COASTAL MODIFICATION MAPPING

Protocols for Digitizing Modifications on East Coast Vancouver Island with Imagery

March 2026

RESILIENT COASTS FOR SALMON

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ACKNOWLEDGEMENTS

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The Resilient Coasts for Salmon project activities took place on the unceded Traditional Territories of many First Nation communities, including the Kwakwaka'wakw, Coast Salish, W̱SÁNEĆ, and Lək̓ʷəŋən (Lekwungen) Peoples. These Territories belong to: T'Sou-ke, Scia'new, Songhees, Xwsepsum, Semiahmoo, S'Klallam, WJOŁEŁEP (Tsartlip), STÁU,TW̱ (Tsawout), BOḰEĆEN (Pauquachin), W̱SÍ¸ḴEM (Tseycum), MÁLEXEŁ (Malahat), Quw'utsun, Tsawwassen, Penelakut, Halalt, Lyackson, Stz'uminus, Snuneymuxw, Snaw'naw'as, Qualicum, K'ómoks, Ma'amtagila, Tlowitsis, Homalco, Lig̓wiłdax̓w Nations (We Wai Kai, Wei Wai Kum, Kwiakah), ɬaʔamɪn gɯ̓ɛ (Tla'amin), and 'Namgis First Nations.

We acknowledge and deeply respect the enduring relationship that First Nations have with these unceded lands and waters - a connection rooted in care, responsibility, and stewardship since time immemorial. Despite the ongoing impacts of colonization and the suppression of spiritual and cultural practices, Indigenous communities continue to manage and steward their lands in a way that honours the balance of the ecosystem and ensures a sustainable and thriving world for all - now and for generations to come. We strongly advocate that all initiatives stemming from this dataset be guided and prioritized by First Nation's governments and Nation members from inception, with financial compensation for their time as noted in each Nation's protocols for engagement.

A very special thank you to Mitch Mille (Michael Miller Media), videographer and vessel captain, we appreciate your commitment to capturing quality imagery to help build this dataset, to Ben Skinner, GIS Specialist, PSF, for your guidance and creating the foundation for the dataset and analyses, and to Isobel Pearsall for dreaming up this incredibly important project. A big thank you to all the individuals who provided their expertise that helped us develop these methodologies, to ShoreZone, Friends of the San Juans, and SeaChange Marine Conservation Society for laying the foundations and groundwork that guided the development of this initiative, and specifically to the following individuals who supported us with their expertise, Kalen Morrow, Tina Whitman, Sarah Cook, John Harper, Mary Morris, Jennifer Tyler, Jody Watson, William Hall, Cowichan Tribes Marine Team, Jacquelyn Huard, Jacklyn Barrs, Elise Pullar, Jamie Hargreaves, Paul de Greeff, Hayley Tomlin, Nicole Frederickson, Ian Bruce, Robyn Holme, and Jim Johannessen.

The project team initially developed the Field Guide for Shoreline Mapping for in-person workshops, which led to the development of the following protocols for digitization. The following resources were used to develop our protocols:

1. Cook, S., Daley, S., Morrow, K., and S. Ward. 2017. ShoreZone Coastal Imaging and Habitat Mapping Protocol. Coastal and Ocean Resources.
2. MacLennan, A., Johannessen, J., and A. Lubeck. 2018. Armor Mapping Methods for the Puget Sound Region.
3. SeaChange Marine Conservation Society. 2020. SIPAS (Saanich Inlet and Peninsula Atlas of Shorelines) 2020 Technical Report – Draft 3.
4. Friends of the San Juans. San Juan County Shoreline Mapping Project 2019.

Shoreline Modifications Protocol prepared by: Maria Catanzaro, Kyla Sheehan, and Ben Skinner
Overwater Features Protocol prepared by: Sophie Weissfloch, Kyla Sheehan, Maria Catanzaro, and Ben Skinner
Log Accumulation Protocol prepared by: Sophie Weissfloch, Kyla Sheehan, Maria Catanzaro, and Ben Skinner

INTRODUCTION

The Resilient Coasts for Salmon (henceforth referred to as Resilient Coasts) team developed protocols for collecting data on coastal modifications and digitized much of the east coast of Vancouver Island using these methods. This was prompted by community groups and researchers expressing the need for coastal modification data to facilitate informed climate adaptation decision-making that adopts the precautionary principle for shoreline management to support communities and natural systems. Digitization protocols were developed for 1. modifications present on the shoreline (hard armouring like seawalls), 2. overwater structures and pilings (e.g., docks), and 3. log accumulation, yielding three corresponding datasets, which were created from revision of boat-based shoreline imagery. The shoreline photography was conducted by Michael Miller Media using Insta360 Pro2 and Canon R5 cameras by boat.

The goal of the protocols and datasets are for educational purposes only, for a high-level look at shoreline modifications and the ability to explore how they overlap with external climate models and other ecological data. It is important to note that data resulting from these protocols should not be used for detailed analysis or decision-making without formal, in-depth assessments from qualified environmental professionals including coastal geomorphologists, who can provide expert guidance tailored at local scales.

OBJECTIVES

Protocols were designed to map (digitize) the following three data types at discreet points in time:

Shoreline Modifications

The resulting linear dataset describes the extent of modifications. These data can be used to visualize the extent (length) and types of shoreline modification features that sit at or water-ward of the natural boundary and provide a glimpse into where habitats are at risk due to coastal squeeze.

Overwater Structures & Pilings

The resulting point feature data layer describes the extent of overwater features (structures and pilings) in the intertidal and nearshore. Understanding the extent of overwater features at a local scale can help inform planning and decision making to help manage and minimize impacts on coastal waters and the species that rely upon them.

Log Accumulation

The resulting line feature data layer describes the spatial extent and level of accumulation along the shoreline, with the goal to address potential connections between log accumulation, logging industry, and impacts to forage fish spawning beaches at local scales.

SUMMARY

QGIS was used to convert features into line and point vector data, to serve as a representation of real-world geographic features. Features of interest include shoreline modifications (e.g. seawalls, rip rap, buildings sitting at or below the natural boundary), overwater features (e.g. docks, ferry terminals, structures associated with industry, and creosote pilings), and log accumulation (differentiating between logs that have been cut and processed, and natural woody debris). Additional attributes were collected to describe these features in detail. A variety of sources were used to determine the presence of features including high resolution boat-based imagery collected for the purposes of this project, Mapillary to store and view the imagery, OpenStreetMap for viewing the imagery, often used in combination with either Google Earth, ESRI, and/or localized ground surveys. Publicly available aerial imagery was frequently relied on when other sources of imagery were unavailable and when ground truthing was not feasible. The resulting linear and point feature datasets describe the extent of modifications at the time the surveys were completed (2022-2024). These data can be used to better understand and manage Vancouver Island's shorelines and coastal

ecosystems at local scales. Datasets are publicly available on the Pacific Salmon Foundation's Marine Data Portal and detailed findings for specific regions can be found on the Resilient Coasts for Salmon Atlas. The following document outlines the methodology used for digitizing shoreline modifications, overwater features and pilings, and log accumulation and explains the limitations and recommendations for future work.

To see the metadata report and learn how you can use and interpret the data, please visit the Marine Data Portal page for the Resilient Coasts for Salmon dataset.

DATA DICTIONARY

For clarity and consistency, a data dictionary was created (Appendix 1).

SENSITIVE DATA

The Resilient Coasts team did not digitize shoreline modification features within reserve lands out of respect for privacy but offered to do so if that was of interest (to be shared privately and omitted from public platforms). We recognize that reserve lands are a product of colonialism and do not accurately reflect First Nations' traditional territories. The territories of First Nations encompass lands, waters, and everything in between, that extend beyond colonially set boundaries. In our efforts to honour First Nations' data sovereignty, we made concerted efforts to avoid digitizing imagery that could consist of any culturally sensitive and significant features. However, we acknowledge our very limited understanding of the full extent of these considerations. Further, we recognize the sensitivity of publicly available data and imagery and have reached out to First Nations within the project region to identify areas to exclude from both imagery and digitized data. **Please contact salmon@psf.ca to have data and imagery removed from public access at any time going forward. If capacity is limited, please let us know so we can provide support.**

LIMITATIONS & RECOMMENDATIONS FOR FUTURE WORK

The Resilient Coasts protocols were developed for the project's objective of mapping shoreline conditions at a discreet point in time. The following are limitations, often not feasible to achieve within the scope of this project but would be valuable to consider in the future to improve the protocols, and furthermore, increase the accuracy and usability of the data. This section also highlights factors to keep in mind when using the datasets produced by the Resilient Coasts project and when you are conducting your own analyses.

Data sovereignty

The Resilient Coasts team strongly recommend that any future data collection/digitization begin with formal processes for securing permission from each First Nation on whose territory you hope to work in, as noted in their specific engagement protocols. Further, we strongly advocate that future work be guided and prioritized by local First Nations governments and Nation members from inception, with financial compensation for their time as noted in each Nation's protocols for engagement.

General Caveats

These data should not be used for detailed analysis or decision-making without formal, in-depth assessments from qualified environmental professionals including coastal geomorphologists, who can provide expert guidance tailored at local scales.

The exact measurement and location of features that were digitized reflect the best of the recorders visual estimations and are not precise due to the complexity of using imagery to visualize real-world positions- the accuracy may vary by up to 3 metres for all data.

There is a high likelihood that a greater number of modifications on the shoreline exist than what is currently digitized; many elements in the landscape can obscure views, including dense vegetation.

The length of a line feature, for shoreline modifications, does not correspond to the level of impact it may have on natural coastal processes.

Beach access and boat ramp features do not distinguish between private or public access, nor are they exhaustive. We do not recommend using this dataset to locate beach access points or boat ramps.

Stormwater outfall data is not exhaustive. It is assumed that there is a greater number present that are not visible to the recorders.

Data Gaps

All three datasets are incomplete for a variety of reasons. Some examples of when data gaps occur:

- gaps exist in all three datasets where boat-based or aerial imagery were not available,
- when image quality was poor,
- when other features obstructed the view of the shoreline,
- when areas were excluded for privacy reasons and
- when requests for exclusions were made
- limited boat access - the area of coastline between Campbell River and Port McNeill is the largest gap. Imagery was not collected between the north edge of Campbell River and Port McNeill due to ocean conditions.

Protocol Adjustments

Total & Natural Shoreline Length Values

Natural (or 'unmodified') shoreline segments are not included in the protocol or datasets – non digitized segments of shoreline are assumed to be unmodified but poses issues when analyzing data and understanding the extent of mapping that was done. Line features were only added **when modification features were present**, leaving open lengths of shoreline present in the data.

You can improve your analyses by recording line features for 'natural' segments of shoreline in addition to the 'modified' line features. This will create a more precise shoreline length value for analyses purposes. To yield more detailed results, add shoreline substrate attributes for natural segments.

Alternatively, recorders can add a new line feature layer for the full length of the shoreline you are interested in. Follow the contour of the shoreline consistent with the protocol for modified segments.

Expand Modification Criteria

Adjust the protocol's criteria to include modifications that exist below the sediment and in the subtidal zone. In the current protocol, features are only digitized when there is a visible above-ground structure that intersects with the shoreline (where the upland meets the shore) or in exceptions where a large portion of a structure is located within the high intertidal zone. This criterion fails to capture additional features that interrupt natural coastal processes, such as partially imbedded stormwater outfalls that are only visible lower in the intertidal zone or subtidal zone.

Seasonal Considerations for Log Accumulation

Collect log accumulation data during the winter months as this would likely provide a more accurate representation of the maximum extent of accumulation due to winter weather causing greater movement of materials. The imagery was captured during the summer months when storms are less frequent, it is assumed that the Log Accumulation data layer represents a lower threshold of accumulation than what a specific area may hold during winter months.

Overwater structures data were collected during an optimal time. However, consideration of the following is encouraged for future data collection efforts. Some overwater structures are removed from the water seasonally to prevent damage to the structure and/or the marine environment. This dataset represents a snapshot of the overwater features that were present at the time when the imagery was captured. Since the imagery was captured in the summer months, these data likely represent the maximum number of overwater features that exist on a given shoreline throughout the year.

Adapt Estuary Protocols

An adapted protocol was required for some estuaries to accommodate complexity, leading to qualitative line feature data for the shoreline modifications data layer. In those cases, quantitative analyses are not possible without adjustments made to the estuary protocol and line features present. It would be beneficial to determine protocols for digitizing modifications in estuaries whereby all data can be used for quantitative analysis. We also recommend that researchers adapt or create new protocols for digitizing within estuaries to meet the specific needs of their project.

Attribute Options to Add or Adjust

1. Currently, the attribute options for Shoreline Modification Type are limited.

Add the following:

- 'Imminent' - Shoreline modifications that do not currently interact with natural coastal processes but are clearly imminent. This can serve as an alternative to 'natural'/'unmodified' shoreline segments, which would provide greater detail and context.
- 'Restored' and 'Restored Hybrid'- Segments of shoreline that were restored using nature-based approaches and hybrid approaches (i.e., using both 'hard' and 'soft' elements in their design). This addition would help differentiate between regular riprap and riprap used in a hybrid design, as they are not visibly apparent or known. For example, riprap can be

a part of a hybrid approach to shoreline protection but is considered a coastal modification feature in this protocol. The Comment attribute was used to record these observations/ knowledge.
- Expand the criteria for what a shoreline modification is, as noted above under Expand Modification Criteria.

2. Add 'Mixed' to the *Material* attribute options.

3. Adjust *Form* option from 'jetty/pier/breakwater' into two distinct options for 'jetty/pier' and 'breakwater'.

4. Add extra options for *Form*. Due to the protocol parameters, all wall structures, whether built as shore protection or to delineate property lines or deter trespassers, are included as shoreline modifications when they meet the protocol criteria (i.e., if they could interact with natural coastal processes). All walls are classified under the attribute "seawalls/bulkheads," although the intention behind building them may differ. More details can be produced by adding options under Form such as the following features commonly encountered during digitization:
   - fence
   - patio
   - berm (e.g., constructed industrial berms, training berms)
   - beach clearing (this often results in groynes on either side of the clearing)
   - cabin/house
   - boat house/boat storage

5. Detailed length and precise location data are not available for every feature. The protocol includes a step for addressing when two modification features are adjacent/connected to one another. This results in one line feature that contains at least two features. Form_1 is the primary modification type and can be filled on its own, however in many cases, Form_2 is used to describe a secondary feature. For example, Form_2 is entered when a feature exists within a larger modified shore segment (Form_1), such as a beach access path/stairs (Form_2) in the middle of a seawall (Form_1). This means that specific length data for Form_1 is available only when there is no Form_2 entered (i.e., Form_1's length includes the length of Form_2 when present). Consider adapting the process for identifying Form_1 and Form_2 to provide more detailed information or separate them entirely depending on the goals of your specific project.

