Margot Hessing-Lewis,
M.Sc. Candidate,
Queen's University

Academic Advisors:

Dr. Shelley Arnott,
Department of Biology, Queen's University

Dr. Paul Treitz,
Department of Geography,
Queen's University

Scientific and Project Advisors:

Edith Tobe, Project Manager,
Squamish River Watershed Society

Cynthia Durance,
Precision Identification Inc.

Colin Levings, DFO

Assessing Eelgrass (*Zostera marina*) Restoration in the Squamish River Estuary, British Columbia

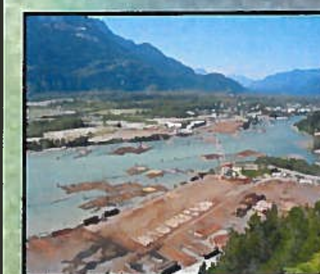
ABSTRACT

Shallow, protected estuarine areas have often been used for log storage in coastal British Columbia. Eelgrass habitats, however, often coincide with these same environments and have been negatively impacted by biophysical changes caused, in part, by these industrial activities. In order to determine the restoration potential of eelgrass communities impacted by industrial activities and changing biophysical conditions in the Squamish River Estuary, a community-based restoration assessment was commenced in the summer of 2004.

Detailed historical extents of eelgrass are unknown in the Squamish River Estuary, however, Squamish First Nations historically regarded eelgrass in the estuary as an important habitat for fisheries, most notably as a herring spawning ground. Presently, no known patches of eelgrass have been documented in surveys of the intertidal region of this estuary. Subtidal accounts of eelgrass patches have been documented in the literature on this region (Hoos and Vold 1975), and will be assessed to depths of 6m using underwater videography.

In order to determine the feasibility of restoration in an area lacking baseline information, this study monitors biophysical variables known to affect eelgrass growth and survival. These variables are recorded at small test patches of eelgrass (100 – 125 shoots) planted in late summer 2004 at 6 intertidal sites within the Squamish River Estuary. Survival and growth of these shoots will be monitored, as well biophysical parameters of the sites, including sediment characteristics, water column turbidity, salinity, temperature and wave action. The parameters of these variables conducive to eelgrass survival have been analyzed in previous eelgrass restoration projects conducted in the Pacific Northwest (Thom 1990) and will be compared to the Squamish River Estuary.

This assessment of restoration potential will benefit other eelgrass restoration projects in British Columbia and the Pacific Northwest by filling a major knowledge gap in current restoration ecology – the ability of eelgrass to grow in substrates impacted by log storage activities. Furthermore the feasibility of community-based eelgrass restoration initiatives in British Columbia will be addressed.



Mamquam Blind Channel Log Storage & Sorting Facilities

Squamish Nations carving and the Chief

Looking North up the Squamish Valley

View of the Squamish River Estuary from the Malamute

Looking North down Howe Sound, log boom in foreground

INTRODUCTION

The Squamish River Estuary is located 50 km north of Vancouver, B.C., at the head of fjordal Howe Sound, within a region known as the Sea-to-Sky corridor. The Squamish River is fed by glacial tributaries, with a late freshet (high run-off) occurring during the summer months. Seasonal variation in river flow contributes to changing conditions in the downstream estuary including water column turbidity, temperature and salinity. The head of Howe Sound is also known for its persistently strong winds.

The Squamish River Estuary has been used for log storage since the 1950's, as well as other industrial activities including a port, chemical plant and land based log and chip sorting facilities. The District of Squamish is currently undergoing a shift away from a resource-based economy. Future management plans for the Estuary are uncertain, but plans to move industry away from portions of the Estuary, as well as for increased residential development in other portions of the estuary are occurring. With this transition in mind, a community-based research project to restore eelgrass habitat affected by years of industrial development and flood control, as well as to record baseline data from which to monitor future development was commenced in the summer of 2004.

