelps, including <i>L. saccharina</i> and <i>groenlandica</i> , <i>Costaria costata</i> , <i>Cymathere triplicata</i> , <i>Agarum</i> , <i>Alaria</i> and <i>Egregia</i> .
Stalked kelps	SK	Large kelps, with stiff upright stalks. <i>L. setchelli</i> , <i>Pterygophora</i> , <i>Lessoniopsis</i> , <i>Postelsia</i> . The bladed kelps <i>Alaria</i> and <i>Egregia</i> are also often present. Generally found in more exposed areas than bladed kelps.
Macrocystis	MAC	Beds of canopy forming giant kelp.
Nereocystis	NER	Beds of canopy forming bull kelp.
Red Algae	RA	A diverse species mix of foliose (leafy) and filamentous (stringy) red algae. <i>Gigartina</i> , <i>Iridea</i> , <i>Rhodymenia</i> , <i>Constantinia</i> , <i>Gastroclonium</i> , <i>Odonthalia</i> , <i>Prionitis</i> , coralline reds) which may be found from the lower intertidal to depths of 10 m primarily on rocky substrate but at times on sand/pebble substrates.
Eelgrass - native	ZOM	Eelgrass (<i>Zostera marina</i>) beds.
Eelgrass - introduced	ZOJ	Eelgrass (<i>Zostera japonica</i>) beds.
Surfgrass	PHY	Areas of surfgrasses (<i>Phyllospadix</i>), which may co-occur with the BK or SK groups.
Upper barnacle	BAR	Band of <i>Balanus glandula</i> and/or <i>Semibalanus cariosus</i> with no algal vegetataion. Limpets, periwinkles and other gastropods are often present.
Mussel/Barnacle	MUS	Dominated by <i>S. cariosus</i> and the California mussel <i>Mytilus californianus</i> . Goose neck barnalces (<i>Pollicipes</i>) are often present. Exposed and semiexposed rocky shorelines.
Bay (blue) mussel	BMU	Dense beds of the smaller bay mussel (can be <i>Mytilus trossulus</i> , <i>M. edulis</i> or <i>M. galloprovincialis</i>). General found in more protected areas than <i>M. californianus</i> . Often bounded on lower limit by large numbers of starfish, <i>Pisaster</i> , sp.
Oysters	OYS	Beds of Pacific oyster, <i>Crassostrea gigas</i> . To be used when oysters are observed in discrete beds and bands.
Urchin barrens	URC	Aggregations of red, green or purple sea urchins in areas with no macroalgae. Generally begin at lower limit of the intertidal zone.

Appendix 4 SELECTING COASTAL FEATURES TO INCLUDE IN YOUR CSIM MAPPING PROJECT

As mentioned in Module 1 (Step 2: Set the Scale and Scope of the CSIM project) it is important to carefully select only those features that will help you in your defined purpose. The CSIM data dictionary has been designed with the flexibility to provide the user with all of the features they might want to map – but to map all of these features would be very time consuming and the user might not get the information on features of real and immediate interest for their purpose. As an initial suggestion the table below lists sets of features that might be of highest priority for the three main users of the CSIM methodology (planners, municipal engineers, local conservation groups) and reasons they might want to undertake a CSIM project:

- A. Local governments Developing coastal zoning for an Official Community Plan (OCP);
- B. Coastal Engineers Identifying potential sources of coastal pollution or erosion; and
- C. Local conservation groups developing a local shorezone stewardship or restoration/enhancement plan.
- D. DFO or CWS habitat managers responding to a foreshore tenure referral or a report of habitat loss

Feature Type		A	B	C	D
Physical	Landform features	X		X	
	Stream feature	X	X	X	X
	Erosion feature		X	X	
Biological	Marine Vegetation	X		X	X
	Intertidal Invertebrate Fauna			X	X
	Invasive Species			X	X
	Wildlife Trees			X	x
	Coastal and Marine Birds			X	x
	Coastal and Marine Mammals, Reptiles & Amphibians			X	X
Anthro-pogenic	Shoreline armoring or other structures	X	X	X	X
	Shorezone point discharge	X	X	x	X
Cultural	Midden, CMT, Ship Wreck, Other			X	

Appendix 5 BLANK DATA FORMS

If you are unable to obtain a GPS with a data logger for recording attributes for your features and co-ordinates, or if your field crew decides to record transect information using the distance measurement methodology, you may use the following field data entry forms for recording information.

