# SHORELINE MODIFICATION & CLIMATE CHANGE COWICHAN VALLEY, BRITISH COLUMBIA

Implications to communities, natural systems and salmon

Photo Credit: Maria Catanzaro

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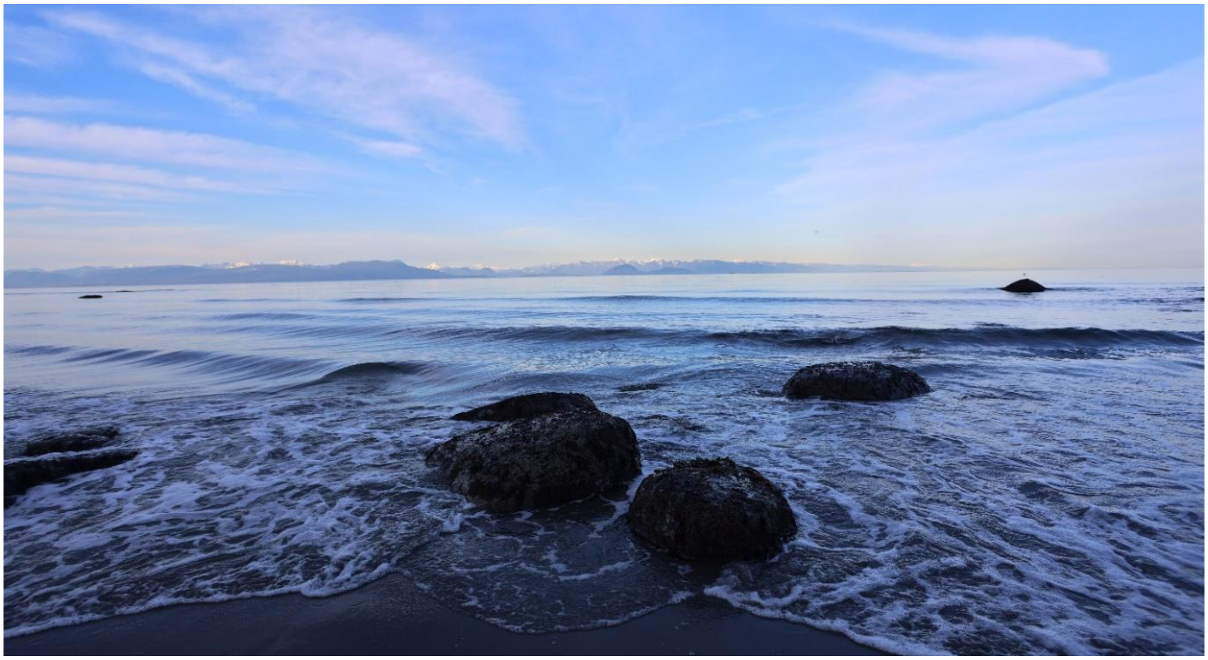
Photo credit: Mitch Miller

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# EXECUTIVE SUMMARY

In 2022 and 2023, the Resilient Coasts for Salmon project collected imagery of the shorelines of the Cowichan Valley on the east coast of Vancouver Island from a small vessel. The resultant dataset has been used to characterize the extent of shoreline modification, overwater structures and log accumulation on beaches in the region. In this report, we present these findings with respect to coastal habitat health for species such as Pacific salmon and forage fish. We also examine the prevalence of these features in areas with high sensitivity to sea level rise, high relative wave exposure, among other factors. It was found that approximately 16.8 % of the shorelines analyzed in the Cowichan Valley Regional District, on the Traditional Territories of multiple First Nations, was modified with structures like logging infrastructure, seawalls/bulkheads, and riprap. There are 190 residential docks and 20 marinas, with 7 of those marinas being within 100m of predicted Pacific sand lance habitat. Nearly 17% of the shoreline experienced a moderate or high accumulation of logs during the time of digitization. The following report will offer recommendations for addressing coastal adaptation with nature-based approaches where possible.

# INTENDED PURPOSE

This report is intended for educational purposes only and aims to share information and context regarding shoreline modifications and how they overlap with basic climate models and other ecological data. While it may highlight areas of concern, it is not a comprehensive assessment or risk inventory. The content should not be used for detailed analysis or decision-making without formal, in-depth assessments from qualified environmental professionals and coastal geomorphologists, who can provide expert guidance tailored at local scales. Visit Appendix A for a list of acknowledged limitations of the data, and considerations for interpreting the results presented in the report.

# ACKNOWLEDGEMENTS

We would like to acknowledge the dedication of the individuals who have made this mapping initiative possible. Thank you to Mitch Miller, videographer and vessel captain - we greatly appreciate your commitment to capturing quality imagery to help build this dataset, to Ben Skinner, GIS Expert, Pacific Salmon Foundation, for your guidance and creating the foundation for the analyses and entire dataset, and to Isobel Pearsall, thank you for dreaming up and making the Resilient Coasts for Salmon project possible.

A big thank you to all the individuals who provided their expertise that helped us develop the mapping methodologies. A special shout out 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. A full list of individuals and references can be found here (pg. 15).

This project is funded in part by the Government of Canada (Environment and Climate Change Canada, Climate Action and Awareness Fund) (2021 – 2026), and we are grateful for this funding to

reach our goals of raising awareness of the impacts of coastal modification, climate change, and how we can better adapt to sea level rise using nature-based solutions.

We acknowledge and deeply respect the enduring relationship that Indigenous Peoples 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 local Indigenous governments and Nation members from inception, with financial compensation for their time as noted in each Nation's protocols for engagement.

## KEY TERMS

**For a full list of terms, see our Data Dictionary within the Digitization Protocol**

**coastal squeeze**: the loss of habitat due to sea level rise where hard structures, like seawalls, prevent habitats from naturally migrating landward.

**digitization**: the process of converting imagery (boat-based and satellite aerial imagery) or ground-truthed visual inspections, into data in QGIS, consisting of line and point feature data. Classify is often used synonymously.

**hard armour(ing)**: *a human-made feature that* was built with the intention of shielding a property or structure from incoming waves. 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.

**nature-based solutions/approaches**: the protection and/or enhancement of natural ecosystem features to improve or restore ecosystem services that natural (or semi-natural) ecosystems can provide. Often employed to address impacts of climate change including sea level rise, erosion and biodiversity loss (International Union for Conservation of Nature and Natural Resources, 2024).

> For the purposes of this report, we refer to the following when this term is used: any restorative activity or action that aims to utilize the most natural methods possible, based on the specific site conditions in question, which may require a hybrid approach. Specifically, actions that support natural processes and the ability for habitats to adapt to change, as opposed to hard engineered designs that disregard natural processes and function.

**shoreline modification**: any human-made feature constructed along the coastline that has the ability to impact natural coastal processes (see Data Dictionary within the Digitization Protocol for more details).

**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).

**managed retreat**: the approach to property management in response to sea level rise where infrastructure is physical moved (relocated or reconstructed) further inland in order 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.

# BACKGROUND

## Project Overview & Objectives

Communities on the east coast of Vancouver Island are experiencing sea level rise and more frequent, intense storms because of climate change, exposing coastal communities and habitats at risk. The **Resilient Coasts for Salmon (henceforth referred to as Resilient Coasts)** project, initiated by the Pacific Salmon Foundation, implemented a multi-faceted approach to educate communities, government decision makers, and coastal professionals in British Columbia about current and future climate impacts and the long-term adaptive benefits of nature-based approaches to address coastal climate change. Funded by the BC Climate Action and Awareness Fund, the project initiated the following objectives:

- producing educational resources, presentations, and workshops to raise awareness about the impacts of hard armouring, such as seawalls, along the coast and provide nature-based alternatives when the circumstances allow,
- building capacity for implementing nature-based approaches on shorelines impacted by climate change by providing Green Shores® training free of charge. Led by the Stewardship Centre for British Columbia, the Green Shores® program offers a credit-based framework for the implementation of nature-based solutions for shoreline development,
- initiating three Green Shores for Shoreline Development demonstration sites on Vancouver Island to showcase nature-based approaches to restoration,
- and finally, creating a dataset of the extent of shoreline modifications, which this report pertains to. These data are for local planners, researchers, and decision makers, to help facilitate informed decisions for adapting to coastal climate change and encourage the uptake of more natural shoreline solutions for the protection and restoration of important habitat.

This report is a follow-up to the shoreline mapping workshop that took place in Ladysmith on October 6, 2022, where the Resilient Coasts team invited community members and interested individuals to learn about coastal climate change, how shorelines function, and ways we can adapt with nature in mind (Figure 1). Detailed data were collected using our Field Guide to Shoreline Mapping, as a means to initiate discussion and learning. After the workshop, the Resilient Coasts team digitized shoreline modifications, log accumulation, and overwater structures within the Cowichan Valley Regional

District, which you will find in this report. For the full scope of these and additional data, please check out the Resilient Coasts for Salmon Atlas.

Figure 1 – A group photo from one of the shoreline mapping workshops hosted at Transfer Beach in Ladysmith within the Cowichan Valley on October 6, 2022. Photo by Nicole Christiansen.

# LOCATION

The Resilient Coasts project activities take place on the unceded Traditional Territories of many Indigenous communities, including the Kwakwa̱ka̱'wakw People, Coast Salish People, W̱SÁNEĆ People, and the Lək̓ʷəŋən People. These Territories belong to: T'Sou-ke, Scia'new, Songhees, Xwsepsum (Kosapsum), Semiahmoo, S'Klallam, W̱JOȽEȽP (Tsartlip), SȾÁUTW̱ (Tsawout), BOḰEĆEN (Pauquachin), WSÍḴEM (Tseycum), MÁLEXEȽ (Malahat), Quw'utsun, Tsawwassen, Penelakut, Halalt, Lyackson, Stz'uminus, Snuneymuxw, Snaw'naw'as, Qualicum, K'ómoks, Ma'amtagila, Tlowitsis, Homalco, Ligʷiłdaxʷ Nations (We Wai Kai, Wei Wai Kum, Kwiakah), ɬaʔamɩn gɩǰɛ (Tla'amin), and 'Namgis First Nations.

The area of focus for this report is the unceded Traditional Territories of the Quw'utsun (Cowichan Tribes), Penelakut, Ditidaht, Pacheedaht, Halalt, Stz'uminus, Ts'uubaa-asatx, Lyackson, MÁLEXEȽ (Malahat), and Pauquachin First Nations, colonially known as Cowichan Valley on southern Vancouver Island. Specifically, this report covers part of the area within the administrative boundaries of the Cowichan Valley Regional District (CVRD), specifically the shorelines within the Cowichan Valley which are on the eastern side of Vancouver Island. In other words, this report does not include the marine shoreline within the CVRD which lies on the western coast of Vancouver Island.

Existing since time immemorial, the Quw'utsun (Cowichan) Tribes are the largest single First Nation in British Columbia by population (Cowichan Tribes, 2015). In the Cowichan region, the most commonly spoken traditional language is a dialect of Hul'q'umi'num, from which the name "Cowichan" is derived, rooted in the word “shquw’utsun,” meaning “to warm one’s back in the sun” (Tourism Cowichan, 2025). The Quw’utsun Tribes have modernized over time, yet continue to practice traditions and ceremonies such as carving, singing, dancing, and knitting. Alongside the Quw’utsun, other First Nation communities maintain strong cultural and spiritual ties to their lands in this area. The Ts’uubaa-asatx at Cowichan Lake, meaning “People of the Lake,” as well as the MÁLEXEŁ (Malahat) community, situated on the western shore of Saanich Inlet, steward their lands while fostering economic growth. The Halalt, historically based along the Cowichan River, maintain connections to their ancestral villages, such as Xeláltw, or “marked houses.” The Stz’uminus along Ladysmith Harbour, the Penelakut across various Gulf Islands, the Lyackson on Valdes Island, and the Pauquachin on the Saanich Peninsula maintain ancestral villages, forests, and mountains such as ŁÁU, WELṈEW̱, traditionally regarded as a “place of refuge.” Further west, the Ditidaht and Pacheedaht (“Children of the Sea Foam”) speak related Wakashan languages and continue to use their traditional coastal territories.

The CVRD stretches from the Malahat region of the Saanich Inlet in the south to North Oyster in the north, and includes several Southern Gulf Islands, such as Thetis, Penelakut, and Valdes. While these lands and waters remain central to the cultural and spiritual practices of First Nations, the coastal areas of the CVRD also support modern infrastructure, including ports, marinas, boat ramps, seawalls, and aquaculture operations.

For the purposes of this report, the area covered is 141.9 km of shoreline, which encompasses the area within the administrative boundaries of the Cowichan Valley Regional District which is on the eastern coast of Vancouver Island (Figure 2 and 3), and encompasses a wide range of shoreline types (Coastal and Ocean Resources, 2017; Figure B1 and B2), including:

- Mud flat
- Human-made
- Gravel flat
- Gravel beach
- Estuary, marsh or lagoon
- Sand flat
- Sand beach
- Sand and gravel flat
- Sand and gravel beach
- Rock, sand and gravel beach
- Rock with sand beach
- Rock with gravel beach

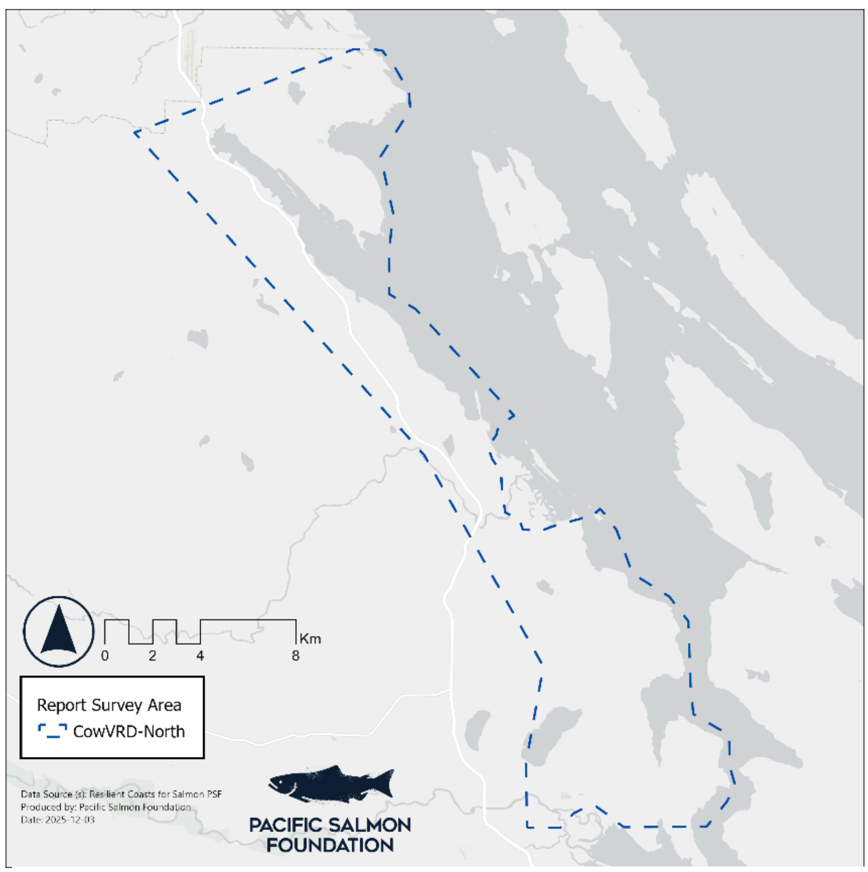


Figure 2 - The northern portion of the extent of shoreline covered in this report, surrounded by a blue dashed line.

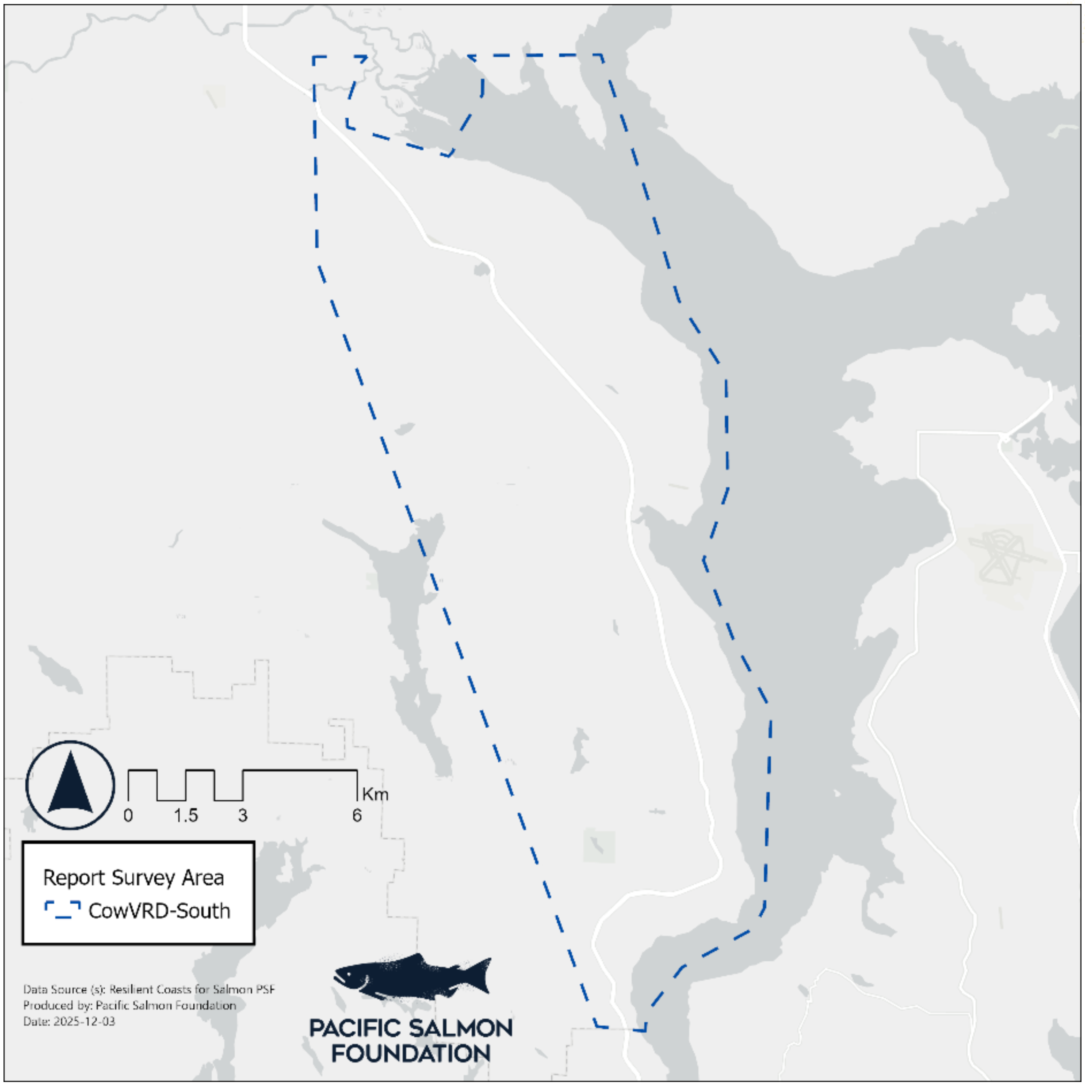


Figure 3 - The southern portion of the extent of shoreline covered in this report, surrounded by a blue dashed line.

There are many ecologically significant areas throughout the report area, including the Cowichan Estuary, which is internationally recognized as an Important Bird Area (Birds Canada, n.d.). Luckily, the Cowichan Valley has seen incredible stewardship by the Cowichan Tribes and other rights holders, as well as groups like the Cowichan Estuary Restoration & Conservation Association, the Cowichan Watershed Board, the Cowichan Community Land Trust, and others. The CVRD, too, has outlined good intentions and understanding of the cumulative effects that impact shoreline habitat and community well-being in their recently adopted Official Community Plan for the Electoral Areas Bylaw, which provides a look ahead at the land use plans for the next 20 years.

# INTRODUCTION

## Sea Level Rise and Flooding

Sea levels rise as ocean waters warm and expand in volume, combined with increasing freshwater draining into oceans from increasing precipitation falling in the form of rain, and from melting glaciers and polar ice caps.

Sea level rise, in combination with larger and more intense winter storms increases the risk of flooding and erosion that communities face (IPCC, 2019). Culturally important areas and shoreline infrastructure are at risk. Impacts extend from saltwater intrusion to destruction of property. The financial, ecological and social implications are huge and already being felt by a growing number of communities. Sea level rise varies across Vancouver Island with low-lying areas being most vulnerable. Sea level rise is projected to be greatest on the north coast, the Fraser Lowland and around southern Vancouver Island (Vadebonceour, 2016). Northwest Hydraulics Consultants (NHC, 2019) conducted a flood risk assessment for the coastline of eastern Vancouver Island within the Cowichan Valley Regional District, and found that in a 1-meter sea level rise scenario, 2% of the land would be flooded with the Territories of the Cowichan Tribes and Halalt First Nation being the most impacted areas in terms of percentage of land flooded. Low-lying regions are becoming more vulnerable to frequent flooding. The NHC (2019) report found that the low lying areas of the Chemainus River and Cowichan-Koksilah River systems are areas of concern as they will see the greatest physical changes. By 2050, historical extreme sea level events that occurred once a century are projected to increase in frequency and occur on average at least once a year in many low-lying regions (Oppenheimer et al., 2019). This places homes, beaches, wetlands, and sites of cultural importance at risk (MOE BC, 2016).

## Natural Coastal Processes

Natural coastal processes, like erosion and deposition of sediment, occur simultaneously to maintain and create our beaches, and they are needed to sustain our shorelines and their integrity into the future. The landscape, as well as wind, waves, and currents that continuously move water and beach materials like logs and various sizes of sediment such as sand, gravel and cobbles. Recognizing that healthy shorelines have natural variations in the movement of water and sediment is fundamental to understanding how shorelines work. While Figure 4 illustrates sediment transport and deposition by longshore current, it is important to recognize that transport mechanisms can vary significantly across shoreline morphologies. The orientation of the shoreline will also the influence the exposure of that shoreline to wave energy and other factors. Human-made structures like seawalls, jetties and groynes can artificially influence erosion and deposition patterns, which we will explore below.

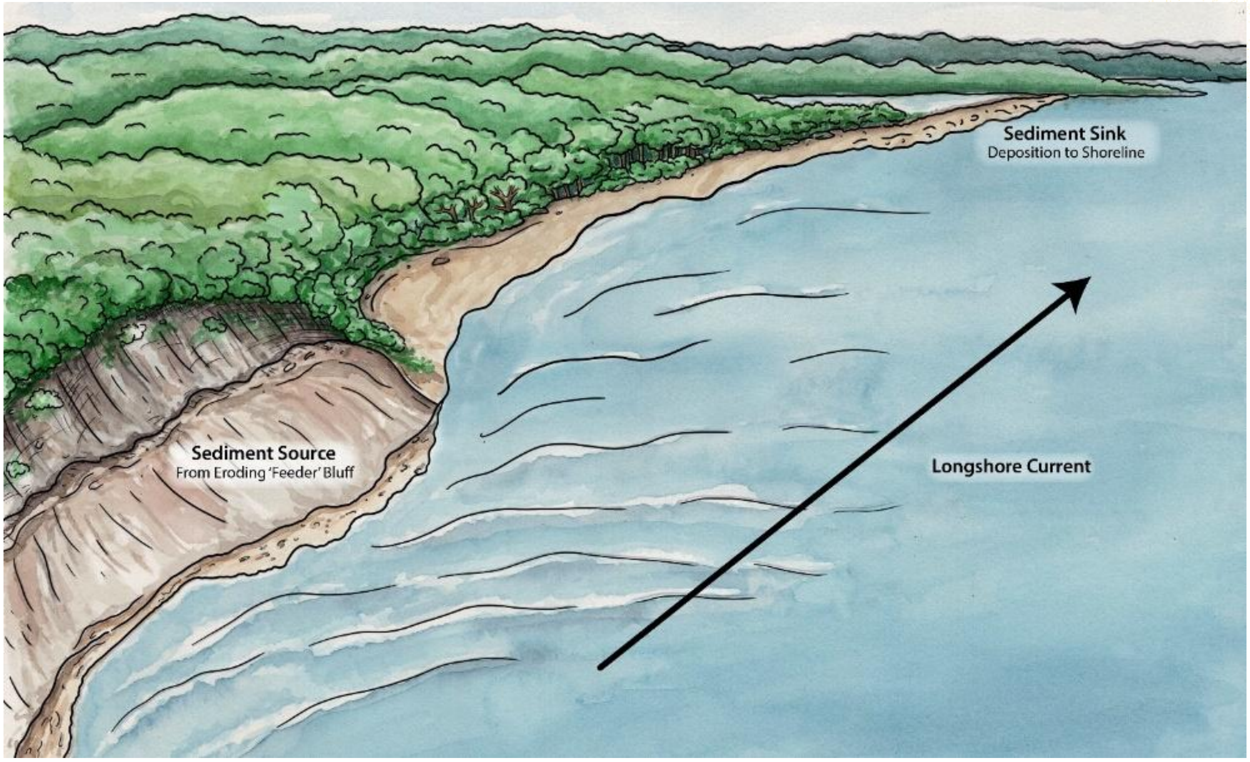


Figure 4 - Longshore current, which is one example of a coastal process, moves sediment from a source like a feeder bluff to a sink area where the sediment is deposited (e.g., a growing sand spit). Illustration by Holly Sullivan.

## Shoreline Modification

Figure 5 - An example of a seawall (one type of shoreline modification). Photo by Maria Catanzaro.

Hard armour refers to structures like **concrete seawalls or rock riprap that are installed to armour shores and the infrastructure behind them from incoming waves (Figure 5).** The construction of shoreline armour has led to a false sense of security and an associated rise in populations in flood prone areas (Rumson et al., 2017). In British Columbia, there are no provincial regulations preventing landowners from constructing shoreline armouring up to the mean high-tide line, which can have negative implications for forage fish and other coastal species (Buchanan et al., 2019). Seawalls also support 23% lower biodiversity and 45% fewer organisms than natural shorelines (Gittman et al., 2016). Local governments have some power here to impose community policies and bylaws to prevent further armouring from being constructed and protecting shoreline habitat. We are hopeful that the new B.C.

Coastal Marine Strategy this will lead to provincial legislative protection of B.C. shorelines. Hard armouring on shorelines can exacerbate erosion by waves scouring the base of the structure over time, causing structures to crack overtime. Natural sediment transfer (replenishment), a natural process along coastlines, is disrupted when modifications exist. Combined with sea level rise, the shoreline's ability of adapting to sea level rise over time will be disrupted where structures exist. While hard armour is very common on shorelines, there are other types of coastal modifications, including overwater structures, which have impacts on the coastal environment.

### Overwater Structures

Overwater structures include personal docks, municipal piers, wharfs, marinas, and even ferry terminals. **Overwater structures can shade the environment below, which has cascading impacts on the coastal food web.** There is often reduced prey availability underneath piers and docks because the lack of light below them changes the habitat for algae, seagrasses (reducing critical rearing habitat for coastal species) and the epibenthic invertebrates that are a critical food source for Pacific salmon (Cordell et al., 2017). Salmon also tend to avoid piers and docks (Munsch et al., 2014) as the lack of light makes it more difficult to see their predators, properly orient themselves, or school together. Particularly for juvenile salmon, the presence of overwater structures in estuaries could impact the success of their outmigration (Toft et al., 2007). Loss of marine vegetation can also impact another important forage species, Pacific herring, which spawn on nearshore surfaces like eelgrass and kelp.

### Log Accumulation

Log accumulations on beaches is a concern due to their potential to **impact coastal habitat for forage fish**. The logs that are predominantly found washed up on beaches are from the logging industry. This means that they have been processed in some way: most have had their ends cut with branches and bark removed, and some have been further treated with preservative agents.

While **natural logs with root wads can be remarkable shoreline restoration tools to help accumulate and secure sediment, their processed counterparts can have very negative impacts on shoreline habitats**. Without branches or root wads, they can easily roll over beaches, crushing any creatures that might be living there including forage fish eggs. Logs can also impact the biotic communities of rocky shorelines. A recent study showed that populations of key foundational intertidal species such as the thatched barnacle were 20-80% lower on rocky intertidal areas where there was abrasion from logs, compared to adjacent areas that were protected from the abrasion (Pérez Andresen et al., 2025). An accumulation of logs can also smother vegetation on the shoreline (Figure 6). When this is combined with coastal modification, those logs may continue to be mobile since they cannot settle higher in the backshore, exacerbating the impacts of erosion on those beaches, and potentially degrading the structures themselves. These impacts can be exacerbated by increasingly frequent and intense storms.

