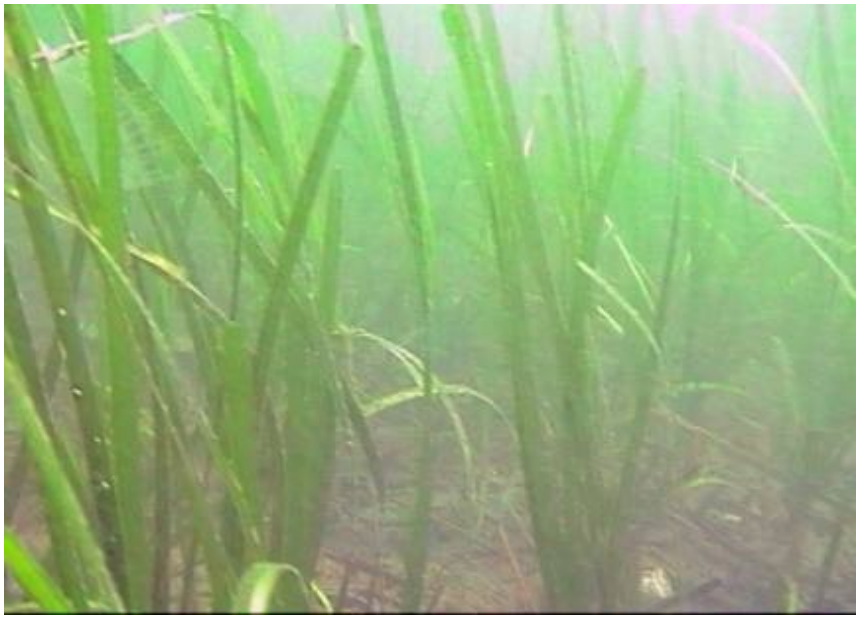
Next Steps in Mapping and Monitoring Eelgrass Habitats in British Columbia:

A Summary Report of a Meeting held in Vancouver, March 24, 2004



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1.0 Introduction

A workshop was held on March 24, 2004 to discuss eelgrass mapping and monitoring in British Columbia.

The objectives of the workshop were;

- To coordinate and where possible integrate the efforts of various groups and agencies working on eelgrass inventory
- To provide updates on current eelgrass mapping projects, including 1) the Coastal Shoreline Resource Information System (Ministry of Sustainable Resource Management), 2) Remote Sensing and Mapping of Marine Vegetation (Olaf Niemann, University of Victoria), and
- To provide recommendations and a list of priorities for addressing impediments to the continued development and integration of all levels (scales) of eelgrass mapping along the coast of British Columbia.

The workshop was attended by representatives from groups involved in eelgrass mapping, including community groups, government agencies, universities, and private foundations. A list of the workshop participants and their affiliations is provided in Appendix 1.

The following report summarizes the information collected and discussed at the workshop including;

- The reasons why eelgrass conservation is essential
- Specific reasons for mapping and monitoring eelgrass as an indicator of nearshore health,
- Current status of both fine and coarse scale eelgrass habitat mapping projects in coastal British Columbia'
- Assessment of the potential for rolling up mapping projects to provide a broader (coastwide) picture of status and trends in distribution of eelgrass habitat'
- Identification of mapping gaps and impediments to completion of mapping, and,
- Recommendations and priorities to overcome these impediments.

A short glossary terms relating to eelgrass terminology is provided in Appendix 2.

2.0 Eelgrass Conservation

Eelgrass, one of several types of seagrass, provides many ecosystem services, both locally and globally. The beds support a high biodiversity of species. It has been estimated that over 80% of all commercial fish and shellfish species depend on eelgrass habitat for at least part of their lifecycle. Eelgrass beds assist with coastal protection by providing a physical baffle (leaves) and reducing erosion (roots & rhizomes). The biomass produced by eelgrass nourishes virtually all marine habitats. It has been estimated that Puget Sound exports over 1.5 billion kilograms of eelgrass detritus each year to marine food webs. Tides and currents carry eelgrass detritus throughout the ocean; fragments have been found in an abyssal rattail fish at -30,000 feet. Seagrasses are believed to account for 34% of benthic global respiration. The United Nations recently estimated a 15% loss in seagrass habitat over the last decade.