Restoration of this habitat is believed to be important for a number of reasons affecting the entire estuarine ecosystem. In Squamish, and other areas of the Pacific Northwest, eelgrass habitats are important as indicators of ecosystem health, for sediment stabilization, as spawning and rearing grounds for many aquatic species and potentially as a means of bioremediation for contaminated sites. The fjordal aquatic landscape, especially, has received little research attention regarding eelgrass habitats. However, given the large biological uncertainties surrounding this eelgrass habitat type in this environment, a small pilot project was a necessary first step in assessing the feasibility of future, larger-scale restoration of eelgrass habitat in the Squamish River Estuary. The following outlines the preliminary data collection steps taken during Summer 2004 to assesses the feasibility of further eelgrass restoration in the Squamish River Estuary, as well as plans for future monitoring of this site.

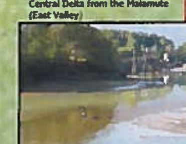
SITE SELECTION

Two primary locations within the Squamish River Estuary were selected for this preliminary study, each containing 3 sub-sites. These sites were selected based on previous scientific knowledge (C. Durance, Precision Identification Inc.) of conditions conducive to eelgrass growth, accessibility, and proximity to log storage areas.

Head of Cattermole Slough, near Site 1. Woody debris covers sediment surface.

The Cattermole Slough sites are located on a dredged slough adjacent to the B.C. Rail line that services a pulp port in the estuary. In previous scientific research on the Squamish River Estuary (eg. Levings 1980) this portion of the estuary has been termed the East Delta. Cattermole Site 1 is located at the head of the slough, adjacent to a wood chip storage site. Sites 2 and 3 are located further south towards Howe Sound and more distant from the direct impacts of woody debris accumulation from on-land storage sites. Furthermore, sites 2 and 3 are adjacent to marsh vegetation as opposed to site 1 where the shoreline has been developed.

View of Cattermole Slough and Central Delta from the Malamute (East Valley)



Cattermole Slough, facing South. Low tide

The Stawamus site is located off the Mamquam Blind channel in the most eastern portion of the estuary. Site 1 is located adjacent to Squamish Nations I.R. 24 and Sites 2 and 3 are located on the deltaic front formed as the Stawamus River enters the Mamquam Blind Channel. All sites in this area are affected by the adjacent log booming grounds, and freshwater input from the Stawamus River.

View of Stawamus Site from the Malamute

Stawamus Delta, low tide

SEDIMENT CHARACTERISTICS

Sediment Type

In the Pacific Northwest, the sediment type found in areas where eelgrass predominantly occurs is mixed sand and mud. However, eelgrass has also been documented growing in rocky substrates and occasionally from wood pilings. Therefore, the range of sediment types amenable to eelgrass growth remains highly variable in this region.

Sediment types at the different eelgrass test sites were determined by taking 20cm deep cores using 2" diameter PVC pipe. Three sediment samples were taken from each site, and well-mixed 200g sub-samples were used for particle size analysis. Wet sieving of these samples into 5 size grades was used to characterize the different sites. Samples were then dried to determine dry weights of the different particle size classes. Full analysis of particle size structure of the different sites has yet to be completed, but preliminary analysis suggests between-site variation, especially regarding the total percentage of the largest (>2.38mm) and smallest (<32microns) silt/clay size fractions.

Photos show PVC cores used for sediment sampling

Sieves used for particle size analysis

Sediment samples prior to drying & burning

Organic content

Log storage can reduce light penetration to the estuary floor, change water column turbidity and lead to the accumulation of woody debris in sediment on the ocean floor. Once log storage activities have ceased in a given region, it is unknown whether restoration of eelgrass beds can occur in these altered substrate conditions. The elevated organic concentrations produced by woody debris accumulation on the estuary floor may continue to contribute to anoxic conditions, which are believed to be unfavourable to eelgrass growth.

To determine the extent to which the substrate of the eelgrass test sites have been affected by log storage activities, woody debris presence in the sediment samples was analyzed through a proxy measurement of organic content, as well as through visual inspection of the core samples. Photographs of all of the sediment cores were taken and presence and depth of visible woody debris layers were noted.

Loss on ignition of organic content was also determined for the sieved samples by burning them in a muffle furnace at 540°C for 4 hours. Other measures of woody debris presence and proximity to log storage sites, such as sulphide and wood preservative content will also be analyzed by a scientific lab. These analyses of sediment characteristics at the eelgrass test sites will provide important information on a primary variable that might impact the growth and survival of eelgrass transplants in this area affected by log storage activities.

