HAEGELE EELGRASS METADATA REPORT:
Source Metadata and Digital Data Specifications

Produced
for

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1 Introduction

1.1 Background

This report describes the digital data specifications for the **Haegele Eelgrass** digital data set with a focus on spatial data collected for use in Geographic Information Systems (GIS). Background information on the source data set is also included in this report (Haegele historical eelgrass mapping).

This report is based in part on a standard template for digital metadata reporting and information produced by the British Columbia's Resources Information Standards Committee (1998). A template was used to ensure this metadata report conforms to recognized standards for quality and consistency. It is anticipated the information in this document will be useful to staff involved in collection of resource inventory data, managers charged with overseeing data collection projects, custodians maintaining resource inventory data sets, and end-users seeking to apply resource inventory data to resource management and land-issues.

1.2 Purpose of Metadata Document

The purpose of this report is to provide information that will assist in the use of the **Haegele Eelgrass** digital data set for data applications, data analysis and GIS mapping initiatives. This document meets the need for the following two requirements: to describe source data collection methodology; and to define the digital form and structure of Haegele Eelgrass digital data set. This document includes:

- Metadata for the source data set;
- Standards for describing thematic content;
- Standards for data specification;
- Geo-referencing and registration standards;
- Quality assurance guidelines; and
- Recommendations for data application.

1.3 Scope of Metadata Document

The metadata as presented in this document defines the Haegele Eelgrass Digital Data set. This majority of this data set was compiled and completed in August 2002 – March 2003 from a source data set collected during the 1970's and early 1980's on the West Coast of British Columbia, Canada. Part of this data set was completed at an earlier date by the Ministry of Agriculture, Food and Fisheries (MAFF), but this document does not contain metadata pertaining to that portion of the data set (see Table 2.6.2).

This document describes digital data definitions including logical and physical descriptions for attribute and spatial aspects of the data sets. This document also describes methods of geo-referencing, data capture, projection, quality assurance and graphic data representation.

1.4 Intended Users of the Standards

This is a technical document intended for an audience of GIS data technicians and GIS data managers using the Haegele Eelgrass digital data set.

This document is focused on the following user groups and organisations:

- The Department of Fisheries and Oceans Canada;
- Ducks Unlimited Canada;
- The Canadian Wildlife Service;
- Municipal groups interested in shoreline vegetation monitoring and management;
- Provincial Government agencies collecting digital marine vegetation data;
- Private-sector contractors involved in analysing eelgrass data; and
- Non-profit groups operating on the BC Coast with interests in historical eelgrass mapping.

Users of this data will refer to this document for specific technical guidance on the source metadata, GIS digital metadata, data form and structure of the eelgrass data set.

2 Source Metadata

The Haegele Eelgrass digital data set is based on paper maps that were compiled by Carl W. Haegele through the 1970's and 1980's. This section of the report details the data collection methods, dates of data collection, and field survey quality assurance procedures for the entire data set. All MS series reports used to compile this metadata section are referenced in Section 9.0.

2.1 Introduction

The Department of Fisheries and Oceans (then referred to as the Department of Environment, Fisheries and Marine Service) undertook eelgrass mapping from the 1970's until the early 1980's on British Columbia's West Coast. The Pacific Biological Station in Nanaimo, BC initiated the project to map the shoreline marine vegetation on herring spawning grounds from aerial photographs. The original data set was compiled with the purpose of gathering "knowledge on the extent and type of shoreline vegetation on which Pacific herring annually deposit adhesive eggs" (Haegele, 1975). This knowledge was to be used to estimate the size of the spawning population (Haegele, 1975). Methods were developed for mapping in 1973 and 1974, applying the use of low-level colour infrared and colour aerial photographs. In total, 16 sites along the West Coast of British Columbia's coastline were photographed and mapped between the years of 1974 and 1983.

2.2 Methods

In 1971, Pacific Biological Station initiated a program to map the vegetation of herring spawning grounds along British Columbia's coast (Haegele, 1975). The justification for using low-level air photography to map marine near-shore plant communities and algae was given in papers studied by Haegele and his associates (Anderson, 1971; Jamison, 1972; Lukens, 1968; and Vadas and Manzer, 1971). These studies recommended the use of colour infrared film (CIR) to identify plants. In water depths beyond water-penetrating capability of infrared film, colour film (COL) could be used to support infrared.

2.3 Developing a Photographic Method

Experimental flights were undertaken in 1971 and 1973 to establish optimum film, filter and altitude combinations for successful photography of shoreline vegetation (Haegele, 1975). The Vancouver Island coastline between French Creek and Ganges Harbour was flown, capturing vertical aerial photographs with a 23 x 23-cm format camera. Four different film types and filters at a variety of altitudes from 183m to 1829m were evaluated (see Table 2.1).

Table 2.1 Experiments with Film, Filter and Altitude

FILM TYPE	FILTER	ALTITUDE (M)
Kodak Aerochrome	Zeiss D	244, 488, 610
Infrared #2443	HF3	488
	W8	244, 488
	W12	244, 488, 1219, 1829
	W15	244
	W21	488
Kodak Aerocolor #2445	None	244
	HF3	244, 1829
Kodak Plus-x-Pan	W12	244, 488, 732

Photography was carried out in clear weather conditions with occasional light haze. Photographs were evaluated in terms of vegetation identification using photographic methods and ground truth surveys to correlate imagery with vegetation types.

2.4 Photographic Results

The best results were obtained with Kodak Aerochrome Infrared film no. 2443 using a Wratten no. 12 yellow filter for absorbing unwanted blue wavelengths. Vegetation appeared in various hues of red with this film and filter combination (Table 2.2). Haegele thereby adapted an interpretation key, which he used to interpret vegetation in each project area (see Table 2.6.2 for a list of project areas).

Table 2.2 Haegele's Vegetation Interpretation Key

Near-shore vegetation	Colour	Texture
Rockweed	Crimson	Rough
Kelp (Brown Algae)	Bright magenta	Smooth to fluffy
Red Algae	Light red	Rough
Green Algae	Light pink	Smooth to fluffy
Sea grasses	Pinkish red	Smooth to fluffy

Water penetration was limited with infrared film, and did not exceed 1m under ideal sun angles of 40°. Kodak Aero Color film no. 2445 exhibited good water penetration capabilities to a depth of 10m, but poor colour separation as most vegetation appeared a light brown or green hue. Kodak Aero Color film no. 2448 was preferred for this reason. Some of the studies used the no. 2445 film to compensate for poor light conditions during the photo capture period (for example MS 1485, Deep Bay to Dorcas Point). The black and white films were found to be of little value because vegetation was not discernable.

It was concluded that the best photographic technique for exposed shoreline vegetation identity was to use color infrared film during the lowest possible tides in bright sunlight, supplemented by color film to determine underwater outer vegetation boundaries. In order to obtain adequate detail for accurate vegetation identification and mapping, photographic scales of between 1: 3000 and 1: 6000 were considered suitable for moderately sloping shorelines with extensive beds of vegetation. Areas with steep shorelines and narrow vegetation zones required scales of 1: 1600 to 1: 2400.

2.5 Mapping Methods and Results

Using the methods and results obtained from experiments in 1971 and 1973, the project began photographing and mapping at Barkley Sound on the West Coast of Vancouver Island in 1974. See Appendix A for complete details of flight results from all geographic areas.

