Section 6 NEARSHORE STUDIES

The Nearshore area is part of the Englishman River estuary. It is vital to survival of many plant and animal species including salmon. The Nearshore ecosystem includes the backshore, intertidal, and subtidal zones out 20 to 30metres. It's described as; "the aquatic interface between freshwater, land, air and the marine environment" (Wright/Deakin, 2009). These critical marine areas include upland and backshore areas that both directly influence shoreline conditions. They are sensitive to adverse land uses such as; run-off from agricultural lands, roadways and landscaped areas.

These zones provide critical habitats for the underlying structure of the marine food chain. For example they provide spawning and rearing habitat for Sand Lance, Pacific Herring and Surf Smelt populations, which are an important in the food chain for juvenile and adult salmon. They also provide the means for fisheries and recreation economies. "Natural vegetation along the interface between the upper intertidal and the backshore, buffers pollutants from entering marine waters and provides food for young salmon. Large woody debris generated from the native vegetation helps to break up the wave energy and reduce shore erosion." (Wright/Deakin, 2009)

An ecosystem approach is needed to watershed management. It is not enough to care for an estuary if we are to ensure survival of salmon and other species. Once fish have left the estuary, sufficient habitat and food are required in order to ensure marine survival. These survivals then connect to the marine fish, mammals and birds that depend on these smaller fish to survive.

Eighty percent of ocean pollution comes from land-based activities (National Ocean Service, 2008). Understanding our nearshore and how we impact it and the areas adjacent, will show us how to manage our activities in order to protect the marine environment, and the ecosystem services we receive from a healthy marine area. These services include currents that determine our weather and temperatures, carbon sinks in the form of eelgrass, food, quality of life, recreation, tourism and commercial fishery industries, cultural and spiritual connections.

In a time of climate change, ocean acidification, an increase in dead zones, over fishing, global shortages of forage fish and extreme species declines; shoreline communities must do what they can to reverse these trends and ensure the continuation of the functions of this thin strip, to help ensure long term ocean health and marine survival, and a continuation of ecosystem services needed by humans.

In this study we have examined the nearshore area from the Little Qualicum River to Craig Bay. This is in keeping with the understanding that when working with shorelines, human actions in one area can impact the nearshore further along the shoreline, and so to limit the study to only the estuary would not necessarily capture the issues.

6. 0 Near Shore Study Goals and Objectives

The goal of this study was to collect information on key species to indicate the health and complexity of the nearshore area. The information should be useful to land managers in decisions regarding planning and management. We also expect stakeholder groups to use the information for education, awareness, and support for any changes in policy, regulation or management of the area.

Originally we intended to only collect the information on hardening vs. natural areas. But as we mapped the shoreline the decision was made to add notes on potential forage fish habitat, and also the health of the marine riparian areas. It was realized that this would mean an inconsistency of data, but the information was collected as indicators only and follow-up would be needed regardless, and by collecting this information now, it was hoped that this would speed up a future process of determining the health of the marine riparian more fully.

The nearshore section contains information focused on;

6.1 Shoreline inventory and mapping of natural vs. hardened

6.2 Marine Riparian Areas inventory and mapping

6.3 Eel Grass inventory and mapping

6.4 Forage Fish inventory and mapping of utilization

6.5 Shellfish comparison of key populations over time

6.6 Discussion of plant and animal community

6.1 Shoreline Inventory

6.1.1 Introduction

Healthy shorelines are constantly changing. Currents pick up sediments off some beaches and deposit it on others. Cliff areas are a key part of a natural shoreline process, providing the nourishment to the beaches. New sediment must come from somewhere, or the beach will turn to cobble. Some beaches are meant to be cobble, but in other areas the sands and fine gravels must come from above or up current from the particular beach. If this nourishment does not happen, then the fines are washed away, and gravel and cobble remain(Healthy Shorelines, 2007, Greenshores workshops 2007/2008). Winter storms move sediments around within bays, create gravel bars, and take them apart, sometimes in different areas of foreshore, and also within the same area over time. Foreshore accretes and then erodes, constantly changing the shape and depth of the waterfront.

With population growth, there is now primarily private ownership of the east coast Vancouver Island shoreline from Victoria to Campbell River. The result of private ownership has seen significant changes to the natural shoreline structure; land is cleared and shorelines filled to hardened edges made typically of concrete, rock and/or piles. Property owners, often new to the coastal areas are unfamiliar with an ocean environment. They are easily concerned and view the process from a short-term window, and usually move to harden the foreshore in an attempt to maintain the size and shape of their waterfront property. Other modifications are made due to a lack of understanding related to legal access to shorelines and the high tide marks (e.g. boat ramps from residential yard to point below high tide). Other modifications are installed by local governments putting in sewer lines, storm drains, public access points, boat ramps and harbours.

These hardened areas change the natural dynamic of the shoreline, often creating unintended erosion. Due to beach dynamics, hardening a shoreline typically creates erosion at either end of the hardening. This often results in a spin-off where the neighbours to the original hardening then feel they must armour their beach, and so on down the beach area. Hardened beaches can also change the substrate from a sandy beach to a gravel and/or cobble beach, removing vital habitat (Emmett, Brian, 2007) .

6.1.2 Objectives

The shore line study was done to; quantify the amount of natural nearshore within the greater estuary area, the types and amounts of shoreline alteration through hardening and anthropogenic impacts.

Determination of the types and level of modification should provide direction on the habitat requirements, which will lead to the activities required for education and habitat restoration in an updated Estuary Management Plan, including additional components regarding the nearshore area.

6.1.3 Methodology

Schedule: Shorelines were mapped throughout the summer of 2008. Since mapping was done at the highest high tide point, there was no need to follow a strict schedule set by tides, though times were selected to ensure a beach area large enough to walk safely.

Volunteer Coordination: Volunteers were used to help on days that summer students were not available to help. Volunteers were coordinated by Ronda Murdock (MVIHES) on behalf of coordinator Michele Deakin (MVIHES). Volunteers were given training on the reasons for the mapping of our shorelines, use of the equipment. They were given responsibilities that ranged from carrying equipment, using a rangefinder, using a GPS, taking photos of shoreline areas, recording data.

Equipment: Garmin GPS 76, Opti-Logic 800XL Rangefinder , Canon camera,

Mapping Methods: The survey area was from the Little Qualicum River, across the mouth of the Englishman River to Craig Bay, a length of approximately 22,266 m or 22.3 km. A minimum crew of two was used. One person would stay at a point where shoreline treatment changed. The other person would take a GPS reading at that point and then walk forward until even with the next change, and stay there, taking a GPS point again. The person behind would use the rangefinder on that front person and get a reading on distance in metres, and walk forward to join that front person. Data was recorded, including the GPS location of the two points. Photos were taken parallel to the beach and towards the water and then if needed from the water to the seawall or land area. The data was then uploaded by the Project Watershed Mapping Centre for entry into a GIS data base where it was portrayed on maps as well as its content analyzed.

6.1.4 Results - Natural vs. Hardened

The shoreline (22,266m) was divided into units determined by the condition. The range of options for shoreline condition included natural or softshore, riprap, wood wall, piled rock, cement block, cement wall, combination, and other. The length of beach used for each shore zone could be one lot, a part of a lot, or several lots together if they had followed the same approach. Figure 6.1 illustrates the placement of various types of armouring along the study area.

Most of the natural areas are those in protected areas including Rathtrevor Provincial Park, the Little Qualicum River Estuary Regional Conservation Area, and the Marshall-Stevenson Unit, Qualicum National Wildlife Area. The softshore beach in the Community Park in the City of

Parksville is not included in these protected areas.

The shoreline is armoured for 11,323 metres in some way. That is 51% of the shoreline that has been hardened and 49% is considered natural, or not armoured.

There are 3,577 metres of shoreline within protected area. The total hardened shoreline within this area totals 1,375 metres or 38% of protected area shoreline has been armoured in some way.