Figure 6 - A high/extreme accumulation of logs on an estuary marsh shoreline in Cowichan Bay, where the majority of the accumulated logs are processed logs from the forestry industry. Photo by Michael Miller Media (Resilient Coasts for Salmon imagery).

**Often, logs treated with creosote (a preservative made from tar) can end up on beaches, or are present in the nearshore environment as pilings, which can have negative consequences for forage fish**. Persistent chemicals such as PAH's found in creosote have negative impacts on marine organisms (Sibley et al., 2001). For forage fish species like Pacific herring whose eggs attach to surfaces like pilings and eelgrass in the nearshore environment, the presence of creosote pilings can sabotage a spawn event, decreasing the success of hatching in some and causing physical abnormalities in others (Vines et al., 2000).

Natural woody debris is considered beneficial for many reasons including stabilizing shoreline sediments, adding nutrients to the shoreline, and providing a substrate for riparian and shoreline plants to grow. Since naturally woody debris can have root wads and branches, they can settle on shorelines, whereby sediment can accumulate, and vegetation may grow. Because natural logs tend to settle and become embedded in shoreline sediments, they will not cause scour like processed mobile logs do. As the trees decompose, they provide nutrients back into the water column that zooplankton feeds on, adding to the productivity of that area. As natural logs are untreated with preservatives, shoreline plants often can grow on those logs, which adds habitat value to the shoreline.

### Impacts of Sea Level Rise and Shoreline Modifications on Salmon and the Coastal Food Web

Juvenile Pacific salmon rely on healthy coastal habitats, including estuaries, marshes, and pocket beaches, to rear and grow in preparation for their open ocean migration. Though modifications along the shoreline alter how natural shorelines function and impact Pacific salmon. For example:

- The impacts of sea level rise are exacerbated by coastal modifications. For example, **coastal squeeze occurs, which prevents habitats from naturally migrating landward as sea levels rise**. When structures like seawalls are present, intertidal habitats are 'squeezed', which can eventually cause a complete loss of intertidal areas, including the associated species, habitat values, and ecosystem services they provide. Eelgrass beds, for instance, provide critical habitat for herring spawn to attach to, and for juvenile and small fish to hide from predators and feed on invertebrates. Because eelgrass occupies a specific range within the intertidal, it can be squeezed out when seawalls prevent that habitat from shifting landward as sea level rises (Figure 7).

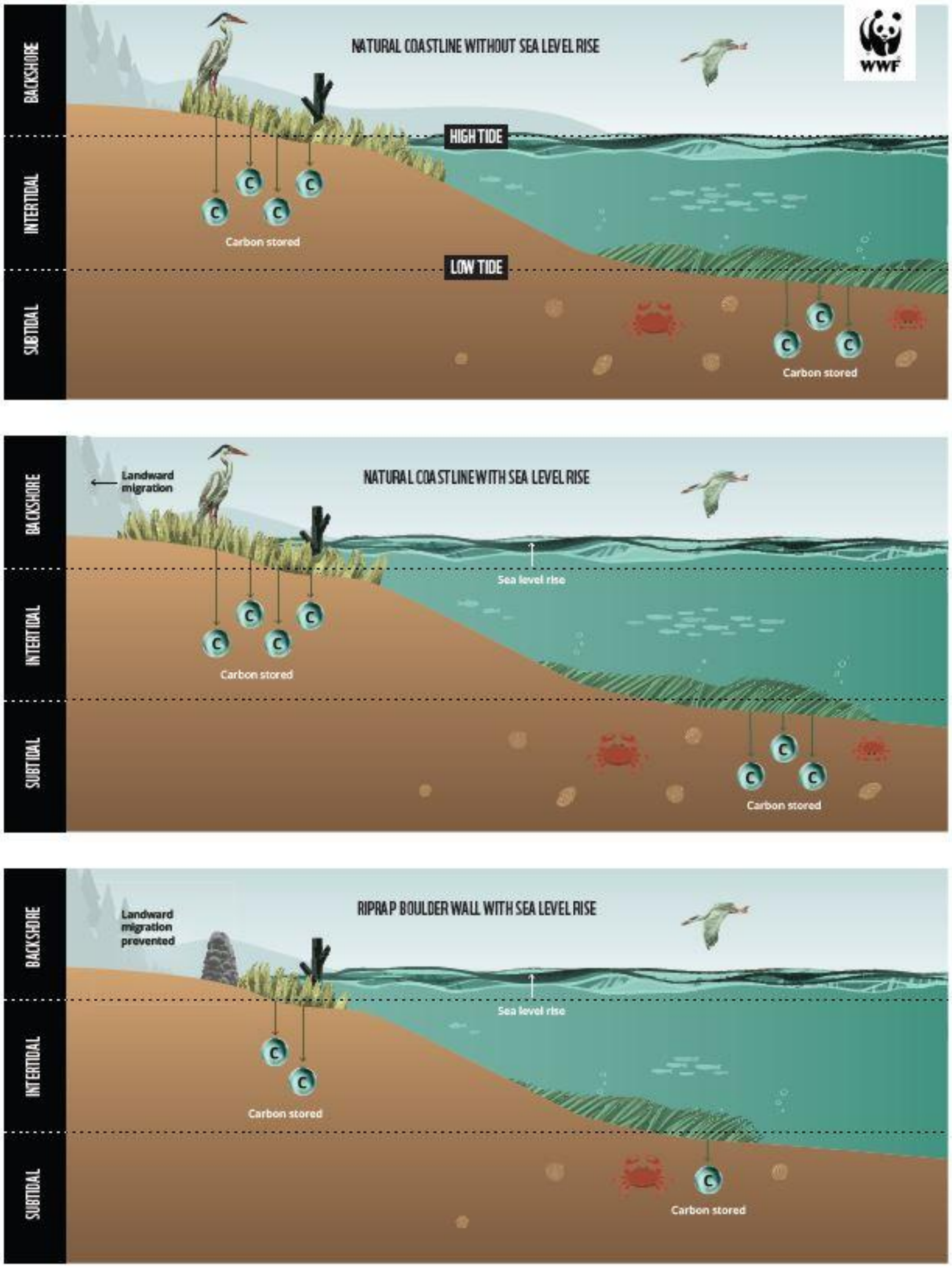


Figure 7 - Depiction of coastal squeeze, where the combination of coastal modification and sea level rise results in a loss of eelgrass habitat and shoreline vegetation. Illustration by World Wildlife Fund Canada.

- **On armoured shorelines, salmon are unable to access their preferred prey items.** Studies have found that shoreline armouring reduced the number and diversity of epibenthic invertebrates (that reside on or above the rock, sand, and mud of the seafloor) and the availability of terrestrial insects compared to unarmoured areas (Cordell et al., 2017). As a result, when young salmon are next to a seawall and other anthropogenic structures, they end up feeding on alternative prey types such as planktonic prey that might be harder to catch and less nutritious.

- **Structures like seawalls that extend into the intertidal zone take away important shallow habitat and expose juvenile salmon to greater predation risk.** With deep water right up to the shoreline, rather than a natural slope where the water gets gradually shallower, these structures allow for larger predators to get close to the shore and hunt smaller fish.

- Surf smelt (*Hypomesus pretiosus*) and Pacific sand lance (*Ammodytes personatus*) are forage fish that play a critical role in the coastal food web, transferring energy to higher trophic levels (Figure 8). These species spawn in the intertidal zone by burying their eggs in pebbly and sandy beach sediment. **Erosion caused by incoming waves crashing into seawalls can take away these key spawning habitats**, by rendering the substrate unsuitable.

Figure 8 - A school of forage fish. Photo by Jake Dingwall.

- Another way that hard armouring can impact forage fish is by altering sediment supply and deposition. Areas of armouring can cause erosion on adjacent beaches (Krueger et al., 2009), **cut off sediment sources that would replenish beaches through natural shoreline processes**, and contribute to cumulative impacts. In the San Juan Islands of Washington State, it was found that a large portion (28%) of the modified shoreline cut off feeder bluffs that would have otherwise contributed sediment that could create and maintain nearby spawning beaches (Friends of the San Juans, 2014).
- Coastal modification also **disrupts overall land and sea connectivity**. Coastal riparian vegetation is lost on modified shores along with the insects that would fall into the water – an important food source for salmon. Surf smelt, a prized prey item for salmon as they grow in coastal areas, also suffer without overhanging coastal vegetation. The shade of the

vegetation regulates the temperature of the upper shoreline, and this is important for surf smelt beach spawning. A recent study in Puget Sound, WA, found that beaches with a seawall or other structures **had more extreme substrate temperatures** (mean 18.8°C compared to 14.1°C on natural shorelines) and air temperatures due to the lack of riparian vegetation that would otherwise shade the beach from the sun (Rice, 2006). Beaches with seawalls also had lower relative humidity. Together, these **hotter, drier conditions could impact egg survival, making modified beaches far less suitable for spawning compared to natural beaches** (Rice, 2006).

## Nature Based Approaches to Shoreline Restoration

As mentioned, **human-made seawalls are static** (Figure 6, left side of the image) and offer little habitat value, can cause overtopping (waves splashing onto the property), and deflects wave energy, which causes erosion and impacts to adjacent areas. However, some **alternatives** to hard armouring are nature-based approaches to restoring shorelines. Restoring shorelines with soft shore (nature-based) approaches (Figure 9, right side of the image) encourages a more **diverse habitat** on the shore and intertidal zones. The **natural gradient tempers wave energy and can adjust dynamically as sea levels rise**. Overhanging tree branches and shrubs also benefit salmon by **providing shade and prey species**.

Figure 9 - A comparison of an armoured shoreline (left) with a natural shoreline (right). Illustration by Holly Sullivan.

**Working with nature encourages resilient ecosystems by allowing natural processes to occur**. These actions can be taken at the residential and community planning level to reduce the impacts of climate change, whilst maintaining or enhancing critical habitat for species like Pacific salmon. Depending on the approach you take, restoring elements of natural functions and processes could allow room for habitats to shift as sea levels rise, and provide numerous climate change mitigation benefits like buffering wave energy. For example, one method used by Guardians of our Salish Estuaries (GooSE) is eco-cultural fencing, whereby natural materials are used to weave a fence around areas of salt marsh, allowing the re-establishment of vegetation and preventing further degradation by goose herbivory. Salt marsh are incredibly important to protect, as they are critical habitat for Pacific salmon. These habits are also carbon sinks, contributing to climate change resilience, and they accumulate sediments which can raise the elevation of marsh platforms over time and protect coastal from erosion by attenuating wave energy.

There are a variety of restoration approaches depending on your site-specific ecological needs, and can include methods like:

- **managed retreat** - moving infrastructure back to allow and plan for sea level rise
- improving drainage on your property to reduce erosion
- protecting the upland by retaining or planting native trees and shrubs to help stabilize the shoreline bank and provide valuable habitat benefits,
- sediment addition (also referred to as nourishment) when the conditions are appropriate, whilst recontouring the gradient of the beach to a natural angle,
- terracing steep slopes while using live staking of native vegetation to stabilize the slope, helping it to erode at a more natural pace,
- preventing herbivory on marsh sites with eco-cultural fencing that deters geese from entering,
- eco-cultural fencing prevents geese from consuming and degrading marsh habitat that species rely on, like Pacific salmon,
- planning for sea level rise by preventing new hard structures from being built in unsuitable areas
- removing existing seawalls, where conditions are suitable, and bringing natural elements back, like planting riparian vegetation to help stabilize the bank

To explore more on how nature-based solutions can be used to help protect coastal properties and provide habitat for coastal ecosystems, check out the educational primer (short version), tool kit, and articles on resilientcoasts.ca.

# METHODS

## Data Collection

Between 2022 and 2024, the Resilient Coasts team collected imagery of the shorelines of east coast Vancouver Island by boat using a high-resolution, 360-degree camera. Still shots of the shoreline were captured from 25-metres to 400-metres distance, at set intervals. The track lines and associated images were uploaded to a web platform, Mapillary. Additional means of capturing data were utilized including, OpenStreetMap, QGIS, Google Earth Pro, ArcGIS (ESRI), drone imagery and ground surveys. Boat-based shoreline imagery within the CVRD was captured in 2022 and 2023.

## Data Digitization

With these data, the team created a digitized dataset of shoreline modifications, log accumulation on beaches, and overwater structures. The digitization process involved reviewing the boat-based imagery to identify features along the shoreline that were anthropogenically constructed, followed by recording them as line or point features in QGIS. To digitize features, the geo-referenced image files were reviewed in OpenStreetMap, along with the aforementioned sources, then the observer either traced the corresponding curvature of the shoreline while creating line features, or added point features, in QGIS. Features within estuarine areas were removed from the analyses, as these data are qualitative. Shorelines within First Nation reserve lands were also excluded from the analyses as they were not digitized out of respect for privacy.

The following provides a glimpse into the digitization process, while the thorough protocols for each dataset can be found here.

### Coastal Modification Line Feature Dataset

Features were included if they had the ability to interact with natural shoreline processes at the time imagery was taken. The following attributes were captured when modifications were found - whether the modification (feature) was on rocky outcrop/platform or not (i.e., loose sediment beaches), the type of modification (form) (e.g., seawall), the material of the modification (e.g., concrete), a confidence rating from the observer for the presence of the modification, and whether the modification was ground-truthed (i.e., visited in person). Modifications were digitized if they were greater or equal to 2 metres in length.

All modifications of the same type and material were mapped in a continuous line regardless of property lines or time of construction. Landscaping features or modifications that are currently situated on the backshore (above the reach of the highest high tide), and any structures built on rocky outcrop/platforms that were deemed to not have any influence on coastal processes due to their elevation, were not included. Additional imagery sources, including Google Earth Pro and OpenStreetMap, ArcGIS (ESRI) and QGIS were often used to confirm the presence or absence of a feature if there was any uncertainty. In some cases, beaches were visited on foot.

### Log Accumulation Line Feature Dataset

The level of log accumulation along the coast was digitized as linear segments and included both natural logs (i.e., fell and deposited naturally on the shoreline, typical to contain roots and branches attached) and logs originating from the forestry industry (i.e., logs with cut ends). Categories described how much the beach was covered by logs between the high tide line and the backshore at the time the imagery was taken and included: low (19% or less), medium (between 20% and 49%), high (between 50% and 89%), and extreme (90% and above). It was noted whether the logs on the beach were mobile (i.e., able to be moved by the tide and waves), and/or embedded in the sediment, and whether any logs appeared to be treated with creosote. It should be noted that approximately 37.4% of the study region's total shoreline was not categorized for log accumulation due to issues with visibility. These gaps include areas behind large marinas and in bays where the entire shoreline was not visible.

Natural-source wood like dead and fallen trees, that are no longer attached to the soil (i.e., resting on the shoreline), were included and digitized within log accumulations. Structures on the beach made from driftwood, such as forts and sculptures, were included in the dataset. It is assumed that the logs used to build the structure were logs that had accumulated nearby on the shoreline.

Ground truthing was not performed for log accumulation data and thus, represents a snapshot in time. However, log accumulations are subject to change throughout the seasons, and often day to day. These data likely represent 'best conditions' of the shoreline, as the imagery was captured during the summer months when the impacts of storms are not as prominent. The boat-based Resilient Coasts shoreline imagery was solely used for this dataset and was captured in 2022 and 2023. Gaps exist in this dataset where imagery was not available.

### Overwater Structures Point Feature Dataset

Overwater structures, including personal docks, abandoned docks, marinas, and pilings, were recorded using point features, and corresponding data was included for the types of material used to construct the structure, and whether it was permanent or floating.

Ground truthing was not performed for overwater structure data, and thus the data represent a snapshot in time. The boat-based Resilient Coasts shoreline imagery was primarily used for this dataset, with some occurrences where satellite imagery was used. Gaps exist in this dataset where imagery was not available.

## Analyses

This report will provide a glimpse into the analyses performed and associated maps to describe the Resilient Coasts' data layers described above, along with external layers, and what this means for the eastern shorelines of the Cowichan Valley as they overlap (e.g., sensitivity to sea level rise and coastal flooding with shoreline modifications).

Feature Manipulation Engine (FME) software was employed to calculate reporting metrics, whereby numerous workflows were developed. It should be noted that none of these workflows, nor the raw data, provide a level of precision that would be needed for activities requiring real world alignment, such as engineering. Details for analyses related to each external data layer are included in the sections below. For additional information on the methodologies undertaken to produce these results, please contact marinedatacentre@psf.ca.

Additional testing was performed for the Resilient Coasts results (i.e., analyses for coastal modification features, log accumulation and overwater structures) to check relative accuracy against the FME workflow process, whereby QGIS vector geometry and vector analysis tools were used to summarize the Resilient Coasts data within each community polygon. Additional quality analysis/quality control were performed on geospatial statistics related to all layers.

### Natural, Modified, and Total Shoreline Length Values

In order to create boundaries for conducting analyses within communities, polygons were created to reflect the extent of a specific community. To calculate the relative length and proportion of shoreline containing modified features and total on natural segments of shoreline, the total shoreline length value was required. Because the shorelines that were deemed natural were not digitized (i.e., no line features were drawn), the total length for natural stretches of shoreline was determined by taking the total length of shoreline from the Freshwater Atlas Coastlines (FAC) dataset (Government of Canada, 2020). Due to disparate methods used to create the FAC layer and the methods used by the Resilient Coasts project, the values are not precise. The FAC layer typically followed the curvature of the shoreline that yielded greater values compared to those recorded by the Resilient Coasts team (Figure 10). In some regions, small islets close to the shoreline were included in community polygon layers (were not removed and therefore included in the total shoreline length values) which resulted in greater values in comparison, as nearshore islands were only digitized by Resilient Coasts recorders when the islands were connected to Vancouver Island (e.g., by a constructed road). For these reasons, any comparisons between modified areas (digitized by Resilient Coasts staff) and natural areas (extracted from the FAC) are approximate. The 'comments' attribute for the coastal modification dataset was also extracted to support discussion of nuances in the data.

Figure 10 - The FAC (green line) often diverts from where coastal modifications were digitized, which could result in an over or underestimation of shoreline length (Government of Canada, 2020).

Log accumulation data were analyzed by determining the length of each log accumulation segment, and totaling the length per category of log accumulation (i.e. all segments of low accumulation of logs were summed together). The proportions of the shore with each category of log accumulation was then generated by comparing the sum of each category with the total shoreline length for a given community. These results, as well as results such as number of shore segments where creosote logs were found, were generated in FME.

The results related to overwater features were generated using FME, where the overwater structures were totaled by type within the boundaries of a given community.

### Wave Exposure

ShoreZone conducted surveys between the 1980's and 2007 to describe wave exposure along the coastline (Cook et al., 2017). This dataset was used to interpret relative exposure along the coastline in Sidney. The wave exposure attribute estimates the amount of wave energy that could potentially impact the intertidal zones of specific Shore Units. Fetch, the maximum distance/length that wind-driven waves can travel unobstructed, can help explain how exposed an area is to wave energy. The level of exposure for a specific area may impact the amount of erosion, flooding, and ultimately damage due to the amount of distance that waves can generate energy.

To calculate the amount of modified shoreline parallel to varying levels of wave exposure, transformation involved the following process: 1) the data input which includes information on wave exposure (e.g., very exposed coastline) was separated based on the varying degrees of exposure, 2) a buffer of 50 metres was created on the left and right sides of each wave exposure sublayer, 3) it was determined which modified shoreline features fell within this buffer, 4) the summative length of these features was calculated, 5) the length of total coastline in the survey area was calculated, 6) the lengths of shoreline modifications that overlap with each wave exposure, respectively, were divided by the length of total shoreline. This gives, for example, the percent of modified shoreline which is very exposed to wave action. Due to the spatial misalignment between the shoreline modifications layer and the comparative layer (i.e., ShoreZone's wave exposure represented within distinct Shore Units), the results in this report add up to slightly more than 100%.

### Sensitivity to Sea Level Rise

To analyze shoreline sensitivity to sea level rise, the BC Parks Shoreline Sensitivity to Sea Level Rise Model was utilized, which ranks units of shoreline in one of five categories of sensitivity to sea level rise from very low sensitivity to very high sensitivity (MOE BC, 2014). This dataset is derived from existing datasets including the Broad Ecosystem Inventory (biogeographic land classification) and the shoreline sensitivity ratings by ShoreZone, along with effects of exposure, slope, and sediment mobility to provide relative sensitivity ratings of BC shorelines (Biffard, Stevens and Rao, n.d.). This BC Parks Shoreline Sensitivity to Sea Level Rise dataset is a simple polyline layer indicating shore units that have physical characteristics that are potentially more or less vulnerable to sea level rise. This analysis was used for the entire BC coast; however, it is quite coarse due to their results showing the overall sensitivity to sea level rise per Shore Unit, rather than showing exactly where the shores vary in sensitivity. Similarly, to the wave exposure results, spatial misalignment between the shoreline modifications layer and the Sensitivity to Sea Level Rise layer resulted in values slightly more than 100%. This was also true for results that compared shoreline modifications, wave exposure and sensitivity to sea level rise (i.e., combinations).

### Forage Fish

Two datasets were used to look at the presence or potential presence of forage fish habitat. The first dataset is from the BC Coastal Forage Fish Network (CFFN, 2019), a collaborative group who monitor beaches for forage fish presence. These data represent beach sampling efforts, as well as any positive detections of forage fish eggs. These values were extrapolated from overlaying the community boundary layer and positive detections of forage fish data.

The second dataset explores potential suitable habitat for Pacific sand lance (PSL). Huard et al. (2022) developed a habitat suitability model for intertidal PSL spawning habitat in the Canadian Salish Sea. This model categorizes coastal habitat based on the likelihood of its ability to support PSL, based on variables such as proximity to estuaries, shoreline slope, substrate, and the distance to predicted subtidal sand lance habitat. The study determined that approximately 5.4% of all intertidal zones within the Salish Sea are predicted as likely or highly likely to support PSL, with only 1.4% of the intertidal predicted to be highly likely to support PSL. Uncertainty in the model outputs are identified as a mask layer, whereby areas are deemed more uncertain when environmental conditions are more dissimilar from the areas where model data were collected. In other words, the model was not able to predict into these areas with high confidence due to the differences in the underlying environmental prediction data. Each area of the modelled region has a numeric value of uncertainty associated with it, where the areas with the lowest uncertainty values corresponded to areas with the highest habitat suitability values. The model does not cover the entire Resilient Coasts project region, and there are some areas that are outside of the model's scope (Huard et al., 2022).

### Notes for unanalyzed data

#### Coastal Flood Hazards

Coastal floodplain data are an important piece of the coastal adaptation puzzle. Although coastal flooding data were not analyzed for this community, we encourage the communities within the Cowichan Valley Regional District to consider using the local risk assessment of floodplains and coastal sea level rise that was completed by Northwest Hydraulic Consultants (2019) to take a closer look at the overlap of coastal modification data and areas that are predicted to flood in the future.

#### Sediment Stability

To describe a shoreline's sediment stability, the Stability Index was used to report qualitatively. The Stability Index is one component of ShoreZone's Coastal Vulnerability Module. The Stability Index, referred to in this document as sediment stability, relates to the relative rate of erosion on a given segment of shoreline. This index categorizes Shore Units into accretional (gaining sediment over time), erosion (losing sediment over time) or stable (no significant change over time) (Cooke et al., 2017). These data were not analyzed (i.e. quantitative results were not generated) for the community of the Cowichan Valley, however the data are shown in static maps and discussed qualitatively in the results section of this report.

# RESULTS

Visit Appendix A for a list of acknowledged limitations of the data, and considerations for interpreting the results presented in the report. Visit Appendix B for additional static maps.

## Shoreline Modification

The total length of shoreline that was digitized is approximately 141.9 km in length, as retrieved by the Freshwater Atlas Coastlines. As of 2023, the approximate length of shoreline that was modified in was 23.8 km, with the remaining 118.1km being either unmodified (i.e., 'natural') or containing modifications that do not yet interact with natural coastal processes (i.e. landward of the natural boundary). Thus, approximately **16.8 % of the shoreline was modified** at the time the data was collected (Figure 10, Figure B3 and B4 in Appendix B).

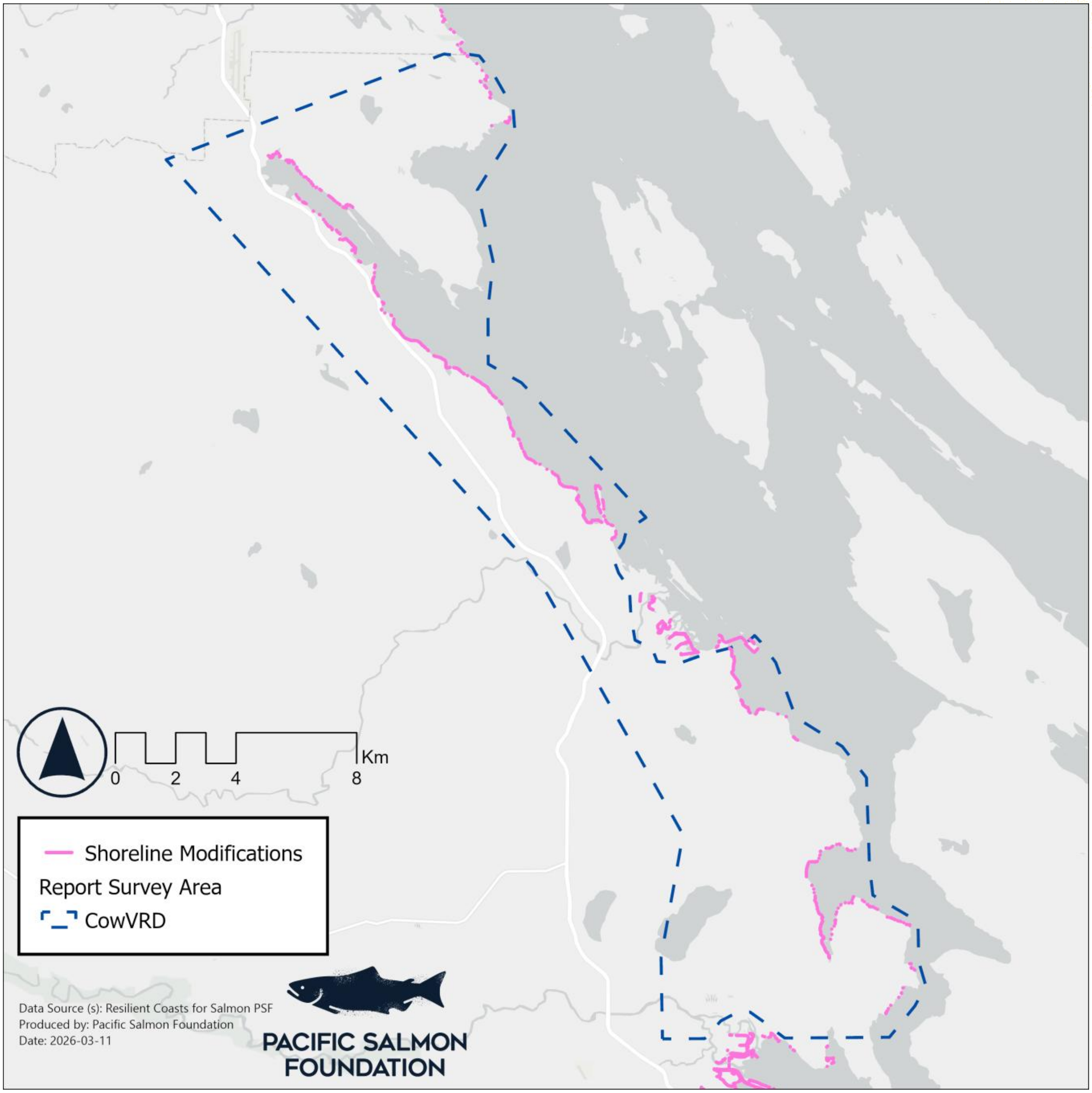


Figure 11 - The extent of coastal modification (shown in pink) within the northern half of the study region (outlined in blue dashes).

Approximately 10.1% (2407m) of the modifications were built on consolidated rock (e.g., hard shoreline substrate like rocky outcrop, rock platform, rock cliff), and approximately 89.9% (21,380m) were built on unconsolidated sediment (e.g., soft shoreline sediment like sand, pebble, cobble).

