Preliminary Habitat Assessment for suitability of intertidally spawning forage fish species, Pacific sand lance (*Ammodytes hexapterus*) and surf smelt (*Hypomesus pretiosus)* Esquimalt Lagoon, Colwood , British Columbia

Prepared for: Esquimalt Lagoon Stewardship Initiative
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Preliminary Habitat Assessment for suitability of intertidally spawning forage fish species, Pacific sand lance (*Ammodytes hexapterus*) and surf smelt (*Hypomesus pretiosus),* at Esquimalt Lagoon, Colwood , British Columbia.

Background:
Since November 2008, the BC Shore Spawners Alliance and Emerald Sea Research & Consulting have been working with communities throughout the Capital Regional District to document intertidal forage fish spawning habitat.

At the request of the Esquimalt Lagoon Stewardship Initiative, on December 29, 2009, four locations along the outer shore of Esquimalt Lagoon were sampled for evidence of surf smelt and Pacific sand lance spawning activity.

Students of Camosun College sampled an area near the Gotha Point in December 2001/January 2002 as part of a field program. Their sampling did not produce evidence of the use of the area by surf smelt and Pacific sand lance.

The outer beaches along the entire length of the Esquimalt Lagoon are composed of well-sorted gravels, sand and shell hash rendering them potential surf smelt and sand lance spawning habitat. These barrier beaches are subject to substantial wave force. Logs are distributed along the narrow upper slope and beach berm. The beach berm is impacted by a roadway and riprap. Erosional sediments from the bluffs near Albert Head maintain the beaches and appropriate spawning sediments. There is no intact, shading vegetation due to development of the roadway along the lagoon shoreline.

Beaches surveyed within the inner lagoon, the beaches are composed of mud and silt with the exception of small pockets of gravel/sand beach slopes near the bridge. An extensive eelgrass bed is located within the lagoon.

Sampling Stations

Site 1: Gotha Point Latitude 48.4305 Longitude 123.4568
The sampling station extended below the bridge seaward along the sand spit exposed by the tide. The sediments are largely composed of coarse sand with some fine pebble under the bridge. The length of potential spawning habitat is approximately 100 m. The beach berm and backshore are heavily impacted including riprap and bridge pilings.

Site 2: Latitude 48.4292 Longitude 123.4579
The sampling station extended along the building and parking lot on the northeast section of the beach. The sediments are composed of fine pebble and coarse sand. The length of potential spawning habitat extends southward for more than a kilometre. The beach berm and backshore are completely modified by riprap, buildings, roadway and a parking lot. Logs are present on the upper beach slope and berm.

Site 3: Latitude 48.4137 Longitude 123.4751
The sampling station was located south of the washrooms on Ocean Boulevard. The sediments are composed of fine pebble and coarse sand. The length of the potential spawning habitat extends southward and northward for more than a kilometre. The upper beach berm is intact and the backshore is 50% natural with some shrubs while the rest is modified with riprap and a roadway. Logs are present on the upper beach slope and berm.

Site 4: Latitude 48.4150 Longitude 123.4739
The sampling station was located north of Site 3. The sediments are composed of fine pebble and coarse sand. The length of the potential spawning habitat extends northward for more than a kilometre. The upper berm is intact and the backshore is 100% impacted with riprap and a roadway. Logs are present on the upper beach slope and beach berm.

Results

The beach character (sediments) of the outer lagoon from the bridge to south of Lagoon Road represents excellent spawning attributes for both surf smelt and Pacific sand lance.