Include Additional Attributes

1. If feasible, consider sourcing additional data on accretion, erosion (e.g., marsh elevation change), predominant wave energy, longshore transport, and localized sediment movement. Modeling future floodplain scenarios would be extremely valuable to visualize against the Resilient Coasts shoreline modification data.

2. Include a *Method used* attribute to indicate what imagery was used to digitize the data (e.g., aerial, drone, boat-based, none, etc.). This would reduce the need to fill in extra details into the comments section.

3. Include an attribute for *Structure Permanency*, to identify whether installations are moveable or not.

4. Include an attribute to identify when a segment of shoreline is human made (e.g., artificial shoreline creation created by infill). This may require sourcing data from multiple datasets.

5. Add attributes to describe shoreline slope, width, and toe elevations of each structure. No toe elevations were included.

External Data Layers

If you plan to conduct analyses with ShoreZone Shore Type data, it would be beneficial to explore the following:

   a. ShoreZone's original shore type dataset that does not include the 'human-made' shoreline type – this would provide the original shoreline type (i.e., what is hidden when the 'human-made' category is included), and
   b. ShoreZone's shore type data with the 'human-made' category.

In doing so, you may be able to yield more accurate, or more detailed, results and provide greater opportunities for QA/QC.

Pilings Data Considerations

Pilings in estuaries were only digitized (included in the Estuary/Shoreline Modifications dataset) when the pilings were lined up in the form of a wall, or when horizontal logs were anchored to them. However, the Overwater Structures dataset captures individual and group pilings, noting whether they are creosote treated. For comprehensive piling data, refer to the Overwater Structures dataset.

PROTOCOL: DIGITIZING MODIFIED SHORELINE FEATURES

The following describes the process for digitizing modifications along the shoreline as line features, with the goal of using total shoreline length to evaluate the extent of modifications along the coast, as well as the types of features present. The digitization methods described in this protocol were developed collaboratively by two recorders who observed and digitized features (shoreline modifications) for the Resilient Coasts for Salmon project. To ensure consistency, the two observers worked in parallel on test sections followed by comparisons, discussions of results, and establishment of rules through collaborative decision-making. Ongoing consultation between the two observers occurred, especially for difficult areas, to support a shared reasoning process and for interpreting data within the objectives of the project.

See Table 2 and 3 for a full list of steps. Special considerations were required for digitizing within estuaries and can be found in Table 3.

Confirmation of Shoreline Modification Features

Typically, the digitization process of observing and recording features by imagery utilizes between one and three sources to confirm the presence of a feature, but often all the following sources are utilized simultaneously: boat-based Resilient Coasts imagery, QGIS, ESRI, Mapillary/Open Street Maps, and Google Earth/Google Maps. Drone imagery supplemented some areas where boat imagery could not be taken. In some cases, sites were visited in person to ground-truth features that were obscured. When visits were not feasible, Google Map/Earth aerial imagery was used to confirm features. For the Resilient Coasts project, we used Mapillary to review and store the imagery that was taken for the purposes of this project; however, other platforms may be used in its place.

Confidence Ratings for Shoreline Modification Features

Confidence is rated as low, moderate, or high for each shoreline modification line feature based on the descriptions in the following table (Table 1). Confidence is rated using the same descriptions regardless of imagery source and often relied on a combination of imagery to determine the appropriate rating. The recorder adds the source and date the imagery was taken under the 'source' attribute field. For specific protocols for digitizing features within estuaries, see Table 3.

Table 1. Description of confidence ratings for shoreline modification features.

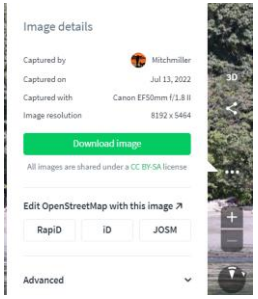
CONFIDENCE LEVEL	DESCRIPTION
Low confidence	*High degree of Uncertainty. The state of deficient visual evidence for the entire stretch of shoreline, or a portion of it.* These areas would be classified as low. This occurs when the understanding of the existence of a potential feature is too poor to make a solid judgement until it is visited in person to ground truth. The recorder is not confident that a feature exists, but it is possible.
Moderate confidence	*Lower degree of certainty/ Reduced but moderate confidence*. This may occur when the imagery is lower quality (i.e., dark/ low clarity) but when there is an elevated likelihood that a structure is present. Often, the beginning and end of a hard structure is not clearly defined, but some visual indications exist in the imagery to predict with some moderate confidence that it is present.
High confidence	*High degree of certainty/ Increased confidence*. The recorder is confident that a feature exists or has visual confirmation of a feature. High quality/resolution imagery provided a high level of certainty that a modification exists, either visible in boat-based, drone and/or satellite aerial imagery, or by ground survey. Little or no vegetation obscures the imagery, or the vegetation does not impede the evidence of a structure behind it. There is still a chance that high confidence does not represent accurate circumstances, especially in cases when historical aerial imagery is used to digitize features (i.e., not using imagery from the year you are digitizing).

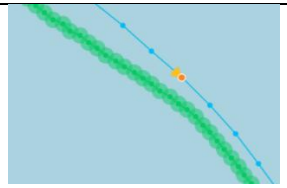
Protocol

Table 2. How to digitize modified shoreline features from imagery.

STEP	MAJOR ACTIVITY	PROTOCOLS, RULES, AND ADDITIONAL DETAILS
1	Download/ install QGIS and start a new project	Download the most recent version. A QGIS Standalone Installer is available at the following link at the time this document is being written - https://qgis.org/en/site/forusers/download.html Open QGIS to start a new project and follow the first 5 steps here, or select the existing project file located on the left side of the screen.
2	Select ESRI basemap	Select the ESRI basemap package in QGIS or download it if it is not present. If this is the first time using QGIS on your machine, you will want to install a plugin that allows you to view basemaps. To install the Quick Map Services plugin: • Open QGIS. Go to Plugins Menu >> Manage and Install Plugins • In the Plugins Window, search for QuickMapServices then click Install button • After it installs, you should be able to find QuickMapServices button in the Web Toolbar.
3	Create Layer in QGIS	Create Layer: click on the Layers>Create Layer>New Shapefile Layer. Give it a name; "Overwater Structures" for the layer and the file (and select file save location). Save a QGIS project file with your initials. If more than one person is entering data separately, ensure that the id (sequence of #'s attached to each line feature) does not overlap. From the 'Geometry Type,' choose "Line." Click OK to save the layer and close the tab.

		In the Layers panel, left-click on your new layer, and click Properties. Select the 'Fields' pane. In the top-left of the box, click the small pencil to activate editing mode, then select 'New Field.' Fill out the 'Add Field' popup parameters with the following: • ID (type: integer):* • Type (text): Anthropogenic modified, Anthropogenic modified on rocky outcrop • Form 1/Form 2 (text): seawall/bulkhead, riprap, beach access (path/stairs), boat ramp, groyne, dock, stormwater outfall, jetty/pier/breakwater, marina, gabion basket, ferry terminal, fill (sand, soil, or other material added), logging infrastructure, aquaculture infrastructure, other (comment) • Material (text): concrete, rock, wood, creosote wood, masonry, metal, undefined (add comment) • Confidence (text): high, moderate, low • Grdtruthed (text): yes, no • Comments (text): • Date (date): • Recorder (text): • Source (text): * Ensure the file name contains your initials. If more than one person is entering data separately, ensure that the id (sequence of #'s attached to each line feature) does not overlap. In the Attributes Form, under Layer Properties, enter the following to begin counting at 100,000: 'IF (maximum("id") is NULL, 100000, maximum("id") + 1)' Still in Properties, open the Symbology tab. Use the small green + to add fields, and add colours and shapes to express these feature types.

		Refer here for more details. If you are inputting the field attributes and need to adjust the sequence of fields, follow these instructions found on the GIS Stack Exchange Forum.	
4	Open boat-based mapping imagery in Mapillary & OpenStreet Map (OSM)	Open Mapillary in your web browser, select the icon with three dots located on the right-hand side of the screen (Figure 1). Select iD under 'Edit OpenStreetMap with this image' to open boat-based mapping data in OpenStreetMap (OSM) (Figure 2).	 *Figure 1 Use the icon with 3 horizontal dots to open OSM.*  *Figure 2 Select iD in Mapillary to open OSM.*

5	View imagery	Use multiple monitors/screens if possible. Find the location of interest that you want to digitize. Zoom in to full extent with the imagery pop-out box. There are two track lines in the boat-based imagery, one is a 360-degree view, and another is high resolution imagery (the blue line in Figure 3). This hi-res imagery is the clearest option to use. Switch between images using the arrows (Figure 4).	 *Figure 3 Two track lines to view imagery. OSM.*  *Figure 4 You can adjust the speed, pause and switch between the series of photos. Mapillary.*
6	Review multiple sources	After reviewing the boat-based imagery in OSM, it is often helpful and necessary to compare imagery across multiple platforms to increase confidence such as ESRI and Google Earth imagery. Google Earth allows you to view the shoreline from multiple perspectives, offering a variety of angles and imagery from different years; use the 'Year' button in the bottom-left corner. Ground truthing is encouraged for cases where an area is not visible by existing imagery. Use ESRI and Google Earth imagery in cases when ground truthing is not feasible and include citations under the source attribute, including the year the imagery was taken. Use the most recent imagery with optimal resolution. If an area is fully obstructed by all means listed above, clearly identify and keep track of these specific areas with GPS coordinates to help others that may use these data.	
7	Find features along the shoreline that were anthropogenically constructed	**When NOT to digitize features:** Do **not** digitize any features (modifications) on reserve lands or areas that First Nations have stated to omit. Avoid these areas and digitize around them, including a buffer. If you are unsure whether a modification is culturally significant, do **not** digitize it or include it in the dataset.	

Criteria (When to digitize features):
Only digitize modifications that can: **1)** impact natural coastal processes (including at high "king" tides) at the time of digitization **and** meet the following criteria below. This would **not** include upland structures, such as landscaping features (Figure 5).

Figure 5 An example of a landscaping feature (wall) that is not digitized because it is upland. Stewardship Centre for British Columbia, 2020.

2) When features are greater or equal to 2 metres in length. If length is difficult to gauge, create a temporary line feature by using the 'Measure Line' function in QGIS (Ctrl+Shift+M).

3) When there are visible above-ground structures on the shoreline that lie perpendicular to the shoreline (e.g., a groyne or outfall). Features that start high in the intertidal zone, such as the groynes in Figure 6 can also be digitized, even though they do not intersect at the upland/shore interface.
Features are **not** digitized when they are buried underneath the sediment, are subtidal, or are offshore (Figure 7).

Figure 6 An example of an exception to the rule - groynes built in the intertidal, with a substantial portion of the construction existing in the high intertidal zone. Image © 2025 Airbus via Google Earth imagery date: 4/2/2025.

4) Pilings are not considered a modification unless there are several lined up in a row, are situated to form a retaining wall (Figure 8) or are oriented in a position that would prevent drift logs from moving landward (e.g., towards a house). Methods differ for digitizing pilings within estuaries (see *How to digitize features within an estuary* below). All pilings are specifically captured in *Overwater Structures Protocol* below.

5) When small islands are connected to Vancouver Island by a road or concrete pathway (Figure 9). Fill would typically have been used to connect them. Do not digitize shorelines on islands that are not connected to Vancouver Island.

6) Do not include/digitize aquaculture infrastructure or equipment unless it is connected to the shoreline and considered permanent (not easily moveable) (Figures 10, 11). Instead, these will be covered with the *Overwater Structures Protocol* below.

7) All wall structures, whether built as shore protection, to delineate property lines or to deter trespassers, are digitized as shoreline modifications when they meet the protocol criteria (i.e., if they are at or waterward of the natural boundary and could interact with natural coastal processes). Classify walls with the attribute "seawalls/bulkheads," even though the intention behind building them may differ. Classify fences and patios as "Other" and include a note in the "Comments".

Figure 7 This structure (an outfall pipe) would impact coastal processes but would not be digitized because it exists mostly below ground on the shore (RC4S Imagery).

If you observe discrepancies between imagery sources, prioritize the most recent imagery.

Figure 8 An example of a retaining wall/bulkhead made with logs. RC4S Imagery, Mitch Miller.

Use Visual Indicators:

- Use indicators like stormwater outfall infrastructure (Figure 12), roads, and large trees as landmarks to help situate you as you digitize.
- Use driftwood and beach wrack lines as indicators for high tides (Figure 13).
- Use vegetation as an indicator surrounding and shoreward of the structure to help determine whether a feature should be digitized (e.g., salt tolerant vegetation species shoreward of the structure, or if terrestrial plant species are in front of the structure and whether it is minimal/sparse or appear to

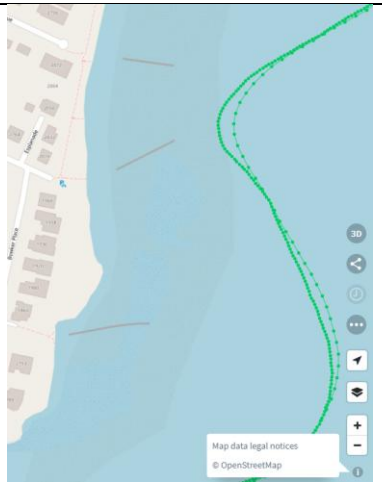
have been damaged by waves). Toe elevation indications found in *Armor Mapping Methods for the Puget Sound Region* (pg. 11) can also help determine the placement of a feature.

- When a feature is obscured by vegetation, zoom in fully to see colour gradients and texture variations in the imagery to help identify the presence of a feature (or where one starts and stops).
- Anthropogenic fill is not always obvious (e.g., extra land created for logging infrastructure). The ShoreZone "human-made" shore type layer may help decipher where fill or other modifications are (Figure 14).

Figure 9 Example of an island attached by a road to Vancouver Island. Image © 2025 Airbus via Google Earth imagery date: 6/12/2024.

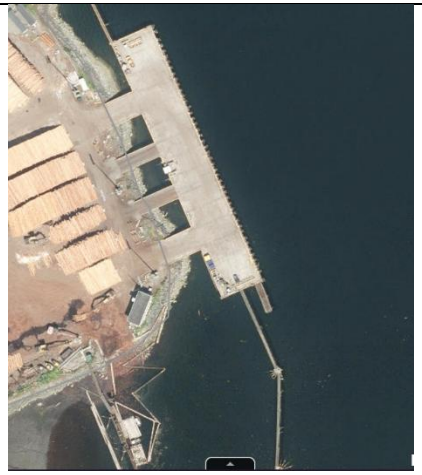
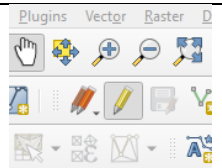
Figure 10 An example of aquaculture equipment that would not be included/digitized. Image © Landsat/Copernicus via Google Earth imagery captured 7/26/2022.

