



NANAIMO ESTUARY MANAGEMENT PLAN

CATHERINE BERRIS ASSOCIATES INC.

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Canada 



ACKNOWLEDGEMENTS

Steering Committee

Department of Fisheries and Oceans: Scott Northrup, Chair
Snuneymuxw First Nation: Kathleen Johnnie, (2002 - 2004), Andrew McNaughton (2005)
Environment Canada: Ken Brock, Andrew Robinson, Alice Cheung
Land and Water B.C. Inc.: Ron Creber (until 2004)
Ministry of Environment – Judy Davis (until 2004), Drew Chapman (2005)
Nanaimo Port Authority: Mike Davidson
Regional District of Nanaimo: Pam Shaw

Interest Group Participants in Steering Committee Meetings

Nanaimo River Estuary Log Storage Association: Bob Colclough
Tim Clermont, The Nature Trust of B.C.
Nanaimo Community Estuary Support Coalition: Geoff Robins and Carey McAllister (2004-2005), previously Tony Dorling, Guy Monty, Jack Whitlam

Consultants

Catherine Berris Associates Inc., Prime Consultant, Planning and Facilitation

Catherine Berris, Principal in Charge
Bill Gushue, GIS Analysis and Mapping

R.U. Kistriz Consultants Ltd., Aquatic Biology

Ron Kistriz, Primary Aquatic Biologist
Dana Haggarty, Assistant Aquatic Biologist (self employed)

Gebauer & Associates Ltd., Terrestrial Biology

Martin Gebauer, Terrestrial Biologist

Coastal and Ocean Resources Inc., Oceanography

Dr. John Harper, Marine Geologist, Project Advisor

Snuneymuxw First Nation Technical Support

Andrew McNaughton, Shellfish Project Coordinator
Kelly Poulin, GIS Coordinator

Photographs

Andrew McNaughton, Tim Clermont, Scott Northrup and other Steering Committee members and consultants

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[Note: Base maps were prepared in 2002. Industry names have changed since then, as noted in the report.]

EXECUTIVE SUMMARY

Background



The Nanaimo River estuary is the largest estuary on Vancouver Island and is a very significant regional feature. It is also a highly productive biological system, particularly in terms of the intertidal plant life, fish, shellfish, and bird species supported. The first known inhabitants were the Snuneymuxw First Nation (SFN or Snuneymuxw), to whom the Nanaimo River estuary is still an important spiritual and traditional use area. The estuary is also surrounded by the rapidly growing population of the Nanaimo area. The estuary is used extensively for log storage as well as recreation. Over the next few decades, the challenge will be to restore the productivity and diversity of this ecosystem with consideration for social and economic benefits to the community.

Prior to this Nanaimo Estuary Management Plan (NEMP), various studies had been undertaken within the Nanaimo estuary, but no integrated process to consider all resources and involve all interests had occurred. Triggered by the impending expiration of a head lease from the Province to the Nanaimo Port Authority, a number of organizations came together to initiate preparation of an overall management plan for the Nanaimo Estuary that would encompass all human activities and uses. The planning process began in February 2002. It was conducted by an interdisciplinary team of consultants guided by a multi-interest Steering Committee (SC). The planning process involved many SC meetings, communication through the media and a Web site, and two public sessions.

Scientifically, the Nanaimo River Estuary covers a large marine area, with its influence extending into Departure Bay and surrounding channels. However, given the time constraints of the project, the SC decided to focus on the immediate estuary first, and to save the larger area for a later phase of work.

Plan Framework

The following plan framework was developed in collaboration with the SC, with input from the public.

Cooperation as the Core

The central focus of the plan reflects the desire for all governments, including the SFN, to work cooperatively together, with input from key interest groups, on a management regime within the estuary.



Vision



The following is the vision for the study area. It is written in the present tense since it describes how it is hoped the estuary will be perceived in the future.

The Nanaimo River estuary, the largest estuary on Vancouver Island, has rich resources that include salmon, shellfish, intertidal vegetation and significant bird populations. The estuary is also the site of human activities including cultural, traditional, industrial, residential, agricultural and recreational uses that benefit the community as a whole.

Purpose

The purpose of planning and management is to restore the productivity and diversity of the natural resources in the estuary with consideration for social and economic returns and benefits to the community as a whole. The plan will provide a balanced approach to the future management and use of the Nanaimo River estuary, recognizing that it is one of the greatest natural assets in the region.

The plan will guide human activity including sustainable resource development, recreational use and habitat management in the Nanaimo River estuary, and lay a framework for ongoing co-ordinated management giving high priority to the health of the estuary and its living resources.

