

Burrard Inlet  
Environmental  
Action  
Program



Fraser River  
Estuary  
Management  
Program



## ROBERTS BANK AND STURGEON BANK REACH OVERVIEW PHASE 2

JULY 2010

# ACKNOWLEDGEMENTS

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## Appreciation

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# EXECUTIVE SUMMARY

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Roberts and Sturgeon Banks are situated within the Fraser River Estuary, a globally significant ecosystem. Established in 1985, the Fraser River Estuary Management Program (FREMP) is an inter-governmental partnership that coordinates planning and decision-making in the estuary. FREMP is guided by the Estuary Management Plan (EMP), "*A Living Working River*", which outlines a shared vision, goals and actions for improving the environmental, economic, and social health of the Fraser River estuary. The EMP contains a number of action programs to guide activities in the estuary, in the areas of environmental protection and human activities, one of which is the development of Reach Overviews for the estuary.

In 2009, FREMP completed Phase 1 of a reach overview for Roberts and Sturgeon Banks (RSBRO); it contains a compilation and synthesis of existing information on the physical, biological and human activities and processes (G.L. Williams & Associates Ltd., Northwest Hydraulic Consultants). The purpose of this report, Phase 2 of the RSBRO, is to provide an analysis of and recommendations for management of water, shoreline and upland issues that transcend individual municipal and agency boundaries.

The work involved the following tasks:

- Update and consolidation of the habitat classifications and mapping for the two banks,
- Identification of issues, considering changing conditions as a result of climate change and other emerging issues,
- Identification of recommendations for: management processes, ecosystem mapping and rating, scientific research, and guidelines for site management and use.

The primary tasks included: preparation of draft maps and recommendations in consultation with the Steering Committee, a workshop with stakeholders and estuary experts , and completion of this report in consultation with the Steering Committee.



Some of the high-level conclusions and recommendations are as follows:

- Ensure that management addresses regional cumulative environmental effects assessments, ongoing monitoring, and comprehensive consultation and communication with all government agencies and stakeholders.
- Conduct new comprehensive mapping, using a consistent approach for Roberts and Sturgeon Banks, including geological, oceanographic, biological, and chemical information, and variations based on tides and seasons, with methods that provide information on changes over time.
- Establish a process for identifying and selecting priority projects for habitat compensation, mitigation, and restoration. Criteria for selecting projects need to include a system-wide approach, set parameters, limits, multiple objectives, and consideration of all values, including social values.
- Conduct research to provide a better understanding of the estuary, and to establish a regional baseline for key indicators of change, working cooperatively among multiple organizations within the scientific community.
- Guidelines for site management and use for marine and upland environments and all potential land uses are provided.



# 1.0 INTRODUCTION

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## 1.1 Overview

Roberts and Sturgeon Banks are situated within the Fraser River Estuary, a globally significant ecosystem. The estuary's waters support millions of migrating salmon at early and adult stages of development while its marshes and bogs provide essential resting and feeding areas for migratory birds on the Pacific Flyway. The estuary is considered one of the most significant Important Bird Areas in Canada.

Established in 1985, the Fraser River Estuary Management Program (FREMP) is an inter-governmental partnership that coordinates planning and decision-making in the estuary. FREMP partners are: Environment Canada, Fisheries and Oceans Canada, BC Ministry of Environment, Metro Vancouver, Port Metro Vancouver and Transport Canada. The FREMP area is on the wetted side of the dyke, downstream from Kanaka Creek and Pitt Lake to the Strait of Georgia and includes Sturgeon Bank, Roberts Bank and Boundary Bay.

FREMP is guided by the Estuary Management Plan (EMP), "*A Living Working River*", which outlines a shared vision, goals and actions for improving the environmental, economic, and social health of the Fraser River estuary. The vision of *A Living Working River* is "to improve environmental quality in the Fraser River estuary while providing economic development opportunities and sustaining the quality of life in and around the estuary".

The goals of *A Living Working River* are:

1. Conserve and enhance the environmental quality of the estuary to sustain healthy fish, wildlife, plants and people.
2. Respect and further the estuary's role as the social, cultural, recreational and economic heart of the region.
3. Encourage human activities and economic development that protect and enhance the environmental quality of the estuary.



The EMP contains a number of action programs to guide activities in the estuary, in the areas of environmental protection and human activities. In 2003, the EMP was updated to include a new Integration Action Program with the objective to: “develop and implement a features and functions approach to management and decision-making in the estuary.” The task under this objective is to develop Reach Overviews for the estuary. An “ecological features and functions approach” or EFFA is an ecosystem-based, collaborative and flexible approach to management which includes estuary and upland features, while taking into account the biological, economic and social characteristics of the river.

The reach overview is a compilation of biophysical and socioeconomic information, acknowledging that natural and human uses are both occurring in the reach and that there are linkages among biological, physical and human processes.

## 1.2 Roberts and Sturgeon Banks Reach Overview – Phase 1

In 2009, FREMP completed a compilation and synthesis of existing information on the physical, biological and human activities and processes for Roberts and Sturgeon Banks (G.L. Williams & Associates Ltd., Northwest Hydraulic Consultants). The Reach Overview “provides a comprehensive and functional compilation of information that will lead to formulating management guidelines with the end goal of achieving more sustainable development.”

**Section 1 Introduction** provides the context for the report, introduces the ecological features and functions approach, and provides the ecological context for the reach, noting the dynamic estuarine conditions, extremely productive natural environment, and the importance of these ecosystems for salmon and for migratory and wintering birds.

**Section 2 Status, Trends and Research Needs** includes a description, research needs and potential impacts on the following habitat types: sandflat, mudflat, eelgrass, intertidal marsh, and backshore.

**Section 3 Overview of the Fraser River Estuary Environment** provides a brief summary of the landscape history and climate; a description of the physical processes including salinity, non-stationary processes in the Delta, changes in land elevation, eustatic changes, and extreme weather events; an overview of the biological context including vegetated habitats, fish, and birds; and an anthropogenic context review including a list of federal and provincial government agencies and their jurisdiction and mandate, legislation and management tools employed, and responsibilities in the study area; regional district role, plans, initiatives and responsibilities; municipal government, First Nations, corporate, and non-government organization initiatives and roles; important designations including Hemispheric Reserve by the Western Hemisphere Shorebirds Reserve Network, Important Bird Area designation by BirdLife International, Sturgeon Bank Wildlife Management Area designation by the B.C. Ministry of Environment, Proposed Roberts Bank Wildlife Management Area designation by the B.C. Ministry of Environment, RAMSAR Wetland of International Importance designation for Alaksen National Wildlife Area, and Highly Productivity Habitat (Red-coded) designation by the Fraser River Estuary Management Program (FREMP).



**Section 4 Dominant Habitat Types in the Roberts and Sturgeon Banks Ecosystems** describes sandflat, mudflat, eelgrass, intertidal marshes, and backshore, and for each ecosystem it provides information including characteristics (characteristic species, controlling factors, processes, functions, stresses, temporal variability) (see Appendix A), physical processes, biological processes, history of human activities, status, trends and research needs.

**Section 5 Summary** notes that the “Ecological Features and Functions Approach (EFA) descriptions are provided to assist FREMP and partner agencies to effectively coordinate the management of economic development whilst sustaining the ecological productivity of Roberts and Sturgeon Banks”. This is followed by the highlights of the habitat types, and keys to management, which include: understanding the interconnectivity of the habitat types, daily to long-term climatic and tectonic changes, growth pressures, invasive species, status of the southern resident killer whale population, impacts of rising Snow and Canada Geese populations, and the effects of climate change.