The modifications along the shoreline in the CVRD are constructed along both residential and commercial properties. The most common modification types were seawalls/bulkheads (28.8%), logging infrastructure (26.4%), and riprap (18.3%) (see Figure 12 and Table 1 for all modification types). Features described as 'other' made up 8.4% of the modifications, which included patios, sheds, cabins/homes, elevated walkways, concrete platforms, and a permanent firepit.

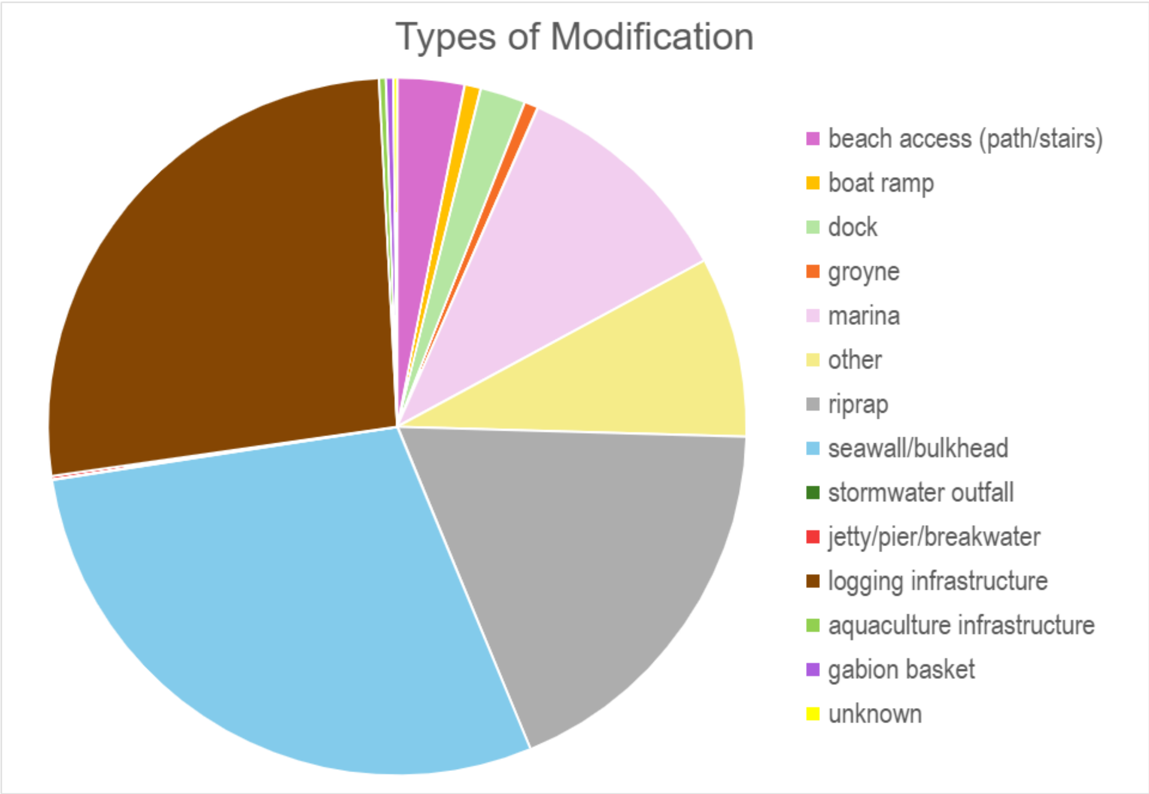


Figure 12 - The proportion of each type of modification found on modified shorelines of the Cowichan Valley, with seawall/bulkhead being the most common type, followed by logging infrastructure.

Table 1 – The length and proportion of shoreline by modification type (Form_1 only).

| Type of modification (Form_1) | Percent of overall shoreline with these modifications (%) | Percent of total modified shoreline by modification type (%) | Total extent/ length (m) |
|---|---|---|---|
| Seawall/bulkhead | 4.8 | 28.8 | 6,848 |
| Logging Infrastructure | 4.4 | 26.4 | 6,288 |
| Riprap | 3.1 | 18.3 | 4,356 |
| Marina | 1.8 | 10.5 | 2,495 |
| Other* | 1.4 | 8.4 | 1,988 |
| Beach Access (path/stairs) | 0.5 | 3.1 | 738 |
| Dock | 0 | 2.1 | 501 |
| Boat Ramp | 0 | 0.8 | 180 |
| Groyne | 0 | 0.6 | 153 |
| Gabion Basket | 0 | 0.3 | 83 |
| Aquaculture Infrastructure | 0 | 0.3 | 72 |
| Unknown | 0 | 0.2 | 41 |
| Jetty/Pier/Breakwater | 0 | 0.1 | 33 |
| Stormwater Outfall | 0 | 0 | 12 |

*Including but not limited to the following modification types: patios, sheds, cabins/homes, elevated walkways, concrete platforms, historic fort, tennis court, and a permanent firepit.

The type of building materials most utilized to construct the structures on the shoreline were unknown material (45.5%), concrete (23.6), and rock (22%) (Table 2). The unknown/undefined category indicates that the recorder could not determine the material that was used, due to issues with image clarity or obstruction, or in cases when a mix of materials were used.

Table 2 - The percentage of modifications, based on the type of material used in the modifications.

| Material of Modification (Form_1) | Percentage of Modifications |
|---|---|
| Unknown/Undefined | 45.5 |
| Concrete | 23.6 |
| Rock | 22 |
| Wood | 6.4 |
| Masonry | 1.8 |
| Creosote Wood | 0.4 |
| Metal | 0.3 |

## Sensitivity to Sea Level Rise

The BC Parks Shoreline Sensitivity Model, although coarse and high level, helps raise awareness on sea level rise but in-depth modelling should be conducted at site specific scales. Bearing these limitations in mind, most of the shoreline in the report area of the Cowichan Valley Regional District can be classified as highly sensitive (41.3%) and very highly sensitive (21%) to sea level rise, with another significant proportion (22%) of shoreline being moderately sensitive to sea level rise (Figure 13 and 14). The Cowichan Estuary is an area where there is a high proportion of high and very high sensitivity to sea level rise (Figure 15). See Figure B5 in Appendix B for a closer look at Croton and part of the Chemainus River Estuary. Only 13.5% of the shoreline was classified as low or very low sensitivity to sea level rise. This means that most (74.6% or 17.8km) of the modified areas were built along areas of high and very high sensitivity to sea level rise (Figures 16 and 17).

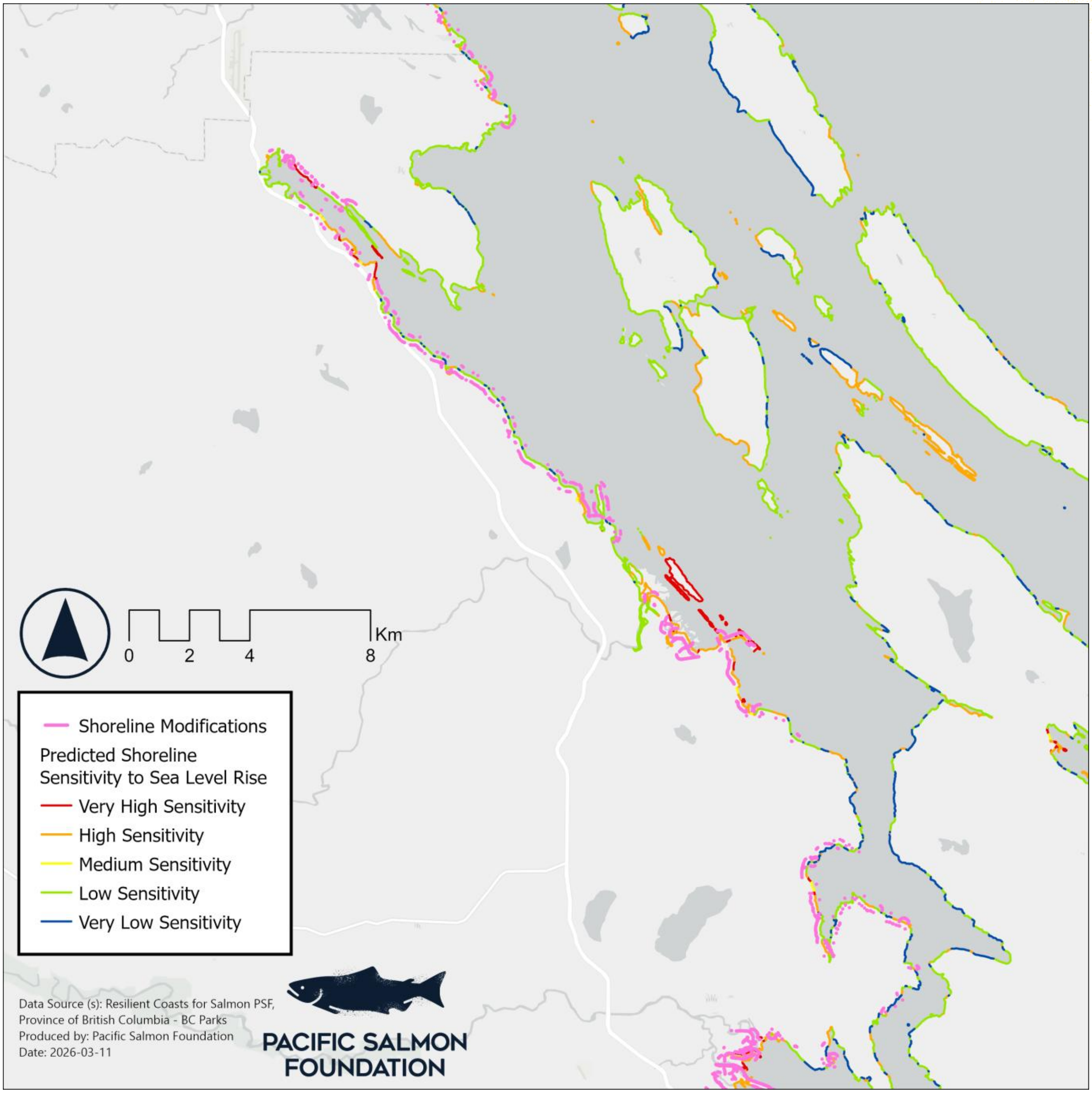


Figure 13 - The northern half of the CVRD's shoreline, colour-coded into varying degrees of shoreline sensitivity to sea level rise (MOE BC, 2014) overlaid with the Resilient Coasts coastal modification features (shown in pink).

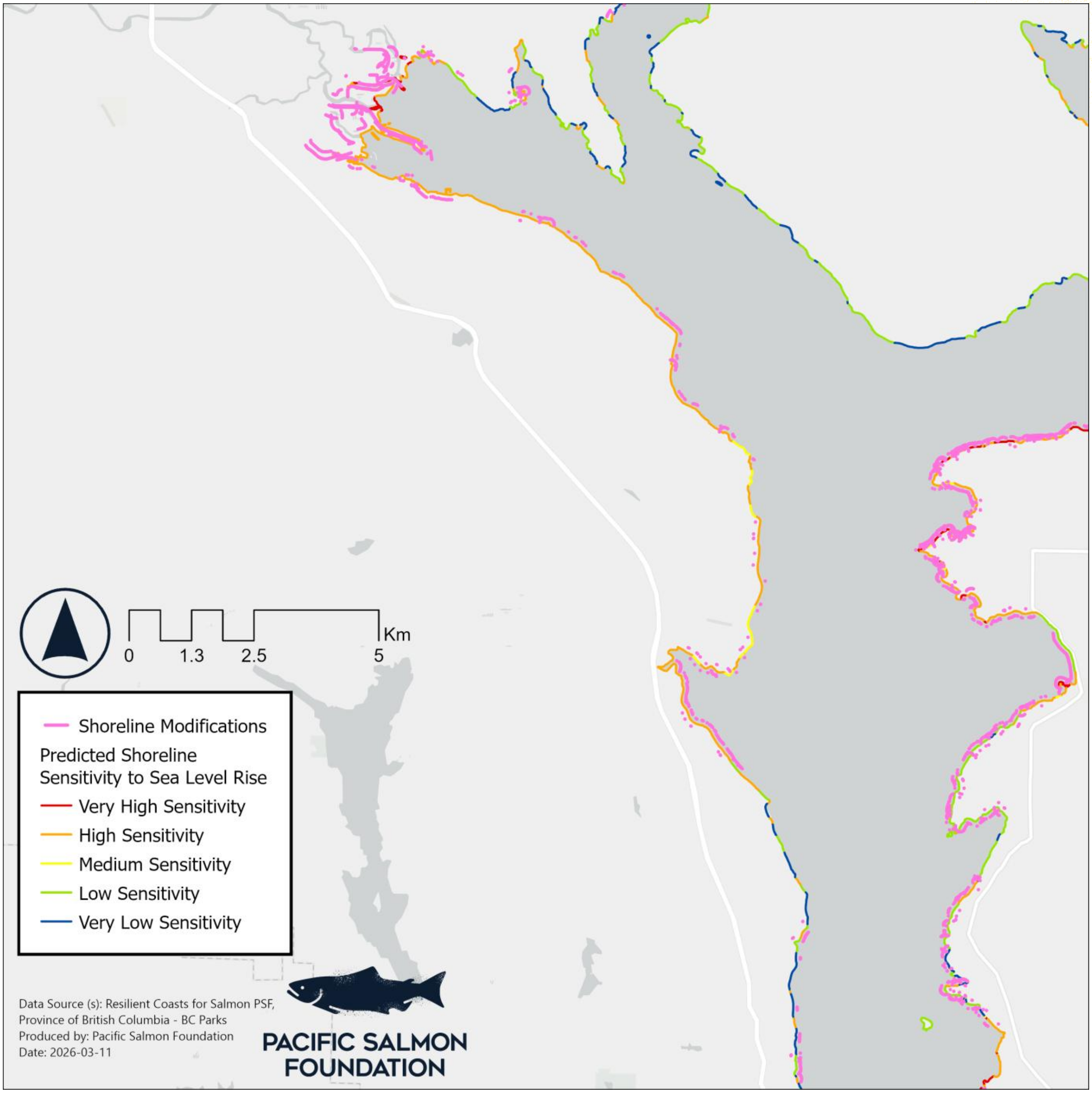


Figure 14 - The southern half of the CVRD's shoreline, colour-coded into varying degrees of shoreline sensitivity to sea level rise (MOE BC, 2014) overlaid with the Resilient Coasts coastal modification features (shown in pink).

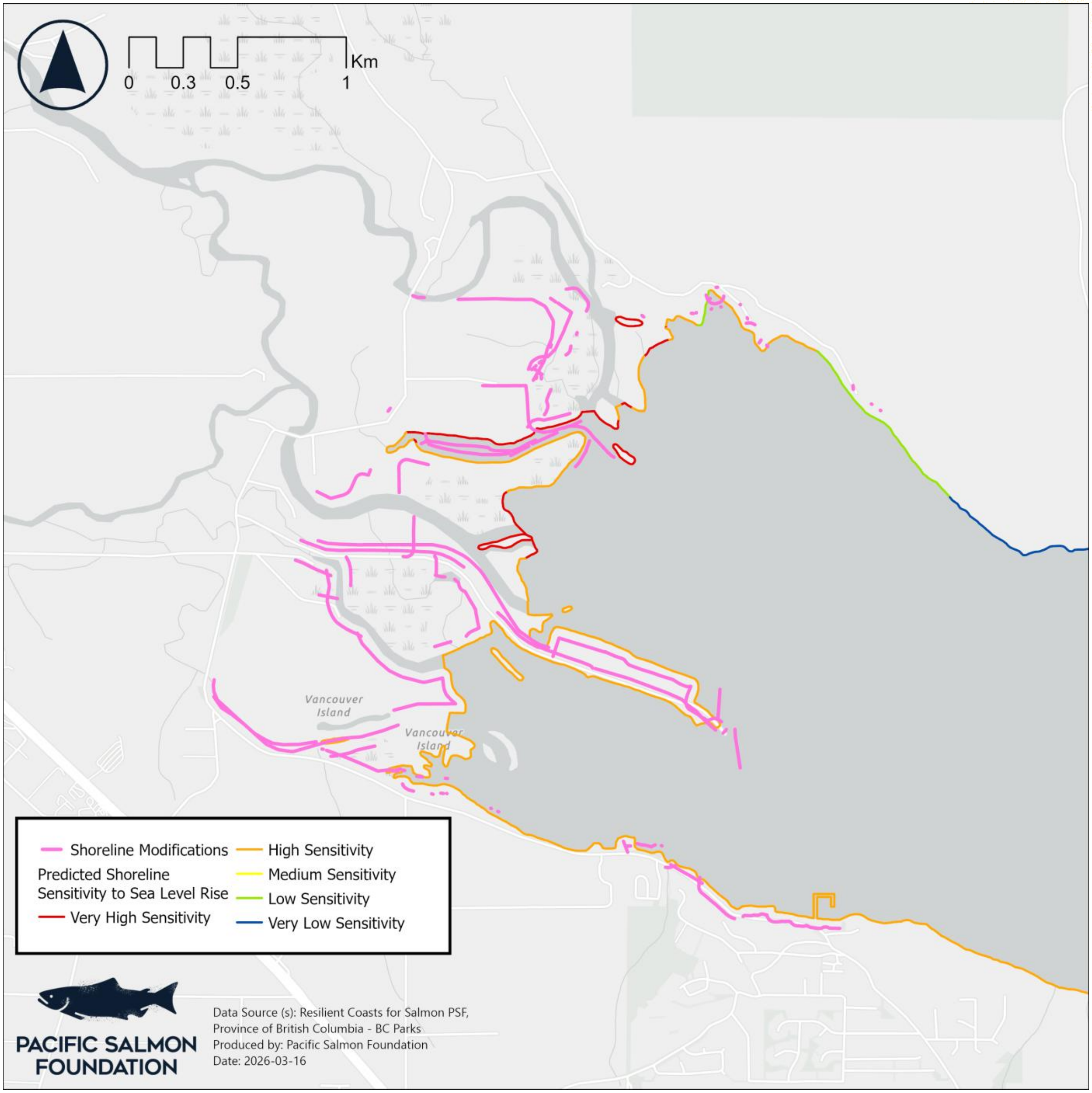


Figure 15 - The Cowichan River Estuary shoreline colour-coded into varying degrees of sensitivity to sea level rise (MOE BC, 2014), overlaid with the Resilient Coasts digitized extent of coastal modification features (shown in pink).

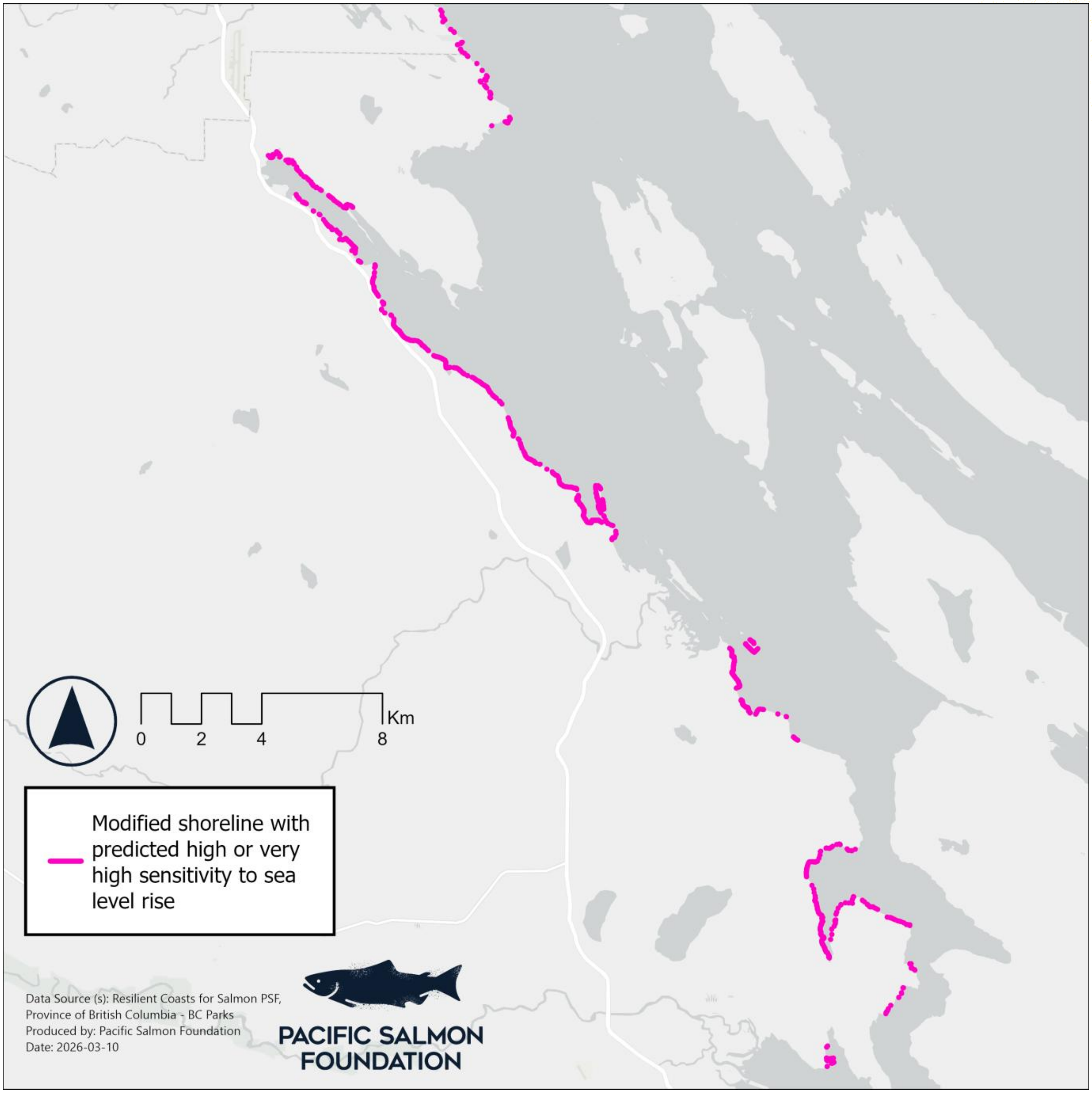


Figure 16 - The northern extent of shorelines covered in this report, showing where the shoreline is modified and classified as high or very high sensitivity to sea level rise (MOE BC, 2014).

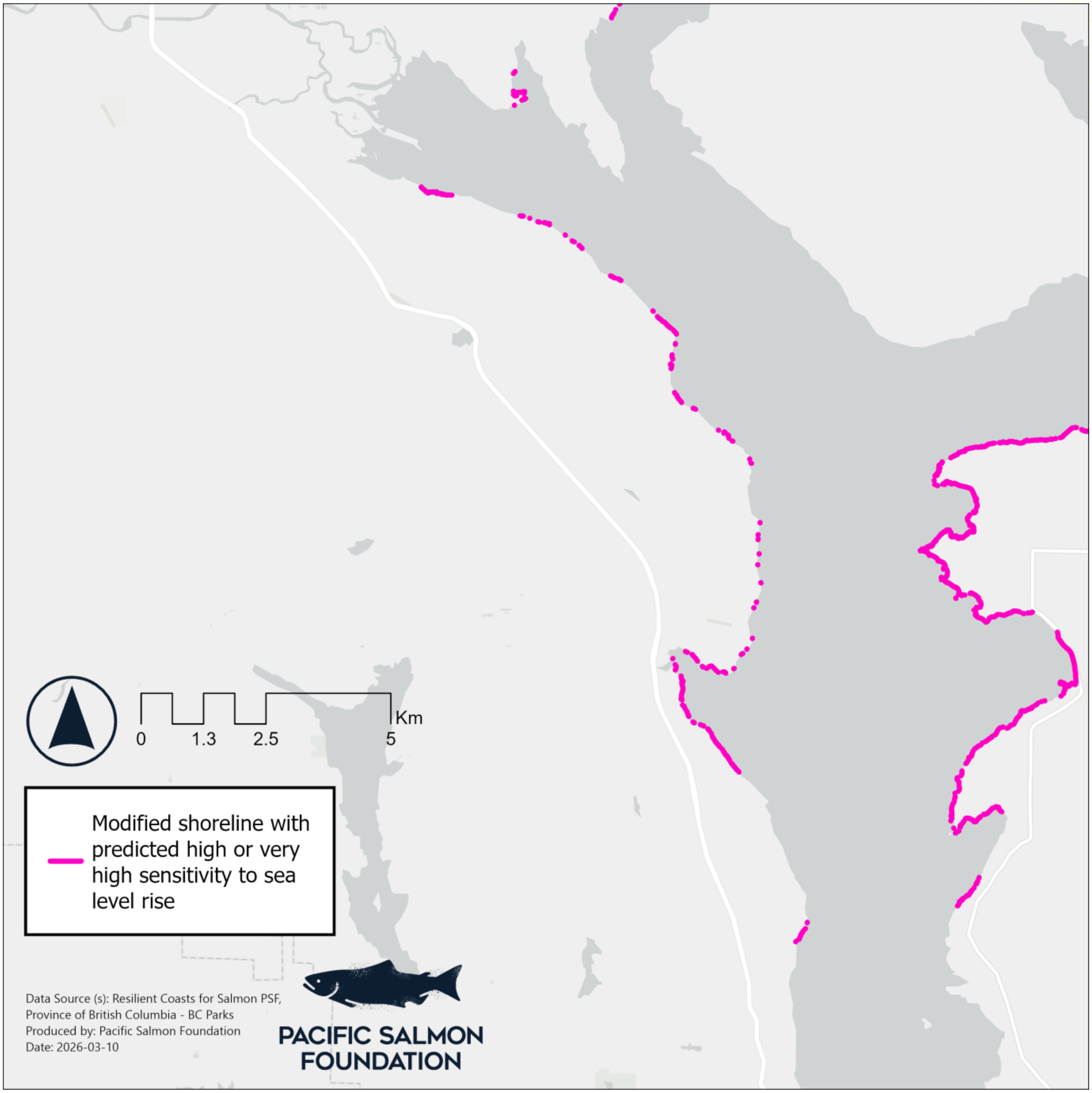


Figure 17 - The southern extent of the shorelines covered in this report, showing where the shoreline is modified and classified as high or highly sensitive to sea level rise (MOE BC, 2014).

## Wave Exposure

The Wave Exposure attribute (Cook et al., 2017) provides an estimate of the amount of wave energy that could impact intertidal zones of specific shore units (designated stretch of shoreline). The eastern shoreline of the CVRD consists mostly of protected, semi-protected, and semi-exposed stretches, with a few small segments of exposed shoreline. Based on the definitions from Cook et al. (2017)'s values for wave exposure, the semi-protected regions in the Cowichan Valley have maximum wave fetch distances in the range of 10 to 50 km and waves are low most of the time except during high winds. In semi-exposed regions, the maximum wave fetch distances are between 50 and 500 km with swell, creating relatively high wave conditions. These semi-exposed shorelines, including around Yellow Point, will receive the largest relative waves within the CVRD. Extremely large waves may occur during storms. In protected regions, like Ladysmith and Chemainus, the maximum wave fetch is less than 10 km; usually areas of provisional anchorages and low wave exposure except in extreme winds (Figure 18 and 19).

All the modified areas of shoreline within the study area were either very protected (1.6%), protected (24%), or semi-protected (72.4%) from wave exposure. For the least protected category of modified shoreline (semi-protected from wave exposure), 51.8% of that area is in an area of high or very high sensitivity to sea level rise (Figure 18 and 19).