Planning Process Objectives

The objectives of the planning process were to:

1. evaluate the condition of the resources of the estuary and how they have been affected by past activities;
2. establish short and long-term guidelines for human activities in and upstream of the estuary that will prevent or mitigate negative impacts of human development and/or activities on water quality and aquatic and terrestrial ecosystems;
3. define a monitoring program to evaluate ongoing impacts, and recommendations for restoring degraded habitat and protecting existing functional habitat; and
4. establish an implementation plan for management of the estuary in the future, including responsibilities for monitoring.

The objectives of the plan itself are contained in other sections of this document.



Principles

The following principles guided the planning process:

1. recognize current and historical biophysical characteristics of the estuary;
2. recognize the short and long-term socio-economic needs of the community as they relate to land and water use decisions;
3. recognize the cultural and heritage values of the plan area; and
4. develop the plan through an open process involving the public and all stakeholders in the estuary management plan area.

Plan and Summary Format

The following is the format of this document and summary:

Section 1 of the document provides the background and framework of the plan,

Sections 2, 3 and 4 of the document discuss the three main topic areas: fish and wildlife habitat, water quantity and quality, and human activities. Within each of these sections, background information, issues and opportunities, objectives and proposed management strategies are provided. This summary provides a brief version of the objectives and management strategies only.

Sections 4, 5 and 6 of the document present the designation plan, the monitoring plan, and the implementation plan. A brief summary of the recommendations in each section is included here.

Fish and Wildlife Habitat

Objectives

- Reduce and eventually stop the degradation of existing habitats.
- Maintain and improve where possible the existing habitat base.
- Maintain a diversity of productive habitats.
- Increase fish and wildlife populations towards historical levels.

Management Strategies

- Protect the most important rearing areas for juvenile salmon.
- Protect and improve the habitats that provide food sources for fish, birds and other species.





- Explore and promote estuary restoration and habitat enhancement projects.
- Review crab harvesting and establish a plan that will ensure that the crab population is sustainable.
- Encourage the development and implementation of a dog management plan for the estuary.
- For any new proposals that could cause significant impacts on fish and wildlife and their habitat, share information, meet, and provide collective comments as part of the environmental assessment process.
- Investigate current practices and impacts and develop best management practices related to debris collection at mill sites and disposal of the debris material at sea.
- Reduce the impacts of log storage on existing habitat.
- Investigate the potential environmental benefits of removing the gravel bar near the mouth of the Nanaimo River.
- Compile existing species inventory data, and support future inventories.
- Encourage and support interest groups who may want involvement in stewardship activities within the estuary.
- Develop a public education program (e.g. signage, brochure, news articles, school programs) regarding habitat significance, sensitivity, and protection measures.

Water Quantity and Quality

Objectives

- Support initiatives to maintain sufficient water quantity from the Nanaimo River and other watercourses to sustain fish and wildlife populations and habitat, with current flows as a minimum.
- Support initiatives to improve the water quality in the estuary and contributing watercourses for the benefit of fish, shellfish, and human health and safety.



Management Strategies

- Collaborate as required to ensure the continued monitoring of water flows and water uses.
- Continue to implement pulse flows to encourage access by Coho and Chinook to the upper river reaches.
- Expand the water quality sampling program.

- Use bacterial source tracking and other methods to investigate the sources of fecal coliform bacteria.
- Improve the water quality to meet the depuration standard for shellfish production in the short term, and the approved standard for shellfish production in the longer term.
- Work towards the identification and management of pollution sources within the watershed.
- Encourage the City of Nanaimo and the Regional District of Nanaimo to implement their Stormwater Management Policies throughout the watershed.
- Work towards the identification and management of pollution sources in the marine environment.
- Develop a public education program to promote water conservation and to minimize water quality impacts from upstream agricultural, urban and industrial sources.
- Work with landowners in the watershed on the management of activities that could affect water quality and quantity.

Human Activities

Objectives

- Protect and restore the resources of the estuary while providing opportunities for public recreational use that is compatible with fish and wildlife conservation.
- Minimize the impacts of log storage and handling on the environmental, recreational, economic and cultural resources of the estuary.
- Work to ensure that new development respects and protects the natural resources of the estuary in addition to supporting appropriate economic objectives.
- Balance needs to support water-dependent industrial use with needs for habitat protection.