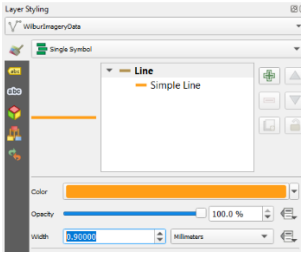
Figure 11 An example of permanent aquaculture infrastructure. Image © 2025 Airbus via Google Earth Imagery Date: 7/8/2023.

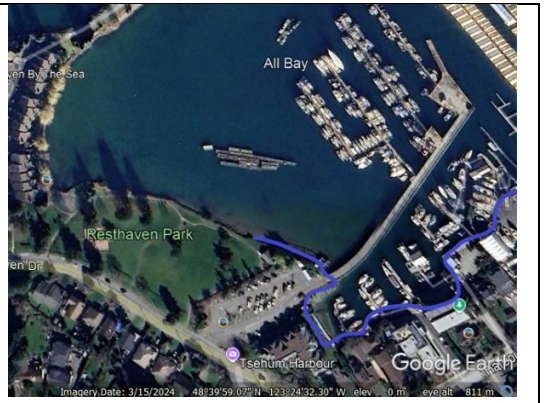


Figures 12 Stormwater infrastructure can be used as visual indicators. OpenStreetMap via Mapillary.

Figure 13 Driftwood. Image © 2025 Airbus via Google Earth imagery captured 3/15/2024.

			 *Figure 14 The grey line shows the human-made shore type layer from ShoreZone. North Cowichan imagery, 6/24/2022, North Cowichan, Vantor | Esri, HERE, Garmin, iPC, NRCan, via Marine Ecosystem Map.*
8	Select "toggle editing" mode to start the digitization process	The yellow pencil icon is for toggle editing mode (Figure 15).	 *Figure 15 Toggle editing mode selected (Yellow pencil icon). QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*
9	To add a line feature	Select "Add Line Feature" in QGIS (Figure 16).	 *Figure 16 Icon for creating a line feature. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*

10	Create a line feature	Left click your mouse to begin a line feature, working as close to the modification as possible. Trace the contour/curvature of the shoreline using vertices as needed. Right-click to end the individual line feature. You can switch between the Pan Map mode (Figure 17) and Edit mode as you create a line feature. The line feature will continue to be made until you right-click your mouse to complete it. Select a colour (e.g., orange, # ff9e17) for the line and increase the thickness to 0.9mm. Set these styles as the default (Figure 18). **Rules for creating line features:** 1. Line features should **not** overlap with one another. 2. All modifications of the same type and material can be mapped in a continuous line regardless of property lines or time of construction. 3. When a structure, like a groyne or pier, runs perpendicular to the shoreline, digitize the part that **runs parallel to the shore only** (Figure 19). 4. When digitizing a marina, add a line along the shoreline parallel to where the marina is built, including where the shoreline has been modified to support or protect the marina (Figure 20). **Create a new line feature when one of the following occurs:** 1. The modification/feature ends and the shore is natural/unmodified or modified by not yet interacting with natural coastal processes.	 *Figure 17 Pan Map icon.*  *Figure 18 Selecting the style for your line feature. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 19 How to digitize a groyne (see orange line feature). Image © 2025 Airbus via Google Earth imagery captured 4/2/2025.*

		2. There is a change in the form of the modification (from seawall to riprap). However, any feature that sits within another larger feature, that is equal or less than 2 metres, can be classified as Form_2. 3. There is a change in the material of the modification (concrete to wood). 4. There is a change in your level of certainty (confidence). 5. When the imagery source has changed.	 *Figure 20 An example of how to digitize a marina. Image © 2025 Airbus via Google Earth imagery captured 3/15/2024.*
11	Fill in field attributes See **Data Dictionary** in the Appendix for more attribute details.	iD - is automatically generated Type - refers to the shoreline substrate that a modification sits on. *Anthropogenic modified on rocky outcrop* refers to a feature located on consolidated sediment - a solid rocky substrate such as a rocky platform or outcrop (built on top of rock) (Figure 21). *Anthropogenic modified* refers to a feature located/built on a shoreline that is unconsolidated sediment – e.g., sandy, pebbly, or cobble substrate (Figure 22). Form 1 and Form 2 - describes the feature(s) being entered. Form_1 is the primary feature type. Although not necessary, use Form_2 to add a secondary feature found within Form_1. E.g., stairs to the beach exist in a seawall, whereby Form_1= seawall, Form_2= beach access (Figure 22). In this case, Form_1 is the main structure with longer length, and Form_2 is the shorter length structure that sits within it. If there are two parallel	 *Figure 21 Example of Type: "Anthropogenic modified on rocky outcrop". There is a structure built on a rocky outcrop. Imagery © 2025 Airbus via Google Earth Imagery Date: 9/20/2025.* 

		installations, such as riprap and a seawall, Form_1 would be the most prominent feature, for example, the modification that has a greater length or greater cover on the shoreline. The most waterward modification can be used if it is difficult to decipher which is most prominent. For marinas, Form_2 can be used to describe a specific modification associated with the marina, while Form_1 = marina (Figure 23). *Gabion basket* features do not require Form_2 or material. Classify wall structures created to delineate property lines or for walls to create boundaries around a private patio, as seawalls/bulkheads. Fences can be included under "other" and noted in the comments. Material – select the dominant material of the feature where it intersects with the shoreline. Comments can include notes for mixed materials. Confidence – ratings reflect the recorder's degree of certainty of the presence and location of a feature, assigning either Low, Moderate, or High. See Step 14. Date – the date that the feature was digitized for internal team awareness. Recorder – the name of the individual digitizing.	*Figure 22 A seawall (Form_1) with beach access (Form_2), located on Anthropogenic Modified (Type). RC4S Imagery, Mitch Miller.*  *Figure 23 Form_1= marina, Form_2= riprap. Image © Landsat/Copernicus via Google Earth Imagery Date: 8/19/2016.*

		Grdtruthed – indication of whether a feature was visited in person to ground truth its presence. Comments – any additional notes that the recorder feels are relevant to providing more detailed information about the feature. Source – the primary source of imagery used to confirm the presence of a feature (e.g., RC4S Imagery, Google Earth, ESRI, etc.) with date imagery was taken and 3rd party contributors (Figure 24). Check specific platforms for attribution guidelines.	 *Figure 5 A screen-capture from Google Maps, showing the imagery credits on the bottom right of the screen. Imagery ©2025 Airbus, Maxar Technologies, Map data ©2025.*
12	Select a confidence rating See **Table 1** for confidence ratings	Ratings reflect the recorder's degree of certainty of the presence and location of a feature, assigning either Low, Moderate, or High. If you are unsure, be conservative and digitize it as low confidence (and visit the site if possible). Approach confidence ratings the same regardless of imagery source. When confidence is rated Low or Moderate, it is helpful to include details describing reason(s) why confidence is less than High. Factors that influence certainty: • quality of imagery • the ability to observe features from boat-based imagery and satellite imagery • whether dense vegetation obstructs view • ability to perceive depth accurately (position of feature in relation to the shoreline and upland) • consistent observations between reliable observers • whether the area has been visited in person (ground truthed)	
13	Editing a line feature	The Vertex tool (Figure 25) and Edit->Edit geometry tab corrects line features. For example, you can adjust a line's position by	

	and attributes	dragging the vertices or add length by clicking + icon that appears when hovering over a feature. To edit a line feature's attributes, select the 'Identify features' icon, then right-click on the line feature (Figure 26). Click the 'Edit feature form' button under 'Identify Results' in the feature form (pop up window).	*Figure 25 Vertex tool.* *QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 26 Identify features icon.*
14	Saving data	Save both the layer (Figure 27) and project (Figure 28) regularly to avoid losing data.	 *Figure 27 Icon for saving the data layer.* *QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 28 Icon to save the full file.*

HOW TO DIGITIZE COASTAL MODIFICATION FEATURES WITHIN ESTUARIES

The protocols outlined above are designed to map modifications (features) along the shoreline, with the goal of using total shoreline length to evaluate the extent of modifications along the coast. Due to the dynamic and changing nature of estuarine forms and habitat types, special considerations are required in most estuaries, whereby total shoreline length is not an appropriate measure for the extent of modifications. To obtain the most relevant modification data within estuaries, we are interested in all modifications built on all estuarine habitat types (e.g., estuarine marsh, estuarine meadows, etc.). Like the protocol above, the goal is to identify modifications at a discreet point in time. Therefore, steps 10 to 16 outlined in the above protocol are generally kept the same for digitizing within estuaries. However, adjustments were made to accommodate several of the estuaries within this project scope. Table 3 outlines the protocols for digitizing modifications within estuaries where the 'shoreline' is not easily defined, and where features overlap across tidal marsh, mud flats, and other nearshore landscapes. The protocols have been established specifically for the purposes of this project, using a qualitative and exploratory approach.

Table 3. How to digitize features within estuaries.

TASK	INSTRUCTION	IMAGE EXAMPLE
When to use estuary protocols	When digitizing, switch from shoreline to estuary protocols as needed, and keeping track of which areas required the estuary protocols. To reflect the specific needs of this project, estuary protocols were used in cases where modifications existed on both the shoreline bank ***and*** on marsh habitat, whereby line features overlapped (Figure 29). This provided the opportunity to visualize modification extent in a qualitative form, where analyses would not be feasible. Due to the complexity of estuaries, this decision of whether to use the estuary protocol	 *Figure 29 Example of when estuary protocols are helpful. Esri Community Maps Contributors, City of Courtenay (2022), Esri Canada, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, US Census Bureau, USDA, NRCan, Parks Canada | AeroQuest MapCon Inc., Maxar.*

	was made on an estuary-by-estuary basis based on the features present during the time of digitization. **In cases where there were no overlapping line features in an estuary, the *Shoreline Modification Protocol* was used to provide quantitative data.**	
What imagery sources to use	Utilize the boat-based imagery for the full extent if available. For areas where boat-based or drone imagery is not available, use reliable, recent, high-resolution aerial imagery (e.g., Google Earth, ESRI). Include the source and imagery date in the comments section. **If you observe discrepancies between imagery sources, prioritize the most recent imagery.** Researching additional sources to confirm discrepancies can increase confidence. On the right, you will see an example of berms in the Cowichan estuary: • berms present in drone imagery (Figure 30), • not present in Google Earth (Figure 31),	 *Figure 30 Screenshot from drone imagery shows berms/dikes in Cowichan estuary. Drone imagery screenshot by Mitch Miller.*  *Figure 31 Satellite in Cowichan estuary shows the removal of remnant berms/dikes with the soils re-distributed. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*

	• research about the area showed that restoration occurred and berms were removed (Figure 32).	 *Figure 32 Image from ArcGIS Storymap by Cowichan Tribes, Nature Trust, and partners for the 'Cowichan Estuary Restoration Project' showing the extent of the berms that have been removed. Left image source: Image © 2025 Airbus via Google Earth Imagery Date: 10/10/2022.*
How to delineate digitization boundaries	**Landward boundary:** Defining a natural boundary for estuaries is challenging due to the extensive alterations and impacts (e.g., filling, draining, and diking). For clear and consistent boundaries when digitizing, digitize up to the point when the following is reached: terrestrial vegetation, or where roads/ highways run parallel to or intersect estuarine habitat (Figure 33). While this does not represent the actual boundary of the estuary, it provides a practical limit for assessing modifications within a defined scope. Ensure that tidal forested wetlands, if present, are included in the digitization process. **Seaward boundary:**	 *Figure 33 Digitize landward until you reach either terrestrial vegetation or major roads and highways. The light-yellow line indicates Highway 1 in this aerial view of Cowichan estuary. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*

	Digitize modifications that are present within 1,000 meters seaward of the Freshwater Atlas Coastlines (FAC), including modifications surrounding shoals and marsh islands (Figure 34). In some cases, you may find guidance on estuarine boundaries from other resources, such as the Pacific Birds Habitat Joint Venture, and Nature Trust. In a separate document, clearly identify the entire area that was digitized with estuary protocols, with GPS coordinates and a polygon, as this will assist others who will use these data to conduct analyses (Figure 35).	 *Figure 34 An example of shoal islands that you may encounter in estuaries within 1000m of the FAC. Chemainus estuary. Image © 2025 Airbus via Google Earth Imagery Date: 6/12/2024.*  *Figure 35 An example of a polygon (blue line) to show the total area covered in the digitization process. Image © Landsat/Copernicus via Google Earth imagery captured 8/18/2016.*

What modifications to digitize and where to place line features	**When NOT to digitize features:** Do **not** digitize any features (modifications) on reserve lands or areas that First Nations have stated to omit. Avoid these areas, including a buffer. If you are unsure whether a modification is culturally significant, do **not** digitize it or include it in the dataset. When digitizing, switch from shoreline to estuary protocols as needed, and keeping track of which areas required the estuary protocols. Recorders digitize the full length of features within the estuary, rather than follow the contours of only the shoreline (i.e., qualitative data is the goal of digitization). For example, the RC4S recorders digitized berms in a continuous line by tracing the shape or curvature of the berm (Figure 36). As per protocol, these areas would be excluded from analyses. Classify berms under 'Other' and provide details in the Comments. It is common to find areas within estuaries that have been converted for	 *Figure 36 Dikes/berms are digitized for their entire length within estuaries. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*  *Figure 37 Agricultural fields within an estuary that is bordered by a dike/berm to protect it from inundation. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*  *Figure 38 An example of agricultural production. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*

	industrial purposes like agriculture. In such cases, the recorder can assume that any lands near estuary channels or within estuary marshes or meadows—areas that would be flooded regularly—are protected by berms/dikes to prevent inundation. These modified areas should be included in the digitization process (Figures 37, 38). Training berms are also found in estuaries, where they modify the natural movement of water, i.e., channelizing waterways. These are not distinguished from regular berms in the modification forms. Straightened channels that are either being 'trained' or used as drainage ditches were not digitized unless there are berms alongside them. Roads, bridges, and berms are often built through estuaries on infill, creating new terrestrial land that did not exist historically (Figure 39). Include these features when digitizing. The ShoreZone 'human-made' data layer can be a helpful reference to determine where fill may have been added.	 *Figure 39 Digitize raised walkways, paved pathways & roads that are present in estuaries. RC4S Imagery, Mitch Miller.*  *Figure 40 An example of riprap in front of a road in an estuary. Image © Landsat/Copernicus via Google Earth imagery captured 8/18/2016.*  *Figure 41 Vertical pilings secured with horizontal logs to hold/corral processed logs. Image © 2025 Airbus via Google Earth Imagery Date: 10/10/2022.*  *Figure 42 An example of aquaculture equipment that would not be included/digitized within this data layer. Image ©*

	Recorders may observe riprap armouring along the waterward edge of berms and raised roads, typically installed to prevent erosion or stabilize the structure - enter Form_1 as 'Other' = berm/dike or road, and Form_2 as 'riprap' (Figure 40). Record any relevant details in the comments section. Pilings are commonly found in estuaries to serve logging operations – digitize these areas only when there are horizontally placed logs secured to these pilings (e.g., Form_1 = logging infrastructure) (Figure 41). Individual pilings are collected as point features in the *Overwater Structures and Pilings Protocol*. Log booms secured by other means (e.g., rope connected to hard substrate) are not digitized. Do not include aquaculture infrastructure or equipment in the digitization process unless modifications are connected to the shoreline and considered permanent (i.e., not easily moveable) (Figures 42, 43). Instead, these more transient structures will be covered in the *Overwater Structures and Pilings Protocol*.	*Landsat/Copernicus via Google Earth imagery captured 7/26/2022.*  *Figure 43 An example of permanent aquaculture infrastructure. Image © 2025 Airbus via Google Earth Imagery Date: 7/8/2023.*

PROTOCOL: DIGITIZING OVERWATER STRUCTURES

The following describes the process for digitizing overwater features in the intertidal and nearshore using point features, with the goal of describing the spatial extent and location of features present. This includes docks (personal/residential, abandoned, those associated with a boat ramp), marinas, industrial structures, ferry terminals, creosote pilings and tourism-related features like piers, walkways and wharfs, at a discreet point in time using point features, and include information on building materials and whether the feature was permanent or floating. The data can be used to extrapolate the extent of overwater features on a local scale to help inform planning and decision making to help manage and minimize impacts on coastal ecosystems. The following described the processes to digitize overwater structures and pilings from imagery.

