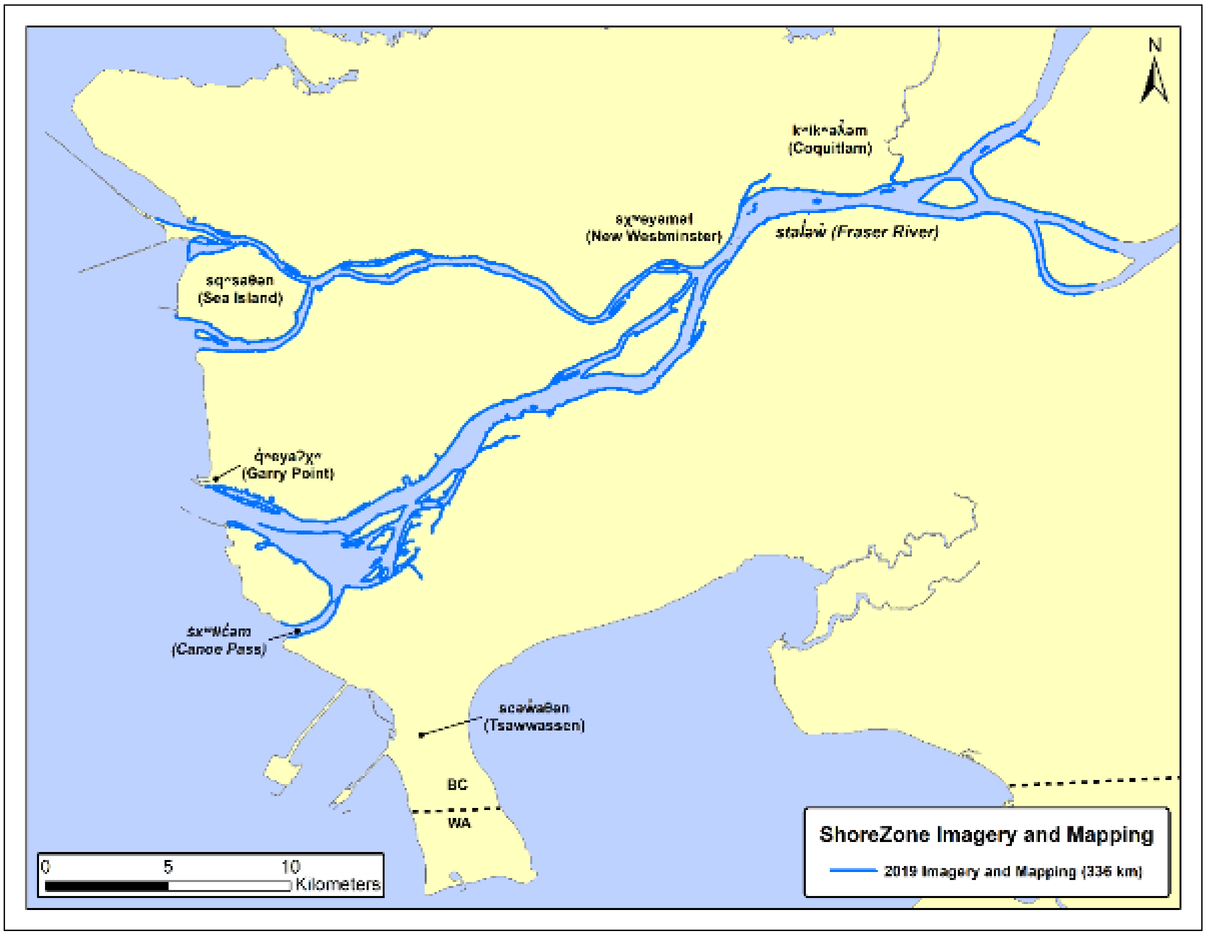
Coastal and Ocean Resources

MCORI Project: 19-05 **January 2020**

ShoreZone Habitat Mapping Summary Report
stal̓əw̓ (Fraser River) Survey Area



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stal̓əw̓ (Fraser River) Area Summary

336 km of shoreline mapped

1,035 shoreline units created

Average unit length of **324 m**

42% of the intertidal is classified as **Sediment-dominated** and **32%** is classed as **Riparian**

90% of the shoreline has a high Oil Residence Index value (residence of months to years)

86% of the shoreline has a **Shoreline Modification** of some type

5 intertidal biobands were classified, with **Wetland Vegetation/Salt Marsh** and **Green Algae** being the most common (65.9% and 29% of units respectively)

7 supratidal biobands were classified, with **Trees and Shrubs** being the most common (76% of units)

1 subtidal bioband was classified, Rooted Vegetation, in 1.2% of units

sc̓əlәxʷqən̓ (Ladner) Harbour

Morey Channel

Swishwash Island

Ewen Slough

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1 INTRODUCTION

ShoreZone is an imaging and habitat classification system for the coastal nearshore margin including the shallow subtidal, intertidal shoreline and supratidal fringe. One objective of ShoreZone is to produce a georeferenced, searchable inventory of the physical and biological attributes of coastal habitats. ShoreZone imagery and habitat attributes can provide a useful baseline from which to study change over time, while the attributes mapped (such as shoreline sediments, predicted oil residence and biotic communities) provide an important resource for scientists and managers. The ShoreZone mapping system provides a decision support tool with many potential uses including: community planning, facilities citing, conservation planning, research and fisheries management, emergency planning and response, search and rescue, education and habitat modeling.

The ShoreZone system was developed in the 1980s and 1990s to map coastal habitats in British Columbia and Washington State (Howes 2001; Berry *et al.* 2004). In 2001 ShoreZone was implemented in Alaska, beginning with Cook Inlet, Outer Kenai, Katmai, and portions of the Kodiak Archipelago (Harper and Morris 2004). ShoreZone has since expanded to a spatially continuous database of over 75,000 km of coastal Alaska and 45,000 km of British Columbia, Washington and Oregon (see Figure 1). Figure 2 shows the extent of the shoreline mapped around the stal̓əw̓ (Fraser River) survey area and is the section of shoreline covered by this summary report.

The ShoreZone imaging survey was conducted in stal̓əw̓ (Fraser River) in August 2019, acquired aerial video and digital still images of the coast during minus tides (zero-meter tide levels and lower). The imagery and associated audio commentary were used to map the physical and biological attributes of the shoreline according the most recent ShoreZone coastal habitat mapping protocol (Cook *et al*. 2017). The purpose of this report is to provide a summary of the physical (Section 2) and biological (Section 3) data imaged and classified in the stal̓əw̓ (Fraser River) survey area.

The length of shoreline mapped is 336 kilometers in 1,035 along-shore segments (units), averaging 324 m in length. The digital shoreline used for the ShoreZone habitat mapping was compiled from multiple sources to create the best available representation of the current shoreline. The primary source for this project was the CHS Pacific High-Water Coastline 2014 BC Albers.

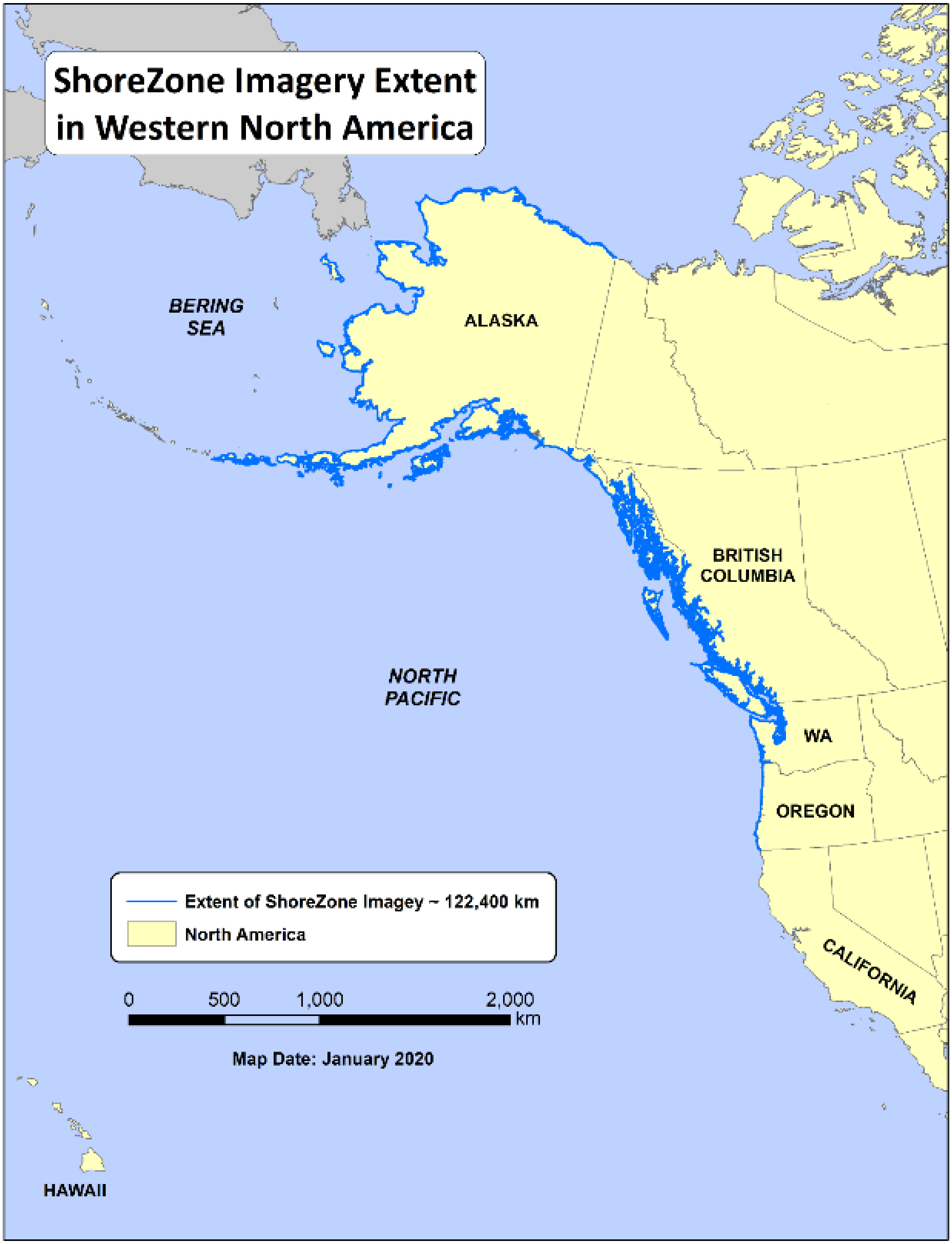

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, Washington State and Oregon as of January 2020. Some sections of the coastline in BC have been imaged more than once.

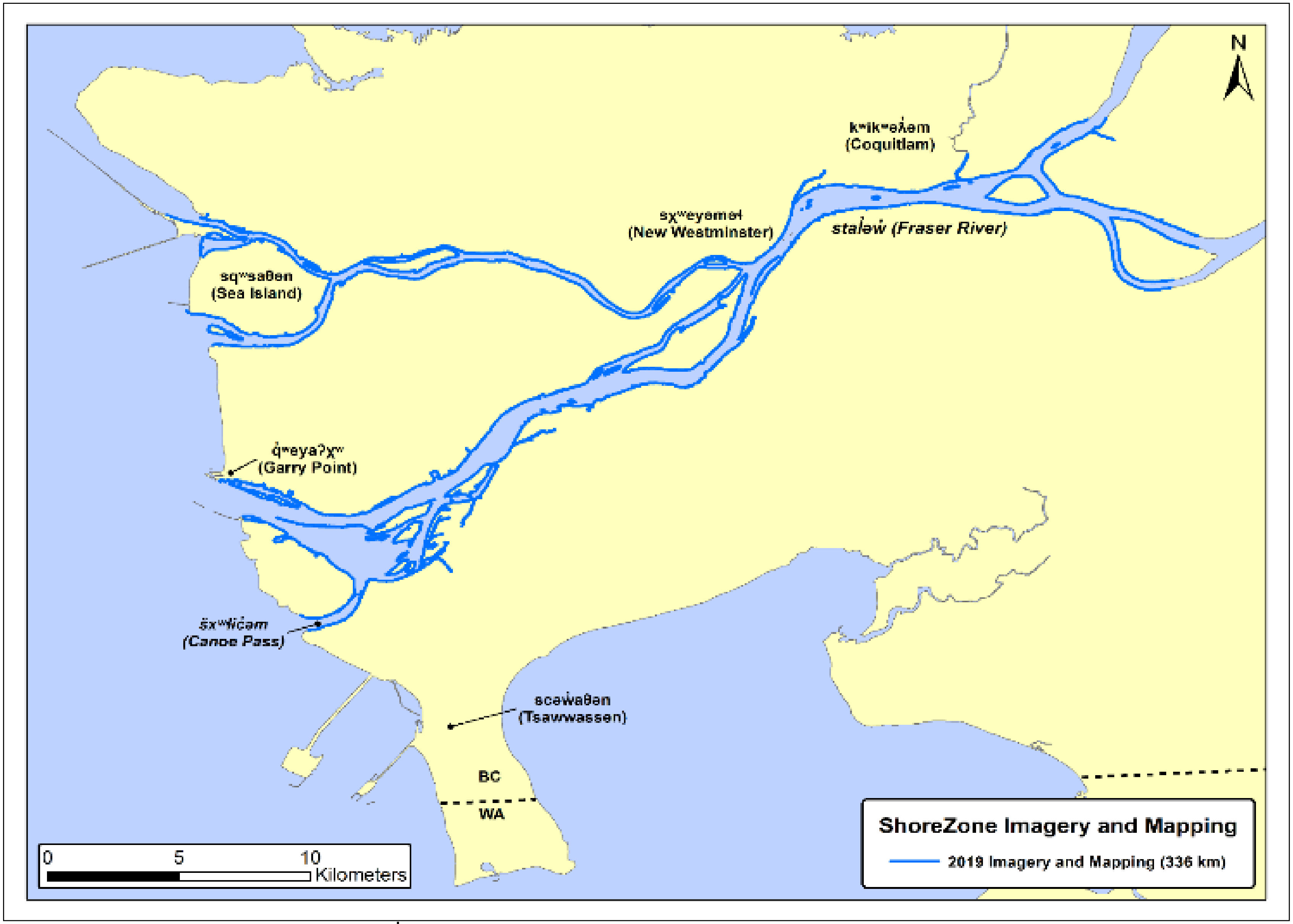

Figure 2. Extent of mapping in the stal̓əw̓ (Fraser River) survey area.