Recent reports by the United Nations Environmental Protection Department demonstrate the value and urgency of seagrass conservation, 'We are becoming aware of the role that seagrass plays in the climatic and oceanic carbon cycles and in coastal protection. The true economic value is difficult to measure, but work suggests it is immense. Seagrass beds have been overlooked by conservationists and coastal development planners throughout their range. Biosphere restoration must include seagrass conservation & restoration.'[1]

3.0 Mapping & Monitoring

Eelgrass can only be protected if its distribution is known. Additionally, eelgrass monitoring can provide a valuable tool for monitoring changes in nearshore health.

Specific reasons to map & monitor eelgrass include;

1. to set up measures to protect it.
2. to design restoration projects for areas that historically had eelgrass or have physical potential for eelgrass.
3. to monitor climate change
4. to monitor impacts of human disturbance from
    a. tenures: finfish, shellfish, log handling/storage, sport lodge, marinas, float houses
    b. foreshore structures: docks, floats, seawalls, jetties, dykes
    c. point source pollution: outfalls
    d. non-point source pollution: runoff, septic
    e. changes in hydrology: removal of backshore vegetation, stream diversions
    f. sedimentation from human activities

[1] Dr. Mark Collins, Director, United Nations Environmental Protection

g. dredging

5. monitor changes from other stresses such as alien species (*Spartina desiflora)* or wildlife (Canada Geese)

4.0 Current Status of eelgrass habitat mapping projects in coastal BC

Workshop participants discussed the current status of eelgrass habitat mapping projects in coastal BC, at both fine and coarse scales. The applicability of various mapping methods for monitoring trends in eelgrass distribution was discussed.

4.1 Broad Scale

4.1.1 Provincial Shoreline Mapping

The only broad scale mapping project in British Columbia that includes eelgrass is the Provincial Shoreline Mapping project, currently named CRIS (Coastal Resource Inventory Study). Mary Morris (Archipelago Marine Research Ltd./Ministry of Sustainable Resource Management) presented an overview of the project and discussed the strengths and weaknesses associated with the project.

Method:

Oblique Aerial Video was flown at tides less than one metre. A team that included a biologist and a geomorphologist recorded commentary as the video was filmed. The date and position were recorded on the video, as well as being recorded as a data stream. The video was post processed by a team of experienced interpreters; a geomorphologist classified the shoreline into units and a biologist classified the biobands within each unit.

The group discussed the strengths and weaknesses of mapping eelgrass from oblique aerial videos (Table 1).

Table 1. Strengths and weaknesses associated with CRIS for mapping eelgrass.

Strengths	Weaknesses
Whole province covered using same method	Produces linear not polygon maps. No across shore (depth) information (This is information in the associated database but is not spatially explicit on mapping),
Images available for all shoreline units	Spatially limited to whole units
Rich attribute base with both biological and physical characteristics of shore unit	Relies on best available shoreline. Is not new mapping of current marine limit.

Can be used to predict biological communities	
Can be used to predict the presence or absence of eelgrass from physical characteristics of shore unit. Prediction of subtidal appears to be reasonable down to 10 m depth.	Cannot be used to confirm the absence of eelgrass.

Results:

This method can be used to identify areas where eelgrass is present as seen at low tide. It can also be used to predict the potential for subtidal colonization by eelgrass, based on physical attributes. The method shouldn't be used to infer the absence of eelgrass.

If the eelgrass bioband is observed within a shore unit, the distribution is recorded according to a subjective category of either 'continuous' or 'patchy'.

The classes are defined as[2]:

Continuous: >50% of unit length has eelgrass

Patchy: < 50 % of unit length has eelgrass

Units tend to average several hundred meters in length and if even a few metres of the unit length of eelgrass is present (a few percent of the unit length) that observation will be recorded as 'patchy'.