The Phase 1 report has provided a foundation for understanding how natural processes are affected by contemporary activities in the area and it is a first step towards understanding what should be considered with regards to future development in the reach. The Phase 1 report should be used as a source of background information for this report.

### 1.3 Purpose and Objectives

The intent of the Phase 2 report is to use the information in the Phase 1 report to take the next steps in analysis and management. The purpose of Phase 2 of the RSBRO is to provide an analysis of and recommendations for management of water, shoreline and upland issues that transcend individual municipal and agency boundaries. While there are plans in place for each jurisdiction, these plans cover different areas and interests. No mechanism exists to look at the water and shoreline interface in a more holistic way.

Some of the objectives of the Reach Overview Phase 2 are as follows:

- Update and confirm habitat classification and mapping,
- Identify areas of greater sensitivity or concern with respect to development (to be confirmed),
- Prepare consistent guidelines and management strategies for all projects, including mitigation and compensation,
- Identify research needs to improve knowledge about habitat features and functions,
- Analyze the critical areas and management strategies that consider changing conditions as a result of climate change and other emerging issues,
- Include consultation with affected stakeholders in the preparation of the management strategy,
- Provide a planning and decision-making process that integrates foreshore and upland activities, for use by municipal planners, federal, provincial and regional government staff, First Nations, developers, landowners, and members of the public,

- Help to support a stewardship initiative that brings the above organizations together to discuss issues and approaches.

The new information will be integrated into the existing FREMP area designation information, habitat inventory, and management/coordination responsibilities.

## 1.4 Planning Process

Phase 2 of the RSBRO is being guided by a Steering Committee of the key FREMP agencies and primary stakeholders in the study area, including Port Metro Vancouver and the Vancouver International Airport Authority. Catherine Berris Associates Inc. was contracted to undertake the work.

The primary tasks included:

- Preparation of a habitat classification map based on the Phase 1 data supplemented with additional information and the input of estuary experts,
- Exploration of potential methods for identifying areas of concern,
- Review of land use plans in terms of their potential impacts on the banks,
- Preparation of a draft set of planning and management strategies, and research needs,
- A workshop with stakeholders and estuary experts to review the draft maps, management strategies, and research needs (see Appendix B), and
- Preparation of a report in consultation with the Steering Committee.



## 2.0 HABITAT CLASSIFICATION AND MAPPING

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### 2.1 Purpose

The primary purpose of habitat classification is to identify and describe the habitat types that occur in the area. Along with this, a map based on current information is provided, however field verification of habitat types is not complete, and it is particularly lacking on Sturgeon Bank.

### 2.2 Habitat Types

Habitat types were initially mapped based on the Phase 1 report. In that report, the habitat classification for Roberts Bank is more detailed than the one for Sturgeon Bank. Table 1 shows a comparison of the classes in Phase 1 for the two banks.

Roberts Bank	Sturgeon Bank
Sand	Sand
Mud	Mud
Marsh	Marsh
High Marsh	
Low Marsh - Dense	
Low Marsh - Pioneer	
Biomat	
Eelgrass, Zj, Zm, Zmixed	
Deciduous Tree Woodland	Deciduous Tree Woodland
Coniferous Tree Woodland	Coniferous Tree Woodland
Mixed Tree Woodland	Mixed Tree Woodland
Low Shrub Woodland	Low Shrub Woodland
Tall Shrub Woodland	Tall Shrub Woodland
Meadow, vascular	Meadow, vascular
Meadow, non-vascular	Meadow, non-vascular
Macroalgae	Macroalgae
Rock	Rock
Tidal Flats - unclassified	

**Table 1: Comparison of Habitat Mapping for Roberts and Sturgeon Banks**

## 2.3 Habitat Classification Map

A first draft of a habitat classification map was prepared by replicating the maps in the Phase 1 report, combining some of the detailed classes for Roberts Bank to be consistent with the classes for Sturgeon Bank per Table 1. The project Steering Committee and stakeholders reviewed the draft map, and the following revisions were made:

- The study area was clarified as being north of the U.S. border, west of Highway 99, south of the centreline of the North Arm of the Fraser River, with the habitat mapping to exclude the causeways. Although the Lower Reaches of the Fraser River are not part of the RBSB study area, they are included for context and because they were mapped within the Phase 1 report.
- Several categories from the Phase 1 mapping appeared to be inconsistent with the overall classification scheme, including: “Tidal Flats – unclassified”, “Other”, “Macroalgae”, “Rock”; and there were some areas that were not classified. These areas were classified with the input of the Steering Committee using air photos and comparison with the mapping of adjacent classes.
- Mud with Biofilm was added to the map due to its global significance for the Western Sandpiper. A polygon on the original map was identified as this class with the assistance of Dr. Bob Elner and his associates at CWS.



**Western Sandpiper Prints and Biofilm**

- Killer whale habitat was added to the map as a graphic.
- Dikes were added to the map as a graphic.
- The term “backshore” was changed to “upland”. The mapping for this area does not have a specific boundary. It is currently based on previous mapping.
- The term “meadow” was changed to “farmland”.

The Habitat Classification Map illustrates the resulting map. Table 2 provides a summary of the extent of each habitat type. The amounts are recorded separately for the banks (Roberts and Sturgeon) and the lower reaches of the river.

<b>Roberts and Sturgeon Banks</b>		
<b>Habitat</b>	<b>Sum of Area (ha)</b>	<b>%</b>
Upland Habitat, Farmland	57.2	0.4
Upland Habitat, Woodland	19.7	0.1
Biomat	50.9	0.3
Eelgrass	1,773.1	11.8
Intertidal Marsh	1,161.3	7.7
Mud	3,032.4	20.2
Mud with Biofilm	119.7	0.8
Sand	8,788.4	58.6
<b>Total</b>	<b>15,002.7</b>	<b>100.0</b>

<b>Lower Reaches</b>		
<b>Habitat</b>	<b>Sum of Area (ha)</b>	<b>%</b>
Upland Habitat, Farmland	1,165.6	43.7
Upland Habitat, Woodland	555.0	20.8
Eelgrass	0.4	0.0
Intertidal Marsh	679.4	25.5
Mud	73.5	2.8
Sand	191.8	7.2
<b>Total</b>	<b>2,665.6</b>	<b>100.0</b>

**Table 2: Habitat Extent**

## 2.4 Habitat Description

Table 3 provides a summary of the key information on habitats from the Phase 1 report, modified to add Mud with Biofilm and Biomat as habitats.



**Biomat**

## 2.5 Habitat Evaluation

An effort was made to rate the relative significance of the habitat types. Various criteria such as ecological significance, productivity, species diversity, uniqueness, fragility, and climate change sensitivity were identified and rated individually. The overall environmental value was determined based on the individual ratings.

Some members of the Steering Committee were concerned that this rating system was too subjective, and that ratings could easily change based on the perceived importance of different species, e.g., birds vs. fish. A decision was made to exclude the habitat evaluation from the draft report.

Habitat evaluation is problematic because subjective evaluations can lead to challenges. Another concern is that once an area has been labeled as slightly less important than another, it can become a target for development. Given that there is still a significant amount of scientific information required, a precautionary approach is warranted.