GPS Survey Field Notes / Summary Form

Intertidal / Foreshore Transect Data Sheet

Riparian / Backshore Transect Data Sheet

Other forms

Appendix 6 MARINE SPECIES LISTS AND IDENTIFICATION GUIDES / VERIFICATION EXPERTS

Selective List of Field Guides to BC Marine Life

Beachcomber's Guide to Marine Life of the Pacific Northwest by Thomas M. Niesen.
Houston, Tex: Gulf Publishing Company, ©1997.

Beachcombers Guide to Seashore Life in the Pacific Northwest by J.Duane Sept. Madeira
Park, BC: Harbour Publishing, ©1999.

Between Pacific Tides by Edward F. Ricketts, Jack Calvin and Joel W Hedgepeth. 5th ed.
Revised by David W Phillips. Stanford, CA: Stanford University Press, 1985.

Common Seashore Life of the Pacific Northwest by Lynwood Smith. Illustrated by
constance Gabriel Schulte. Edited by Vinson Brown. Healdsburg, CA:Naturegraph
Publishers, ©1962.

Exploring the Seashore in British Columbia, Washington and Oregon by Gloria Snively.
Edited by Gordon R. Elliott. Vancouver: Gordon Soules Book Publishing, Ltd;
Mercer Island, Wash: Writing Works, ©1978.

Fieldbook of Pacific Northwest Sea Creatures by Dan H. McLachlan and Jak Ayres. Happy
Camp, CA:Naturegraph, ©1979.

Guide to Common Seaweeds of British Columbia by R. F. Scagel. Illus. by Ernani G.
Meñez. [Victoria] K. M. MacDonald, Printer to the Queen, 1972 [reprinted 1973]

Guide to Marine Coastal Plankton and Marine Invertebrate Larvae by DeBoyd L. Smith.
Dubuque, Iowa : Kendall/Hunt Publishing Company, 1977.

Guide to Marine Coastal Plankton and Marine Invertebrate Larvae by DeBoyd L. Smith and
Kevin B. Johnson. 2nd ed. Dubuque, Iowa : Kendall/Hunt Pub. Co., ©1996.

Guide to Marine Invertebrates: Alaska to Baja California by Daniel W. Gotschall. Monterey,
CA: Sea Challengers, 1994.

Marine Biology by Herbert Webber and Harold Thurman. 2nd ed. New York, NY:Harper
Collins Publishers, ©1991.

Marine Life and the Sea by David H. Milne. Belmont: Wadsworth Publishing Company,
©1995.

Marine Wildlife : From Puget Sound Through the Inside Passage by Steve Yates ;
illustrations by Catherine Eaton Skinner, Fred Sharpe, D.R. Harriott. Seattle,
Wash. : Sasquatch Books, 1998.

Marine Wildlife of Puget Sound, the San Juans, and the Strait of Georgia by Steve Yates.
Chester, CT: Globe Pequot Press, 1988. [this is the older edition of the above
book]

North Pacific Seaweed by Rita M. O'Clair and Sandra C. Lindstrom. Illustrations by
Katherine M. Hocker and Patricia s. Holley. Auke Bay, Alaska:Plant Press, c2000.

Pacific Coast Crabs and Shrimps by G.C. Jensen. Monterey, CA:Sea Challengers, 1995.

Pacific Coast Inshore Fishes by Daniel W. Gotschall. Monterey, CA:Sea Challengers, 1989.