2 Physical Attribute Data Summary

2.1 Coastal Class

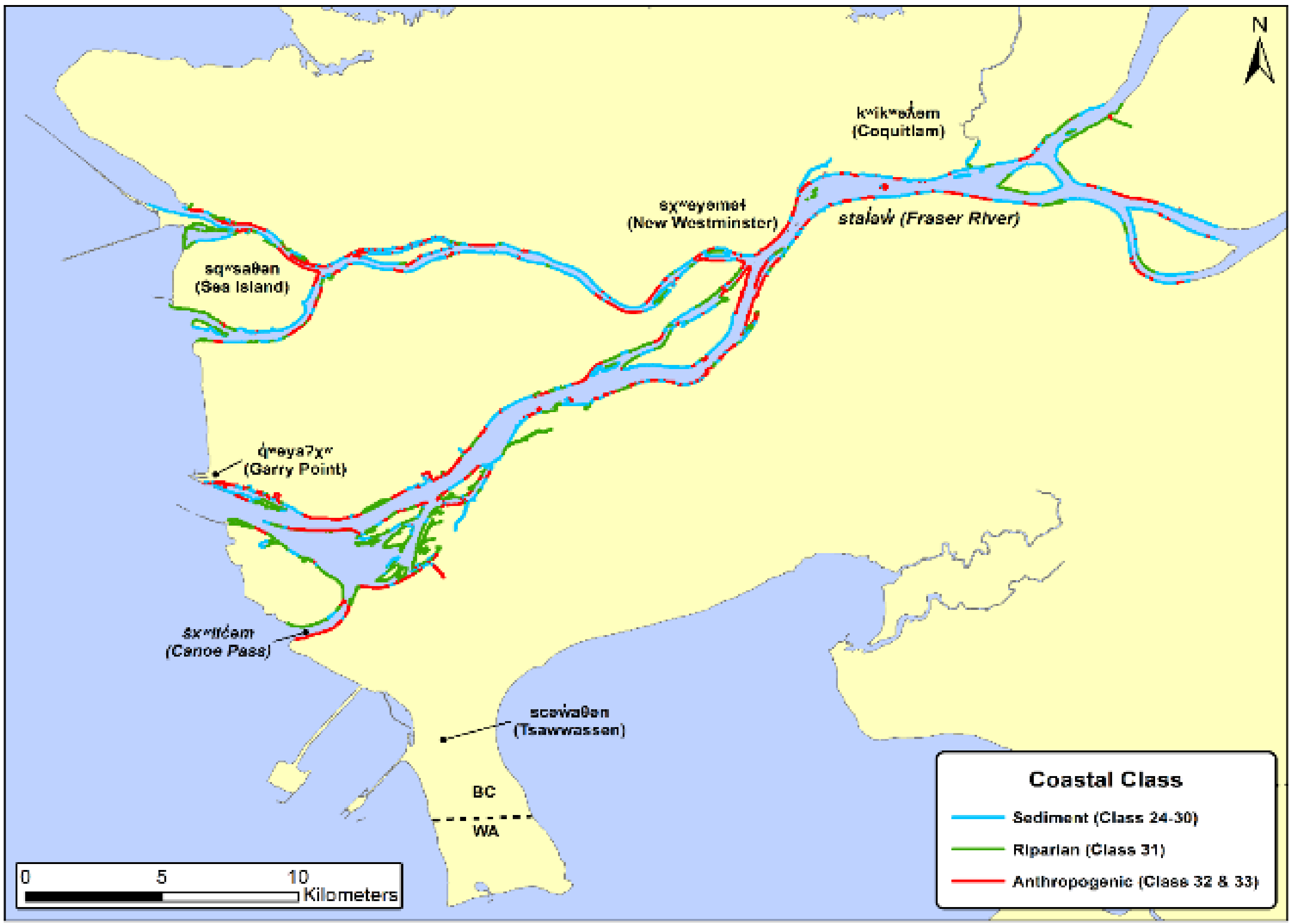

Figure 3. Map of the Coastal Class categories (also known as Shore Type) in the stal̓əw̓ (Fraser River) region, grouped by type.

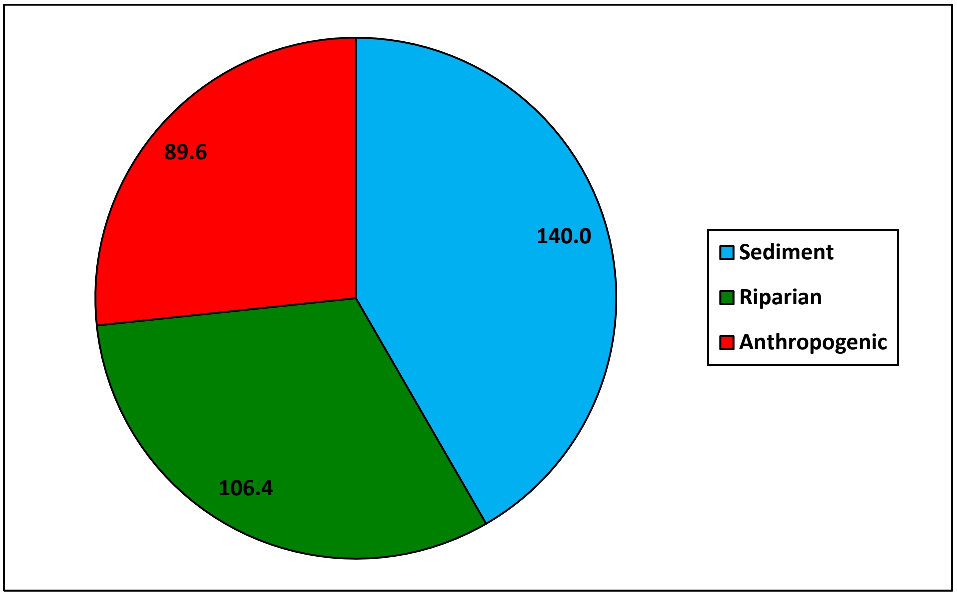

Figure 4. Grouped Coastal Class categories by shoreline length (km).

The Coastal Class is used to define along-shore coastal units based on the dominant process, geomorphic features and other attributes such as substrate size, across-shore width, and slope (Cook *et al*., 2017 after Howes *et al.* 1994). The principal characteristics of each along-shore unit are used to assign one of 39 overall unit classifications. Sediment shorelines (41.7%) dominated the stal̓əw̓ (Fraser River) area. Riparian shorelines followed with 31.7% and Anthropogenic shorelines were found along 26.7% of the coast (see Figures 3 and 4 for distribution and summary statistics). The description for each Coastal Class category in the survey area is given in Table 1. Photographic examples of the major Coastal Classes mapped in the stal̓əw̓ (Fraser River) study area are found in Appendix A, Table A-1.

Table 1. Summary of the Coastal Class attribute for the stal̓əw̓ (Fraser River) survey area.

Substrate Type	Shore Type		Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
	No.	Description				
Sediment	24	Sand & gravel flat or fan	2	9	1	**41.7%** **140.0 km**
	25	Sand & gravel beach, narrow	16	65	5	
	28	Sand flat	10	43	3	
	29	Mudflat	26	78	8	
	30	Sand beach	86	254	26	
Organics	31	Organics/Estuarine	106	243	32	**31.7%** **106.4 km**
Man-made	32	Man-made, permeable	83	300	25	**26.7%** **89.6 km**
	33	Man-made, impermeable	6	43	2	
Totals:			***336***	***1,035***	***100***	***100%***

Note: This table only includes Coastal Classes observed in the stal̓əw̓ (Fraser River) survey area.

2.2 Environmental Sensitivity Index (ESI)

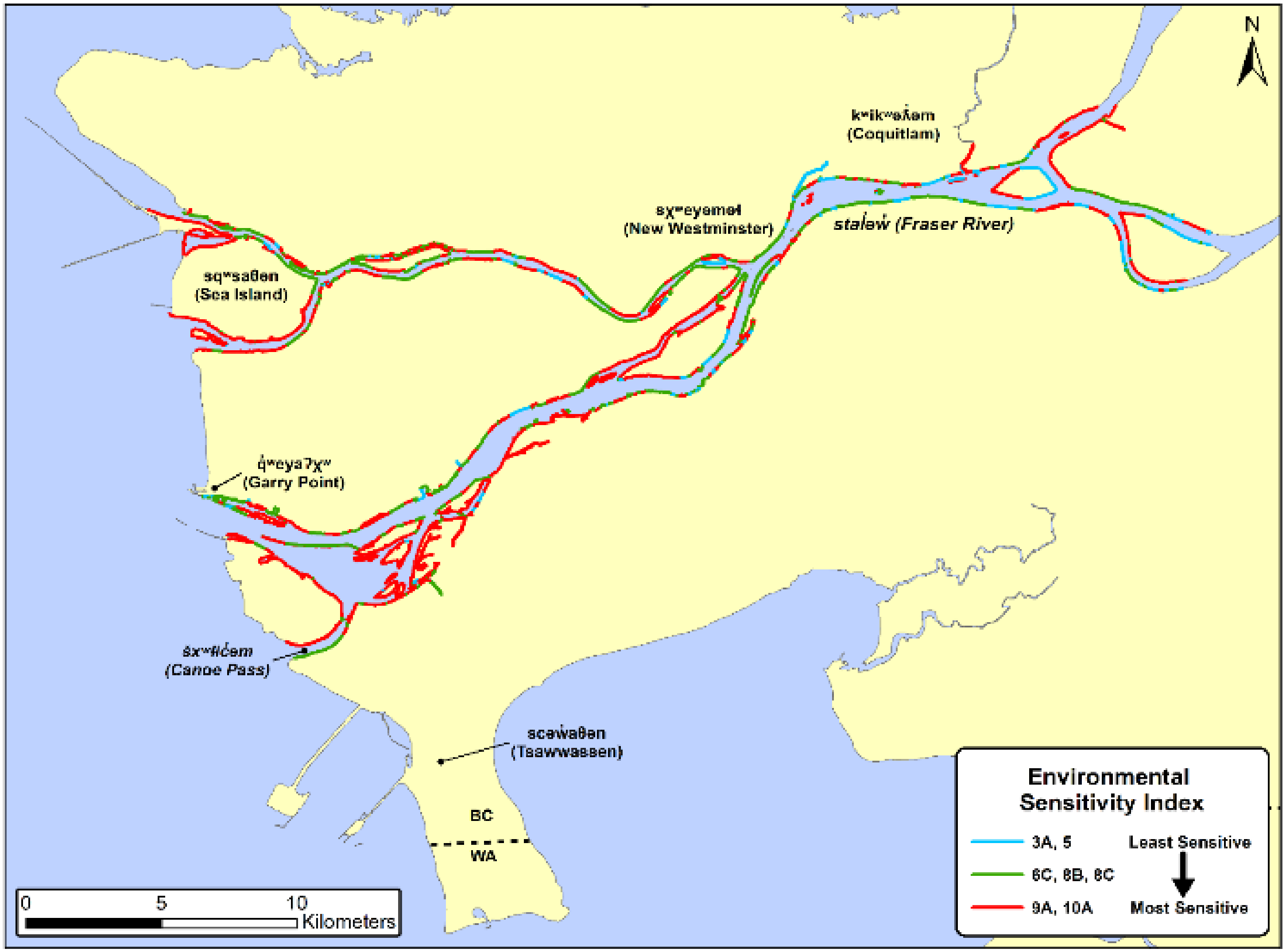

Figure 5. Distribution of the grouped ESI categories from least to most sensitive to oiling.