Anthropogenic shoreline classes are recorded in BC, with across-shore attributes recorded in the associated database. In Washington and Alaska, percent of the unit with each type of modification is also recorded in the database.

4.1.2 Landsat 7 Thematic Mapper and RadarSat

Olaf Niemann (University of Victoria) is working with Kathleen Moore (Canadian Wildlife Service, Environment Canada) to develop methods that integrate Landsat 7 ETM+ and RadarSat imagery to classify wetlands, including eelgrass beds. (Power point presentation made at the March meeting available through seachange@shaw.ca)

Methods:

Optical: Landsat 7 ETM+ and RadarSat

[2] The definitions used here differ from those used elsewhere in this report. Appendix 2 provides definitions for these terms as used elsewhere in this report.

Results:

The method is currently unable to always distinguish specific vegetation types, although it is expected that further refinements of the technique will enable accurate vegetation classification.

Landsat alone can correctly resolve eelgrass habitat 80% of the time. The 20% that were misclassified were where mudflats with and without eelgrass were confused. Radarsat was combined with Landsat resulting in an increased resolution of 87%.

Table 2. Strengths and weaknesses associated with Landsat/Radarsat for mapping eelgrass.

Strengths	Weaknesses
Landsat imagery is free of charge	Does not distinguish between mudflat and vegetation
Landsat is able to distinguish vegetation types fairly well.	Radarsat does not penetrate through water
Radar sat data can be collected through clouds and at night	Ability to map subtidal eelgrass beds dependent on water depth and turbidity; not able to map species layer.
Technique provides polygons rather than linear units	Radarsat is expensive and has to be ordered specially.

It is expected that with refinements to the technique, it will be possible to provide good mapping for eelgrass flats that are exposed at low tide, however mapping eelgrass fringes that are restricted to the subtidal is likely beyond the capabilities of this method.

Other remote sensing methods that could be used to map eelgrass include:

Traditional air photo – can be used to map vegetation to depth of –10m under good conditions

Oblique video

Multispectral

Hyperspectral (> 100 channels)

LiDar – depth only

Multi- and Hyper- spectral can penetrate water up to 50 m (in tropical locations) depending on clarity but it is expensive to collect and process. The method is dependent on clear water and good weather.

4.1.3 Other coarse scale mapping projects

Environment Canada has recently mapped the estuaries in BC, which are maintained by a 4th order or larger stream.

A Federal program, currently under development, plans to monitor wetlands, including eelgrass beds, over time using satellite imagery.

The Fisheries and Oceans Canada -Provincial Pacific Coast Fisheries Atlas contains anecdotal information on location of eelgrass beds from their field staff.

NOAA plans to film entire Pacific US coast this year. Brad Mason (FOC) is discussing the possibility of co-operative mapping with them.

4.2 Fine Scale

4.2.1 Data Review

Kathy Dunster conducted a review of the fine scale mapping projects that have been conducted in British Columbia, *Eelgrass Mapping Review: Eelgrass Mapping Initiatives in British Columbia* (March 2003). The review determined that most of the mapping projects were in response to specific concerns such as;

- Aquaculture concerns (Jervis Inlet)
- Official Community Plans (Salt Spring Island)
- Impact Assessment (GSX Pipeline - Boatswain Bank)
- Herring Spawn Surveys (1974 to 1983)
- Habitat Assessments (Saanich Inlet Study 1996)

The report is available online at http://www.cmnbc.ca . Information relating to studies that were not included in the review may be sent to precid@shaw.ca.

4.2.2 The BC Coastal Eelgrass Mapping and Stewardship Project

This two year project began with funding support from Environment Canada in June, 2002. Twenty coastal conservation groups are mapping and creating stewardship programs to protect eelgrass habitats near their communities. These groups include a naturalist group in Kitimat, land trust organizations in Campbell River and Cowichan valley, the Snuneymeux and Heiltsuk First Nations (Nanaimo and Bella Bella), the Bamfield Marine Science Centre and other conservation groups in the north, central and south coast of BC.