Pacific Coast Nudibranchs: A Guide to the Opisthobranchs: Alaska to Baja California by David W. Behrens. Monterey, CA:Sea Challengers, 1980, 1991.[Public Library has 1980 edition]

Pacific Coast Pelagic Invertebrates: A Guide to the Common Gelatinous Animals by David Wrobel and Claudia Mills. Monterey, CA:Sea Challengers:Monterey Bay Aquarium, 1998.

Pacific Coast Subtidal Marine Invertebrates by Daniel W. Gotschall and Laurence L. Laurent. Los Osos, CA:Sea Challengers, 1979.

Sea Cucumbers of British Columbia, Southeast Alaska, and Puget Sound: Royal British Columbia Museum Handbook by P. Lambert. Vancouver, BC:UBC Press, 1997.

Sealife: A Complete Guide to the Marine Environment edited by Geoffrey Waller. Washington, DC: Smithsonian Institution, ©1996

Seashore Life of the Northern Pacific Coast : An Illustrated Guide to Northern California, Oregon, Washington, and British Columbia by Eugene N. Kozloff. Seattle: University of Washington Press, ©1993. Fourth printing, 1996. Paperback.

Seashore of the Pacific Northwest by Ian Sheldon. Edmonton, BC: Lone Pine Publishing, 1998.

Shells and Shellfish of the Pacific Northwest: A Field Guide by R.M. Harbo. Madeira Park, BC: Harbour Publishing, 1997.

Whelks to Whales: Coastal Marine Life of the Pacific Northwest by Rick M. Harbo. Madeira Park, BC: Harbour Publishing, ©1999.

Selective List of Web Sites with Photos of and Keys to BC Marine Life

Clam identification key:

<http://dnr.metrokc.gov/wlr/waterres/beaches/clam/clamid.htm>

Sea Star identification key:

<http://dnr.metrokc.gov/wlr/waterres/beaches/seastar/seastarkey.htm>

Marine critters photos:

<http://dnr.metrokc.gov/wlr/waterres/marine/photos.htm>

EZ-ID guides (Photos):

<http://www.beachwatchers.wsu.edu/ezidweb/ezidindx.htm>

**Appendix 7 SAMPLE LETTER REQUESTING PERMISSION TO
SURVEY OR GAIN SHOREZONE ACCESS VIA PRIVATE PROPERTY**

Project
Team
Logo

Project Team title

Project team address and phone

Web Site: //http:www.project web page

Revenue Canada Charitable Number: xxx xxx xxx

Date

Dear Project Area Resident,

Over the next few weeks, shoreline mapping crews will be working in and around the shoreline of Project Area order to update information on the biophysical aspects of these areas. This project will be conducted by Project Team, a non-profit group that is dedicated to the protection and preservation of Project Area's natural heritage. Shore zone mapping is a vital aspect of coastal protection and restoration work -- specific features of shorelines must first be known before any planning, enhancement or restoration work can take place.

We will conduct all work quickly, and with the utmost respect for private property. Crews will stay within the inter-tidal zone whenever possible, though we may request permission to conduct a small survey in the immediate backshore in order to characterize this region for a length of shoreline. Members of the crew will be careful not to disturb your waterfront property and will close all access gates as they go.

It is expected that our surveys will be conducted between start date and end date. Crews will do their best to make their presence and whereabouts known; please do not hesitate to talk with the crews when you see them. Our members will identify themselves as Project Area employees, and they will be careful not to leave any traces of their presence.

We desire to work with you to help protect the shorelines in Project Area and we value your cooperation and support as a waterfront resident. Furthermore, if you would like to become involved in shore zone protection and restoration within the Project Area, call Project Area at the number below.

If you have any questions or concerns regarding this project, please contact:

Contact name #1;
Mapping and Inventory Coordinator
Phone # 1

or

Contact Name #2;
Executive Director
Phone # 2