Flight lines were plotted from the photographs with the aid of a mirror stereoscope, transferring photo centers to adjacent photographs. Vegetation zones were identified and marked on the positive transparences with coloured pencils. Hydrographic charts were enlarged to photo scale with a reflecting projector (also described as a vertical sketchmaster modified to accept transparencies). See Table 2.5.1 for scale and number of hydrographic chart applied in each study area. For the Barkley Sound area, no suitable large-scale charts existed for the region of coastline therefore all high water and 0m tide contours were also charted. Hydrographic charts for areas such as Ganges, Nanoose, etc. did contain fathom contours.

The shoreline marine vegetation was mapped at the scale of photography. Exposed vegetation was identified from the CIR dipositives by colour and texture, employing the key Haegele previously developed (Table 2.1, Haegele, 1975). Submerged vegetation (usually the outer vegetation boundaries) was mapped from the COL dipositives mostly by texture since the colour information was confined to the narrow spectral range of dark green to light brown. Against a light background of sand, vegetation could be discerned to depths of 10m in the absence of surface reflection.

In cases where no distinct uni-species vegetation zones was evident, vegetation zones were plotted according to either the:

- Single dominant type (if it occupied not less than 80% of the total area)
- Mixed vegetation zones (if two or more vegetation types each occupied more than 20% of the total area)

Vegetation types covering less than 20% of a zone were not included in zone identification.

Table 2.5.1 Base Mapping and Source Data Capture Details

Site	Base Map Used and Scale	Coastline Mapped	Map # / Size	Photo scale / Area Mapped	Published Scale
Port Simpson	Canadian Hydrographic Service Chart No. 3799 (1: 91,430)	50 km	10 / 83 cm by 64 cm	1: 6000 / 19.1 km^2	1: 23,163
Kitkatla	Canadian Hydrographic Service Chart No. 3761 (1: 36, 530)	**	12 / 64 cm by 83 cm	1: 6000 / 19.1 km^2	1: 24,000
Cumeshewa	Canadian Hydrographic Service Chart No. 3894 (1: 73,026)	69.4 km	11 / 64.5 by 82.5 cm	1: 6,000 / 3.87 km by 4.96 km	1: 23, 000
Skincuttle	*	*	*	*	*
Laredo	Canadian Hydrographic Service Chart No. 3737 (1: 77,429)	77.2 km 78.4 km	9 / 83 cm by 64 cm	1: 6000 / 5 km by 3.8 km	1: 23,300
Thompson	Canadian Hydrographic Service Chart No. 3787 (1: 36,396)	76.2 km	8 / 84 cm by 64 cm	1: 6000 / 5 km by 3.8 km	1: 23,300
Kildidt	Canadian Hydrographic Service Chart No. 3784 (1: 36,504)	65.8 km 81.8 km	10 / 75 cm by 58 cm	1: 6000 / 4.5 km by 3.5 km	1: 21,000
Quatsino	Canadian Hydrographic Service Chart No. 3617 (1: 48, 662) and No. 3680 (1: 38,317)	**	18 / 64 cm by 82 cm	1: 6000 / 18.9 km^2	1: 23,000
Nuchatlitz	No chart available.	24 km	3 / **	1: 6000 / 22 km^2	1: 21000
Nootka	No chart available.	16 km	2 / **	1: 4800 / **	1: 22000
Hesquiat	No chart available.	26 km	5 / **	1: 4800 / **	1: 21000
Clayoquot	Canadian Hydrographic Service Chart No. 3648 and No. 3649 (both replaced by charts 3673, 3674)	87 km 1561 ha	14 / **	1: 6000 / 1561 ha	
Barkley	No chart available.	14 km	5 / **	**	1: 9000 to 1: 13000
Comox	Canadian Hydrographic Service Chart No. 3532 (1:40,000)	114km	19 / 62.7 cm by 81.5 cm	1: 6000/ 3.76 by 4.89 km	1: 22,600
Deep Bay	**	60 km	12 / **	1: 6000	**
Nanoose	**	47 km	10 / **	1: 3600 / 3.7 km by 2.8 km (minimum res. of 10m)	1: 12346 to 1: 16667
Yellow	Canadian Hydrographic Service Chart No. 3453; (1: 73,026) (replaced by chart 3443)	76 km	12 / **	1: 6000	**
Ganges	**	46 km	8 / **	1: 3600 / 3.7km by 2.8km (minimum res. of 10m)	1: 12346 to 1: 16667

* - no report published
** - no data given in report

2.6 Ground Truthing Methods and Results

A sub-section of the study sites were surveyed and sampled for bottom vegetation with the aid of scuba divers. Samples were collected by divers at regular intervals along transects perpendicular to a baseline surveyed parallel to the high-water mark.

Transects roughly perpendicular to the shoreline were established at varying intervals, usually no closer than 400m apart and sometimes several kilometers apart (MS 1485). Teams of divers sampled along each transect at intervals dictated by changes in vegetation type or percent cover. Usual intervals between samples ranged from 20m to 50m and consisted of all but crustose vegetation rooted within a ¼ m^2 or a $1m^2$ quadrat. Divers also collected information on bottom type, particle class, percent cover, and depth. Each species was rated to whether it was dominant, major (>= 5% of sample weight), or minor (<= 5% of sample weight). All vegetation samples were sorted by species according to Widdowson (1973, 1975) and Scagel (1967), and weighed wet to the nearest gram. A more detailed description of the herring sampling and surveying procedure was published in MS series 613 by in Humphreys and Haegele (1976).

The results of the above sampling procedure showed that the identification of vegetation from aerial photographs was better in shallow water than in deep water and better at higher percent covers (MS 1485). Vegetation zones determined by this procedure closely correspond to those determined from aerial photography with the exception of the sparse red algae (<25 g/m^2 or 25%), the detritus zone (which did not have heavy enough concentration of healthy plants to register of aerial photographs) and the narrow sea-lettuce zone. Where vegetation on the outer limits was sparse, photographic analysis was not as successful at recognizing marine vegetation.

Not all sites had diver survey to verify data interpretation. The following table is a list of areas where ground truthing was undertaken and the results. The table is based on all available information contained in the MS series reports for each vegetation survey (see reference list Section 9.0).