When we remove the shoreline attributed to protected areas (3,577 m), there are 18,688m of shoreline used by residential, municipal and tourism-based users. The percentage of this that is hardened is 54%.

The most popular forms of armouring outside protected areas include Rip Rap (31.5%), Cement wall (20.9%), and Combinations (18.6%). Within the protected areas, of the area that has been armoured, the more popular technique is Cement Wall (47%), followed by Combination (28%), and Rip Rap (21%).

The Combination category includes a range of combinations from cement block and wood wall, to logs and cement wall, to rip rap in front of cement walls, and other combinations. In some cases the combinations seemed to be attempts to continue to armour the shoreline after the initial wall had started to erode, or the shoreline to the side of the original wall had started to erode. In a few cases, the layering of walls seemed to be the original design.

6.1.5 Results - Anthropogenic or Human Made Impacts

Anthropogenic alterations such as storm drains, groynes, culverts, docks, boat ramps, public access points, were noted within each shore area differentiated by a change in hardening type or a change between natural and hardened shoreline. Figure 6.2 illustrates the anthropogenic changes.

There were 4,532m of shoreline with anthropogenic changes of some kind. That results in 20% of the shoreline with a human-made change other than hardening. In some areas this will be in addition to hardening and in others it is not accompanied by hardening. It is possible to have more than one anthropogenic change in one area. In fact, local governments will often create a public access, storm drain and possibly even a culvert all together, in order to save costs.

Stairways are the most prolific anthropogenic change to the shoreline, followed by public access points, and groynes. A percentage breakdown by anthropogenic type is as follows:

- Public Access 1400 metres 6.3% of shoreline
- Culvert 353 metres 1.6% of shoreline
- Groyne 649 metres 2.9% of shoreline
- Pathway in cobble 286 metres 1.3% of shoreline
- Sewer 203 metres 0.9% of shoreline
- Stairway 1493 metres 6.7% of shoreline
- Storm Drain 344 metres 1.5% of shoreline
- Berm 216 metres 1.0% of shoreline

Lines of boulders running perpendicular to the beach were another anthropogenic item. It is unclear what some of these lines were for. Some seemed to be associated with storm drains, but others had no such association.

Other oddities included a water tank of some type on the beach below a house with piping running from the lot to the tank. Boat ramps existed in a few locations, some of which were paved and at ground level, but some were raised to allow boats to move from a boathouse into the water. One extended from the boathouse through the entire intertidal blocking movement along the beach except at a low tide.

Only a small percentage of the shoreline within protected areas had anthropogenic changes and they consisted of a public access or a groyne.

6.1.6 Results – Summary Natural vs. Modified

Approximately 61% of the shoreline is altered, totaling 13,582.07 metres, or 13.58 km. Hardening has affected the shoreline from anthropogenic alterations (storm drains, culverts, stairways, etc.).

The protected areas make up a significant portion of the natural shoreline within the mapping area. Within the protected areas, 57% of the shoreline has no hardening and no anthropogenic change, indicating 43% that has been changed. It should be noted that areas restored were considered a natural beach. The reason for this was that the intent of the study is to quantify the hardening, and of other negative human impacts. Restoration of a beach through softshore approaches does not fit within these parameters and so needed to be treated as natural.

The eastern side of Parksville Bay and towards French Creek Harbour lacks hardening due to high cliffs isolating the area from development. There is some impact along the shoreline due to erosion, or the creation of a cabin, but for the most part the clearing and impacts are at the top of the cliffs – and in some cases may lead to further erosion and impact, but for now the shoreline is rated as natural.

It is also interesting to note that these particular cliffs support extensive forest and show little erosion except where clearing of some type has resulted. This is very different compared to other cliff areas (e.g. just east of Qualicum Beach between the Judges Row area and Milner Gardens) where disturbance of the cliffs has increased the erosion and resulted in various forms of hardening.

Figure 6.1 Map – Parksville-Qualicum Beach Shoreline Inventory – Shoreline Hardening

Figure 6.2 Map – Parksville-Qualicum Beach Shoreline Inventory Anthropogenic Features

Figure 6.3 Parksville-Qualicum Beach Shoreline Inventory Natural vs. Modified Shoreline

6.1.7 Shoreline Inventory Discussion

The study was stopped at a small creek east of Craig Creek, and so in order to complete this mapping to the WMA boundaries, and to match it to the area covered by eelgrass mapping, the section between this point and Craig Creek must be finished - a total of 1710 metres, and a small distance on the east side of the Little Qualicum River. This distance should be covered as soon as possible.

Though photographic images have been collected of each unit of shoreline, they are not available at this time to be matched in an orderly fashion to information on specific parcels of land, due to time needed to work out map production challenges. This should be addressed as soon as possible. Some photos have been included to provide an indication of the range of shoreline modifications that exist.

The slope of the shoreline facing a given property was a good predictor of whether hardening had occurred or not. Usually houses at the top of a rise would not have a wall of any kind, but those houses on a slope would have a hardened shoreline.

Older homes tended to have a natural shoreline, but new homes had obviously armoured their shore as part of the building project or soon after construction.

Some homes attempted to use a softshore approach that may or may not have been part of their plan. The placement of driftwood, for example, was seen throughout the shoreline, possibly as one approach to managing erosion.

Other information available regarding shoreline modifications are two videos of the region. One was done in March 2009 by helicopter, and another collected several years ago. The comparison of these two videos would indicate a change in the shoreline and habitat, and highlight trends in development. It could also provide the initial indication of where to start researching shoreline variances.

Shoreline variance reports are becoming common in the Georgia Basin, Puget Sound area. These include a review of shoreline modifications and a collection of the history of the number of variances that have been granted and how; but also a review of the modifications to see if they are being kept up and if they are still legal. This information is useful to help develop OCPs, and related zoning, planning policies, and education of elected officials and community. It is also useful as a tool to help bylaw staff and others to follow up with landowners to ensure proper care is taken of any modification that has been approved.

Overall there is significant modification of the shoreline in Parksville-Qualicum Beach. Currently there are no bylaws to prevent further hardening of the shoreline and though the Fisheries Act should provide protection for these areas, the resources don't exist to proactively review all shoreline modification projects in one of the fastest growing areas of BC.

Some groups, such as Greenshores, are involved in softshore approaches to shoreline development, but their focus is on accreditation for certain professionals. They are also focusing on development options and not options for restoration. There are gaps then, regarding outreach that are not being focused on. These are the gaps that stewardship groups should fill in.

Further alternatives may need to be developed for protected areas, and for those areas of shoreline where natural restoration may be possible.

Alternatives to armouring need to be presented to residents, real estate agents, landscape architects, developers, planners and elected officials. Restoration of softshores would be expected to improve the natural function of the nearshore, and would be most effective on a community-wide planning effort. The Seagrass Conservation Working Group is working on these issues.

Partnerships with the SCWG should be explored regarding this work. Also, the Healthy Shorelines workshop that was developed and offered in 2007 should be improved and added to in order to create a series for residential owners.

Both the Town of Qualicum Beach and the City of Parksville have indicated an interest in partnering with MVIHES on public education regarding these issues.

6.1.8 Shoreline Inventory Conclusions

Hardening and modification is greatly altering the shoreline and so will have a correlation in the negative effect on the ecological functions of the shore of the Parksville-Qualicum Beach area, and the Englishman River estuary.

- We need to educate the public, developers, real estate agents, landscape architects, elected officials and property owners about alternatives to armouring a shoreline.
- Partnerships with those groups already involved in this work should be explored. There are gaps regarding outreach that some groups (e.g. Greenshores) are not focusing on. These are the gaps that stewardship groups should fill in.
- A series of workshops and other tools should be developed for the audience groups, by building on what has already been accomplished (Healthy Shorelines workshop).
- We need to review the possibilities for restoration of softshores within the study area.
- We need to have laws to protect our nearshore including local bylaws and enforcement of the Fisheries Act.
- We need to review our shoreline variances in order to understand how shoreline modifications are approved and then develop tools and/or a revised process to assist in better decisions regarding nearshore health.