Over 5,000 hectares of eelgrass has been mapped. Much of the data is now on the Community Mapping Network website (http://www.cmnbc.ca). The next steps for this project include creating a strategy for the north, central and south coast groups to generate funds for continued mapping and stewardship, selecting sites

to monitor and selecting sites for restoration. The groups are part of the *Seagrass Conservation Working Group*, a consortium of government and non-government agencies working together since 2001 to conserve seagrasses in British Columbia.

4.2.3 Fine Scale Method

Rob Knight (Fisheries Biologist: MWLAP) suggests the use of Photopoint sampling as a method for monitoring eelgrass beds.

Photopoint establishes reference point from which to take photos to monitor changes in eelgrass beds over time.

The study team photographs the bed from a specific location and returns to the same land base point over time to record with changes with repeat photos.

This method would only work in areas with a high point of land that can look down over eelgrass beds.

The detailed methodology is available from (www.cqs.washington.edu/salmonweb/pubs/pplots.html).

5.0 Site selection for monitoring eelgrass: Recommendations and priorities

The workshop participants discussed various criteria for selecting sites that would provide representative data. This information would be used to assess the status of eelgrass habitat in British Columbia over time. Sites should be included that represent a range of conditions, both geographically and in terms of disturbance.

5.1 General Criteria

- To facilitate data collection it would be useful to include sites that could be sampled easily and accurately by remote sensing or photopoint sampling.
- Selecting sites for which there is existing baseline data would enable assessment of changes that have already occurred.
- There are many advantages to selecting sites with local resources (human and financial) to build on the existing infrastructure. These include areas where there are trained community groups, education facilities (e.g. Bamfield), existing government programs (e.g. Gwaii Haanas), and/or local expertise (e.g. Sabina Leader-Mense on Cortes Island)
- Sites that have monitoring programs in place include: Cowichan Bay, Boundary Bay, Roberts Bank, Pacific Rim, Gwaii Haanas, and Comox.

5.2 Criteria to ensure representative samples

- Monitoring should include geographically stratified sites with some combination of marine eco-sections to capture different oceanographic regimes and potential climate change responses.
- Each eco-section should characterize the most significant stressor(s) in that region.
- A reasonable mix of bed types should be monitored including: flats, wide fringe, narrow fringe, large, small

5.3 Reference Sites

Reference sites should be selected to provide a baseline for comparison with other sites. Criteria related to selecting reference sites include;

- Areas that are protected under the jurisdiction of Parks Canada
- Areas for which there are no known existing stresses

5.4 Non-Reference Sites

- Sites should include areas that are of immediate concern. These would include: sites that are immediately threatened (e.g., oil and gas exploration, new applications for tenure) and areas where coastal planning is about to occur (funding available and spin off benefits).
- Sites should include areas that have been identified as “Important” areas for wildlife, fish etc. (e.g., Boundary Bay Important Bird Area). Other funding could then be contributed.

6.0 Assessment of the potential for integrating eelgrass mapping projects in B.C.

There is currently no baseline data available that can be used for monitoring the status and trends of eelgrass distribution on a provincial basis. There are however, several sites within British Columbia for which baseline data exists that could be monitored.

The Landsat 5 Thematic Mapper and RadarSat technique may be a valuable tool in the future for monitoring eelgrass flats, however a different method would be needed to monitor eelgrass fringes.

Aerial photographs, flown during the extreme low tides this summer (2004) would provide a basis from which to start a monitoring program. Ground truthing and monitoring could be facilitated through partnerships with community groups and Parks Canada. Additional sites would be required; the criteria for site selection are discussed in Section 5.