The digitization methods were originally developed by a co-op student, Sophie Weissfloch, who worked as a research assistant for the Pacific Salmon Foundation. Weissfloch led the Resilient Coasts team through the methodology, providing examples from the imagery. The protocols were updated with minor adaptations to suit the needs of the project, and digitization continued by a Resilient Coasts team member.

Confirmation of Overwater Structures

Boat-based imagery of the shoreline was used to observe, record, and digitize overwater structures and creosote pilings. When available, drone imagery supplemented areas where boat-based imagery was not feasible. Google aerial imagery supported the observation and confirmation process on occasion. Ground truthing was not performed, therefore this layer represents a snapshot in time. Because the imagery was captured during the summer months, there is a high likelihood that the dataset represents the extent of overwater structures that were present during the time of year the imagery was taken.

Confidence Ratings for Overwater Structures

Confidence is rated as low, moderate, or high for each overwater feature based on the descriptions below (Table 4).

Table 4. Descriptions of confidence ratings for overwater structures.

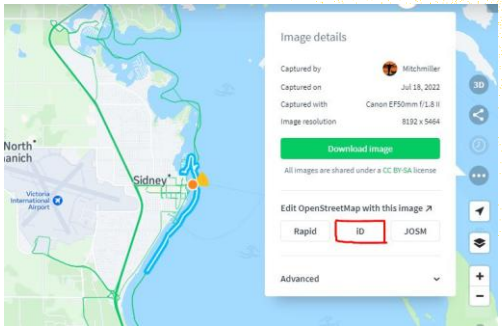
CONFIDENCE LEVEL	DESCRIPTION
Low confidence	*High degree of Uncertainty. The state of deficient visual evidence for a feature's presence.* These areas would be classified as low. This occurs when the understanding of the existence of a potential feature is too poor to make a solid judgement until it is visited in person to ground truth. The recorder is not confident that a feature exists, but it is possible.
Moderate confidence	*Lower degree of certainty/ Reduced but moderate confidence*. This may occur when the imagery is lower quality (i.e., dark/ low clarity) but when there is an elevated likelihood that a structure is present. Some visual indications exist in the imagery to predict with some moderate confidence that a feature is present. Perhaps the recorder is certain of the presence of a feature, but less confident about the specific type.
High confidence	*High degree of certainty/ Increased confidence*. The recorder is confident that a feature exists or has visual confirmation. High quality/resolution imagery was available (boat-based imagery). There is still a chance that high confidence does not represent accurate circumstances.

Protocol

Table 5. How to digitize overwater structures and pilings from imagery.

STEP	MAJOR ACTIVITY	PROTOCOLS, RULES, AND ADDITIONAL DETAILS
1	Create Layer, Save file and distinguish ID numbers	Refer to steps 1-2 in Table 2 if you need to create a new QGIS project. Then, in your QGIS project, follow these steps below. Make sure you have an ESRI satellite basemap selected. Create Layers: click on the Layers>Create Layer>New Shapefile Layer. Give it a name; "Overwater Structures" for the layer and the file (and select file save location). Save a QGIS project file with your initials. If more than one person is entering data separately, ensure that the id (sequence of #'s attached to each line feature) does not overlap. From the 'Geometry Type,' choose "Point." Click OK to save the layer and close the tab.

		In the Layers panel, left click on your new layer, and click Properties. Select the 'Fields' pane. In the top-left of the box, click the small pencil to activate editing mode, then select 'New Field.' Fill out the 'Add Field' popup parameters with the following: • ID (type: integer)* • Type (text): personal/residential dock (small), personal/residential dock (large), marine (small), marina (large), abandoned dock, creosote pilings, industrial overwater structure, ferry terminal, dock associated with boat ramp, pier/wharf/boardwalk • Form (text): floating (attached to movable stairs), floating (not attached to movable stairs), permanent (pilings anchored into sediment) • Material - Pilings (text): creosote/treated wood, vinyl wrapped, metal, concrete • Material (text): wood, metal, concrete, mixed • Confidence (text): high, moderate, low • Comments (text) • Date (date) • Recorder (text) *Distinguish ID numbers: Ensure the file name contains your initials. If more than one person is entering data separately, ensure that the id (sequence of #'s attached to each line feature) does not overlap. In the Attributes Form, under Layer Properties, enter the following to begin counting at 100,000: 'IF (maximum("id") is NULL, 100000, maximum("id") + 1)' Still in Properties, open the Symbology tab. Use the small green + to add fields, and add colours and shapes to express these feature types. Refer here for more details. If you are inputting the field attributes and need to adjust the sequence of fields, follow these instructions found on the GIS Stack Exchange Forum.

2	Set Up Boat-Based Imagery in OSM to observe overwater structures in your location of interest	Use two or three monitors to improve ease of digitizing. Open QGIS on one screen, with OpenStreetMap (Mapillary) and Google imagery data on the one or two other monitors. Open Mapillary and search for the area you want to observe. Click the three dots on the right side of the screen and press the iD box in between 'RapiD' and 'JOSM', under 'Edit OpenStreetMap with this image' (Figure 44). This will open up Open Street Map. There will be two track lines in Mapillary and OSM. These two track lines are images taken from the boat. One of the track lines is a 360-degree view, while the other is high resolution imagery (the line with points further apart)– use the latter for optimal resolution, and use the 360-degree imagery to confirm the location of floating, unattached docks and creosote pilings (Figure 45). Overwater features and creosote pilings can be found along the shoreline, in the intertidal and nearshore (within approximately 300 metres from the shore). Overwater features are typically attached to the shoreline by some means; however, there are floating docks anchored to a piling or a mooring buoy.	 *Figure 44 - How to open OSM via Mapillary.*  *Figure 6 Click points along the track lines to view imagery. OSM.*

3	Review Satellite Imagery (optional)	Open Google Earth (or other aerial imagery platform) and locate your area of interest. The date the satellite imagery was taken will be on the bottom left-hand side. Use the most recent imagery with optimal resolution (Figure 46). If the boat-based imagery lacks clarity, verify whether the features are visible on Google Earth within the same year. In some cases, areas were not captured by boat (e.g., most estuaries), in which case satellite aerial imagery can be used to verify overwater features during that year. If there are discrepancies between the boat-based imagery and aerial imagery, defer to what is seen in the boat-based imagery.	 *Figure 7 It may be difficult to see features that sit behind other features like marinas in the boat-based imagery. If you suspect there may be a structure, use Google imagery data to verify. Image © Landsat/ Copernicus via Google Earth Imagery Date: 8/19/2016.*
4	Digitizing Features	In QGIS, select the overwater features layer on the left-hand side. Select 'toggle editing' mode (the yellow pencil icon), followed by 'add point feature' (the icon with three points) *(Figure 47).* When a feature of interest is found in the imagery, place the point feature on the approximate center of the feature. Do **not** digitize any features (modifications) on reserve lands. Instead, avoid these areas and digitize around them. If you are unsure whether a modification is culturally significant, do **not** digitize it or include it in the dataset. **Criteria:**	 *Figure 47 Toggle editing mode (yellow pencil) then select the icon with three dots to begin digitizing point features. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 48 - An industrial overwater structure (red dot) built at the end of a human-made spit in an estuary. This structure is built far out in the*

1. Only digitize structures that are present in the intertidal or nearshore zone and meet the following criteria:

2. Only digitize overwater features within approximately 200 metres from the shore. However, in estuaries digitize features within 1000 metres from the shoreline. Overwater structures in estuaries often extend into the intertidal zone or nearshore- these will typically be industrial overwater structures (e.g., log processing infrastructure) present within 1000 metres of the shoreline (Figures 48 and 49). If no boat-based or drone imagery exists for estuaries, then use the most recent Google imagery data available, and record the imagery type and year in the comments. Confidence rating should reflect the quality and recentness of the imagery.

3. There are often small islands/islets near Vancouver Island, digitize features surrounding these islands when they are connected to Vancouver Island by road or pathway.

Rules:

1. One point should be used per feature. Some exceptions apply and are detailed below.

2. Only digitize free-standing pilings that are treated with creosote (i.e., leave out any free-standing pilings made of other materials).

estuary from the natural shoreline. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

Figure 49 - An industrial overwater structure. RC4S Imagery, Mitch Miller.

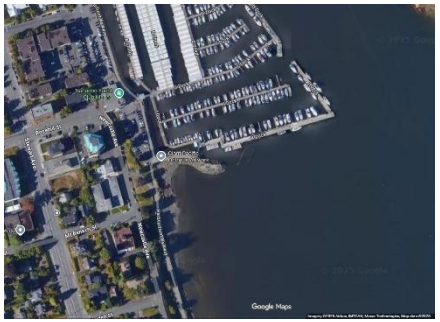


Figure 50 - Multiple marina-type docks extending from shore can be considered part of one large marina (use one point to mark the feature). Imagery © 2025 Airbus, IMTCAN, Maxar Technologies, Map data © 2025.

3. Mark free-standing pilings as a single point feature as close to the feature as possible. For clusters or linear assemblages of pilings that are separate from other features (e.g., not associated with marina or logging industry), mark a single point feature in the approximate middle of the assemblage and write in the comments the approximate number of pilings that the point represents.

4. If a boat moorage/storage area is separated into multiple docks/buildings that are in close proximity, do not assume that each dock has a separate marina owner. Use a single point feature to label it as a large marina (if the total boat storage is >50; (Figure 50).

5. Do not digitize log storage areas, as these are transient overwater structures. These will look like a collection of floating logs, corralled together on the surface of the water (Figure 51).

6. To determine how far up an estuary (i.e., how far landward) to digitize overwater features, use your judgement to determine a natural boundary where the estuary begins to branch and form marsh habitat. For eastern Vancouver Island estuaries, these boundaries are often marked by major roads

Figure 51 - Aerial imagery of a log storage area, where the floating logs are corralled in the estuary. Image © 2025 Airbus via Google Earth Imagery Date: 5/31/2023.

Figure 52 – Use major roads and highways to infer the landward boundary of an estuary. The yellow line indicates highway 1 in this aerial view of the Chemainus estuary. Image © 2025 Airbus via Google Earth Imagery Date: 6/12/2024.

		or highways that run parallel to the shoreline (Figure 52). 7. For pilings in estuaries: there are often vertical pilings installed for various reasons: training structures that help influence the movement and accumulation of sediment in certain areas, used as cues for helping vessels navigate through the waterways, or associated with industrial activities such as log processing. Only digitize free-standing pilings that are likely or obviously treated with creosote. Add a point feature on individual free-standing pilings, or in the approximate center of the group if there are many individual pilings or clusters of pilings. Use the 'comments' attribute to note the approximate number of pilings. Only digitize free-standing pilings that would meet the water at some point in the tidal cycle (i.e., do not digitize terrestrial/ upland pilings) (Figure 53).	 *Figure 53 - A grouping of creosote pilings present in the nearshore of the Cowichan estuary (circled in red). Add a point feature in the approximate middle of this grouping, then note the number of pilings in the comments. RC4S Imagery, Mitch Miller.*
5	Describe Feature with Attributes See **Data Dictionary** in **Appendix 1** for full attribute details.	Select the attribute table icon (Figure 54). Choose the most appropriate responses for each attribute by selecting one of the drop-down options once the point feature has been placed: ID is often automatically generated. If not, input numbers in chronological order to avoid duplicates. ***Note: If you want to check what number is assigned to a line feature:*** *In the 'Layers' panel (bottom left in QGIS), highlight the layer that you want to work with, e.g., "Overwater*	 *Figure 54 - Click the icon shown in red to open the attribute table to make any changes. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*

Structures" and zoom out so that everything you have digitized so far is visible in your map viewing window. In the top tool bar, click the "Open Attribute Table" button to view all the features you have digitized so far. On the left side of the table, there is an "Expressions" panel. Use the scroll bar to view the numbers that you have already assigned to a feature. Scroll to the bottom to view the last number you used – your next feature will be that number plus 1 (Figure 55).

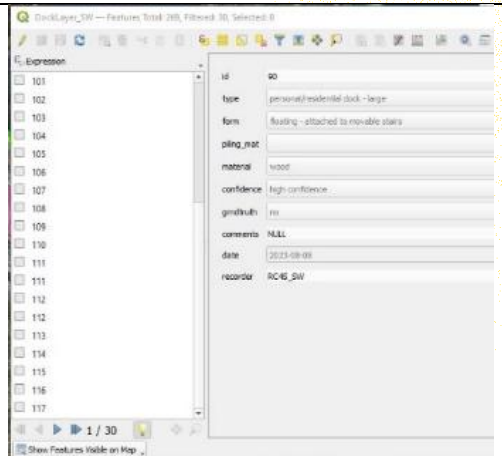


Figure 55 - The attribute table showing the full list of digitized features in that layer by ID number. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

Type – Type is the first descriptor of the overwater feature. See the data dictionary starting in Appendix 1 for more photos and full descriptions of each type.