Photos of 20cm sediment cores, sediment composition visually different

Core primarily sandy sediment

Core with mud/woody debris layer at sediment surface

EELGRASS TRANSPLANTS

Due to the limited extent of known eelgrass beds in Howe Sound, transplant donor stock for the eelgrass transplants was obtained from the Roberts Bank region of the Fraser River Delta. Shoots were harvested by hand at low tide from the intertidal zone in this region. Differences in biophysical conditions in this area from those in the Squamish River Estuary might affect the adaptability of transplants. Eelgrass shoots were broken to obtain 4 to 10 cm rhizome and the blade(s). These were stored in saltwater overnight before the transplanting occurred at low tide the next day.

Robert's Bank Eelgrass

Harvesting donor eelgrass from Robert's Bank

In order to ensure that the transplanted eelgrass shoots remain anchored in the substrate while their roots are re-establishing, each plant was attached to a metal washer with a twist tie. The washer, along with the rhizome is buried at a depth of 2-5 cm, with the eelgrass shoot penetrating the substrate surface through the hole in the washer.

Anchoring eelgrass rhizomes to washer before transplanting, storage of plants in coolers

Eelgrass were planted at all sites at Cattermole Slough and Stawamus at 0 m chart datum. Twenty five shoots were planted in each 1 x 1 m quadrat (5 rows of 5 plants each). At Cattermole Slough five quadrats (125 shoots/site) were planted at each of the 3 sites and at Stawamus four quadrats (100 shoots/site) were planted at each of the 3 sites. The total number of eelgrass transplants in this pilot study remains small compared to other eelgrass transplant projects, but will provide a preliminary assessment of eelgrass growth and survival in the Squamish River Estuary.

Planting a quadrat of donor eelgrass

MONITORING

Eelgrass Counts

In order to determine the success of eelgrass transplants in the Squamish River Estuary test sites, eelgrass will be monitored by counting the number of shoots present in each quadrat and through visual inspection of health. Blade length and width will also be measured when possible. Monitoring of the August 2004 transplants will occur at low tide or by scuba diving and will occur monthly when low tides permit. By December 2004, an initial assessment of survivability and growth of eelgrass transplants will be possible. Monitoring of these test sites will continue for 2 years post-transplant when and where possible.

A quadrat of transplanted eelgrass (25 shoots)

Water Column Characteristics

Three other primary variables controlling eelgrass growth will be investigated and monitored at all sites throughout the duration of this project. Temperature and salinity will be measured using a YSI probe, while turbidity will be measured using a Secchi disc. Dissolved oxygen content, as well as pH will also be recorded using probes. Approximate wave height and current conditions will also be noted. Measurements will be taken at a consistent depth in the water column and at a similar tidal height. Bi-monthly monitoring of these variables should provide an indication of their values and between-site variation. Optimal parameters for eelgrass include temperatures of 10 – 20°C, salinity ranges from 10-30 ppt and Secchi depths of 1-3 m. Data from these water column measurements will determine if the Squamish River Estuary transplant sites lie within these parameters, and whether these variables may affect eelgrass survival.

YSI physical measurements

Secchi disc measurements

COMMUNITY-BASED EELGRASS RESTORATION

Squamish volunteers transplanting eelgrass at Stawamus site

This eelgrass restoration project is being conducted in partnership with Queen's University (through Margot Hessing-Lewis' Master's project), the Squamish River Watershed Society, Precision Identification Inc., Squamish Nations, District of Squamish and DFO. This initiative was spearheaded by local groups in Squamish and remains indebted to volunteer help and support from project partners. As with many grassroots initiatives, problems arising from equipment and labour needs, consistency of measurements and continuous monitoring of sites must be addressed in analysis of project results. While these realities must be acknowledged, it is the goal of this project to improve on these problems in the future by attracting further research and funding for future, larger-scale eelgrass restoration projects. This is the first community-based eelgrass restoration project in British Columbia, and will help serve as a guideline for other Eelgrass Stewardship and community groups to conduct similar restoration initiatives. This project also brings attention to the unknown impacts of historic and current log storage activities on eelgrass habitat in British Columbia. This area of research deserves further attention in order to mandate future eelgrass restoration projects in affected areas of the Pacific Northwest

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