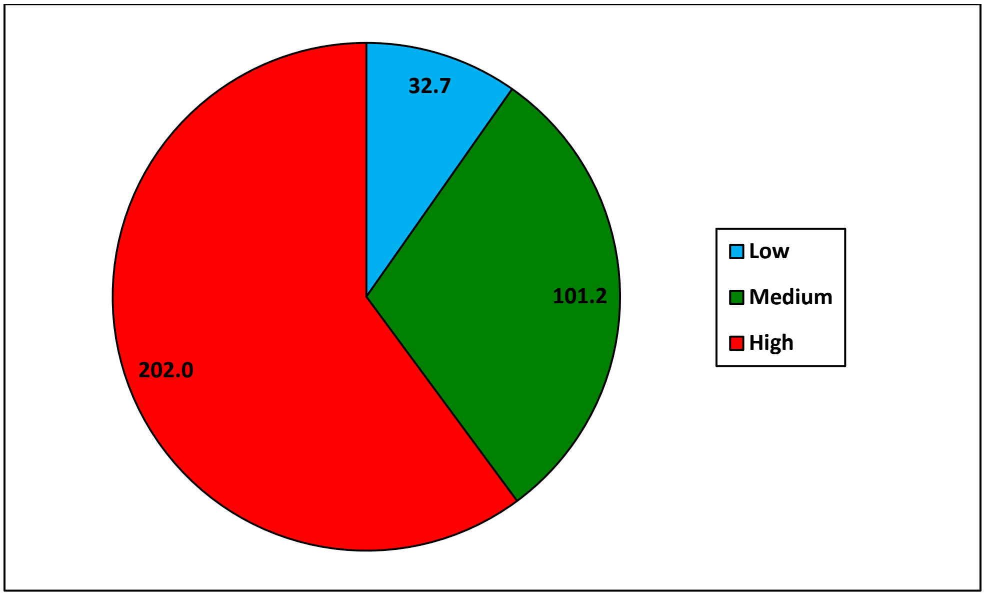

Figure 6. Grouped most sensitive ESI categories by shoreline length (km).

The NOAA Environmental Sensitivity Index (ESI) is a shoreline classification system developed to characterize coastal regions based on sensitivity to potential oil spills (Petersen *et al*. 2002). The ESI system uses wave exposure and principal substrate type to assign a rank of 1 to 10 (with 10 being the most sensitive to oil) to alongshore units. Up to three ESI numbers can be assigned to each ShoreZone unit (high, mid and low intertidal) if applicable. The highest ESI number for each unit, which is the most sensitive, is used in this analysis.

The stal̓əw̓ (Fraser River) study area is dominated by the grouped High category (60.1% of shoreline length). These sections of the shoreline have a potentially high sensitivity to oil. At the other end of the spectrum, only 9.7% of the shoreline was mapped with a potentially low sensitivity to oil (Figures 5 and 6). The summary of Shore Type by ESI class can be seen in Table 2.

Table 2. Summary of Shore Types by ESI Class for the stal̓əw̓ (Fraser River) survey area.

Environmental Sensitivity Index (ESI)		Sum of Unit Length (km)	# of Units	% of Total Shoreline Length
No.	**Description**			
3A	Fine- to medium-grained sand beaches	23	63	7
5	Mixed sand and gravel beaches	10	44	3
6C	Rip rap	1	2	<1
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	19	107	6
8C	Sheltered Rip Rap	82	293	24
9A	Sheltered tidal flats	12	52	4
10A	Salt- and brackish-water marshes	190	474	57
	Totals:	***336***	***1,035***	***100%***

Note: ESI Classes not observed in this survey area were not included in the table.

2.3 Oil Residence Index (ORI)

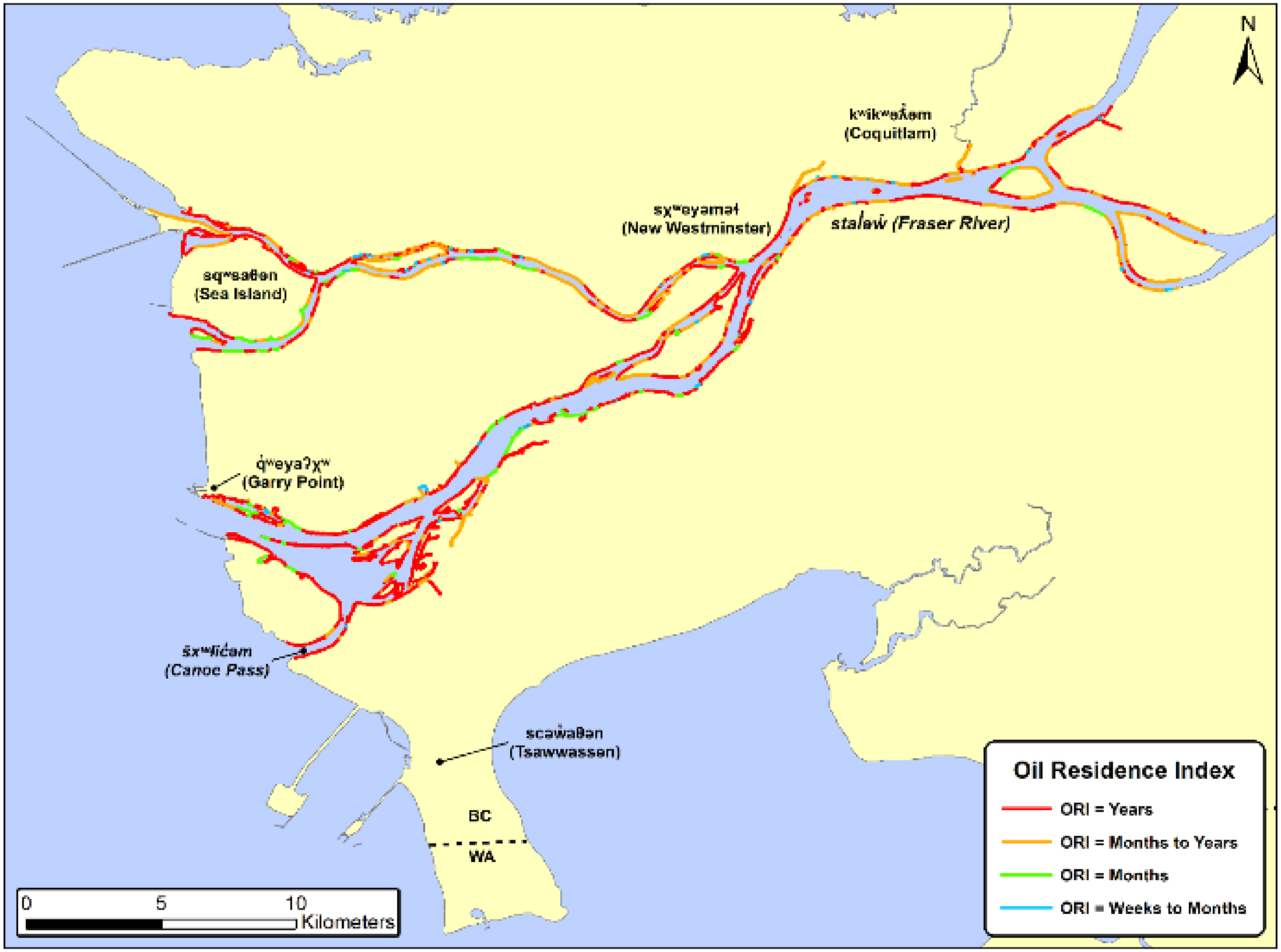

Figure 7. Distribution of the Oil Residence Index (ORI) categories.

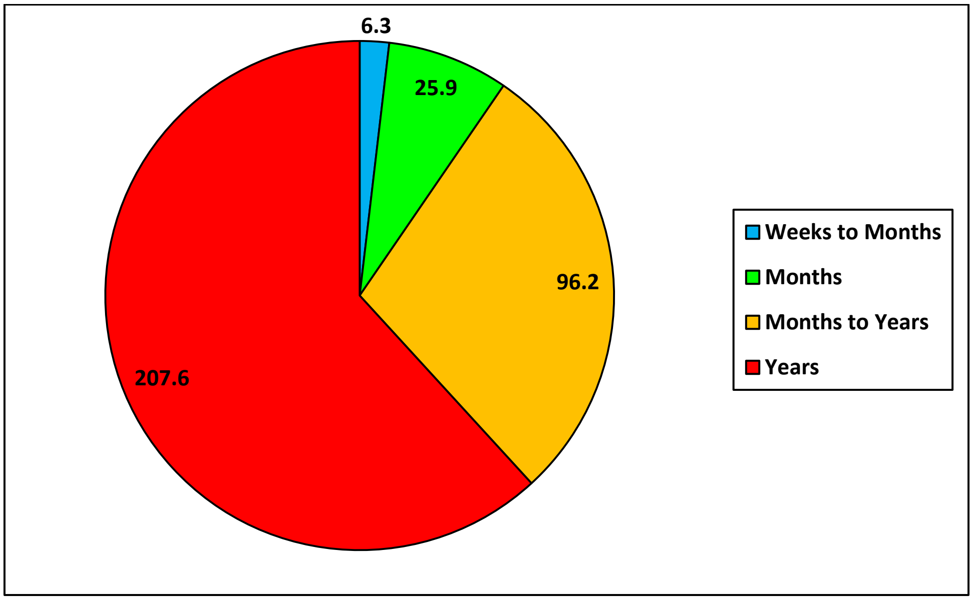

Figure 8. Oil Residence Index (ORI) categories by shoreline length (km).

The Oil Residence Index (ORI) is a rating between 1 and 5 with a value of 1 indicating a relatively short oil residence (days to weeks) while a value of 5 reflects potentially very long oil residence times (years). An ORI value is applied to each alongshore unit and to each across-shore component based on sediment texture and wave exposure (Cook *et al*. 2017). The ShoreZone ORI was developed by Dr. John Harper based on his many years of experience with cleaning up oiled shorelines, starting with the Exxon Valdez spill in Prince William Sound in Alaska. Lower wave exposures and unconsolidated sediments lead to high ORI values for 90.4% of the shore segments in the stal̓əw̓ (Fraser River) area, indicating oil residence times are on the order of months to years (see Figures 7 and 8 for distribution and summary statistics).

2.4 ShoreZone Coastal Vulnerability

2.4.1 Flood Zone Width

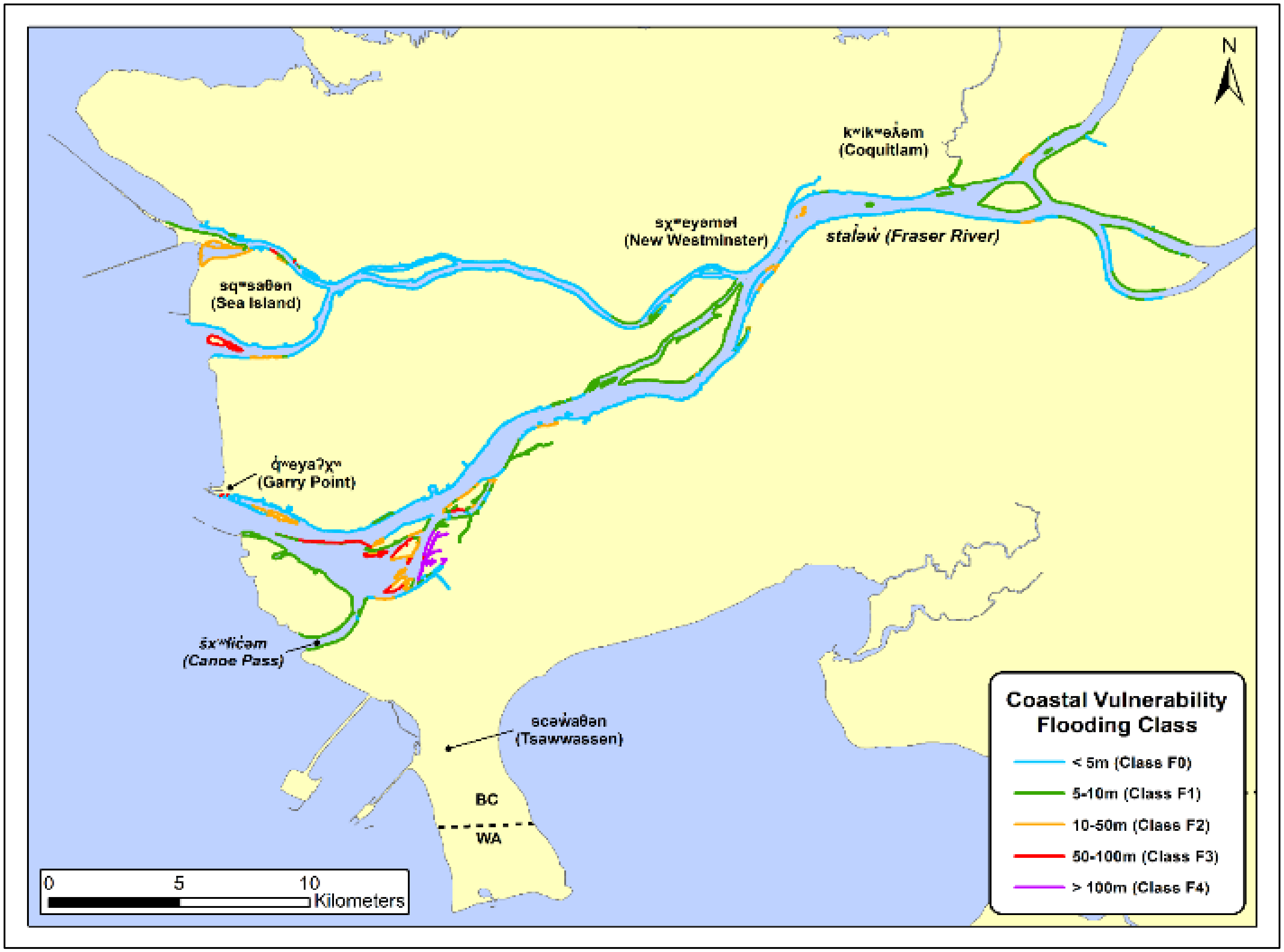

Figure 9. Distribution of the Coastal Vulnerability Flooding Class.

