Resilient Estuaries of the Salish Sea

Baseline Assessments and Ground-truthing

Preliminary Year 2 Summary Report
2024-2025

RESILIENT ESTUARIES of the SALISH SEA

SEACHANGE MARINE CONSERVATION SOCIETY

BC Salmon Restoration and Innovation Fund

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Executive Summary

Estuaries are essential aquatic habitats whose resilience is necessary to maintain with the increased impacts of human activities, especially climate change. The initial part of The Resilient Estuaries of the Salish Sea project is focused on studying the small and medium sized estuary ecosystems of the Salish Sea to understand features that lead to resilience and suggest ways in which humans can help maintain that resilience. For this project, we have defined estuaries as: a coastal region with freshwater input at some part of the year where there is sediment deposit (alluvial fan). Resilience was more challenging to define but through resistance, recovery, or adaptation, resilience for a functional estuarine has been correlated with diversity, which can be measured as habitat diversity, biodiversity, genetic diversity or other attributes. The main questions we focused on were: What estuary variables correlate with habitat and species diversity? Do habitat and species-diverse estuaries correlate with observations of resiliency in these local estuaries? Moreover, what ecosystem features differentiate resilient estuaries from non-resilient ones?

The result of our literature search and discussions with experts led us to focus on measuring water quality (pollutants, nutrient loads), physical water features and proxies for mixing (salinity, temperature, oxygen), biodiversity (underwater surveys, plankton ID, and eDNA), and habitat diversity (mapping via tow camera with GPS overlay). We also incorporated historical data, human impacts and shoreline modification, the proximity of estuaries to other features, sea level rise predictions, and personal experience and understanding of local water sites from communities. Traditional Knowledge was not part of this year's work; however, we have worked closely with First Nations conservation and fisheries teams. Our final ranking system is still being developed but will likely focus on a combination of low water contamination from bacteria, moderate nutrient concentrations, and high bio- and habitat-diversity.

In Area 2 (Southeastern Coast of Vancouver Island and Southern Gulf Islands) we identified 5 estuarine systems to add to the Area 1 estuaries we worked in for Year 1: Chemainus River Estuary, Retreat Cove and Montague Harbour on Galiano Island, and Village and Horton Bay on Mayne Island. We conducted field surveys in each of these systems and measured the attributes we identified as being suitable proxies for resilience. Action plans were created for each of these estuaries that identified conservation, restoration and educational activities that could be used to enhance and maintain estuary function and resilience. The final phase of the RESS project (funded through AERF) acted on those recommendations. Those activities are detailed in a separate report.

The Resilient Estuaries Team

Project Manager/Researcher: Dr. Susan Anthony
North Salish Sea Regional Coordinator: Phil Climie
South Salish Sea Regional Coordinator: Isabelle Maurice-Hammond
Outreach Coordinator: Kendra Nelson
Operations Manager: Justin Lisaingo
Dive Team: Jamie Smith (Boat Captain); Justin Bland (Diver); Viki Kolatkova (Diver)
Executive Director: Sarah Cook, R.P.Bio.
Mapping Supervisor: Seanie Malcolm
Mapping Technicians: Thomas Armitage and Elle Schroeder
Mentor: Nikki Wright

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Rob Underhill (Mayne Island Conservation Society)
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1. Introduction

Estuaries are essential aquatic habitats for numerous fish and invertebrate species, including commercially important species such as Pacific salmon. Each Pacific salmon species relies on estuaries for one or more activities, such as shelter, food, and reproduction. Not only do salmon depend on the estuary at the mouth of their natal stream, but they also depend on a series of estuaries (Moore *et al.* 2016) along which they stop to feed and avoid predators. The estuaries that provide these stopover points along the 'salmon highway' are essential but difficult to identify as they may not have large or even small salmon bearing streams associated with them. The importance of the small to medium sized estuaries of the Salish Sea has not been well-studied, which is a significant gap in knowledge in terms of conservation of essential fish habitat for Pacific salmon and many other species. Preserving the connectivity between the natal river mouth of the large and small Pacific salmon populations and the open ocean through estuary restoration and conservation is therefore crucial to protect salmon.

Given the importance of estuaries to ecologically, economically, and culturally important species, as well as to First Nations and settler communities, one goal of Phase 1 to the RESS project is to establish what attributes make an estuary resilient to the effects of climate change. With this knowledge, we can suggest actions that SeaChange, First Nations, or other community partners can implement in the second phase of the project to help small- to medium-sized estuaries maintain resilience and support ecosystem healing. Our methods will be through the lens of reconciliation, acknowledging the role we play in the damage to these ecosystems and the rights of First Nations to lead within their traditional territory. We will receive Traditional Ecological Knowledge (TEK) openly and with reverence when it is offered and allow it to take priority. We also acknowledge that research and primary literature have historically and currently undervalued TEK, and with our work, we wish to share our knowledge and findings with all communities.

The first stage of the Resilient Estuaries of the Salish Sea (RESS) project is focused on collecting baseline data in the small and medium sized estuary ecosystems of the Salish Sea to understand attributes that lead to resilience and suggest ways in which humans can help maintain that resilience. This portion is being funded through the BC Salmon Innovation and Restoration Fund (BCSRIF), which is supported by Fisheries and Oceans Canada (DFO) and the Province of BC. The second stage of the RESS project will be to take action to conserve and restore resilience in those estuaries as well as educate the public about the importance of estuarine systems and the actions they can take in their everyday lives to protect them. That stage is being funded by the Aquatic Ecosystem Restoration Fund (AERF) which is also through DFO. This report outlines the goals of the first stage of the RESS project, Baseline Assessment and Ground-truthing, and the work completed in Year 2 of the project, which focused on the Eastern coast of Vancouver Island and the

Southern Gulf Islands. After looking at historic data and engaging in discussions with local groups, we chose five estuaries in Area 2 to focus on: Chemainus Estuary, Retreat Cove and Montague Harbour on Galiano Island, and Village and Horton Bay on Mayne Island (Figure 1).

We also began conversations with groups interested in other estuaries within Area 2 and Area 3 (Figure 1), which will lead to collecting baseline data and, where welcomed, TEK gathering for the purpose of long-term restoration and conservation planning. The Area 2 estuaries are: Ganges Harbour on Salt Spring Island (with the Salt Spring Island Conservancy and the Penelakut First Nation); Goldstream Estuary (with the Malahat Nation); the Cowichan River Estuary; the Mount Arrowsmith Biosphere Region; and Hornby Island (with the Conservancy Hornby Island and Hornby Island Divers). The Area 3 estuaries are: the K'ómoks/Comox Estuary (with the K'ómoks First Nation and Project Watershed), Cortes Island (with the Friends of Cortes Island and the Klahoose First Nation), Lasqueti Island (with the Lasqueti Island Nature Conservancy); and the Campbell River Estuary (with the Wei Wai Kum First Nation and Greenways Land Trust, among others).

In Year 2, members of the RESS team also joined two transboundary working groups and have begun three other initiatives which are not specific to one estuary or study areas. The groups were the Eelgrass Collective, a transboundary group whose purpose is to knowledge share across the Canada-US border all things eelgrass related; and the "Anchor Out" Project from the Northwest Straits Commission, which works to unify messaging about eelgrass protection (and specifically voluntary no-anchor zones) with boaters. The other initiatives we became involved in were the "South Island Regional Collaborative" which we formed with the Pacific Salmon Foundation with the goal of working to learn how to better take lead from First Nations to achieve more successful outcomes in restoration; the "Indigenous Plant Food Nursery" in collaboration with other estuarine conservations groups which was formed to develop a nursery dedicated to estuarine plants native to the Salish Sea, including edible and medicinal species; and we also began collaborating with the Resilient Urban Systems & Habitat (RUSH) platform (whatstherush.ca), which is an online portal focused on the Saanich Peninsula with the goal of connecting the public with datasets to help them learn about the impacts of climate change and groups doing work that are helping to mitigate those impacts. The RUSH platform will be hosting the Area 1 RESS data with the aim of connecting residents of Victoria and the surrounding area with the data we have collected and connecting them to actions they can take to increase the resilience of their local estuaries.

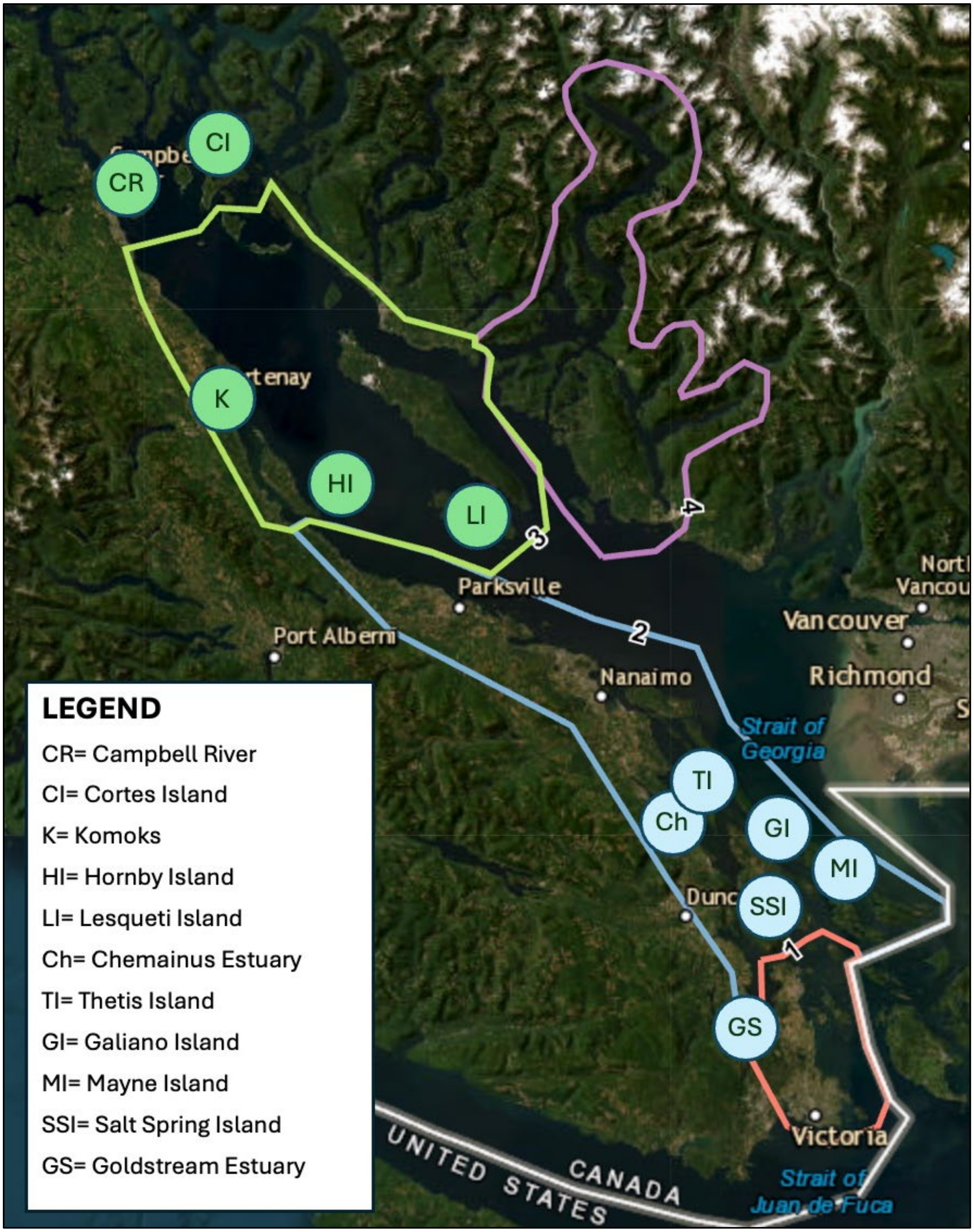

Figure 1. Resilient Estuaries of the Salish Sea study areas. We chose five estuaries to focus on in Area 2 (blue circles labelled Ch, MI, and GI) for Year 2 of the RESS project. We have also begun planning for work in three other Area 2 estuaries (blue circles labelled GS, TI and SSI) and five Area 3 estuaries (green circles labelled CR, CI, K, HI and LI) for Year 3 of the RESS project.

We aim to acquire data using non-invasive sampling methods where possible, with the exception of plankton tows, which destructively sample planktonic organisms. Our divers are trained to observe marine life with little disturbance to the ecosystem, the towed camera is manually operated to prevent dragging along the seafloor, and our eDNA sampler is designed to collect only seawater, with very little phytoplankton and no animals.

Understanding Estuaries and Resilience

Estuaries are where freshwater meets seawater at the coast; they are the interface between land and sea. As straightforward as that seems, the technical definition of an estuary can get blurry: To what extent does an estuary extend from the mouth of the river into the sea? How far inland does an estuary extend *vs* where the river ends? Does the salinity of the region matter? Do the species and habitats in the area matter? What about the substrate composition? These questions are still a question for debate in the coastal mapping community. Every time a definition is put forward, some regions are unacceptably identified as *not* being estuaries. The reality is that there is no "true" definition of an estuary (Elliott and McLusky 2002; Pritchard 1967). Therefore, we began this project by creating the working definition of an estuary we intend to use for the RESS project:

For the Resilient Estuaries of the Salish Sea Project, an estuary is defined as: a coastal region with freshwater input for the majority of the year, and where there is sediment being actively deposited (delta or alluvial fan).

Based on this definition and our focus on small- to medium-sized estuaries, we expect most of our estuaries will be found within bays and inlets. We also expect to see many similar between these estuaries, such as eelgrass beds, evidence of infaunal species, maximum salinity of approximately 31 ppm, and areas with shallower depth profiles.

The next definition needed for this project was: What is coastal resilience and how does it relate to estuaries? This question is more complex. Resilience has become a popular word when we speak of ecosystems. No longer is there debate that climate change will affect every part of our planet and cause shoreline erosion, sea level rise, impacts to harvesting and fisheries, and habitat destruction, amongst other things and we no longer have the ability to completely prevent these effects. However, resilience, if we think of it as the ability to withstand these effects, is our hope for the coastline. Just as individual organisms can be resilient, so can ecosystems. Mechanisms can differ between species, populations, ecosystems, and even within an organism: the ability to resist change, recover from change, or adapt to change (Oliver *et al*. 2015). With these resilience mechanisms, there is always a ripple effect from the genotype to the phenotype, the organism, the population, the species, the community, and the ecosystem. Our research will focus on the overall ecosystem function rather than the individuals within, which will be more challenging to study. Our decision to focus on estuaries local to the Victoria area means we were working on systems more heavily impacted by human disturbance, so we also decided to focus efforts where conservation and restoration already have been implemented, where there is interest, or where we already have support from local First Nations communities. This focus allowed our team to build upon collaborations established by our predecessors and streamline our methodologies. Also, it allowed us to discover the features that may or may not be associated with estuary resilience, which will provide us with a yardstick by which to compare estuaries in future years.

One common definition is that a resilient estuary is one "untouched" by humans (Bates *et al*. 2015); however, being "untouched" does not mean that those estuaries directly *un*affected by human impacts are inherently essential habitats. This is also not a great working definition of resilience as estuaries tend to be highly utilized parts of the coast and with human occupancy ever increasing and the future expansion of marine traffic in the Salish Sea (eg. The Deltaport Expansion, Province of BC) the pressure on even the small and medium sized estuaries of the Salish Sea will only increase. And culturally and economically important species, such as salmon, herring, and surf smelt, do not have the luxury of choosing where they live and which estuaries they utilize.

How does an estuary's ecosystem function relate to its resilience? Whether through resistance, recovery, or adaptation, resilience has been correlated with diversity (the "Portfolio Effect"; Schindler *et al.* 2015). Diversity, such as habitat diversity, biodiversity, genetic diversity, *etc.*, has inherent redundancy. Just as investors have a range of investments where changes in one part of the market are offset by another, regime changes from climate change will be offset by the redundancies in nature. Just as habitat diversity will likely allow an estuary to maintain ecosystem function through changes, this diversity is also essential for salmon survival as smolts (Chalifour *et al.* 2019). What diversity looks like, how it can be measured through non-destructive methods, and what other features can act as proxies for resilience are concepts, we are pursuing in the baseline assessment portion of the RESS project. Our main questions are:

What estuary variables correlate with habitat and species diversity?

Do habitat and species-diverse estuaries correlate with observations of resiliency in these local estuaries?

What ecosystem features differentiate resilient estuaries from non-resilient ones?