6.2 Marine Riparian Areas

6.2.1 Goals and Objectives

Similar to the riverine riparian areas, the marine riparian provides many important ecosystem services including nourishment of beaches, shade and cooling, insects and other nutrients for salmon and other species. This inventory was developed informally, to provide a visual indicator of marine riparian health, to use as tool until a more formal and complete analysis of riparian health can be developed.

6.2.2 Methodology

Native species provide a better riparian function, though in some cases having some type of vegetation there, even if an introduced species can help provide some function. (R. Russell, 2009) Vegetation was classified using the SHIM database. Vegetation with a high value for a natural riparian area was rated and coloured for High Value (e.g. Dune- grass, Gumweed, coniferous forest, etc.). Other vegetation was rated Low (e.g. English Ivy, California Poppies, Berries). Each line on the map with the corresponding colour indicates the presence of a species with a high or low rating. Together this rating shows those areas with the riparian area more intact than others.

Anywhere a group of seagrass was noted, the group was assigned "Dunegrass" to fit with the SHIM database so that there would be some vegetation of value, or some function, recognized on the map, but Native Dunegrass (*Elymus mollis*) may not be present in all places it is mentioned-though it is in most and possibly all locations.

6.2.3 Results

Figure 6.4 shows that the healthiest riparian areas are in protected areas. It also illustrates that several spots along the coast show 1-2 lines representing vegetation indicating some riparian element. Most areas are developed and have little or no riparian function.

The map also indicates that most vegetation that is in the riparian zone is of high value. As the process was used to develop only a visual indication of riparian health, there was no numbered rating system applied. No figures regarding depth of the riparian area, or relation to any structures or infrastructure were collected.

Because the observations were started part way through the study and because area size of riparian vegetation within a section of shoreline was not calculated, the following measurements are only indicators of trends observed. The shorelines that were natural had more high value vegetation (6459.52 metres) than those that were modified (4811.05 metres).

Overall there were 11,270.57 metres of some quantity of high value vegetation and 666.38 metres of low value, indicating that overall in the areas that it was noted, there is at least some riparian function. This would show that where there is vegetation along the shoreline, it is usually a native species, though introduced and invasives were observed.

6.2.4 Discussion

Because the map provides a line of appropriate vegetation colour for each different species (e.g. Gumweed), or group noted (e.g. mixed forest), it only indicates presence and not quantity. There is no capture of health of the vegetation, or area covered. Not all species were noted. For example more than one species of grass was noted in some areas, but only Dunegrass was used to indicate the function, as the project did not allow the time to key out the variety of species actually found.

A more complete study would be useful. This study should note the variety of substrates in sections of the shore, and the number and variety of species within a section of shore and into the backshore. The depth of the riparian should be noted and also existence of types of function – e.g. overhanging vegetation to provide cooling of water and source of insects for juvenile salmon.

A review of species that should be in the riparian area but no longer exist would also be useful. Many landowners are becoming interested in planting native species in an effort to save water, and be more environmentally responsible. This information could be provided to land managers, real estate agents, local gardening clubs and other stakeholders, and some instruction given regarding the planting and growing of these species.

A review of species important to First Nations would be valuable for many reasons. It would provide some cultural history of the area, indicating sources of food and medicines and culturally important species and areas of use. It would also indicate some significant vegetation species perhaps not known to be in the area, or not currently recognized for the significance.

For example, estuary gardens would have existed in the area (Recalma-Clutesi, K. 2007). These were likely native plants that were encouraged to grow through various means.

Also, riparian vegetation in parts of the study area were important to First Nations people from Campbell River to Victoria. Because of the unique ecosystems, significant plant species grew/grow only in this area. These plants need to be identified and managed.

Perhaps through partnerships function could be restored to the estuary and nearshore. Encouraging growth of native species can only increase the biodiversity in the area, and the stabilization of our shorelines, and provide unique opportunities for education programs for all community members.

The marine riparian area in a developed area can not be expected to support invasives. The impact of the invasives on this small area, and on an island like Vancouver Island, would be more significant than in a larger area, or on the mainland. In those areas where invasive species are found, removal should be encouraged through public education where possible. Bylaws and incentives should be considered to prevent further introductions of known invasives, and to encourage removal of those that currently exist.

6.2.5 Marine Riparian Area Conclusions

- The marine riparian area has been impacted by development. It provides important biological function to the nearshore and to humans.
- A more complete study of the marine riparian area should be conducted.
- A study of the marine riparian vegetation that is not in existence but should be needs to be completed. Information from such a study should be shared through education programs, and incentives given to plant and restore the riparian zone.
- A study of the marine riparian vegetation that is important to First Nations should be completed. Information from such a study should be used to help restore function to the estuary and nearshore, but also create partnerships with First Nations communities. Consideration should be given to re-establishing estuary gardens, and designing protection and restoration projects for important native plants.
- Bylaws and incentives to prevent introductions of known invasives and encourage removal of existing invasives should be considered.

Figure 6.4 Map – Parksville-Qualicum Beach Shoreline Inventory Riparian Areas

6.3 Eel Grass Mapping

Eelgrass (*Zostera marina*), when healthy, helps buffer the shoreline as it slows the wave action down. The rhizomes of the plant, help hold the sediment in place and prevent erosion of the foreshore. The swaying motion of the eelgrass also helps clean the water thereby reducing turbidity. As a green, photosynthesizing plant it provides us with both oxygen, and effective carbon sinks.

Eelgrass is often equated to the coral reefs or tropical rainforest, due to the amount of biodiversity that seasonally moves through the beds. 80% of commercial fish and shellfish species depend on *Z. marina* at some point in their lifecycles. This can be for protection from predation, sunshine and fresh water. Eelgrass also provides nursery grounds for some and hunting grounds for others. It also supplies nutrients to salmonids and other fish, shellfish, waterfowl and about 124 species of faunal invertebrates. The plants offer surface area for over 350 species of macroalgae and 91 species of epiphytic microalgae. It is an extremely important part of ecosystem health. (Wright/Deakin, 2009)

Eelgrass is a fairly flexible plant, but does have some preferred habitat requirements. It prefers to grow in mudflats, and/or sandy substrate, needs a certain level of sunlight, a particular range of wave action, and a range of salinity (BC Coastal Eelgrass Mapping Network, 2003). The area of the Englishman River Estuary and the shorelines of Parksville-Qualicum Beach provide exemplary habitat for eelgrass. Whereas most of the coast consists of small eelgrass beds, tucked between rocky shores, the extensive beaches of the Oceanside area provide stretches of potential habitat that are several kilometres long.

6.3.1 Goals and Objectives

This mapping and monitoring of eelgrass is intended to collect information to show the location of eelgrass beds, quantify the amount of eelgrass and the carbon being sequestered. Comparison to historic mapping efforts will give some indication of any change in location or size of beds. These results can be used to indicate water quality issues, changes in sea level, or visitor management issues.

6.3.2 Methodology

Schedule: Due to limited resources and the extent of *Z. marina* in this area, multi-year mapping has been necessary. Mapping efforts were focused on areas that were more susceptible to human impact. Intertidal eelgrass was mapped at low tides over the last 4 years. Some sites were repeated as monitoring sites. Subtidal eelgrass was mapped at close to low tides over the last 3 years.