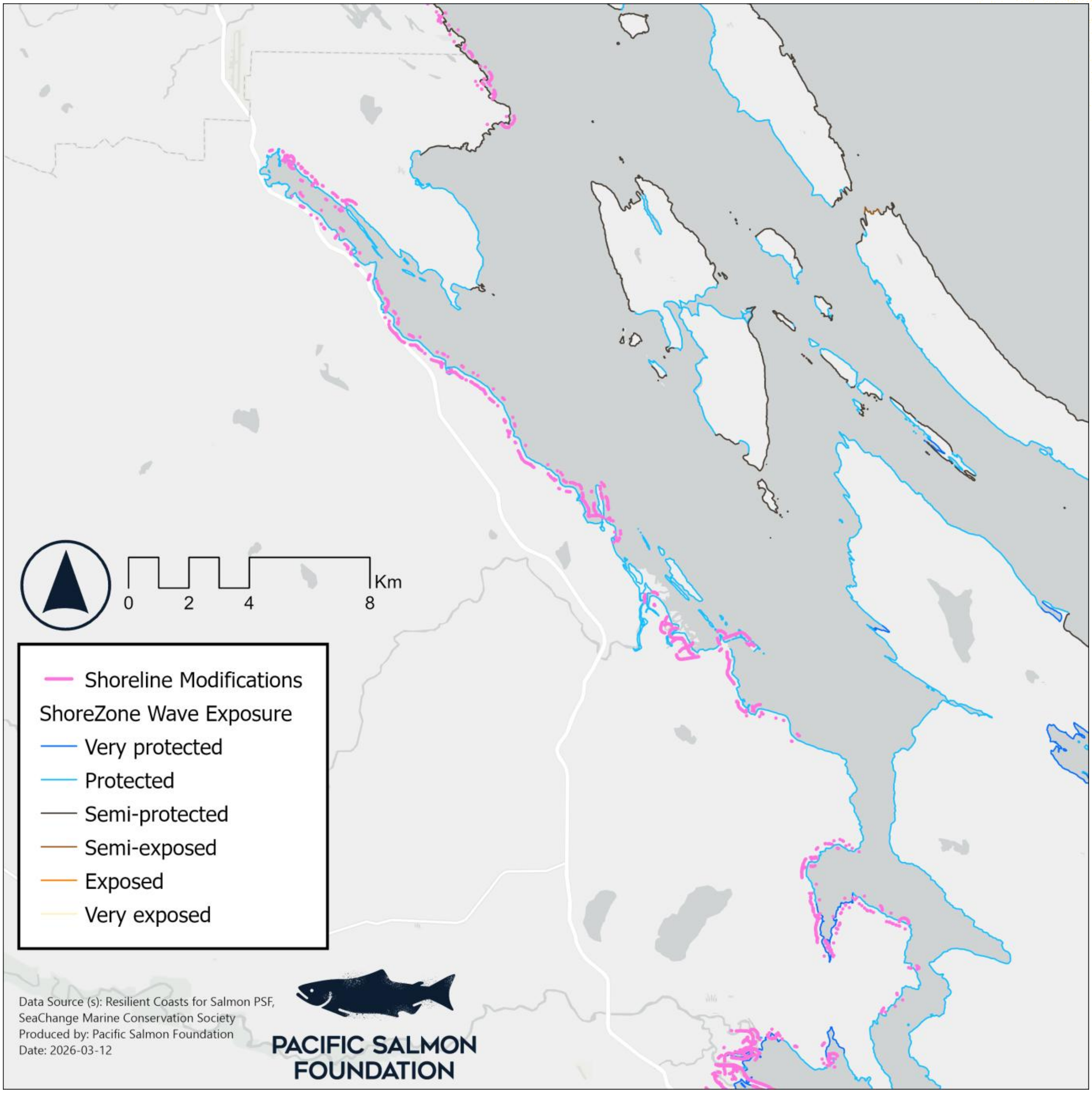


Figure 18 - The shorelines of the northern half of the CVRD, showing their relative wave exposure category (Cook et al., 2017), overlaid with the extent of coastal modification.

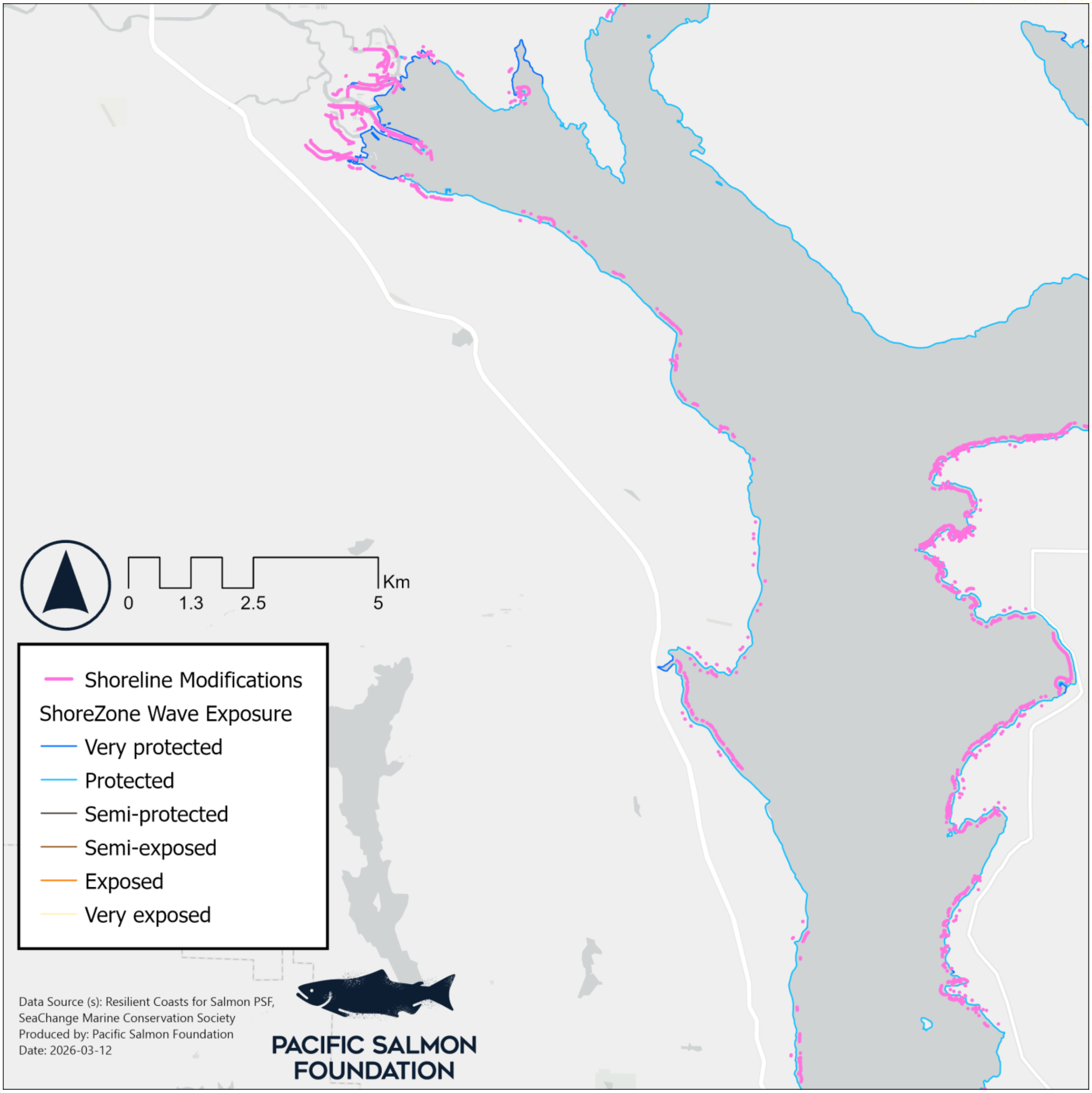


Figure 19 - The shorelines of the southern half of the CVRD, showing their relative wave exposure category (Cook et al., 2017), overlaid with the extent of coastal modification.

## Coastal Sediment Stability

These categories described by ShoreZone, indicate whether shoreline segments are eroding and providing (transporting) material to other areas of shoreline, and where areas are accreting sediment (receiving that sediment) (Coastal and Oceans Resources 2017). The vast majority of the CVRD's shoreline is considered stable, in terms of sediment stability, with some areas throughout the southern portion of the CVRD being considered accretional (Figure 20). There is one small area south of Cowichan Bay and another in Crofton which are considered erosional (Figure 20 and B6 in Appendix B). Data is missing for the shorelines north of Crofton (Figure B6 in Appendix B), which is why only the map of the southern portion of the CVRD is featured in this section of the report. Additionally, since the sediment stability class description delineates the flow of sediment, a natural coastal process, it does not identify locations of localized erosion due to sea level rise.

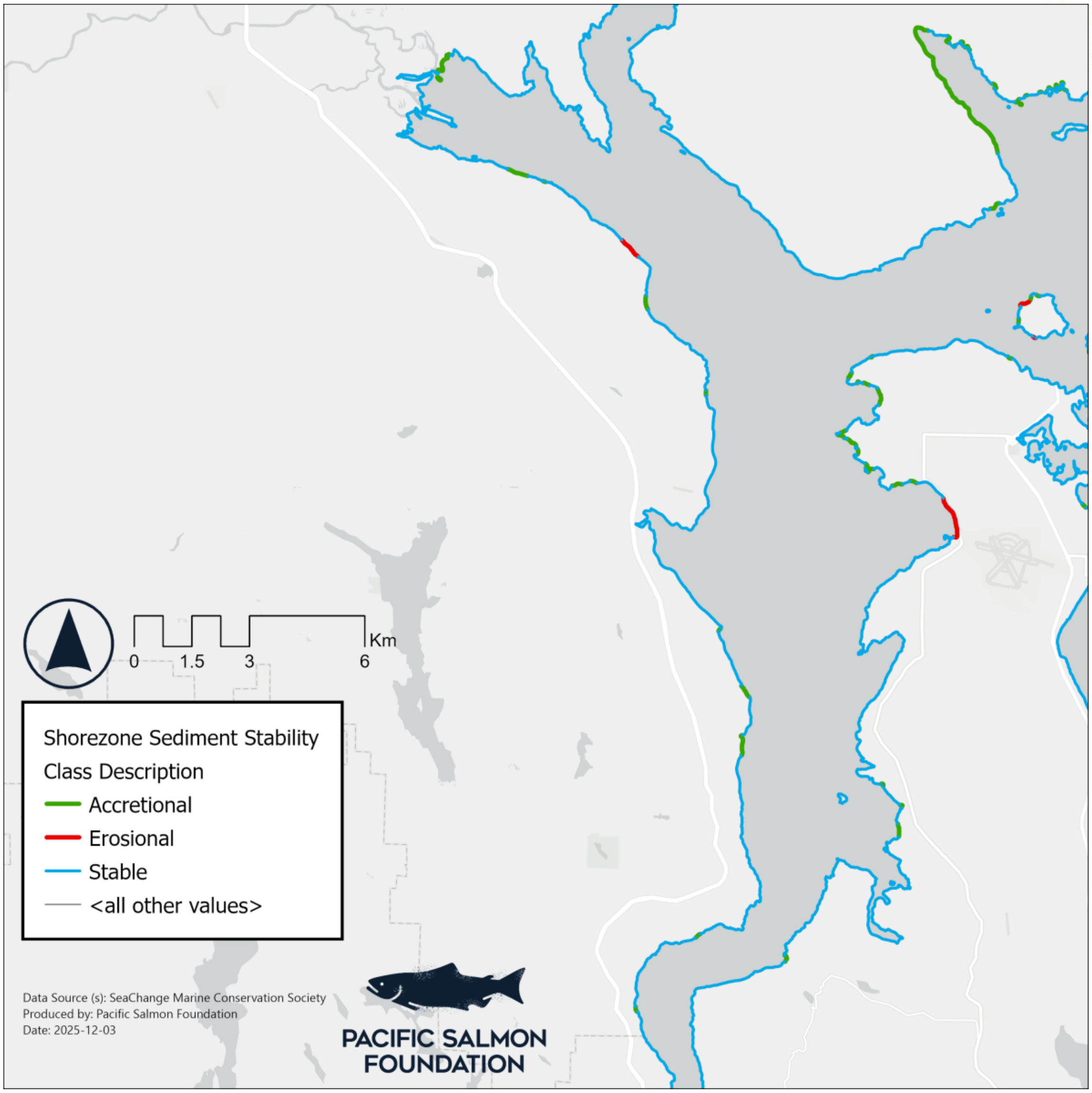


Figure 20 - ShoreZone sediment stability class descriptions for the southern half of the CVRD, showing that most of the shoreline is considered stable (Coastal and Ocean Resources, 2017).

## Forage Fish Habitat

The model (Huard et al., 2022) does not cover the entire CVRD's eastern shoreline (47.3% of the shoreline was outside of the model's scope). Approximately 38.3% (54.4 km) of the shoreline has modelled results for PSL habitat suitability with higher certainty values, whereas the remaining 14.4% (20.4km) of shoreline has modeled results, but with less certainty (i.e., within model uncertainty). The results presented below include values that are all modeled results (i.e., both outside and within model uncertainty.

The Cowichan Valley has a significant amount of predicted suitable spawning habitat for Pacific sand lance, with 15.7% (22.8km) of the shoreline estimated to be likely and 30% (44.7km) highly likely to support the species. Unfortunately, about 24% (16.4 km) of that likely or highly likely habitat also contained shoreline modifications (e.g., seawalls, rip rap and logging infrastructure), with the majority of those beaches having a high likelihood of being suitable (17% or 11.4 km). That is over 16.4 km of potential forage fish habitat that could be lost if those sediments are eroded or will erode (Figure 21 and 22, Table 3).

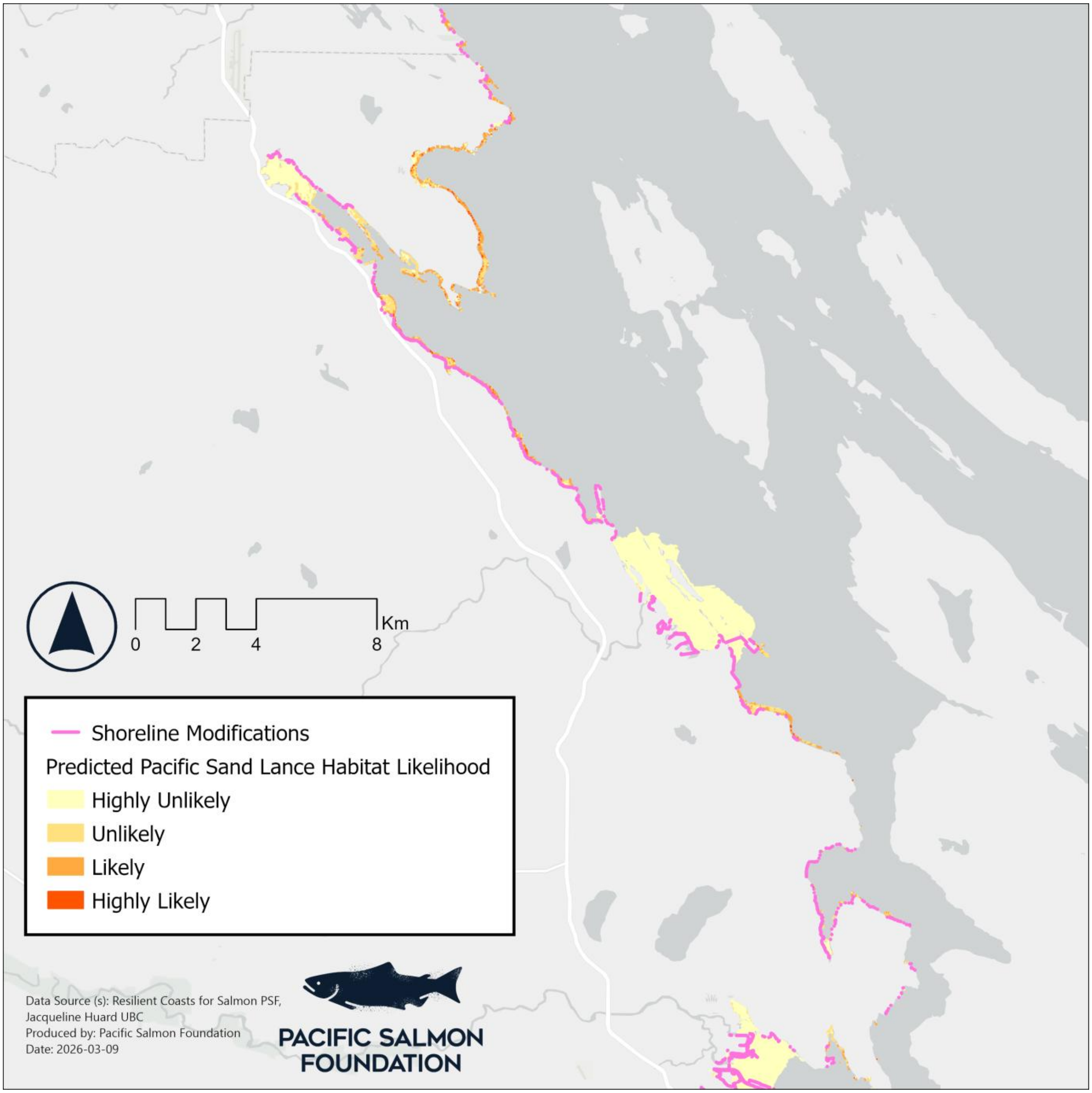


Figure 21 - The results of a predictive model (Huard et al., 2022) showing likelihood of Pacific sand lance habitat, overlaid with the extent of coastal modification within the northern half of the CVRD.

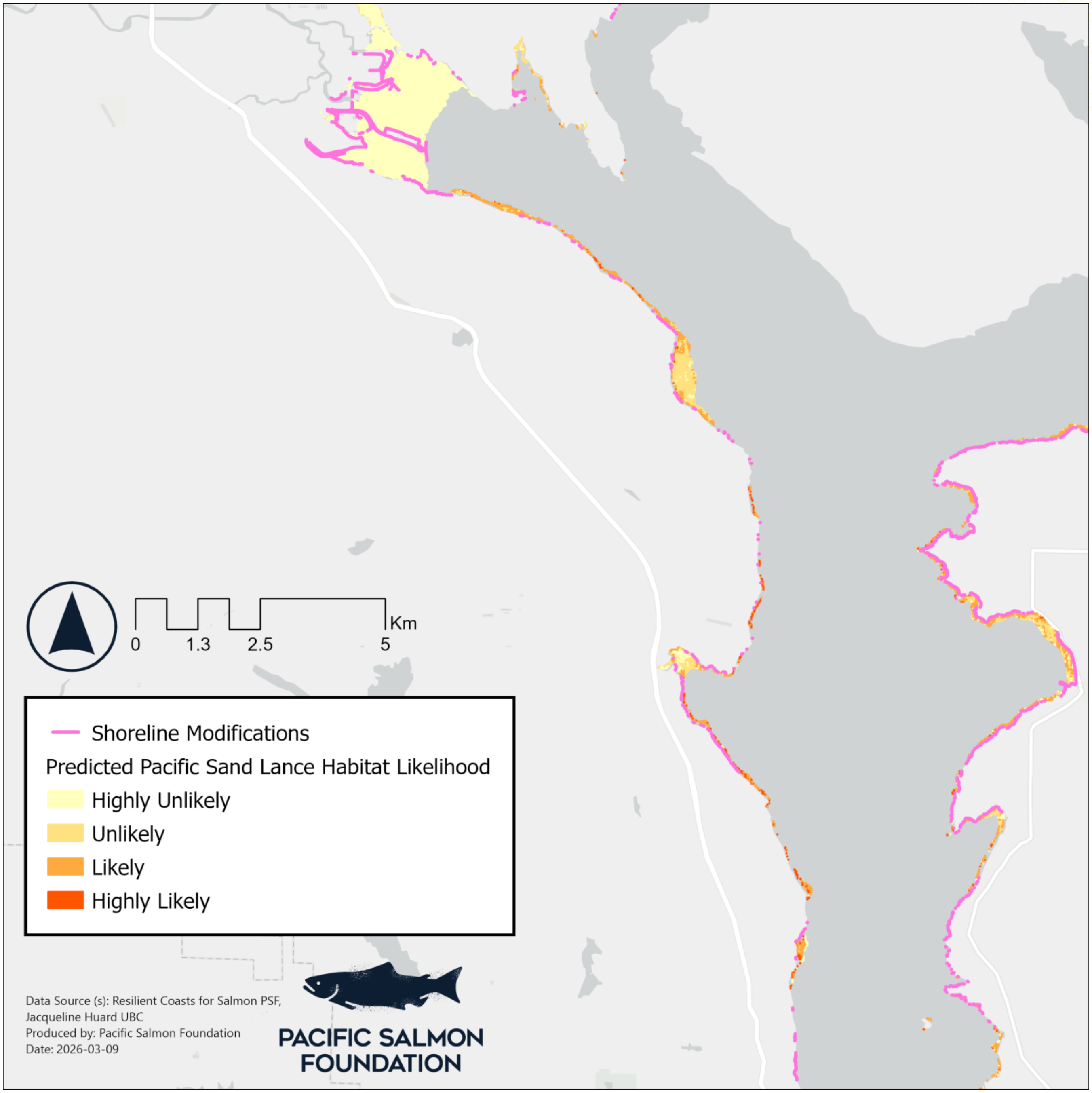


Figure 22 – The results of a predictive model (Huard et al,. 2022) showing likelihood of Pacific sand lance habitat, overlaid with the extent of coastal modification within the southern half of the CVRD.

Table 3 - Values of shoreline proportion and length by likelihood of Pacific sand lance habitat (Huard et al., 2022).

| Likelihood of PSL habitat | Proportion of total shoreline (%) | Length of shoreline (m) | Length of modified shoreline (m) |
|---|---|---|---|
| Very highly likely modelled PSL habitat (>93%) | 0 | 0 | 0 |
| Highly likely = high likelihood modelled PSL habitat (89 – 93%) | 30.7 | 44,669 | 11,433 |
| Likely = moderate likelihood modelled PSL habitat (71 – 89%) | 15.7 | 22,852 | 4,951 |
| Unlikely = low likelihood modelled PSL habitat (42.1 – 70%) | 8.9 | 12,878 | 2,485 |
| Highly unlikely = very low likelihood modelled PSL habitat (0 – 42%) | 6.2 | 9,063 | 2,155 |

Groups like the Mount Arrowsmith Biosphere Region Research Institute and their dedicated volunteers have been monitoring CVRD beaches for forage fish eggs through the Coastal Forage Fish Network. There were many detections of PSL eggs found in Maple bay and the areas around Cherry Point in recent years (2021-2023), as well as eggs from an unconfirmed species of forage fish in Cowichan Bay, the Cowichan River Estuary and Genoa Bay. Most of these detections were found within modified areas. In fact, 4.2% of the modified shoreline had a recorded forage fish embryo detection within 50 m of it.

## Overwater Structures

Overall, the amount of overwater structures in the Cowichan Valley is extensive, with 307 total overwater structures. These 307 features include 190 residential docks, 33 industrial overwater structures, 40 individual or groupings of creosote pilings, and 2 ferry terminals. There were also 20 marinas, 8 of which are large marinas capable of accommodating over 50 boats at any given time. A variety of modification forms serve the marinas, including boat ramp/launch, parking lots/fill, creosote pilings, rip rap, groynes, and nearshore breakwaters. Seven of the marinas are located within 100 m of predicted PSL habitat, and therefore could impact the quality of those habitats (Figure 23 and 24). A stretch of shoreline along Mill Bay Rd in Mill Bay is particularly suitable (likely or highly likely to be PSL spawning habitat), where there also exists a marina, creosote pilings and an overwater walkway/pier, all of which have some creosote-treated wood elements which could have negative impacts to fish health or the success of a spawning event (visit the interactive map to see this area in closer detail; Figure 24).

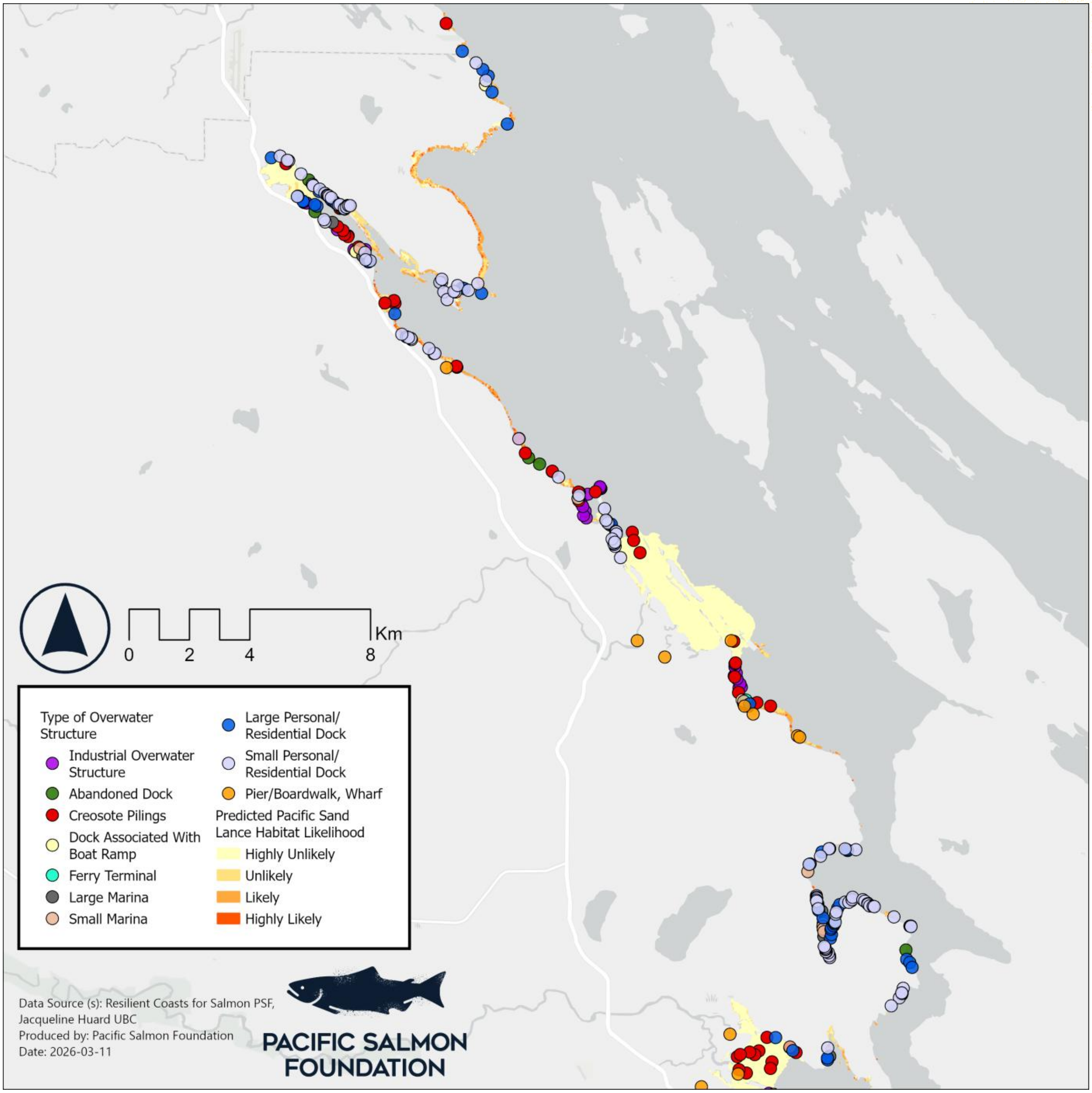


Figure 23 – The extent of overwater structures within the northern half of the CVRD, overlaid with the predicated habitat for Pacific sand lance (Huard et al., 2022).