We began with a primary literature search for attributes that are potential proxies for resilience in estuarine systems (Gunderson, 2000; Gibbs, 2009; Morecroft et al., 2012; Wainger et al., 2017;). This led us to focus on measuring water quality (pollutants, nutrient loads), physical water features and proxies for mixing (salinity, temperature, oxygen), biodiversity (underwater surveys, plankton ID, and eDNA), and habitat diversity (mapping via tow camera with GPS overlay). We also decided to incorporate historical data, human impacts and shoreline modification, the proximity of estuaries to other features, sea level rise predictions, and personal experience and understanding of local water sites from communities. Traditional Ecological Knowledge (TEK) was not part of this year's work. However, in working with the Nations, we have found that their goals have been shaped by TEK, and therefore we are indirectly taking a lead from that Knowledge although not acquiring it ourselves. The site "Present Conditions Reports" were shared with the interested groups as they were being produced (First Nations and settler conservation groups invested in the region), and feedback was given unofficially during the process. We have shared our methods and data freely, which has led to information sharing and training opportunities.

2. Baseline Estuary Assessments (Area 2)

Background

The RESS project is interested in studying functional estuary ecosystems to understand the features that lead to resilience and suggest ways in which humans can help maintain that resilience. We have identified a number of measures that will help to define resilience in an estuary:

- Salinity and Temperature depth profiles to determine the extent of water exchange in an estuary;
- Dissolved oxygen profiles to identify areas of hypo- or hyper-oxia;
- Turbidity as a proxy for shading or light attenuation;
- Bacterial and nutrient concentration to identify the extent of agricultural and sewage run-off from land (which can lead to eutrophic conditions);
- Pollutant contamination of sediments, seawater, and tissue that can cause human health concerns and effect First Nations' cultural fisheries;
- Zooplankton tows to determine the presence of food for salmon (copepods) and forage fish;
- Biodiversity surveys and eDNA to identify salmon usage or other species of concern;
- Habitat mapping to delineate habitat diversity and suitability;
- Side-scanning for the detection of debris that can damage the seafloor and pollute the water.

This section presents the methods used to collect the data in each estuary and then the general results from that data collection. The data analysis and rankings presented here are considered preliminary for some surveys that were conducted close to the end of the fiscal year (31 March 2025) and for some attributes data is still being analyzed. It also includes data from Area 1 estuaries that were not provided or analysed until after the previous year's report (31 March 2024). A summary of the work completed to date for all attributes is present in Appendices A-F (Individual Estuary Reports). An updated, final report will be produced after those analyses are completed and amalgamated into the ranking system.

Methods

General Site Data

- We make shoreline observations by the most appropriate method, which could include by boat, walking the shore, or aerial images (ShoreZone, orthophoto, satellite). We observe and note information such as: general shoreline characteristics, animals observed, and human use or anthropogenic modifications to the shoreline.
- We often provide a general sketch of the area and take situational awareness photographs.

Abiotic Water Measurements

- Water sampling sites are chosen in a non-randomized way: we create three lines radiating from the mouth of the predominant freshwater input (named "A", "B", and "C"); samples are taken at 250, 500, 750, 1000 m from the mouth. Other samples are taken on a transect line that run perpendicular to transect B (labelled "pB") at 250, 500, or 750 m to the North, South, East, or West. The distances were decided from pilot site visits and to keep the estuaries' site data consistent for comparison among locations.
- Additional sites could be added to encompass different habitats in the estuary as delineated by the habitat mapping. The additional sites are decided based upon analysis type (i.e. closer to marinas and "liveaboard" boats for bacterial tests, along the shoreline for sediment analyses, and closer to the mouths of the rivers and creeks).
- The exact site coordinates are recorded in the ArcGIS app and transferred to the Navionics's app aboard the ship's iPad.
- Water quality measurements taken using a YSI probe were Salinity (parts per thousand: ppt), Temperature (degrees Celsius: °C), and Dissolved Oxygen (milligrams of dissolved oxygen per Litre of seawater: mg/L). At each site, we took readings at the surface (0 m depth), and every metre to -9 m depth (or at the Bottom, if the water is shallower than -9 m). At some sites that were samples early in the program, we had a shorter cable on the YSI and only had measurements to -3m or -4 m.
- Turbidity (metres: m) was determined by Secchi Disk on the sunny side of the boat: the Secchi depth is the depth at which the disk is no longer visible. At some shallower sites, the turbidity was measured by collecting the seawater and measuring its clarity by colorimeter (in Formazine Attenuation Units, FAU).

Zooplankton Tows

- We use a 1,000 mm zooplankton net with a 1,000 mm cod end and drag it just below the water surface (unless otherwise indicated) for 50 m at 0.5 knots.
- We remove any visible fish or shrimp from the cod end by hand understanding that it may result in lost plankton samples.
- We store the samples in plastic 500 mL bottles and add 5 mL Formalin (with 40% formaldehyde) making it ~0.4% formaldehyde.
- The zooplankton samples are processed by Biologica Inc. with everything identified to the lowest taxonomic level possible and counted.

Biodiversity surveys

- Divers run a 50 m transect towards the mouth of the freshwater input with the start and end marked with buoys.
- Four 25 cm^2 quadrats are placed at a random distance within 10m to either side of the transect along a line perpendicular to the transect line.
- Divers identify (or photograph for future identification) and count or estimate percent cover for all the species and substrate composition within the quadrat.
- Biodiversity analyses are done in the software program R.

Side Scanning for Debris

- We conduct sidescan surveys by boat and follow a route through the estuary in parallel lines spaced 25 m apart at a speed of 2 knots.
- When an object is detected on the side-scanner the location is marked in the Navionics computer program and notes are made about its general size and shape on datasheets, relating the location to the notes by marker number.
- This gives a map of the location of the debris for future cleanup.

Water Sampling (Nutrients and Contamination)

- We sample seawater at the surface with a sterile bottle, or a clean Nalgene bottle which has been rinsed three times with seawater at the sampling site. We also sample seawater at depth with a 1.7 L Niskin Bottle.
- For Bacterial sampling we use sterile bottles pre-loaded with Sodium Thiosulfate (a preservative). The water samples are kept in a cooler at <10 °C and transported to the testing lab within 24 h of collection.
    - These samples are tested for number of colony forming units (CFUs) per 100mL of *Enterococcus* spp. and/or fecal coliforms.
- For Nutrients (Nitrate, Nitrite, Orthophosphate, and Phosphate) and Pollutants (Heavy metals, Polycycle Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), Pesticides, Dioxins/Furans) we collect samples in sterile bottles that are stored in a cooler at <10 °C until they are transported to the testing lab within 24 h of

collection. We also sometimes conduct Nitrate and Phosphate low-range analyses in-house using a Lamotte Smart3 BLE Colorimetre.

Sediment Sampling and Analyses

- If we are sampling sediment on the shore or the intertidal, we collect sediment into sterile jars provided by the testing lab using a spoon, trowel, or washed hand), with as much water removed as possible. The jars are transported to the testing lab in a cooler and are analyzed for heavy metals, pH, grain size, or other contaminants.
- If a sediment core is needed from a subtidal area, the divers hammer in a 1m tall, 4 inch wide, PVC sediment corer as far as possible, cap the bottom, and bring the core to the surface held upright to settle the sediment. Divers can also collect min-cores of sediment with modified 500cc syringes.
- The cores are processed using an extruder, with 1 or 5 cm thick slices stored in plastic bags. The sediment slices are frozen and shipped to a radiocarbon lab at the University of British Columbia and further onto the Flett Research Lab for carbon accumulation rate analysis by Pb-210 and Ra-226.
- The cores are kept cool and transported to a lab to be tested for a range of contaminants including Heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs), Polychloroniated Biphenyls (PCBs), Pesticides, and Dioxins/Furans as well as Grain size.

Tissue Sampling and Analyses

- Animal tissue is collected and frozen in sterile containers supplied by the testing lab and are transported in a cooler to the lab within 24 hours. The tissue can be collected from a range of organisms including oysters, mussels and crabs.
- The tissue samples can be tested for a range of contaminants, such as Heavy metals, Polycycle Aromatic Hydrocarbons (PAHs), Polychloroniated Biphenyls (PCBs), Pesticides, and Dioxins/Furans.

Habitat Mapping

- For habitat mapping we use an underwater camera system with an integrated GPS (SeaViewer system) that is towed along a grid with lines spaced 50 m apart. There may be deviations on the route due to obstacles such as rocks and boats. The video is recorded on a hard drive with the date, time and position burned onto the file.
- The video is classified after collection with general habitat characteristics (such as presence/absence of eelgrass or other algae as well as sediment type) are entered into a spreadsheet and converted into GIS layers.
- The initial outcome is lines of point data throughout the estuary which is then turned into polygons.
- Is it sometimes desirable to do more detailed mapping of Eelgrass habitat in an estuary. We follow similar methods as above, but use transects parallel to the shore

spaced 20m apart with the mapper on the boat making notes regarding the location of the edge of the eelgrass bed on a datasheet or directly into an ArcGIS mapping app.

Environmental DNA (eDNA)

- We collect eDNA with Ocean Diagnostic Inc's (ODI) Ascension Deployment Apparatus and we follow the protocols outlined in their instructions. Briefly, we suspend the Ascension sampler from the sampling vessel and collect up to 2L of sample water, filtering it *in situ* through a 0.45-micron MCE filter.
- We collect six samples and one blank "Control" per location; the sampling depth and amount of seawater we filter differs between sites to cover the variety of mesohabitats found within the estuary and in response to the turbidity of the water (higher turbidity, the more difficult it is to filter the water, leading to lower volume).
- The filters are removed from their casings on shore in a somewhat sterile environment such as a countertop sterilized with ELIMINase and/or diluted bleach solution, with the sampler wearing proper PPE. We then preserve the filters in 10mL Eppendorf tubes pre-filled with Longmire's Solution (a preservative), supplied by the eDNA analysis lab or we remove the filter paper in a sterile environment and put each in a small coin envelope, and two or three envelopes into a Ziploc bag with Silica two to three tablespoons of Silica drying beads.

Results

Environmental DNA (eDNA) (Year 1 Samples)

The Year 1 eDNA sampling results are being presented in the Year 2 reports as the data were not made available by the eDNA lab until after that report had been finalized. Please note that species found in only a few samples per estuary may be a sampling error or could be the result of sampling at different locations within the estuary, rather than replicates at each site within the estuary. The sampling in all estuaries was conducted in early April 2024.

Sixteen (16) taxa were identified from the one sample that ended up being viable from Cadboro Bay (Figure 2), therefore the presence of these species is not conclusive. Most of the species identified were benthic invertebrates or taxa associated with planktonic communities. The harpacticoid copepod *Amonardia perturbata* was the main species of interest as they are an important food source for juvenile salmonids.

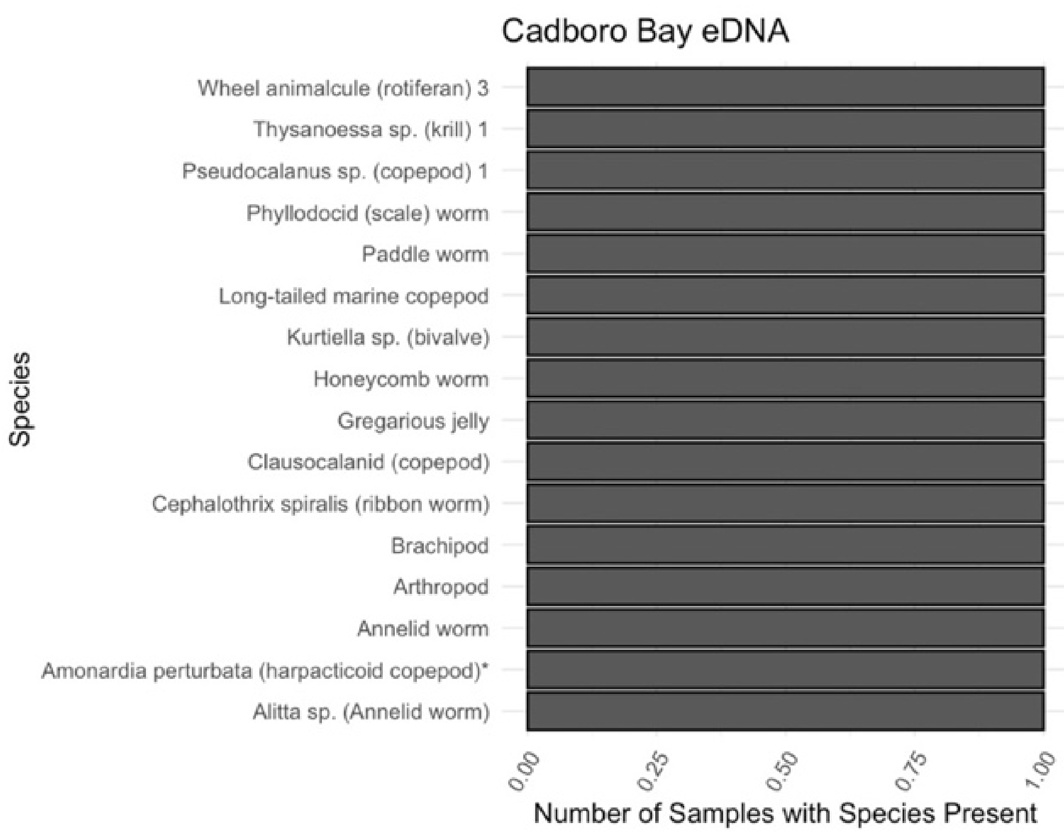

Figure 2. The taxa identified in the eDNA sampling conducted in Cadboro Bay. Only one sample was viable from this location.

81 taxa were identified across 5 viable samples (Figure 3) taken in Oak Bay. One taxon (the Perciform or perch-like fish) was only detected in one sample and therefore cannot be considered to be conclusively present. Most taxa were again associated with the benthic invertebrate or planktonic communities. A few fish taxa, including sculpins, gunnels and ratfish, were identified in two samples as were Harbour Seals (*Phoca vitulina*) and Bufflehead Ducks (*Bucephala albeola*). There were 38 taxa found in three or more samples and therefore have more certainty associated with them. This includes harpacticoid copepods which are important food for juvenile salmonids, Pacific Herring (*Clupea pallasii)* which are important members of the forage fish community, and Northern Pacific Krill (*Euphausia pacifica*) which is a critical link in the oceanic food chain as it is a food source for forage fish and was noted in all 6 estuaries samples in Year 1. One introduced species, the Eastern Soft-Shell Clam (*Mya arenaria*), was also identified and is known be on multiple beaches in the area.

There were 124 taxa identified across 6 viable samples (Figure 4) taken in Roberts Bay and all were in at least two samples which was the highest diversity noted at any of the estuary sites sampled in Year 1 of the RESS project. Seventy-three (73) species were identified in at least three samples. This was the only estuary were Chum Salmon (*Oncorhynchus keta*) was noted, as were Pacific Herring, and other fish groups such as flatfish, smelt, and perch. Manila Clam (*Ruditapes philippinarum*) and Eastern Soft-Shell Clam, which are both introduced species, were also noted. Interestingly, Pacific Geoduck (*Panopea generosa*), which is a commercially important species in BC, was also noted.

There were 85 taxa identified across 7 viable samples (Figure 5) taken in Saanichton Bay, and all were noted in at least two samples. There were 48 species identified in at least three of the samples. Two species of forage fish, Pacific Sand Lance (*Ammodytes hexapterus*) and Pacific Herring, were noted along with their food source, krill. Other fish groups noted included stargazers, which were only noted at this one site, sanddabs, perch, sculpins, and other herring/anchovy. Red Rock Crab (*Cancer productus*) were also noted as were the introduced Manilla and Eastern Soft-shell clams.

There were 75 taxa identified across 7 viable samples (Figure 6) taken in Tod Inlet, and all were noted in at least two samples. There were 45 species identified in at least three of the samples. Pacific Herring and krill were noted although few other fish taxa were identified at this site.

Environmental DNA sampling was completed in Year 2; however, the results were not available in time to be included in this report so will be reported on in the Year 3 report.