Volunteer Coordination: Once field days were established, the mapping was led by the project coordinator, Michele Deakin. For the first 3 years, volunteers were solicited and coordinated by Michele. Through this project, Ronda Murdock found volunteers. The number of volunteers ranged from 2 to 6 persons per sample site, though in the case of Rathtrevor Provincial Park special groups of volunteer geocachers were brought in totaling from 10-20 each time. Most volunteers were adults and retirees, though some children were involved. Two school groups were involved including one which conducted a separate 3 year study regarding growth rates of *Z. marina* vs. *Z.*

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Volunteers were offered responsibilities before work was undertaken for duties such as; carrying the equipment, laying the transect, recording data, running the GPS units, counting densities. Training was done before to familiarize volunteers with the species and its significance to the ecosystem and humans. Volunteers were also trained each outing on equipment and proper mapping techniques. Careful movement in and around eelgrass beds was also stressed to reduce the impact to the habitat and wildlife.

Equipment: 60m transect tape, quadrats 0.25 sq. metres, GPS, camera.

Mapping Methods: Eelgrass is mapped using the methodology developed by Precid Identification for Canadian Wildlife Service, Environment Canada. This 41 page manual is located at www.stewardshipcentre.bc.ca/eelgrass/methods.pdf.

The most basic approach is to use a GPS to record points and walk the outside of the bed, so that the location and size are noted, while completing a standard data collection sheets. If there is the opportunity to map at a higher level (i.e. collect details regarding density), then the intertidal methodology involves the laying of a 60 metre tape parallel to the beach at low tide in the middle of an eelgrass bed. 30 quadrats are then counted for number of plants, number of reproducing, and leaf area index is calculated. Other flora and fauna found in the bed are also noted. A Garmin GPS is used to note the ends of the transect, but also the outline of the bed.

Subtidal mapping of eelgrass involves a boat, GPS, underwater camera and viewer. The beds are located with the viewer and then the camera is used to keep the boat on track along the outside edge of the beds. GPS points are entered along the route which will then provide a polygon outlining the bed on the atlas.

Where possible, divers can be included to apply the same methodology as the intertidal mapping, underwater to calculate densities and health of the bed.

Whether it is intertidal or subtidal information, this data is downloaded and entered onto the Community Mapping Network site in the Eelgrass Mapping Atlas for the coast of BC. Data entry includes cleaning up of GPS points, creating points, lines, and polygons to indicate locations and size of eelgrass beds. Attribute data is also entered and connected to the features.

The data collected by Haegle for the Department of Fisheries and Oceans in the 1970s and early 1980s was gathered together into a digital database by the Department in 2003. The area of Parksville-Qualicum Beach was inventoried in 1977. Haegle collected the data through the "use of low-level colour infrared and colour aerial photographs. 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." (Bennett, K. 2003)

Some ground-truthing was completed with the use of divers. In the Deep Bay area, 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." (Bennett, K., 2003) Despite the correspondence, Haegle recommended in his report that analysis of the data should emphasize total area of each species type, not the positional location of the polygon itself.

The Haegle data was included to illustrate the complexity of our beds, but also provides some useful comparisons about eelgrass bed locations and size. Since the mapping work of Haegle, the introduced brown algae, Sargassum (*Sargassum muticum*), has apparently been spreading (according to anecdotal evidence) and so the vegetation zones will have changed in some areas. Sargassum presented challenges to mapping the subtidal eelgrass as it is mixing in and around the beds, making it difficult to see exact boundaries on the eelgrass locations.

Data gaps: There are still some gaps regarding the outside edge of the subtidal beds. Also some beds were such a mix of marina and sargassum that it was not possible to differentiate between them given the tides and weather during mapping. Several mapping attempts were cancelled due to wind.

Subtidal mapping did not include density counts. Despite efforts in the past, a team of qualified volunteer divers was not found. A group of free divers however have been working in other locations on the mainland and Gulf Islands the last two years and so would be a resource to use to get some baseline densities of the subtidal *Z. marina* in this region.

The eelgrass atlas is hosted on a publicly accessible network of community mapping efforts, CMN Network. This allows the efforts of many volunteers to be displayed. The benefit of the atlas is that part of the mapping process can be done online without the maintenance of expensive software and base maps. The atlas also presented some challenges. Digitizing lines was time consuming because the start and finish of the lines was confined to the screen size available, so numerous lines had to be digitized to create a polygon for example. In addition, an attribute form had to be filled out for each line. It was discovered part way through the project that in order to show consecutive year data (with different coloured lines) a GIS technician would have had to have been paid, which was not in the budget. As it stands the viewer must click on each line to open a report to view the date of survey. Visually, this is not ideal.

The atlas has recently been transferred into new software that will eventually make the online mapping more user friendly, but it is in its infancy. More funds are needed to add useful features and bugs are still being ironed out. Leanna Boyer, Seagrass Conservation Working Group and Gordon Luckett, Arrow Geomatics Inc., have volunteered many hours to get the data and maps together for this project to export to Project Watershed and then in final clean up.

Figure 6.5: Map – Parksville-Qualicum Beach Eelgrass (Haegle Data)

6.3.3 Results

Figure 6.5 illustrates the results of the mapping work done by Haegle in 1977 within the 2009 study area. There are several areas of mixing of seagrass and algae and it illustrates the complexity of marine vegetation along this shoreline.

Figure 6.6 illustrates the current locations of eelgrass both intertidal and subtidal along the shoreline of Parksville-Qualicum Beach area, including the Englishman River estuary. In those areas where a polygon is shown, it is known that the bed has been mapped in its entirety. Many areas show a line of eelgrass indicating a narrow bed, or a fringing bed that crosses from intertidal into subtidal. In some cases a line indicates a subtidal bed left incomplete due to wind and/or visibility issues. Other single points indicate locations of eelgrass that are approximately a metre in size but not large enough to create a polygon or a line.

Figure 6.7 shows the seagrass and seagrass/mixed areas captured by Haegle, compared to the eelgrass mapped between 2004-2008 in Parksville-Qualicum Beach by MVIHES. In some areas, eelgrass mapped by Haegle is sea-ward of the current locations, or lower on the beach. This indicates that the *Z. marina* is noticeably moving up the beach. Eelgrass moves up a beach in response to changing water quality, and/or rising sea levels.

Some areas have experienced an increase in eelgrass coverage, and others a loss. From the Little Qualicum River and westward, there has been an increase in the linear area of eelgrass identified, and the disappearance of some small beds in the intertidal.. Currently there is some intertidal *Z.marina* mapped, but it is in quantities too small to create a polygon. There is an edge that fringes at very low tides into the subtidal. The outside edge of the subtidal needs to be closed.

In the area of Qualicum Beach, patches of *Z. japonica* have been recently mapped, and some mixed beds, containing both *Z. japonica* and *Z. marina.* We can also see a significant increase in eelgrass within a large polygon off Columbia Beach area. This area was a patchy line when mapped by Haegle.

Moving westward, west of the French Creek Harbour and east of Parksville Bay there seems to be a loss of eelgrass since Haegle mapped it. In 1977 this area was clearly identified as eelgrass, This area was mapped by boat by MVIHES over two years but the mixing of species was high, making it difficult to separate out, indicating that the size of the eelgrass beds have diminished. Sargassum was high in this area and so may have pushed out the kelp that should be there and is now moving into the area suited for eelgrass. Though it prefers a rocky shore, some scientists (Druehl, L, 2003) say that Sargassum can grow anywhere it is protected from wave action.

In Parksville Bay area, *Z. japonica* has appeared since 1977, and there has been a loss of *Z. marina.* There are some small increases in other areas along the shoreline in Rathtrevor Provincial Park area, and the Z. marina has moved beachward in some areas. However, Craig Bay seems to have lost a considerable amount of eelgrass. The mappers came into the inside edge by boat and found nothing in that area, beachward from what is mapped. A kayak could be used to confirm this finding, if needed. The Atlas will not permit calculations of distance that the eelgrass has migrated beachward or seaward, and so specific size of changes are not possible.