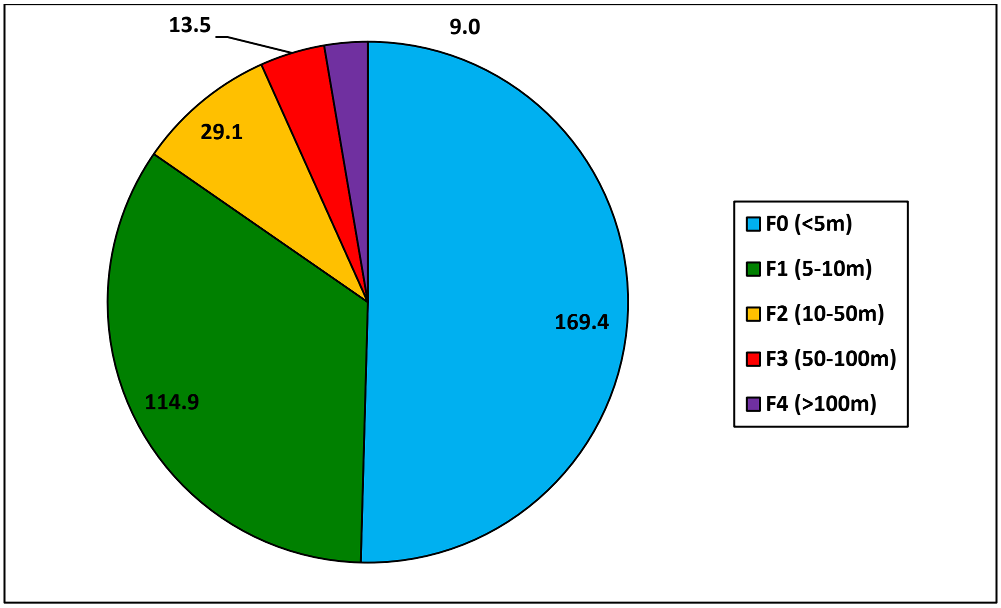

Figure 10. Flooding Class categories by shoreline length (km).

The Coastal Vulnerability Module (CVM) includes a classification of flooding sensitivity based on the across shore profile and photographic evidence of historical flooding such as an unambiguous marine debris line. The Flooding Class is an estimate of vulnerability to inundation of the terrestrial area beyond the supratidal. The distance to the debris line is measured and used to classify the flooding potential. Flat shorelines with very low gradients that show evidence of historical flooding have a higher risk of being inundated by storm surges. Potential for damage due to flooding is generally low in the study area, with 50.4% of the shoreline at a low risk of flooding <5m from MHW (see Figures 9 and 10 for distribution and summary statistics). The flooding class is a parameter of the Coastal Vulnerability Index (see Page 16).

2.4.2 Coastal Vulnerability Observations

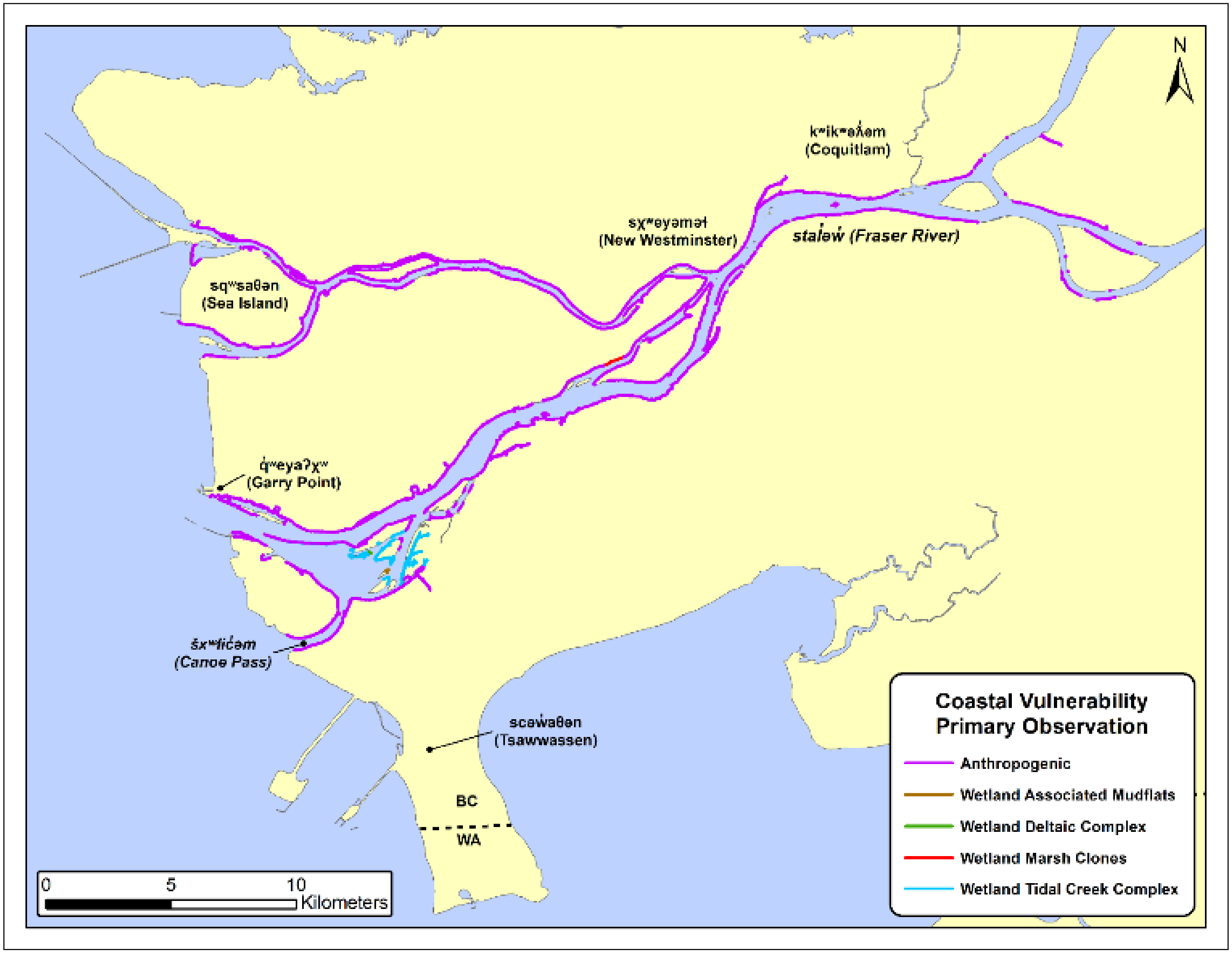

Figure 11. Distribution of the Coastal Vulnerability Observations categories.

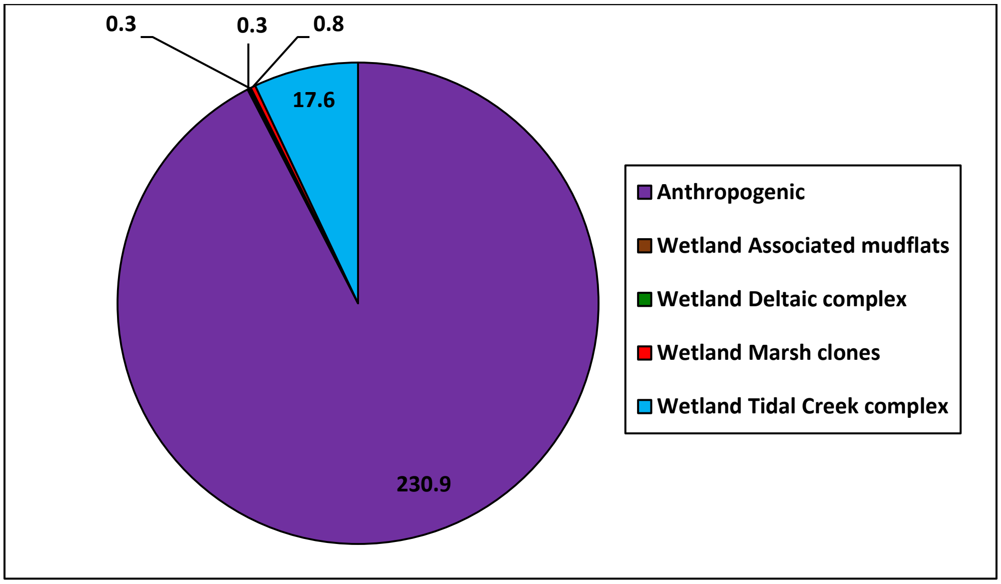

Figure 12. Coastal Vulnerability Observation categories by shoreline length (km). Category 'None' not shown.

The Coastal Vulnerability Module of ShoreZone includes several attributes to provide qualitative estimates of the vulnerability of a unit to impact from sea level rise, whether that is due to anthropogenic causes or natural phenomena such as storm surge (Cook *et al*. 2017). One of these attributes is an observation of features important for estimating the potential impact of coastal inundation based on the condition of the shoreline in the supratidal. Natural shorelines are, generally, considered to be more resilient to inundation due to features such as marshes or dunes while shoreline hardening, or modification can cause the shore to lose resiliency. These observations are meant to complement the 'Anthropogenic' Coastal Class (Page 4) which indicates significant modification of the intertidal and the Shoreline Modifications attribute (Page 19) which catalogues the type of modifications observed (supratidal or intertidal). In the staləw̓ (Fraser River) study area, apart from the 'None' category, the majority of observations were from the Anthropogenic category with 230.9 km (see Figures 11 and 12 for distribution and summary statistics). It is important to point out that these areas are not necessarily areas of vulnerability, but areas that could have reduced resilience.

2.4.3 Coastal Vulnerability Index

The methods of Thieler and Hammer-Klose (2000) ((http://woodshole.er.usgs.gov/project-pages/cvi/) were adapted to calculate the Coastal Vulnerability Index (CVI) using five ShoreZone attributes: Shore Type, Max Tide Range, Shoreline Erosion index, Flood Zone Width, and Wave Height. See the most recent ShoreZone protocol for more details (Cook *et al*., 2017). When we first attempted to calculate the CVI for the portion of the shoreline funded in the Eastern Aleutians by OSRI, it did not match the observations of the mappers as it appeared to rank too much of the rocky, steep shoreline as High or Very High in terms of vulnerability to sea level rise. After analysis of the data, we determined this was due to using a relative ranking system where the values from the study area were only compared to each other to determine the CVI rank. To resolve this issue we calculated an absolute value for each CVI rank which is described in the latest version of the protocol (Cook *et al*., 2017). The distribution of ranks in the stal̓əw̓ (Fraser River) study area is shown in Figure 13. The fact this survey area is completely in a large river estuary as well as the presence of so much anthropogenic modification was not something present in the areas where the CVI was developed and may make the results more challenging to interpret. The whole survey area was ranked as either Low or Moderate in terms of vulnerability to sea level rise with the Moderate values all being present closer to the mouths of the river.