Personal/residential docks can be found in front of or near homes or private properties. Personal docks can be described as small (capacity for 1-2 vessels) or large (capacity for >2 vessels).

Marinas are recognized by a series of docks with a large capacity of moored watercrafts. Marinas can be described as small (capacity for ≤ 50 vessels) or large (capacity for >50 vessels).

Abandoned docks -unused, unmoored, or broken docks, usually found washed up on the shoreline, usually not attached to any walkways or stairs, and in some state of disrepair (Figure 56).

Figure 56 - An abandoned dock left on the shoreline. RC4S Imagery, Mitch Miller.

Creosote pilings - pilings sticking out from the water with nothing attached to them, that are creosote treated.

Industrial overwater structure – structures in the lower intertidal and nearshore that are associated with industrial activities including logging, milling, and aquaculture.

Ferry terminal – terminal structures in the nearshore where passenger ferries dock; can include associated structures such as parking, gangways, and more.

Dock associated with boat ramp – a dock that directly accompanies a boat ramp. Typically present at municipal wharves and boat launch areas to allow for a queue of boats to prepare to launch while others dock (Figure 57).

Pier/wharf/boardwalk - long overwater structures often perpendicular to a shoreline that are intended for tourism and public use – can include restaurants, sheltered seating.

Form - describes whether the dock observed is floating or permanent.
Floating – not attached to moveable stairs: the dock is sitting on the surface of the water and can be moved. It is not set in place with pilings and does not have a walkway or stairs that connect it to the shoreline.

Floating – attached to movable stairs: the dock is sitting on the surface of the water and can be moved. It is not set in place with pilings but does not have a walkway (gangway/ramp) or stairs attached that extend from the backshore or high intertidal (Figure 58).

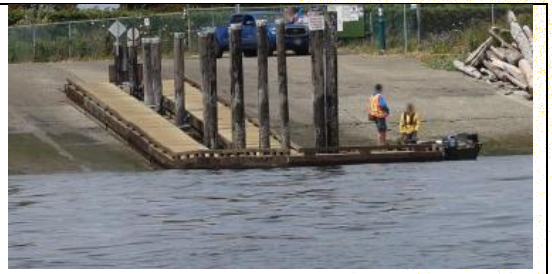


Figure 57 - A small dock associated with a public boat launch. RC4S Imagery, Mitch Miller

Figure 58 - A floating dock with a ramp/walkway linking it to the shoreline. RC4S Imagery, Mitch Miller

Permanent:
Has pilings anchored into the sediment.

Material (of the overwater feature) – describes the dominant material of the overwater feature visible to the recorder. Common materials for overwater structures: wood, concrete, metal, and mixed. Often, personal docks are made of wood (on the surface). Note that there are often buoyant materials such as polystyrene and air-filled rigid plastic containers associated with floating overwater structures but are not visible above the surface of the water (Figure 59). For this attribute, note the dominant material that is visible in the imagery. Leave this attribute blank if unsure, or if you are digitizing free standing creosote pilings.

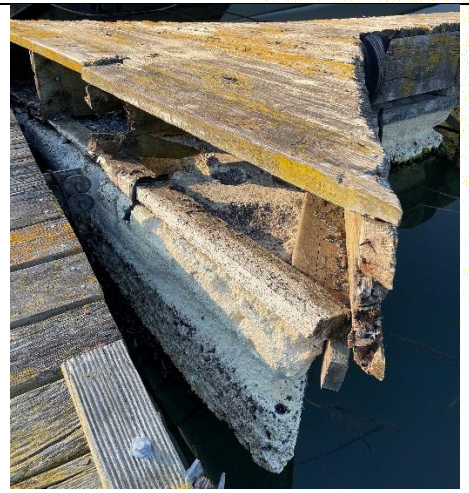


Figure 59 - The underside of a floating dock reveals a polystyrene core beneath the wood structure (RC4S Imagery).

Material of Pilings - describes the material of the pilings that are attached to permanent docks and other overwater structures such as ferry terminals and industrial overwater features. Common materials of pilings include creosote/treated wood, vinyl wrapped, and metal. Select the most dominant material visible, if more than one is present. Metal pilings are often a rust color, and vinyl wrapped pilings have a black vinyl wrapping from the bottom of the piling to about halfway up. Leave this attribute blank if unsure, or if there are no pilings attached to the feature (e.g., floating dock). If digitizing free-standing creosote pilings, leave this attribute blank, or select creosote/treated wood.

Figure 60 - A screen-capture from Google Maps, showing the imagery credits on the bottom right of the screen. Imagery ©2026 Airbus, Maxar Technologies, Map data ©2026.

		Confidence – The level of certainty a recorder has that a feature exists, and that the location of attributes selected is accurate. Assign the feature a confidence level of either Low, Moderate, or High. • If confidence is rated high, then no further explanation is required if confidence is rated high. • If confidence is rated low or moderate, provide a reason in the Comments attribute. **When determining the confidence level, consider some of the following factors:** • Whether the feature is clear in the boat-based imagery. • Whether the features can be observed from the boat imagery and satellite imagery. • Ask a second observer to view the imagery and provide feedback on their interpretation of the imagery, and the details of the feature in question. See Table 4 for more details on Confidence ratings. Comments - any additional notes that the recorder feels are relevant to providing more detailed information about the feature. Comments are necessary when reasoning needs to be added as to why certain attributes were selected, if there are doubts about the imagery, or if any secondary shoreline features were observed (e.g. when there is a boat storage shed attached to a small personal dock, the recorded would note the additional structure of the storage shed).

		Date - the date that the feature was digitized. Recorder – the name of the individual digitizing. Source – if something other than the boat-based imagery was used as the primary source of imagery to confirm the presence of a feature, then note it here. When using Google Maps or Google Earth, the imagery source appears in the bottom of the screen, starting with "Image(ry) ©..." (Figure 60). Copy the imagery credits as they appear on the screen, then note the platform on which you viewed the data (e.g., Google Earth), and the date of the imagery that you are viewing. The imagery credit in the 'Source' attribute should appear as such: "Imagery ©2025 Airbus, IMTCAN, Maxar Technologies, Map data ©2025 via Google Earth imagery captured 6/9/2024."
6	Editing a point feature and attributes	If you need to delete a point feature or move it to another location, use the vertex tool (Figure 61). The individual vertexes will become illuminated by red circles, and you can left-click each to delete, or move it. To edit the attributes associated with a point feature, select the "Identify Features" icon, and right-click the point feature (Figure 62). In the 'Identify Results' panel, select 'Edit Feature Form' to open the form and edit the attributes. You must be in editing mode (pencil highlighted) to edit the attribute form (Figure 63).

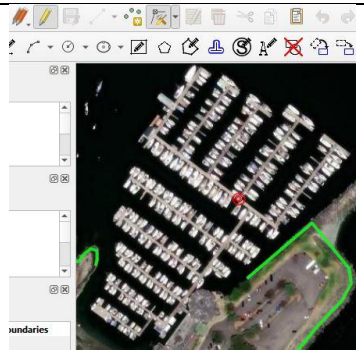
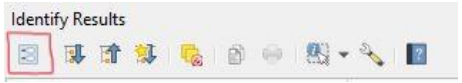


Figure 61 - Toggle edit mode (yellow pencil) then click the Vertex tool and left click on any feature to move or delete it. QGIS Development Team (2020). QGIS Geographic Information

			System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.  *Figure 62 - Identify features icon.* *QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 63 - In the Identify Results panel, select the Edit Feature Form button (circled in red).*
7	Save & Export Data	Save both the layer (Figure 64) and project (Figure 65) regularly to avoid losing data. First, click on the 'Save Layer Edits' button, then save the project file. When you are ready to share/ export your data, you will save all layers as a geopackage using the followings steps: QGIS - Learn / GeoPackage (openwaterfoundation.org). • Click "project" on the top left and choose "Save/Save As." This saves the project. • Click "Processing" > "Toolbox" • Click the small arrow to expand 'Database' section. • Click 'Package Layers' in the 'input layers' field, click the … button and select the layers that you want to include. • Click 'Run' to allow the data packaging to begin.	 *Figure 64 - Icon for saving the data layer.* *QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 65 - Icon for saving the full file.*

PROTOCOL: DIGITIZING LOG ACCUMULATION

The following describes the processes used for digitizing log accumulation as line features. The goal of digitizing these features is to describe the spatial extent and level of accumulation along the shoreline at local scales, and help address potential connections between log accumulation, logging industry, and impacts to forage fish spawning beaches. The digitization methods were originally developed by a co-op student, Sophie Weissfloch, who worked as a research assistant for the Pacific Salmon Foundation. Weissfloch led the Resilient Coasts team through the methodology, providing examples from the imagery. The protocols were updated with minor adaptations to suit the needs of the project, and digitization continued by a Resilient Coasts team member.

Confirmation of Log Accumulation

Imagery of the shoreline, that was taken by boat, was used to observe, record and digitize log accumulation. Drone imagery supplemented one area where boat-based imagery was not feasible. Ground truthing was not performed, therefore this layer represents a snapshot in time.

Confidence of Log Accumulation

Confidence is rated as low, moderate, or high for each segment of log accumulation based on the following descriptions below.

Table 6. Description of confidence ratings for log accumulation.

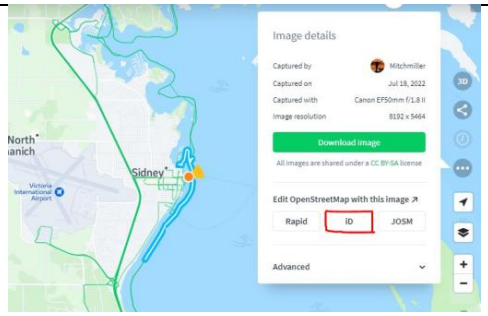
CONFIDENCE LEVEL	DESCRIPTION
Low confidence	*High degree of uncertainty. The state of deficient visual evidence for the entire stretch of shoreline, or a portion of it.* These areas would be classified as low. This occurs when the understanding of the visibility in the imagery is too poor to make a solid judgement about the number of logs on the shoreline. The recorder is not confident of the amount or beach that the logs cover but can make an informed guess with the imagery available.
Moderate confidence	*Lower degree of certainty/ Reduced but moderate confidence*. This may occur when the imagery is lower quality (i.e., dark/ low clarity) but when there is an elevated likelihood that the category of log accumulation is accurate. In these cases, parts of the shore segment may be partially obstructed by

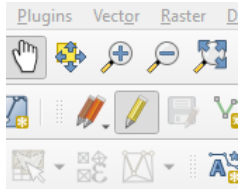
	features like boats in the nearshore or overhanging vegetation, impacting the observer's view, or the slope of the beach made it difficult to see the full extent of the accumulated logs. The observer can see most of the shore segment clearly and may have used Google imagery data to check their assessment.
High confidence	*High degree of certainty/ Increased confidence*. The recorder is confident of the existence of a feature or has visual confirmation of the number of logs on the shore. High quality/resolution imagery provided a high level of certainty that the coverage category accurately reflects what is seen in the imagery. There is little or no part of the shore segment that is obscured by boats, overhanging vegetation, or otherwise. The observer may have used Google imagery data to check their assessment but feels confident without it. There is still a chance that high confidence does not represent accurate circumstances.

Protocol

Table 7. How to digitize log accumulation on shorelines from imagery.

STEP	MAJOR ACTIVITY	PROTOCOLS, RULES, AND ADDITIONAL DETAILS
1	Create Layer, Save file and distinguish ID numbers	Refer to steps 1-2 in Table 2 if you need to create a new QGIS project. Then, in your QGIS project, follow these steps below. Make sure you have the ESRI satellite basemap loaded. Create Layers: click on the Layers>Create Layer>New Shapefile Layer. Give it a name; **"Log Accumulation"** for the layer and the file (and select the file save location). From the 'Geometry Type,' choose "Line." Click OK to save the layer and close the tab. In the Layers panel, left click on your new layer, and click Properties. Select the 'Fields' pane. In the top-left of the box, click the small pencil to activate editing mode, then select 'New Field.' Fill out the 'Add Field' popup parameters with the following: • ID (type: integer)* • Type (text): low, moderate, high, extreme • Mobility (text): mobile, anchored, both • Creosote (text): yes, no, uncertain • Natural (text): yes, no, uncertain • Confidence (text): high, moderate, low

		• Comments (text) • Date (date) • Recorder (text) *Distinguish ID numbers: Ensure the file name contains your initials. If more than one person is entering data separately, ensure that the id (sequence of #'s attached to each line feature) does not overlap. In the Attributes Form, under Layer Properties, enter the following to begin counting at 100,000: 'IF (maximum("id") is NULL, 100000, maximum("id") + 1)' Still in Properties, open the Symbology tab. Use the small green + to add fields, and add colours and shapes to express these feature types. Each type should be expressed as a different colour on your map: Low = green Moderate = yellow High = orange Extreme = red Refer here for more details. If you are inputting the field attributes and need to adjust the sequence of fields, follow these instructions found on the GIS Stack Exchange Forum.
2	Set Up Boat-Based Imagery in OpenStreetMaps and observe log accumulation in your	Use two or three monitors to improve ease of digitizing. Open QGIS on one screen, with OpenStreetMap (Mapillary) and Google imagery data on the one or two other monitors. Open Mapillary and search for the area you want to observe. Click the three dots on the right side of the screen and press the iD box in between 

	location of interest	'RapiD' and 'JOSM', under 'Edit OpenStreetMap with this image' (Figure 66). This will open Open Street Map (OSM). There will be two track lines in Mapillary/ OSM. These two track lines are images taken from the boat. One of the track lines is a 360-degree view, while the other is high resolution imagery (the line with points further apart)– use the latter for optimal resolution (Figure 67).	*Figure 66 - How to open OSM.*  *Figure 67 Click points along the track lines to view imagery in OSM.*
3	Digitizing Features - Observe the shoreline of interest and assess the level of log accumulation present	Log accumulation is determined by the percent cover or extent of the beach that is covered by the logs and is described as low (≤19%), moderate (20-49%), high (50-89%) or extreme (≥90%) (see Step 4) and the Data Dictionary for more details). In QGIS, click the layer you want to work with, then select 'toggle editing' mode to place the point feature and then 'add line feature'. *Click the yellow pencil, and then the icon showing a green line connecting points to create a line feature (Figures 68 and 69).* When adding a line feature to represent the level of log accumulation: Start a line feature at any natural point along the shoreline (e.g., community boundary) and end it ***when a change in the category (amount) of accumulation is observed***. At your starting point,	 *Figure 68 - Toggle editing mode selected (yellow pencil icon) in QGIS.*  *Figure 69 - Once in editing mode, select the icon with dots connected by a green line to begin digitizing a line feature in QGIS.*

click to add your first point of the line feature, then think about which category of log accumulation (see step 4 for details on the categories of log accumulation) you would use to describe this particular area of beach. Make a mental note, then continue moving along the shoreline with the Open Street Maps imagery and add points to your line in QGIS to follow where you are in the imagery. When the amount of log accumulation changes to a different category (e.g., low to high), add a vertex to your line at that point of transition, then right-click to complete your line. This finishes the individual line feature (Figure 70).