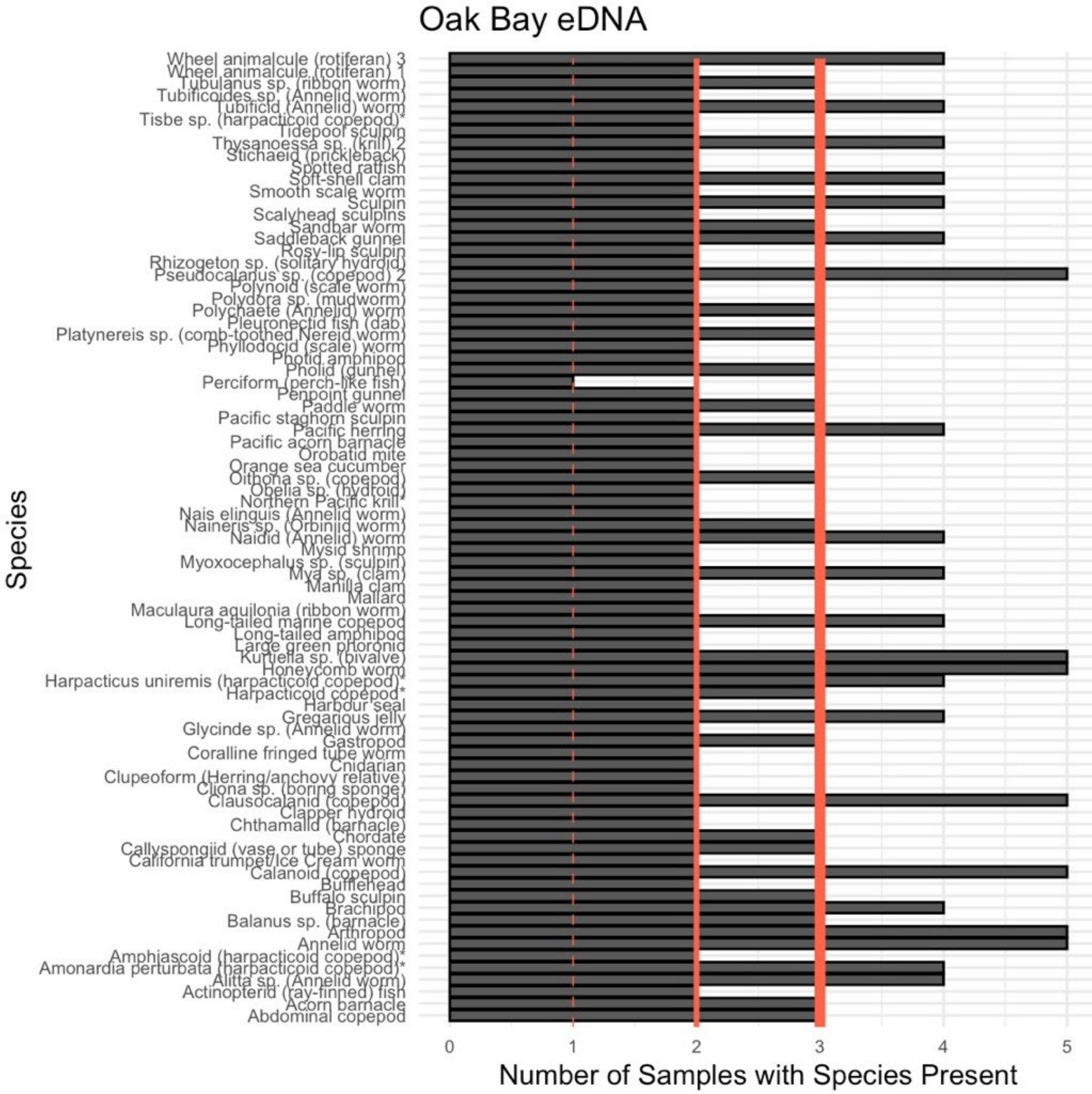

Figure 3. The taxa identified in the eDNA sampling collected in Oak Bay and the number of samples each was identified in.

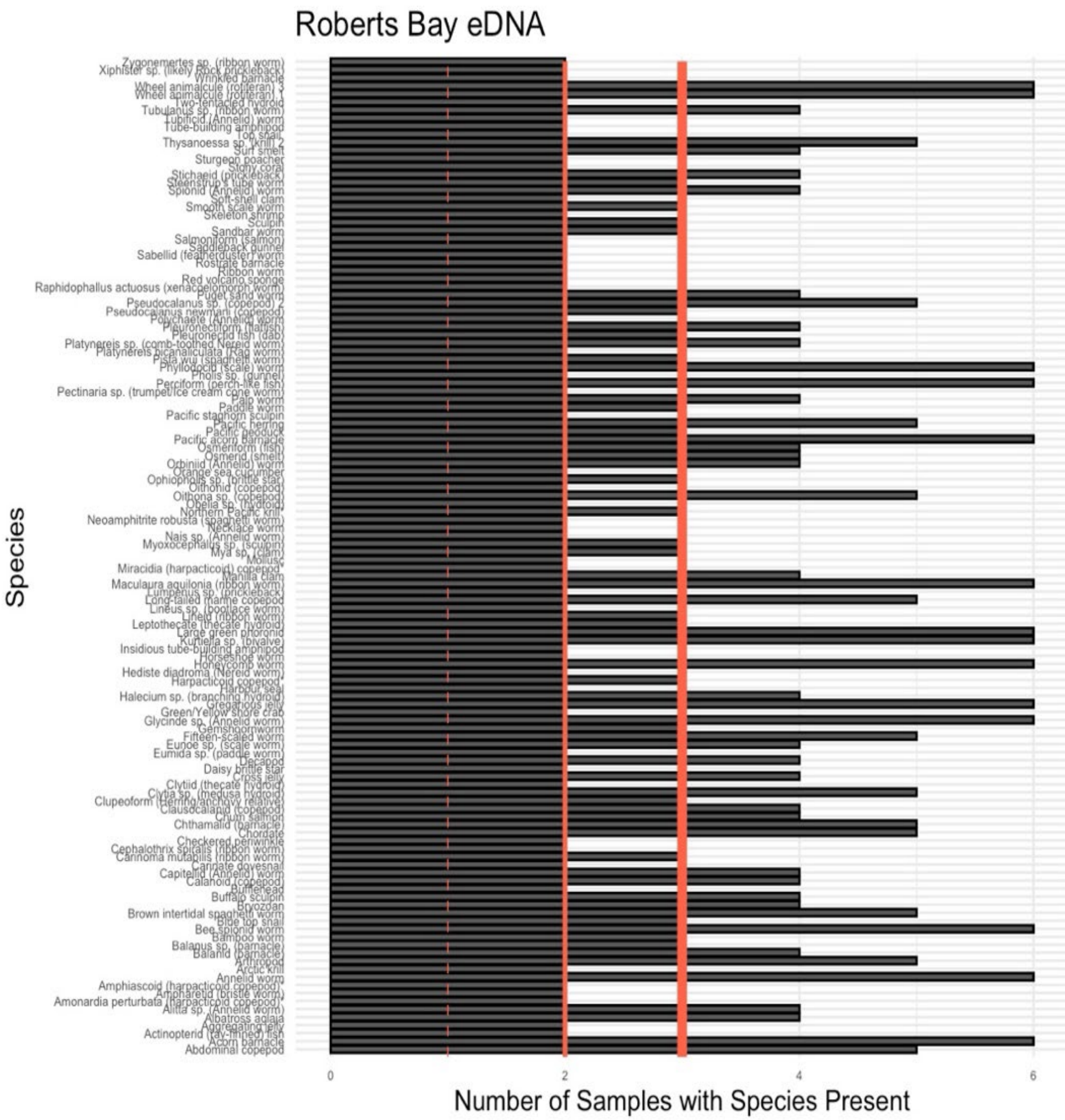

Figure 4. The taxa identified in the eDNA sampling collected in Roberts Bay and the number of samples each was identified in.

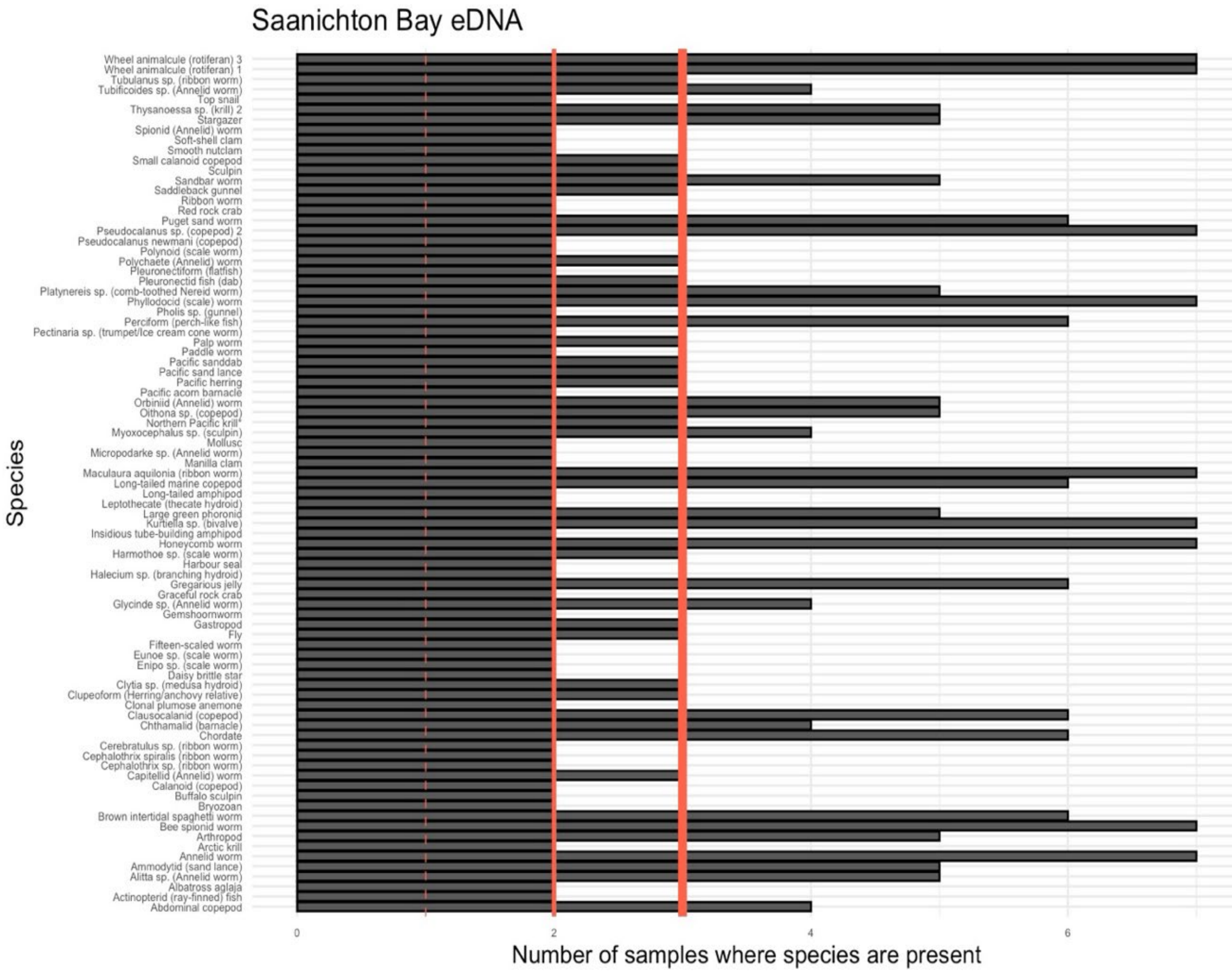

Figure 5. The taxa identified in the eDNA sampling collected in Saanichton Bay and the number of samples each was identified in.

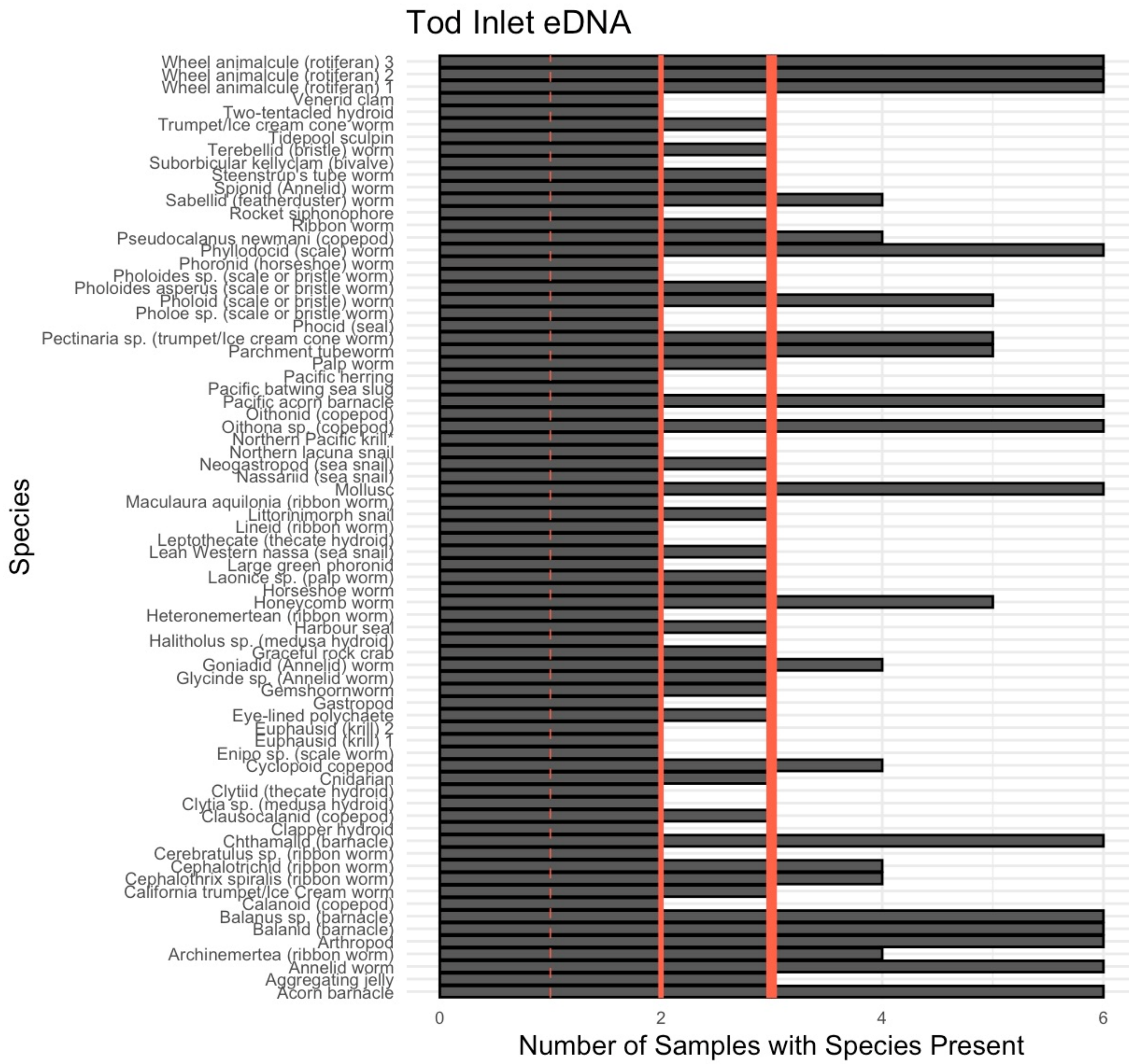

Figure 6. The taxa identified in the eDNA sampling collected in Tod Inlet and the number of samples each was identified in.

Biodiversity Surveys

Underwater biodiversity surveys were conducted by divers in the Chemainus River Estuary, in Horton Bay and Village Bay on Mayne Island (Figures 7 to 9). The species observed in the highest numbers were Littorinid snails (likely *L. saxatilis*) in Village Bay, bubble snails (*Haminoea vesicula* or *Haminoea* sp.) in Chemainus, and bay/coonstripe shrimp (*Pandalus danae*) in Horton Bay. These species are all known to occur in high densities and their numbers were estimated by the divers. Bubble snails were found on eelgrass shoots, while the snails were attached to eelgrass as well as algae.