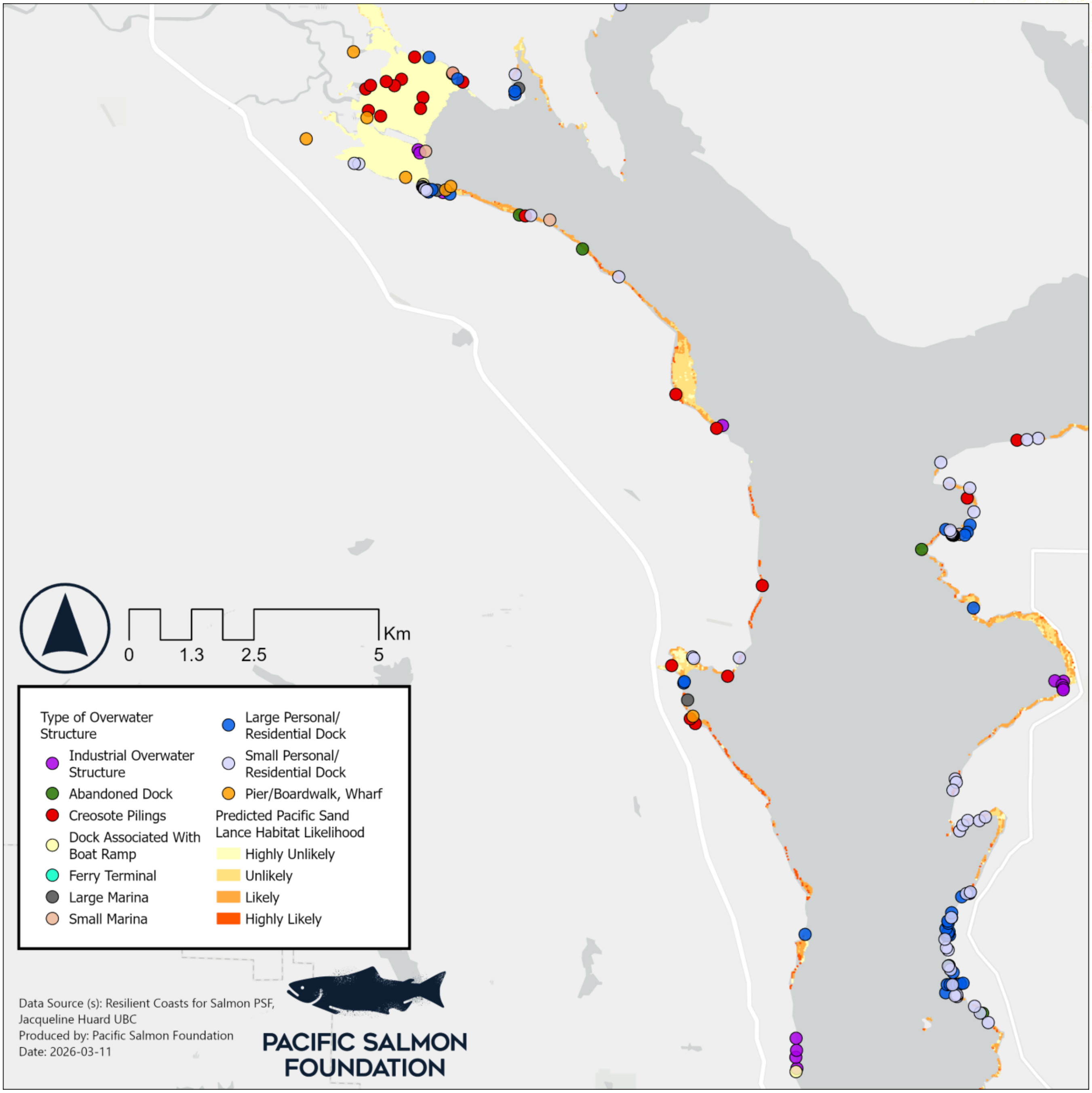


Figure 24 – The extent of overwater structures within the southern half of the CVRD, overlaid with the predicated habitat for Pacific sand lance (Huard et al., 2022).

## Materials

The dominant materials noted for overwater structures in the CVRD were wood (57%), mixed (16%), and concrete (2.3%). For 22% of the structures, the material was unknown, which often indicated that it was not possible to determine the material from the imagery. It should be noted that overwater structures often are made of multiple materials including synthetic materials used as pilings, railings, or to help the structures float, although the recorders noted the dominant material.

The dominant kind of pilings were also noted, although often there are multiple types (materials) of pilings used in one structure. For most of the structures (60%), they either did not have pilings associated with them, or the material of their pilings was unknown. The most common type of piling used was creosote/treated wood (22%) which was used in 69 overwater structures, followed by metal or metal-wrapped pilings (10%), then concrete pilings (6.5%), and vinyl-wrapped pilings (0.6%).

### Abandoned Docks and other Marine Debris

There were 9 abandoned docks found in the Cowichan Valley Regional District. Often these docks sit on the shoreline as debris.

### Creosote-treated Pilings

There were 40 individual or groupings of creosote pilings standing independent of other structures. A total of 20 overwater structures were supported by creosote pilings, the number of which could be between 2 and 60+ for each structure. Of the total 40 individual or groupings of creosote pilings, 19 were detected within 25 m of modelled PSL habitat.

### Cumulative Impacts: Coastal Modifications & Overwater Structures

Maple Bay is one area of concern whose shoreline is extensively modified with features such as concrete seawalls and piers and wharfs with creosote wood. Much of this shoreline is also predicted to be likely or highly likely suitable spawning habitat for PSL. In fact, the Coastal Forage Fish Network have detected PSL eggs in the beaches of Maple Bay in recent years (2019, 2021-2023) (Figure 25).

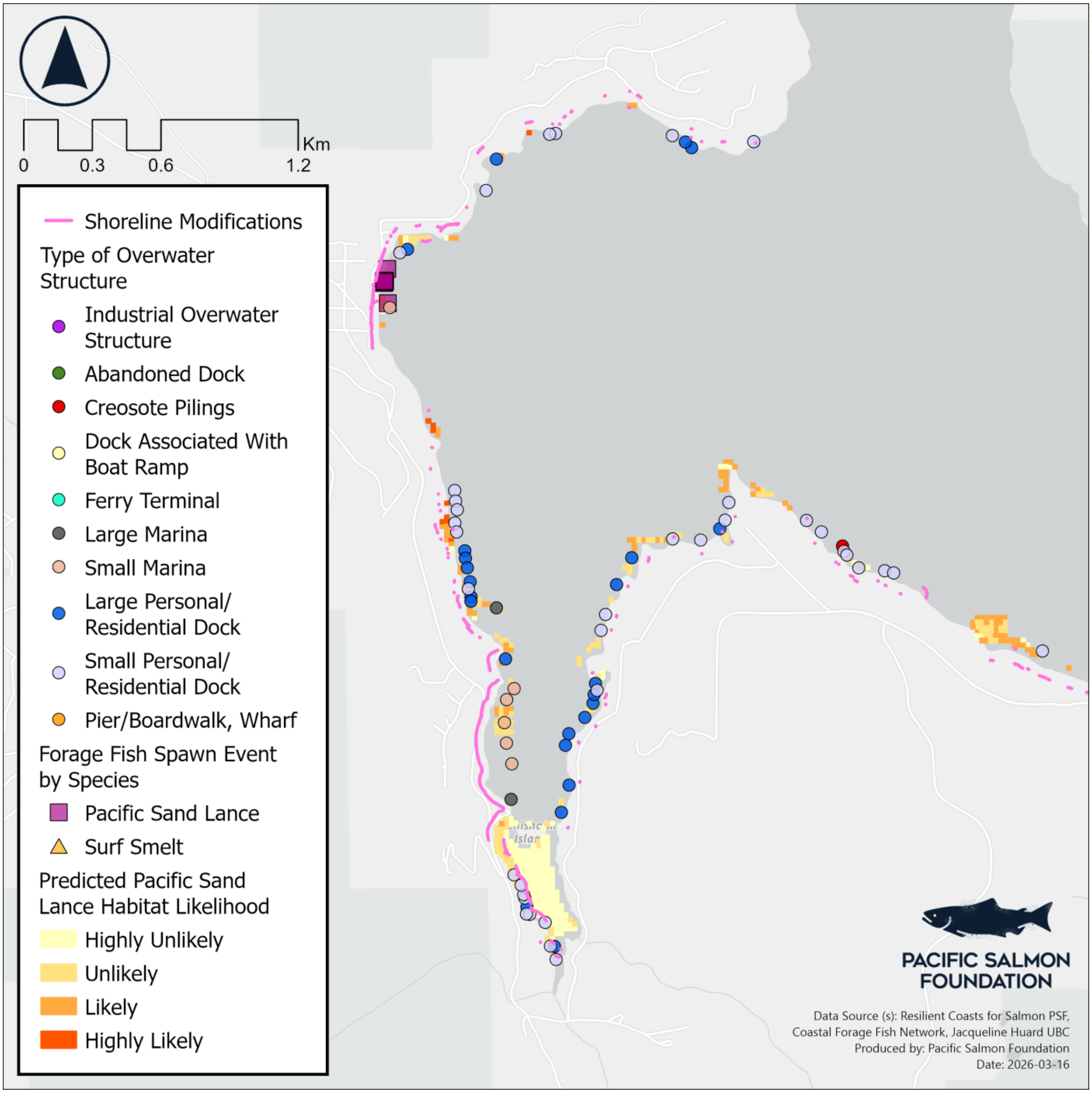


Figure 25 – The extent of coastal modifications and overwater structures within Maple Bay, overlaid with the predicated habitat for Pacific sand lance (Huard et al. 2022) and positive detections of forage fish (CFFN, 2019).

## Log Accumulation

Of the total shoreline, the largest portion 44.6% (63 km) was found to have a low (<20%) accumulation of logs. A 6.8 km portion (4.8%) of the shoreline had a high accumulation (50 to 89% coverage), and 12.2% (17.4 km) having moderate levels (20% to 49%) of the beach covered by logs. It should be noted that the moderate log accumulation category also represents a significant coverage of logs – whereby 20-49% log coverage on a given beach could negatively impact shoreline habitat. It should be noted that a large portion (37.4% or 53 km) of the Cowichan Valley shoreline was not digitized for log accumulation due to two factors: 1) the shoreline was within a First Nation reserve land and was not digitized out of respect for privacy, or 2) shoreline imagery was not available for these stretches due to them being estuaries or bays (Table 4).

Table 4 - The length of shoreline (in percentage and metres) by category of log accumulation.

| Log Accumulation | Percentage of Shoreline | Metres |
|---|---|---|
| Extreme (>89%) | 1 | 1,434 |
| High (50 to 89%) | 4.8 | 6,788 |
| Moderate (20 to 49%) | 12.2 | 17,362 |
| Low/None (<20%) | 44.6 | 63,260 |
| Unknown | 37.4 | 53,093 |

## Log Mobility

The logs accumulated on beaches were often mobile, defined as being susceptible to shifting on top of the sand with the tide and waves. In fact, of the areas where log accumulation is known, approximately 49.8% of the shoreline segments contained only mobile logs, and 49.9% had both mobile and anchored wood.

## Creosote-treated Logs

Creosote logs were observed within 139 shoreline segments which means there were at least 139 individual creosote logs noted on the beaches within the study region. It is possible that multiple creosote logs were noted in the same shore segment.

## Log Accumulation and Wave Exposure

Areas with high wave exposure and an accumulation of logs could be at risk of further erosion – particularly on sediment shorelines; however, due to the nature of the eastern shoreline of the CVRD, wave exposure is minimal. There is also a large gap in the wave exposure dataset, which limits the results in this section. For the areas of high and extreme log accumulation, about 1,459 m (1%) of shoreline was semi-protected from wave action, while another small portion (733 m or 0.5%) of the shoreline had both an extreme or high accumulation of logs and was protected from wave action.

### Log Accumulation and Forage Fish Habitat

Of particular concern is the overlap of significant log accumulations with forage fish spawning habitat (Figure 26 and 27). On about 3.7% (5.3 km) of shoreline, there was a high accumulation of logs in areas that were likely or highly likely to be PSL spawning habitat. An even larger chunk (9% or 13.1 km) of shoreline has both a moderate accumulation of logs and were likely or highly likely to be PSL spawning habitat (Figure 26 and 27, Table 5). There are some of these areas of moderate log accumulation along the Mill Bay Road stretch, which has been noted in earlier sections as a considerable area for PSL spawning habitat (Figure 27). Although they are not lengthy sections, there are areas near Bamberton Park, Yellow Point, and north of Mill Bay which include moderate, high and extreme log accumulations where nearby or overlapping are areas of likely and highly likely PSL spawning habitat (Figure 26 and 27). In addition, there were three occurrences where extreme log accumulation was within 25 m of surveyed areas where forage fish embryos had been detected by the Coastal Forage Fish Network.

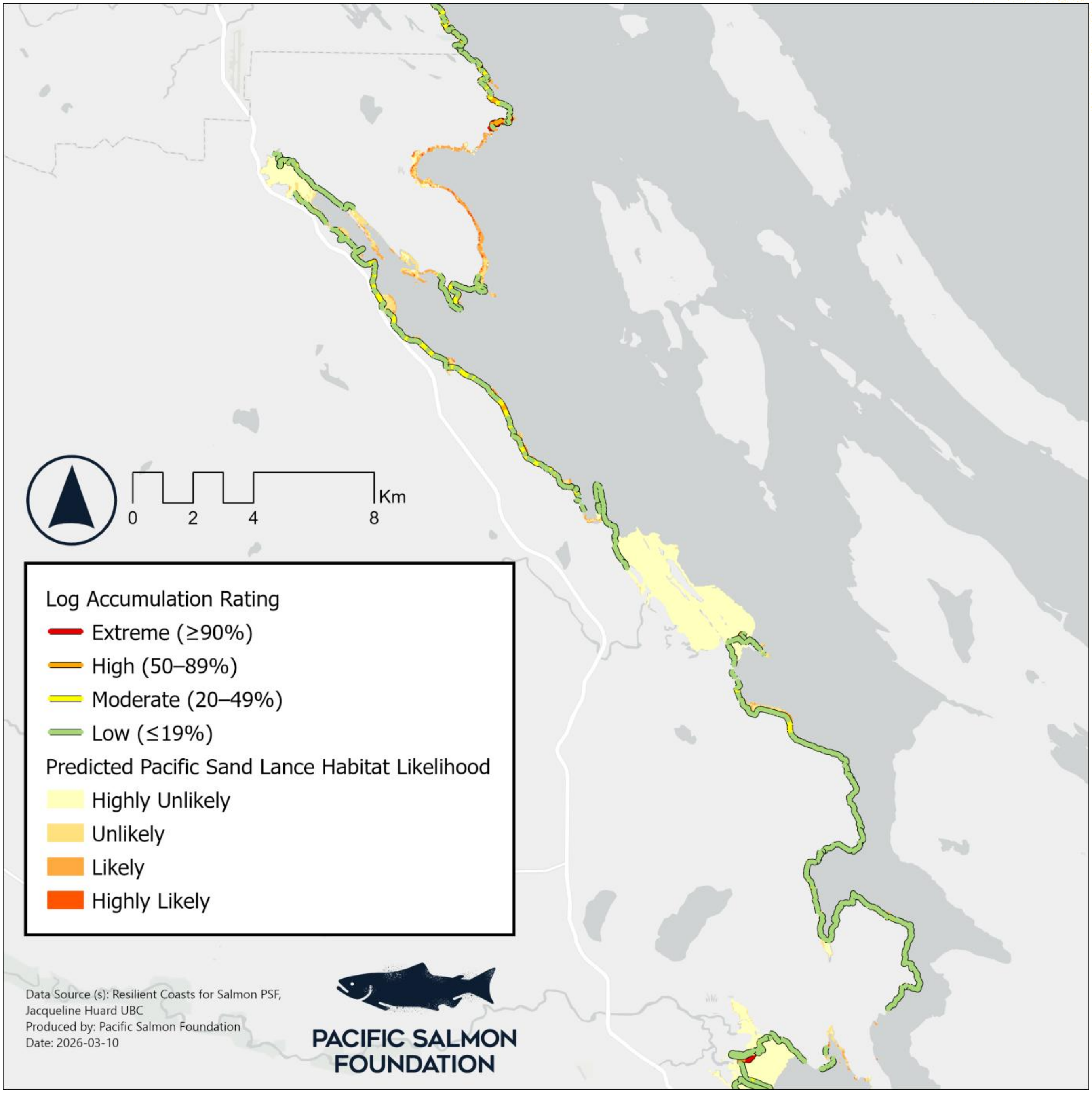


Figure 26 – The extent of log accumulation on the beaches of the northern half of the CVRD, overlaid with modeled likelihood of Pacific sand lance spawning habitat (Huard et al., 2022).

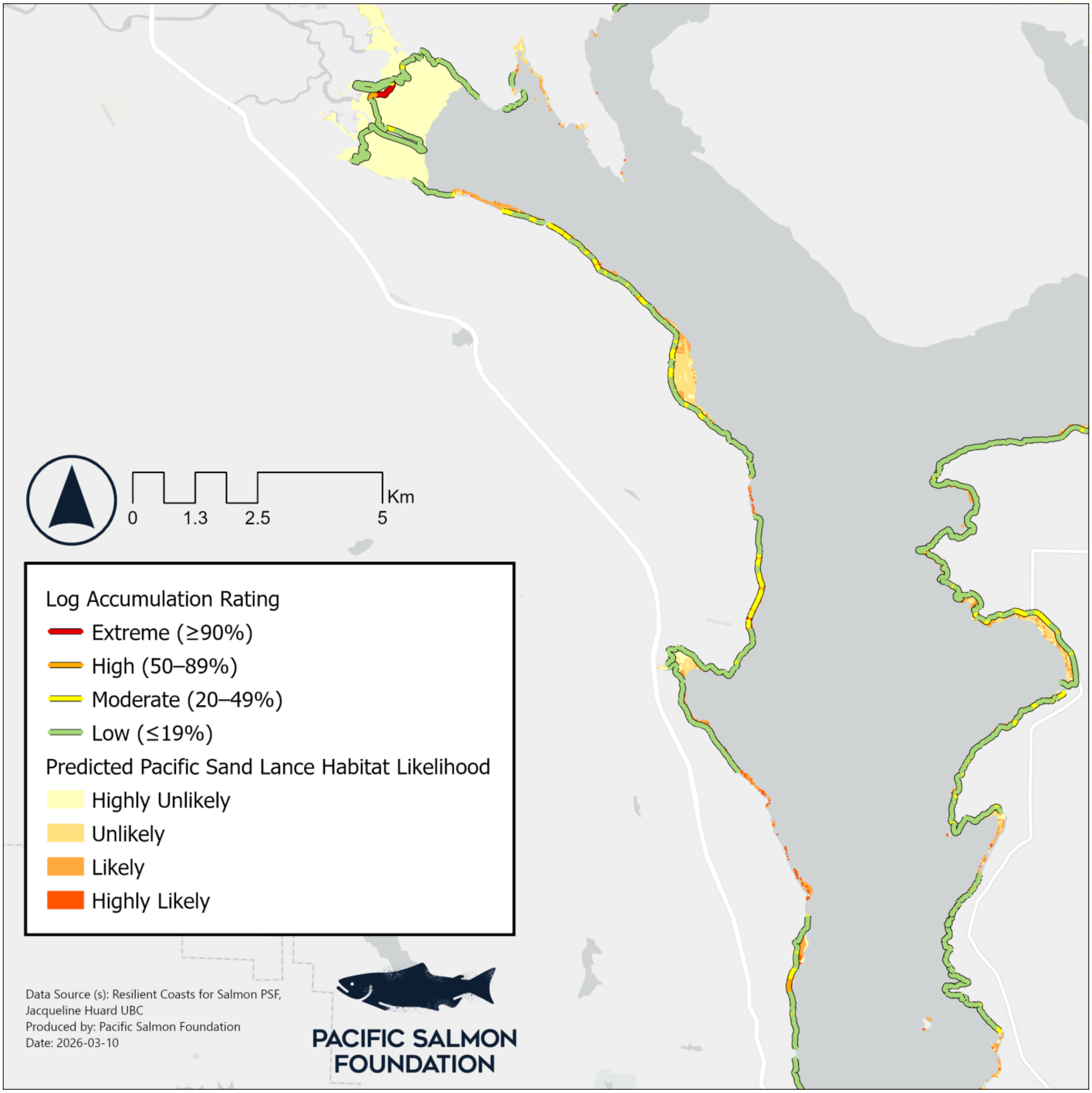


Figure 27 - The extent of log accumulation on the beaches of the southern half of the CVRD, overlaid with modeled likelihood of Pacific sand lance spawning habitat (Huard et al., 2022).

Table 5 - Length and percent of shoreline by wave exposure rating where there was also a high or extreme amount of accumulated logs.

| Log Accumulation Rating | Length of shoreline with very high modelled likelihood (>93%) of PSL spawning habitat (m) | Length of shoreline with high modelled likelihood (89 – 93%) of PSL habitat (m) | Length of shoreline which is modelled to be likely (71 – 89%) PSL habitat (m) |
|---|---|---|---|
| Extreme Log Accumulation (>89%) | 0 | 842 | 191 |
| High Log Accumulation (50 to 89%) | 0 | 4,594 | 729 |
| Moderate Log Accumulation (20 to 49%) | 0 | 10,453 | 2,663 |

## Cumulative Impacts: Log Accumulation, Coastal Modification and Overwater Structures

Of the areas of shoreline with moderate log accumulation, about 20% (2.6 km) was also modified with structures including sea walls and riprap. This can pose a risk to forage fish habitat where logs being pushed into seawalls or similar structures can erode fine sediments that are critical for spawning. A small portion of the likely or highly likely areas of PSL spawning habitat were also modified with seawalls (Figure 21 and 22, Table 3). There was minimal overlap of modification structures where there was also high or extreme log accumulation and likely or high likelihood of PSL habitat (<1km each).

Other factors such as Crownland Tenures for aquaculture and logging are extensive in estuaries, bays and inlets throughout the CVRD and could have impacts to nearshore and shoreline habitats. For the CVRD, these activities take place in Ladysmith Harbour, the Chemainus River Estuary and Chemainus Bay, and the Cowichan River Estuary. In the Ladysmith Inlet, there is a high number of overwater structures including industrial structures, residential docks (on the north side of the inlet), creosote pilings and marinas (Figure 28). This area is also heavily used by the logging industry for log storage and aquaculture. The Cowichan river estuary is another area where there are large areas of log storage, as well as associated creosote pilings and overwater features (Figure 29). Logs were noticed as accumulating on marsh platforms in this area, which could have negative impacts to the marsh vegetation (Figure 30). See Figure B7 and B8 in Appendix B for a broad look at the extent of Crownland Tenures for activities in the nearshore throughout the Cowichan Valley overlaid with log accumulation data. See Figure B9 and B10 in Appendix B for a look at the Crownland tenures overlaid with coastal modifications throughout the Cowichan Valley nearshore environment.


Figure 28 – The Ladysmith Harbour and Inlet showing the extent of overwater structures and shoreline log accumulation, overlaid with industrial use tenures including log handling and storage, and aquaculture (MFLNRORD, 2020).

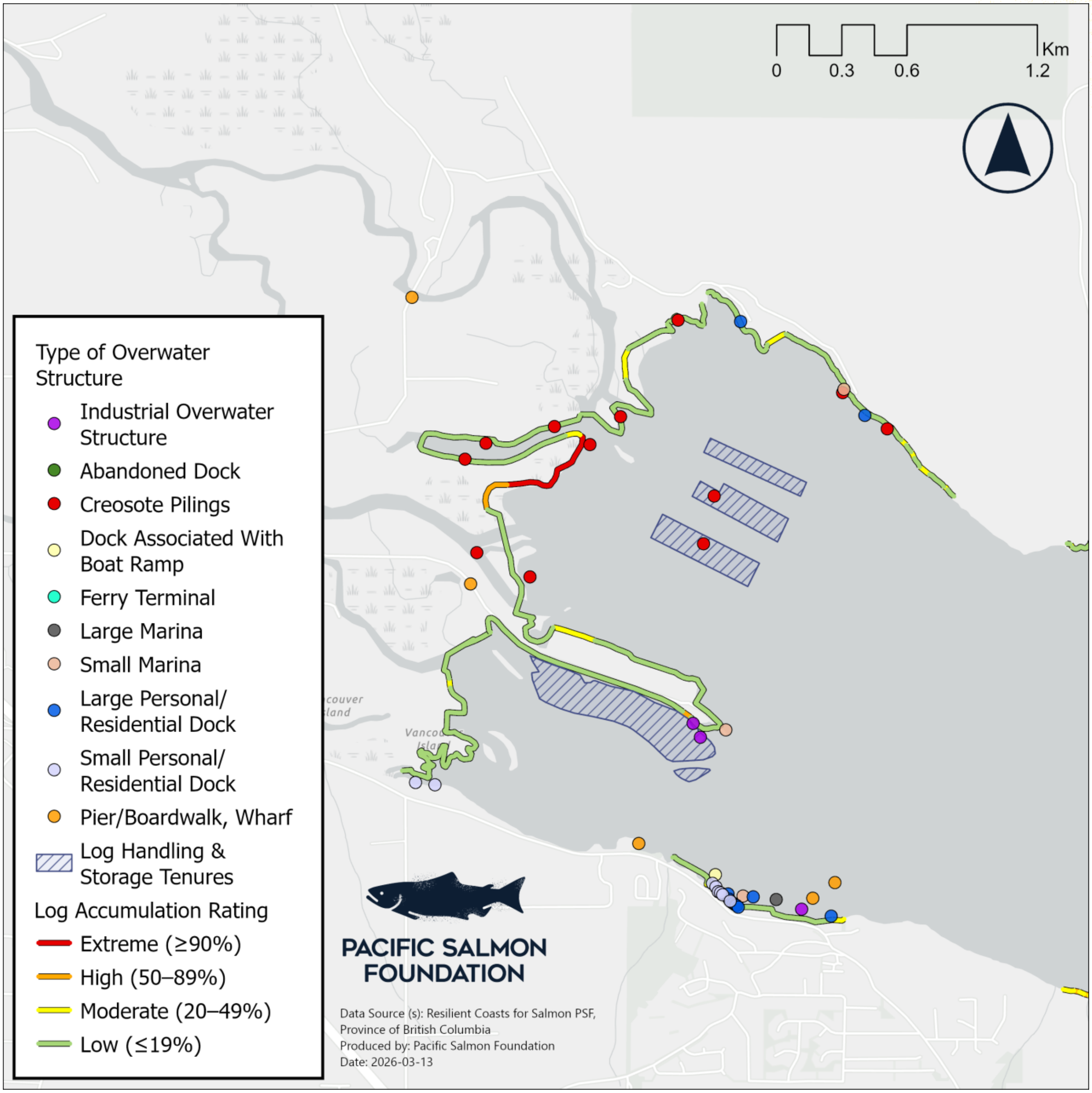


Figure 29 - The Cowichan River estuary showing the extent of overwater structures and shoreline log accumulation, overlaid with industrial use tenures of log handling and storage (MFLNRORD, 2020).

Figure 30 - Imagery from the Cowichan River Estuary, showing log accumulation of mostly processed logs on a marsh platform. Photo by Michael Miller Media (Resilient Coasts for Salmon imagery).

The Chemainus shoreline is largely modelled to be likely or highly likely to support PSL spawning habitat. While much of this shoreline is characterized as having low accumulations of logs, there are stretches of moderate and even high amounts of log accumulation. With the log storage area in Chemainus bay, there is a risk that logs could escape and end up on these beaches where there would likely be impacts to PSL. This area also includes multiple creosote pilings and industrial overwater structures which include creosote-treated wood, both of which could have negative consequences for a spawning event (Figure 31 and 32). Much of this area is also modified with features such as seawalls, and is largely rated as low sensitivity to sea level rise (Figure B11 in appendix B).

Figure 31 - Creosote pilings were often found as part of industrial overwater structures present in estuaries and the nearshore marine environment in the Cowichan Valley. Photo by Michael Miller Media (Resilient Coasts for Salmon imagery).