You can switch between the Pan Map mode (Figure 71) and Edit mode as you create a line feature. The line feature will continue to be made until you right-click your mouse to complete it.

Do **not** digitize any features (modifications) on reserve lands. Instead, avoid these areas and digitize around them.

If you are unsure whether a modification is culturally significant, do **not** digitize it or include it in the dataset.

Criteria (When to digitize features):

)igitize logs that are no longer living or are ttached to the soil by roots, including logs that have

Figure 70- On the left side of the yellow line, there is a moderate accumulation of logs, which stops approximately at the yellow line. The recorder would end their 'moderate log accumulation' line feature here and begin a 'low log accumulation' line. RC4S Imagery, Mitch Miller.

Figure 71 - Pan Map icon to move to other parts of the map.

scaped industry log booms (that contain cut ends) nd naturally sourced logs (may contain branches, ots) that have fallen, are no longer rooted in its riginal place (in the backshore soil), and/or drifted hrough natural processes.
igitize the entire length of shoreline to provide data n the level of log accumulation present at the time hat imagery was taken.
igitize line features for the level of accumulation of gs between the high tide line and the backshore.

Rules:

1. Log accumulation is digitized for the entire shoreline where imagery is available, including when zero logs are present in some areas.
2. Follow the contour of the shoreline using vertices as needed (Figure 72). Left-click your mouse to begin a line feature, tracing the line across the approximate mid to upper intertidal zone to reflect where the logs have accumulated. Right-click to end the individual line feature.
3. The 'type' or category of log accumulation assigned is based on the amount of logs present in each shore segment. Assess the amount of logs present between the natural boundary/backshore and high tide line and estimate a percent cover value for the area that is covered by logs. Typically, the natural boundary presents a physical

Figure 72 - A line feature digitized to describe a shore segment of moderate log accumulation. QGIS Development Team (2020). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

Figure 73 - An accumulation of logs on the shoreline, as seen in the boat-based imagery. RC4S Imagery, Mitch Miller.

Figure 74 Logs often accumulate throughout estuarine marsh platforms. RC4S Imagery, Mitch Miller.

		border where log accumulation stops. On regular shorelines, assess the number of logs that exist between the high tide line to the natural boundary/backshore to make your decision about the accumulation category (Figure 73). In estuaries, the observer should also consider the number of logs that have accumulated on the marsh as well as any intertidal beach or backshore areas that may be present. During storms and high tides, logs can get deposited on top of the marsh, potentially smothering the habitat or causing scour when they are moved around by waves (Figures 74 and 75). 4. Do not digitize logs that are still attached to the shoreline bank (Figure 76). When looking at fallen/dead trees, ones that are attached to the soil will appear as angled over the shoreline, rather than resting directly on the shore like that in Figure 77. Often, natural logs (e.g., dead and dying trees) will be in the process of falling onto the beach but are still attached to the soil. 5. Line features should **not** overlap one another. 6. Only logs that have accumulated on a beach through natural processes (i.e., wind and wave, bluff erosion), whether they are processed or natural, should be considered log accumulation. Do not digitize logs that	 *Figure 75 Here, the yellow line (moderate log accumulation) was digitized to account for all the logs on the marsh platform landward of the FAC. QGIS Development Team (2020). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 76 Sometimes dead trees remain attached to the shoreline, where they overhang the shore. These should be excluded from the log accumulation data. RC4S Imagery, Mitch Miller.*  *Figure 77 A detached natural-source log (dead tree) that would be considered in the log accumulation assessment*

		are present on the shoreline as pilings (vertical logs stuck into the sediment) or as part of a landscaping or protective structure such as a seawall or bulkhead (Figure 78). Logs that have been moved to form seating or as part of forts and other temporary structures on the shoreline should be counted in your assessment of log accumulation (Figure 79). 7. In areas where the imagery is missing or low quality to the point where a determination of classification cannot be made, add a note about this in a separate document, and leave this area undigitized (i.e., no line feature). 8. Use Google imagery data only as a secondary source of data to check your assessment of log accumulation. See the Tips section below for how Google imagery data can support your assessments. 9. If you come across an accumulation of natural logs where trees have fallen onto the shoreline from a bluff or riparian area, leave a comment about the type of materials (e.g. rock, sand, debris) you see within this segment of shoreline, and notes about signs of erosion and/or sloughing from a bluff or backshore (Figure 80). 10. Ere on the conservative side if you are uncertain (i.e., if you are stuck between	*because it is no longer attached or rooted in soil. RC4S Imagery, Mitch Miller.*  *Figure 78 Pilings in the nearshore, such as these, should not be digitized as log accumulation, as they have not arrived at this location through natural processes. RC4S Imagery, Mitch Miller.*  *Figure 79 A temporary structure made of woody debris, which should be considered when assigning a log accumulation category to this segment of shoreline. RC4S Imagery, Mitch Miller.*

low and moderate accumulation, choose low).

11. Do not digitize floating log storage areas (Figure 81); only digitize logs that have come loose and ended up on the shoreline or marsh platform.
12. If there are logs that have been arranged parallel to the shoreline as a means of keeping logs within an area (associated with logging industry), do not include this in your digitization (Figure 81).
13. Use the Freshwater Atlas Coastlines (FAC) dataset to determine how far up an estuary to digitize log accumulation (i.e., how far inland you should follow the creek, river, stream, or channel that flows into an estuary). Since there is no 'shoreline' at stream crossings, do not add a line feature (for log accumulation) in these areas (Figure 82).

Figure 80 An erosion event caused this bluff to slough off sediment and for trees to fall onto the shoreline. RC4S Imagery, Mitch Miller.

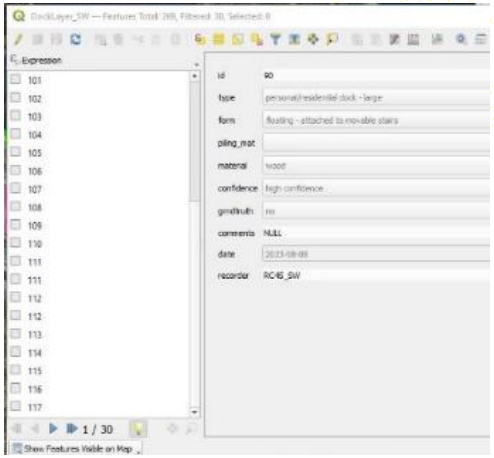
Figure 81 Aerial imagery of a log storage area, with horizontal logs line the edges of this inlet as a 'log barrier'. Neither of these features should be digitized as log accumulation. Imagery ©2025 Airbus via Google Earth Imagery 10/10/2022.

<u>Tips:</u>

- Sometimes your view of the entire beach can be obstructed by overhanging and low-lying branches from trees (Figure 83). Use the zoom feature and approach the location from different angles (select a variety of dots on the track line) to best determine whether there are logs underneath those branches.

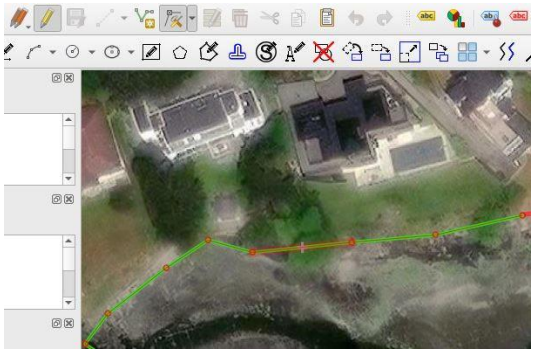
Figure 82 Freshwater Atlas Coastline (FAC), where a stream enters the estuary. Only digitize log accumulation as far landward as the FAC. QGIS Development Team (2023). QGIS Geographic Information System. Open

		• Google imagery data can support recorders by providing an angle and perspective for the width a beach or segment of shoreline may have at a given time and can provide depth perception that is better than what is often visible in the boat-based imagery. The aerial perspective can help support or reject your assessments from what is visible in the boat-based imagery (Figure 84). Always use the most recent aerial imagery available to check the amount of accumulated logs. The log accumulation data should reflect the snapshot in time when the boat-based imagery was taken.	*Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 83 Overhanging vegetation from live and dead trees can obscure your view of the log accumulation. RC4S Imagery, Mitch Miller.*  *Figure 84 Use Google imagery data to confirm the size of the accumulation in areas where it is difficult to determine due to the slope of the beach or the quality of the boat-based imagery. Image © 2025 Airbus via Google Earth Imagery Date: 5/31/2023.*
4	Describe Line Feature with Attributes See **Data Dictionary** in **Appendix 1** for	When the attribute table opens, select the most appropriate responses for each by selecting one of the drop-down options once the line feature has been placed: ID is often automatically generated. If not, set a starting value to avoid duplicates with other recorders. Open the attributes form and select ID,	

	full attribute details.	then under the 'Defaults' menu, enter the 'Defaults value' this code: IF (maximum("id") is NULL, 1, maximum("id") + _a number_). **If you want to check what number is assigned to a line feature:** In the 'Layers' panel (bottom left in QGIS), highlight the layer that you want to work with, e.g., "LogAccumulation" and zoom out so that everything you have digitized so far is visible in your map viewing window. In the top tool bar, click the "Open Attribute Table" button to view all the features you have digitized so far (Figure 85). On the left side of the table, there is an "Expressions" panel. Use the scroll bar to view the numbers that you have already assigned to a feature. Scroll to the bottom to view the last number you used – your next feature will be that number plus 1 (Figure 86). Type - a descriptor for the segment of shoreline and its level of log accumulation (for the specific line feature created) and indicates one of the following: • *Low* is a percent cover between 0 and 19% • *Moderate* is 20 to 49% • *High is 50% to 89% (Figure 87)* • *Extreme* (%) is ≥ 90% Creosote Logs – indicates the	 *Figure 85 - Click the icon shown in red to open the attribute table to make any changes.*  *Figure 86 - The attribute table showing the full list of digitized features in that layer by ID number. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*  *Figure 87 - An example of a high log accumulation segment (type). RC4S Imagery, Mitch Miller.*

		presence or absence of creosote-treated logs within the log accumulation segment. Creosote logs are unnaturally darker in color and will be free of roots and branches (Figure 88). *Yes:* Select yes if there is even one creosote log in the section being analyzed. *No:* Select 'no' if none are present, *Uncertain:* it is unclear due to image quality, obstructions blocking certain logs, or otherwise. Mobility – describes the ability of logs to be moved by incoming waves and tides on the shore. *Anchored: all the logs in this segment seem to be partially embedded in the soil.* These logs will not move by wind, waves, or the regular cycle. *Mobile:* all of the logs in this segment appear to be resting on top of the sediment or rock. These logs will be easily moved by wind, waves, or the regular tidal cycle (Figure 89). *Both*: There are both anchored and mobile logs present in the segment. Natural – indicates whether there is a presence of natural source logs such as logs with branches, roots, and/or root wads (Figure 90). They can be the same size, smaller, or larger than cut logs, but contain some remnant natural parts. Select one of the following: *Yes* - if there is at least one log that is unprocessed.	 *Figure 88 - Creosote logs will appear darker than natural logs, often with dark patches where the creosote is seeping out of the interior. RC4S Imagery.*  *Figure 89 A mobile log that could easily be moved or carried away by an incoming wave or higher tide. RC4S Imagery, Mitch Miller.*

		No - if no natural logs are present and visibly confirmed. *Uncertain* - if it is unclear whether natural logs are present in the segment, due to image quality, obstructions blocking part of the segment, or otherwise. Confidence – The level of certainty that a feature exists, and the attributes are accurate. ratings reflect recorder's degree of certainty of the presence and location and descriptions of a feature, assigning either *Low, Moderate, or High* • If confidence is rated high, then no further explanation is required. • If confidence is rated low or moderate, provide a reason in the Comments attribute. **When determining the confidence level, consider some of the following factors:** • Whether the features can be clearly observed from the boat, imagery, including adequate depth perception to determine the level of accumulation. • Ask a second observer to view the imagery and provide feedback on their interpretation of the imagery, and the details of the feature in question. See Table 1 for more details on Confidence ratings.	 *Figure 90 A root-wad, considered a natural log. RC4S Imagery, Mitch Miller.*

		Comments - any additional notes that the recorder feels are relevant to providing more detailed information about the feature, when reasoning needs to be added as to why certain attributes were selected but were low or moderate confidence, if there are doubts about the imagery, or if any additional shoreline features were observed such as driftwood forts. Date - the date that the feature was digitized. Recorder – the name of the individual digitizing.	
5	Editing a line feature and attributes	Use the Vertex Tool to edit line features, such as deleting or adjusting portions of a line, and adjusting a line's position by dragging the vertices (Figure 91). The individual vertexes will become illuminated by red circles, and you can click each to delete, move, or add additional vertexes to the line (Figure 92). You can also add more length to a line by clicking on the + sign that appears when you hover over the line. To edit attributes associated with a line feature, select the "Identify Features" icon, then right-click on the line feature (Figure 93). The feature form will pop up, click the "Edit Feature Form" button under Identify Results.	 *Figure 91 Vertex Tool.*  *Figure 92 The vertices of the line feature will become highlighted by red circles when the vertex tool is active. You can click on each vertex to move, delete, or add to it. QGIS Development Team (2023). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*

		Additional editing options can be found under Edit, Edit Geometry. E.g., to move a line feature.	 *Figure 93 Identify Features icon.*
6	Save & Export Data	Save both the layer (Figure 94) and project (Figure 95) regularly to avoid losing data. First, click on the 'Save Layer Edits' button, then save the project file. When you are ready to share/ export your data, you will save all layers as a geopackage using the followings steps: QGIS - Learn / GeoPackage (openwaterfoundation.org). • Click "project" on the top left and choose "Save/Save As." This saves the project. • Click "Processing" > "Toolbox" • Click the small arrow to expand 'Database' section. • Click 'Package Layers' in the 'input layers' field, click the ... button and select the layers that you want to include. • Click 'Run' to allow the data packaging to begin.	 *Figure 94 Icon for saving the data layer.*  *Figure 95 Icon to save the full file.*