Habitat Type (from lower to higher elevation)	Sand (intertidal)	Mud (intertidal)	Biomat	Mud with Biofilm (intertidal)	Eelgrass, Zj, Zm, Zmixed	Intertidal Marsh (general)	Backshore Habitat, Woodland	Backshore Habitat, Meadow
Description	unvegetated, intertidal and shallow tidal areas with medium to fine sand substrates occurring along the outer delta below mean water level	unvegetated intertidal areas with fine sand and silt-sized substrates occurring from the middle to upper tidal zone	unvegetated intertidal areas with fine sand and silt-sized substrates in a formation of crusty ridges with channels between	intertidal areas with fine sediment and silt-sized substrates, characterized by the presence of a rich microbial surficial mat (biofilm)	marine and higher brackish vegetated communities occurring in sandy or muddy intertidal and shallow subtidal areas	productive marine and brackish vegetated habitats occurring along most of the foreshore of the banks from 3.2 to 4.8 (higher high water)	tree and shrub woodland in riparian areas above high tide that provide feeding areas for birds and other wildlife, perching for birds	upland grassland, herbaceous, and agriculture areas above high tide that provide feeding areas for birds and other wildlife
Productivity	reduced invertebrate productivity	moderate productivity - invertebrates, fish and waterbirds at high and low tides, detritus-based food web	high productivity - invertebrates, fish and waterbirds at high and low tides, detritus-based food web	very high productivity - invertebrates and a primary food source for shorebirds; biofilm captures the detritus and moves it back into the food web	high productivity - invertebrates, fish and waterbirds at high and low tides, detritus-based food web	high productivity - important feeding and cover areas for fish and waterbirds; maintain the detritus-based food web	high productivity - support birds and wildlife that use the intertidal habitats	moderately high productivity - important for birds that use the intertidal habitats
Stability	low - reworking of sands with waves	moderate, but very sensitive to change	moderately high, but very sensitive to change	moderate, but very sensitive to change	moderate	high, except for Brunswick Point (eroding)	very stable	very stable
Flora and Fauna	patchy distributions of benthic diatoms and infauna exposed for birds at low tide; water with fish, feeding birds, and marine mammals at high tide	diverse flora and fauna at certain times, including benthic microalgal communities and macrophytes	diverse flora and fauna at certain times, including benthic microalgal communities and macrophytes	diverse and abundant flora and fauna, including biofilm, bacteria, benthic microalgal communities and meiofaunal epifauna in and on a mucilaginous matrix	Zostera marina (native) extends from -3 to 1.5 m; Zostera japonica (introduced) extends from 1.4 to 3.5 m	salt marsh is dominated by pickleweed and saltgrass, brackish marsh is dominated by bulrush and sedge; important foraging, resting and staging area for birds	forest, riparian areas (including shrubland), support birds and wildlife	meadow, wetlands, and agricultural crops, especially grains and potatoes, together support nesting, roosting and feeding for birds
Key Processes	sandflats reduce wave energy, protect inner habitats; salinity is variable and constantly changing	less exposed to waves, above water 50% of time, inundated with marine and freshwater inputs	less exposed to waves, above water more than 50% of time, inundated with marine and freshwater inputs	less exposed to waves, above water 50% of time, inundated with marine and freshwater inputs	dense beds dampen wave energy, promote sediment accretion, alter drainage patterns, and enhance nutrient entrapment and processing	thick vegetation offers good protection to shoreline, surface erosion is rare; marshes process and export nutrients to surrounding habitats	the small amount of backshore woodland in the study area is most susceptible to sea level rise	the low elevation of meadow in the study area make it susceptible to sea level rise
Trends	proposed developments - port, YVR runway, Iona outfall twinning, ferry expansion (Iona), periodic sand dredging from navigation channel	jetties and causeways have reduced overall energy and diverted sediments away; colonization by invasive cordgrass (Spartina anglica) is spreading, outcompeting native species	human activities within the biomat (heavy machinery tracks) are causing impacts	causeways have reduced overall area of avifaunal grazing quality biofilm and remaining biofilm threatened by sea level rise and changes in currents from coastal installations	eelgrass coverage has expanded greatly, mainly Zj at higher elevations; causeways may be a factor in the expansion; subsequent reduction due to dendritic channels and sand lobes	heavy grazing pressure from geese, promoting erosion and tidal channels; colonization by invasive cordgrass	fragmentation from dykes, agriculture and urban development	biggest issue is the loss of farmland due to its importance for birds
Research Needs	measure sediment accretion and deposition rates, measure subsidence, effects of longshore transport interruption, study effects of major developments on impacts such as drainage patterns/ dendritic channel formation and potential mitigation	role in the intertidal continuum; study effects of major developments on drainage patterns/ dendritic channel formation and potential mitigation	role in the intertidal continuum; study effects of major developments on drainage patterns/ dendritic channel formation and potential mitigation	ecologically-based studies on geochemicals, nutrient cycling, biofilm dynamics, role in the intertidal continuum; study effects of major developments on drainage patterns/ dendritic channel formation and potential mitigation	Study eelgrass in Fraser River estuary, e.g., nature of epiphyte communities on eelgrass, why on Roberts and not Sturgeon Bank, impacts of Zostera japonica on native habitats	study impacts of geese grazing on erosion and tidal channels, research on chemical control of cordgrass, map marsh communities and composition to identify and changes from various potential factors (p. 7)	study the use of backshore habitats by waterfowl and passerines to better understand connectiveness between upland and intertidal habitats, e.g., impacts of raptors, people	study the use of backshore habitats by waterfowl and passerines to better understand connectiveness between upland and intertidal habitats, e.g., impacts of raptors, people
Restoration Needs		program for removal of invasive cordgrass and Battalaria (snail)		program for removal of invasive cordgrass and Battalaria (snail)		program for removal of invasive cordgrass		
Management Needs				map the biofilm, consider biofilm in environmental assessments, determine how to create biofilm habitat			maintain riparian woodland due to its scarcity and importance as an edge	maintain traditional farmland for the benefit of waterfowl, educate people to avoid approaching flocks

Table 3: Information on Habitat Types

## 3.0 MANAGEMENT STRATEGIES

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### 3.1 Issues

In order to provide focus for the development of management strategies, the issues related to management of the banks were identified. These are outlined below for specific topics:

#### ***Management Processes***

- Jurisdictions are complex, with multiple agencies responsible for management review, decision making, and stewardship of the area; proponents are unable to work with a single agency (see map Jurisdictions).
- The division in jurisdictions is particularly acute between those managing upland vs. marine areas.
- The various government and private organizations have mandates that sometimes conflict.
- Public awareness of the importance of the banks is lacking.
- Methods for determining environmental value are relative, and ratings are based on limited current knowledge.
- Project-specific review and adaptive management is local in scale and reactive. Given the lack of information on rates of change in the area due to climate change and other processes, there is a very poor baseline upon which to base adaptive management strategies. Existing FREMP ratings are primarily driven by the *Fisheries Act*, and they do not consider other species.
- FREMP management designations are linear along the shoreline; they are not applicable to this broad study area, of which the entire shoreline is “red”. The habitat on the banks is all sensitive and requires a polygonal approach to mapping and management due to the large distance between the high and low tide levels.
- A process to screen out projects that don’t belong here is lacking.

#### ***Demands and Impacts***

- There are inherent conflicts and tensions between existing and proposed human activities / development projects and ecologically sensitive areas / environmental functions. For example, both Richmond and Delta have designations in their OCPs that could lead to new development applications along the adjacent shoreline (see Zoning / OCP maps). Major projects may also occur on and near the banks (see map Areas of Potential Impact).
- Past development and human activities have had significant impacts on habitats and species on the banks.
- The existing uses are given; proposed uses are expansions of existing uses, and they need to expand within a limited geographic area.