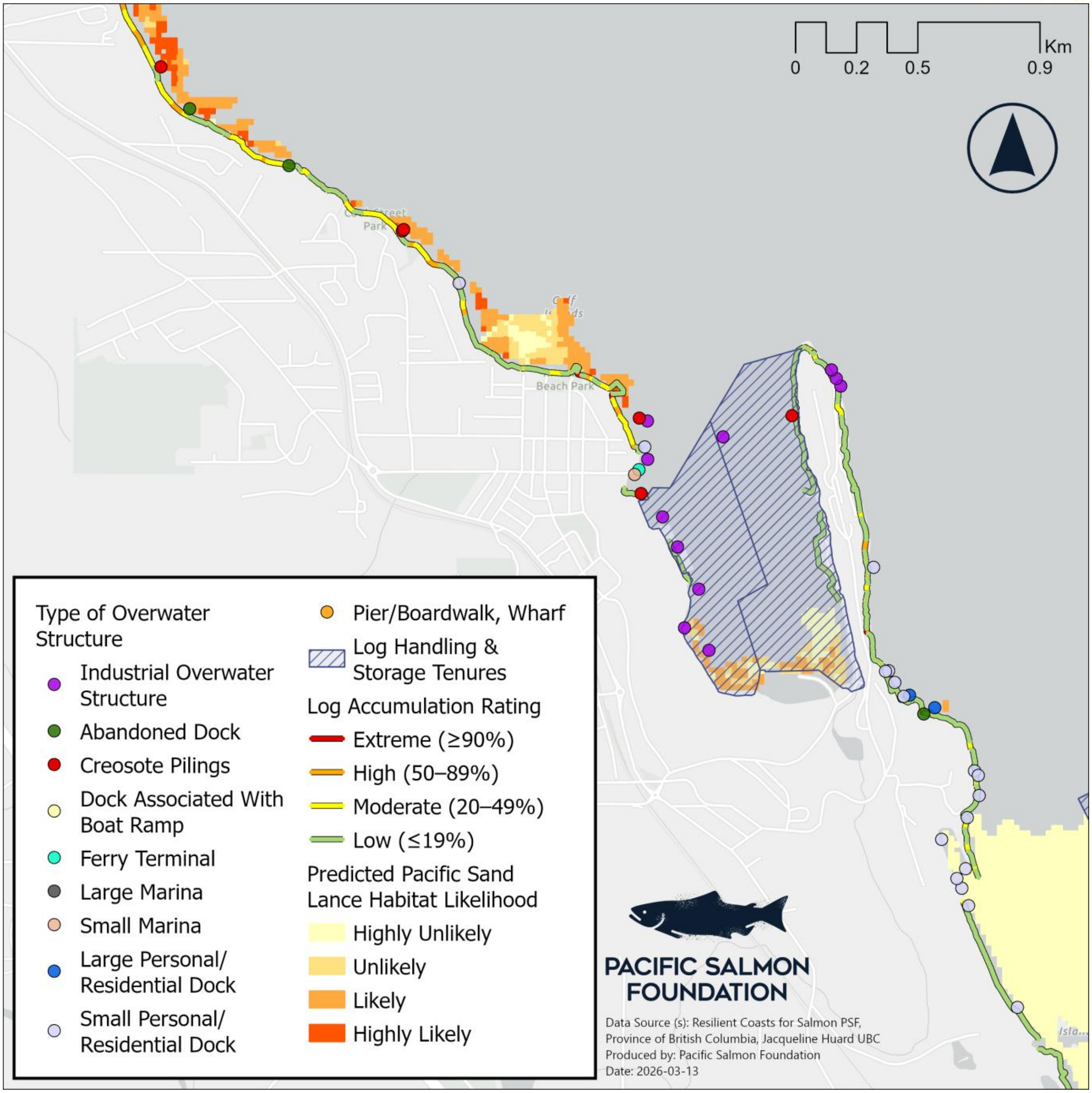


Figure 32 - Most of the Chemainus shoreline, showing log accumulation ratings and overwater structures, overlaid with log storage tenures (MFLNRORD, 2014) and modeled likelihood of Pacific sand lance spawning habitat (Huard et al., 2022).

Another area of potential concern is Crofton where three are areas of modeled likely and highly likely PSL habitat nearby many overwater structures and creosote pilings and coastal modifications. Just north of the areas with modeled PSL habitat are log storage tenures. Although the log accumulation in this area is currently rated mostly as low, there is a risk that logs could escape from these storage areas and smother the spawning habitat (Figure 33 and 34).

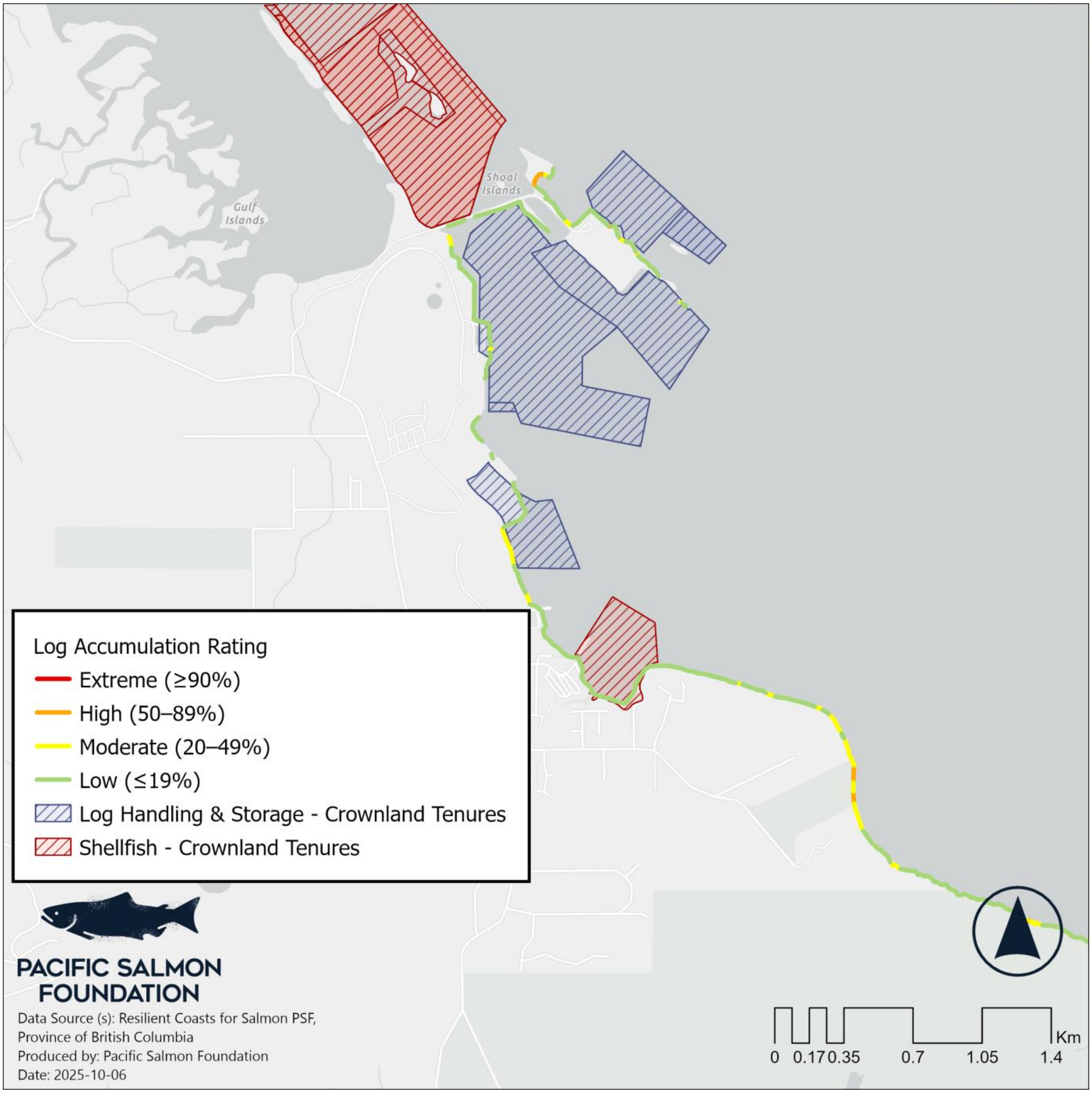


Figure 33 – The shorelines of Crofton, showing the extent of log accumulation overlaid with Crownland Tenures for aquaculture and logging activities in the nearshore (MFLNRORD, 2014).

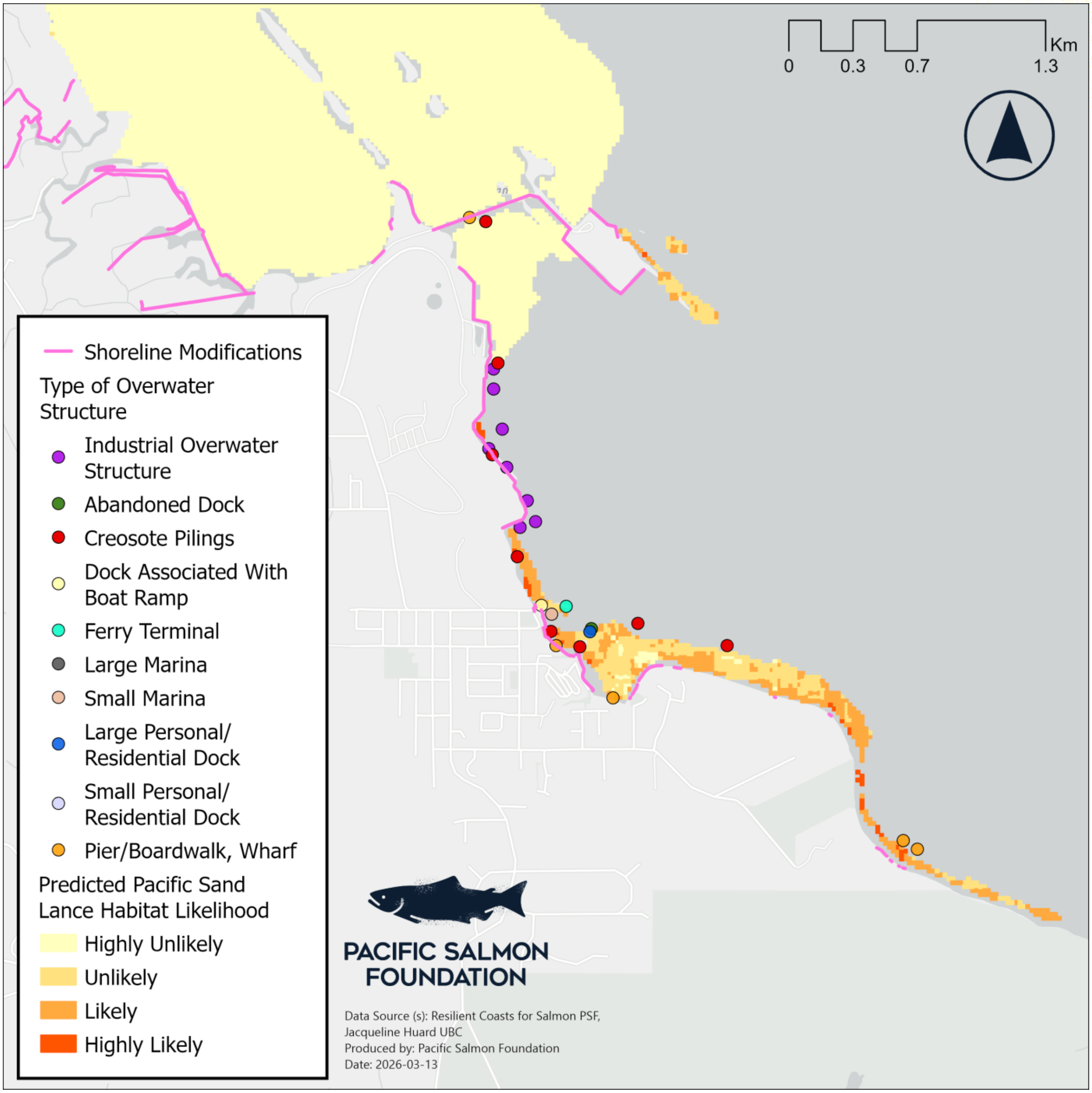


Figure 34 – The shorelines of Crofton, showing the extent of shoreline modification features and overwater structures, overlaid with modeled likelihood of Pacific sand lance spawning habitat (Huard et al., 2022).

[Click here to dive deeper into the data for any area along the east coast of Vancouver Island on our interactive map on the Resilient Coasts for Salmon Atlas.]

# DISCUSSION/KEY TAKEAWAYS

## Coastal Modification

This survey represents a snapshot in time, as the imagery for this area was collected in the Cowichan Valley on the eastern shoreline of Vancouver Island in 2022 and summer 2023. During this time, it was found that approximately 16.8% of the eastern CVRD shorelines were modified with structures, with the majority being seawalls/bulkheads, logging infrastructure and riprap. Our estimates of the extent of shoreline modifications are conservative, as our methodology captures modifications that currently have the ability to impact natural coastal processes and not modifications that will in the near future (e.g., roads that are situated along the ocean that have minimal vegetation between the road and the higher high-water mark, will be impacted by storm surges and sea level rise in the near). This value will inevitably change over time: new developments could increase the number of structures present on the shoreline, existing structures may be removed and replaced with nature-based solutions, and some may remain in place but their interaction with the sea will change. Overlaying modelled results for future coastal floodplain scenarios with the coastal modification data would be worthwhile, and could help to identify areas for further study or restoration.

With the vast majority (90%) of the modifications being found on loose sediment shores, rather than rocky outcrop, there is more potential for erosion and changes to the shoreline. Erosion that causes a change to the shoreline will occur much slower on a rocky shoreline compared to one with loose sediment. The finer the sediment, the easier it will be carried away by waves. When hard structures are built on top of the intertidal area, regardless of sediment type, habitat will be impacted. For example, rocky outcrops provide nesting habitat for some bird species, and bio-banding on rocky shorelines indicate living organisms whereby the availability of habitat and species present depend on factors like duration of being covered by the tide – but this can be altered when structures are built on top of them.

Since wave exposure was quite limited (i.e. shoreline was largely rated as protected, semi-protected and semi-exposed to waves) in this region, nature-based approaches to shoreline management may be more practical than compared to other areas that are more exposed to incoming wave energy. All of the modified shorelines were very protected, protected or semi-protected from waves; however most (74.6%) of these areas are all also high or very highly sensitive to sea level rise. Given this, it would seem that the more pressing threat to these areas is sea level rise, rather than damage or erosion from wave exposure. Given the relative low exposure to incoming waves, conditions may be suitable for soft approaches that still protect coastal infrastructure. It may be prudent to consider managed retreat in these are which are most sensitive to sea level rise. These are coarse findings, however, and the best approaches for specific properties should be determined by professional assessment.

In some cases, seawalls may be necessary, such as in situations where managed retreat is not feasible. It is important that we plan for sea level rise when building new structures, building further from the shoreline boundary to allow space for sea levels to rise and the shoreline to adapt. The intent of this report is not to shame or denigrate property owners who have built shoreline armouring, but to raise awareness of the impacts that these structures can have on coastal habitats, and how we can use nature-based and hybrid designs to protect coastal infrastructure as well as provide habitat for coastal species.

## Log Accumulation & Forage Fish

The study area was found to have a high proportion (46.4%) of shoreline that is likely or highly likely to support PSL. This figure is significant, considering only 5.4% of all intertidal zones in the Salish Sea are estimated to be likely or highly likely to support these species (Huard et al., 2022); however, there are some factors like coastal modification and log accumulation that can threaten that habitat in the Cowichan Valley.

Although log accumulation is not a prevalent issue in this region, there exist some stretches of moderate, high and extreme accumulation of logs where the habitat has been modelled as likely or highly likely as PSL spawning habitat. Some of these areas include Mill Bay Road, Yellow Point, Kingscote Road Beach Access, Chemainus, south Crofton, and a stretch of beach north of Whiskey Point. These are areas of concern because of the potential of the mobile logs to impact the suitability of the habitat for forage fish There were about 6.4 km of shoreline with high or extreme log accumulations in areas also modelled as likely or highly likely spawning habitat for PSL. If we include the moderate accumulations of logs, this number grows to 19. 5 km of likely or highly likely spawning habitat for PSL which is likely to be impacted by logs. These areas should be considered for log removal/salvage.

It is a benefit that much of the CVRD shoreline is protected or semi-protected from wave exposure, as this should mean that fine sediments suitable for forage fish spawning are less likely to be carried away by wave action. Although high wave exposure if not a major coastal factor of concern in the CVRD, and much of these areas of are considered to be stable in terms of sediment stability (not eroding nor accreting), these beaches could be at risk of sediment loss due to log-driven erosion and increasing intensity of storms.

### Cumulative Impacts: Coastal Modifications & Log Accumulation

The coincidence of coastal modification and log accumulation on beaches could result in erosional stress, with the incoming waves pushing mobile logs up against structures like seawalls. The majority of the Cowichan Valley's shorelines are considered to be naturally stable (not eroding or accreting), however over time coastal modification features and log accumulation can contribute to the erosional forces acting upon those soft sediment shores. In areas where there are modifications that sit low on the shoreline, mobile logs may be less likely to become embedded in the sediment, and they could bounce off the seawalls during storm events, leading to increased erosion of the sediment. If we are to protect these beaches where forage fish are likely to spawn, we might also consider removing hard armouring structures where possible and to consider nature-based approaches to restoring shorelines instead.

## Overwater Structures

The overwater structures in the CVRD were extensive and can impact Pacific salmon, forage fish, and other marine life, and the habitats they rely on. The large amount (20) of marinas throughout the eastern shores of the CVRD mean that there are large areas of the nearshore altered, and the number of boats moored in these areas is considerable. Eelgrass habitats, critical nursery areas for juvenile salmon and crab species, require light to grow, while overwater structures threaten their ability to survive if they are shaded out. Additionally, boat anchoring can scour and damage eelgrass resulting in a reduction in density and extent of this important habitat, leaving it fragmented. Anchoring also suspends sediment in the water column that can smother eelgrass by reducing its ability to grow and thrive. Effluent, gas, oil, as well as debris such as abandoned buoys and derelict vessels and gear from marine traffic and vessel storage associated with marinas are yet another threat to marine life.

Although the predominant material making up the 307 overwater structures in the CVRD was wood, it is worth noting 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. Should these structures become damaged or loose during storm events, these materials could become a form of marine debris that could be harmful to many creatures.

The extensive amount of free-standing or supportive piling structures made of creosote-treated wood could have catastrophic effects on the success of events such as broadcast spawning like with species such as Pacific herring. Creosote logs observed on the shoreline could also have negative impacts on the success of PSL spawning events, although the overall amount of log accumulation is not a major concern.

On several occasions, partially or derelict boats and docks were observed in the Resilient Coasts imagery. Abandoned and derelict vessels can negatively impact the marine environment when they leak fluids like oil and gasoline, and when washed up on shore, they can cause erosion and smothering of habitat – not to mention, they can be navigational hazards. See our recommendations section to learn about how we can reduce the impacts of the marinas and residential docks.

Additional overwater structures such as Crown tenure areas of log storage could be a concern in the CVRD as well. While industry and recreation along the coast are an important part of the economy and culture, the overwater structures associated with those activities can have impacts on the environment. Fortunately, there are ways of improving practices and the physical structures to reduce our impact. Please see our recommendations below for resources related to reducing the impacts of structures such as marinas on the health of the coastal ecosystem. fic activities. The extensive restoration efforts on the Cowichan estuary are a testament to how the Cowichan community values and cares for this area which is an internationally recognized Important Bird Area and critical habitat for out-migrating Pacific salmon.

One structure of note are the log storage areas or log booms along the coast. It has been documented that seals and other pinnipeds use human-made floating structures such as log booms and docks strategically for hunting salmon (Sabal et al., 2021). In the Cowichan River Estuary, specifically, the

Salish Sea Marine Survival Project (SSMSP) found that the presence of log booms in the Cowichan river estuary was associated with lower survival rates of the Chinook salmon population significantly (Atkinson et al., 2024). The mechanism could be seal predation, habitat fragmentation or altering the natural flow of the river (Sabal et al., 2021) ; however, it is worth noting that pinnipeds were observed in the Resilient Coasts imagery using log booms as haul-outs (Figure 35). Another area that may warrant some additional investigation into the impact of logs booms is the Ladysmith Inlet for its high density of log storage tenures.

Figure 35 - Harbour seals use a log boom as a haul-out where they can easily hunt Pacific salmon in the Cowichan River Estuary. Photo by Michael Miller Media (Resilient Coasts for Salmon imagery).

## RECOMMENDATIONS

As noted earlier, this report is intended for educational purposes only and aims to share basic information and context regarding shoreline modifications and how they overlap with basic climate models and other ecological data. While it may highlight areas of concern, it is not a comprehensive assessment or risk inventory. The content should not be used for detailed analysis or decision-making without formal, in-depth assessments from qualified environmental professionals and coastal geomorphologists, who can provide expert guidance tailored at a localized scale. With this in mind, the following are some recommendations.

### Suggested Management Actions

We strongly advocate that the CVRD prioritize what is desired by local First Nations' government and communities and allow these requests to guide next steps, including amendments to already established plans made by the CVRD. Ask local First Nations' government what their capacity to engage is, what they require, and create space and time for this process. Follow engagement protocols chosen by each Nation, establish cultural safety, provide financial compensation for engagement as set by each Nation, set up agreements and/or memorandums of understanding if requested, and begin the process of educating oneself about historical and present day colonialism on Southern Vancouver Island and beyond. The following recommended management strategies are not meant to negate the positive work that the local governments have done or are currently working towards. We appreciate that many local governments have taken significant steps in working respectfully with First Nations towards effective coastal adaptation, and it should be noted that we did not conduct a detailed review of the actions that the CVRD and municipal governments within the Regional District already have in place. Please consider this list of recommendations a starting point in working to build coastal resilience for people and habitat.

1. Use the coastal sea level rise assessments conducted as part of Cowichan Adapts program alongside the Resilient Coasts coastal modification dataset to help identify priority areas for restoration or managed retreat. If it has not already been done, pursue comprehensive coastal flood inundation modeling that include site investigations, coastal engineering analysis, alongside coastal geomorphologists and geologists. One suitable model to start with is the Coastal Storm Modeling System (CoSMoS), which examines the combined effects on local scales for sea level rise, storms and river flooding. CosMos examines hazard exposure through tools specifically for coastal flooding, coastal groundwater, shoreline change, and a multi-hazard viewer.

2. Collect additional data and submit to the Vital Signs data portal, including drift cells in functional condition, extent of forest cover in nearshore marine riparian areas, feeder bluffs in functional condition, areas of sediment accretion and erosion, and miles of intertidal beach in functional condition.
   - Continue to survey, and expand the survey range if possible for forage fish monitoring within the CVRD to better understand the habitats that are currently being utilized by various species of forage fish. Get in touch with the Coastal Forage Fish Monitoring Network to get involved and support their monitoring efforts.
3. The CVRD Official Community Plan (OCP) can help guide decision making at a local level by addressing the following:
   - Introduce strict coastal development policies for the CVRD with the Shoreline Development Permit Area (DPA), to protect the integrity of the shoreline, further manage or limit coastal development, and protect existing development from the impacts of coastal climate change.

There is an excellent synopsis of the potential cumulative impacts that can occur from development on the marine shoreline in the OCP document.

- Informed by the CVRD's Sensitive Areas Mapping, support ongoing erosion monitoring (which can include indicators chosen by the Nations), to move towards a non-contingency fund to support the longevity of shoreline health, and towards planning for continued, foreseeable changes on shorelines.
- Incorporate strong sensitivity to sea level rise models into community adaptation plans; consulting models before any development permits are accepted.
- Hire coastal geomorphologists, coastal engineers, and biologists to provide expert consultation to review and provide expert guidance for approvals for shoreline development permits and design plans. Ensure that individuals responsible for issuing permit approvals have readily available access to these experts. Ensure that all Qualified Environmental Professionals (QEP) and Registered Landscape Architects hired under the DPA to supervise or provide recommendations for development plans, are: highly knowledgeable about natural coastal processes and hydrology, and include the following in their process: site specific coastal processes modelling, historical change assessments including historical knowledge, observed and future erosion potential, recommending setbacks to accommodate erosion when possible, assessments to drastically reduce project footprint and potential habitat degradation, requiring landowners to monitor the project into the future (designed by experts), and following up with monitoring requirements.
- Strengthen the OCP to minimize further hard armouring and shoreline development
    - Create bylaws and policies whereby seawalls/bulkheads are a last resort. Some communities have done so by requiring that it be proven that hard armouring is the only viable option before proceeding with building a new structure or replacing/repairing an existing structure.
    - Require strict ecological assessments to prevent loss of habitat, including shellfish habitat that can become buried.
    - Recommend stricter conditions for development permits that address bank instability and the identification of areas that cannot be developed except what is permitted in the conditions (Hewson et al. 2023).
    - Introduce laws for larger setbacks. Prohibit new builds along the coastline within a specific setback so that parks and natural areas have the ability to adjust with rising sea levels. Require adequate consultation with professionals like coastal geomorphologists.
    - Remove unnecessary armouring on public lands, such as parks, with proper assessment by coastal professionals.
    - Taking a precautionary approach to potential habitat degradation and habitat disruptions.
    - Refer to other jurisdictions that have included Green Shores® measures in their Official Community Plans (e.g., District of Central Saanich).

- In addition to protecting environmentally sensitive areas with high ecological value, prioritize the protection of:
    - places that First Nations' communities express interest in protecting,
    - existing natural shorelines,
    - stretches of shoreline with intact marine riparian vegetation,
    - beaches with favorable forage fish spawning sediment beaches (identify with expert guidance**),
    - beaches where forage fish spawning has or is occurring,
    - and areas that have maintained their natural hydrological functions.

  **We encourage that marine and terrestrial conservation planning be guided and informed by the model developed by Huard et al. (2022) and other relevant research and forage fish monitoring data.

- Focus on bio-cultural indicators of well-being as expressed by First Nations' community members, First Nations' governments, and general community members. This may include physical, mental and spiritual health, ability to access safe foods, ability to practice traditions and ways of life that support holistic well-being, and much more. This can help guide restoration priorities and areas that require protection from future degradation and development.
- Protect and restore connectivity between the upland and shoreline where possible; and support soft shore approaches (nature-based approaches) for climate change impacts such as erosion, as well as critical habitat. If redevelopment in coastal areas occurs, include restoration requirements on the foreshore that protect natural coastal processes and habitat.
- Introduce stricter policies to greatly restrict or prohibit tree removal and other riparian vegetation within a specific setback distance along the shoreline.
- Work with groups such as the Cowichan Community Land Trust and Nature Trust BC to support the work of returning properties to nature where appropriate, as was done in the Cowichan Estuary.

4. Incorporate coastal natural assets into the Cowichan Valley Regional District's asset management plan.

- As part of the 2023-2026 Strategic Plan, the CVRD has committed to implementing an asset management plan which includes natural assets.
- If not already implemented, we suggest creating an inventory of existing natural assets.
    - This would include condition assessments and ratings of natural assets that can inform the municipality on the ecological health of natural resources and influence decision-making for coastal development, restoration, and more. Include human well-being as indicated above (#3).
- Encourage sustainability efforts and investment into natural resources and environments by incorporating them into a management program.

5. Develop a strategy to reduce habitat fragmentation by boat moorings. Traditional moorings, which consist of heavy chains and anchors, drag and scour the seafloor as the tide ebbs and flows. Anchoring can scour and damage eelgrass, resulting in a reduction in the density and extent of eelgrass and creating fragmented habitat. It also suspends sediment in the water column that can smother eelgrass, reducing its ability to thrive and receive light.
   - Damage to eelgrass can be avoided by anchoring in depths beyond 7m.
   - Environmentally- friendly moorings contain a mid-line float that holds a rope above the seafloor – it will not scour or damage eelgrass. See here for more information.
   - Explore opportunities to install Voluntary No Anchor Buoys in your community.

6. Reduce impacts of overwater structures:
   - Pursue and/support marinas that want to pursue eco-certification through the Strait of Georgia Alliance's Clean Marine BC program. In the Cowichan Valley, there are two marinas certified under the Marina eco-certification program: the Maple Bay Marina and the Ladysmith Marina, Oak Bay Marine Group.
   - Encourage the building of salmon-friendly docks when docks are necessary, and the sharing of docks amongst neighbours when possible.

7. Create and/or promote climate action incentives for community members to:
   - reduce erosion on properties by incentivizing the installation of proper drainage by professionals
   - planting marine riparian vegetation with emphasis on native species
   - utilizing nature-based soft shore restoration instead of hard armouring
   - restoration of riparian vegetation in locations where seawalls are necessary
   - managed retreat where possible
   - removal of seawalls when the site and conditions are appropriate as deemed by qualified professionals
   - nature-based solutions around the home, including reducing impermeable paving, discouraging the use of pesticides and fertilizers, encouraging the use of less harmful cleaning supplies or by making them, manage stormwater runoff and incorporate raingardens to help filter pollutants before it can enter waterways, and encouraging rainwater harvesting and not watering lawns during the summer months. Many financial incentives are available through the CVRD's Water Conservation and Stewardship Rebate and Incentive Program for home-owners who adapt water conservation measures on their property, including installing rain barrels, soil improvements, and smart irrigation system upgrades.

8. Provide ongoing environmental training by professionals (local climate change specialists, biologists, coastal geomorphologists, coastal engineers) for municipal and regional district staff
   - Provide training opportunities for local planners and other staff to understand current climate change risks and impacts, and restoration strategies that utilize a nature-based approach. The Green Shores® training program is a great place to start.

9. Reduce log accumulation on beaches through log salvage. Log salvaging can be a great way to remove unwanted logs from a beach and protect forage fish habitat. Anyone looking to salvage logs from the shore must obtain a valid provincial permit. Western Log Sort and Salvage is a licensed buyer of marine salvage logs in the Vancouver/Vancouver Island region – helping drift logs return to the market, helping to reduce the impacts to marine vessels and the environment. Learn more at Marine Log Salvage - Province of British Columbia.