Table 2.6.1 Ground Survey Results

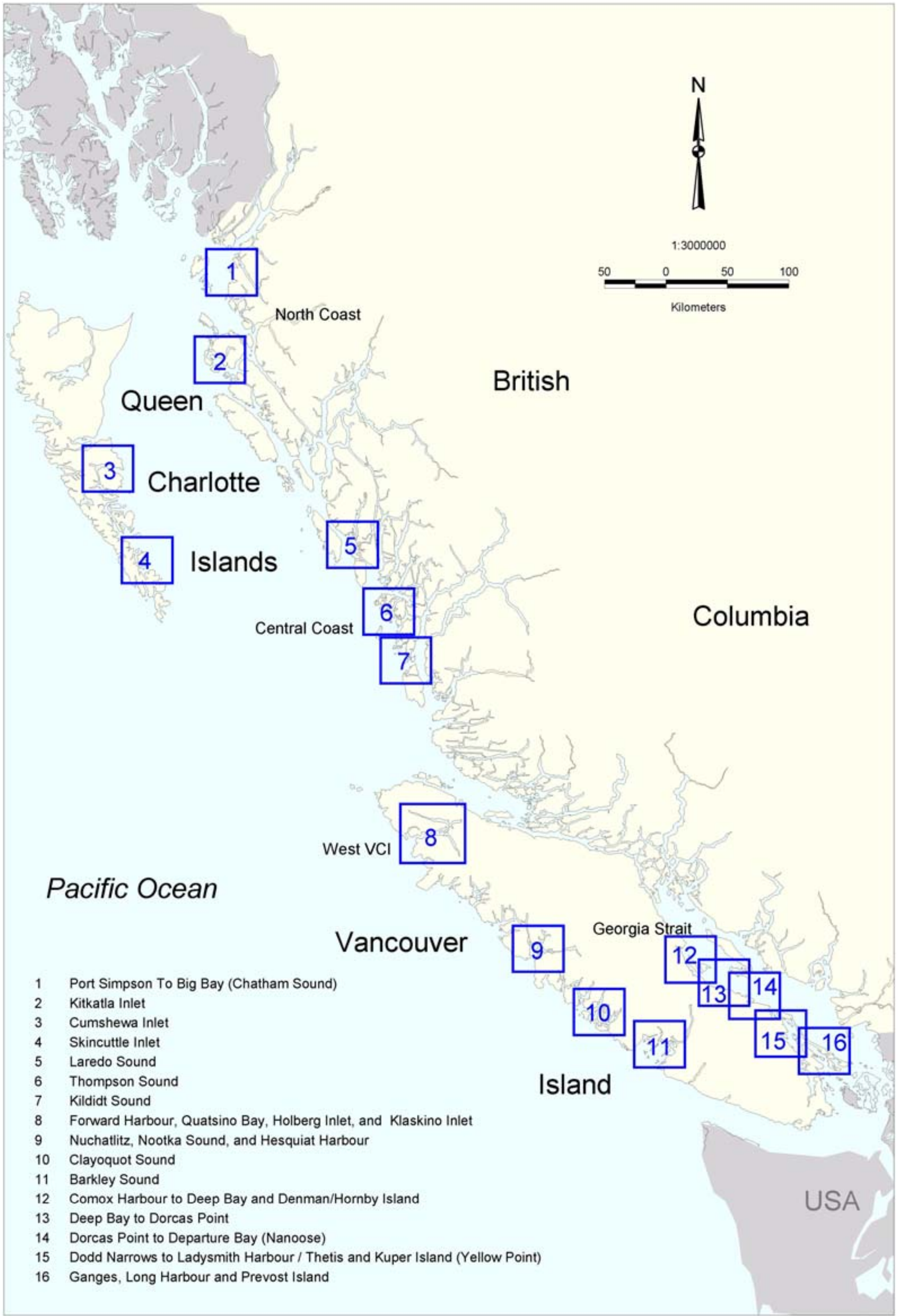
Location	*Ground Survey*	*Year*	*Results*
Port Simpson	No	--	--
Kitkatla	No	--	--
Cumshewa	No	--	--
Skincuttle	*	*	*
Laredo	No	--	--
Thompson	No	--	--
Kildidt	No	--	--
Quatsino	Only herring diver survey	1985; 1986	Klaskish Inlet and Forward Inlet – no discrepancies apparent (Haegele and Hamey, 1987).
Nuchatlitz	No	--	--
Nootka	No	--	--
Hesquiat	No	1974	
Clayoquot	Yes	1979	Presence of vegetation identified on aerial photos for 99.2% of the samples and correctly types for 94.9 % of vegetation sampled (Haegele and Hamey, 1979).
Barkley Sound	Yes	1975, 1977	Sparse red algae with percent cover less than 25% extended to 5fm contour, photographs only show it extending to the 3fm contour (Haegele and Hamey, 1977; Haegele and Hamey, 1980).
Comox	No	--	--
Deep Bay	Yes	1978	The presence of vegetation was identified for 72% of transect samples, and 60% of transect samples were correctly mapped from the aerial photographs. Shoreline vegetation incorrectly mapped as bare from aerial vegetation was almost exclusively (90%) beyond the outer edge of vegetation identified in photographs and in deep water. Many of these areas exhibited patchy vegetation. (Haegele, 1978.)
Nanoose	Dive survey	1976	Vegetation charts drawn from aerial photographs are mostly correct except for locating outer vegetation limits where vegetation is sparse (Haegele and Hamey, 1976).
Yellow	No	--	--
Ganges	No	---	--

* No report published

Table 2.6.2 Complete list of Sites and Metadata

Locality	Year of Photo-graphy	MS Number	GIS Data Conversion	Date
North Coast				
Port Simpson to Big Bay	1980	1660	Geostreams	2002
Kitkatla Inlet	1980	1664	Geostreams	2002
Central Coast				
Laredo Sound	1979	1580	Geostreams	2003
Thompson Bay	1979	1579	Geostreams	2003
Kildidt Sound	1979	1592	Geostreams	2003
Queen Charlotte Islands				
Cumshewa Inlet	1979	1619	Geostreams	2002
Skincuttle Inlet	1981	*	Geostreams	2002
West Coast of Vancouver Island				
Winter Harbour (Quatsino)	1981	1921	Geostreams	2003
Holberg Inlet (Quatsino)	1981	1921	Geostreams	2003
Brooks Bay (Quatsino)	1981	1921	Geostreams	2003
Nuchatlitz Inlet	1976	1430	MAFF	2001
Nootka Sound	1976	1430	MAFF	2001
Hesquiat Harbour	1976	1430	MAFF	2001
Clayoquat Sound	1978	1536	MAFF	2001
Barkley Sound	1974, 1978	1549; 1430	MAFF	2001
Strait of Georgia				
Comox Harbour to Deep Bay, Denman and Hornby Islands	1979	1617	Geostreams	2002
Deep Bay to Dorcas Point	1977	1485	Geostreams	2002
Dorcas Point to Departure Bay (Nanoose)	1975	1408; 1412	Geostreams	2002
Dodd Narrows to Ladysmith Harbour, Thetis and Kuper Islands	1977	1534	Geostreams	2002
Ganges, Long Harbour, and Prevost Island	1975	1408; 1433	Geostreams	2002

* - no report published



Haegle Eelgrass GIS Dataset

updated March, 2003

3 Data Description

The physical format of the Haegele Eelgrass data set is:

Feature Classes

Polygons Count	9049
Total Area	19460.69 ha
Minimum Mappable Area	25 m^2
Largest Polygon Feature Mapped	772 ha
Smallest Polygon Feature Mapped	29m^2
Snapping Tolerances	3-5m

Co-ordinate System Description

Projection	UTM
Zone	9/10
Datum	Nad83
Units	Meters
Spheriod	GRS1980

The Haegele Eelgrass data set contains attribute data that assists to define the physical data.

Output Co-ordinate System Description

Projection	Albers Equal Area Conic
Datum	Nad83
Units	Meters
Spheriod	GRS1980
Central meridian:	-126.0 (126:00:00 West longitude)
Latitude of projection origin:	45.0 (45:00:00 North latitude)
First standard parallel:	50.0 (50:00:00 North latitude)
Second standard parallel:	58.5 (58:30:00 North latitude)
False easting:	1000000.0 (one million metres)
False northing:	0.0

3.1 Attributes

Table 3.1 Attribute fields and physical parameters

Field	*Width*	*Type*	*N. Dec*	*Notes*
Shape	-	-	-	Generated internally by ArcView
Id	8	Decimal	0	Generated internally by ArcView
Algae	10	Char	-	
Acc_level	5	Decimal	0	
Year_pht	8	Decimal	0	
Name		Char	-	
Recno	11	Decimal	0	
Area	16	Decimal	3	
Perimeter	16	Decimal	3	

3.1.1 Data format

Data format for attributes is stored in the DBF table associated with the Haegele Eeglrass shapefile (DBASE IV).