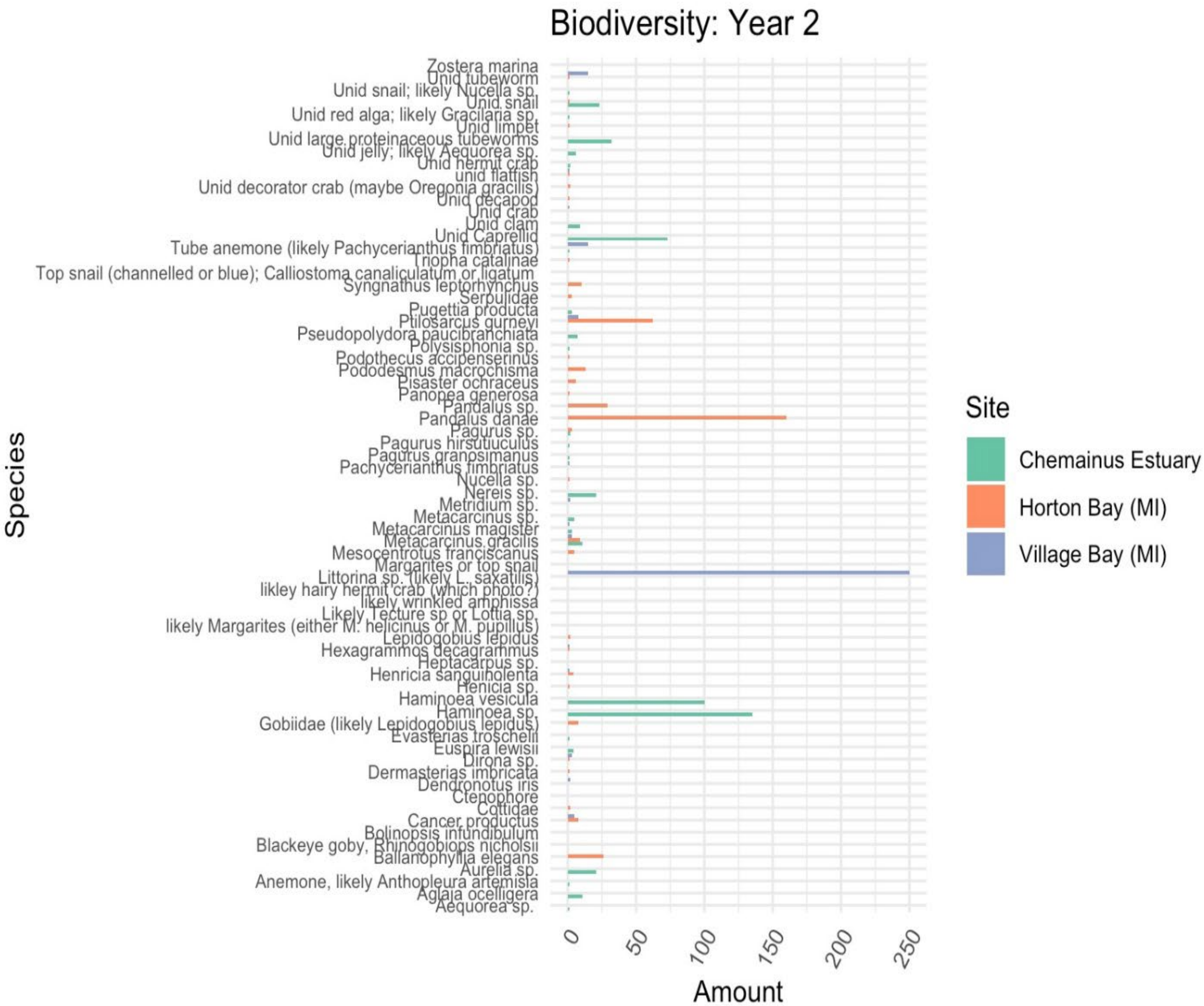

Figure 7. Species identified during underwater biodiversity surveys in Chemainus Estuary, Horton Bay, and Village Bay. Counts (Amount) are the sum of all individuals found in the quadrats and transects, but excludes species quantified as percent cover (see Figure 9 below for percent cover).

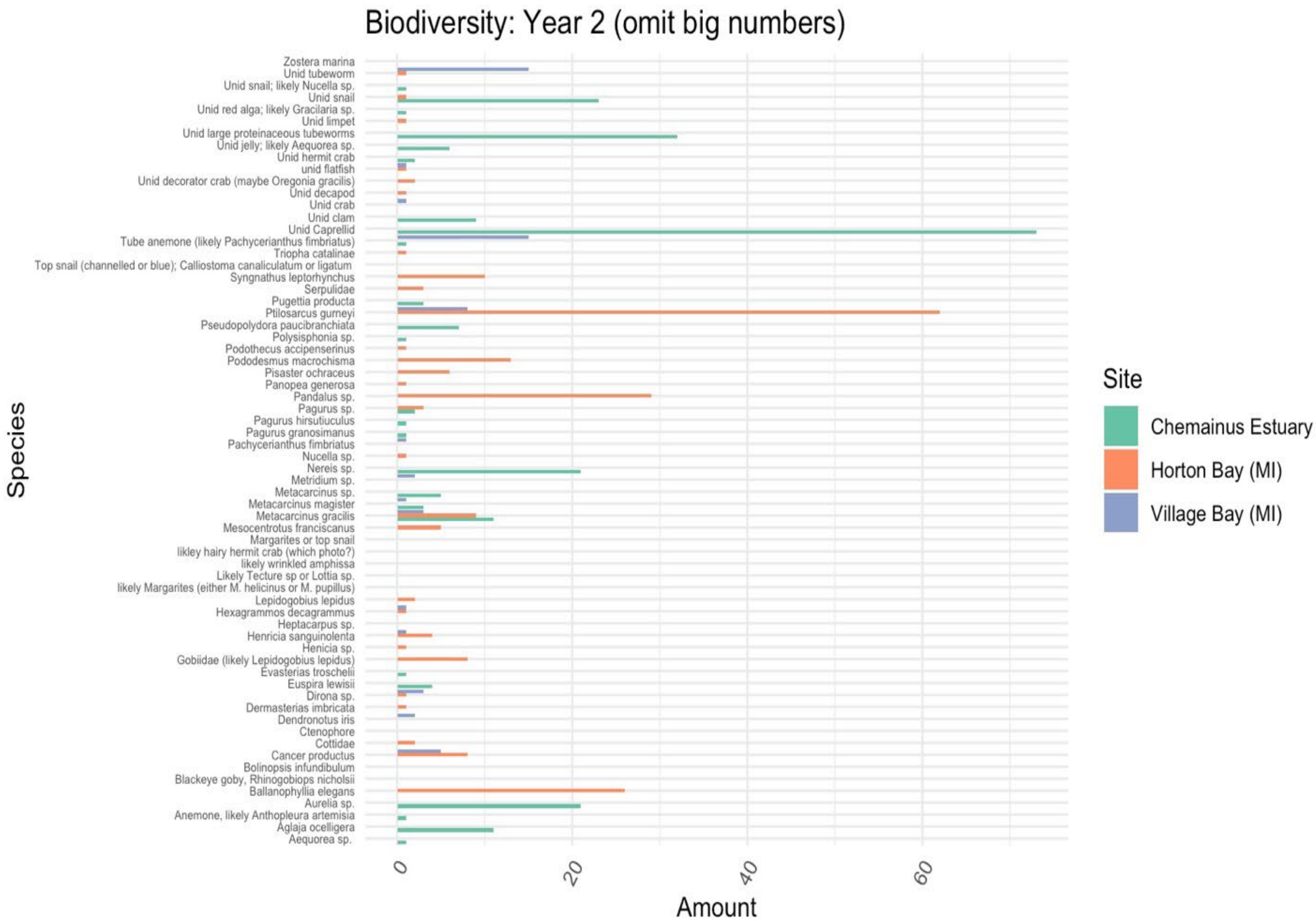

Figure 8. Counts of species identified during underwater biodiversity surveys in Chemainus Estuary, Horton Bay, and Village Bay after removing the three species that were most abundant (Littorinid snails, bubble snails, and bay/coonstripe shrimp). The number of individuals for species with >15 individuals is an estimated value.

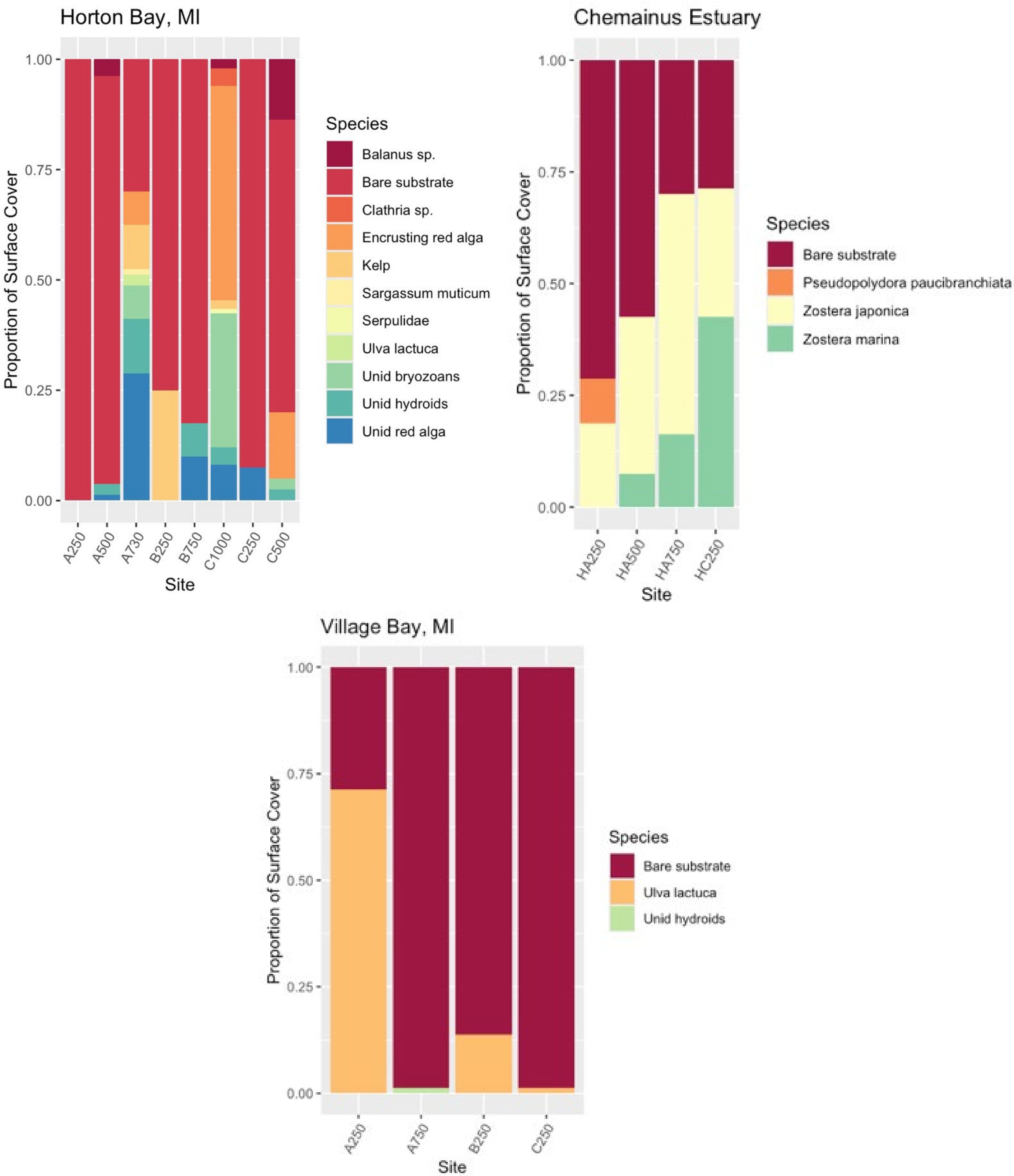

Figure 9. The proportional value of different seafloor covers at each estuary and site within the estuary.

The largest proportion any substrate or attached biota in most quadrats was bare substrate (in red). Eelgrass (*Zostera marina* and *Z. japonica*) were present only in the surveys in the Chemainus Estuary. Those sites were chosen to capture the eelgrass in order to provide information for the Halalt First Nation. Cover of Sea Lettuce (*Ulva Lactuca*) was high in Village Bay (site A250) and there was little in the way of other biota. Dense Ulva has become a concern according to the Mayne Island Conservancy, and we are continuing our Ulva monitoring with seawater nutrient testing and drone imagery in the intertidal. Horton Bay had more taxa associated with hard or rocky substrate which is different from the other estuaries.

Water Sampling Results

This section presents a summary of the preliminary results of the baseline water sampling surveys from the Area 2 estuaries of the RESS project.

Salinity, Temperature, and Dissolved Oxygen Depth Profiles

In estuaries, freshwater and saltwater mix, and the extent of mixing may help determine the health of the ecosystem. Exchange of water with the open ocean helps in the removal of waste products, oxygenation of the water, and the supply of food and nutrients to immobile organisms. Depth profiles can approximate how water moves within the estuaries and the extent of mixing. Salinity, temperature, and dissolved oxygen values in estuaries vary depending on several factors, such as the volume and velocity of freshwater input, how the input of freshwater mixes and exchanges with the open ocean, number of photosynthetic organisms, time of year, and stagnation.

Salinity measurements taken in Late Fall/Winter across the Year 2 study sites show a range of 28 to 30 ppt at depth, while surface salinity varies more widely, from 24 to 39.5 ppt (Figure 10). Chemainus (sampled in February) shows the most pronounced stratification, with a steep salinity gradient from surface to depth, indicating a strong freshwater layer overlying more saline water. Retreat Cove (sampled in January), due to its shallowness, lacks deeper data for comparison, but still exhibits slightly more surface salinity variation than other sites—though this variability remains minor. In contrast, Village Bay, Horton Bay (both samples in December), and Montague Harbour (sampled in January) display relatively uniform salinity profiles from surface to depth, suggesting more consistent vertical mixing or less surface freshwater input at the time of sampling.

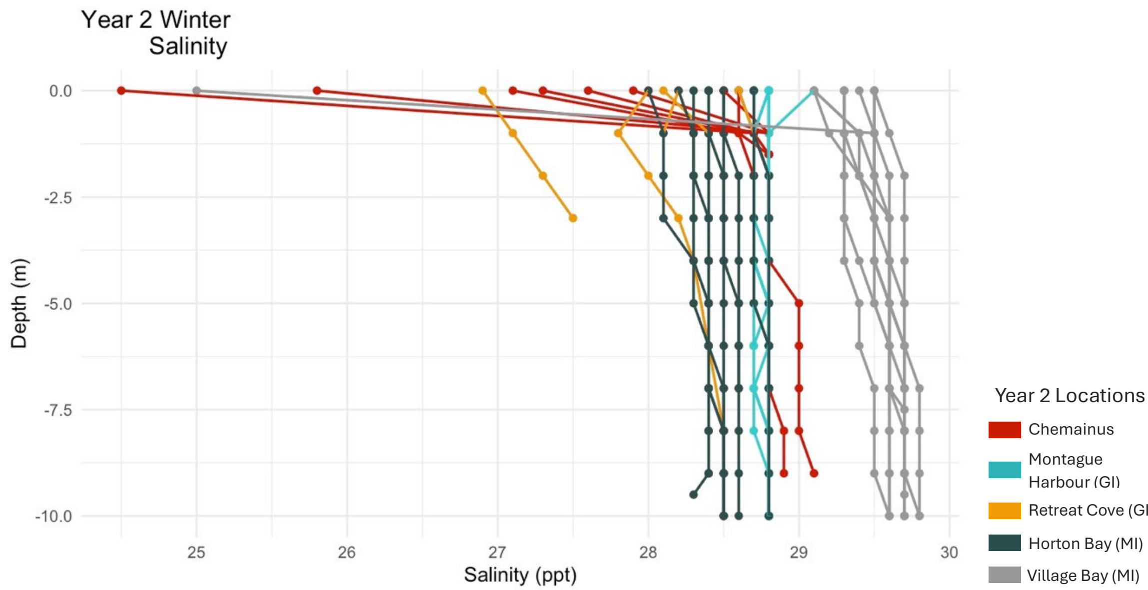

Figure 10. Salinity profiles taken in Late Fall/Winter in Chemainus (red), Montague Harbour (blue), Retreat Cove (orange), Horton Bay (black), and Village Bay (grey).

Temperature data was taken during the Late Fall/Winter sampling, and those profiles (Figure 11) show that Chemainus had the lowest overall temperatures among the surveyed sites, followed by Montague Harbour. Horton Bay and Village Bay recorded the highest temperatures, around 9 °C. Retreat Cove exhibited the widest temperature range across the profile, though the total difference remained small at approximately 2 °C. Across all sites, there was little to no vertical temperature stratification, with surface and bottom temperatures closely aligned, suggesting well-mixed conditions during the winter sampling period.