- Cumulative impacts are not adequately addressed in environmental assessments.



### ***Scientific Information***

- From a geological perspective, the broad tidal flats are indicative of an ongoing process of transgression, i.e., a rise in relative sea level (due to a combined effect of actual sea level rise and subsidence of the delta), leading to landward migration of the shoreline. When the delta stopped building out into the strait around 5000 years ago, there were likely very limited areas of tidal flats and the shoreline would have been close to the present edge of the flats. Since then there has been a gradual receding of the shoreline to its present position. That process may seem slow at human time scales, but it represents a long term trend that will be accelerated by more rapid sea level rise due to climate change. The rate of change is unknown.
- Having fixed the shoreline in place with protection structures (dikes) in most locations, the process of transgression becomes “coastal squeeze”. Because the shoreline can no longer migrate landwards as in a natural transgression, the bathymetric profile will gradually deepen and because most of the habitats are depth dependent, they will be squeezed out against the fixed shoreline.
- Data is lacking in some locations, e.g., data is minimal for Sturgeon Banks.
- Data is lacking in some new emerging fields, e.g., data lacking on biofilm includes: more understanding of the dynamics of biofilm production and consumption by shorebirds, and the dynamics of sediment-stabilizing substances produced mainly by benthic diatoms; extent of biofilm grazing by other shorebird species in relation to the broader scale distribution of suitable biofilm.
- There is not enough information to confidently identify the “most” critical areas. There is a lack of consensus among professionals and agencies on relative habitat values.
- Habitats and their values change over time. These time periods range from diurnal (high / low tide), to seasonal, to several years (responses to development), to multiple years (subsidence, sea level rise).

## 3.2 Proposed Management Processes

The following are proposed management processes based on the draft report and input from the stakeholder workshop:

- Ensure that management addresses regional cumulative environmental effects assessments (for Roberts Bank and Sturgeon Bank), beyond project-specific assessments. The first need for adaptive management is a regional baseline for key indicators for change, e.g. morphologic change, sedimentation rate. To accomplish this, a broad network of monitoring is required, and specific criteria are needed for compensation and follow-up monitoring evaluations.
- Prepare an evaluation framework adopted by all agencies that addresses cumulative as well as site-specific impacts.
- Continue to implement a harmonized BCEA/CEA assessment and an adaptive management strategy for major projects, as undertaken by the Port for Deltaport 3rd Berth. This involves 8 years of study, including: baseline, monitoring, mitigation and compensation of observed impacts. Ensure that the harmonized process includes communications with local government. Increase the planning and monitoring time frame, e.g., to 100 years.
- Consider the effects of climate change on proposed structures. Clarify the process for project review on the banks, ensuring that there is a group review process in which shared objectives are the basis for considering projects. Define a bottom line with respect to shared objectives, a point at which a “no go” is envisioned.
- Ensure that all levels of government and relevant agencies work closely together on project evaluation and decision-making. Prepare a reach “checklist” that helps to direct projects to an appropriate process based on the habitat values and potential impacts. Include the following in the checklist:
  - Respect for environmental designations, e.g., bird designations, wildlife management areas, RAMSAR.
  - Respect for adjacent land uses, e.g., erosion risk, potential liability issues for property owners.
- Provide compensation/mitigation/restoration priorities to proponents so they can contribute to high priority needs. Ensure that proponents can get “credit” for research and compensation initiatives, even when they may be undertaken prior to the actual project. Review and implement agency policies that permit “habitat banking” in advance of potential impacts.
- Improve tools for communication with other agencies in an effort to achieve FREMP partner involvement early in potential development processes. This information should include: environmental sensitivities, scientific data known and not known, etc.
- Improve tools for communication with the public regarding FREMP and the values and sensitivity of the banks.
- Encourage and conduct extensive education of all stakeholders, including: the public, property owners, industry, local government staff and elected officials.
- Ensure that proper permits for industrial or commercial activities or facilities are obtained from the municipality and that Port processes are followed within the Port jurisdiction.

- Encourage and support the update, completion and implementation of the Wildlife Management Areas (WMAs) for Sturgeon Bank and Roberts Bank.
- Centralize all data and information for Roberts and Sturgeon Banks so there is “institutional memory” and easy access to past studies.
- Strengthen Development Permit for waterfront in Delta (Richmond’s is already fairly stringent).
- Encourage Richmond to complete and implement its ESA map.
- Pursue funding for mapping, monitoring, restoration and research projects.

### 3.3 Proposed Ecosystem Mapping and Rating

The following are proposed research recommendations based on the draft report and input from the stakeholder workshop:

- Conduct new mapping of existing ecosystems, using a consistent approach for Roberts and Sturgeon Banks.
- Establish a defined limit to the mapping on the upland.
- Consider the use of a 4- layer mapping system (NRCAN) which is a more comprehensive approach, with layers potentially including: geological – substrate; oceanographic – energy; biological – fish and wildlife; chemical – nutrients, etc. Include information on the extent and density of intertidal plant species, locations and relative density of biofilm and eelgrass, and variations based on tides and seasons.
- Map marine mammal habitat in the area, including killer whales, porpoises, and grey whales.
- Conduct the mapping so that it considers diurnal and seasonal variations.
- Prepare a system for ongoing mapping in order to obtain information on changes over longer periods of time.
- Explore a system for understanding the relative values of the various ecosystems. The system should be: well-defined, based on measurable criteria, transparent, capable of incorporating new information, and inclusive of the values of all stakeholders.

### 3.4 Proposed Mitigation, Compensation and Restoration

The following are proposed mitigation, compensation and restoration recommendations based on the draft report and input from the stakeholder workshop:

- Establish a process for identifying and selecting priority projects for habitat compensation, mitigation, and restoration. Criteria for selecting projects need to include a system-wide approach, set parameters, limits, multiple objectives, and consideration of all values, including social values.
- Consider the entire system as a whole with respect to assessment of resources, cumulative effects, mitigation, remediation and compensation, e.g., since birds pose risk issues at YVR, consider bird habitat improvements farther south.

- Identify candidate compensation projects in the area, such as:
  - create marshes (if possible, perhaps using dredgeate, however this method has not been confirmed as viable),
  - provide rip-rap protection along Steveston North Jetty,
  - increase Backshore Woodland with a series of tree planted dykes and shaded sloughs,
  - use fertilizers to increase density/biomass of existing bulrush especially at Westham Island,
  - study the sensitivity of different species to disturbances, and determine needs for setbacks,
  - improve habitat for Snow Geese in Roberts Bank area,
  - removal of invasive cordgrass and Battalaria (snail), which occur mostly in mud and intertidal marsh habitats,
  - enhance cover crop program on Westham Island,
  - purchase farmland on Westham Island and manage it for both farming and birds.
- Identify candidate restoration projects in the area, such as:
  - return sediment supply to foreshore marshes and mudflats,
  - construct sloughs potentially with planting on banks,
  - protect eelgrass between causeways,
  - implement management prescriptions to minimize negative impacts, e.g., people and dogs.
- Establish a structure for encouraging and supporting mitigation, compensation, restoration and research (see section 1.5 for options).