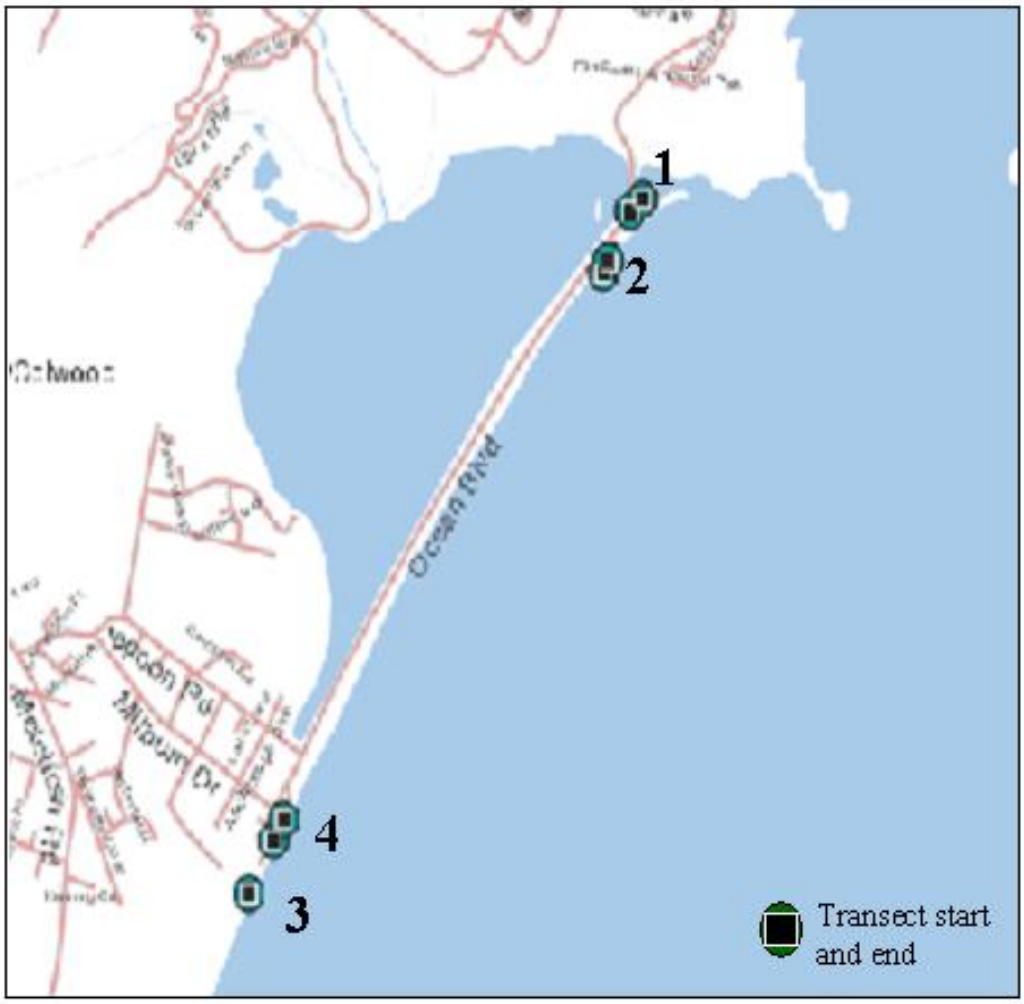
Forage fish eggs were found in sites 1, 2, and 4 (Table 1). Surf smelt spawn was detected in three sites and Pacific sand lance at one site (Figure 1). The survey data are posted on the BC Forage Fish Data Atlas. Unfortunately, photos are not available as the survey took place after sunset.

Both surf smelt and Pacific sand lance eggs were detected in the samples. Precise embryonic developmental results have not been completed, but based on eggs examined and a 30-day winter incubation period for both species, surf smelt spawning likely occurred on November 30, December 17, December 21, December 29, 2009 (Table 1). Pacific sand lance spawning likely occurred on or before November 30, 2009 (Table 1).

Table 1: Results of Sample Processing – Species and Brood States

Sample Location	Sampling Date	Result	Number of Spawning Events (broods)
Site 1	December 29, 2009	1 Surf smelt egg (1.5 coil)	1 brood
Site 2	December 29, 2009	3 sand lance eggs (1hatched; 2 dead)	1 brood
Site 2	December 29, 2009	24 surf smelt eggs	Approximately 4 broods
Site 3	December 29, 2009	No eggs detected	
Site 4	December 29, 2009	1 Surf smelt egg (hatched)	1 brood

Forage Fish Sampling Sites
Esquimalt Lagoon – Ocean Boulevard
December 29, 2009



Map produced from the BC Forage Fish Data Atlas
By: Emerald Sea Research & Consulting
February 21, 2010

Figure 1: Four Spawning Survey Locations

Recommendations

While surf smelt eggs were found in both the north and south sampling sites, sand lance eggs were only found in one northern site at the distal end of the drift cell. Sand lance eggs often co-occur with smelt eggs in sand and fine pebble sediments (Pettily 2000). It is likely that sand lance do spawn in the southern area of the outer beaches of the Esquimalt Lagoon and further sampling in the fall/winter of 2010 will be required.

In British Columbia, critical fish habitat is protected under Section 35 of the Fisheries Act. I would recommend a program be initiated to:

1. Survey the entire foreshore area of the Esquimalt Lagoon to determine the spawning duration and spatial extent of spawning of both surf smelt and Pacific sand lance. Standard intertidal forage fish spawning habitat surveys are conducted for 24 months;
2. Map the drift cell dynamics of the Coburg Peninsula to understand the primary geomorphic processes maintaining this critical fish habitat, especially in light of future development of the Royal Bay foreshore and its role in sediment transport for the Esquimalt Lagoon.

To achieve these objectives, the BC Shore Spawners Alliance and Emerald Sea Research and Consulting are available to train community volunteers, process samples, and design a survey program. Grant funds for forage fish survey kits can be obtained through the Pacific Salmon Foundation.