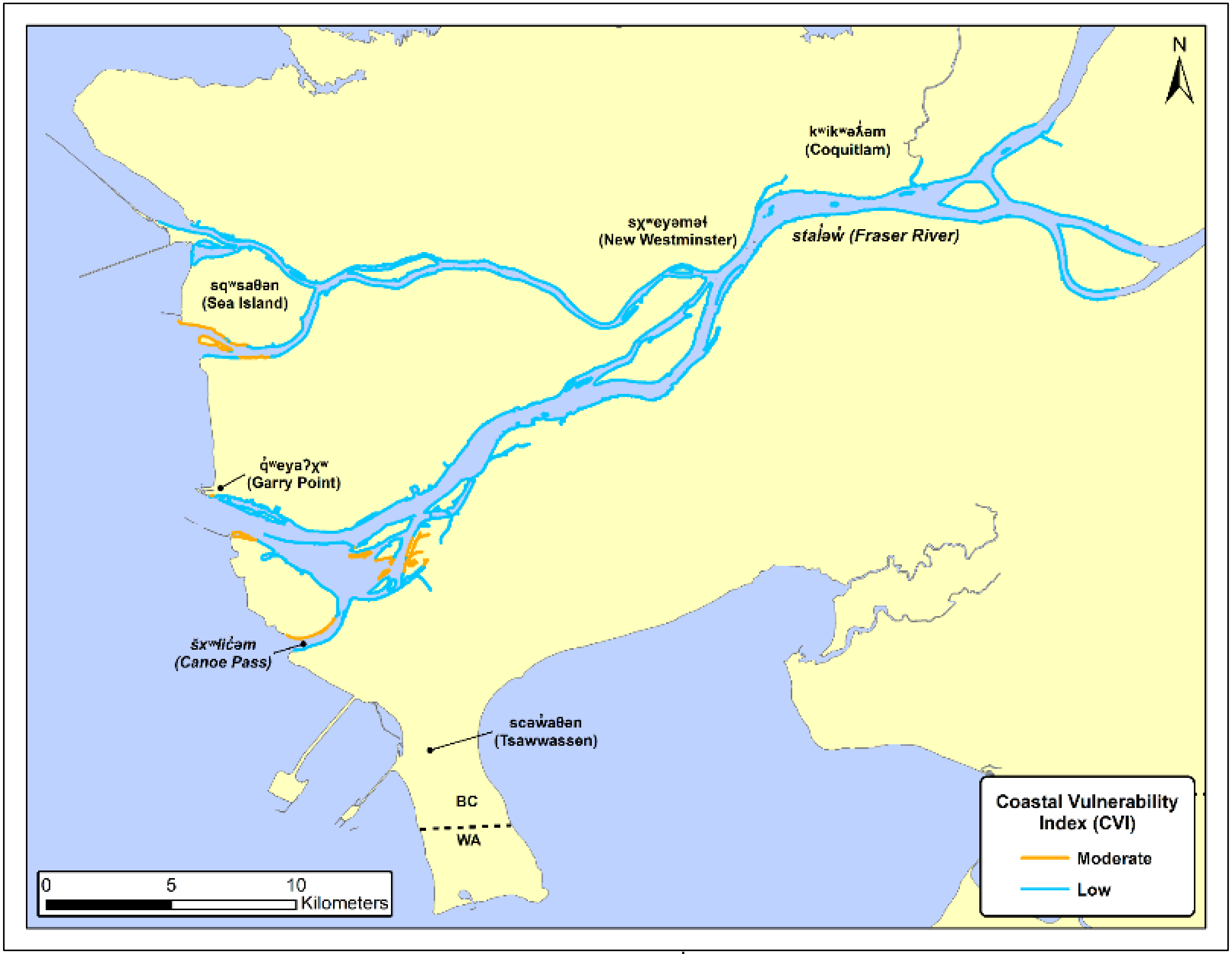

Figure 13. Distribution of Coastal Vulnerability Index ranks in the stal̓əw̓ (Fraser River) study area.

2.5 Anthropogenic Shoreline Modifications

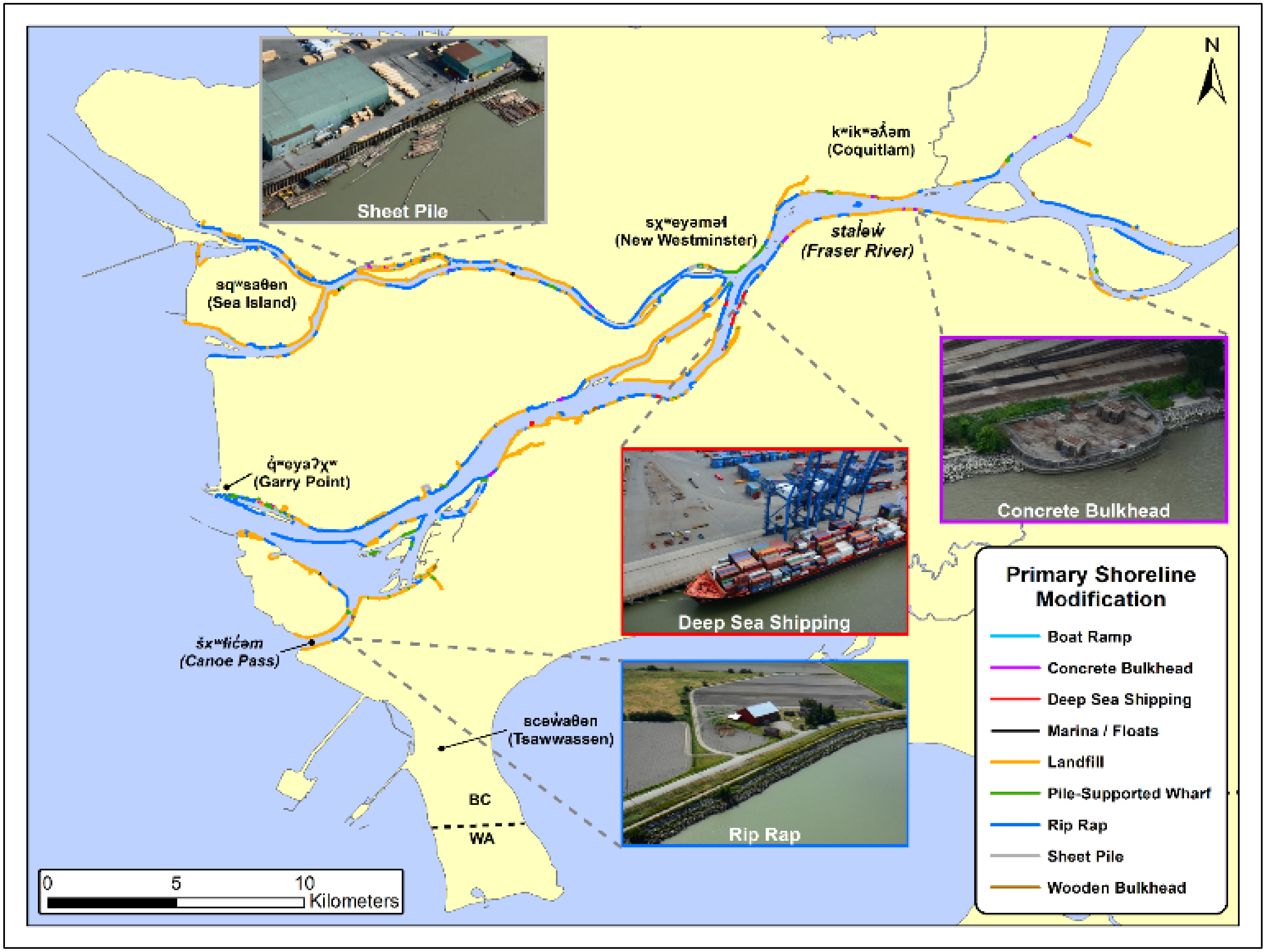

Figure 14. Distribution of types of the primary Shore Modifications. There may be other shore modifications in any given unit. That data would be found in the Shore Modifications table in the geodatabase.

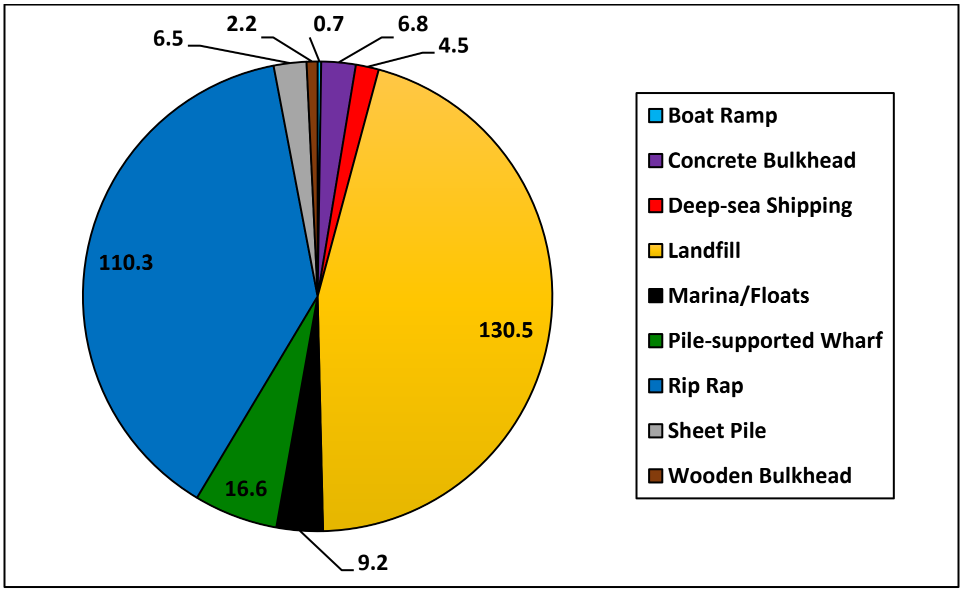

Figure 15. Shore Modifications by estimated shoreline length (km) of each modification type.

The Shoreline Modification attribute provides a thorough catalogue of the specific types of anthropogenic modification in each unit (Cook *et al*., 2017). This includes many modifications within a given unit. For example, if both riprap and a pile-supported wharf occur, both are catalogued in the appropriate zone of that unit with an estimate of the alongshore length of the unit that modification covers. A total of 85.5% of the shoreline (taking the estimated length of that modification within the unit into account) exhibits shore modifications in the stal̓əw̓ (Fraser River) study area (Figure 15). Landfill was the most commonly recorded observation (45.4%) with Rip Rap observed along 38.4% of the shore. The associated map (Figure 14) shows the distribution of primary shore modifications though it should be noted that any given modification isn't necessarily along the entire length of the indicated shore unit. The Geodatabase delivered with this report displays each shore modification with a specific length category (meters) along the shoreline pertaining to each unit as well as the specific zone (supratidal or intertidal) the modification occurs in.

3 BIOLOGICAL ATTRIBUTE DATA SUMMARY

3.1 Biobands

Biobands represent assemblages of coastal biota found on the shoreline at typical wave exposures, substrate conditions and across-shore elevations. Biobands are spatially distinct, with alongshore and across-shore patterns of color and texture that are visible in aerial imagery (see Appendix A, Table A-2 for examples from the Howe Sound/Vancouver Port survey area). Full descriptions of all biobands, including indicator and associated species can be found in the ShoreZone protocol (Cook *et al*. 2017). The metrics for measuring the biobands are also detailed in the protocol document. The specific elevation (or zone) of the bioband on the shoreline determines the metrics applied. Biobands found in the supratidal (A Zone) and subtidal (C Zone) are described by percent of alongshore length of unit and a width category. The intertidal (B zone) biobands are described by percent of alongshore length of the unit and percent cover of the zone.

The 10 individual biobands mapped in the stal̓əw̓ (Fraser River) study area are summarized in Tables 3 and 4. The survey area was more brackish toward the mouth of the river moving to a fresh-water system further upriver. It was challenging to define the transition from brackish to fresh based solely on the imagery, although some clues were present. For example, Cattail (*Typha latifolia*) and the invasive Purple Loosestrife (*Lythrum salicaria*) could be seen at higher elevations near the river mouth but moved lower in the intertidal in the fresh-water portion of the river. Also, some species like Pond Water-Starwort (*Callitriche stagnalis*), which are not salt-tolerant, were visible from the imagery and distinguished fresh from brackish. We recorded occurrence of Purple Loosestrife and Pond Water-Starwort, even though they are not defined biobands in the ShoreZone protocol, and their distribution is shown in Figures 16 and 17. However, these cues did not appear in all imagery so we used the definitions of the reaches of the lower stal̓əw̓ as provided to us by xʷməθkʷəy̓əm personnel to decide where the marshes should be classed as Salt Marsh (SAMB) or Wetland Vegetation when it was not clear from the imagery. See Figure 18 for the distribution of these biobands in the survey area. For this survey area, the Green Algae bioband, which occurred in 29.0% of units, was completely composed of an unidentified filamentous green algae that grew on a wide range of substrate like rocks, wood debris and sediment. Figure 19 shows a map of the distribution of this bioband.