#### *Mud with Biofilm*

- Consider biofilm in environmental assessments, and ensure that its importance and sensitivity to physical and biotic changes are understood. Determine how to create biofilm habitat since it is susceptible to being reduced with climate change; potential may exist to place dredgeate in certain locations to achieve this (see note above).

#### *Backshore Woodland*

- Ensure that Brunswick Point is protected from erosion, e.g., with shoreline stabilization, as it is a “land hinge” for the entire system, protecting the biofilm and backshore meadow areas.
- Maintain riparian woodland due to its scarcity and importance as an edge.

#### *Backshore Meadow*

- Work with farmers to maintain traditional farmland for the benefit of waterfowl.
- Purchase more of this land to protect values for waterfowl.
- Educate people to avoid approaching flocks.



### 3.5 Proposed Scientific Research

The following are proposed research recommendations based on the draft report and input from the stakeholder workshop:

- Establish a regional baseline for key indicators of change that include and define the natural rates of change (see section 3.3). The most simple and measurable indicators would be morphologic change – bathymetry and sedimentation rate. Since these will not be uniform across the region, a broad network of monitoring should be established. If this could be achieved, each project could be considered within this baseline context. Morphologic monitoring could be conducted through regular bathymetric surveys (every 1 to 5 years) using new observation technologies, e.g., University of Victoria's Ocean Networks Canada VENUS project which could involve monitoring stations on the tidal flats using other communication and power systems, e.g., cell phone communications, solar power and the Data Management and Archiving System (DMAS) that allows real time posting of quality controlled data.
- Conduct research to provide a better understanding of the physical and biological conditions, including:
  - changes to habitats and environmental functions over time and the implications for planning and management, e.g., fish data bases > 20 years, long-term temperature data ,
  - information on what types of habitats can be restored/compensated to create usable functioning habitat, e.g., creation of salt marshes, biofilm, eelgrass, etc.
  - effects of climate change,
  - effects of non-native mollusks on ecosystem,
  - more comprehensive data on more species of migratory birds,
  - impacts of pesticide use, e.g., sample for pesticide residues, compare to MoE/CCME guidelines, determine if more appropriate agricultural practices are required.,
  - the effects of human activities, e.g., people, dogs, on birds, including bird behaviour and energy budgets.
  - continue to assess bulrush loss due to geese.
  - determine the historical and current effects of training walls and jetties on water and nutrient flow patterns, and sediment deposition rates in marsh and mudflat areas.

#### *Sand*

- Measure sediment accretion and deposition rates, and measure subsidence over time.
- Identify the effects of longshore transport interruption, and the effects of major developments on impacts such as drainage patterns/ dendritic channel formation, and identify potential mitigation strategies.

#### *Mud and Biomat*

- Study the effects of major developments on drainage patterns/ dendritic channel formation, and identify potential mitigation strategies.

#### *Mud with Biofilm*

- Continue research on biofilm dynamics and its role in the intertidal continuum, including: more understanding of the dynamics of biofilm production and consumption by shorebirds, and the dynamics of sediment-stabilizing substances produced mainly by benthic diatoms; extent of biofilm grazing by other shorebird species in relation to the broader scale distribution of suitable biofilm.

#### *Eelgrass*

- Study the nature of epiphyte communities on eelgrass, why there is eelgrass on Roberts and not Sturgeon Bank, and the impacts of *Zostera japonica* on native habitats.

#### *Intertidal Marsh*

- Study the impacts of geese grazing on erosion and tidal channels, and conduct research on chemical control of cordgrass.

#### *Backshore Woodland and Meadow*

- Study the use of backshore habitats by waterfowl and passerines to better understand the connectivity between upland and intertidal habitats, e.g., impacts of raptors, people.
- Collect information on the shoreline of Brunswick Point. Some scientists believe it is eroding and others expect it may be accreting, with some localized erosion, possibly related to geese grazing. If information is not available, conduct research with empirical measurements of any changes to the shoreline.

### **3.6 Guidelines for Site Management and Use**

The following are guidelines for the management and use of upland and marine areas to support fish and wildlife (especially bird) functions:

#### ***Shoreline and Upland***

##### *All Uses*

1. Preserve habitat features to maintain fish and wildlife functions; waterfowl and shorebird nesting, roosting and feeding (trees, shrubs); leaf and insect input; wildlife feeding and refuge cover. Compensate and mitigate for unavoidable impacts through the establishment or enhancement of other habitats in the vicinity of similar functions.
2. Preserve and protect riparian vegetation to the degree possible, including trees and overhang for fish cover and feeding, shrubs and grasses.
3. Design facilities to minimize building or surface footprints.
4. Maintain large tree stands to avoid fragmenting bird habitat.

5. Use replanting or complexing of existing stands to enlarge habitat in lieu of preserving isolated habitat.
6. Retain dead trees for snags.
7. Encourage property to refer to the Fisheries and Oceans Canada *The Dock Primer* (Prairies Edition), the *Living by Water Guidebook* ([livingbywater.ca](http://livingbywater.ca)), Green Shores Program at [www.greenshores.ca](http://www.greenshores.ca), Ministry of Environment's *Best Management Practices for Lakeshore Stabilization* for additional foreshore development guidelines.
8. Control invasive species, e.g., purple loosestrife, knotweed, Scotch broom.
9. Encourage pet management (e.g. dogs on leash) to avoid disturbing fish and wildlife functions, especially during sensitive periods such as bird nesting, animal rearing of young, etc.
10. Manage the impacts of geese on bulrush and other vegetation.

#### *Recreation Uses*

1. Minimize trail impacts on trees by avoiding significant trees and vegetation, use of permeable surfacing, minimal width to retain maximum riparian buffer, siting to avoid sensitive habitat, and confining access to reduce impacts.
2. Site waterfront lookouts on trails and in parks to minimize impacts on riparian and intertidal habitat.
3. Locate recreation paths around perimeter of stands or on dykes to minimize disturbance to birds and wildlife.
4. Follow appropriate Best Management Practices for recreational uses, planning and management.

#### *Residential Uses*

1. Ensure that shoreline stabilization structures for extending lawns or gardens or providing space for additions to existing structures or new outbuildings are prohibited.
2. Where stabilization works are required, encourage property owners to use the 'softest' stabilization measures (e.g., including or using vegetation) that will satisfy stabilization needs.
3. Ensure that stabilization works and measures must be located within the property line of the waterfront parcel, above the natural boundary of the shoreline. Soft shoreline measures that provide restoration of previously damaged ecological functions may be permitted waterward of the natural boundary.

#### *Commercial, Industrial and Agricultural Uses*

1. Maintenance activities should be acknowledged as a necessary component of shoreline management, e.g., the installation of riprap for bank protection, and these should be done in a way that incorporates habitat functions.
2. Prevent encroachment of industrial or port operations on riparian and intertidal habitat by fencing, barriers, hedges, or material containment.

3. Manage stormwater according to Ministry of Environment regulations (e.g., discharge permit on industrial sites) and institute best management practices such as filter berms, containment ponds, and effective on-site drainage. Resources for stormwater management include websites like [www.gvrd.bc.ca/sewerage/stormwater\\_reports.htm](http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm) and [www.waterbalance.ca](http://www.waterbalance.ca).
4. Identify opportunities to design and construct water access in disturbed or lower quality habitats associated with developed sites so that bird and wildlife impacts can be minimized.
5. Contain aggregate products; build fences or pens to prevent spillage onto foreshore areas.
6. Use best management practices in agricultural operations, e.g., waste management, reduction of fertilizers and pesticides, sensitive habitat protection, winter crops - see the Delta Greenfields project, stormwater management, etc.
7. Encourage the development and implementation of voluntary Environmental Farm Plans. For more information see [http://www.bcac.bc.ca/efp\\_programs.htm](http://www.bcac.bc.ca/efp_programs.htm).

