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**Coastal ocean dynamics and primary productivity near traditional
Indigenous clam gardens in Fulford Harbour, Salt Spring Island,
British Columbia**

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Coastal Ocean Dynamics and Primary Productivity Near Traditional Indigenous Clam Gardens in Fulford Harbour, Salt Spring Island, British Columbia

Introduction

Ancient clam gardens in Fulford Harbour, Salt Spring Island, British Columbia are the subject of a restoration project by the Gulf Islands National Park Reserve in partnership with Royal Roads University. As part of this partnership, a two-year coastal ocean dynamics field monitoring program parallel to two clam gardens is being conducted seasonally. Students of Royal Roads University have recently conducted research on the mapping of, governance of, and impacts of sea level change on these ancient clam gardens (McIntosh, 2013; Wyatt, 2015; Laidlaw, 2016). This body of work, including this current thesis research, is part of a growing literature to characterize the physical and biological properties of clam gardens, to complement the existing Traditional Ecological Knowledge of these eco-cultural landscapes. This thesis will involve the analysis and interpretation of a time series of water property data collected seasonally near clam gardens on Russell Island and in Fulford Harbour, Salt Spring Island, British Columbia (Figure 1 below).

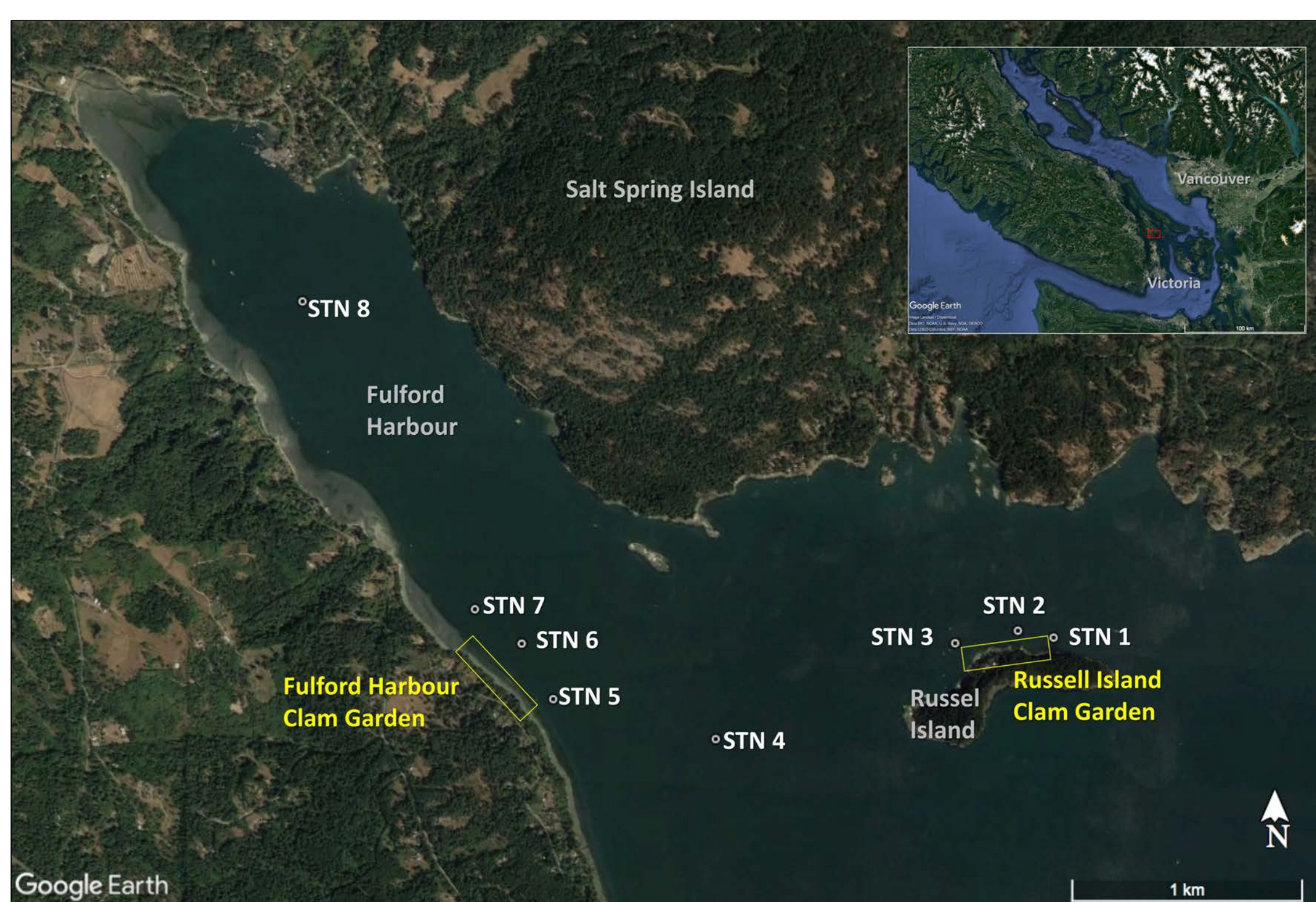


Figure 1: Thesis study area including stations for water property measurements adjacent to the clam garden on Russell Island (STN 1 – 3), at the mouth of Fulford Harbour (STN 4), adjacent to the clam garden in Fulford Harbour (STN 5 – 7), and at the head of Fulford Harbour (STN 8)

Ancient Clam Gardens

Along the Pacific coasts of British Columbia and Alaska, it has recently come back into general knowledge that Indigenous communities traditionally built and maintained clam gardens in the intertidal zone by clearing rocks, aerating sediments, and/or building rock walls in the intertidal zone (Groesbeck et al., 2014; Lepofsky et al., 2015) (Figure 2 below). Biomass (mass of clams per unit volume of sediment) and density (number of clams per unit volume of sediment) in clam gardens has been demonstrated to be higher than similar, unaltered habitats by up to 1.96 and 2.44 times, respectively (Jackley et al., 2016).