7.0 Mapping Gaps & Recommendations

A baseline polygon map of eelgrass distribution along coastal British Columbia is needed. Field surveys to monitor specific sites over time could be co-ordinated in some areas with groups and agencies that are currently engaged in mapping activities. Sites should be selected according to the criteria listed in Section 5. Table 3 lists the monitoring parameters that would be required in order to achieve various levels of sensitivity. The list is based on a series of parameters recognised to be important indicators of eelgrass plant and bed conditions. Large changes could be detected through monitoring the area occupied by eelgrass either by remote sensing (e.g. Air photos) or by ground surveys (e.g. GPS). A program that included density and leaf area index monitoring would be able to detect smaller changes. It would also be advantageous to record known stresses on bed.

A list of relevant websites was compiled by workshop participants and is provided in Appendix 4.

Table 3. Parameters associated with various sensitivities. Levels 2, 3, and 4 require the parameters listed for lower levels.

Level of Sensitivity	Parameters to Monitor
1 - low	Area of bed; either via remote sensing or GPS (points a minimum of 15 m apart)
2	Maximum depth and minimum depth of eelgrass relative to datum
3	Density of bed (approx. 30 quadrats per zone within bed)
4 - high	Leaf area index (1 sample per quadrat, approx. 30 quadrats per zone within bed)

Metadata is essential to ensure the validity of any mapping or monitoring project. A metadata report, prepared by Brad Mason (Fisheries & Oceans Canada) is provided in Appendix 3.

8.0 Recommendations

The recommendations below are based on discussions at the workshop, and ongoing conversations with community groups along the coast; not all issues were discussed during the meeting.

1. Coast wide inventory maps should be made easily accessible to all agencies and community groups involved with mapping and monitoring eelgrass habitat.

2. Funding needs to be made available for ground truthing and monitoring work by community groups.

3. Appropriate field mapping methodologies must be selected according to project objectives (mapping or monitoring)

4. Partnerships between agencies and community groups need to be linked with funding and other resources (i.e., technical support).

5. Ongoing analysis of data from monitoring efforts should be made available to all interested parties.

Appendix 1 Workshop Participants

Name	Affiliation
Ann Archibald	Cowichan Community Land Trust
Bill Austin	Marine Ecology Station
Lynne Bonner	State of Environment Reporting Ministry of Water Land & Air Protection
Jacqueline Booth	Jacqueline Booth and Associates
Leanna Boyer	University of Victoria Graduate Studies
Margaret Cuthbert	Friends of Semiahmoo Bay
Heather Deal	David Suzuki Foundation
Cynthia Durance	Precision Identification Consultant
Melody Farrell	Department of Fisheries & Oceans
Gretchen Harlow	Environment Canada/Canadian Wildlife Service
Susan Jesson	Community Mapping Network/BCCF
Rob Knight	Ministry of Water, Land & Air Protection/Community Mapping Network
Lynn Lee	World Wildlife Fund
Jeff Marliave	Vancouver Aquarium
Brad Mason	Dept. of Fisheries & Oceans/ Community Mapping Network
Sabina Leader-Mense	Friends of Cortes Island
Kathleen Moore	Canadian Wildlife Service
Mary Morris	Archipelago Marine Research Ltd/Ministry of Sustainable Resource Management
Olaf Niemaan	University of Victoria
Marcel Pepin	Precision Identification
Frank Polsen	Environment Systems
Alex Shaw	
Nikki Wright	Seagrass Conservation Working Group

Appendix 2 Glossary of Terms

Continuous: Continuous beds are not fragmented. The eelgrass cover relatively homogenous.

Patchy: Patchy beds are fragmented; the distribution of eelgrass is limited to isolated groups or islands of plants.

Flat*: Areas with exensive broad shallows, such as river deltas and pocket beaches.

Fringe*: Areas with relatively linear shorelines where potential Z. marina habitat is limites to a narrow band of bathymetry. ‘

Narrow finge*: Fringe sites less than 305 m wide

Wide Fringe* : Fringe sites less than 305 m wide

Leaf Area Index (LAI): Leaf width multiplied by leaf length. This estimate of leaf area provides an indication of the size of the plants and the habitat available to organisms within the seagrass canopy. Changes in LAI are known to reflect environmental changes.