The most common Splash Zone bioband was Black Lichen, occurring in 14.2% of the units. Trees and Shrubs was the most common supratidal bioband, occurring in 76.0% of units. Many units were heavily modified in the supratidal and that clearly had a large impact on both the biobands present but also the composition of those bands. For example, it was clear both from the imagery and the ground survey that there was a great deal of Himalayan Blackberry (*Rubus armeniacus*), an invasive species, present as part of the Trees and Shrubs bioband. Only one band, Rooted Vegetation, was observed in the subtidal zone. Based on the ground surveys (Cook *et al*., 2019), that vegetation was likely a combination of Unidentified Stonewort (*Chara* sp.) and Beaked Ditch-Grass (*Ruppia maritima*).

Table 3. Percent cover category for the intertidal biobands in the stal̓əw̓ (Fraser River) study area.

Bioband		Zone	Number of Units By Percent Cover Category (Intertidal Zone)							Total Number of Units* With Bioband Present	% of Total Units* with Bioband Present
Name	Code		<5%	5-25%	26-50%	51-75%	76-95%	>95%	Bioband present, Percent Cover Not Assessed		
Wetland Vegetation	WEVE	Upper to Mid Intertidal	44	217	79	44	13	1	0	**398**	**38.5%**
Salt Marsh (BC)	SAMB		11	115	67	53	37	1	0	**284**	**27.4%**
Green Algae	GRAL		56	210	30	4	0	0	0	**300**	**29.0%**
Rooted Vegetation	ROVE	Mid to Lower Intertidal	0	3	0	0	0	0	0	**3**	**0.3%**
Eelgrass	EELG		4	9	0	0	0	0	0	**13**	**1.3%**

Table 4. Width category of supratidal and subtidal biobands in the stal̓əw̓ (Fraser River) study area.

Bioband		Zone	Number of Units By Width Category				Total Number of Units* With Bioband Present	% of Total Units* with Bioband Present
Name	Code		<1 m	1-5 m	>5 m	Bioband present, Width Not Assessed		
Splash Zone	SPZO	Splash Zone (A)	38	7	0	0	**45**	**4.3%**
Black Lichen	BLLI		147	0	0	0	**147**	**14.2%**
			<10 m	10-30 m	>30 m	Bioband present, Width Not Assessed		
Trees and Shrubs	TRSH	Supratidal (A)	784	1	2	0	**787**	**76.0%**
Grasses	GRAS		27	0	1	0	**28**	**2.7%**
Dune Grass	DUGR		11	1	0	0	**12**	**1.2%**
Wetland Vegetation	WEVE		26	17	29	0	**72**	**7.0%**
Salt Marsh	SAMB		4	0	1	0	**5**	**0.5%**
Rooted Vegetation	ROVE	Subtidal (C)	10	2	0	0	**12**	**1.2%**

*Please note that Total Number of Units is used to describe the distribution of biobands rather than length (in kilometers) because biobands are usually not continuous along the entire length of a unit. A calculation could be performed to estimate metrics, like length or percent cover, of a bioband over a region using the percent length metric in the dataset.

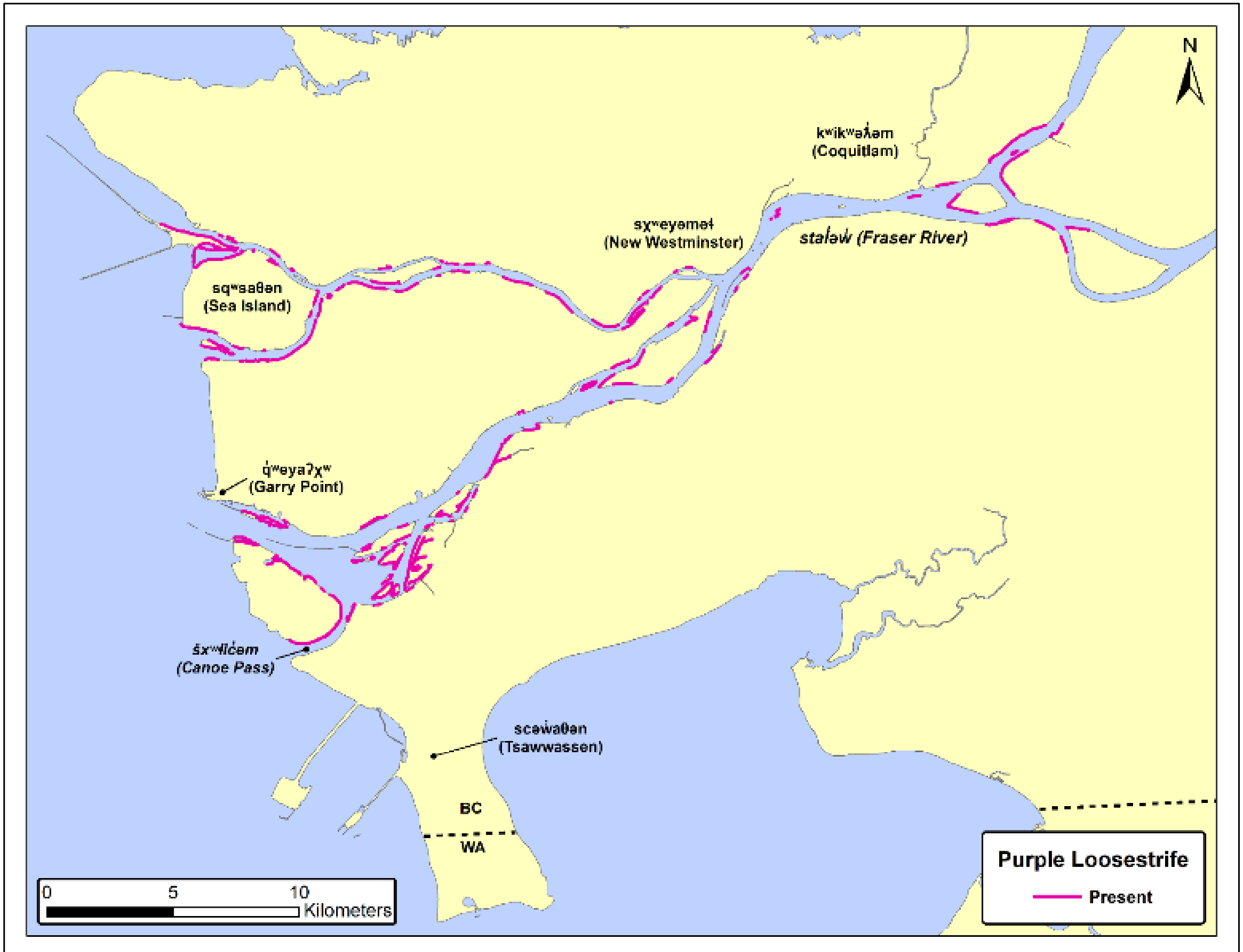

Figure 16. Distribution of Purple Loosestrife observed in the imagery in the staləw̓ (Fraser River) study area.

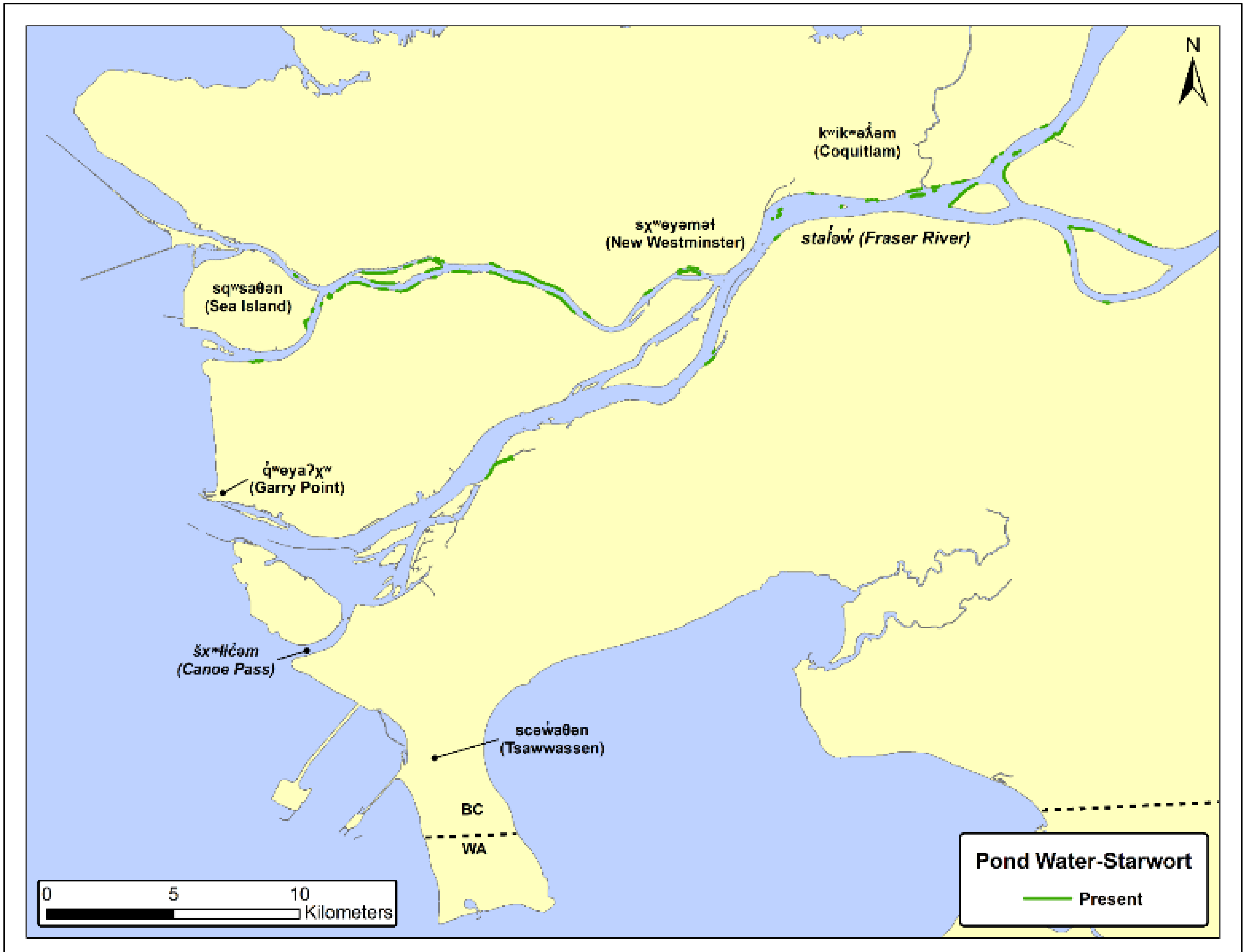

Figure 17. Distribution of Pond Water-Starwort as observed from the imagery in the stal̓əw̓ (Fraser River) study area.

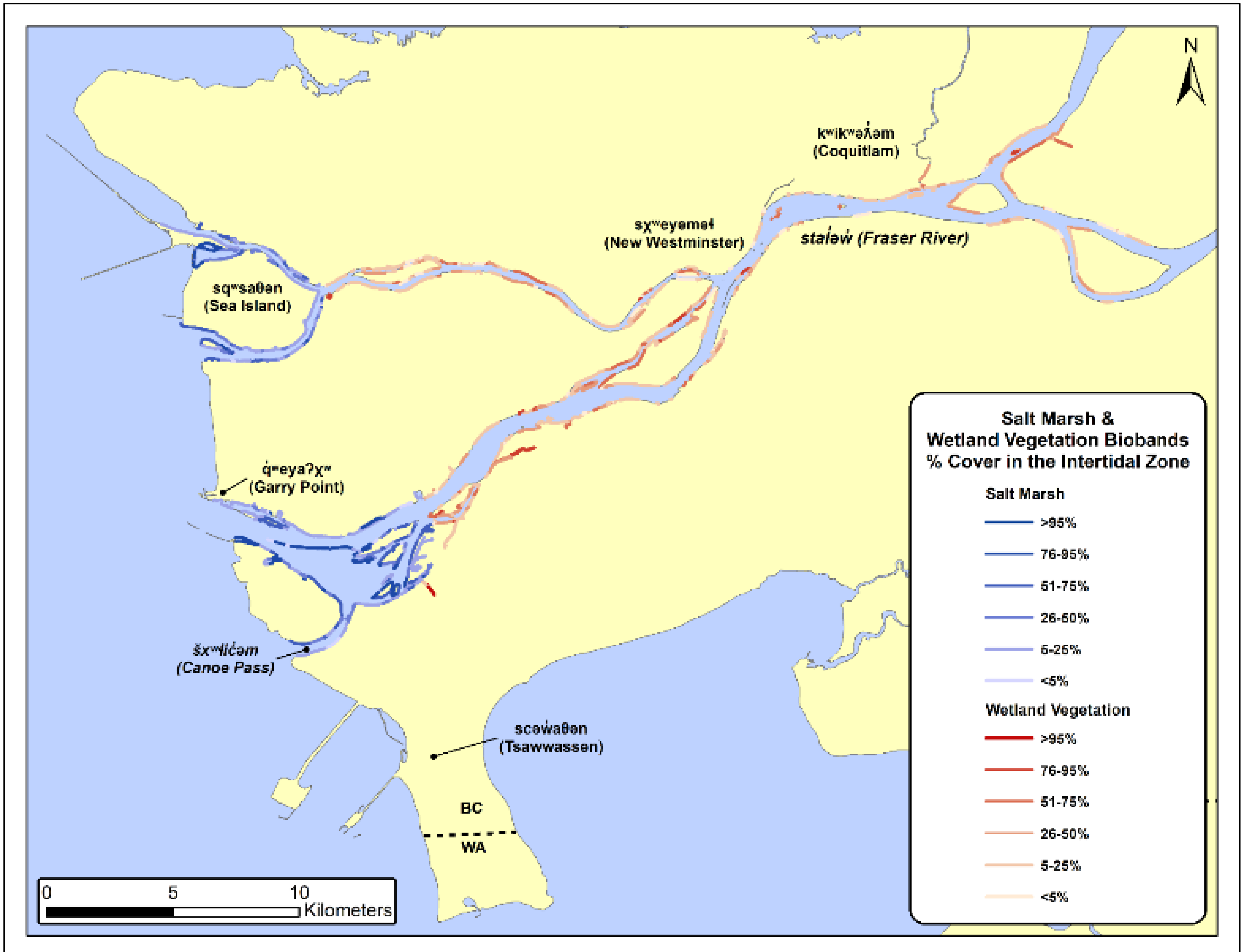

Figure 18. Distribution of the Salt Marsh and Wetland Vegetation Biobands in the stal̓əw̓ (Fraser River) study area.