3.2 Spatial

3.2.1 Coordinate System

- A UTM NAD 83 Coordinate System was used during image registration, digitizing and data processing.
- The complete data set was merged and output in BC Albers Standard Projection.

Table 3.2.1 GIS Coordinate System

ESRI Arc Shape – UTM or BC Albers			
Horizontal Unit of Resolution	metre	Horizontal Measurement Unit	metre
Vertical Unit of Resolution	N/A	Vertical Measurement Unit	N/A
X Offset:	0	Y Offset:	0

3.2.2 File Storage for data delivery

- Data is merged into a single shape file (Albers projection). Data is also presented in the geographic location by project name (examples include Skincuttle, Ganges, etc.; UTM Nad 83 Zone 9/10 projection).

3.2.3 Spatial Data Format

Spatial data is submitted in the following format:

- ArcView Shapefile

3.2.4 Feature Classification

Each feature was attributed according to its classification designated on the hardcopy maps by differential shading, cross-hatching, or dotting. Five separate classes were listed on each map, and each class was assigned a type code used to identify each classification code. Please see the table below.

Table 3.2.4. Feature Classification

Shading on Hardcopy Maps	*Attribute*	*Type Code (Algae)*
Horizontal lines	Sea grasses	SG
Vertical lines	Rockweed	RW
Diagonal – left to right	Red Algae	RA
Diagonal – right to left	Brown Algae	BA
Dotting	Green Algae	GA

3.2.5 Layer Names

Each file was named using the following naming conventions to allow for easier transfer of materials between data managers.

All spatial data conforms to the following layer scheme:

Table 3.2.5a. Physical data description – Layer Names

Coverage Name	Layer Type	Layer Description	Topology
Haegele_eelgrass	Polygon	Complete Haegele eelgrass data set created by Geostreams.	N
Deepbay_eelgrass	Polygon	Haegele eelgrass for Deep Bay to Dorcas Point	N
Comox_eelgrass	Polygon	Haegele eelgrass for Comox Harbour to Deep Bay, Denman and Hornby Islands	N
Nanoose_eelgrass	Polygon	Haegele eelgrass for Dorcas Point to Departure Bay (Nanoose)	N
Yellow_eelgrass	Polygon	Haegele eelgrass for Dodd Narrows to Ladysmith Harbour, Thetis and Kuper Islands	N
Ganges_eelgrass	Polygon	Haegele eelgrass for Ganges, Long Harbour, and Prevost Island	N
Quatsino_eelgrass	Polygon	Haegele eelgrass for Brooks Bay, Holberg Inlet, Winter Harbour	N
Laredo_eelgrass	Polygon	Haegele eelgrass for Laredo Sound	N
Thompson_eelgrass	Polygon	Haegele eelgrass for Thompson Bay	N
Kildidt_eelgrass	Polygon	Haegele eelgrass for Kildidt Sound	N
Portsimpson_eelgrass	Polygon	Haegele eelgrass for Port Simpson to Big Bay	N
Kitkatla_eelgrass	Polygon	Haegele eelgrass for Kitkatla Inlet	N
Cumshewa_eelgrass	Polygon	Haegele eelgrass for Cumshewa Inlet	N
Skincuttle_eelgrass	Polygon	Haegele eelgrass for Skincuttle Inlet	N

Table 3.2.5b. Physical data description – feature classification

LAYER TYPE	TYPE CODE	DESCRIPTION
Sea grasses	SG	Near-shore vegetation; Sea grasses beds
Rockweed	RW	Near-shore vegetation; Rockweed beds
Red Algae	RA	Near-shore vegetation; Red Algae beds
Brown Algae	BA	Near-shore vegetation; Brown Algae beds
Green Algae	GA	Near-shore vegetation; Green Algae

Polygon features were classified according a system developed by Haegele. Polygon attributes in the database describe algae types found within that polygon. In some cases, no distinct uni-species vegetation was found and vegetation was classified either as a dominant type or a mixed vegetation zone. In mixed vegetation polygons, algae codes were synthesized into a combination code. For example, if Sea grasses and Rockweed were found in the polygon, the type code was classified as SGRW. For consistency of order, the hierarchy of the above list was maintained throughout the database (SGRW always expressed in the database, never RWSG).

3.2.6 Feature Codes and Ids

The id code (numeric) and type code will be present for all polygons that are part of the data set.

3.3 Polygon Description

The Haegele GIS dataset is comprised of 9041 unique polygons. The polygons within the data set exist as unique items, even when they share the same id type code. No overlapping polygons exist in the data set.

The Haegele GIS data set was built using the historical data (see Section 2.0) as a source data set. The source maps were scanned and georeferenced (see Section 4.0). The polygons were built based on these source georeferenced images.

At the edges of map scans and between data sets, polygons have been merged based on the data set with the highest accuracy level (low RMS value) and best ‘fit’ to the TRIM coastline.

Additions, deletions or alterations occurred infrequently through out the source data set. These changes to the eelgrass layers on the source scans were ignored for this project due to the nature of these alterations. When polygons or polygon classification was altered, no accompanying notes or justification was available. There was no further information to support these additions therefore the data manager was forced to choose between the known data set accuracy, and the unknown accuracy of the changes indicated on the maps. The data manager chose to ignore the changes.

The eelgrass polygon data set was merged and output as one seamless eelgrass data layer.

4 Georeferencing

Source data was created via air photo interpretation and mapped using hydrographic charts as a base data set. Please see Section 2.0 for a detailed description of this method.

The Department of Fisheries and Oceans Canada contracted out the Haegele Eelgrass hardcopy source maps to a Vancouver-based digital capture company, IKON Office Solutions for conversion of hardcopy maps.

The maps ranged in size from 34 by 28 inches to 40 by 28 inches. Images were scanned at a resolution of 200 dpi. The scans were saved as black and white images. Marine vegetation appeared as linework on these map scans and was well defined at this resolution.

The map scans were digitally referenced to the TRIM Watershed Atlas base data set. Please see Section 5.0 for details regarding this base data set.

4.1 Georeferencing GIS Data

4.1.1 Co-ordinate System

A UTM co-ordinate system was used to georeference the source image scans.

4.1.2 Horizontal Datum

All data was registered to NAD83 - North American Datum 1983, earth-centered ellipsoid derived from Geodetic Reference System 1980 (GRS80). No vertical datum was necessary to define this data set as vertical features were not present.

4.1.3 Projection

UTM Nad 83 projection was used to georeference eelgrass image scans. Features were created using the UTM Nad 83, Zone 10 projection. A single projection was used for ease and speed of georegistration and mapping. Although the Albers Equal Area projection would have been a good option to retain a single referencing projection, at the 1:5,000 scale, distortion was present that made georegistration difficult.

Eelgrass polygons have been saved in UTM Nad 83, Zones 9 and 10. The complete merged output data set was export to BC Albers Equal Area Conic standard projection for the province. Although several different projections were used to create the data set, at the very large registration and digitizing scale (approximately 1: 5,000) a negligible amount of distortion occurred.