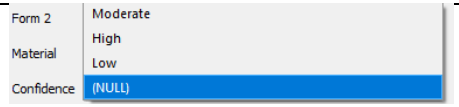
APPENDIX 1- DATA DICTIONARY

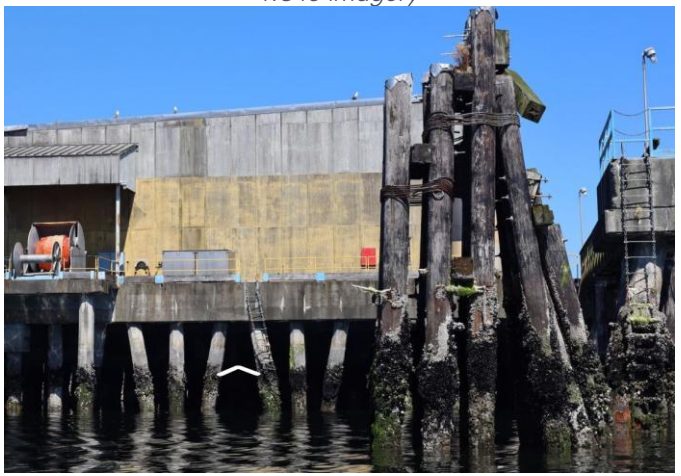
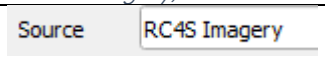
TERM	DEFINITION	EXAMPLES
agricultural marshland	An area that was historically subject to tidal flooding and natural coastal processes, but was altered and converted, with dykes, ditches, drainage, roads, breakwaters and other modifications, for agricultural purposes.	 *Agricultural fields within an estuary that are bordered by a dike/berm to protect it from inundation. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*
anchored (logs)	Refers to the logs accumulated on beaches; logs that are secured in place, preventing them from drifting and moving. Can be secured by being trapped and lodged in sediment, wedged in between rocks, or held by a rope. Anchored logs are not easily moved by natural forces.	 *RC4S Imagery, Mitch Miller*
anthropogenic modified/ anthropogenic modified on rocky outcrop	Any human-made feature that can impact natural coastal processes, with distinction made for what sediment type the structure is built upon. If the structure was built on unconsolidated materials, that feature is just called 'anthropogenic modified', whereas if it was built upon a solid rock platform, the distinction was made that the feature is called 'anthropogenic modified on rocky outcrop.'	 *'Anthropogenic modified' - built on unconsolidated sediment. RC4S Imagery, Mitch Miller.*

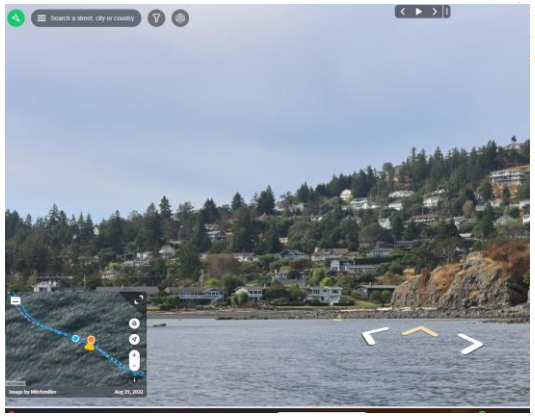
	See 'type' attribute in the shoreline modification layer in the interactive map.	 *'Anthropogenic modified on rocky outcrop' - built on solid rock platform. RC4S Imagery, Mitch Miller.*
backshore	The backshore exists above the ordinary high water mark, experiencing ocean influence during extreme tides, especially combined with storms. Regarding log accumulation: the upper limit of where logs would be deposited during storm or king tide events would be found here (above the natural boundary – landward of the OHWM).	 *Mitch Miller*
basemap	The background map you select when in aerial view (e.g., ESRI Satellite).	
beach access/path	A pathway/pedestrian access to the shoreline.	 *RC4S Imagery, Mitch Miller*

beach wrack	A line of dried seaweed, kelp, seagrasses, and other debris that gets deposited at high tide.	 *RC4S Imagery*
berm/dike	For this project, berm is used interchangeably with the term dike and is defined as a human-made structure designed as a barrier to prevent flooding by the sea. Berms can take the form of raised mounds of fill, like compacted soil, ridges, walls, or embankments. Berms are typically built to protect industrial activities occurring on converted estuarine habitat, like agriculture and logging operations.	 *Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024.*
boat ramp	Ramps for boats, kayaks, and other vessels to access the ocean; usually made of poured concrete.	 *RC4S Imagery*

breakwater	A barrier that provides an area of reduced wave energy, commonly for harbors and marinas (ShoreZone). Can be oriented perpendicular or parallel to the shore.	 *RC4S Imagery*
coastal modification/ shoreline modification	Any human-made feature that can impact natural coastal processes or contribute to coastal squeeze. This includes walls that have been built to protect land along the coast from the sea (e.g., bulkhead/seawall/riprap), freestanding structures like homes built below the natural boundary, boat ramps, and modifications associated with piers and docks, etc. These structures can be made of a variety of materials including concrete, rocks, masonry, wood, etc. Used synonymously with shoreline modification.	 *RC4S Imagery*
coastal squeeze	The loss of habitat due to sea level rise where hard structures, like seawalls, prevent habitats from naturally migrating landward.	
comments	A field when digitizing to provide space for comments by the recorder. The recorder can add relevant details like what a feature is when it falls under 'other' (form) category, if there are additional features present in a	

	segment (e.g., a driftwood fort structure in the log accumulation data layer), an explanation for confidence rating selection, or to record the approximate number of pilings represented by a data point in the Overwater Structures dataset.	
concrete	A digitization attribute to indicate the material the shoreline modification is made from (e.g., seawall made of concrete).	 *Concrete wall (RC4S Imagery)*  *Concrete pilings (RC4S Imagery, Mitch Miller)*
confidence	Confidence ratings are assigned to indicate the degree of certainty of features entered in QGIS. Line Features for shoreline modifications and Point Features for overwater structures have a confidence rating of either Low, Moderate or High within the field attributes. See digitization protocols for more details.	

creosote (treated) wood	A digitization attribute to indicate that a log on the shoreline is treated with creosote and could have negative impacts on the shoreline ecosystem. Or to indicate the material of pilings associated with an overwater feature. Creosote is a coal tar preservative that prevents decay but is toxic and is commonly used in the marine environment.	 *RC4S Imagery*  *RC4S Imagery, Mitch Miller*
data source	In the interactive map, the data source is listed in the pop-up window to indicate who created and owns the data.	

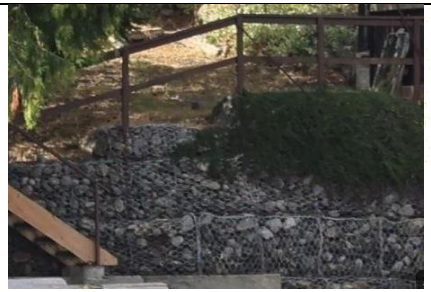
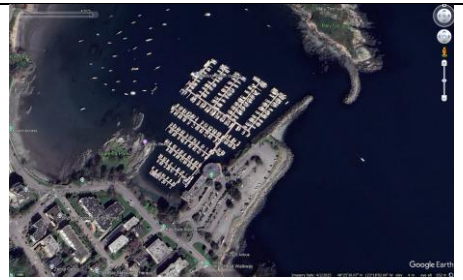
digitize/ digitization/ digitizing	In this project's context, digitization refers to the process of converting imagery (boat-based and satellite aerial imagery) or ground-truthed visual inspections, into data in QGIS (line and point feature vector data), to serve as a representation of real-world geographic features (i.e., shoreline modifications, overwater structures, log accumulation). The term classify is often used synonymously.	 *An example of the recorder's Mapillary screen during digitization, whereby shoreline modifications are converted into line features. Imagery by MitchMiller, via Mapillary licensed under CC BY-SA.*
dike	See berm.	
dock	An overwater structure typically used for recreation and to secure boats. Often, but not always, accompanied by an overwater walkway that connects the dock to the shore. See below for distinct dock type definitions.	 *RC4S Imagery*
dock associated with boat ramp	A dock associated with a boat ramp, typically associated with public launch sites. The dock is intended to assist boaters in launching into and out of the water.	 *Image © 2025 Airbus via Google Earth Imagery Date: 3/15/2024*

dock (personal/ residential – small)	Private overwater structures built along the shoreline, typically extending into the nearshore, and serve as a designated space for the access of personal watercrafts or for other uses (e.g., patios, boat sheds, cabins). Small personal/residential docks are privately owned and can hold one or two boats maximum. There are some examples of small docks that are owned by restaurants offering 1-2 spots for guests to visit their establishment. These are considered small personal docks.	 *RC4S Imagery*
dock (personal/ residential – large)	Private overwater structures built along the shoreline, typically extending into the nearshore, and serve as a designated space for the access of personal watercrafts or for other uses (e.g., patios, boat sheds, cabins). Large personal/residential docks are privately owned and can hold more than two boats.	 *RC4S Imagery, Mitch Miller*

dock (abandoned)	Dock that is no longer used, maintained, or in service. Abandoned docks can be recognized by the lack of maintenance: overgrown vegetation or accumulation of dirt and debris, deterioration (rotting/decaying wood), or structural instability (weakened/damaged support posts).	 *RC4S Imagery, Mitch Miller*
feature	An object of interest that is being digitized; either an object built on the shoreline (shoreline /coastal modification), an overwater structure, piling, the presence and level of log accumulation, or another object. The terms *object*, *hard structure*, and *modification* are often used interchangeably. In the interactive map, the primary feature type is listed in the title of the feature pop up window. Often, there may be a secondary feature listed in the pop-up window as well, to highlight a less dominant feature that is also present in the digitized line or point feature. E.g., a seawall may be the primary feature, but beach access may be a secondary feature if there are stairs included in that section of the seawall.	 *Feature: riprap (RC4S Imagery)*

ferry terminal	A feature/ structure that provides services for passengers traveling by vessels. Other vessel terminals that are not for public passengers are also included.	 *RC4S Imagery, Mitch Miller*
floating – not attached to movable stairs	In the context of docks (see dock definition). Structures designated to float on the surface of the water. A floating structure can be moved locations or removed from the water at any time. These structures are not supported by pilings that are fixed into the sediment; however, they may be tethered to the shore with chains, rope, or structural arms, but not walkways or stairs. Floating docks can sometimes be found on the shoreline (outside of the water).	 *RC4S Imagery, Mitch Miller*
floating – attached to movable stairs	In the context of docks (see dock definition). Structures designated to float on the surface of the water but are attached to the shore by a walkway/gangway. These structures are not supported by pilings that are fixed into the sediment; however, the walkways that attach to them are often supported by pilings.	 *RC4S Imagery, Mitch Miller*

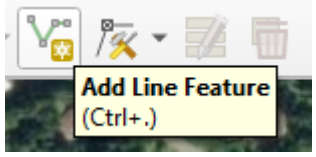
foreshore	The zone from the low water mark to the high-water mark (indicated with a red arrow).	 *Mitch Miller*
form	A digitization attribute to describe a particular feature/physical structure or its purpose (e.g., seawall, riprap, groyne). There is Form_1 and Form_2 for the Shoreline Modifications dataset. For the Overwater Structures dataset, features are categorized as floating or fixed. See specific protocols for more details.	 *Form_1: seawall, Form_2: stormwater outfall (RC4S Imagery)*  *Example of 'fixed' - permanent structure affixed with pilings that are installed in the sediment. RC4S Imagery, Mitch Miller.*

gabion basket	A digitization attribute that indicates the material the shoreline modification is made from. A type of retaining wall. A wirework container structure filled with materials (e.g., rocks).	 *RC4S Imagery, Mitch Miller.*
Google imagery data	Google imagery data utilized in the digitization process uses satellite imagery and aerial photography, including Google Map data from third party providers. E.g., Google Earth can be used to access satellite imagery and allows you to view the shoreline from multiple perspectives, offering a variety of angles and imagery from different years.	 *Image © 2025 Airbus via Google Earth Imagery Date: 4/2/2025*
ground truth	A digitization attribute indicating whether the segment of shoreline (feature) was visited and verified in-person.	 *RC4S Imagery*

groyne/groin	A human-made structure built perpendicularly (or at an angle) to the shoreline that interrupts natural coastal processes.	 *RC4S Imagery*
halophytic vegetation	Salt-tolerant plants that encounter saline waters either through salt spray, their roots or occasional inundation and can thrive in sandy soils. They typically grow in buffers along estuaries and marine environments. Examples of halophytes include sea asparagus (*Salicornia* spp.), sea plantain (*Plantago maritima*), beach pea, dune grass, and pink/yellow sand verbena.	 *RC4S Imagery*
hard armour(ing)	A human-made feature that was built with the intention of shielding a property or structure from incoming waves or drift logs during storms. This includes walls that have been built to protect land along the coast from the sea (e.g., bulkhead/seawall/riprap). These structures can be made of a variety of materials including concrete, rocks, masonry, wood, etc.	 *RC4S Imagery*

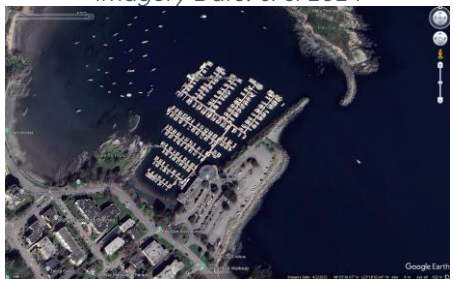
herbaceous plants	Herbaceous plants are plants that have no persistent woody stems above ground. For example, grass and other low-lying vegetation.	 *RC4S Imagery*
industrial overwater structure	An overwater structure that exists for the purpose of industrial activities such as logging, shipping, aquaculture etc. Can include large docks for shipping, shipping platforms for tanks/barges being filled with materials, piers and equipment, or docks associated with aquaculture activities. In the interactive map, see the 'Comments' attribute to note what kind of structures are present.	 *RC4S Imagery, Mitch Miller*
intertidal	The area of shoreline between where the water reaches at the lowest low tide and highest high tide during a regular tidal cycle. This area is regularly exposed then submerged during a 24-hour period due to the tidal cycle. Logs are typically deposited on the shoreline at the high tide mark. Overwater features and creosote pilings in this zone were digitized.	 *RC4S Imagery, Mitch Miller*