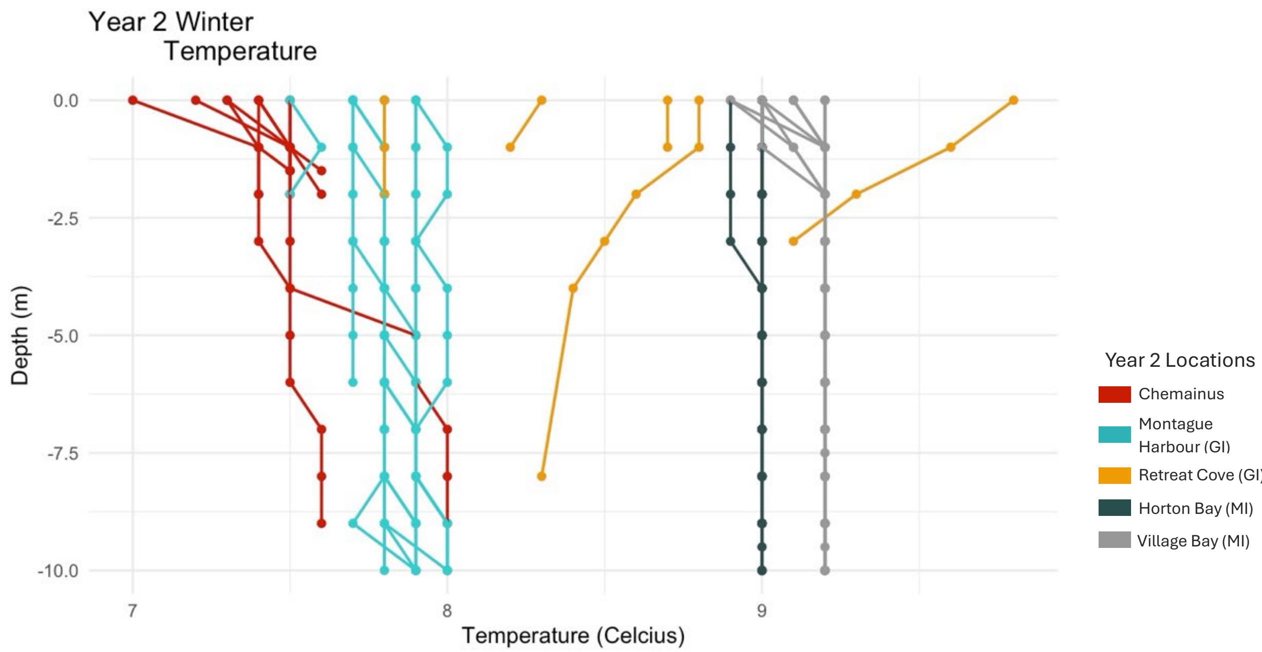

Figure 11. Temperature profiles taken in Late Fall/Winter in Chemainus (red), Montague Harbour (blue), Retreat Cove (orange), Horton Bay (black), and Village Bay (grey).

Dissolved oxygen (DO) levels varied among the estuaries, with Village Bay exhibiting the lowest overall concentrations (Figure 12). Horton Bay had similar DO levels but remained on the lower end compared to the other sites. Chemainus, Montague Harbour, and Retreat Cove showed greater variability in DO within each estuary, with ranges of approximately 2 mg/L, 2 mg/L, and 2.5 mg/L, respectively. In contrast, Village Bay and Horton Bay displayed much lower variability, with differences of only about 0.5 mg/L, indicating more stable oxygen conditions at those sites.

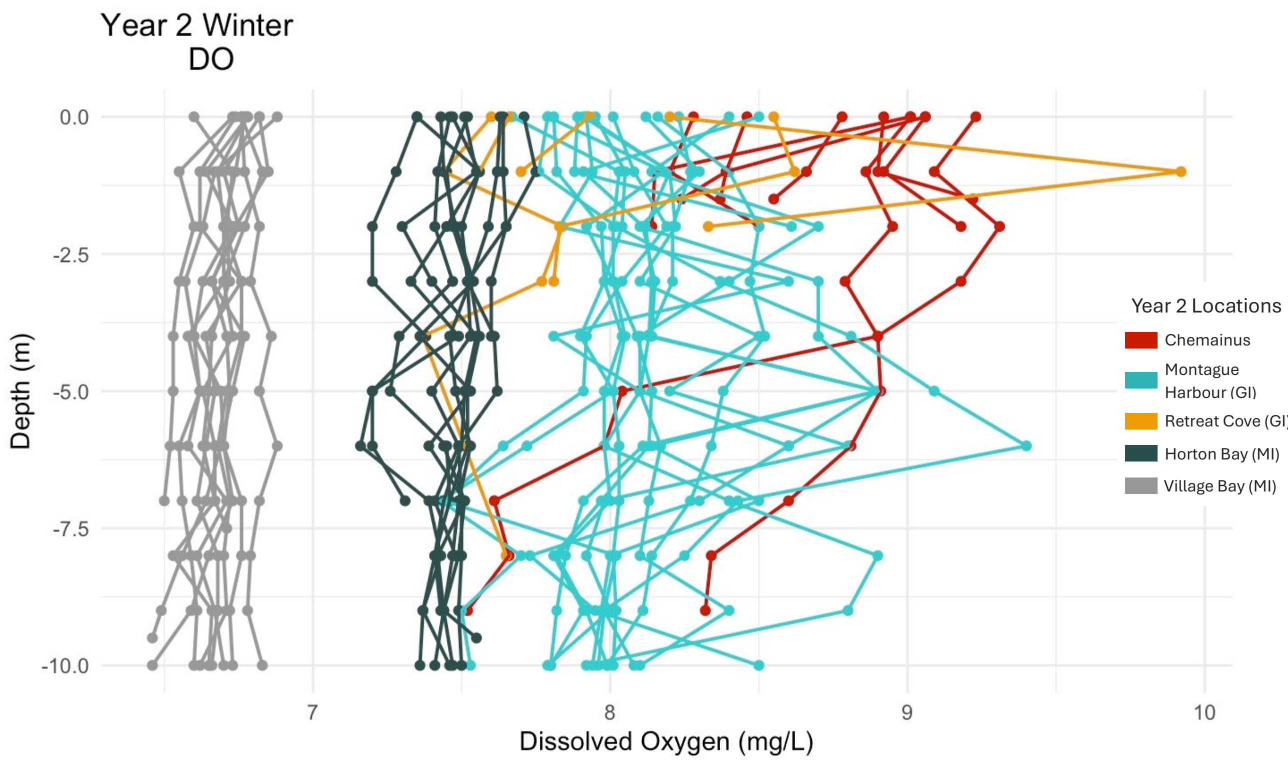

Figure 12. Dissolved Oxygen profiles taken in Late Fall/Winter in Chemainus (red), Montague Harbour (blue), Retreat Cove (orange), Horton Bay (black), and Village Bay (grey).

Turbidity, Nutrient, and Bacterial Concentrations

Turbidity levels (Figure 13) were relatively consistent across all sites and estuaries, showing little variation between areas closer to or farther from freshwater inputs. This uniformity suggests that factors influencing turbidity—such as suspended sediment or plankton—may be evenly distributed or that mixing is sufficient to prevent localized accumulation. During the winter, turbidity is likely influenced more by higher sediment runoff, while summer conditions may involve reduced sediment input but potentially higher plankton activity due to seasonal blooms, although no significant turbidity increase was observed.

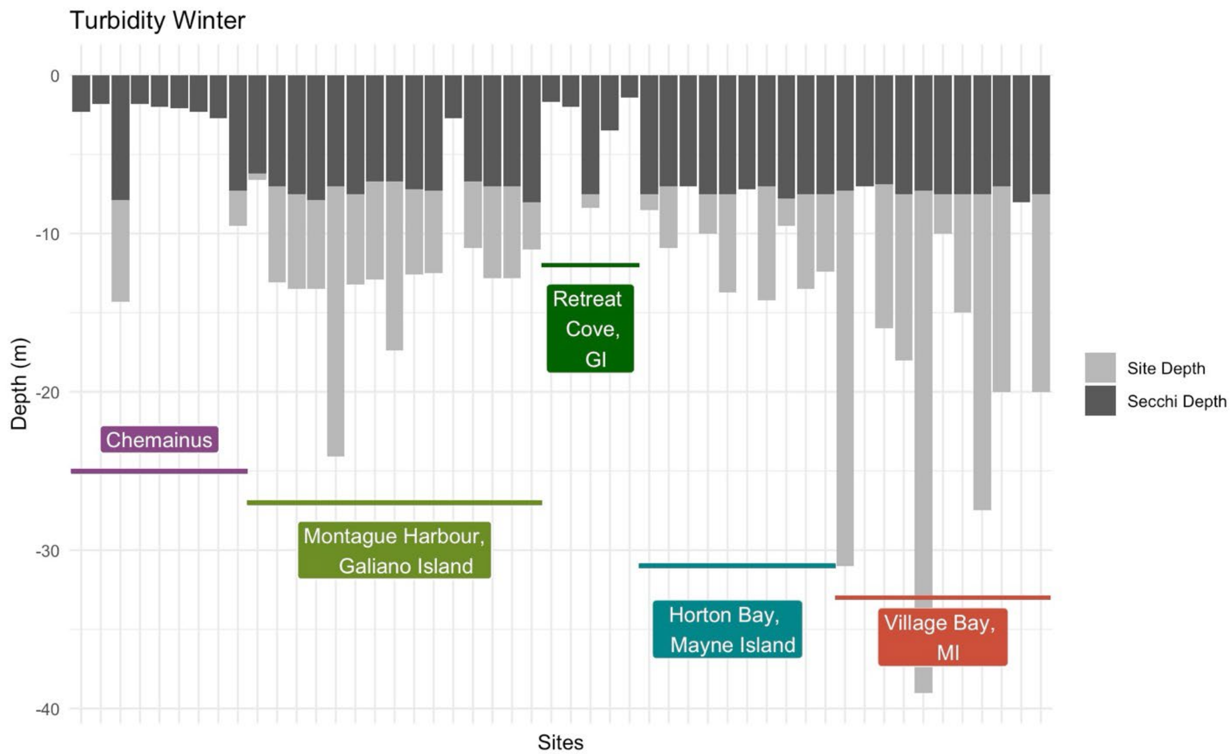

Figure 13. The turbidity of all sites in all estuaries from winter, as expressed as Secchi Depth. Where the sites are deeper than the Secchi depths, we can get a true measure of turbidity. Where the site and Secchi depths are the same (the seafloor can be seen), the Secchi depth is not useful as a metric.

Nitrate + nitrite (N+N) and orthophosphate concentrations were lower in Chemainus than the other regions, although the orthophosphate levels were not significantly lower (Figure 14). The higher concentrations at the sites around Galiano and Mayne Islands may be partially influenced by the timing of sampling, as Chemainus data were collected in February while the other locations were sampled earlier in the fall. However, the supposition is that the high nutrient concentrations around the island is due to the influence of the Fraser River. Horton Bay site B250 showed notably elevated N+N levels, suggesting a possible localized nutrient input.

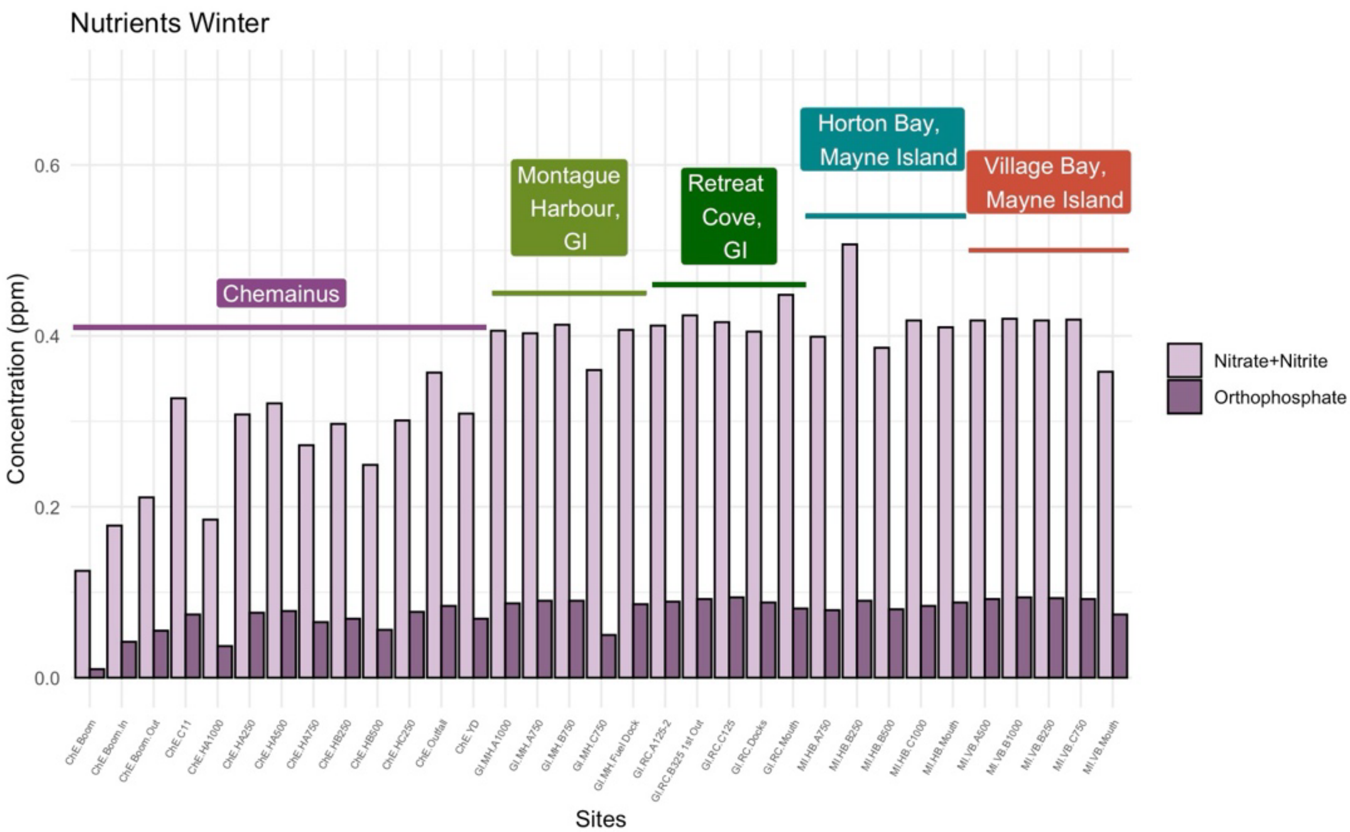

Figure 14. The nitrate + nitrite (N+N) and orthophosphate levels in the winter, collected in Chemainus in February, Galiano Island (Montague Harbour and Retreat Cove) in January, and Mayne Island (Horton Bay and Village Bay) in December. The nitrite concentrations were zero, and therefore N+N is equivalent to nitrate along.

Bacterial concentrations in the estuaries varied by site (Figure 15), with most locations showing low levels of *Enterococcus* spp. and fecal coliforms: the range is from 0 to c. 11 CFUs/100 mL at Galiano Island. However, in Chemainus in September, elevated bacterial levels were observed at Boom In, Boom Out, and especially at HA500, where *Enterococcus* spp. concentrations exceeded the 35 CFUs/100 mL threshold considered unsafe for recreational water use by the Vancouver Island Health Authority. A possible source of this localized contamination is the log booms, where numerous seals were observed resting—likely drawn to the area by returning salmon and contributing to high fecal inputs. Despite these findings, conversations with members of the Halalt community suggested that bacterial levels were not considered a primary concern, particularly when compared to issues surrounding food contamination, which became a greater focus of the study.

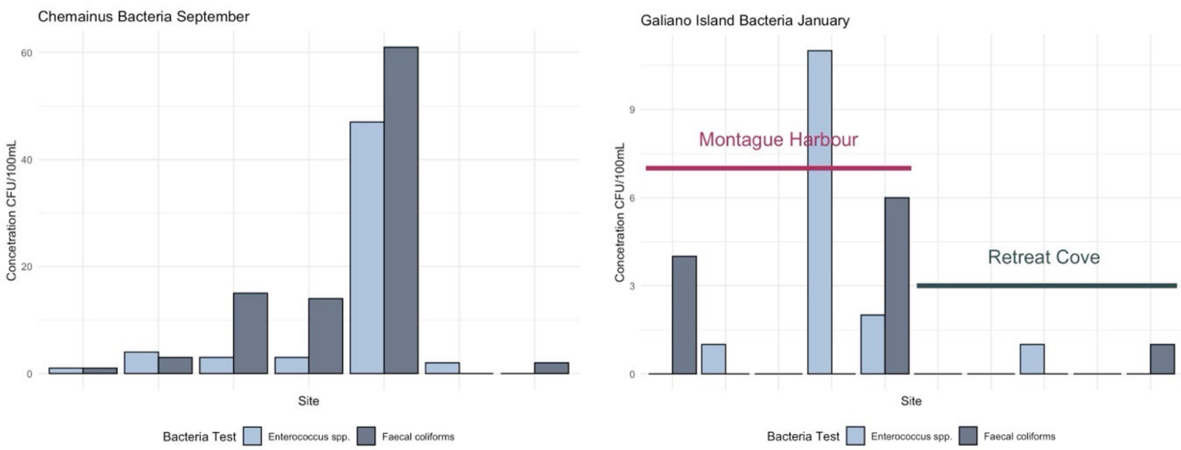

Figure 15. The Bacterial concentrations in Chemainus (left) and Montague Harbour and Retreat Cove on Galiano Island (right). The concentrations are in CFUs/100mL, which are colony forming units per 100 mL of seawater. The two bacterial tests are for *Enterococcus* spp. (pale grey) and faecal coliforms (dark grey), which are species of bacteria found in faecal matter.