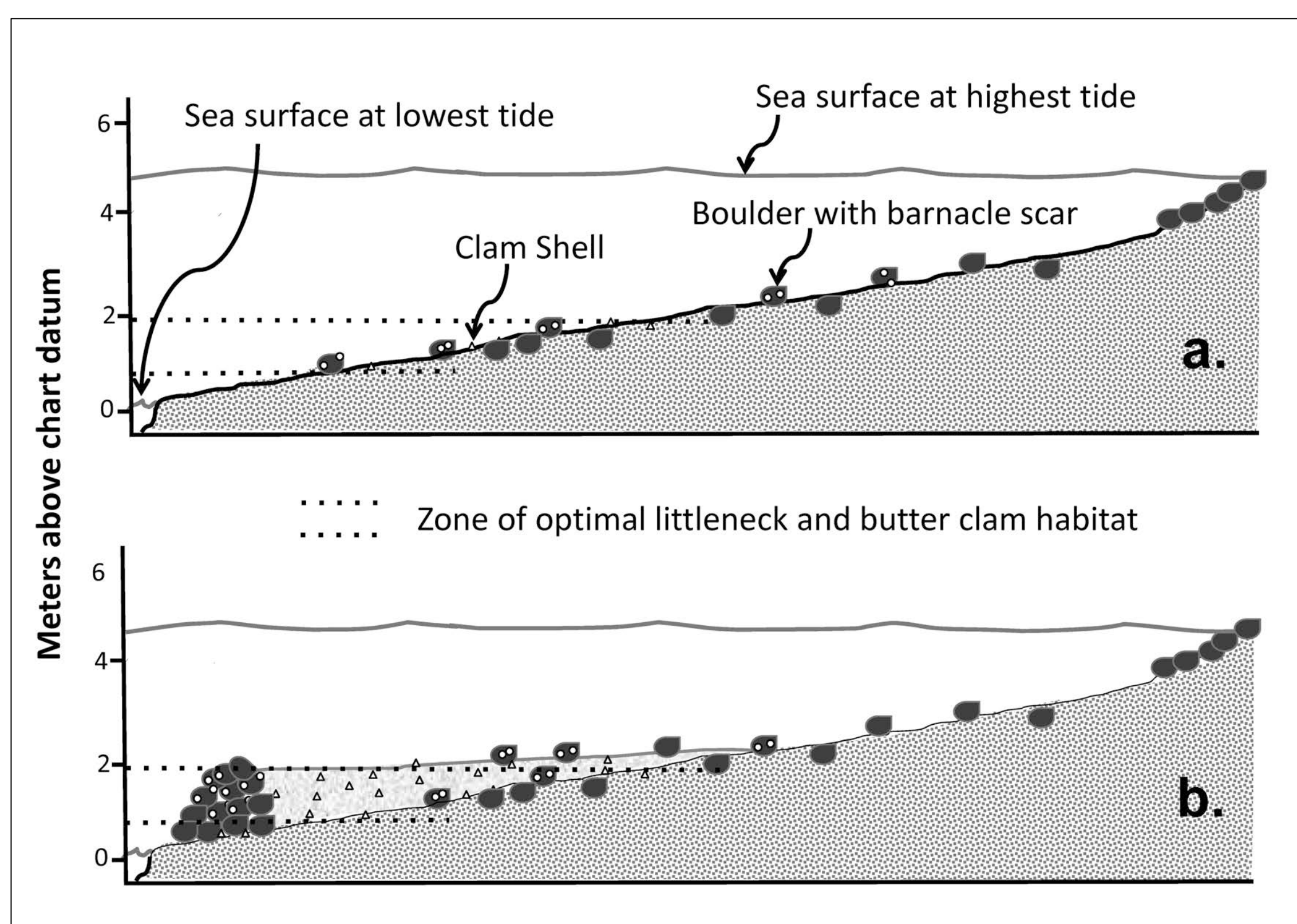


Figure 2: Sequence of clam garden construction: a. naturally sloped, unmodified beach, and b. infilled clam garden terrace (Lepofsky et al., 2015)

Water Properties and Clams

Shellfish species such as clams vary in the environmental requirements for success in completing their varied life histories, with some species tolerating a wide range of conditions and some requiring more specific environmental conditions (Cross and Kingzett, 1992). For this thesis, harvestable clam species (cockles) are of particular interest as they are the target species for clam gardens. Cockles which are found within the GINPR include butter, littleneck, and manila clam (Parks Canada, 2015).

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Figure 3: Royal Roads University's research boat, Raincoast Survey, in Fulford Harbour

Coastal Ocean Dynamics

Fulford Harbour is located in the Gulf Islands archipelago, which is connected to the western side of the Strait of Georgia, an arm of the Pacific Ocean between the Coast Mountains of mainland British Columbia and Vancouver Island, and is connected to the open ocean through the Strait of Juan de Fuca. Including the Puget Sound, the ocean area between the mainland and Vancouver Island, is now known as the Salish Sea. The Strait of Georgia is characterized by certain water temperature and salinity distributions, wind and wave patterns, tides, currents, and water renewal processes (Thomson, 1981). Each of these processes could affect local primary productivity and other environmental variables in areas such as Fulford Harbour.

Research Question