Figure 6.6 Map – Parksville-Qualicum Beach Eelgrass (MVIHES)

Figure 6.7 Map – Parksville-Qualicum Beach Eelgrass (MVIHES + Haegle Seagrasses)

6.3.4 Discussion

We have chosen to inventory some key plant species to indicate overall health of the nearshore. Eelgrass is a key indicator species. It is the central element in the discussion of healthy shorelines and healthy salmonid populations. If eelgrass meadows are healthy and resilient to changes, including those of climate, so too is there a higher likelihood of juvenile salmonids growing robust and surviving the open ocean. Healthy nearshore habitats increase marine survival of salmonids, forage fish, such as herring and sand lance and other important fish species. None of this nearshore can exist sustainably if the natural process of formation and maintenance of the shoreline has been interrupted by human impact.

Anecdotal information on changes to eelgrass since 2004 include the reduction of intertidal bed size in the Qualicum Beach and Rathtrevor Beach areas. This could be due to trampling but should be reviewed.

Along the Parksville Bay area, the movement of pebble and cobble, likely due to altered shorelines is likely impacting the growth of eelgrass. Historic photos and a discussion with a coastal engineer confirm that the beach in front of Surfside used to be a sandy beach. It is understood by coastal engineering experts that creating of the rip rap along that beachfront has altered the current significantly and created the gravel bars in the area. There is a large gravel bar that has come and gone naturally over time, but now seems to be permanent and continuing to grow. Mapping of eelgrass shows a loss of marina, but in the eelgrass that is remaining, the cobble is mixing with eelgrass along this area and it seems that we are monitoring the continued decline of this habitat.

This area has traditionally been an important area for herring spawn and for migratory birds including the Black Brant goose. Resident birds like the listed Great Blue Heron use it regularly for feeding, standing in the eelgrass beds to fish.

Other changes we are seeing occur in eelgrass in this study area and other areas of the Georgia Basin include the earlier development of ephiphytes. A typical cycle of diatoms on eelgrass is that in late July/August Z. marina would “turn off” the chemical that prevents epiphytes from attaching to the plant. This then permits the diatoms to attach and this is in time to feed the copepods and other zooplankton that are arriving in the area, and that this then ensures that there is a food source for salmon smolts coming out of the streams and rivers. The question we have been asking is, does this upset the cycle of diatoms to copepods to salmon? The relationship of one to the other is significant.

Recent research shows that diatoms feed copepods that are needed to sustain salmon. Will there be enough left for movement of salmon into the nearshore from river? Is this a result of climate change and warming of the water, or a water quality issue? A form of sun screen? Research needs to be done on this trend.

Water quality samples were taken last year by the Tribal Journey canoe trip to Duncan. Collection of that data and mapping of the results might help indicate where changes are occurring due to water quality issues. Other sampling should be undertaken in an organized study to quantify water quality in areas where eelgrass has moved up the beach, or where significant decline has been noted. Attempts should be made to determine whether any water quality issue is due to local influence, a regional issue or concerns the whole of Georgia Basin.

In some areas of the Georgia Basin this year, eelgrass has suddenly disappeared and there is not yet an explanation. The San Juan Islands have also been experiencing sudden losses of eelgrass and further research is needed into the reasons. But it highlights the importance of maintaining the eelgrass we do have as any remaining eelgrass becomes even more significant as other areas experience losses of the habitat.

Wasting disease is a potential factor in these sudden disappearances that should be researched in the Georgia Basin. In the 1930's a widespread collapse of eelgrass occurred on the Atlantic coast. So far the Pacific coast has not experienced that collapse, but wasting disease is present in Puget Sound. It is thought that *Zostera marina* is always infected with the fungi *Labyrinthul* (Short, F.T, L.K. Muehlstein, L.K. & D. Porter, 1987). There are different theories about how this pathogen is triggered. Some suggest it is set off by a change in salinity, or light levels or temperature and that pollution is the most likely trigger of all these changes. Others suggest that the fungi is actually a saprophyte and only feeds on dead eelgrass cells. Still another suggestion is that the eelgrass meadows only seem to be a monoculture and so susceptible to widespread wasting disease, but in fact each meadow is actually full of a variety of smaller plants and animals that provide the antibiotics necessary (Kruckeberg, A. 1995). The Bamfield Marine Science Centre is currently researching wasting disease and will work with the Seagrass Conservation Working Group to promote partnerships in research and management in the Georgia Basin and West Coast of Vancouver Island.

Once reasons for decline have been identified, consideration of transplants would be possible. Given the substrate in this region, it is likely that there was more eelgrass in the area than we currently have. A transplant would help increase the habitat and support its adaptation to climate change, but also increase the potential biodiversity of the area, and the storage of carbon. Also a transplant is a very useful tool to educate and involve the community in understanding and protecting their nearshore environments.

Zostera japonica (japonica) was introduced to the coast several years ago, traveling with oysters from Japan. This plant was studied about 10 years ago and at that time it was determined that it is not an invasive. It tends to grow high up on the intertidal and is an annual and so does not compete with the *Z.marina*. Some mapping projects in this study area and in other locations along the coat however are catching a possible change in behaviour. It is possible that *Z. japonica* is evolving and adapting to its new environment. This inventory and others have found *Z. japonica* mixed into beds of *Z. marina*. This could mean that the japonica is moving down the beach as it adapts to its new environment, the *Z. marina* is moving up the beach due to water quality issues, or that sea levels have changed and forced the *Z. marina* further up the beach.

Mapping of *Zostera japonica* would be worthy of consideration as well. Some biologists consider japonica as increased habitat, and other biologists are concerned about the spread of japonica impacting habitat for migratory birds that feed intertidally. Mapping of the introduced eelgrass would indicate the level of growth, and likely indicate if there has been a change in behaviour in the plant. This may then answer concerns for some, or indicate a need for management considerations.

A more detailed study comparing growth rates of *Z. Marina* to *Z. Japonica* should be undertaken to determine if there has been a change in japonica behaviour. This would help answer the questions regarding whether *Z. Marina* is moving up the beach or japonica moving down, and so indicate changes in water quality and/or sea level. If it is a change due to sea level increase, then the results may indicate the ability of the *Z. Marina* to adapt to a changing sea level and what else occurs in the changing habitat.

The hardening of our shoreline may explain some changes in location and/or health of our eelgrass beds. Eelgrass can be severely impacted by hardening of shorelines. Because eelgrass spreads most successfully by rhizome, one bed can consist essentially of one plant. The rhizomes are dug out of the substrate by wave action that is created and/or increased in response to the armouring of a beach. Hardening alters the pattern of the current from a travel route along the beach and forces it to come in straight, almost perpendicular to the beach. The wave action then "bounces" down the beach until it finds a soft spot to absorb the impact – usually at the end of the seawall or structure, where all that stored energy creates erosion of the shoreline. At the same time, this “bouncing” is done in a circular motion that digs out the finer substrate in front of the armoured section, and thus will dig out and remove sand and mud leaving cobble behind. This reduces the ability of the beach to support a level of biodiversity. It also removes habitat important for birds, wildlife, fish, marine vegetation and wildlife, including eelgrass.

Figure 6.8 compares the shoreline hardening to the eelgrass mapped by MVIHES. In order to make a proper comparison it would be important to have information on the locations of shoreline hardening in 1977 to map with the Haegle data. It is likely however, that there has been an increase in shoreline hardening since 1977 given the rise in population and the trend that newer residents tend to armour their beach.

Losses in the area of Qualicum Beach, Columbia Beach, Parksville Bay and Rathtrevor Beach areas may all be linked to the hardening of those shores.

Other changes that could have impacted eelgrass include the construction of the French Creek Harbour, which would have altered currents and wave action in the area. It would also have interrupted transport of sediments needed to build some of the beaches and may have impacted the sediments needed to hold the eelgrass beds in place.