Seafloor Sediment Samples

Sediment sampling was conducted in the Chemainus River estuary as contamination from log booming and industry in the area was identified as a priority concern by the Halalt First Nation. Results are presented in Figure 16.

There are no defined limits for Aluminum (Al), Calcium (Ca), Iron (Fe), Magnesium (Mg), and Sodium (Na), in marine sediments, elements that are all in high levels at the Chemainus sites. These are also nutrients that are typically abundant and are absorbed by marine organisms to bloom and build shells. Iron is also often a limiting micronutrient in the marine environment. The heavy metals without limits are not all considered safe at high levels, but there has been no official limit posted.

Copper is the only heavy metal at a concentration that exceeds the limits for protection of marine wildlife, but it is one of the most toxic metals when at high concentrations (Cui, et al., 2024).

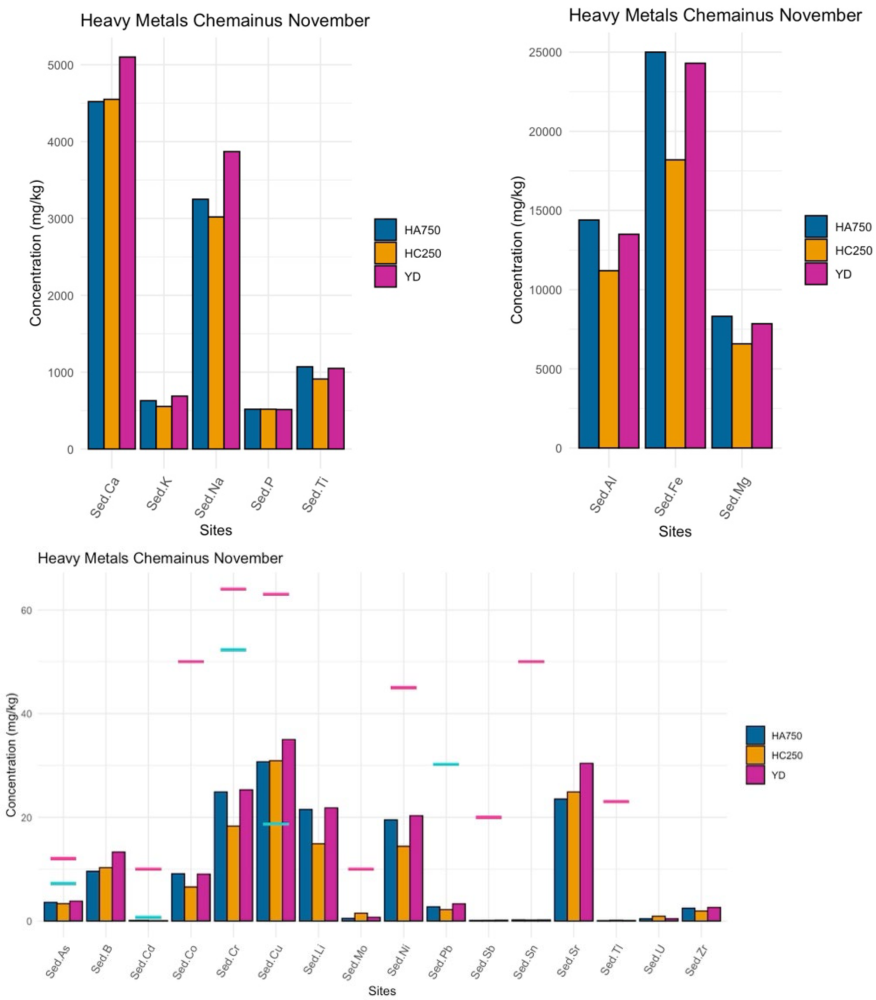

Figure 16. Concentrations of heavy metals in sediment from three underwater sites in the Chemainus Estuary. Top left and right: the metals found in the highest concentrations (see axis values). Bottom: metals found in low concentrations, along with the limits outlined in the Canadian Water Quality Guidelines for the Protection of Wildlife for marine environments (blue) and park soils (pink) (Canadian Council of Ministers of the Environment). The park soil limits are not relevant to marine environments but is added for comparisons.

Looking among the sites, site YD is within an active log booming area with patchy eelgrass, HA750 is directly next to a log booming site within an eelgrass bed, and C250 is away from the log booms and near the mouth of the freshwater channel within another eelgrass bed (chosen as a "non-booming" site). The metal concentrations are more similar between YD and HA750, than with C250 (with C250 being lower). Exceptions: P all similar, Ca lowest at HA750, followed by HC250 then YD. The concentration of metals follows one of two trends: 1. Highest level at YD, second highest HA750, and lowest at C250; or 2. Highest at YD followed by C250 then HA750. Either way, YD (nearest to the log boom) has the highest metal concentrations (exceptions: iron, aluminium, magnesium).

Polycyclic aromatic hydrocarbons (PAHs) detected in the Chemainus estuary sediments were all below established guideline limits, where such limits exist (Figure 17). The distribution of PAHs followed a similar spatial trend to that observed for heavy metals, with higher concentrations at sites HA750 and YD compared to HC250. However, there were exceptions—particularly at the YD site, where four PAHs (acenaphthene, anthracene, benzo(a)pyrene, and benzo(k)fluoranthene) were not detected. There were no detected concentrations of polychlorinated biphenyls (PCBs), pesticides, or herbicides in the Chemainus estuary sediment samples.

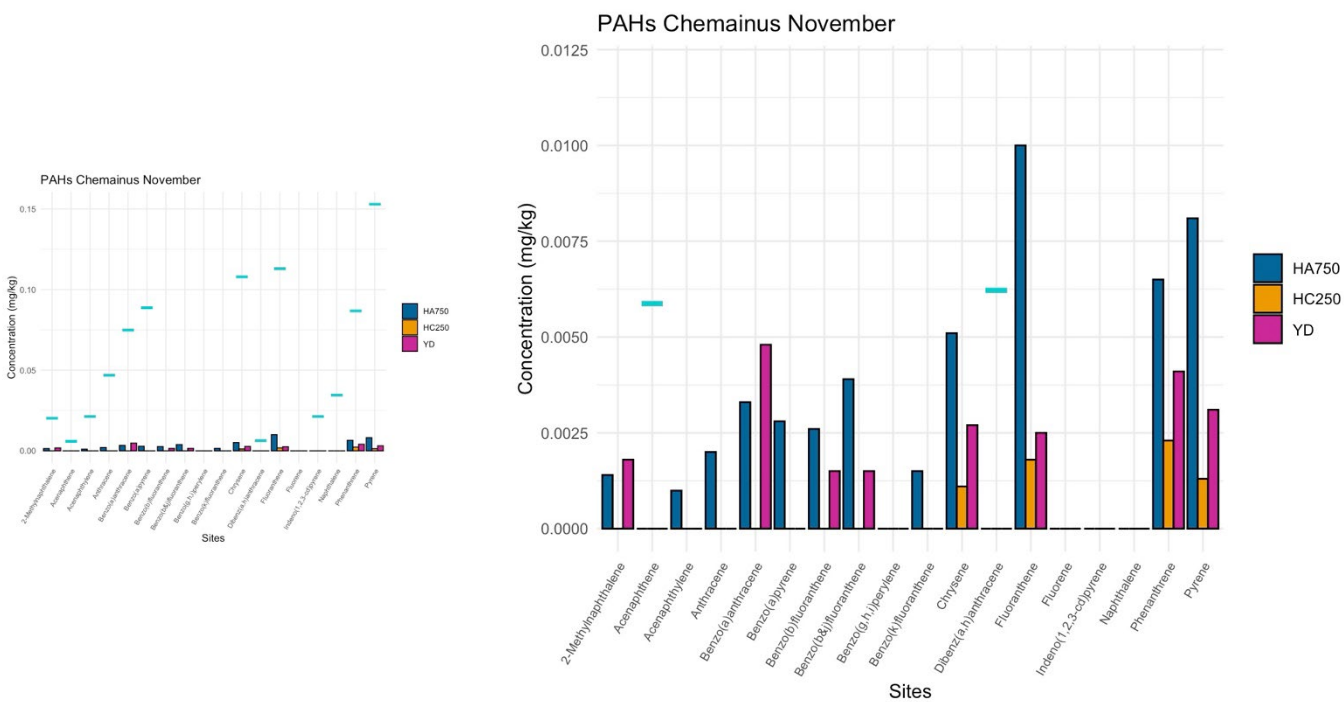

Figure 17. Sediment concentrations of PCAs in the Chemainus estuary, collected from subtidal sites (HA750 in blue, HC250 in yellow, YD in pink). Left: the concentrations along with the BC marine water PAHs limits (blue lines); graphed from 0 to 0.15 mg/kg). Right: a graph showing the close-up for the concentrations (0 to 0.0125 mg/kg).

Sediment grain size varied across sites in the Chemainus estuary, with the smallest overall grain size found at YD, located within a long-boom area (Figure 18). Both YD and HA750—sites situated closer together and near log booms—contained clay, whereas HC250, which lies farther from the booms but directly outflowing from the freshwater channel, had coarser sediments and lacked clay. These differences could be interpreted as the finer particles are more likely to settle in low-energy zones like boom areas, while coarser materials dominate in more dynamic environments with active freshwater input.

Sediment pH also varied among sites, with the highest pH (most basic) recorded at YD and the lowest (most acidic) at HC250. This result contrasts with prior evidence, as sediment beneath log booms is often assumed to be more acidic due to higher organic content and anaerobic decomposition. The unexpectedly high pH at YD suggests that other site-specific factors—such as buffering capacity or reduced decomposition—may be occurring. It is also important to note that all samples were exposed to air and stored cool prior to lab analysis, which could have altered pH values compared to those measured in situ.

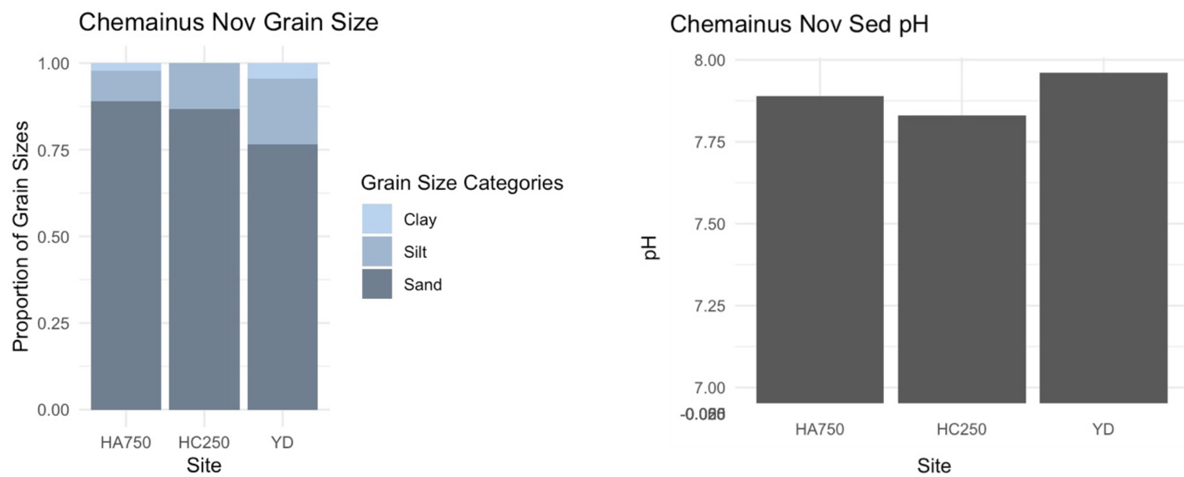

Figure 18. Chemainus Estuary subtidal sediment grain size (left) and pH (right). The grain is categorised by size, with clay being the smallest grain size to sand, the largest.

Habitat Mapping

Habitat mapping was conducted in the Chemainus River estuary, Village Bay and Horton Bay on Mayne Island, and Retreat Cove on Galiano Island (Figure 19). The habitat map of these four areas shows extensive sandy areas (yellow). Given these are estuaries, and the tow camera footage was from winter (RC, VB, and HB only), the sandy areas may be covered in algae in the warmer months. The Chemainus estuary map (from footage collected in the summer of 2024) shows large eelgrass beds which were then mapped in more detail using more refined methods (more detail below).

Village Bay, Retreat Cove, and Chemainus estuary all show eelgrass that are in subtidal bands. From information on Mayne Island, the bed is narrowing, and it is retreating from the shoreward side, possibly from goose herbivory or *Ulva* shading.

The eelgrass in Horton Bay is in three places: in front of the river mouth, along the south of the bay, and along Curlew Island. The new marina sited in the bay was designed to allow light to get through to the eelgrass, and to provide mooring for boats. However, in the summer the boats are tied to mooring buoys and generally fill the whole bay.

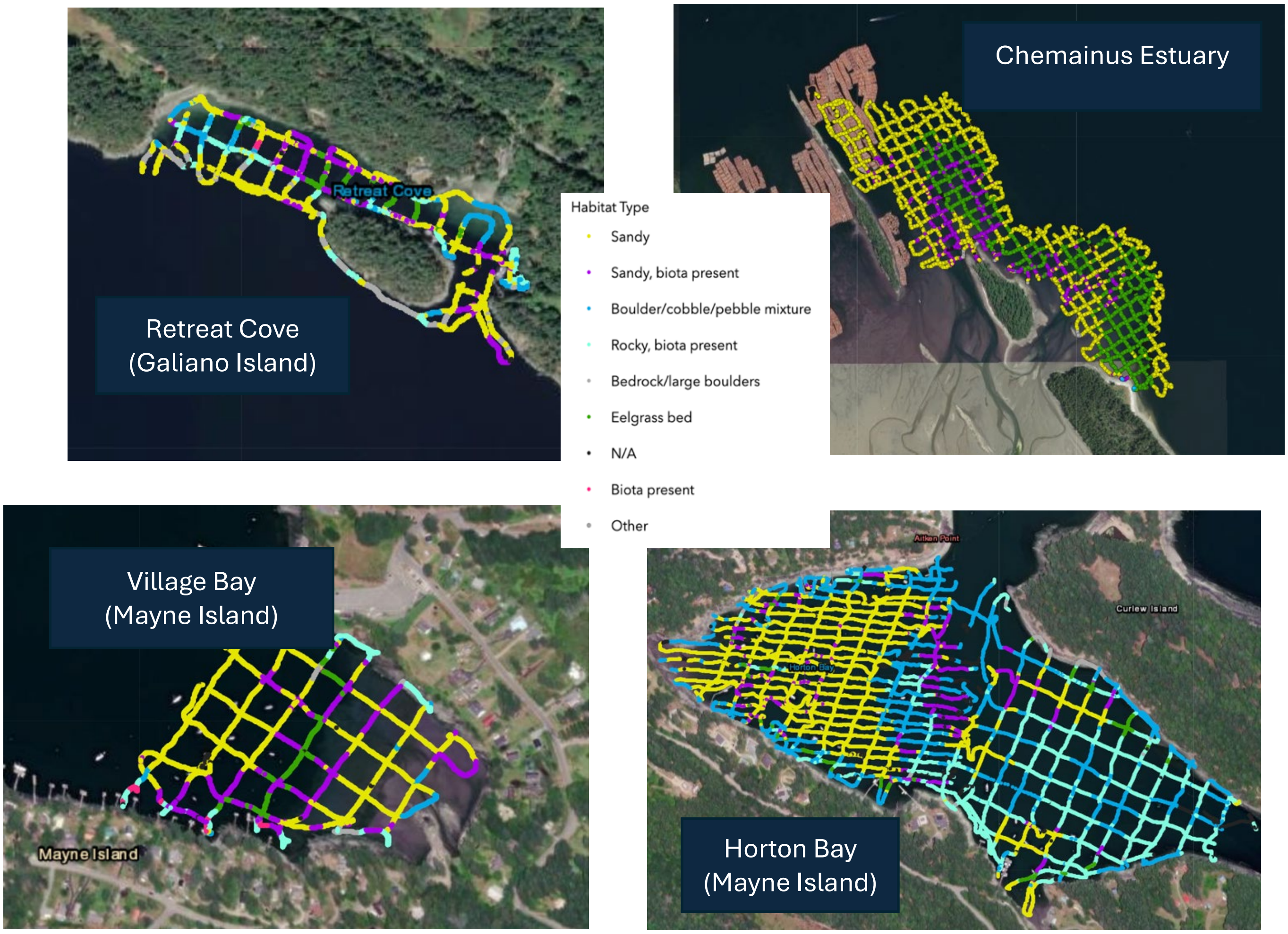

Figure 19. Habitat maps created from analysis of underwater tow camera imagery at 4 estuaries.