What is the timing and quantity of delivery of coastal ocean primary productivity in waters near traditional Indigenous clam gardens in Fulford Harbour, Salt Spring Island, British Columbia? How do coastal ocean dynamics over two years, interpreted from Seabird 25 water property data, and tidal and weather records, impact this?

Significance

This research would be the first ever study of coastal ocean dynamics at the site of ancient clam gardens, measuring timing and quantity of primary productivity delivered to ancient clam garden sites. This in turn could relate to optimal conditions for clam production as a function of clam garden location, weather patterns, seasonal upwelling, or other factors. Furthermore, this research can contribute to the GINPR clam gardens restoration project by providing further information for Indigenous communities related to their traditional practices.

Methods

The coastal ocean dynamics field monitoring program involves in situ measurement of water properties including:

- Temperature,
- Depth,
- Conductivity,
- Turbidity, and
- Fluorescence (as a proxy for chlorophyll a, and thus an indication of primary productivity).

Measurements are made seasonally using a Seabird25 conductivity-temperature-depth (CTD) probe fitted with some additional sensors and deployed from Royal Roads University's research boat, Raincoast Survey (Figures 3 and 4 below). A smaller, less expensive Sontek Castaway CTD probe is being deployed with the Seabird25 to assess its potential for community-based monitoring.

Water property data will be processed by the Seabird, SeaSave and SBE Data Processing programs, and displayed using the graphic program Surfer. Example plots of preliminary data in the following section were generated in Microsoft Excel.