Forage Fish Backgrounder

Forage fish species such as Pacific herring, Pacific sand lance and surf smelt are the cornerstone of the nearshore marine food web connecting zooplankton to a host of secondary predators. Pacific sand lance (*Ammodytes hexapterus)* and surf smelt (*Hypomesus pretiosus*) are prey to hundreds of species of birds, fish, and marine mammals. In fact, Pacific sand lance may represent a greater trophic biomass than herring (WDFW D Penttila per. comm.). In turn, forage fish predators like salmon, lingcod and rockfish become prey for larger animals, such as pinnipeds and Killer Whales.

Surf smelt and Pacific sand lance use certain intertidal sandy-gravel beaches for spawn deposition/incubation, high on the beach near the log line (Figure 1). Surf smelt are known to spawn year round while Pacific sand lance spawn in Puget Sound from October-February (Penttila 2000). Pacific sand lance and surf smelt eggs are adapted to this harsh, high tide existence. But, this unique spawning behaviour puts them directly in a zone vulnerable to shoreline modifications.

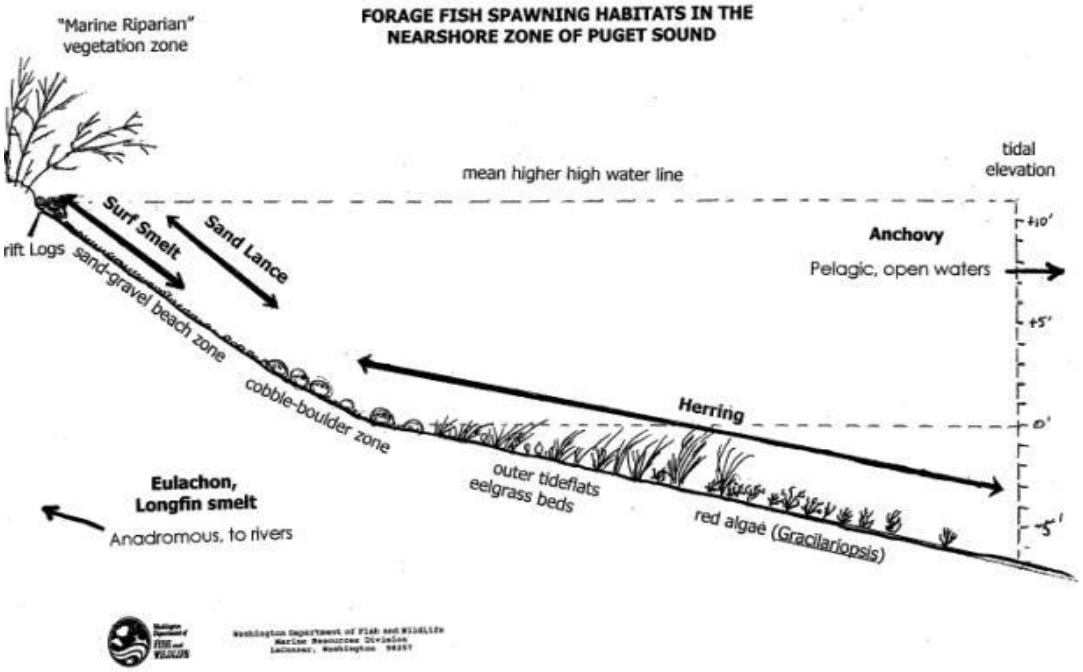


Figure 1: Forage Fish Spawning Habitats in the nearshore zone of Puget Sound (sketch by Mr. D. Penttila, WDFW)

Surf smelt and Pacific sand lance depend on a healthy nearshore and beach habitat, and they are vulnerable to impacts from shoreline development. Beaches with natural erosion processes supplying appropriate sized gravels and extant marine riparian zones are an optimal state for spawning surf smelt and sand lance. Of primary importance for spawning is the mixture of gravels and sand.

Critical forage for marine ecosystem function:
Pacific sand lance and surf smelt are important to the recovery of at least 13 marine species at risk (from Humpback and Killer whales to Marbled Murrelets); the marine survival of salmon (such as Chinook and Coho); and the provincially listed coastal cutthroat trout. Both Chinook and Coho feed on sand lance both as juveniles and as adults (proportion of sand lance in diet: Chinook 10-50% and Coho greater than 50%; Sockeye 10-50%; Pink 10-50%). Trophic energy statistics of sand lance for rockfish and other marine fishes are similar to those as the salmonids. Successfully rebuilding endangered populations and local salmon stocks may rely, in part, to protecting local forage fish stocks.