5 Registration

Images were registered to the TRIM watershed atlas coastline base data set at a scale of 1:20 000.

5.1 Base mapping and Base Positional Accuracy

- TRIM Watershed Atlas - 1:20 000

Heights of land, watershed boundaries, and river segments are derived from TRIM planimetric and DEM baseline data sets. The accuracy of this product is limited to that described for the Provincial Baseline Digital Atlas 1:20 000 (TRIM). For this project, only the TRIM Watershed Atlas coastline data file was used for registration.

6 Digital Data Capture Rules/Requirements

6.1 Quality of Digital Data Capture

Quality of digital data capture is composed of accuracy, precision, resolution, and degree of detail. For a discussion of these terms, refer to "Scale, Accuracy, and Resolution in a GIS" at http://www.srmwwwgov.bc.ca/gis/gisscale.html.

6.1.1 Interpretation accuracy/error

The Haegele Eelgrass data set was interpreted by Haegele and associates during the data collection phase of the historical source data set. Eelgrass data was interpreted from infrared and colour air photographs. Haegele initiated a ground truthing excersize that established an expected interpretation accuracy level. He found that vegetation zones examined by divers closely corresponded with those identified through air photo examination. He found that the only areas that were not well identified on the air photos were small, patchy vegetation polygons < 25 g/m^2 and the vegetation in the detritus zone where plants were not heavily concentrated. See Section 2.0 for a more detailed examination of the methodology.

Digital interpretation of the source data scans set was not complex, and involved examination of the data lines, and data types represented on the georeferenced image scans. The interpretation accuracy is thought to be high for the digital data set and error is expected to be very low.

6.1.2 Absolute (datum related) positional accuracy/error

Absolute or datum related positional accuracy and errors are dealt with during the data collection phase of this process. Haegele and associates undertook this phase during the 1970's.

Data collection included air photography of eelgrass study sites, and interpretation of these air photos. The data was then projected on a wall along with the hydrographic chart and the algae was traced onto the hydrographic chart. The charts were then reduced in scale for publication.

Therefore, base positional accuracy is dependent upon:

- The accuracy of the air photo scale
- The accuracy of the base data set, in this case the hydrographic charts
- The transformation of the data set to a publication scale

6.1.3 Relative (internal positional) accuracy/error

Relative positional accuracy specifies how closely the shape of a feature in its coordinate space reflects its true shape on the ground, and its relationships to other features in the dataset. Relative or internal positional accuracy and errors are dealt with during the data collection phase of this process. The internal positional accuracy is expected to be high, since the data polygons were originally interpreted from air photos.

6.1.4 Digitizing accuracy/error

Digitizing accuracy or errors are dealt with at the data set level. Digitizing and accuracy error can be introduced when adding features to the digital database. Digitizing accuracy was controlled during the digitizing process using tolerance levels, and through the application of a quality assurance routine. A snapping tolerance level of 3m was applied through out the data set to control the extent of polygon snapping. Each polygon was digitized at a large enough scale to ensure a high level of accuracy when visualizing the source scans and interpreting the polygon features. Digitizing accuracy was controlled in part by the thickness of the linework on the original image scans. Lines were often quite thick (1m – 6m), forcing a centerline digitizing approach by the data technicians when interpreting polygon extents.

6.1.5 Precision

Precision of the data set is determined by a combination of factors:

- The precision level applied during the data capture procedure of the source data sets, including TRIM and the Hydrographic chart data.
- The precision of the attributes of features in the resulting seamless data set.

Only the latter of these two is addressed in this report. The first issue is defined by the source data set data capture method.

Attribute precision is determined in the data model, via decimal places reported in the database (see Table 3.1).

6.1.6 Resolution

Data resolution is only a factor at the source data interpretation phase and during the conversion of the source images to digital scans. Raster-based data sets (air photos) were used to interpret eelgrass during the source data collection phase. These air photos were captured and interpreted in most cases, at a scale of 1: 6,000 (see Table 2.5.1). These maps were reduced to smaller scales for transfer onto base maps for publication. The reduced maps were scanned and output at a resolution of 200dpi. The marine algae captured on these maps were shown as black and white line features that were not effected by the resolution. Therefore resolution had no impact on digital interpretation.

6.2 Minimum Feature Size

A feature includes one single eelgrass polygon. The minimum feature size is determined at the data capture phase (see section 6.1.1) and in the digitizing phase.

Table 6.2 Minimum and Maximum Features size as examples and general rules.

Data Type	*Minimum Polygon (m^2)*	*Maximum Polygon size (ha)*
Eelgrass	25	766.135
General Rule	25	800

6.3 Data Capture Rules/Requirements

Maps were digitized using ESRI's ArcView 3.3 GIS software. Rectified map images were displayed and eelgrass polygons were digitized using a 'heads-up-digitizing' method. This method was recommended over a raster-to-vector conversion method. In testing the raster-to-vector conversion approach, many small and complex lines were output, which would have required a large amount of time to clean and correct.

Hardcopy data was mapped in UTM projection, Nad83 at a zoom scale of 1: 7000 or better. Interim data sets were also mapped in UTM projection. The final data format was provided in UTM and a merged data set was projected in the standard BC Albers Conformal Conic projection. Maps were digitized at a scale of 1: 7000 or better to capture features and maintain polygon detail with the least amount of redundancy. In order to accurately capture polygon detail, a zoom scale as large as 1: 4000 was used. Generally, a zoom scale greater than 1: 4000 was not needed.

At various points in the data set, eelgrass polygons were connected as "mats", and polygons shared boundaries. The ArcView polygon addition tool was used to 'add' or 'build on' new polygons to existing polygon data. The snapping tolerances maintained the level of accuracy and reduced the occurrence of sliver polygons.

In addition to these factors, rules were defined when mapping eelgrass polygons:

- Overlapping Polygon Features

No overlapping polygon features were allowed. Some cases were found where it appeared the eelgrass mats were continuous along a shoreline, but were interrupted by different types of eelgrass. For example, sometime a red algae polygon would contain small polygons of brown algae within them. The brown algae polygon was 'cut' from the red algae. It is unknown whether or not the red algae mat was continuous underneath the brown algae occurrence. Because of this lack of knowledge, the algae mats were assumed to be dis-continuous, flat features, and were mapped according to this assumption.

- Polygon Holes

Polygon holes where eelgrass mats were discontinuous were not recorded in the database. A hole was 'cut' from the eelgrass mat, and the polygon was deleted from the database.

7 Quality Assurance Procedures

Sound quality assurance procedures were applied to the Haegele Eelgrass data sets. The data model houses the attribute information that can be used to interpret a general accuracy level of the Haegele Eelgrass data.

7.1 Assigning Accuracy Levels

Establishing rules for the Haegele data set controlled accuracy levels. A maximum error of 100 meters was allowed at any one place in the image from the TRIM map base. The error was measured in ArcView using the ruler measurement tool, but was not measured to exact proportions. If the error was greater than 100m at any one place through the image, the rectification procedure was repeated until the fit was improved. In the situation where an image had been rectified several times, the error was isolated in one location exceeding 100m, and the rest of the image was mapped accurately, then the polygons were either flagged in the database and/or shifted accordingly to fit the TRIM base.

These rules were used in conjunction with a database field that identified a numerical accuracy level, and a field that contained a description of any outstanding rectification and accuracy issues.