10. Continue to invest in programs such as the Sh-Hwuykwselu (Busyplace) Stormwater Management & Mitigation Plan to address, control and rectify contaminants and pollution within the Cowichan Valley Regional District, including sanitary waste control, to work towards safe access to traditional foods and a healthy ecosystem.

# RESOURCES

## Funding Opportunities for Nature-based Approaches

Looking for funding to support a restoration or adaptation project? There are federal, provincial, private and non-profit organization funds available. Here are some examples. Please note that some specific grants and funding opportunities listed below may not be currently available at the time of distribution of this report.

## For First Nations

Funding from Federal and Provincial Government

- The Government of Canada:
  Federal funding opportunities change every few years, but you can start at this landing page for environmental funding to see what is currently available.
  https://www.canada.ca/en/environment-climate-change/services/climate-change/indigenous-partnership/funding.html
    - In March of 2026, the Government of Canada announced $3.8 billion of new funding through the strategy: A Force of Nature, where there will be three streams of funding available. Watch this space for more information from the Federal Government about eligibility and how to apply for the funds. Click here to read the statement regarding this funding announcement from PSF President & CEO, Mike Meneer.
    - As of April 2026, funding applications have closed for the Indigenous Habitat Participation Program, however futures opportunities to apply for funding and capacity support will be updated on the linked page.
    - Additional funding may be available through Indigenous Services Canada – there are often many streams of funding available, with climate adaptation funding usually being listed under the Health and Infrastructure headings. The ISC's Capital Facilities and Maintenance Program, for example, offers funding to support infrastructure for First Nations on reserve properties. In terms of climate-related updates, this funding can be applied for things like roads and bridges, community energy systems, water and waste-water, and more.
    - The Indigenous Partnerships for Species at Risk (IPSAR) may also be an opportunity for funding related to species at risk and their habitats. For general questions, enquiries, and news about the IPSAR, including funding opportunities, please email PAEP-IPSAR@ec.gc.ca
    - For grant funding through Fisheries and Oceans Canada (DFO), visit their funding page for current offerings. Indigenous groups seeking funding between 2019 and 2025 can contact DFO.AHRF-FRHA.MPO@dfo-mpo.gc.ca.
    - Environment and Natural Resources funding includes current funding like the Coastal Restoration Fund and the Indigenous Habitat Participation Program. Check back often to determine which funding is currently active and best suits your needs.
    - Natural Resources Canada offers various funding programs for Indigenous communities and individuals – these funding opportunities may include support for local Indigenous-led community development and natural resources projects that support the transition to clean energy.

Funding from the Non-Profit Sector

- First Nations Emergency Services Society (FNESS)

- FNESS is a nonprofit society that supports BC First Nations in climate adaptation. FNESS connects communities with resources, research and funding to support their specific needs related to climate adaptation and emergency preparedness and response.

- Community Salmon Program (Pacific Salmon Foundation)
  - Provides grants to streamkeepers, First Nations, schools, and conservation organizations — People for Salmon across the province — to save and restore Pacific salmon and their habitats. This includes emergency funding.
- Climate Emergency Fund (Pacific Salmon Foundation)
  - This fund is intended to support entities with qualified personnel and experience in salmonid habitat requirements, hydrology, and in-water construction techniques to undertake emergency actions which directly benefit salmon that are threatened by drought or other climate emergencies. For enquiries about the funding or to submit a proposal, please contact emergencyresponse@psf.ca.
- North American Partnership for Environmental Community Action (NAPECA): cec.org
  - The NAPECA grant program, a program of the Commission for Environmental Cooperation (CEC), is aimed at empowering Indigenous Peoples in climate adaptation.
  - Future grant programs may become available through the CEC; you can check back at any time through the Grants tab (http://www.cec.org/grant-programs/), or email napeca@cec.org.
- Habitat Conservation Trust Foundation (HCTF)
  - HCTF regularly offers grant funding for projects that benefit habitat and biodiversity in B.C. Visit https://hctf.ca/grants/ to learn about current offerings.
- SeaDoc Society
  - Funding through the SeaDoc Society is intended to support scientific research and conservation concerning environmental issues facing the Salish Sea. There was a round of funding offered in 2024, but it is unclear whether another call for proposals will occur in the future. (seadocsociety.org)
- Coast Funds
  - Coast Funds is a partnership of two organizations managing and delivering funds from private donors, the British Columbia Provincial Government and the Government of Canada. Each year, Coast Funds compiles a list of available funds for First Nations in the Great Bear Rainforest area and Haida Gwaii.

Funding from Industry

- BC Hydro Fish and Wildlife Compensation Program (FWCP)
  - The FWCP is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations, and public stakeholder to conserve and enhance fish and wildlife in watersheds impacted by existing BC Hydro dams. Projects are funded to compensate for impacts to fish, wildlife, and their supporting habitat resulting from the

construction of existing BC Hydro dams. For more information contact FWCP's Environmental Project coordinator Melissa.FieldeSousa@bchydro.com or fwcp@bchydro.com.

- TD Friends of the Environment Foundation (FEF)
    - The TD FEF supports a wide range of environmental initiatives, with a primary funding focus on revitalization, animating, and stewarding public green spaces. Questions can be directed to the TD FEF Pacific and Prairies Regional Manager: Mandip.Kharod@td.com
- Wawanesa Climate Champions: Local Grants
    - New granting initiative to support organizations working on the front lines to improve climate resiliency in local communities across Canada. Questions can be directed to communityimpact@wawanesa.com

## For Municipal Governments

- The Government of Canada –
    - Federal funding opportunities change every few years, but start at this landing page for environmental funding to see what is currently available.
    - In March of 2026, the Government of Canada announced $3.8 billion of new funding through the strategy: A Force of Nature, where there will be three streams of funding available. Watch this space for more information from the Federal Government about eligibility and how to apply for the funds. Click here to read the statement regarding this funding announcement from PSF President & CEO, Mike Meneer.
- The Union of BC Municipalities (UBCM)'s Local Government Program Services offers administration for Provincially-funded grant programs. Check out this link for active funding programs to take on large scale climate adaptation projects with nature-based solutions.
- Visit the Natural Resources Canada Green building programs landing page to find funding that supports green infrastructure. This can be applied to energy efficiency, reducing pollution, and getting infrastructure up to environmental and safety coding.
- You can browse the latest and upcoming funding programs from Environment and Climate Change Canada at this link. These funding programs are specifically targeted to support climate adaptation in communities, supporting species at risk, and addressing pollution.
- To apply for support related to infrastructure projects, Infrastructure Canada offers funding to help communities address natural disasters related to climate change and invest in green buildings.
- The Clean Coast Clean Waters (CCCW) was a provincial fund to help communities remove sunken or abandoned vessels. CCCW initiative funds are available for both local governments and organizations – local governments and organizations who hope to clean up marine debris that might be impacting coastal ecosystems. While this funding opportunity is closed as of 2024, it may return in future years and is worth checking on.

### For Homeowners

- Many nature-based solutions are low cost and may even help your household save money on monthly water and heating bills. The Resilient Coasts for Salmon Tool Kit provides advice that you can incorporate today.
- Incentives/Rebate Programs:
    - There may be financial rebates available through the CVRD for tools and technologies such as rain barrels and smart irrigation systems that contribute to water conservation within the community. Contact environment@cvrd.bc.ca for more information.
    - If you are a resident of or developer within the municipality of North Cowichan, you may be able to apply for a rebate if you have made upgrades to improve the energy-efficiency of your home through their Step Code Program.
    - You can also apply for a Canada Greener Homes Loan through Natural Resources Canada to make energy-efficient updates to your home.

## Links to Relevant Resources

- Visit resilientcoasts.ca to browse our educational resources and learn about all things related to coastal stewardship. Our website hosts videos about restoring a coastal slope and choosing native plants for your garden or restoration project, as well as a plethora of 'how to' articles in our Tool Kit.
- Check out the resource library from the Cowichan Watershed Board, a collaborative partnership between the Cowichan Tribes and the Cowichan Valley Regional District, which includes annual reports, Impact Plans documents, board meeting notes, and more.
- Stay informed about the Cowichan Regional Disaster Risk Reduction and Climate Adaptation Plan, which is set to be completed by June 2026.
- The Marine Ecosystem Map, from the Marine Data Centre, is a visualization platform of geospatial data with hundreds of layers from ecological to human use. You can also submit data to the portal for others to use – contact them here.
- Browse ShoreZone data to help inform community planning.
- The Climate Ready Infrastructure Service is a new free service offered by the Government of Canada to connect communities with climate experts to help inform and support projects related to addressing challenges associated with climate change.
- Work with local stewardship groups and environmental non-profits across the Island, such as the Cowichan Estuary Restoration & Conservation Association and the Nature Trust of BC to identify potential sites for restoration or bring awareness to these issues.
- Review the design guide for nature-based infrastructure for coastal flood and erosion risk management in Canada, created by the National Research Council of Canada.
- Read the document: Rising Seas and Shifting Sands: Combining Natural and Grey Infrastructure to Protect Canada's Eastern and Western Coastal Communities – Intact

Centre on Climate Adaptation (intactcentreclimateadaptation.ca) to learn more about how communities can use hybrid designs.

- Check out the Stewardship Centre for British Columbia's Green Shores programs. The Green Shores for Shoreline Development Credits and Ratings Guide can be used as a framework for implementing nature-based solutions in commercial, multi-family residential, subdivision, park, and institutional waterfront development areas.
- Sign up for Green Shores training to learn about the program's guidelines and how nature-based solutions can provide shoreline benefits.
- Check out Northwest Straits Foundation's Shore Friendly program website for helpful articles and videos about shoreline restoration and coastal processes in the Salish Sea.

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Photo credit: Mitch Miller

RESILIENT COASTS FOR SALMON

GREEN SHORES

STEWARDSHIP CENTRE FOR BRITISH COLUMBIA

PACIFIC SALMON FOUNDATION

# APPENDIX A - DATA LIMITATIONS & CONSIDERATIONS

This section highlights factors to keep in mind when interpreting the results produced by the Resilient Coasts project.

## General

- The length of a line feature, for shoreline modifications, does not correspond to the level of impact it may have on natural coastal processes.
- It is likely that a greater number of coastal modifications exist than what was digitized due to several reasons including:
    - many elements in the landscape can obscure views, including dense vegetation;
    - aerial imagery was less clear in some regions – digitization in some regions relied heavily on aerial imagery as its source;
    - many features were observed that will imminently interact with natural coastal processes as sea levels rise but are not included in the dataset as they do not currently interact with coastal processes;
    - the imagery sources used to digitize features vary, including the dates they were captured (dates are included for each feature within each dataset).
- 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.
- 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.
- Shoreline Type options are limited - There are segments of shoreline that have been modified by restoration or restoration using a "hybrid" approach (i.e., using both "hard" and "soft" elements in their design). However, these features are not separated from "hard" shoreline protection in this protocol. For example, riprap can be a part of a hybrid approach to shoreline protection but is considered a coastal modification feature in this protocol. Recorders made notes in the Comments section when they were aware of such projects; however not all are known, nor would all hybrid restoration projects be visibly obvious.

## Data Gaps

- Gaps exist in all three datasets where boat-based or aerial imagery was not available, image quality was poor, the area was excluded for privacy reasons, or for other reasons.

## Shoreline length values

- To report on the level of modified shoreline in a specific region, the Freshwater Atlas Coastlines (FAC) line was used as a proxy for total shoreline length. While the FAC provides a line from which analyses can be run, it is imperfect, and often resulted in overestimations of total shoreline length, producing discrepancies toward more conservative estimates. Some ways this occurs include:

- The polygons around each community analysed were created intentionally so that major nearby islets and islands not connected to Vancouver Island by road or bridge were excluded from the total shoreline length (FAC) to increase accuracy of analyses.
- The FAC line diverges from the locations of digitized features, which skews some results, often producing a higher total length of shoreline (Figure A1).
- Shorelines on First Nation reserve lands were not digitized out of respect for privacy, so those shorelines were excluded from the analyses. In some cases, the Federal Government reserve land polygon boundaries were slightly waterward of the FAC (Figure A2). Unfortunately, for the communities of **Oak Bay, Sidney and Cowichan Valley**, these shorelines were not excluded from the calculations, resulting in an overestimation of 'non-modified' or 'natural' shoreline.

Figure A1 – The FAC dataset (green line) does not align with the digitized feature locations (orange line), which skews results, resulting in an over or underestimation or shoreline length.

Figure A2 – In some cases, the Federal government First Nation reserve land boundary (shaded blue) was inland of the FAC (purple line).

## Conservative Values due to Timing of Mapping

- Because the imagery was captured during the summer months when storms are less frequent, there is a high likelihood that the log accumulation data layer represents a lower threshold of accumulation than what a specific area may hold during winter months.

## Shorezone Shore Type Analyses

- The Shore Type data layer used (ShoreZone) contains a category for 'human-made' shore type. This prevented visualization of original shore type before the modified structure was installed.

## Additional Imagery Capture

- For estuaries and certain bays where access was difficult by a larger vessel, shoreline imagery was collected by alternative means. This includes imagery capture my tender (small vessel), drone, or on foot. In most cases for estuaries, shoreline imagery capture was not possible, so digitization was completed through available aerial imagery.

# APPENDIX B - SUPPLEMENTARY FIGURES

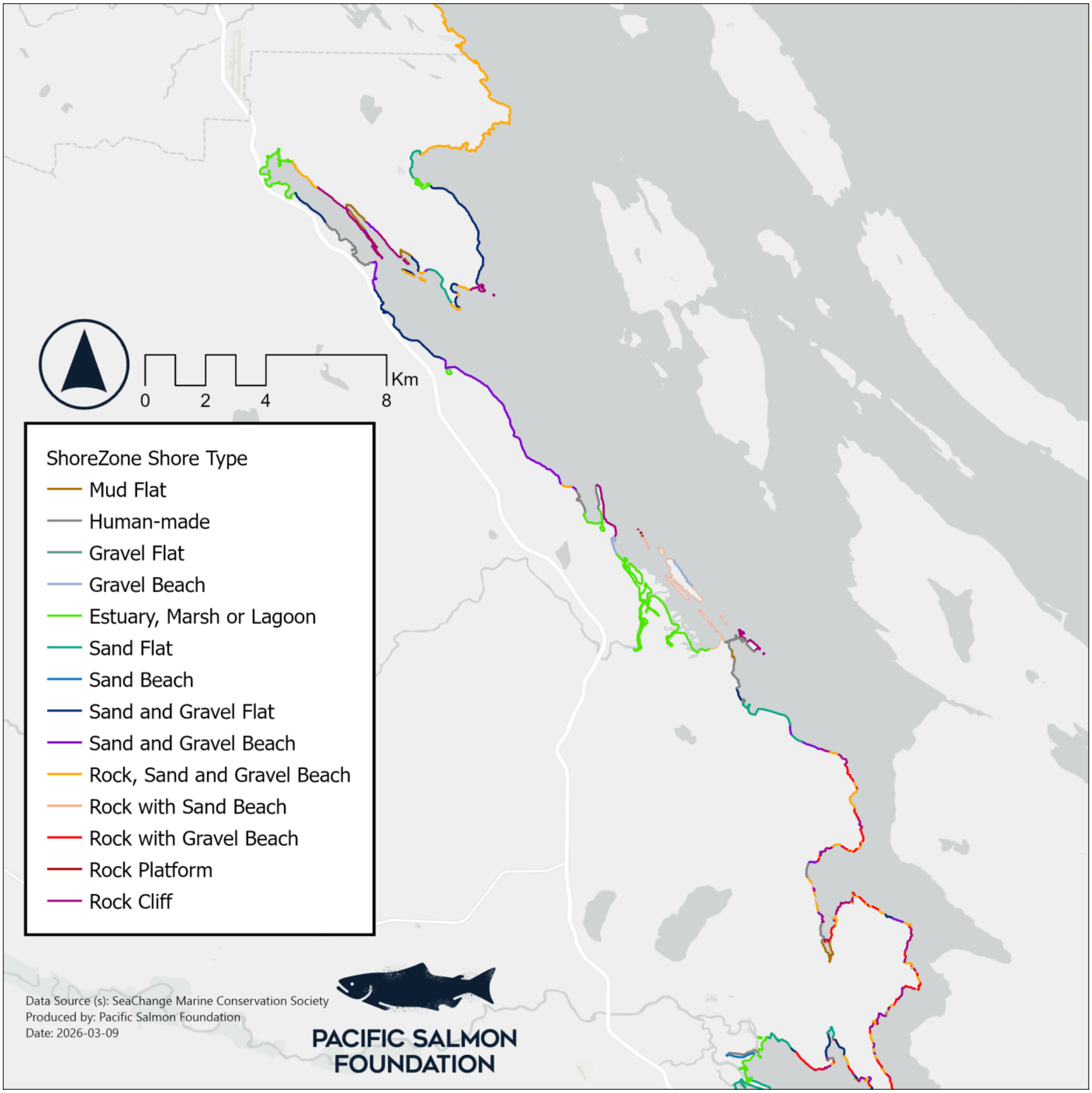


Figure B1 - The distribution of shore types within the northern half of the Cowichan Valley Regional District. Data from ShoreZone (Coastal and Ocean Resources, 2017).

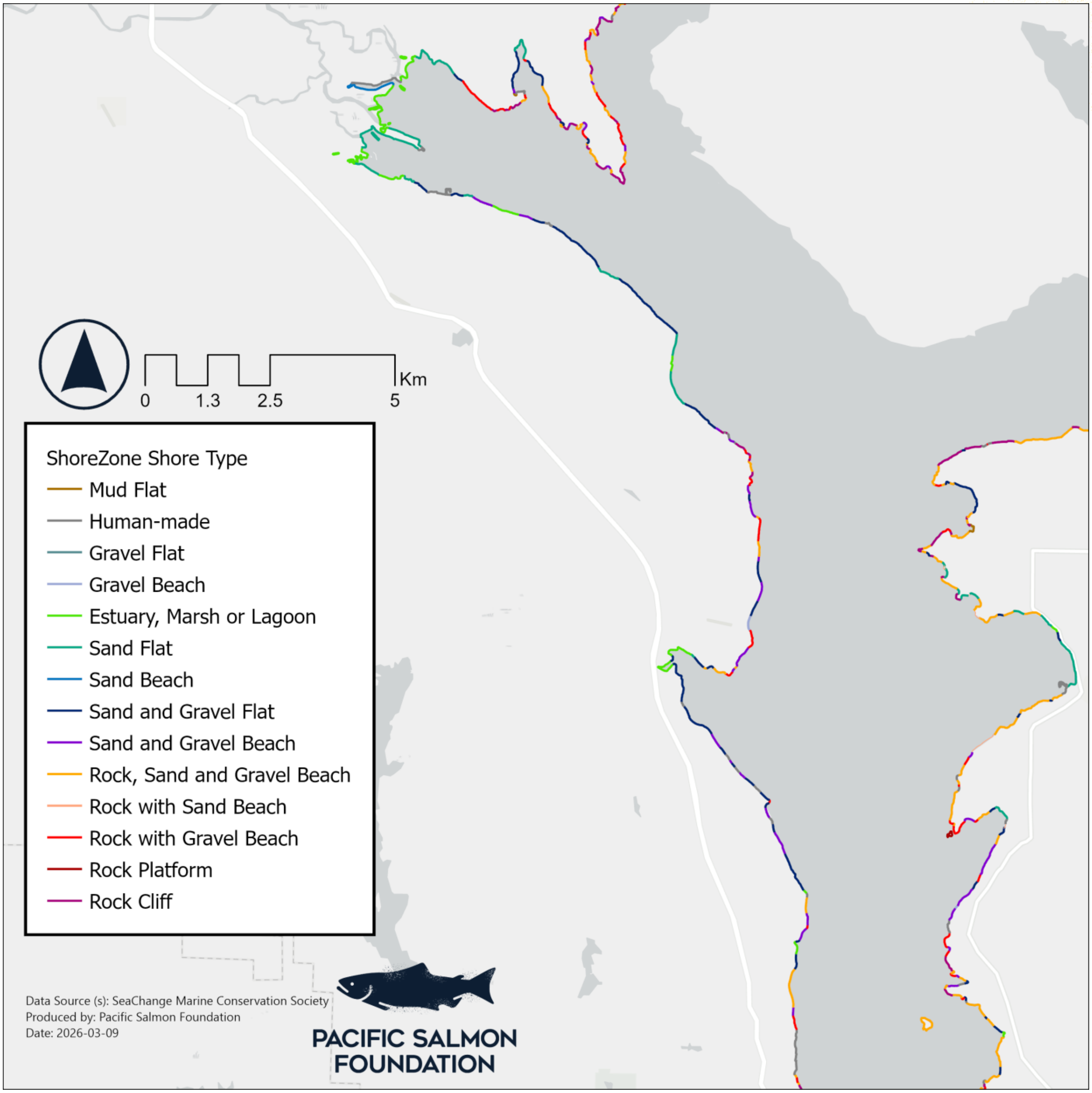


Figure B2 - The distribution of shore types within the southern half of the Cowichan Valley Regional District. Data from ShoreZone (Coastal and Ocean Resources 2017).

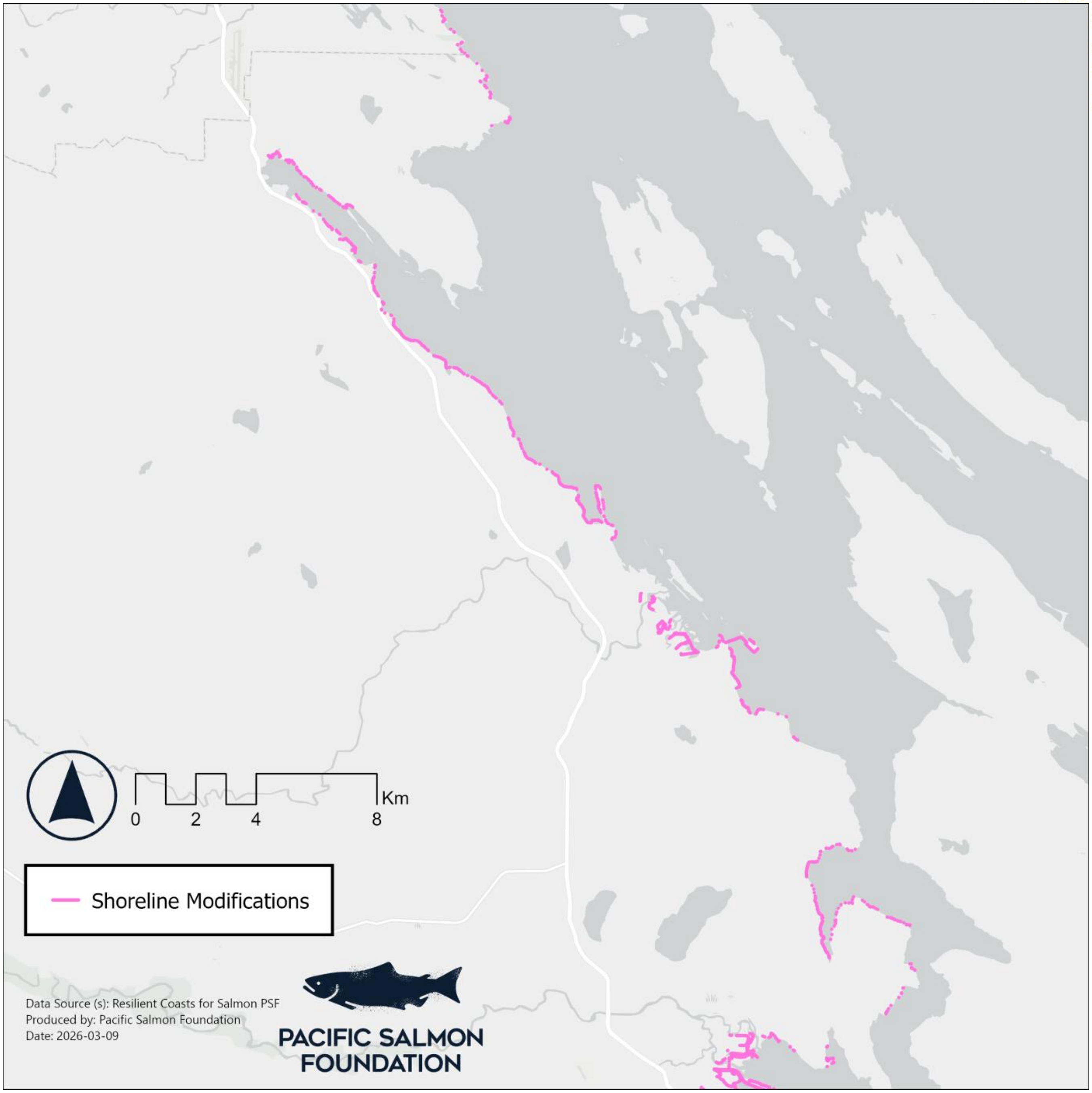


Figure B3 – The extent of coastal modifications within the northern half of the CVRD.

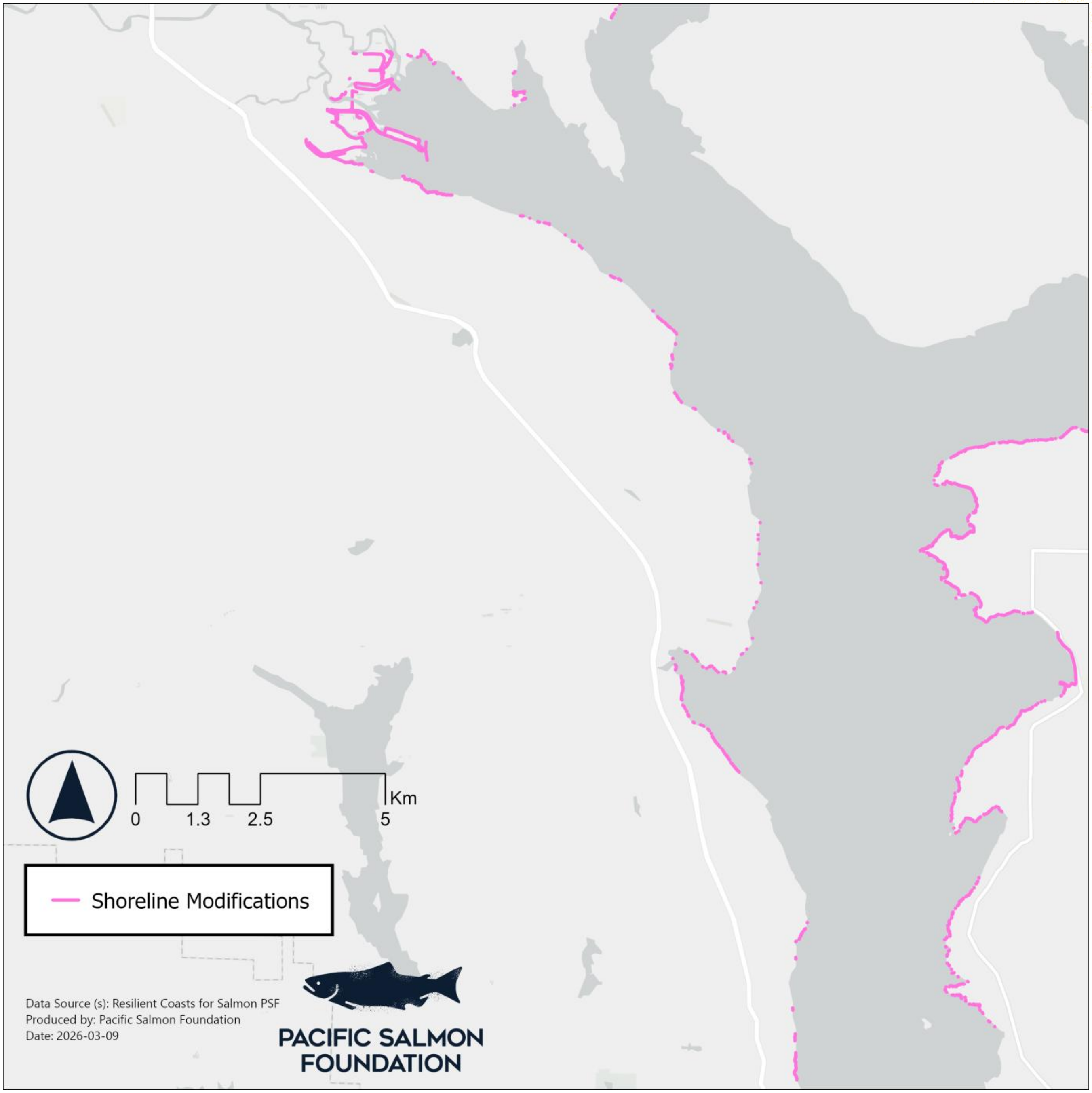


Figure B4 - The extent of coastal modifications within the southern half of the CVRD.