Numerous fish, seabird, and marine mammal populations are in precipitous decline in British Columbia; and scientists have started to look at the link between forage fish biomass reduction and these declining populations. For some seabirds, (such as puffins, Marbeled Murrelet and Rhinoceros Auklets) more than 80% of their diet is comprised of sand lance. Threatened Pacific Humpback whale populations are also heavily reliant on forage fish prey including herring and Pacific sand lance. The southern resident killer whale, are dependent on Chinook salmon runs as a preferred food source. There are numerous species listed on our Provincial and Federal listings of species of concern that depend on bait or "forage" fishes as prey.

Connections to other valued ecosystem components:
In summary, forage fish depend on nearshore habitat for their survival. Herring spawn on marine vegetation such as eelgrass and seaweeds; and Pacific sand lance and surf smelt spawn high up the beach near the log line. Like numerous fish species, surf smelt and Pacific sand lance also require eelgrass beds and kelp forests for rearing.

Shoreline Development –
Primary threat to surf smelt and sand lance spawning habitat:
Shoreline modifications can negatively impact the nearshore marine food web in numerous ways, but are a primary threat to surf smelt and sand lance spawning beaches (Penttila 2005).

Many human activities impact and alter marine shorelines either through disruption of the sediment drift cell or by physical alteration of the beach, including: piers, pilings, docks, jetties, groins, breakwaters, riprap, seawalls and others. Diversion of sediment-bearing streams through culverts can also starve beaches of spawning sediment. Many of these activities render beaches unusable for spawning. These shoreline modifications can also limit sediment exchange in the shallow subtidal where sand lance are known to burrow.

The presence of overhanging vegetation in marine riparian zones is important for the ecological function of nearshore marine habitats providing insect prey for migrating fish (Levings and Jamieson 2001; Brennan and Culverwell 2004) and having a positive effect on summer surf smelt spawn survival (Penttila 2001). The loss of shading increases thermal stress and desiccation to incubating eggs as sediment temperatures rise resulting in increased mortality of buried eggs (Penttila 2001, Rice 2006). Vegetation buffers the drying effect of winds, and where beaches have lost riparian zones, eggs can also suffer a higher mortality than normal due to wind-induced desiccation effects.

Other threats to surf smelt and sand lance eggs include contamination from acute oil spill events and chronic oiling can result in 100% mortality of surf smelt eggs. Oiling from vessel operations near beaches can potentially cause mortality of incubating forage fish eggs (herring, sand lance, and surf smelt) (Penttila 2005).

BC Wild Salmon Policy and our obligation to protect critical fish habitat:
The BC Wild Salmon Policy lists protection of intertidal forage fish spawning habitats as essential to salmon rehabilitation. Forage fish spawning habitat protection will have positive benefits for marine species by protecting a vital food source for salmon and numerous marine predators. These marine predators also feature significantly for the economic health of recreational and commercial fisheries for BC coastal communities. In Washington State, forage fish spawning beaches are protected not only as a valued ecosystem component but also as critical habitat components for salmon.

In British Columbia, critical fish habitat is protected under Section 35 of the Fisheries Act. Yet, there have been no government programs to document critical intertidal forage fish spawning habitat.

The BC Shore Spawners Alliance and Emerald Sea Research & Consulting
In British Columbia conservation science and stewardship efforts to benefit intertidal forage fish spawning habitats has been minimal. The role of forage fish species in the ecosystem and the need to protect their critical spawning and rearing habitats requires recognition and public attention. The goal of the BC Shore Spawners Alliance is to address these issues through science, education, community stewardship, and habitat restoration. In the fall of 2008, the BCSSA launched the first Province-wide initiative to protect critical spawning habitat for surf smelt, capelin, and Pacific sand lance.

Our mandate is to develop a network of communities and partnerships with agencies to provide necessary data and educational materials on the spawning habitats of surf smelt, capelin and Pacific sand lance for coastal planning and ecosystem management. The BCSSA provides training, sediment processing, educational resources, GIS data entry tool, and expertise to assist communities and shoreline property owners. The BC Shore Spawners Alliance provides access to equipment so that sampling will proceed in keeping with established protocols.

The BC Shore Spawners Alliance is composed of community groups, biologists, First Nations, consultants, scientists, students, stewards, Bamfield Marine Sciences Centre

Public Education Program, and interested individuals from Northern British Columbia to Puget Sound. The majority of interest groups include those involved as Streamkeepers, eelgrass mappers, naturalists, Shorekeepers and Straitkeepers. As well, many individual beach property owners have joined and to survey beaches in their community.

Members of the BCSSA work to share resources and experiences to promote conservation of both marine and fresh-water forage fish habitats. Beach data collected is uploaded to the BC Forage Fish Atlas, a public data atlas developed by Mr. Brad Mason, Fisheries and Oceans Canada, with the BCSSA and housed on the Community Mapping Network. Our forage fish surveys and projects encourage agencies and granting societies to recognize this crucial environmental issue.