## ***Marine***

### *All Uses*

1. Preserve habitat features to maintain fish and wildlife functions; fish feeding (marshes); waterfowl and shorebird nesting, roosting and feeding (trees, shrubs); leaf and insect input; wildlife feeding and refuge cover. Compensate for unavoidable impacts through the establishment or enhancement of other habitats in the vicinity of similar functions.
2. Design facilities to minimize structure or surface footprints, even for elevated structures such as docks.
3. Preserve intertidal areas, including sandflats, mudflats and marsh, to the degree possible.
4. For mitigation, consider complexing marsh habitat, e.g., tidal channels, planting, large woody debris, to improve fish access and utilization.

### *Recreation Uses*

1. Minimize impacts to intertidal marshes, for example by minimizing width or designing trails, boardwalks and lookouts to eliminate shading impacts.
2. Manage the speed of recreational watercraft to minimize impacts on habitat (e.g., wake from boats may lead log booms to ground on shoreline habitat), and on wildlife particularly during breeding, spawning, nesting and rearing periods.
3. Encourage boating Best Management Practices including through the distribution and use of the "Guide to Green Boating" available at <http://www.georgiastrait.org/CleanBoating/guidep1.php>.

### *Commercial and Industrial Uses*

1. Ensure dredging and in-stream works do not impact intertidal mudflat habitat values.
2. Any dredging activities should follow FREMP Dredge Management Guidelines and the appropriate Fisheries and Oceans and Port guidelines (e.g. timing windows). For further information, see the FREMP Toolbox at <http://www.bieapfremf.org/fremf/projectreview/toolbox.html>.

3. Ensure compliance with FREMP Log Management Guidelines; this includes ensuring that log storage does not impact riparian or intertidal marsh habitat. See <http://www.bieapfremf.org/toolbox/pdfs/logstorage99.pdf> for information.



## APPENDIX A: PROCESSES AND FUNCTIONS

Following are tables that provide a summary of the processes and functions for the habitats described in the Phase 1 report:

Processes	Sand	Mud	Eelgrass	Intertidal Marsh	Backshore
Primary Production	✓	✓	✓	✓	✓
Carbon Sequestration	✓	✓	✓	✓	✓
Food Web Support	✓	✓	✓	✓	✓
Refuge			✓	✓	✓
Reproduction			✓	✓	✓
Element Cycling	✓	✓	✓	✓	✓
Organic Matter Export			✓	✓	✓
Filtration of Contaminants and Nutrients			✓	✓	✓
Successional Development	✓	✓	✓	✓	✓
Sediment Supply and Trapping	✓	✓	✓	✓	
Tidal Drainage Delay			✓		
Subsidence	✓				
Algae Mat Growth and Die Off		✓			
Wave and Current Energy Dampening			✓	✓	
Upland Erosion Control					✓
Water Storage					✓



Functions	Sand	Mud	Eelgrass	Intertidal Marsh	Backshore
Water Quality Maintenance	✓	✓	✓	✓	✓
Invertebrate Production	✓	✓	✓	✓	✓
Salmonid Production	✓	✓	✓	✓	✓
Other Fish Production	✓	✓	✓	✓	✓
Avifauna Production	✓	✓	✓	✓	✓
Wildlife Production	✓	✓	✓	✓	✓
Aesthetics and Recreation			✓	✓	✓
Flood Attenuation	✓	✓	✓	✓	✓
Erosion Prevention	✓	✓	✓	✓	✓
Storm Surge Protection	✓	✓	✓	✓	✓
Wave Dampening and Energy Dissipation	✓	✓			
Biodiversity Maintenance	✓	✓	✓	✓	✓
Food Production					✓

## APPENDIX B: WORKSHOP RESULTS

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A draft of this report was presented to stakeholders and estuary experts at a workshop on June 8, 2010. The format included a brief presentation of the draft report, followed by two sets of workshops on three topics:

1. Habitat Mapping, Classification and Values,
2. Compensation/Mitigation/Restoration and Research, and
3. Management Processes.

Approximately 35 participants each attended interactive workshop discussions on two of the topics. The following is a high-level summary of the input from the workshops. A more detailed tabulation of input is available from FREMP.

### ***Habitat Mapping, Classification and Values***

- Habitat mapping is useful, e.g., for understanding trends, calculating production, footprints, etc.
- The habitat mapping for this area is old and comprised of a variety of data. New habitat mapping using a comprehensive, well-defined approach is required.
- We know very little about Sturgeon Bank, especially compared to Roberts Bank; it requires habitat mapping and study.
- The one-layer approach to habitat mapping is too simplistic, there is a trend towards 4- layer maps (NRCAN) which is a more comprehensive approach. The layers are: geological – substrate; oceanographic – energy; biological – fish and wildlife; chemical – nutrients, etc.
- Rating of habitats is controversial. Some participants feel it is important and helpful, and there was some support for using the subjective approach as a good interim solution, considering it better than nothing. Others support a rating scheme that is: well-defined, based on measurable criteria, transparent, capable of incorporating new information, and inclusive of the values of stakeholders. Some expressed support for a cumulative ranking system.
- Habitat mapping and rating needs to have a way to consider and account for climate change.
- “Backshore” may be better defined as “upland”. The limit of mapping on the upland is confusing.
- “Farmland” is not “meadow”, as it is currently mapped.

### ***Compensation/Mitigation/Restoration and Research***

- A process is required for identifying and selecting candidate and priority projects for habitat compensation, mitigation, and restoration, some of which could be implemented as part of a habitat compensation “bank”. Criteria for selecting projects need to include a system-wide approach, set parameters, limits, multiple objectives, and consideration of all values, including social values. Some key potential projects are:
  - Increase Backshore Woodland with a series of tree planted dykes and shaded sloughs,
  - Marsh development along SNJ using dredge spoil,

- Study the sensitivity of different species to disturbances, including the needs for setbacks.
- Research is required to provide a better understanding of Fraser River freshwater/sea water interface and nutrient deposition, since this is a main driver of processes on the banks. Information is also needed on:
  - Changes to habitats and environmental functions over time and the implications for planning and management, e.g., fish data bases > 20 years, long-term temperature data ,
  - Information on what types of habitats can be restored/compensated to create usable functioning habitat, e.g., creation of salt marshes, biofilm, eelgrass, etc.,
  - Effects of climate change,
  - Impacts of pesticide use, e.g., sample for pesticide residues, compare to MoE/CCME guidelines.
- A significant amount of discussion focused on the structure for encouraging and supporting mitigation, compensation, restoration and research. Some ideas include:
  - Work through farmers and existing programs, e.g., Delta Farmers and Wildlife Trust, Ducks Unlimited,
  - A broader, formal Roberts Bank and Sturgeon Bank Mitigation, Compensation, and Restoration Initiative, including a research component,
  - An overall scientific committee for the estuary,
  - NSERC CRD (collaborating, research, development) with industrial partners, aimed at linking scientists and interested parties ,
  - Environment Canada policy on habitat banking ,
  - Encouraging more collaboration among government, YVR, universities (including graduate students), etc.,
  - Provide FREMP with a role in conveying research objectives, results and needs,
  - Develop working groups that can identify options and recommendations.