Table 7.1 Accuracy level and description

Accuracy level	Description
1	RMS value of 3 or less
2	RMS value of 4-7
3	RMS value of 8-11
4	RMS value of 11 or worse (not to exceed 15)
5	No value (polygon shifted to fit TRIM, or otherwise altered to correct issues)

An accuracy level was adjusted if the fit in a particular area of an image was very close to the base data set (TRIM).

7.1.1 Data Collection Accuracy levels

Haegele Eelgrass data sets were collected and in some cases field-checked by dive survey. There was no formal schema to assign accuracy levels. However, based on the limited dive surveys that were completed, a general trend of accuracy levels does exist.

Please see Table 2.6.1 for these results. Base data set accuracy is also dependent upon scale of the base data sets, which is defined by photo scale, base data set scale, and transformation between these data sets. Scales of photos, base data sets and publication scales are listed in Table 2.5.1.

7.2 General Data Quality Assurance

Quality assurance was controlled through the application of a quality assurance maintenance routine. After the first 100 maps sheets were completed, a preliminary quality assurance routine was run. This QA consisted of searching the data set for slivers, ensuring the attributes information for the database was complete, and updating the area and perimeter data fields.

A final quality assurance routine was established for the entire data set upon completion of the last 50 map sets. The quality assurance routine involved a thorough review of each data set and corresponding rectified source image data. Polygon feature interpretation and classification was all examined carefully. To maintain objectivity, a person other than the original mapping technician carried out the data review.

8 Cartographic Representation/Output

8.1 General Cartographic Representation

The suggested cartographic representation is in conjunction with TRIM watershed coastline base data. When analysing information, emphasis should be placed on total area of each species type, not on the positional location of the polygon itself (see Accuracy levels, Section 7.0 and Source Metadata, Section 2.0).

9 References

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Appendix A

Appendix A: Complete Source Metadata for Haegele Historical Data Set by Site

Locality / Date	Focal Length	Size Format	Scale of Photography	Overlap/ Solar Altitude	Length of Flight / #	Flight Altitude	Film Type / Filter Type	Aircraft Used	Camera Type	No. of Photographs CIR/COL	Notes
Port Simpson to Big Bay June 3, 1980	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	50 km 11 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (525 nm) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (420 nm)	Cesna 180 fixed wing	Wild RC10	223 / 196	CIR imagery obtained between 1117 and 1204. COL imagery obtained between 933 and 1046. Low tide was at 1040 at a height of 1.0m.
Kitkatla Inlet June 4th – June 6th, 1980	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	No data*** 16 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (525 nm) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (420 nm)	Cesna 180 fixed wing	Wild RC10	226 / 227	June 4th, 1980 - CIR imagery obtained between 1002 and 1219. Low tide was at 1120 at a height of 1.2m. June 6th, 1980 - COL imagery obtained between 1247 and 1356. Low tide was at 1325 at a height of 1.7m.
Cumshewa Inlet July 16th, 1979	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	72.1 km flown, 69.4 km mapped 12 flight lines	No data	Kodak Areachrome Infrared No. 2443 (CIR) with a clear (420 nm) filter; Kodak Ektachrome MS Aerographic No. 2448 (COL) with a medium yellow (525 nm) filter.	Cessna 180 fixed wing	Wild RC10	160/ 136 diapositives	CIR imagery was obtained between 1120 and 1223 PST. COL imagery between 1300 and 1330 PST, Predicted low tide was 1.5m at 1220 PST.
Skincuttle Inlet	*	*	*	*	*	*	*	*	*	*	*
Laredo Sound March 20th, 1979 March 22nd, 1979	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	77.2 km CIR / 78.4 km COL 12 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (525 nm) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (420 nm)	Cesna 180 fixed wing	Wild RC10	141 / 143	March 20st, 1979 - CIR imagery obtained between 1100 and 1236. Low tide was at 1143 at a height of 1.2m. March 22th, 1979 - COL imagery obtained between 1257 and 1355. Low tide was at 1403 at a height of 1.1m.
Thompson Bay March 19th, 1979 & March 21st, 1979	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	72.9 km CIR / 76.2 km COL 10 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (525 nm) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (420 nm)	Cesna 180 fixed wing	Wild RC10	133 / 139	March 21st, 1979 - CIR imagery obtained between 1130 and 1235. Low tide was at 1238 at a height of 1.2m. March 19th, 1979 - COL imagery obtained between 1050 and 1140. Low tide was at 1033 at a height of 1.1m.
Kildidt Sound March 19th, 20th, and 21st, 1979	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	65.8 km CIR / 81.8 km COL 11 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (525 nm) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (420 nm)	Cesna 180 fixed wing	Wild RC10	120 / 149	March 21st, 1979 - CIR imagery obtained between 1250 and 1335. Low tide was at 1238 at a height of 1.2m. March 20th, 1979 – Flight line 11. CIR 1030. Low tide was at 1133 at a height of 1.2m. March 19th, 1979 – COL imagery obtained between 940 and 1040. Low tide was at 1033 at a height of 1.1m.
Quatsino April 26th, 1981	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	*** 16 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (525 nm) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (420 nm)	Cesna 180 fixed wing	***	215 / 210	CIR imagery obtained between 1315 and 1413. COL imagery obtained between 1126 and 1234. Low tide was at 1136 at a height of 1.2m.
Nuchatlitz (1430) May 19th, 1976	***	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	*** ***	***	Kodak Aerochrome Infrared #2443/ medium yellow (Wratten #9) filter; Kodak Ektochrome MS Aerographic #2448	***	***	55 / 50	CIR imagery obtained between 957 and 1013. COL imagery obtained between 935 and 950. Low tide was at 1050 at a height of 0.5m.