* definition from: Puget Sound Submerged Vegetation Monitoring Program: 2000-2002 Report. Washington State Department of Natural Resources, Nearshore Habitat Program, PO Box 47027. Olympia, WA 98504-027

Appendix 3 Metadata Requirements

The following information was submitted by Brad Mason (FOC).

Field	Description
FEATURE_TYPE	Point, line, polygon
UniqueID	Id for each feature, note there may be more than one feature for a feature ID.
FEATUREID	ID to link features to attributes
LOCATION	Name of location from chart or gazetteer
GEOREFERENCING	How was the feature georeferenced -
ACCURACY	From pick list
OBS_METHOD	From pick list
FIELD_SURVEY_PLATFORM	From pick list
FIELD_SAMPLING_METHOD	From pick list
PHOTO	Y/N
GPS_USED	Y/N
GPS_MODEL	Name of GPS model (pick list)
REFERENCE_MAP	Linked to master list of reference maps; enter chart number of map sheet ID in this field from pick list
COMMENTS	
SOURCE_1	
SOURCE_2	
DATA_DTE	Date of field survey of if anecdotal information, year which reflects currency of knowledge
MAP_DTE	Date information was entered in GIS database
COMPILER	Linked to file which gives contact information for compiler

Fields describing the Reference Map (master list built up for all possible reference maps. Note reference map could also be an air photo or satellite image.

REFERENCE_NAME	Name of map series
REFERENCE_DATE	Date of issue of map
REFERENCE_SCALE	Scale of reference map
PROJECTION_NAME	Name of reference map projection
PROJECTION_DETAIL	Other details of reference map

DATA_DTE	Link to feature table
START_TME	
FINISH_TME	
START_TIDE_HEIGHT	
FINISH_TIDE_HEIGHT	
TIDE_HEIGHT_REF	

Fields describing the survey date (fill in this table for each survey date)

Fields describing the Source

Full_Citation	If the source is a report (vs a person)
Name	If the source is a person
Position	Relative to mapping the resource
Organization	Organization they belong to in the capacity of mapping the resource
Sector	Note change of field name – this is the sector to which the person belongs (gov,NGO, community group…)
Experience	Verbal description to give an idea of the eprson's reliability and perspective
Year_Start	Year the person began their relevant experience

Data Quality Information

2.1 Attribute Accuracy
2.1.1 Attribute Accuracy Report:
How accurate are the data; description of the limitations of the dataset

2.2 Logical Consistency Report:
Statement regarding errors; ie. duplicate features (if applicable)

2.3 Completeness Report:
Info re: gaps in the data, omissions, generalization, data anomalies, inconsistencies... (if applicable)

2.4 Positional Accuracy
2.4.1 Horizontal Positional Accuracy
2.4.1.1 Horizontal Positional Accuracy Report:
An estimate of accuracy of the horizontal positions of the spatial objects

2.4.2.1 Vertical Positional Accuracy Report:
An estimate of accuracy of the vertical positions of the spatial objects, if applicable

2.5.1.1 Methodology Type:
Field (eg.)
2.5.1.3 Methodology Description:
Materials and Methods
2.5.1.4 Methodology Citation:

2.5.2 Process Step
(Each processing step taken in the creation of the data base; eg. Data manipulation, statistical tests (if not reported under "analytical tools"), etc; may be repeated as to cover all steps taken)
2.5.2.1 Process Description:
Explanation of survey, data manipulation, statistical procedures/analyses
2.5.2.3 Process Date:
Date of completion
2.5.2.4 Process Time:
Time of completion
2.5.2.6 Process Contact
(Person responsible for the processing step)

Appendix 4 Websites

The following list websites was compiled by workshop participants.

- Downloadable stewardship documents: Stewardshipcentre.bc.ca
- Community Mapping website: cmn.bc.ca
- Underwater video coverage of Victoria Inner Harbour, Gorge Waterway and Esquimalt Lagoon: crd.veheap.bc.ca
- Integration of the various levels and types of mapping data that have been collected for the Gulf of Alaska to date: coastalaska.net