Figure 19. Distribution of the Green Algae Bioband in the staləw̓ (Fraser River) study area.

3.2 Biological Wave Exposure

Biological wave exposure categories range from Very Protected (VP) to Very Exposed (VE) and are defined in ShoreZone on the basis of a typical set of biobands. When present, the observation and relative abundance of biota in each alongshore unit is used to determine the classification for the biological wave exposure. The assemblages of biota observed are then used as a proxy for the wave exposure at that site. For definitions of the Biological Wave Exposures and the exposure ranges of the biobands, see the most recent ShoreZone protocol (Cook *et al*. 2017).

The distribution of the wave exposure categories mapped in the stal̓əw̓ (Fraser River) study area are summarized in Figure 20 and a distribution map of the categories is shown in Figure 21. 99.7% of the coastline was in the low exposure categories of Protected or Very Protected, with only 0.3% Semi-Protected which was right at the mouth of the river.

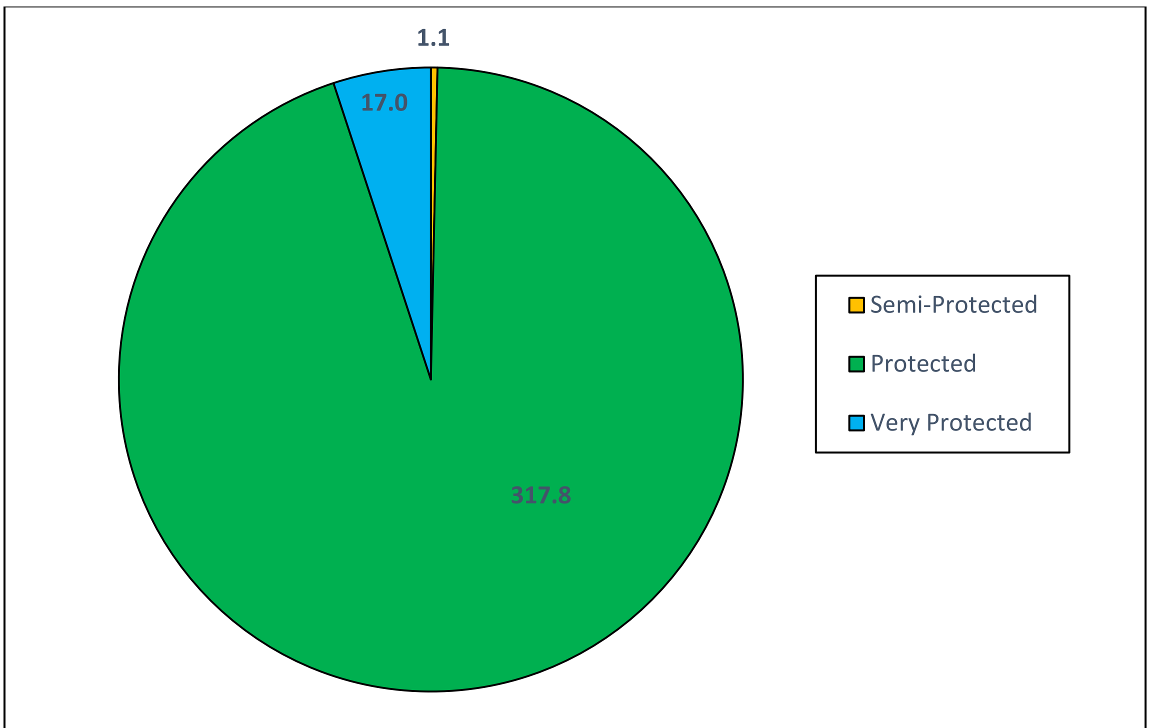

Figure 20. Distribution of biological wave exposures mapped in the stal̓əw̓ (Fraser River) study area by shoreline length (km).

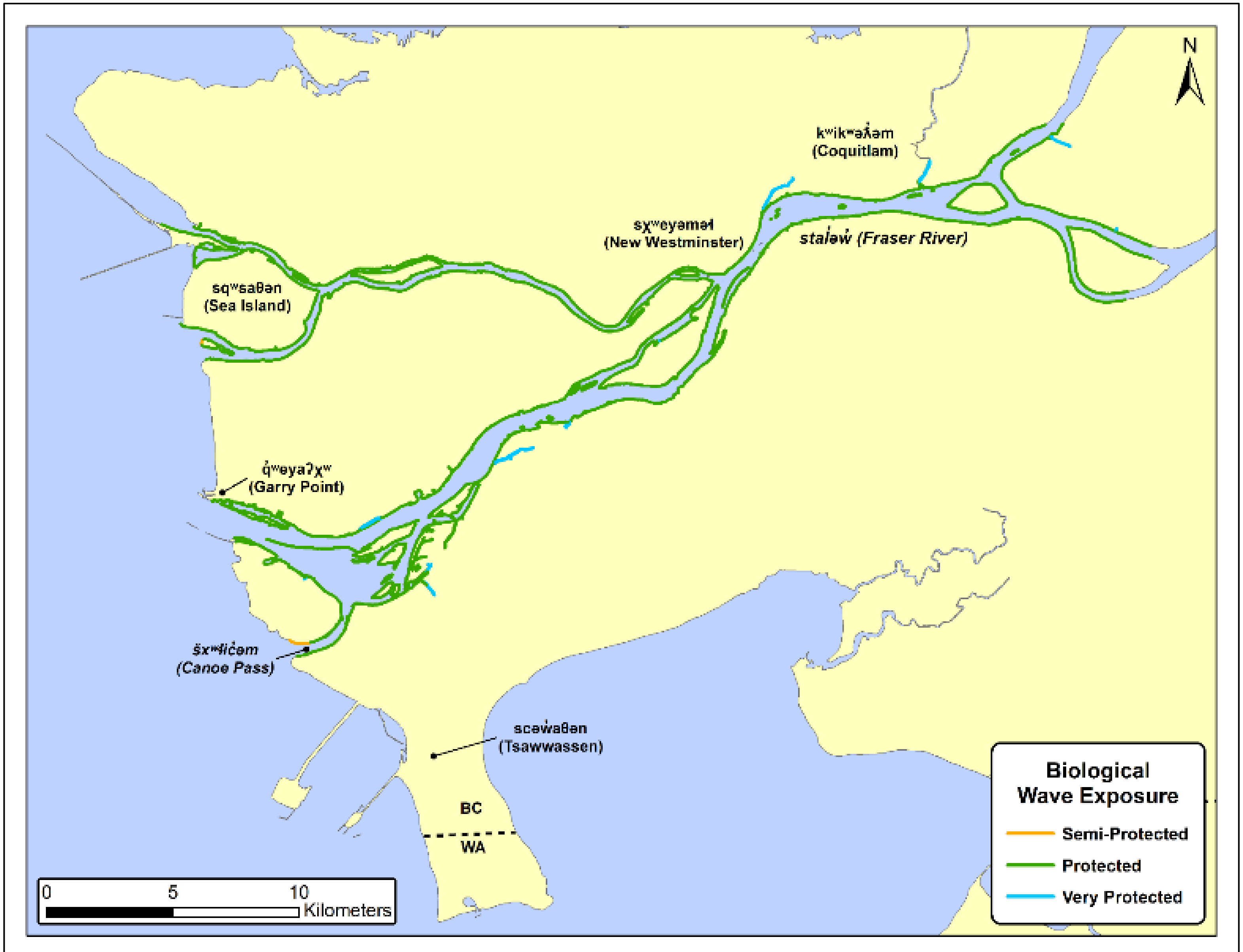

Figure 21. Distribution of the Biological Wave Exposure in the stal̓əw̓ (Fraser River) study area.

3.3 Habitat Class

The **Habitat Class** attribute is based on wave exposure and geomorphic characteristics observed on an alongshore unit. The habitat class is intended to provide a single attribute to characterize the biophysical features of each unit. The habitat class is assigned by the biological mapper and weighted according to the dominant structuring process. Wave exposure is the most common structuring process, with less commonly observed habitats are those structured by current, estuarine/fluvial processes, and anthropogenic structures. For habitat classes structured by wave exposure, substrate mobility determines the presence of epibenthic biota. Where the substrate is highly mobile, biota is sparse or absent, and where the substrate is stable, biota can be abundant. For further definitions and explanations of Habitat Class codes please see the most recent ShoreZone protocol (Cook *et al*. 2017).

The distribution of habitat class categories mapped for the staləw̓ (Fraser River) study area are summarized in Figures 22 and 23. Mobile substrate classes are the dominant shoreline types (61.7%) with Anthropogenic habitat classes making up most of the rest of the shoreline (34.8%). These anthropogenic habitat classes included both areas with anthropogenic structures and areas where the natural sediment in the supratidal or intertidal had been significantly moved or altered, thereby affecting the biota present or the distribution of the biota in the unit. The Riparian, or Estuary, Habitat Class was not mapped as it requires specific features be present in a unit (fresh water input, a delta fan and a wetland bioband) which did not occur for any one unit in this survey area, although it should be noted that the whole survey area is actually a giant estuary.

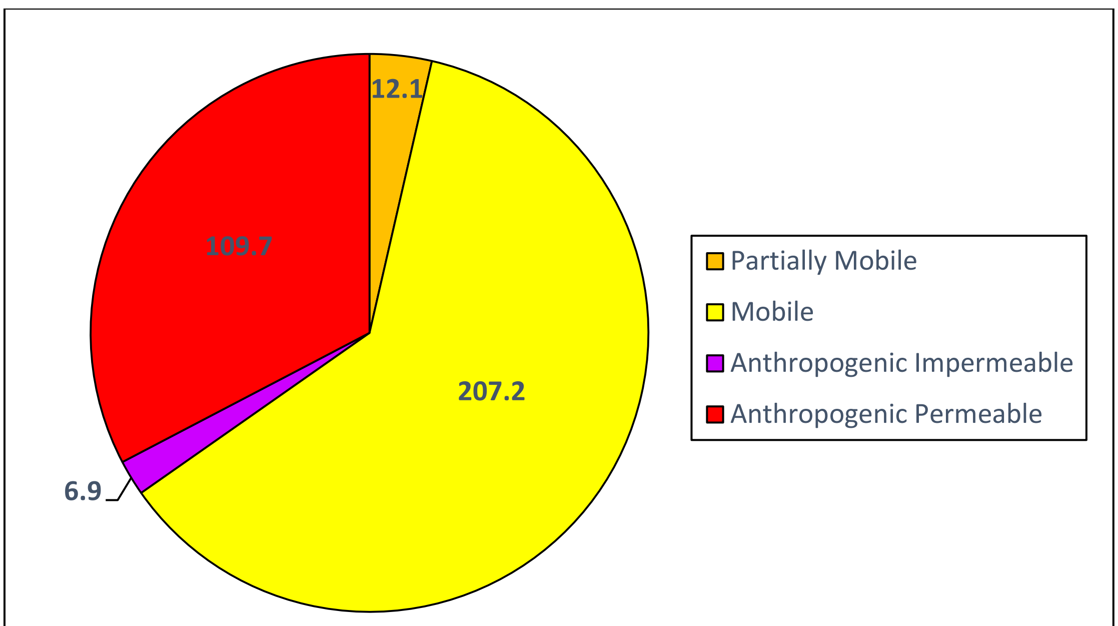

Figure 22. Distribution of Habitat Class categories in the staləw̓ (Fraser River) study area by shoreline length (km).