The underwater imagery was also analyzed for underwater debris and anthropogenic items (Figure 20). These items included garbage, ghost gear and even sunken derelict vessels. This mapping will allow the SeaChange team to target these items for cleanup operations should them be determined as a useful action for these areas. In the Chemainus River estuary woody debris is of particular concern due to both historic and current log booming activities so woody debris was also mapped in that area (Figure 21). This debris may be from the log booms or from the river, which is a natural source of woody debris in an estuary.

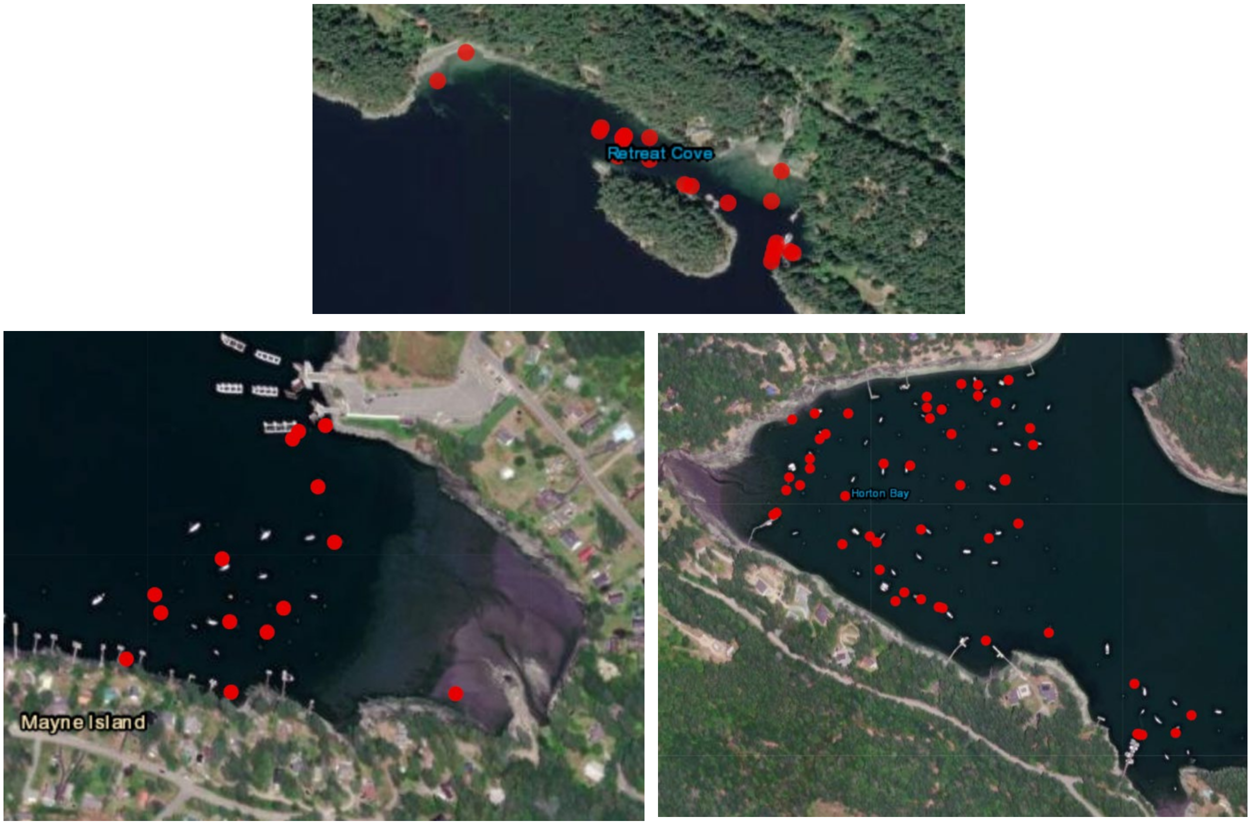

Figure 20. Anthropogenic items and debris identified at Retreat Cove (top), Village Bay (bottom left), and Horton Bay (bottom right).

Figure 21. Woody debris identified near the log booms in the Chemainus River estuary.

As mentioned above, more detailed eelgrass bed mapping was conducted in the Chemainus River estuary. Those maps are presented in Figure 22.

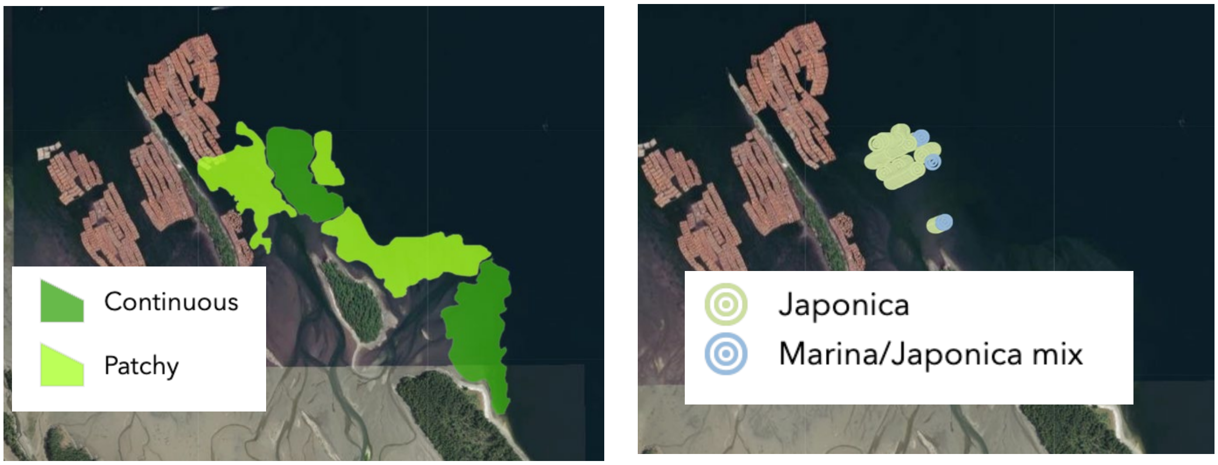

Figure 22. Eelgrass mapping showing (left) polygons of continuous vs patchy portions of the eelgrass beds; and (right) the presence of *Zostera japonica* or a mix of *Z. japonica* and *Z. marina*, the remaining space is solely *Z. marina*.

The eelgrass mapping methods are similar to habitat mapping, but instead of identifying every secodn of footage, the mapper identified the beginning and end of the patches of eelgrass and they towed the camera at 20m transect lines, rather than 50m for habitat mapping.

Online ArcGIS App
The RESS team has designed an online ArcGIS App with historic data layers and the data collected during these first two years of the RESS Project with data, images and documents. This interactive online app is accessible via this link. The layers available on this site include:

- Estuary Reports (Source: RESS)
- Sites (Source: RESS)
- Year 1 Estuary Habitat Maps (Source: RESS)
- Year 1 Anthropogenic Items (Source: RESS)
- Year 2 Estuary Habitat Maps (Source: RESS)
- Year 2 Anthropogenic Items (Source: RESS)
- RESS Activities (Source: RESS)
- No Anchor Zones Midline Floats (Source: SeaChange)
- Saanichton Bay Eelgrass Bed (Source: RESS)
- Eelgrass Polygons (ShoreZone) (Source: ShoreZone)
- BC ShoreZone New Imagery (2017-2023) (Source: ShoreZone)
- BC ShoreZone Old Imagery (2004) (Source: ShoreZone)

3. Resilient Estuary Ranking System

The ranking system of ecological resilience for small- to medium-sized estuaries of the Salish Sea aims to focus efforts and resources on regions where actions to maintain or increase resilience will have the most impact. All estuaries are important coastal areas; however, there are estuaries that have yet to receive attention, and which have the possibility to better weather the effects of climate change and increased coastal human populations than the rest, if efforts to conserve and restore those areas are made. The purpose of this project is to listen to the needs of the local communities, and determine the data collected as part of this project reflects the wants and needs of those communities. Our overall objective is to do the best for the estuaries of the Salish Sea and the species that depend on them. For this reason, we plan to stick to non-invasive sampling methods, collaborate freely, seek permission as needed, and share results immediately with the First Nations on whose territory we work, and be open and transparent about our goals, funding sources, and collaborators.

This section presents our preliminary methodology to rank the small to medium sized estuaries of the Salish Sea in terms of their resilience to climate change. These rankings will help to inform where we direct resources for this project in future years as well as the actions plans developed for each site. This ranking methodology will continue to evolve as we analyze more of the data in future years and as the project progresses to other parts of the Salish Sea. The rankings of the estuaries from Area 2, which were the focus of this report, will hold significant value as these sites experience significant anthropogenic pressure, so we were unsure what to expect during our surveys. We were interested to see if any estuaries demonstrated significant functionality despite the pressures facing them.

For our preliminary ranking of the estuaries of Area 2, we relied upon a review of historic data from those estuaries as well as insight from the analysis of the Area 1 estuaries. Each estuary had its own unofficial committee which included representatives of local First Nations, scientists and conservation and restoration practitioners, as well as settler community members. During discussions with members of the local First Nations and community groups, we learned about the priorities identified from past work and the deep connection these groups had with these estuaries, despite the impacts from human activity. Although it would be simpler to “write off” estuaries already impacted by human activity and focus any work on more remote and “pristine” environments (Bates et al, 2019), the community connections that existed with these estuaries gave them a higher priority for this project. For example, Chemainus is a site impacted by log booming and industry but was also an important site of shellfish harvesting for the Halalt First Nation. This cultural importance, and the Nations’ focus on the right to food security as outlined in the Douglas Treaties, 1850-1854) made this site important to focus on for restoration efforts. Details of meetings and events organized and attended to solicit this community involvement is detailed in Section 5.

The **preliminary** ranking for Area 2 estuaries from this expert assessment, from most to least resilient was:

1. Chemainus River Estuary
2. Horton Bay
3. Village Bay

The Retreat Cove biodiversity survey has not been analyzed yet; therefore, this ranking is still preliminary. A final report that presents all the analyses and ranks the estuaries explored as part of this project will be completed at the end of the work.

4. Restoration and Conservation Action Plans

A major goal of this phase of the RESS project is to use the data collected on current conditions to create actions plans that outline restoration and conservation activities that could maintain or boost the resilience of the estuaries we assess. These could also help to inform such activities in other estuaries of the Salish Sea by providing a list of activities that provide benefits to estuaries in general. These activities may be carried out under the RESS project (that work would be funded as part of Phase 2 of the RESS project funded by the Aquatic Ecosystem Restoration Fund and is reported on separately) or by outside organizations or agencies. Each estuary will have individual needs, such as marine debris removal, derelict vessel removal, eelgrass transplants, Voluntary No Anchor Zone buoy deployment, enforcement of boating bylaws, education into shoreline protection with indigenous plants, identifying sewage sources, and/or reducing the impacts of Canada goose herbivory. SeaChange has a long history of effective coastal zone conservation and restoration, along with collaborators in freshwater and terrestrial restoration, eelgrass transplanting, debris removal, and education.

Chemainus River Estuary

The major goals identified by the Halalt Nation during the RESS project discussion were: ocean harvested food that is free of contamination; healthy eelgrass beds; resilient estuaries and streams for salmon; and eradicating European Green Crab (EGC). From preliminary results, we conclude that the log booms and the presence of EGC are the most immediate issues the Chemainus River estuary faces. The Halalt Nation are currently working on a EGC eradication program. These goals helped to define the action plan for this estuary, with the following items being identified as potentially helpful actions:

- Implementation of a monitoring plan to identify contaminants in the species traditionally harvested for food in the estuary (this is already being planned).
- Documentation of the log booming practices in the estuary, including where the logs are allowed to rest on shore when the tide is out and which sections might block

eelgrass from growing due to debris and shading. We hope this will provide information that helps inform future conversations about booming tenures.
- Investigation of carbon storage and terrestrial carbon input (through bark from logs) which will guide subtidal restoration efforts that could include remediation through sediment capping and eelgrass transplanting.
- Monitor how salmon uses the estuary and the stream through eDNA sampling and other methods. This could help inform future conversations about conservation of certain areas of the estuary.
- Provide training for members of the Halalt Fisheries in underwater sampling techniques, transplanting, and mapping so that information can be collected more frequently and in more detail.

Retreat Cove

This small estuary on Galiano Island, where Grieg Creek drains into the Salish Sea, was identified by the Galiano Conservancy Association (GCA) as an area of interest and is actually where their offices are located, so there are many opportunities for monitoring and protecting the eelgrass beds found in the protected cove. Our observations indicate an estuary with few direct anthropogenic impacts, so we recommend the following action items:

- Signage installed on the public dock informing boaters about “anchoring out” and avoiding the eelgrass bed.
- Installation of a voluntary “No Anchor” zone to reinforce the dock signage.
- Communicate with boaters through presentations, pamphlets, and signs about anchoring deeper than eelgrass, using seafloor-friendly mooring, the importance of using pump stations and disposing of garbage responsibly.
- The Galiano Conservancy Association does educational events where they release salmon in the creek, and we would like to add to this by educating the residents on the life stages of salmon in the estuaries of the Salish Sea.

Montague Harbour

Montague Harbour is a larger estuary on Galiano Island, with Jakes Creek draining into the western side of the bay. This is an unusual estuary as it is partially divided by the Gray Peninsula, with a larger salt marsh complex on the opposite side of the peninsula to the stream mouth. Parts of the Bay are also covered by the Montague Harbour Provincial Marine Park. This is a large area, and we were not able to completely map the habitat. However, we observed eelgrass beds along the North and South shores, and in conjunction with eelgrass mapping by the GCA, we have been able to identify the following potential actions:

- Continue monitoring the eelgrass beds.

- Communicate with boaters through presentations, pamphlets, and signs about anchoring deeper than eelgrass, using seafloor-friendly mooring, the importance of using pump stations and disposing of garbage responsibly.
- Collaborate with the Park managers to provide education for visitors on eelgrass awareness, including beaching their boats on the shore.
- Communicate with the Park managers about installing permanent seafloor-friendly mooring buoys for visitors to prevent anchoring damage in eelgrass habitat.
- Installation of a voluntary no anchor zone on the NE side of the bay to protect the eelgrass in that area. If that is successful, a transplant could be done in that area.

Village Bay

Village Bay on Mayne Island, where Deacon Creek empties into the ocean, has a lovely eelgrass bed, although recent data suggests it is declining. The docks present in the bay are mostly too deep to affect the eelgrass; however, there is a ferry terminal in the bay which may have an impact. Thus far, we know that water has high levels of nutrients, likely from the Fraser River. That is not something that can be solved locally, but other actions could help mitigate other impacts:

- Map the extent of Ulva in the intertidal using drone imagery throughout the year, to investigate the role of Ulva growth on the extent of intertidal eelgrass. This may lead to a pilot removal program for Ulva.
- Deliver a community presentation on seafloor-friendly boating activities and resilient shorelines.
- Create a volunteer-led monitoring program to investigate the impact of geese and Ulva in the bay.

Horton Bay

Horton Bay, on Mayne Island, is where Horton Brook drains into the ocean. The main issue identified in Horton Bay is the abundance of vessels anchoring. Each vessel has the potential to scour the seafloor, preventing any eelgrass from establishing or being retained. Also, with vessels there is often debris, and our survey confirmed a large amount in the area. There are the same issues as Village Bay with the near-shore loss of eelgrass, and Ulva or geese could also be the cause. Another potential issue is development of shoreline properties which can include damage to riparian areas or the installation of new structures, such as seawalls, which can change sediment dynamics in the bay. The following action items were identified for Horton Bay:

- Conduct a marine debris removal program.
- Map the extent of Ulva in the intertidal using drone imagery throughout the year, to investigate the role of Ulva growth on the extent of intertidal eelgrass. This may lead to a pilot removal program for Ulva.

- Deliver a community presentation on seafloor-friendly boating activities and resilient shorelines.
- Create a volunteer-led monitoring program to investigate the impact of geese and Ulva in the bay.
- Develop a program to help offset the cost of replacing a traditional mooring line with a seafloor-friendly mid-line buoy line to encourage their use in the bay.
- If the anchoring issue can be address, it could lead to the installation of a voluntary no-anchor zone and a transplant into the area.
- Communicate with residents about erosion control through Indigenous planting or other soft-sediment solutions.