Sewage, and other run off from the residential, municipal and tourism uses would certainly alter water quality, and so would impact growth of eelgrass. Even though there is now a sewage treatment plant at French Creek, the effluent would be the same as from other sewage plants and include a variety of chemicals that can affect growth of vegetation and living organisms.

Canada geese have a serious impact on eelgrass, ripping out the whole plant instead of taking the top third as the Black Brant does. They feed along the nearshore throughout the study area.

Trampling in the beaches especially Qualicum Beach, and Rathtrevor Park could also have impacted intertidal eelgrass. Parksville Bay is another well used beach area, but people tend to stay closer to shore rather than walk out to the eelgrass location, and so it may not be a factor at that location.

Work should be done to help clarify the reasons for eelgrass decline and increase. This information should be used to create bylaws and incentives to protect eelgrass, but also identify any infrastructure changes that are needed, and to set priorities for a possible shoreline restoration project, and identify the possibility and potential location of an eelgrass transplant.

Education programs would be useful as well, to provide the public with the information they need in order to enjoy their shoreline in ways that help ensure its continued function and provision of ecosystem services.

Given that there are approximately 18,984 linear metres of eelgrass in the area, and assuming an average width of 3 metres on the eelgrass beds, there is an estimated 56,952 square metres of *Zostera marina,* or about 57 hectares of eelgrass. In many areas the beds are wider than this, but once the subtidal edges are completed a more accurate estimate would be possible.

Because eelgrass sequesters on average 500 gC/m^2/year carbon, the beds currently are able to sequester 28,476,000 gC per year. (Durance, C., 2007) Since 1000Kg = 1 metric tonne, we can estimate that the eelgrass beds in this area sequester approximately 28.48 metric tonnes of carbon annually. Even though the leaves do break away, eelgrass beds do not decompose for 40-50 decades and so the value of eelgrass as a carbon sink is high (Durance, C. 2009). With restoration, it would be possible to increase the size of the carbon sink and provision of key habitat for many species.

It seems that the spread of Sargassum may be impacting the eelgrass beds. This could be clarified with a comparision to the Haegle mapping information. Sargassum is likely easier to map than *Zostera marina* and should be considered for such a project. Also, some researchers (Drs. Timothy Wootton and Kevin Britton-Simmons) have found that after manual removal of the Sargassum, the native community will recover in approximately a year. Removal of *Sargassum muticum* is extremely labour intensive, small-scale eradication is possible and can be successful. They also found that physical disturbance of kelp beds helps spread the Sargassum and so management practices should be put into place to avoid disturbance of nearshore kelp beds.

Figure 6.8 Map – Parksville-Qualicum Beach Shoreline Inventory Eelgrass and Shoreline Hardening

6.3.5 Eel Grass Study Conclusions

The eelgrass beds of Parksville-Qualicum Beach are a significant nearshore plant community vital to a healthy ecosystem. Management plans of the estuary have to include this important plant. Below are recommendations based on this study and references.

Changes in Eel Grass communities seem to be occurring – movement up the beach, possible stabilization of *Z. japonica,* change in timing of epiphytes. Conduct more research to explain these changes and potential impacts on food chains in the ocean.

Review information on changes to eelgrass since 2004 including the reduction of intertidal bed size in the Qualicum Beach and Rathtrevor Beach areas. Determine if trampling is an issue. Recommend management actions.

Study the interrelationship of diatoms on Eelgrass and the role with copepods that are needed to sustain salmon. Given the changes described, will there be enough left for movement of salmon into the nearshore from river? Is this a result of climate change and warming of the water, or a water quality issue? A form of sun screen? Research needs to be done on this trend.

Determine the impacts of the gravel bar forming at Parksville Bay and recommend management actions.

Water quality may be an issue, contributing to changes in behaviour of the Z. marina. Attempts should be made to determine whether any water quality issue is due to local influence, or a regional issue or concerns the whole of Georgia Basin. Water quality samples were taken last year by the Tribal Journey canoe trip to Duncan. Collection of that data and mapping of the results might help indicate where changes are occurring due to water quality issues. Other sampling should be undertaken in an organized study to quantify water quality in areas where eelgrass has moved up the beach, or where significant decline has been noted. Attempts should be made to determine whether any water quality issue is due to local influence, a regional issue or concerns the whole of Georgia Basin.

The Bamfield Marine Science Centre is currently researching wasting disease and will work with the Seagrass Conservation Working Group to promote partnerships in research and management in the Georgia Basin and West Coast of Vancouver Island. MVIHES and land managers should continue to work together on this research.

Once reasons for decline in different areas have been identified, consideration of transplants would be possible.

Education programs and tools should be designed to provide the public with the information they need in order to enjoy their shoreline in ways that help ensure its continued function and provision of ecosystem services.

Mapping of *Zostera Japonica* should be undertaken to monitor the area it has taken, but also any changes in behaviour that may be significant. This would include a detailed study comparing growth rates of *Z. Marina* to *Z. Japonica.*

An ecosystem approach must continue in monitoring of eelgrass, relating the habitat to other species that benefit from healthy eelgrass beds, and human actions that can impair the health of the system

Mapping of kelp in the area would be useful and help complete the picture of nearshore function

A review of the spread of sargassum should be done and compared to Haegle data. Based on that information, small-scale removal should be explored in an effort to return the native communities of both kelp and eelgrass in some areas.

6.4 Forage Fish

Forage fish are those fish that are preyed upon by larger species. In our area, these include Sand Lance (*Ammodytes hexapterus*), Surf Smelt (*Hypomesus pretiosus)*, Shiner Perch (*Cymatogaster aggregate)*, Pacific Herring (*Clupea pallasii)*, and juvenile salmonids. Not a lot of information exists on some of these species, where there has not been a commercial fishery.

Forage fish species are declining around the world at alarming rates. As larger species disappear, commercial fisheries move down the food chain. Also, the aquaculture industry harvests forage fish to feed their captive fish. A global decline in marine mammals and seabirds has been attributed directly to the decline in forage fish (Oceana, 2009). As the basis for several food chains it is vital we maintain the habitat for forage fish.

Both Sand Lance and Smelt spawn in the intertidal areas. For at least part of their life cycle, Sand Lance remain in the upper intertidal even after the tide recedes, and this seems to be the area in which they spawn, making them very susceptible to impacts from human use of the shoreline.

Given the extent of sand and fine gravel intertidal areas, the beaches of the Oceanside area present substantial potential habitat for both Sand Lance and Smelt.

The upper intertidal area is easily impacted by human use. By determining locations of potential habitat, existing habitat and potential for change through human modification of the shoreline, land managers should have basic information to work with in order to develop policies, planning approaches, and restoration projects needed to ensure a functioning forage fish population.

6.4.1 Methodology

Schedule: Sand Lance was the initial focus of the study and so low tides during the winter spawning window were chosen to initiate a presence and absence study. The identification of potential forage fish habitat was noted during the mapping of shoreline modifications.

Volunteer Coordination: Volunteers were coordinated by the project coordinator, Michele Deakin, and Ronda Murdock. They ranged in age from students to retirees, and were given responsibilities that included carrying equipment, laying a transect, collecting samples, recording data and sorting the sample and looking for eggs.

Equipment: 60 m transect tape, trowel, GPS, camera, stick (name),

Mapping Methods: As per training by Pam Thuringer, MSc, Fisheries Biologist who has worked with Sand lance for 20 years. This approach is based on that used by Thuringer under the advice of Dan Pattilla of the Washington State Department of Fish and Wildlife.

At tides low enough to expose the potential spawning sites, 60 m transects were laid parallel to the beach, in areas of substrate matching description of potential habitat. Samples were taken within 5 feet of each side of the transect. Trowels were used to dig down up to 2 cm deep at random points along both sides of the transect. Though random, attempts were made to spread the samples out evenly in the sample area, regardless of substrate types. (e.g. if some of the area was sand, and some was pebble, the sample would not focus on the sand substrate but would also include sample from the pebble area) A total of 2 litres of sample is collected for each transect.