		 *RC4S Imagery*
jetty	A pier or structure often built for human enjoyment and can exist both perpendicular and parallel to the shoreline. The term is used synonymously with pier and wharf.	 *Image © 2025 Airbus via Google Earth Imagery Date: 3/15/2024*
jetty/ pier/ breakwater	A grouped attribute selection in the shoreline modifications data layer to describe Form_1 or Form_2. See definitions for jetty and pier. Although a breakwater can also exist both perpendicular and parallel to the shoreline, its purpose is to protect/stabilize/deflect energy from a channel, inlet, or harbour (ShoreZone). See definition for breakwater.	 *Image © 2025 Airbus via Google Earth Imagery Date: 3/15/2024 (jetty/pier)*

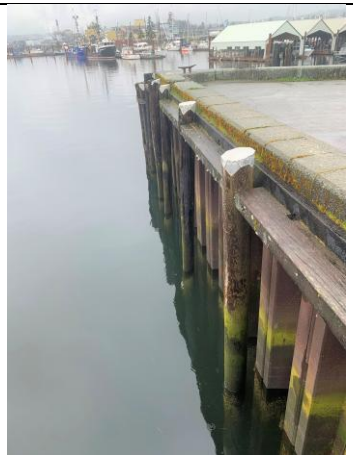
		 *Example of a breakwater (RC4S Imagery)*
landscaping feature	A feature, like this low rock wall, that is well above the high-water mark.	 *Stewardship Centre for BC, 2020*
line	A code indicating the type of linear feature that is being classified. In the interactive map, Resilient Coasts coastal modification and log accumulation data are shown as line features.	 *QGIS Development Team (2020). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.*

log accumulation	Areas of the shoreline where logs accumulate – specifically, logs that have escaped industry log booms (that contain cut ends) and naturally sourced logs that have fallen and drifted through natural processes. The log accumulations are measured by the amount of beach that is covered with logs between the high tide line and the backshore/natural boundary. In estuaries, log accumulation is digitized across marsh habitats as well. Areas of log accumulation are categorized as low (≤19%), moderate (20-49%), high (50-89%), and extreme (≥90%). For details, see log accumulation (low, moderate, high, extreme) definitions. *Note: log accumulation also represents areas with zero logs present, which would be classified as "low."	 *RC4S Imagery, Mitch Miller*  *RC4S Imagery*
log accumulation (low)	Whereby a section of shoreline contains either no logs, sparse logs, or 19% or less of the beach is covered by logs, between the high tide line and the backshore/natural boundary.	 *RC4S Imagery, Mitch Miller*
log accumulation (moderate)	Whereby a section of shoreline contains between 20% and 49% of logs within the high tide line and the backshore. Logs may be spread out, but the beach contains a larger quantity of logs compared to a low log accumulation rating.	 *RC4S Imagery, Mitch Miller*

log accumulation (high)	High density of logs, with 50% to 89% of the beach covered. Logs can be overlapping.	 *RC4S Imagery, Mitch Miller*
log accumulation (extreme)	Beach is completely or almost completely covered in logs, with some logs piled up one on top of the other. More than 90% covered in a high density of logs.	 *RC4S Imagery, Mitch Miller*
logging infrastructure	Any infrastructure constructed for forestry operations that exist along the shoreline and sometimes extend into the nearshore. Includes log sorts and areas of land/water used for sorting, processing, and transporting/sorting logs in forestry operations. Sometimes this is seen as floating logs corralled in bunches in the nearshore. Often, logs that have accumulated on beaches originate from logging activities where logs have become loose and transported to the shoreline.	 *Image © 2025 Airbus via Google Earth Imagery Date: 3/15/2024*
managed retreat	The approach to property management in response to sea level rise where infrastructure is physically moved (relocated or reconstructed) further inland to prevent risk of damage to those structures by waves, flooding and storms, and/or to reduce the	

	impacts of coastal squeeze on shoreline habitat.	
Mapillary	A web-based platform that makes street-level, and ocean-level, images, and map data available to scale and helps automate mapping.	 *Mitch Miller*
marina	A facility built along the shoreline to service and hold multiple boats and watercrafts. For the purposes of this project, marinas can accommodate up to 50 vessels, and large marinas can accommodate over 50 vessels.	 *Small marina. Image © 2025 Airbus via Google Earth Imagery Date: 6/9/2024*  *Large marina. Image © 2025 Airbus via Google Earth Imagery Date: 4/2/2025*
Marine Ecosystem Map	A visualization platform that offers access to centralized marine-focused geospatial data.	

marine riparian vegetation	Vegetation on the backshore that is adjacent to the marine environment. This may include species of grasses, sedges, shrubs, and trees found at or near HHWLT (Higher High Water, Large Tide) water elevation level.	 *RC4S Imagery*
masonry	A digitization attribute that indicates the material the shoreline modification is made from. Masonry typically involves building a structure with materials (e.g., stones, bricks), plastered and bound together.	 *RC4S Imagery*
material	A digitization attribute to indicate the materials that a feature is made with. For shoreline modifications, the material options are concrete, rock, wood, creosote wood, masonry, metal and undefined. The recorder notes the most dominant material used. When digitizing overwater structures and pilings, two material attributes are utilized: the material of the overwater feature, and the material of pilings associated with that feature. Overwater structures are often made	

	of a variety of materials, but the recorder chooses the predominant material that is visible in the imagery. The options for both attributes are wood, metal, concrete, mixed; and creosote/treated wood, vinyl wrapped pilings, concrete, respectively.	
metal	A digitization attribute to indicate the material a feature is made from. Typical metals used in marine and coastal features include steel, aluminum, and more. E.g., metal sheet piles are used to create seawalls/bulkheads. Often, overwater features can be made of several types of materials, and the recorder chooses the predominant material type visible on the feature. Metal pilings are often visibly rusted (orange in colour).	 *RC4S Imagery*  *RC4S Imagery, Mitch Miller*

mobile (logs)	Logs that are free to move or be transported by people or by natural forces such as currents, tides, or wind.	 *RC4S Imagery, Mitch Miller*
natural boundary	The visible high water mark that can be observed through evidence of typical/common ocean influence, e.g., waves carrying materials that are deposited like wrack lines, physical changes in the slope, sediment, and terrestrial vegetation (like evidence of damage), etc. Regarding log accumulation: the upper limit of where logs would be deposited during storm or king tide events would be above the natural boundary (landward of the OHWM -> the backshore).	
natural (logs)	Logs found on the shoreline that originated from forests as fallen trees, often retaining natural characteristics such as root wads and branches. Natural logs are not derived from forestry operations (not processed for market).	 *RC4S Imagery, Mitch Miller*

nearshore	The zone waterward of where the lowest tide hits the shore, extending out several hundred meters from shore where most wave-breaking and sediment transport occur. Often, logging infrastructure in the nearshore can contribute to log accumulation on the shoreline. Overwater structures and creosote pilings in the nearshore were digitized when visible from the boat-based imagery.	 *RC4S Imagery, Mitch Miller*
OpenStreetMap	An open-data map whereby people around the world can contribute and maintain a variety of data.	OpenStreetMap OSM
overwater feature/ structure	A data layer that includes docks, piers/wharfs, marinas, ferry terminals, industrial features, and free-standing creosote pilings in the nearshore and intertidal zone. The term 'overwater structure' is often used interchangeably.	 *RC4S Imagery, Mitch Miller*

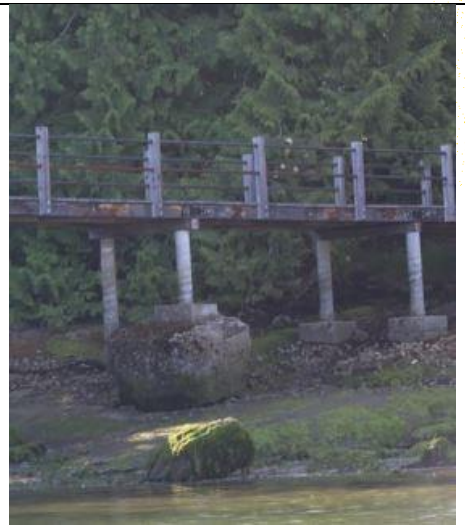
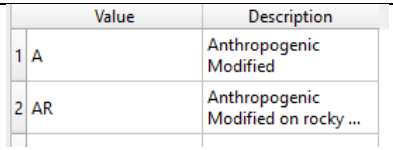
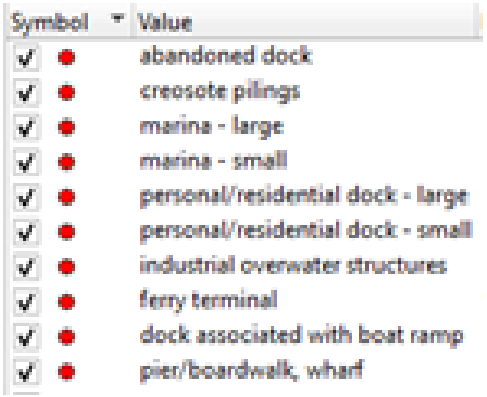
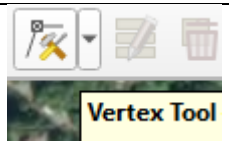
permanent (pilings anchored into the sediment)	In the context of overwater features, permanent is an option of the 'form' attribute to describe structures built along the shoreline to withstand long term use and remain in place indefinitely. Permanent overwater features are commonly anchored with pilings or concrete footings.	 *RC4S Imagery, Mitch Miller*
pier/ wharf/ boardwalk	Long overwater structures often perpendicular to a shoreline that are intended for tourism and public use. Typically built on the shore and projecting to the nearshore where people can walk or large boats can be tied/moored, sometimes with structures on it (e.g., restaurants, fish markets). Terms used synonymously with jetty.	 *RC4S Imagery, Mitch Miller*

		 *Image © 2025 Airbus via Google Earth Imagery Date: 3/15/2024*
piling(s)	Logs inserted vertically into the sediment that are either free-standing (often used in forestry operations) or used to support structures (e.g., docks, piers). Can be made of materials like creosote wood, concrete, metal, or vinyl/plastic. Pilings are often found individually, in line formation, or tethered together in clusters. Pilings are digitized in the Overwater Structures data layer and not in the Log Accumulation data layer, as these logs did not arrive at that location through natural processes (i.e., they would have been installed).	 *RC4S Imagery, Mitch Miller*

piling(s) (creosote)	See pilings definition. Creosote pilings are made of wood that has been treated with creosote, a coal tar preservative that prevents decay but is toxic.	 *RC4S Imagery*
point	Vector data used to demark overwater structures.	
recorder	The individual that enters the data – either digitizing imagery or visiting the features in person. 'Observer' is used interchangeably.	
rock	A digitization attribute that indicates the material the shoreline modification is made from. Rock is often used as riprap.	 *RC4S Imagery*
rocky outcrop/platform	Visible exposure of bedrock, exposed boulders, or deposits/geologic formations on the lands' surface. Includes natural rocky platforms.	 *RC4S Imagery, Mitch Miller*

seawall/ bulkhead	A retaining structure, often built to protect property from ocean processes. Often made of reinforced concrete, rock, or wood. Fencing, walls, patios, or other barriers can function similarly to a bulkhead (e.g., prevent movement of natural materials on the shoreline), and have been digitized as seawall/ bulkheads or noted under 'other' in the comments section. The terms seawall, bulkhead and retaining wall are used synonymously.	 *RC4S Imagery*
shoreline modification/ coastal modification	Any human-made feature that can impact natural coastal processes or contribute to coastal squeeze. This includes walls that have been built to protect land along the coast from the sea (e.g., bulkhead/seawall/riprap), freestanding structures like homes built below the natural boundary, boat ramps, and modifications associated with piers and docks, etc. These structures can be made of a variety of materials including concrete, rocks, masonry, wood, etc. Used synonymously with coastal modification.	 *RC4S Imagery, Mitch Miller*
shore type	Defined by ShoreZone, shore types - also referred to as coastal class - are the dominant structuring process, slope, morphology, substrate, and width character for a shore unit (segment of shoreline) of the intertidal zone (Cook et al. 2017).	
shore unit	A shore unit delineates the shoreline into homogeneous stretches. They are separated	

	when there is a substantial change in a section of shoreline, which can include change in exposure or wave energy, or a change from a beach to a rocky platform. Terminology was created by ShoreZone and the Province of British Columbia.	
toe elevation	Where the bottom of structure intersects the beach at the most waterward point (yellow line in photo).	 *RC4S Imagery*
type	For the Shoreline Modifications data layer, type is an attribute to describe what sediment type a structure is built upon, being either 'Anthropogenic Modified,' or 'Anthropogenic Modified on Rocky Outcrop.' See 'Anthropogenic Modified/Modified on rocky outcrop' definition. For the Overwater Structures data layer, type refers to the specific feature being digitized: personal/residential dock (small), personal/residential dock (large), marina (small), marina (large), abandoned dock, industrial overwater structure, ferry terminal, dock associated with boat ramp,	 Value | Description 1 A | Anthropogenic Modified 2 AR | Anthropogenic Modified on rocky ...  Symbol | Value abandoned dock creosote pilings marina - large marina - small personal/residential dock - large personal/residential dock - small industrial overwater structures ferry terminal dock associated with boat ramp pier/boardwalk, wharf

	pier/wharf/boardwalk and creosote piling. See individual definitions for each type. For the Log Accumulation data layer, type refers to the specific feature being digitized, referring to the percentage/extent/presence of the feature of interest (i.e., log accumulation).	
uncertain	For the Log Accumulation data layer, this term is used when the observer is unable to confidently say whether there is a presence or lack of creosote-treated logs or natural logs in a segment. When there is a lack of clarity in either of these attributes (natural logs and creosote logs) due to the angle or quality of the imagery, the observer selects 'uncertain.'	
vertex	Used to define unique segments of a feature, e.g., a multi-line would be composed of different segments with vertexes at each end. Segments can be edited by moving/deleting or creating new vertexes.	
wood	A digitization attribute to indicate the material with which the feature is made. Wood treated with creosote is a distinct material type, see 'creosote-treated wood' definition.	 *RC4S Imagery*

RESILIENT COASTS
FOR SALMON
resilientcoasts.ca

Resilient Coasts for Salmon is a collaborative initiative led by the Pacific Salmon Foundation with many valued partners including the Stewardship Centre for British Columbia, World Wildlife Fund - Canada, Peninsula Streams and Shorelines, and others.

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PACIFIC SALMON FOUNDATION

STEWARDSHIP CENTRE
FOR BRITISH COLUMBIA

GREEN SHORES

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