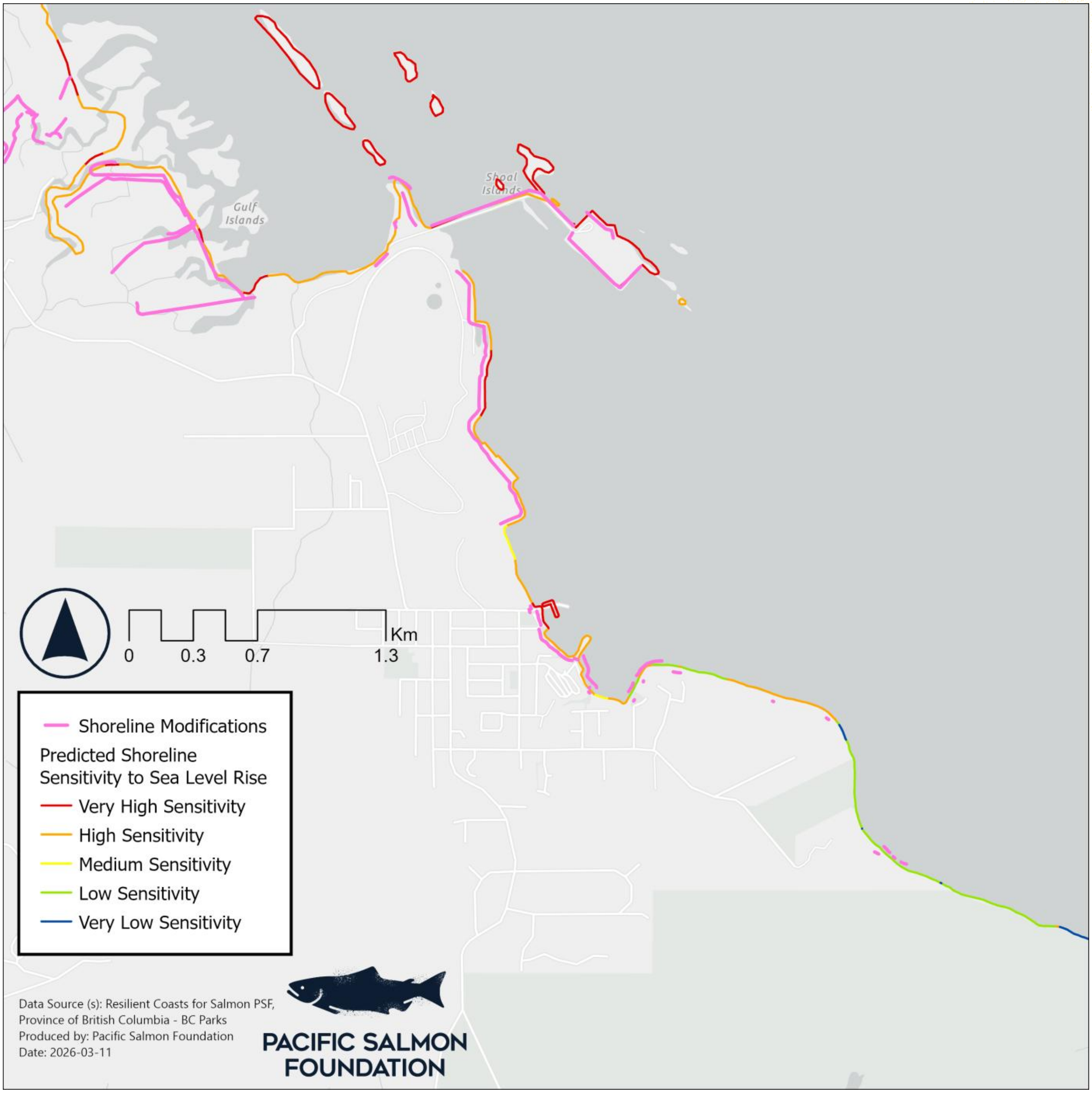


Figure B5 - The Crofton shoreline (including the southern portion of the Chemainus River Estuary) colour-coded into varying degrees of sensitivity to sea level rise, according to the British Columbia Ministry of Environment (2014) overlaid with the Resilient Coasts digitized extent of coastal modification features (shown in pink).

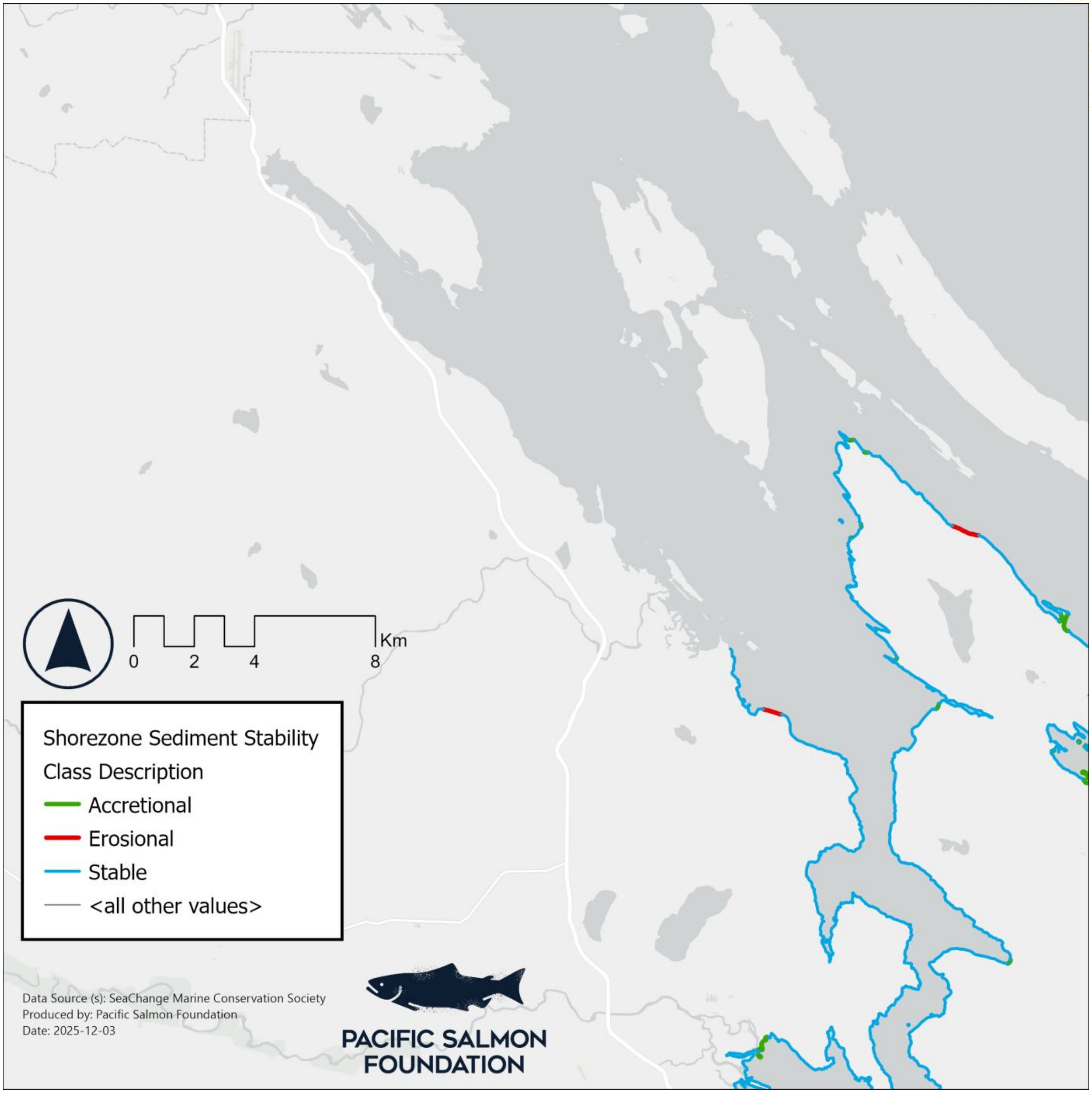


Figure B6 - ShoreZone sediment stability class descriptions for the northern half of the CVRD, showing that there is a data gap north of Crofton, but that most of the shoreline analyzed is considered stable (Coastal and Ocean Resources, 2017).

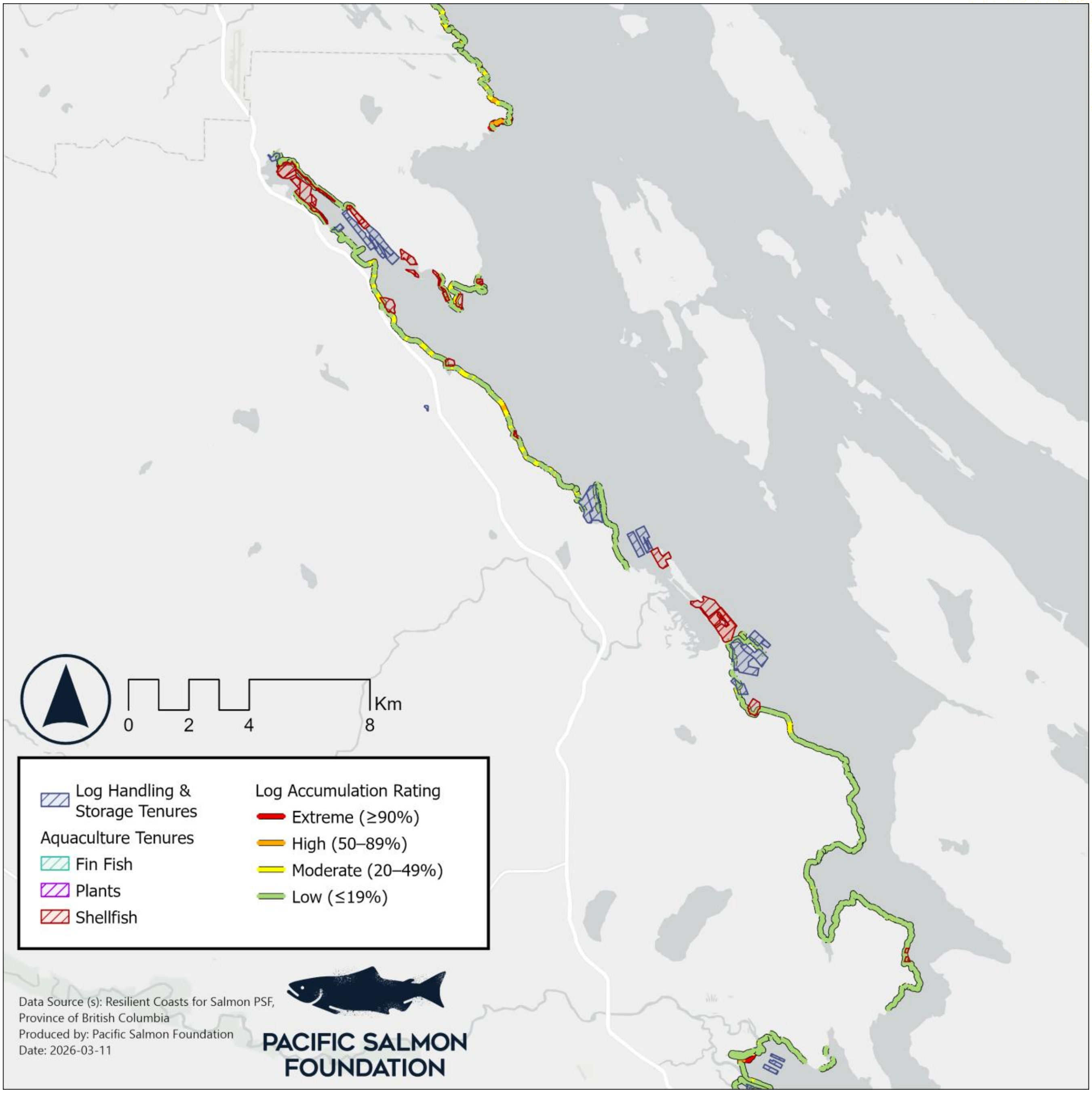


Figure B7 – The shorelines of the northern half of the CVRD, showing the extent of log accumulation, overlaid with Crownland tenures for log storage and aquaculture (MFLNRORD, 2014).

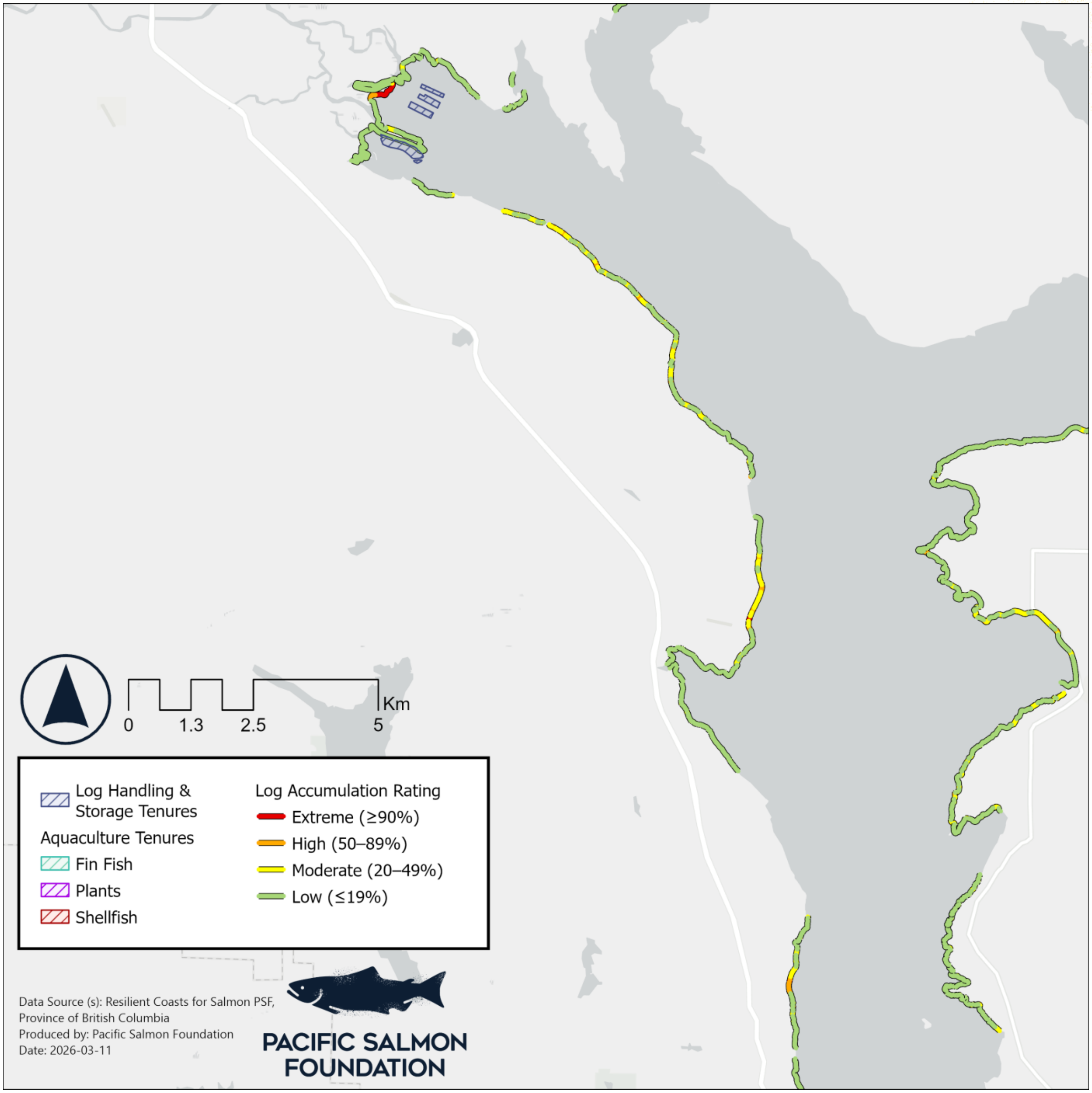


Figure B8 – The shorelines of the southern half of the CVRD, showing the extent of log accumulation, overlaid with Crownland tenures for log storage and aquaculture (MFLNRORD, 2014).

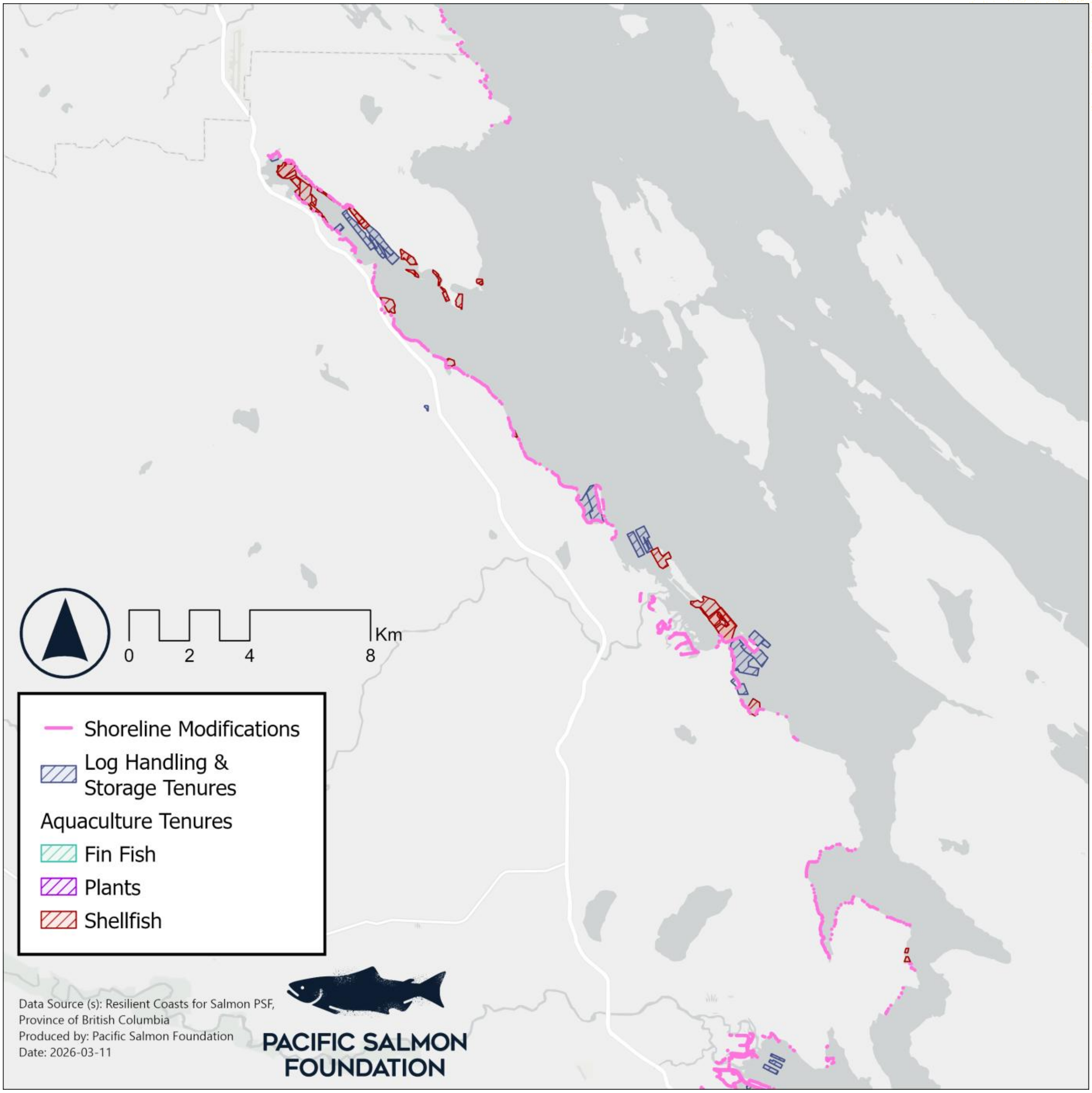


Figure B9 – The shorelines of the northern half of the CVRD, showing the extent of coastal modifications, overlaid with Crownland tenures for log storage and aquaculture (MFLNRORD, 2014).

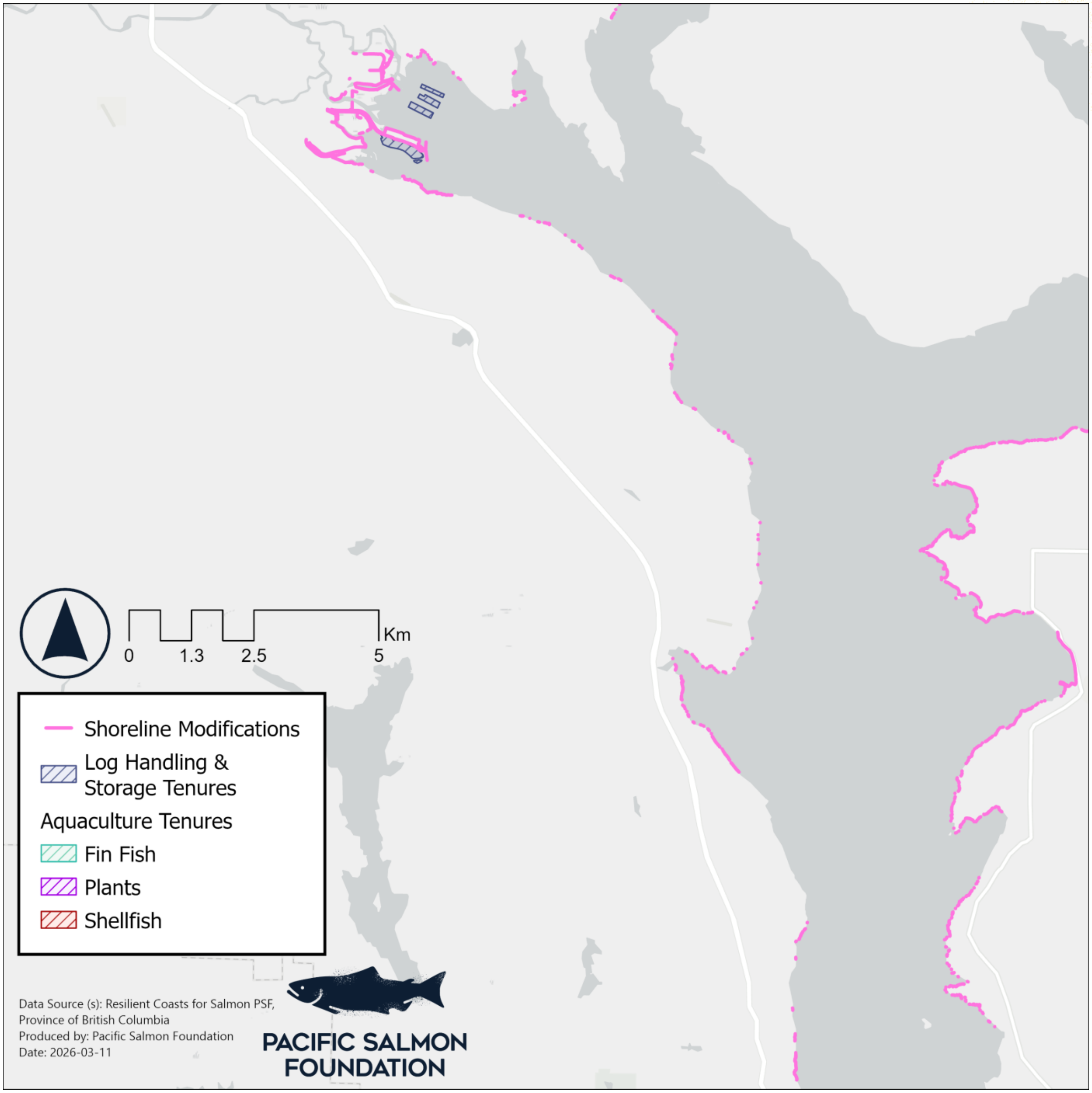


Figure B10 – The shorelines of the southern half of the CVRD, showing the extent of coastal modifications, overlaid with Crownland tenures for log storage and aquaculture (MFLNRORD, 2014).

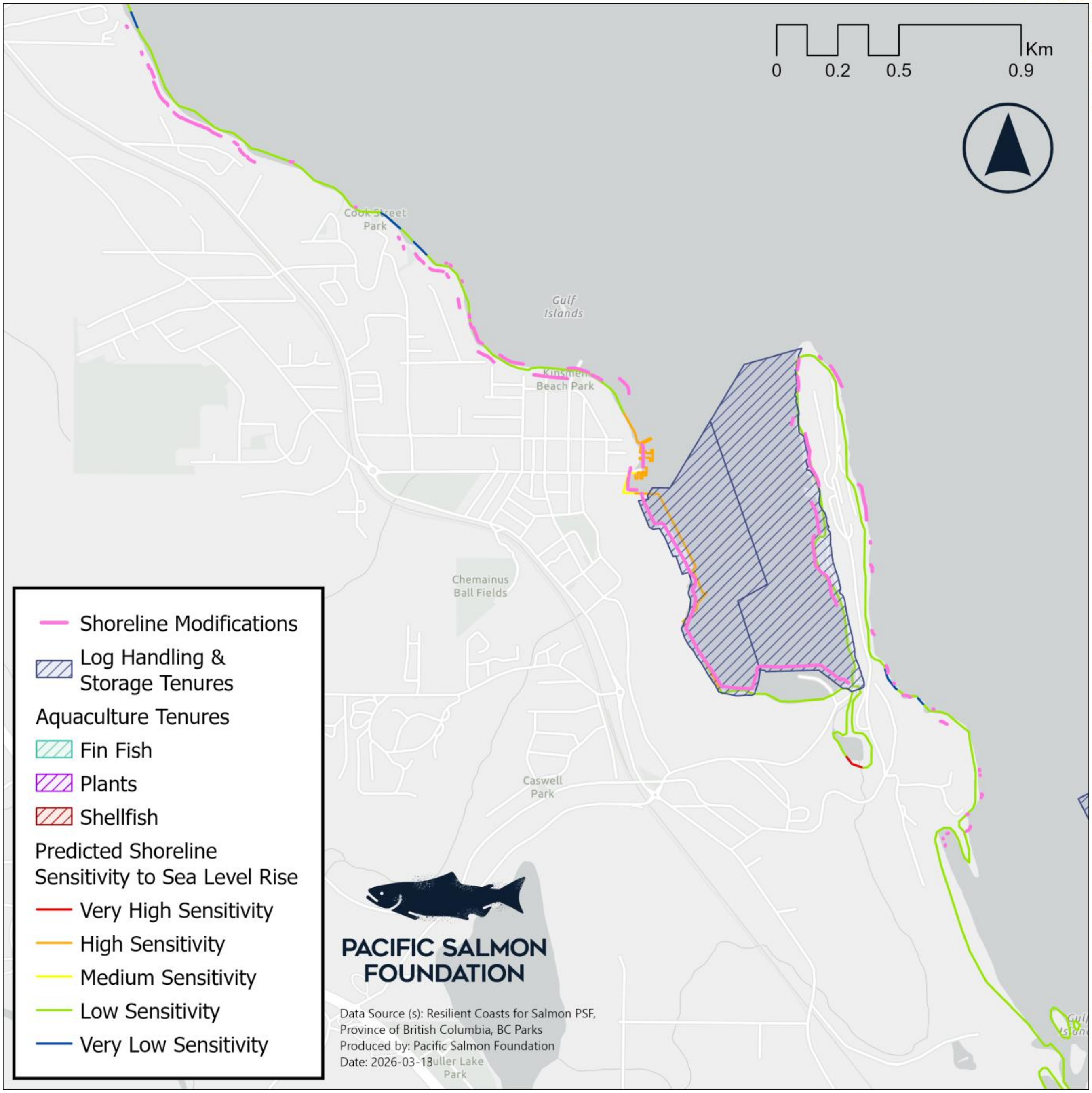


Figure B11 – Most of the Chemainus shoreline, showing the extent of shoreline modification features, overlaid with sensitivity to sea level rise (MOE BC, 2014), as well as Crownland tenures for log storage and aquaculture (MFLNRORD, 2014).