Data sheets are completed during the transect regarding wind and fetch, compass readings taken. Samples are labeled to match the data sheets and kept refrigerated until reviewed within a 4-day period.

To review the samples, they are rinsed with water through specially designed filters that reduce the size of the sample but leave those sections most likely to contain spawn. Gold panning techniques are used to winnow the sample down further and examine each few tablespoons at a time under a microscope and bright lights. The first time through a sample the sediment is saved and then 500 ml of that sample are passed onto another reviewer to look through in the same manner as a double-check.

Any possible spawn is put into sample bottles with preservative and then sent to Pam Thuringer to confirm identification.

Data gaps: The potential habitat on the study area is quite extensive. This study focused on Sand Lance choosing some sample beaches in the area. The potential habitat in winter will look different than during the summer as a result of natural beach processes. For this reason, the study gives some indication of places to check for presence/absence but some of the beaches identified may have different substrate in winter.

Few transects were attempted at this time, and so the presence/absence does not represent the potential of the whole area. Also as the eggs are the same size or smaller than a grain of sand, it takes a practiced eye to find the eggs. As capacity is increased in the volunteers, it will be likely more eggs will be found.

Also, similar to Pacific Herring, Sand Lance move spawning areas. Spawn is also moved around in the water column by the tides, between beaches. So data from one year is an indicator, but similar to herring several years of information are needed in order to determine the habits of Sand Lance and their need for habitat.

Also, the original intent of the shoreline study was to quantify modifications and not forage fish habitat. This was added in after the study was begun as the potential to easily add this factor in was realized. For this reason some areas of potential habitat have not been included in the study.

Since the shoreline changes seasonally, it would be important to capture the potential habitat year-round. A photo-point monitoring program should be considered to cover one year once/month, or a program covering a wider selection of beaches 4 times/year may be enough.

Figure 6.9 Map- Parksville-Qualicum Beach Forage Fish

6.4.2 Results & Discussion - Sand Lance

Potential habitat for Sand Lance exists throughout the nearshore area of the study area. Several transects were done within the study area to sample for possible spawning sites for Sand Lance. One egg was found on December 31st, 2008 in one sample and that location is highlighted on the map that is Figure 6.9.

Finding of one egg indicates that Sand Lance do use these beaches to spawn. Given the date of the sample, it also indicates that samples need to be collected earlier in the year, likely early December or in November. Because Sand Lance are similar to herring and may not use the same beach in subsequent years, not finding eggs does not necessarily mean that the beach is not a spawning beach, or used at some other time in the life cycle of this fish.

The eggs are the size of a grain of sand, and so volunteers need to develop an eye for them. As this capacity increases it is expected that the number of eggs found will also increase.

Most of the shoreline was noted for potential forage fish habitat, but other areas will exist as well, given that the notes on forage fish habitat were not taken from the beginning. A photo-point monitoring project will identify those beaches most likely to be used for either Sand Lance or Surf Smelt.

Mapping for Pacific Smelt should be completed as well. These fish spawn in summer also in the upper intertidal area, and so are subject to the same issues as Sand Lance. A similar methodology is used for Pacific Smelt, except for the requirement of laying of transects a little lower in the intertidal.

6.4.3 Results & Discussion - Herring

Pacific Herring (*Clupea pallasii),* is sometimes considered a keystone species because of its very high productivity and interactions with a large number of predators and prey. This is another forage fish important as an adult to other fish and marine mammals. The spawn of this fish supports a high marine biodiversity contributing to health of Brant geese, other seabirds, and sea mammals including migrating whales, and sea lions.

Pacific herring spawn in variable seasons, but often in the early part of the year in intertidal and subtidal environments, commonly on eelgrass or other submerged vegetation; however, they do not die after spawning, but can breed in successive years.

Central in the marine food web, Pacific herring are a key fish prey contributing 30 to 70% to the summer diets of Chinook salmon, Pacific cod, lingcod, and harbour seals in southern B.C. waters. Herring eggs constitute an important part of the diets of migrating seabirds and gray whales, and invertebrates. It contributes 58% of the diet for Coho Salmon and 53% for Pacific Halibut. Pacific herring spawn in coastal areas, requiring abundant algal beds and uncontaminated waters. A growing concern is a threat by coastal development to the spawning habitat of Pacific herring.

Figure 6.9 highlights the areas used by the Pacific herring (*Clupea pallasii)*. A colour code has been applied so that the darker the pink, the higher the use in that area over time.

The data to create this map was collected through the Pacific Biological Station. It is at this station that Fisheries and Oceans Canada conducts ongoing surveys on herring populations and spawning areas.

The geographical distributions of Pacific herring (*Clupea pallasi*) spawning sites have been estimated each year since 1928. The analysis was based on approximately 30,000 spawning events recorded mostly by fishery officers and diver teams in six regions of the British Columbia (BC) coast. For each of 101 geographical *sections* of BC, time-series maps were constructed to delineate annual herring spawn depositions along each kilometre of shoreline from 1930 to 2001. Total cumulative egg deposition from 1928 to 2008 was also mapped using proportionately sized, multi-coloured, bubble plots which rank and classify each kilometre of herring spawning habitat according to the long-term frequency and magnitude of spawns over time. Cumulative spawn analysis was conducted coast-wide so that any kilometre on the BC coast could be easily compared with any other BC coastal kilometre.

Annual fluctuations of herring spawners may indicate migratory movements (to some degree) between adjacent regions. Tagging evidence presented by Hay, D.E. et al, 2001 suggests that approximately 10 to 20 percent of the spawning biomass in any region may move to adjacent regions in subsequent years. Considerably greater inter-area movements occurs between smaller spatial units such as statistical areas, herring sections or locations. Migratory movements of tagged herring (1936 to 1992) are shown in detail, on tag, origin and recovery maps. (DFO website, April 2009)

Approximately 5,260 km (or 18 %) of British Columbia's extensive 29,500 km coastline have been ranked and classified as herring spawning habitat. An estimated 400 to 600 kilometres of BC coastline or about 1.8 % of BC's total shoreline length are intensively utilized by spawners in a typical year (DFO website). The area of this study then represents three to four percent of potential spawning area for herring in BC. Within this study area there is 292,089,646.26 square metres of herring spawn area, or 29,208.96 hectares.

Figure 6.10 compares eelgrass to forage fish distribution and highlights areas where there is overlap. There has been some discussion about whether herring actually prefer eelgrass or kelp or whether they just spawn as they are ready. This map shows some overlap with high use areas by Pacific herring and larger eelgrass beds, and an overall overlap between eelgrass beds and herring spawn areas of all ratings. The Fisheries and Oceans manual for Herring Spawn Surveys recognizes the role of seagrasses in the spawn site selection by herring.

Figure 6.10 Map – Parksville-Qualicum Beach Forage Fish and MVIHES Eelgrass

According to Fisheries and Oceans Canada, seagrasses, are used coast-wide by spawning herring more often than other vegetation types. Two forms are found, both in shallow water. The most common grows on mud/sand flats in protected locations while the other prefers rocky crevices exposed to surf. (DFO website – herring spawn survey manual, 2009). The first type of grass would likely be eelgrass and the latter would be surf grass. Also the female travels back and forth along the substrate to lay her eggs in layers. It would seem then that the fish generally look for vegetation to lay their eggs on. In this area, Sargassum and Zostera Marina provide extensive areas for herring to spawn. The invasive Sargassum prefers rocky shores and so is likely filling a function normally provided by native kelps (Monteiro, C, et al, 2009). Typically kelp and eelgrass do not compete and prefer different substrates, providing a similar function in different types of situations. However, some (Druehl, L. 2003) point out that Sargassum prefers the rocky shores but can grow almost anywhere the wave action is low enough, and so may be pushing the eelgrass out.