### ***Management Processes***

- Management must address regional cumulative environmental effects assessments (for Roberts Bank and Sturgeon Bank), beyond project-specific assessments. The first need for adaptive management is a regional baseline for key indicators for change, e.g. morphologic change, sedimentation rate. To accomplish this, a broad network of monitoring is required, and specific criteria are needed for compensation and follow-up monitoring evaluations.
- Define a bottom line with respect to shared objectives, a point at which a “no go” is envisioned.
- Define the process for major project reviews to suggest the type of review, e.g., independent panel vs. comprehensive study depending on the overall importance of the habitat.
- Ensure that environmental designations are respected, e.g., bird designations, wildlife management areas, RAMSAR.
- Provide compensation/mitigation/restoration priorities to proponents so they can contribute to high priority needs.
- Consider adjacent land uses in review processes, e.g., erosion risk, potential liability issues for property owners.
- Consider the effects of climate change on proposed structures.

- Expand the coordinated review process for efficiency when dealing with safety issues, e.g., trees on airport land.
- Centralize all data and information for Roberts and Sturgeon Banks so there is “institutional memory” and easy access to past studies.
- Increase the planning and monitoring time frame, e.g., to 100 years.
- The following specific ideas were provided for monitoring:
  - CWS based project officer dedicated to area, can use the Alaksen CWS site (among others) for observations,
  - Academic partnership opportunities.
- Finalize WMAs for Roberts and Sturgeon Banks.
- Environmental Farm Plans are already developed, money and resources are needed for implementation of best management practices.
- Richmond needs to complete and implement its ESA mapping.
- Public education is required.

# BIBLIOGRAPHY

Elnor, Robert W., Beninger, Peter G., Jackson, Daniel L., and Potter, Tracy M. "Evidence of a new feeding mode in western sandpiper (*Calidris mauri*) and dunlin (*Calidris alpina*) based on bill and tongue morphology and understructure". *Marine Biology* 2005: 1223 – 1234.

Kuwae, Tomohiro, Beninger, Peter G., Decottingnies, Priscilla, Mathot, Kimberly J., Lund, Dieta R., and Elnor, Robert W. "Biofilm grazing in a higher vertebrate: The western sandpiper, *Calidris Mauri*". *Ecology* 2008: 599 – 606.

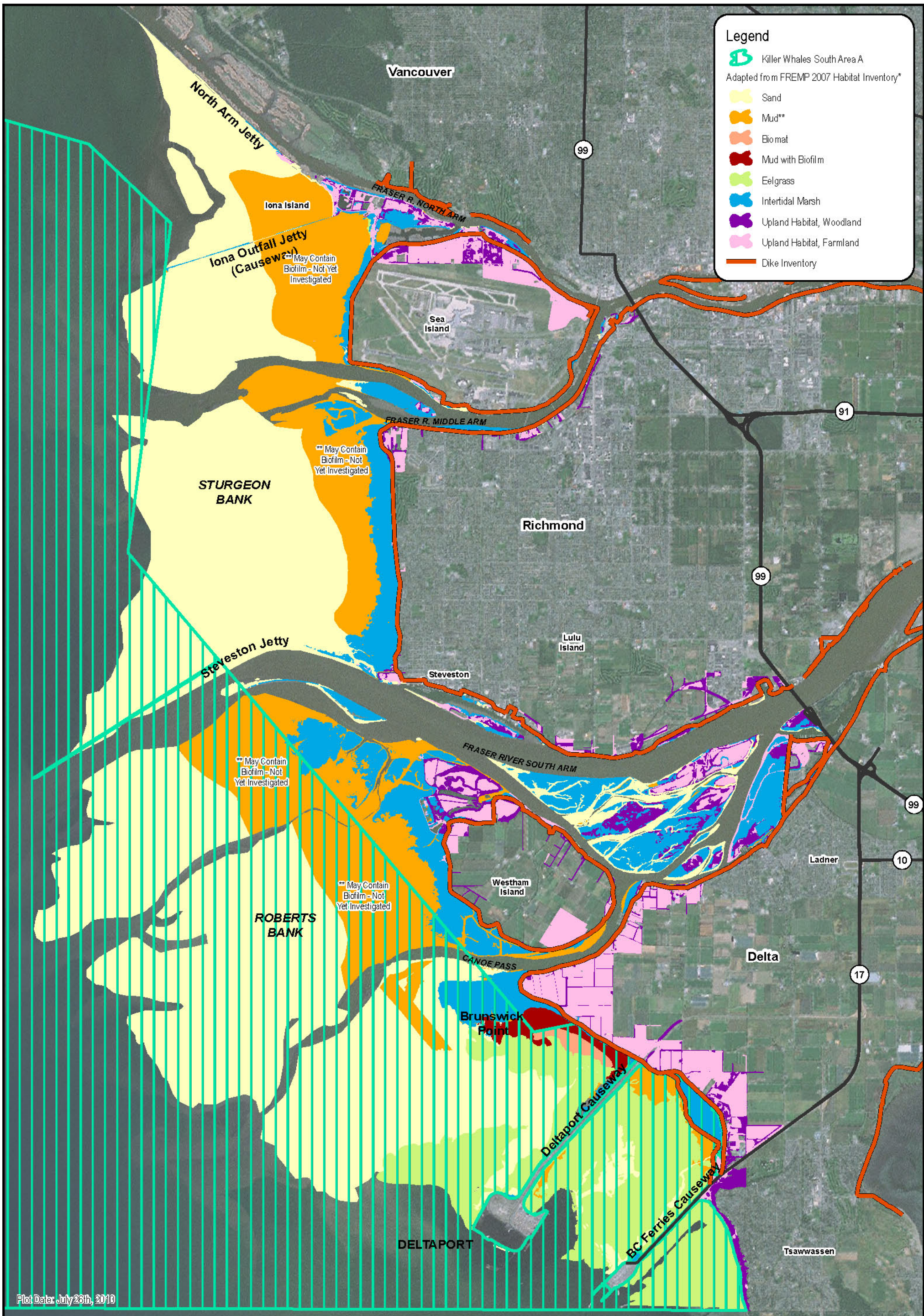
Mathot, Kimberly J., Smith, Barry D., and Elnor, Robert W. "Latitudinal clines in food distribution correlate with differential migration in the western sandpiper". *Ecology* 2007: 781 - 791.

Northwest Hydraulic Consultants, GL Williams & Associates Ltd. *Roberts Bank and Sturgeon Bank Reach Overview*". Burnaby, British Columbia: Fraser River Estuary Management Program, 2009.