Figure 4: Seabird25 CTD probe, fitted with additional sensors

Preliminary Results

Water property monitoring has been conducted on six occasions so far:

- September 26, 2016
- November 23, 2016
- June 22, 2017
- July 25, 2017
- October 28, 2017 (data lost due to equipment malfunction)
- March 13, 2018

Preliminary results are presented in Figure 5 below for measurements made at Station 4 (mouth of Fulford Harbour) on September 26, 2016 and March 13, 2018.

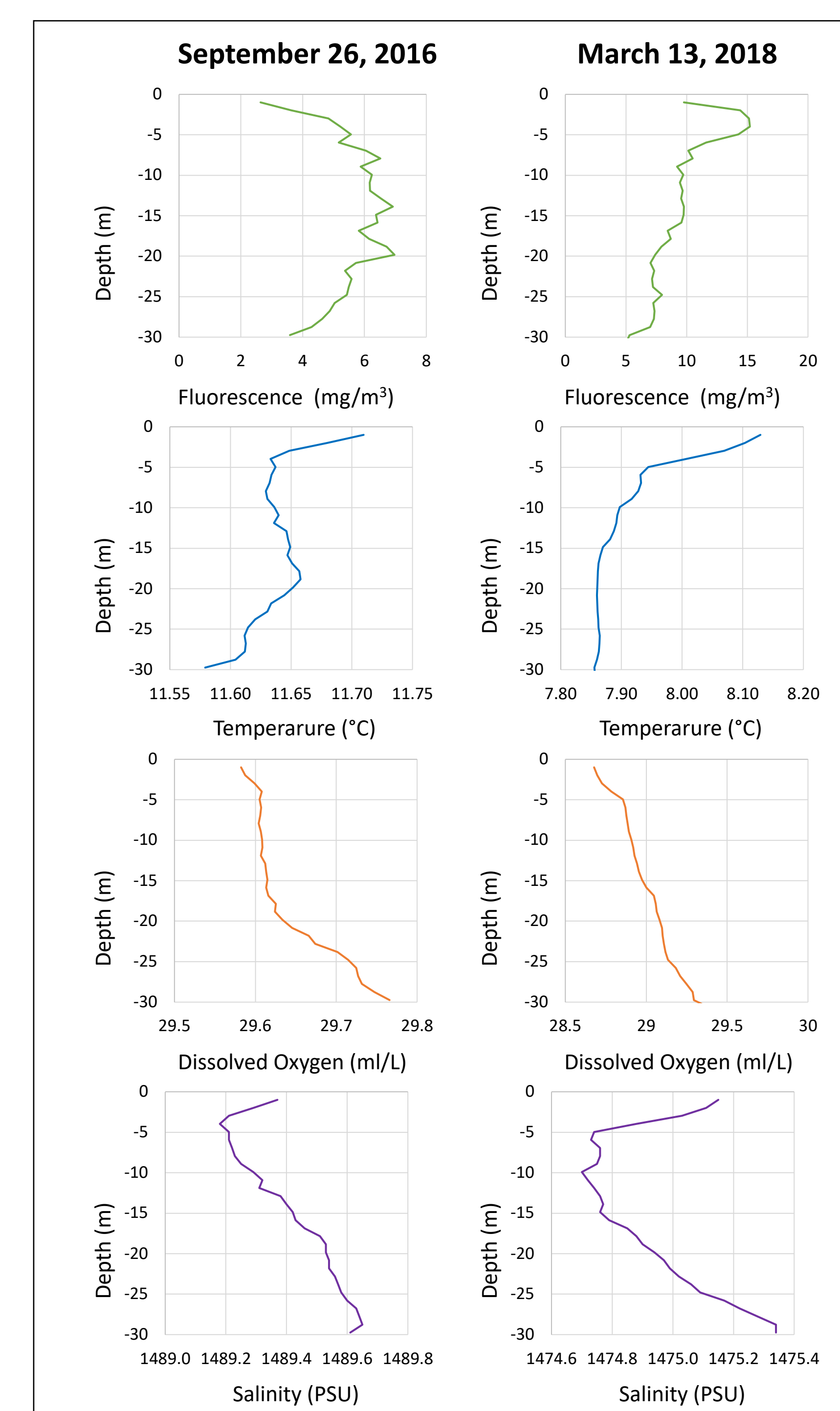


Figure 5: Preliminary fluorescence, temperature, dissolved oxygen, and salinity results measured on September 26, 2016 and March 13, 2018 at Station 4 (mouth of Fulford Harbour)

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