The study area is quite close to the Bowser Bay area which is the "most significant herring spawn location in BC" (Penn, B., 2009), but concerns about the scallop aquaculture industry in the Bowser area have been raised regarding health of the herring fishery. Doug Hay, retired herring fishery biologist has stressed the need to "limit future industrialization of the Bowser area coastal zone, and adjacent areas. These areas support very important herring habitat." (Penn, B., 2009)

The herring populations in the study area then are of a provincial concern. Monitoring of the fishery vs. the habitat should continue, and a forage fish policy pursued similar to that in the state of Washington.

It is clear that the nearshore area within Parksville-Qualicum Beach is important to the population of herring in BC. Herring use most of the study area for spawning but mapping by DFO shows that some particular areas are used more than others.

Fisheries and Oceans, on their website, have indicated that if regular information can be collected in order to contribute as an indicator to herring management decisions they would consider adding that indicator to their decision-making framework. Considering the acknowledged value of seagrasses to herring, continued monitoring of eelgrass and the addition of mapping kelp in the area would be of value to forage fish management.

Acknowledgement of the value of the local nearshore to the herring and the many food chains dependent on herring, needs to occur. This information should be included in a variety of education programs.

There should also be further development of policies and regulations to protect and restore the fisheries habitat.

6.4.5 Forage Fish Conclusions

This section of coastline contributes 3-4 percent of herring spawn habitat for the province. Of the herring spawn mapping done within the study area, there are many areas that indicate a high use zone.

- The beaches of Parksville-Qualicum Beach also appear to offer many locations for Sand Lance and Surf Smelt habitat.
- Mapping for Surf Smelt should be completed as well, using a methodology similar to that used for Sand Lance.
- Sand Lance spawning sampling needs to be collected in November, and early December, and expanded throughout the study area.
- Several years of data collection should occur in order to capture the movement of Sand Lance use of different beaches over time.
- A photo-point monitoring program to identify and monitor forage fish habitat should be considered to cover one year once/ month, or a program covering a wider selection of beaches 4 times/year may be enough.
- Considering the acknowledged value of seagrasses to herring, continued monitoring of eelgrass and the addition of mapping kelp in the area would be of value to forage fish management.
- Acknowledgement of the value of the local nearshore to the herring and the many food chains dependent on herring, needs to occur. This information should be included in a variety of education programs.
- Decline in forage fish is a global issue. We need to review what is being done elsewhere to prevent the same losses in our ecosystems.
- There should also be further development of policies and regulations to protect and restore the fisheries habitat.
- Monitoring of the fishery vs. the habitat should continue, and a forage fish policy pursued similar to that in the state of Washington.

6.5 Shellfish Study

In 1999, the Shorekeepers conducted intertidal surveys along the shoreline including one location in the ER estuary, and one location on the nearby beach in Parksville Bay. The location within the estuary matches one of the locations used for beach seining by this study. The Parksville Bay site matches where intertidal survey work has been done before and after construction of a softshore beach in 2008.

A review of these studies will provide a comparison of populations of key species, useful as another indicator of nearshore health and how it has been changing over the years. Clam species to be compared include the manila and littleneck. Varnish clams will also be noted in order to capture the impact of the invasive species in this region.

At time of writing of this report, the final report from the bio-inventory of the City of Parksville softshore beach is not available, and so the comparison is not possible at this time. When the report comes out, a comparison will be done.

6.6 Looking at the Nearshore - A Discussion

Figure 6.11 illustrates the complexity of the nearshore and some of the interactions between elements of the study. Several recommendations come about through looking at the interrelationships in the nearshore area, and considering an ecosystem approach.

An issue that exists in this region and others is the increasing interest in using natural products to fertilize gardens. This is also happening as an influx of non-coastal people move to waterfront property and do not understand the importance of the wrack line to maintaining life on the beach. Many of these new residents find the beach messy and hire others to clean it up for them.

The combination of harvesting eelgrass and kelp for gardening and cleaning up the “messy” beaches are stripping beaches of important nutrients. Rusty Feagin, Coastal Restoration Specialist at Texas A&M University points out that “the wrack line influences the system. A beach doesn’t get a lot of nutrients, so whatever can get in is very significant” (Feagin, R., 2009). An education program focused on both the coastal home owner, and the avid gardener would be a useful next step.

The nearshore of the study area has been important to First Nations for thousands of years. Large sandy bays provided quiet breaks from storms or rough seas and a place to harvest food. Plants important to people from Campbell River to Victoria grow only in this study area an indication of the uniqueness of the ecosystems in this region. Consultation with hereditary chiefs and land managers should occur regarding potential changes in management regimes including spraying of plants to create visitor play areas, consideration of restoring areas including estuary gardens and clam gardens, and resulting education programs for the First Nations and broader community. Restoration of the gardens and other natural vegetation could help stabilize shorelines, increase biodiversity and marine riparian function, and potentially provide an alternative to some of the armouring that is happening.

In those areas where people gather to use the neashore for recreation, a program unique to the area including programs providing ambassadors offering programs and education regarding local ecosystem and local issues, and person-to-person invitations to practice desired behaviour in order to assist with restoration work (e.g. stay off revegetating areas, or, how to practice good skimboarding ethics to protect eelgrass and associated wildlife)

A more detailed review of the marine riparian area would be extremely useful to indicate health of the whole nearshore, and possible management actions and best practices to suggest to property owners.

The issue of Canada Geese was raised under the vegetation section. Canada geese are also a threat to the eelgrass meadows. They rip out the whole plant and can destroy large sections of a bed at a single feeding. The same urgency exists about the impacts on our nearshore vegetation as exists for the inner estuary. There is a need to raise the profile of these issues and create an understanding and support for potential solutions through development and implementation of a public education program. This would include presentations to public, mainstream animal rights groups and other key audiences.

The role of groundwater in the estuary and nearshore areas is an area that has not been well studied. We know that the most complexity in aquifers exists at the estuary. Three layers of aquifer are found there. The amount of groundwater that naturally flows into a healthy estuary has not been quantified. Also in the nearshore area it is not unusual to find trickles of water running down the beach to the sea and this raises the question of function for those trickles some of which would be surface water and some groundwater. Without a target amount needed to keep an estuary and nearshore functioning, this could not be considered properly in a water management plan for the watershed. And so studies need to be done in order to determine the role of groundwater in an estuary and nearshore areas generally and the ER estuary and nearshore specifically.

Also the estuary area has been rated very vulnerable in the water vulnerability mapping project developed by Ministry of Environment, Regional District of Nanaimo and the Vancouver Island University and others. This should signal some real concern over the future of water supplies to the estuary and nearshore. Studies should be done to clarify flow, salinity and DO within the estuary to better understand what levels are required and set baselines in different areas of the estuary.

Associated with water flows in the estuary and nearshore is the research that has been done indicating a fidelity in salmon to specific tidal channels (Birtwell, I., 2009). In studies done in estuaries, juvenile salmon had strong preferences for specific tidal channels even if there was no food in that area. We need to understand more about this dynamic between water, salmon and other nearshore functions if we are to maintain the many ecosystem services the nearshore provides.

This study has shown some of the complexity of the nearshore and this information should be communicated to the public, land managers and politicians. A communications/education program would help increase understanding and support for various management approaches and protection of the nearshore. This would include guided tours of the softshore beach in Parksville and workshops for property owners regarding softshores. It would also include development of tools for local government to use to help protect their shorelines, including case studies and examples of potential bylaws and other policies and regulations to protect their nearshore.

As public understanding and support grow, a regional shoreline planning process would be a strong step towards a wide-ranging healthy nearshore.

Figure 6.11 Map – Parksville-Qualicum Beach Forage Fish, Eelgrass and Modified Shoreline

Legend 6.11 Forage Fish, Eelgrass and Modified Shoreline

Shoreline Photo Page 1

Shoreline Photo Page 2