Nootka Sound (1430) May 19th, 1976	***	23 x 23cm	1: 4800	20% lateral overlap; forward overlap 60% / ***	*** ***	***	Kodak Aerochrome Infrared #2443/ medium yellow (Wratten #9) filter; Kodak Ektochrome MS Aerographic #2448	***	***	28 / 25	CIR imagery obtained between 1018 and 1022. COL imagery obtained between 924 and 930. Low tide was at 1050 at a height of 0.5m.
Hesquiat Hbr. (1430) May 19th, 1976	***	23 x 23cm	1:4800	20% lateral overlap; forward overlap 60% / ***	*** ***	***	Kodak Aerochrome Infrared #2443/ medium yellow (Wratten #9) filter; Kodak Ektochrome MS Aerographic #2448	***	***	78 / 70	CIR imagery obtained between 1032 and 1050. COL imagery obtained between 850 and 915. Low tide was at 1050 at a height of 0.5m. Eastern entrance seagrass beds are mostly <u>Phyllospadix</u> sp. rather than the prevalent <u>Zostera marina</u>.
Clayoquat Sound June 26th, 1978	152 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	87 km 14 flight lines	914 m	Kodak Aerochrome Infrared #2443/ medium yellow (Wild 525 nm AV2x) filter; Kodak Ektochrome MS Aerographic #2448/ clear filter (Wild 420 nm AV2x)	***	Wild RC110	138 / 136	
Barkley Sound (1430) July 21st, 1974	30.48 cm	23 x 23cm	1: 3600	20% lateral overlap; forward overlap 60% / 25 to 30°	14km ***	1100m	Colour infrared no. 2443; Color no. 2445 (reported as 2448 in MS 1430)	***	***	57 / 57	CIR imagery obtained between 750 and 835. COL imagery obtained between 700 and 740. Low tide was at 745 at a height of 0.0m.
Barkley Sound (1549) 1978	**	**	**	**	48 km **	**	**	**	**	**	**
Comox (1617) April 26th, 1979 COL April 27th, 1979 CIR	152mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	114 km 19 flight lines	***	Kodak Aerochrome Infrared #2443 with a medium yellow filter (525nm) and Kodak Ektachrome Aerographic Color #2445 (120nm)	Cesna 180 fixed wing	Wild RC10	279 / 270	CIR imagery obtained between 1109 and 1301. COL imagery obtained between 1033 and 1240. Low tide for April 26th was 1.1m. Low tide for April 27th was 0.9m.
Deep Bay (1485) April 7th, 1977	***	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	60 km ***	***	Kodak Aerochrome Infrared No. 2443 with a medium yellow filter (Wratten #12) and Kodak Aero Color Neg. #2445	***	***	***	CIR imagery obtained between 1305 and 1400. COL imagery obtained between 1400 and 1505. Low tide was at 1405 at a height of 0.9m.
Nanoose (1408) July 19th 1975	***	23 x 23cm	1: 3600	20% lateral overlap; forward overlap 60% / ***	47 km 11 flight lines	1097 m	Kodak Aerochrome Infrared #2443/ medium yellow (Wratten #9) filter; Kodak Ektachrome MS Aerographic #2448	***	***	159 / 147	CIR imagery obtained between 1120 and 1220. COL imagery obtained between 1230 and 1330. Low tide was at 1215 at a height of 0.4m.
Yellow Aug 14th, 1977	305 mm	23 x 23cm	1: 6000	20% lateral overlap; forward overlap 60% / ***	76 km 12 flight lines	1838 m	Kodak Aerochrome Infrared #2443 / medium yellow (B111170) filter; Kodak Ektochrome MS Aerographic #2448 / clear (HF3) filter	***	Zeiss RMK A30/23	141 / 140	CIR imagery obtained between 1025 and 1125. COL imagery obtained between 0915 and 1020. Low tide was at 1026 at a height of 0.8m.
Ganges (1408) July 9th, 1975	***	23 x 23cm	1: 3600	20% lateral overlap; forward overlap 60% / ***	46 km 7 flight lines	1097 m	Kodak Aerochrome Infrared #2443/ medium yellow (Wratten #9) filter; Kodak Ektachrome MS Aerographic #2448	***	***	147 / 139	CIR imagery obtained between 935 and 1030. COL imagery obtained between 1050 and 1125. Low tide was at 1039 at a height of 0.2m.

* - no report published
** - report not obtained
*** - no data in report

Appendix B

Appendix B: Source Dataset Library References

Numbers	Title	Author	Publisher and Date	Stored
CATNO 35071 ISSN 07066473	Shoreline vegetation on herring spawning grounds in Chatham Sound, British Columbia.	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1982. 27 p. Canadian manuscript report of fisheries and aquatic sciences; 1660.	BVAFI SH 223 F55 no.1660 1 SHELF 02017105
			Shoreline vegetation maps were developed for Port Simpson and Big Bay in Chatham Sound from 1:6,000 photographic scale 23 cm format colour and colour infrared diapositives. 50 km of coastline were mapped from 419 photogaphs.	
CATNO 35070 ISSN 07066473	Shoreline vegetation on herring spawning grounds in Kitkatla Channel, British Columbia.	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1982. 29 p. Canadian manuscript report of fisheries and aquatic sciences; 1664.	BVAFI SH 223 F55 no.1664 1 SHELF 02017101
			Shoreline vegetation maps were developed for Kitkatla Channel from 1:6,000 photographic scale 23 cm format colour and colour infrared diapositives. 80 km of coastline were mapped from 453 photographs.	
CATNO 108 ISSN 07066473	Shoreline vegetation on herring spawning grounds for Cumshewa Inlet, Queen Charlotte Islands.	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1981. 25 p. Canadian manuscript report of fisheries and aquatic sciences; 1619.	BVIEM FRB-MR /1619 1 SHELF 04011279
			Shoreline vegetation maps were developed for Cumshewa Inlet in the Queen Charlotte Islands from 1:6000 photographic scale 23 cm format colour and colour infrared diapositives. 69 km of coastline were mapped from 296 photographs.	
CATNO 43 ISSN 07066473	Shoreline vegetation on herring spawning grounds in Laredo Sound British Columbia.	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station. Canada. Department of Fisheries and Oceans. 1980. 23 p. Canadian manuscript report of fisheries and aquatic sciences; 1580.	BVAFI SH 223 F55 no.1580 1 SHELF 02017191
			Shoreline vegetation maps were developed for Laredo Sound British Columbia from 1:6000 photographic scale 23 cm format colour and colour infrared diapositives.	
CATNO 69 ISSN 07066473	Shoreline vegetation on herring spawning grounds in Thompson Bay British Columbia.	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1980. 21 p. Canadian manuscript report of fisheries and aquatic sciences; 1579.	BVAFI SH 223 F55 no.1579 1 SHELF 02017193
			Shoreline vegetation maps were developed for Thompson Bay British Columbia from 1:6000 photographic scale 23 cm format colour and colour infrared diapositives	
CATNO 72 ISSN 07066473	Shoreline vegetation on herring spawning grounds in Kildidt Sound British Columbia	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1980. 25 p. Canadian manuscript report of fisheries and aquatic sciences; 1592.	BVAFI SH 223 F55 no.1592 1 SHELF 02017180
			Shoreline vegetation maps were developed for Kildidt Sound British Columbia from 1:6000 photographic scale 23 cm format colour and colour infrared diapositives.	
CATNO 102331 ISSN 07066473.	Shoreline vegetation maps on herring spawning grounds in the upper west coast of Vancouver Island.	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1987. 43 p. Canadian manuscript report of fisheries and aquatic sciences; 1921.	BNP Serials 2 SHELF 01005880
			Shoreline vegetation maps of marine algae and sea grasses were developed for the upper west coast of Vancouver Island from 1:6000 photographic scale 23-cm format colour and colour infrared diapositives. The areas mapped were Quatsino Sound and Forward, Holberg, Klaskino and Klaskish inlets. The observed presence of five vegetation types is presented.	