Future Monitoring Plans

The baseline data collected in the project provides a snapshot in time while the true story of resilience in estuaries is told over time. One of the main recommendations from this project is to implement long-term monitoring activities in the estuaries chosen in Area 2. These activities will rely on volunteers residing local to the estuaries in question, and will involve tracking goose, boat, and Ulva extents (Gulf Islands).

Other activities we believe would provide the best data over a long time are biodiversity surveys through eDNA sampling with Ocean Diagnostics Inc's portable eDNA pump system (pre-purchased and in fabrication) and could be done in the field without extensive training. These samples would be best collected throughout the year to capture the transient nature of salmonids and other forage fish.

We would also like to see water, sediment, and tissue samples that test for contaminants such as heavy metals, PAHs, PCBs, and Dioxin and Furans, particularly in the Chemainus Estuary, where sea life consumption is part of the communities' culture and is relied upon for food security. The water and sediment samples are stable for several days if kept cool, and the tissue samples can be stored for up to six months frozen, which is easily doable by citizen scientists and volunteers.

In Montague Harbour, Galiano Island, we will request help from the Provincial Parks staff in monitoring boating activities at the north end of the harbour (anchored and beaching boats). We will also set up a monitoring program with the Galiano Conservation Association, which already leads students and volunteers to learn about stream and salmon science at Greig Creek, which flows into Retreat Cove.

5. Communications Report

Collaboration is one of the fundamental parts of the RESS project which means communicating the work the RESS Team is doing as part of the Baseline Assessment and Ground-truthing phase of the project is important and has been a focus of the team. This open communication has led to new collaborators and connections and has led to better understanding of the pressures facing the estuaries we are working in. It is also important to provide education around these activities so community members have a better understanding of the ecosystems at their doorstep and the steps that can be taken to protect and restore them. The Communications Manager at SeaChange has led these efforts and we have been able to work effectively with local First Nations, community conservation groups, and governmental organizations. This section summarizes the communications that were undertaken as part of this phase of the project.

As part of community outreach efforts, members of the RESS team attended and presented at a number of events through Year 2 of the project, including many cultural and informative events, which are detailed below.

NEMO Talk: Taking Out the Trash
SeaChange, and RESS specifically, was invited again to give an online talk for World Ocean Week by the Sunshine Coast Conservation Association. Susan Anthony gave a 1 hour talk on June 7, 2024 called “Taking Out the Trash”, which was about the issue of marine debris and derelict vessels in the Salish Sea. There were 25 people in attendance. This talk elicited responses from locals asking about volunteering with us and giving direction for future clean-ups. We will follow up with these connections as we move into Area 4 and begin baseline data collections in the areas that have been suggested.

Oak Bay Dock Talks
SeaChange’s RESS team set up a table on June 7th and July 25th, 2024 at the Oak Bay Marina with the goal of connecting directly with boaters about the various work done through RESS in the area, learn more about concerns boaters have, and encourage stewardship (Figure 23). Boaters expressed their concerns and priorities for conservation work in estuaries, primarily focused on fisheries species health/abundance, marine debris presence, and pollution/derelict vessels.

Figure 23. Operations Manager Justin Lisaingo and Communications Manager Kendra Nelson at June 7, 2024 Oak Bay Dock Talk table.

Clam Garden Restoration Work
SeaChange staff attended an event with members of the Penelakut First Nation and Gulf Island National Park Reserve to help with clam garden repairs at the sea garden site on Russell Island. The team also helped with removal of Sea Lettuce (*Ulva* sp.) which was growing thickly in the sea garden area. Staff also attended a clam garden restoration day hosted by the Malahat First Nation in Mill Bay on August 19th, 2024. The purpose of the event was to repair the clam garden wall, see if any clams were establishing in the area, and for elders to teach the children how to build octopus hooks. The event was attended by many different NGOs and Parks employees and provided SeaChange with an opportunity to connect with the Malahat Marine Science team.

Mayne Island Apple Fest
The RESS team set up a table at the last market of the year on Mayne Island, which is also known as the Apple Festival on October 12, 2024. The event was organized by the Mayne Island Agricultural Society with proceeds going to the Mayne Island Food Bank. Our purpose was to connect with community members to learn about concerns for the nearshore environment, so we had a printed map of the island with pens for people to mark

areas of concern. We received interest from the head of the Mayne Island Boaters Association, who we have since followed up with and started a discussion about how to engage with boaters, particularly in Horton Bay. It was also a chance for our South Salish Sea Regional Coordinator to get to know the island and its residents.

SeaChange's Annual General Meeting
SeaChange held our AGM on November 18th, 2024 at the Shaw Centre for the Salish Sea. Our Executive Director, Sarah Cook, shared about the work the RESS project had done with the 15 people in attendance. This was a great opportunity for us to introduce RESS to SeaChange members and discuss the project more with the board of directors.

Let the Herring Live Forum 2025
SeaChange staff were invited to attend the Let the Herring Live Forum hosted at the Tsawout First Nation Reserve on February 13, 2025. The focus of this event was the important of herring to local Indigenous groups. The event was attended by roughly 200 people and included talks from Elders, Indigenous leaders, Dr. David Suzuki, Dr. Pauly, and John Driscoll. Staff learned a great deal about herring and were able to connect with many members of local Indigenous groups.

Herring Fest
The North Salish Sea Regional Coordinator attended Herring Fest on Hornby Island which was organized by the Hornby Island Conservancy and ran from 13-15 March, 2025. He made contact with Hornby Island Diving and the Conservancy Hornby Island after hearing their presentation on the multi-year review of eelgrass conservation in Tribune Bay. They discussed where their goals aligned with RESS and how RESS could support their work forward, including further data collection, restoration, and protection. More meetings are planned in Spring 2025 which will help determine more specific plans for the partnership. We will be working with them in the future, when plans have been made concrete.

In addition to these specific events, RESS team members also engaged with several collaborative working groups whose goals and work aligned with the RESS project.

Eelgrass Collective
The eelgrass collective first formed in 2024 preceding the Pacific Estuarine Research Society's (PERS) annual conference. Members of the Hakai Institute, Pacific Salmon Foundation, SeaChange, and others invited practitioners and experts at PERS to attend a special meeting and design what the collective's goals would be. Since then, the Collective has hosted four "mini-exchanges" where individuals speak on a particular topic, such as eelgrass mapping, transplanting, etc. The events are online, and we have members from around the Salish Sea.

Indigenous Plant Foods Nursery Working Group
In collaboration with WWF and other local estuarine restoration organizations, such as Guardians of our Salish Estuaries Society (GooSE), and restoration practitioners, a plan was drafted to develop a nursery dedicated to estuarine restoration and that includes

plants with traditional value for Indigenous groups, particularly those used in traditional estuarine root gardens. This would include medicinal and edible plant species. This working group has met several times, and we have drafted a proposal and budget that identifies several estuaries and Nations to collaborate with and sets out the steps and timelines. This proposal has been forwarded to WWF, who intends to fund this project. We will focus on collaborating with Nations to determine preferred plants for estuarine restoration. This will include visiting the estuaries for assessments and finding local and appropriate sources for propagules for the nursery.

South Island Regional Collaboration

Based on a conversation with members of the Pacific Salmon Foundation (PSF), a need was identified for stronger regional collaboration between NGOs in the Coast Salish region. An initial meeting was held with PSF staff to discuss this issue and try to establish solutions. A cross-organizational collaborative was proposed. Based on this discussion, we researched whether such an organization already existed in this region: there were similar examples, but nothing to fit our specific needs. We connected with other local NGO staff (such as Habitat Acquisition Trust (HAT)) about best practices in collaborative working with local and Indigenous communities.

Social Media and Online Reporting

Social media and online platforms, such as our website, are another way the RESS program provides information about the projects to community members and also allows us to solicit feedback. We have posted about RESS eleven times on our social media platforms in 28 posts on four different social media platforms (Figure 24). These posts are meant to inform the community of our work, goals, and accomplishments. They have also been a great tool in gauging volunteer interest and making connections with other groups. We have been able to reach a total of 72,808 accounts through our social media channels.

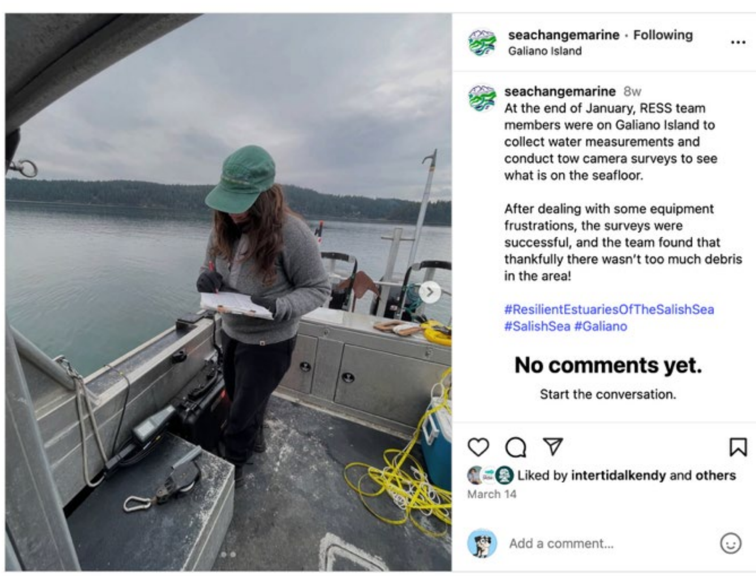

Figure 24. Instagram post about RESS work on the SeaChange account.

Newsletters
RESS project work was shared through the monthly SeaChange newsletter. We shared details about the project, research being conducted, biodiversity surveys, debris cleanup work, and events that people can attend to discuss the project with us. These newsletters were sent to an average of 422 people each month, with a 50% opening average for these newsletters. Our newsletter archive can be found here:
https://us15.campaign-archive.com/home/?u=72484b5f2a0dab1f75967ad96&id=220bada55f

Communication for Year 3
In addition to the work described in this report, relationship development and planning for potential work in Year 3 of the project. Below is a summary of the potential work discussed to date.

Salt Spring Island
While conducting work on Galiano and Mayne Island, we were told by Indigenous and settler peoples with ties to Salt Spring Island that our help was needed there, specifically relating to derelict vessels and marine debris removal. To date, communication has been established with the Salt Spring Island Conservancy, Penelakut First Nation, Tsawout First Nation, and several other people working on estuarine restoration and salmon habitat conservation on the island. Currently, community comments strongly indicate that support is needed in removing underwater debris in Ganges Harbour. There are also concerns about eelgrass bed declines and their potential association with *Ulva* blooms. Because this Island, and its estuaries, are shared by many Nations, current outreach efforts with Tsartlip, Tsawout and Cowichan are ongoing to determine what concerns they may have and how the RESS project can be of support. Current indications are that we may also be of help in Burgoyne Bay and Fulford Harbour, which are also culturally significant places. One highly likely outcome of this project, to date, will be large-scale marine debris removal in Ganges Harbour, and an education campaign for locals about best practices for waste management when living on a vessel.

Cowichan Estuary
RESS has been engaging with a contact at DFO regarding a proposed estuarine restoration plan in Cowichan First Nations territory. This work would have a specific focus on expanded restoration that includes planting of species of nutritional and medicinal value to the Nation, which are often overlooked in restoration projects. A proposal has been revised and shared with DFO; however, next steps are dependent on whether internal DFO funding is available for the project, which will dictate the role of RESS in the project. In the case that DFO funding does not become available, other funding initiatives will be explored. Ideally, future work will include the restoration of near tidal and intertidal plant communities within the estuary.

K’omoks Estuary
The K'ómoks Estuary is one of only eight Class 1 estuaries in BC and supports hundreds of bird and plant species, as well as dozens of fish species, including all five species of Pacific salmon, and a plethora of other marine organisms. Project Watershed Society, a Comox-based non-profit, and the K’omoks Nation have been working together for years to improve conditions in the estuary, including substantial riparian restoration projects, eelgrass transplanting, and much more.

The RESS regional coordinator has met with Project Watershed 5-6 times to identify areas where additional resources and support from RESS would enable more work to take place. The main expressed priority from Project Watershed and K'ómoks First Nation is to complete a comprehensive mapping of the estuary seafloor. At the time of this report submission, the project is intending to begin work in May 2025, when the Nation members are available to be present. This would begin with mapping, water and sediment sampling, and ecosystem surveys. The information would then be used to identify next steps as well as to integrate, inform, and update existing planning documents, including the Courtenay River Estuary Management Plan. It is also worth noting that K’omoks Nation recently ratified their modern treaty which, once affirmed by Provincial and Federal governments, will result in co-management jurisdiction across the estuary. As such, later phases of potential work include training for K’omoks marine and guardian programs and developing a long-term estuary monitoring program.

Cortes Island
In November 2024, the RESS project connected with Friends of Cortes Island (FOCI) at an eelgrass symposium in Campbell River. For the next few months, preliminary project planning and scoping took place to identify potential estuaries around the island that would be of conservation risk, benefit, and priority. In Spring 2025, RESS and FOCI met remotely with Klahoose First Nation to understand their interest in participating in the project. Additionally, in 2024, BC Parks and Comox Valley Project Watershed Society completed a preliminary eelgrass report for two locations on the island: Manson’s Landing and Háthayim (Von Donop) Marine Park. A meeting was held with these groups to establish a unified approach to advancing eelgrass research and recovery across the island. More work will be done in the Spring and Summer of 2025 to identify a path forward and to develop a monitoring program with the support of SeaChange and RESS. An initial visit to the island is planned in May 2025, to meet with FOCI and Klahoose, and to review potential sites in more detail.

Lasqueti Island
In 2020, with resources from the Coastal Restoration Fund, SeaChange completed debris cleanup and an eelgrass transplant in Scottie Bay/Maple Bay on Lasqueti Island. Connections with the Lasqueti Island Nature Conservancy (LINC) have been maintained

since that time, and in Fall 2024, LINC identified an interest in SeaChange returning to examine the potential for additional work.

In February 2025, the regional coordinator visited the island for two days, conducting preliminary site assessments and meeting with LINC members. After that visit, it was determined – due to LINC's interest and SeaChange's previous work – that the Scottie Bay/Maple Bay area would be the most valuable site to return to. RESS will seek to assess the health of the 2020 transplant and donor beds to evaluate the effectiveness of the work after 5 years. Additionally, LINC and BC Parks Foundation are currently developing a management plan for a new park on Marina Island, which is expected to bring an increase in recreational boater traffic to the area. The island acts as the Northern enclosure of Maple/Scottie Bay. Returning to the area to do an assessment of the health of eelgrass beds around the island and in the bays could generate the information needed to incorporate eelgrass protection and monitoring into the park's management plan. LINC is also interested in testing freshwater inputs into the estuaries to assess potential toxins and contaminants.

Mount Arrowsmith Biosphere Region
In August 2024, the regional coordinator attended the opening of the Mount Arrowsmith Biosphere Region (MABR) Education Centre – ts'xwelikwshenawtxw – in Qualicum Beach. At that event, numerous local conservation groups expressed an interest in RESS supporting education and public awareness in the Region. A number of these groups recalled SeaChange and work that had been done in previous years to build collaboration and action throughout the region. Since then, the regional coordinator joined the Mid-Island Stewardship Caucus (MISC) – a group of 10-15 conservation groups that meet monthly to discuss local initiatives between Nanaimo and Deep Bay. The partnership with MABR and MISC to date has been strong, and additional work in research, restoration, and more is being explored.

Campbell River Estuary
Greenways Land Trust and Wei Wai Kum First Nation, along with numerous other partners, have been conducting extensive restoration, research and monitoring work in the Campbell River Estuary, with a significant focus on eelgrass. RESS has had multiple meetings with Greenways and Wei Wai Kum to offer support and resources to fill gaps that would enable further monitoring and restoration to take place. No work is planned at this point; however, conversations are continuing about potential training programs for Wei Wai Kum Guardians and Greenways biologists in marine research and designing a monitoring program. It is expected that there will be more opportunities to work together later in 2025 and into 2026.

Hornby Island

SeaChange has long been connected with divers and researchers from Hornby Island Diving, including working with them to develop new eelgrass monitoring protocols. Hornby Island Diving and Conservancy Hornby Island are nearing the completion of a multi-year effort to conduct a comprehensive review of eelgrass in Tribune Bay. In March 2025, at the Hornby Island Herring Fest, they presented a summary of work to date and possible next steps, most of which is very well aligned with the RESS project. It was at this event that a connection was made about the potential for RESS to support project, including further data collection, restoration, and protection. More meetings with these groups are planned in Spring 2025 which will help determine more specific plans for the partnership.

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