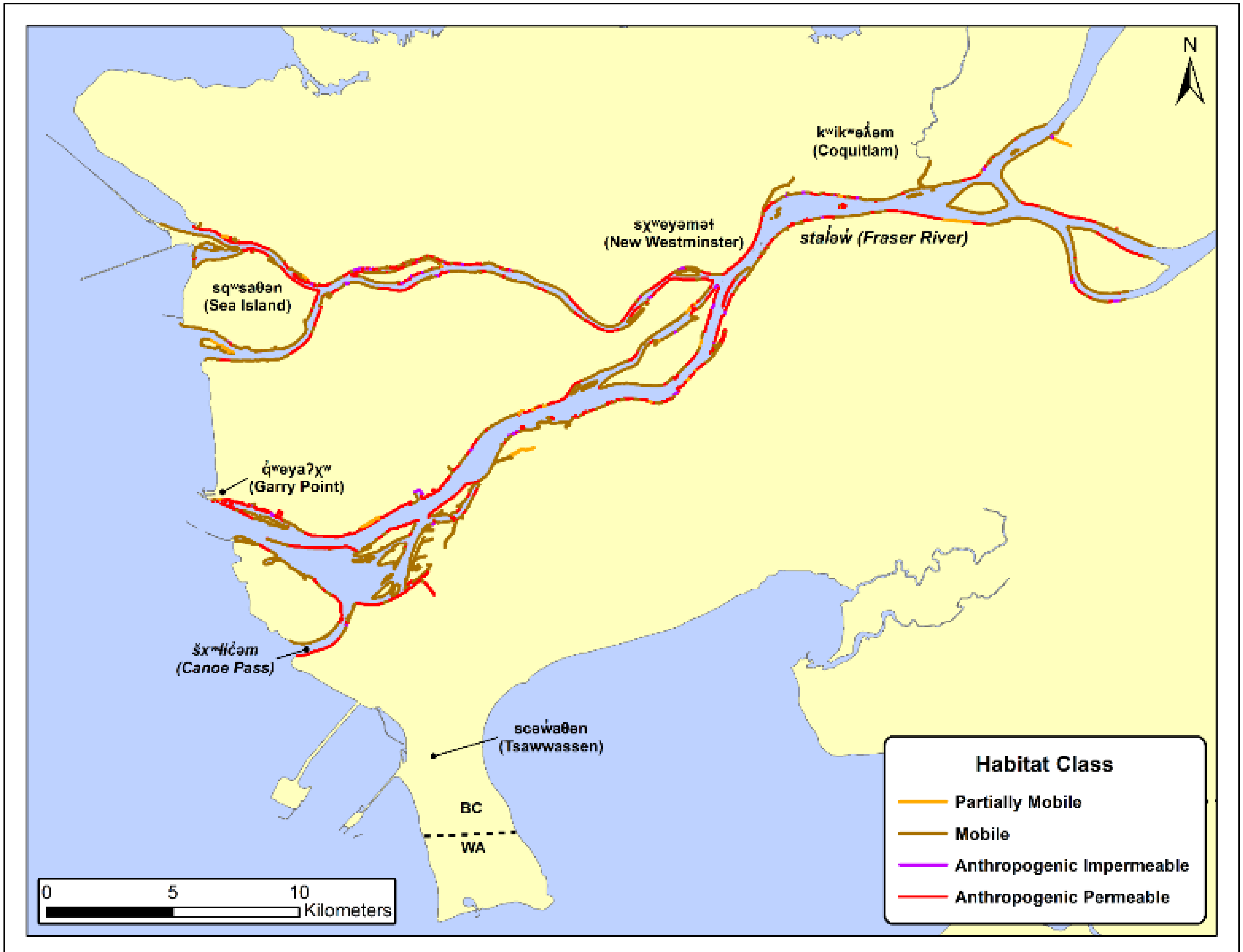

Figure 23. Distribution of grouped Habitat Class categories in the stal̓əw̓ (Fraser River) study area.

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5 ACKNOWLEDGMENTS

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Protocols for data access and distribution are established by the program partner agencies. Please see www.ShoreZone.org for a list of partner agencies and related web sites for the US ShoreZone. Video imagery can be viewed and digital stills downloaded online at www.ShoreZone.org and Coastal and Ocean Resources' ArcGIS site. Any hardcopies or published data sets utilizing ShoreZone products shall clearly indicate their source. For questions regarding the protocols or information in this report, please contact Sarah Cook, General Manager of Coastal and Ocean Resources at Sarah@coastalandoceans.com (250-658-4050). For data requests or analytical support contact Kalen Morrow at Kalen@coastalandoceans.com.

APPENDIX A

Photographic Examples of Coastal Classes and Biobands

Table A-1. Examples of the Coastal Classes in the stal̓əw̓ (Fraser River) area.

Photo bc19_fr_02371: Example of Coastal Class 24; Sand and gravel flat or fan.
Lulu Island.

Photo bc19_fr_02949: Example of Coastal Class 25; Sand and gravel beach.
stal̓əw̓ (Fraser River).

Photo bc19_fr_02993: Example of Coastal Class 28; Sand flat.
Essondale Islet.

Photo bc19_fr_00841: Example of Coastal Class 29; Mudflat.
sqʷsaθən (Sea Island).

Photo bc19_fr_00175: Example of Coastal Class 30; Sand beach.
stal̓əw̓ (Fraser River North Arm).

Photo bc19_fr_02817: Example of Coastal Class 31; Organics/Fines.
Middle Island, Sapperton Channel.

Photo bc19_fr_01053: Example of Coastal Class 32; Man-made, permeable.
Steveston Island.

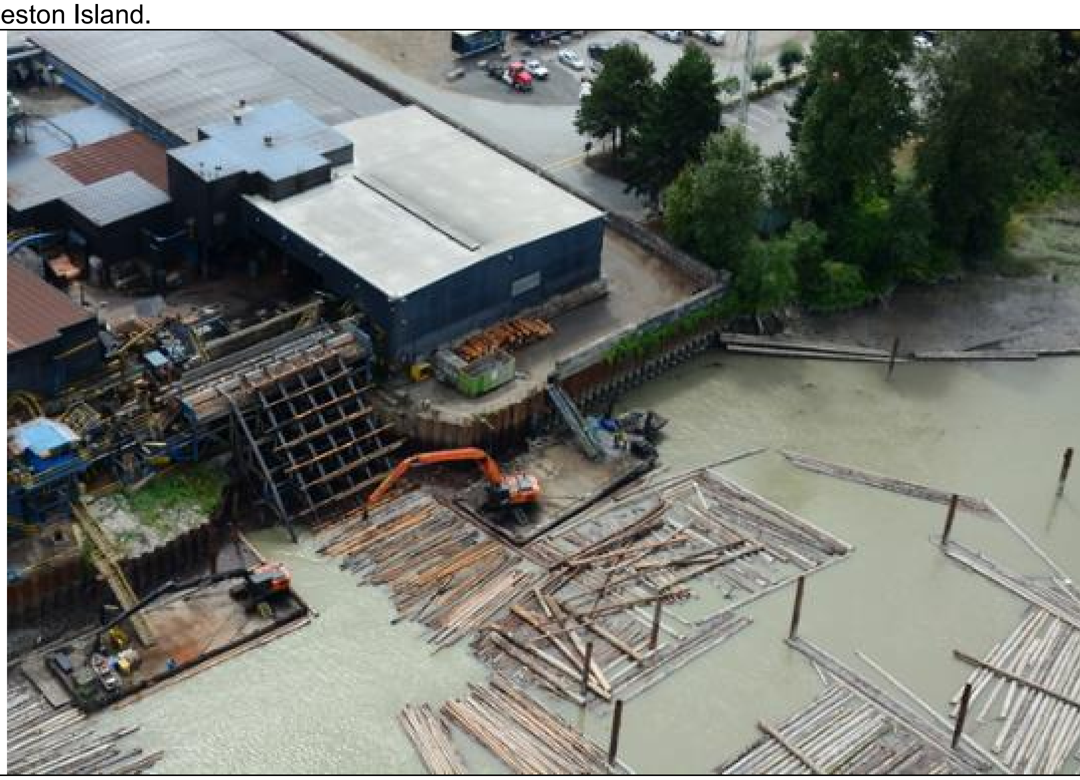

Photo bc19_fr_02178: Example of Coastal Class 33; Man-made, impermeable.
Annacis Channel.

Table A-2. Examples of the common biobands in the stal̓əw̓ (Fraser River) area.

Photo bc19_fr_00977: Good example of the Black Lichen (BLLI) bioband which is a black band in the supratidal zone, usually caused by the lichen *Verrucaria* sp. Steveston.

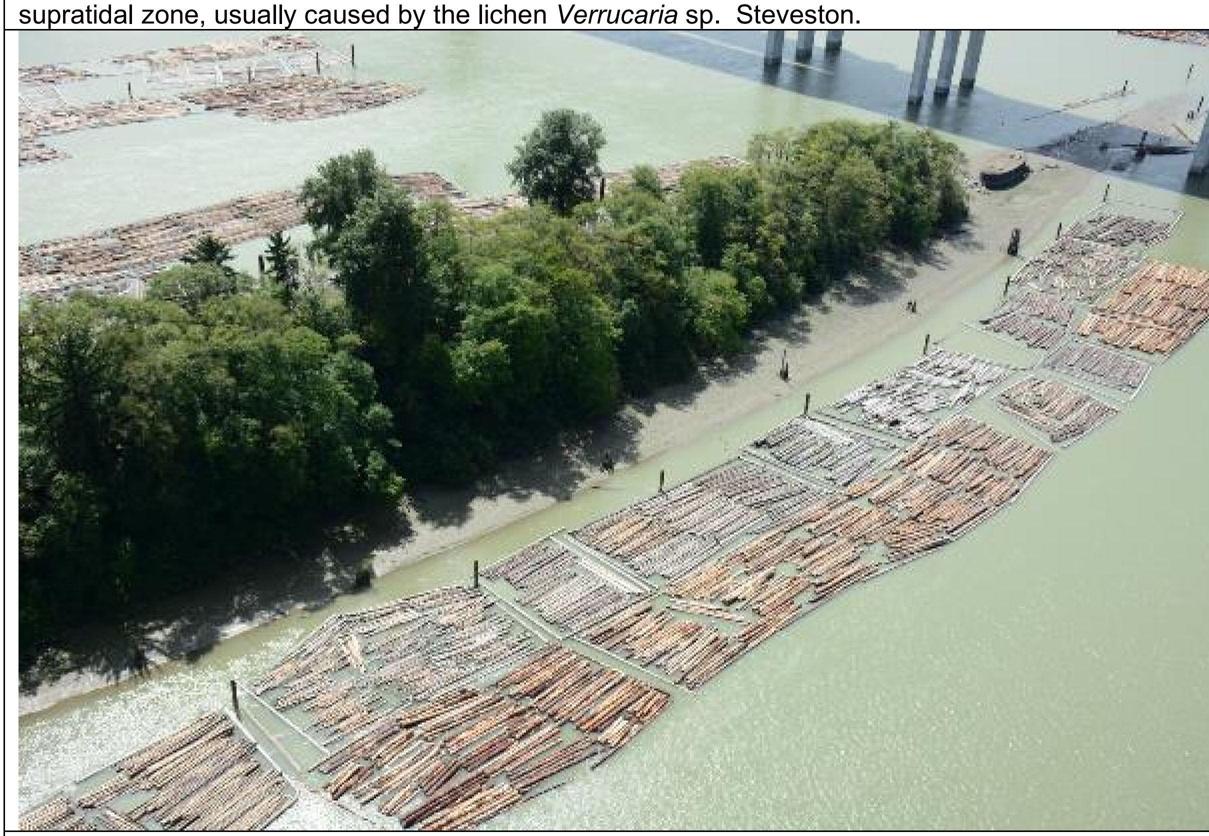

Photo bc19_fr_02978: Good example of the Trees and Shrubs (TRSH) bioband which is the community of trees with understory vegetation that occur in the supratidal. Tree Island.

Photo bc19_fr_02817: Good example of the Wetland Vegetation (WEVE) bioband which is a marsh bioband that is not able to be classed as a more specific marsh bioband, such as Salt Marsh. Purple Loosestrife and Pond Water-Starwort are also visible in this image. Sapperton Island.

Photo bc19_fr_00091: Good example of the Salt Marsh (SAMB) bioband. Point Grey Golf Course.

Photo bc19_fr_01054: Good example of the Green Algae (GRAL) bioband. Steveston Island.