CATNO 16600 ISSN 07017618	Shoreline vegetation on herring spawning grounds in Clayoquot Sound.	Haegele, C.W.;Hamey, M.J.	Fisheries and Marine Service, 1979. iii, 39 p. Fisheries and Marine Service manuscript report; 1536.	BVAFI SH 223 F55 no.1536 1 SHELF 02017239
			Large format colour and colour-infrared photographs were obtained for 87 km of shoreline in Clayoquot Sound on June 26, 1978. Vegetation maps were prepared from these using colour and texture keys previously developed. There were 1561 ha of vegetation mapped with sea grasses accounting for 55%, the remainder being associations of red and brown algae. A diver survey of herring spawnings in March 1979 was used to field check the vegetation mapping.	
ISSN 07017618	Shoreline vegetation maps of some major herring spawning localities on the west coast of Vancouver Island : Nuchatlitz, Nootka Sound, Hesquiat Harbour, and Barkley Sound.	Haegele, C.W.;Hamey, M.J.	Fisheries and Marine Service, 1977. iii, 41 p. Fisheries and Marine Service manuscript report; 1430.	BNP Serials 1 SHELF 01013486 BVAFI SH 223 F55 no.1430 1 SHELF 02017350
			The vegetation was mapped by five major types as identified from their spectral reflective characteristics on large format vertical aerial colour infrared and colour photographs: sea grasses, rockweed, red algae, brown algae, and green algae.	
CATNO 36337	Shoreline vegetation on herring spawning grounds in Barkley Sound in 1978 compared with similar assessments for 1974 and 1975.	C.W. Haegele, and M.J. Hamey	Nanaimo, B.C.: Fisheries and Marine Service. 1980. iv, 37 p. Fisheries and Marine Service manuscript report;1549.	MWFW 1 SHELF 230068 Paper and microfiche copy
			The vegetation on major herring spawning grounds is being mapped in British Columbia from large format colour and colour-infrared photographs. Photographs were obtained for 48 km of coastline in Barkley Sound in 1978, repeating 14 km photographed in 1974. A diver survey of 4.8 km at two locations photographed was conducted in 1975. There were 734.2 ha of vegetation mapped from the 1978 photography of which red algae accounted for the major portion followed by sea grasses, brown algae and rockweed. There were no major shifts in vegetation noted between the 1974 and 1978 photographs or between the 1975 diver survey and 1978 photographs. However, vegetation both deeper than -5 m and of less than 25 percent cover cannot be identified on aerial photographs taken on a +1.5 m tide.	
CATNO 107 ISSN 07066473	Shoreline vegetation on herring spawning grounds for Comox, Denman Island, and Hornby Island	Haegele, C.W.;Hamey, M.J.	Pacific Biological Station, Canada. Department of Fisheries and Oceans. 1981. 41 p. Canadian manuscript report of fisheries and aquatic sciences; 1617.	BVAFI SH 223 F55 no.1617 1 SHELF 02015313
			Shoreline vegetation maps were developed for Comox, Denman Island and Hornby Island from 1:6000 photographic scale 23 cm format colour and colour infrared diapositives. 114 km of coastline were mapped from 549 photographs	
CATNO 22905 ISSN 07017618	Shoreline vegetation on herring spawning grounds between Deep Bay and Dorcas Point, Strait of Georgia, B. C.	Haegele, C.W.	Fisheries and Marine Service, 1978. iv, 49 p. Fisheries and Marine Service manuscript report; 1485.	BVAFI SH 223 F55 no.1485 1 SHELF 02017301
			The ability to accurately record and assess herring spawnings depends to a considerable degree on knowledge of the vegetative substrate upon which the adhesive eggs are deposited. Large format colour and colour-infrared photographs were obtained for the shore-line between Deep Bay and Dorcas Point on April 7, 1977. Vegetation maps were prepared from these using colour and texture keys previously developed. Subsequently, betweens March 5 and April 11, 1978, a diver survey of herring spawnings in the study area was used	

			to evaluate the accuracy of the photo-mapped vegetation.	
CATNO 73884 ISSN 04107721	Surveys of vegetation in herring spawning localities in the vicinity of Nanoose Bay, B.C.	Haegele, C.W.;Humphreys, R.D.	Research Board of Canada. Fisheries Research Board of Canada. 1976. 37 p. Manuscript report series (Fisheries Research Board of Canada); 1412.	BVAFI SH 223 F55 no.1412 1 SHELF 02017372
			The ability to accurately record and assess herring spawn depositions depends to a considerable degree on a knowledge of the vegetative substrate upon which the adhesive eggs are deposited. Aerial photographs from which shoreline vegetation maps were prepared were obtained for the Nanoose Bay Herring Management Unit in July 1975. During the 1976 herring spawning season, an intensive underwater survey was undertaken at three localities in this area.	
CATNO 73880 ISSN 04107721	Shoreline vegetation maps of Nanoose and Ganges Herring Management Units.	Haegele, C.W.;Hamey, M.J.	Fisheries Research Board of Canada. 1976. 43 p. Manuscript report series (Fisheries Research Board of Canada); 1408	*
			Shoreline vegetation charts, for the purpose of recording and assessing herring spawnings, were prepared from large format aerial photographs for Ganges and Long harbours on Saltspring Island, Prevost Island and the shoreline from Departure Bay to Dorcas Point. Vegetation was mapped by five major types as identified from their spectral reflective characteristics on colour infrared and colour film : seagrasses, rockweed, red algae, brown algae and green algae. Each of the 18 charts were reduced from a photo scale of 1:3600 to page size and portray an area approximately 3700 X 2800 m.	
Cat. no. Fs 97-4/1534 ISSN 07017618	Shoreline vegetation on herring spawning grounds in Stuart Channel, Strait of Georgia, British Columbia.	Haegele, C.W.;Hamey, M.J.	Fisheries and Marine Service, 1979. iii, 29 p. Fisheries and Marine Service manuscript report; 1534.	BNP Serials 2 SHELF 01011145 BVAFI SH 223 F55 no.1534 1 SHELF 02017242
			The ability to accurately record and assess herring spawnings depends to a considerable degree on knowledge of the vegetative substrate upon which the adhesive eggs are deposited. Large format colour and colour-infrared photographs were obtained for 76 km of coastline in the northern portion of Stuart Channel on August 14, 1977. Vegetation maps were prepared from these using colour and texture keys previously developed. There were 728.1 ha of vegetation mapped with sea grasses accounting for 38%, most of the remainder being associations of red and brown algae. Vegetation was generally in excess of 100 m wide.	
CATNO 18128 ISSN 07017618	Vegetation survey of herring spawning localities in Ganges Harbour, B.C.	Haegele, C.W.	Nanaimo, B.C.: Fisheries and Marine Service, 1977. iii, 17 p. Fisheries and Marine Service manuscript report; 1433.	BVAFI SH 223 F55 no.1433 1 SHELF 02017347
			The ability to accurately record and assess herring spawn depositions depends to a considerable degree on a knowledge of the vegetative substrate upon which the adhesive eggs are deposited. A map of the shoreline vegetation in Ganges Harbour and vicinity was prepared from aerial photographs of this region taken in July, 1975.	

CATNO 16637	An evaluation of herring spawn survey techniques used in British Columbia waters	Humphreys, R.D.;Haegele, C.W.	Pacific Biological Station, 1976. ix, 142 p. Technical report (Canada. Fisheries and Marine Service. Research and Development Directorate); 613.	BNP serials 1 SHELF 01006204 6 BVAFI SH 223 F56 no.613 c.2 2 SHELF 02019123
			In order to examine the effectiveness of current procedures for estimating the extent and intensity of herring spawn depositions, and intensive underwater survey was undertaken during the 1975 spawning season on two spawning locations in Barkley Sound. These two locations were also surveyed in the traditional manner by a Fishery Officer. Preliminary analysis suggests the alternative method of estimating spawn intensities in terms of layers of eggs may be less variable than the present intensity scale. Also, spawn deposition assessment problems associated with the detection and measurement of spawn in the subtidal zone can be alleviated by the preparation of detailed topographic maps of major spawning grounds showing vegetation zones. These procedures involve low-level aerial photography supplemented by diver surveys.	

Library Locations

BVAFI
Fisheries and Oceans Canada
Library 200-401 Burrard Street
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BVIEM
Institute of Ocean Sciences
P.O. Box 6000
Sidney, BC V8L 4B2
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