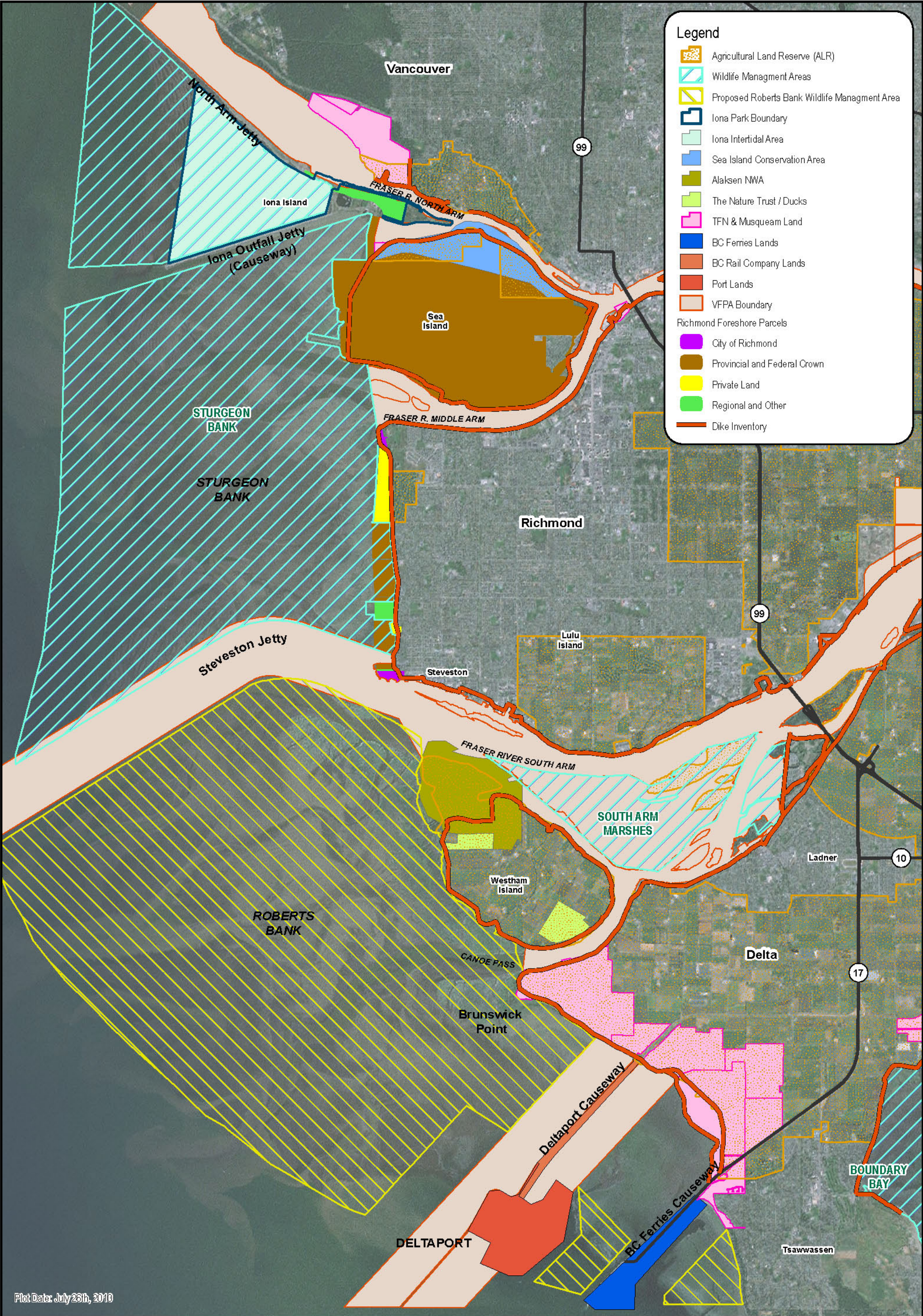
Sutherland, T. F., Shepherd, P.C.F., and Elnor, R. W. "Predation on meiofaunal and macrofaunal invertebrates by western sandpipers (*Calidris mauri*): evidence for dual foraging modes". *Marine Biology* 2000: 983 – 994.

Vancouver Airport Authority. *YVR: Your Airport 2007, 20 – Year Master Plan*. Richmond, British Columbia: Airport Postal Outlet, 2007.









Plot Date: July 23th, 2010





Plot Date: July 23rd, 2010

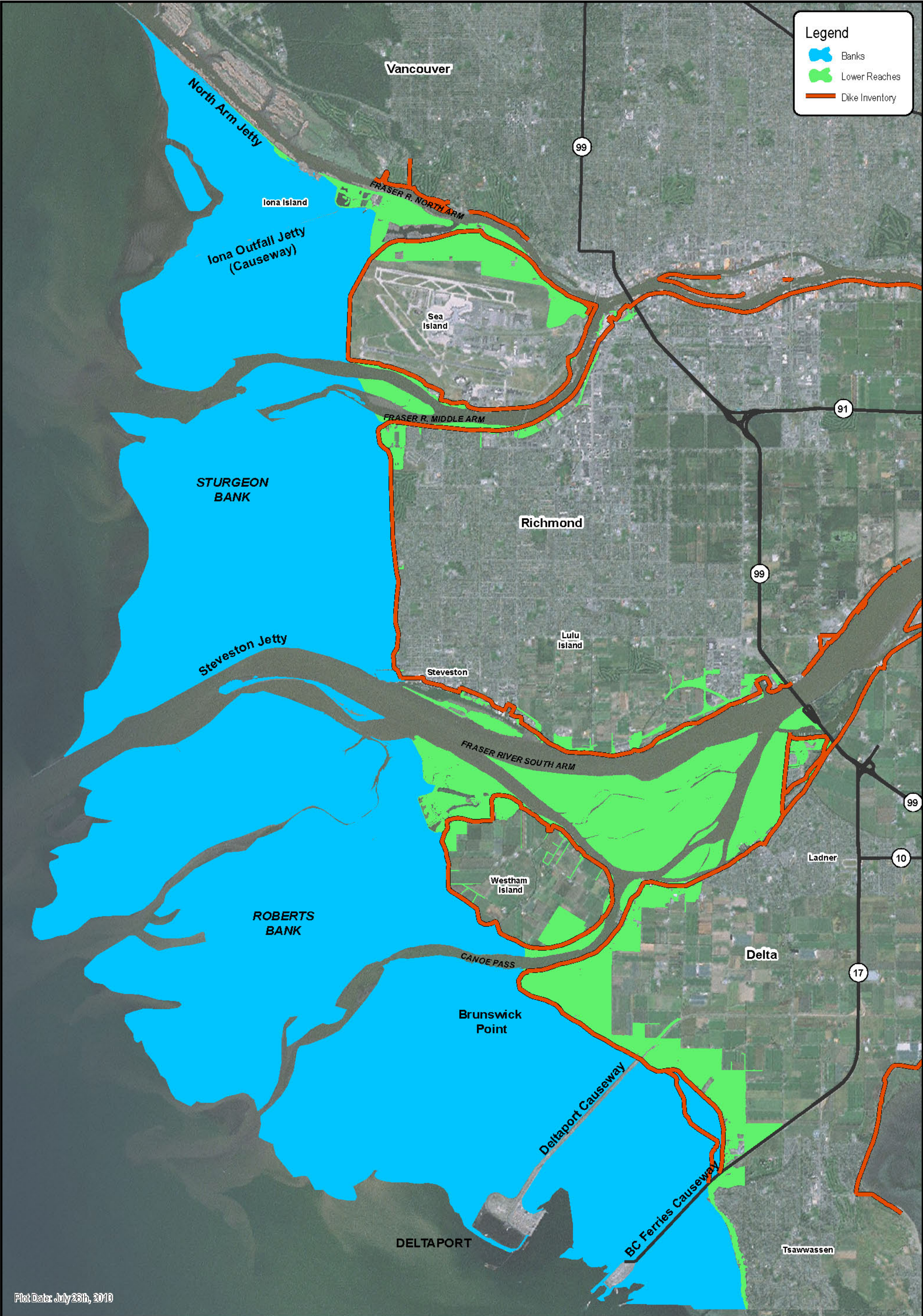


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## Roberts Bank & Sturgeon Bank Reach Overview Phase 2

Areas of Potential Impact





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