Management Strategies

- Continue work to return estuarine cultural artifacts to the SFN.
- Take appropriate measures to protect cultural sites and to support cultural activities.
- Reduce the impacts of log storage on existing habitat. Management strategies that will be important are related to monitoring of log handling, log storage, log movements, and previous log storage





- sites; site restoration, and exploration of alternative log storage facilities and practices.
- Work with the City of Nanaimo in investigating opportunities for public access around the estuary in keeping with the objectives of this plan.
 - Maintain or improve ecosystem functioning and ecological integrity in the riparian zone adjacent to the estuary.
 - Assist enforcement agencies in fulfilling their mandate of providing enforcement of regulations in the estuary.
 - Support the provision of more personnel dedicated to monitoring and enforcement within the estuary, including SFN initiatives.
 - Increase stewardship of the estuary¹.
 - Work with Malaspina University College and MOE to increase the efficiency of monitoring through the Resource Management Officer Technology program.
 - Develop a standardized method for collecting information on recreation and other human use of the estuary.
 - Collaborate with SFN, the City, and MOE to support safe hunting practices within the estuary, potentially including reconfiguration of the designated hunting area, and respecting the size of the existing hunting area.
 - Designate Oak Island as a sensitive habitat area, with no unauthorized access.
 - Provide an interpretive kiosk near the parking lot with information on the resources of the estuary and regulations.
 - Prohibit collecting of rare or threatened plant species, other than SFN harvesting and authorized scientific collections.

¹ Stewardship is defined as activities involved in caring for the land and associated resources, e.g., habitat enhancement projects.

Designation Plan

A designation plan (see Map 11) for the estuary has been developed using the following designation categories.



	Description	Objectives
C _E	Conservation – native eelgrass beds, highly sensitive	Protect the integrity of the eelgrass beds.
C _S	Conservation - shellfish reserve – gravel/cobble reef, sensitive area due to high density of shellfish and extensive use by birds	Protect the environmental integrity of the reef habitat. Provide opportunities for shellfish harvest (possibly including aquaculture) as a secondary priority, if water quality standards can be met.
C ₁	Conservation – sensitive river channel, tidal channels, marshes and mudflats	Protect the habitat values of the river channel, tidal channels, marshes and mudflats.
C ₂	Conservation – less sensitive, large gravel bars, unstable, adjacent to and within river channel	Recognize the instability of the gravel bars and their importance to river processes.
R	Recreation, main area – includes parking lot, trails, viewing platform, interpretive signage	Provide opportunities for wildlife viewing and associated low-impact recreational activities.
L ₁	Log storage area – sand flats, least sensitive	Provide opportunities for log storage in these areas with less environmental sensitivity.
L ₂	Log storage area – mudflats, moderately sensitive	Provide opportunities for log storage as a second priority in these areas with moderate environmental sensitivity.
L ₃	Log storage area – eelgrass beds and tidal channels, highly sensitive	Protect the eelgrass beds and tidal channels from the impacts of log storage.
S	Shellfish reserve – sand/gravel flat	Provide opportunities for shellfish harvest (possibly including aquaculture) as a high priority, if water quality standards can be met. Protect environmental integrity.
I	Industry – loading and transportation areas related to mills and port	Support the needs of adjacent industry.

Monitoring Plan



The monitoring plan provides a framework and guidelines for a comprehensive and integrated biophysical monitoring program. The overall goal of the monitoring program is to assess the long-term health and integrity of the Nanaimo Estuary, impacts of human activities, and the success of habitat restoration and enhancement initiatives.

The proposed monitoring program is based on the following principles:

- Monitoring objectives are clearly stated and include measurable indices against which to measure change.
- A thorough baseline of existing conditions is provided.
- Key biophysical components and functions of the estuarine ecosystem are represented in the monitoring plan.
- The plan has a good spatial as well as temporal coverage of the estuarine habitats and the ecological processes.
- Partnerships are developed with existing government and non-government organizations that are involved in estuarine/marine monitoring efforts.
- Periodic workshops are organized to help establish and strengthen coordinated estuarine monitoring partnerships that include the Nanaimo Estuary.
- A panel of local and regional estuarine experts develop specific monitoring protocols, establish priorities, evaluate results, provide quality controls, and generally guide the direction of the monitoring program.
- The estuarine performance indicators selected for the monitoring plan are based on specific standards or criteria to which results can be compared.
- Monitoring includes measures related to recreation and industrial use.
- The monitoring program includes searching out the causes related to the monitoring results.
- The monitoring program is linked to an adaptive management plan so that recommendations based on the results of the monitoring work can be acted upon.
- The results of monitoring are made available to the public.

The monitoring plan provides goals, objectives and other criteria required for measurement of performance indicators related to the primary resources and uses within the estuary.

Implementation Plan



The agencies involved in preparing the plan and the City of Nanaimo are committed to working together to ensure that the plan is implemented in accordance with each member's existing jurisdiction, legislation, regulations, policies, procedures and bylaws. Implementation of the NEMP will not require any new jurisdictions or bylaws. The Nanaimo Estuary Management Committee (NEMC) will appoint their own Chair for a time interval determined by them. The NEMC will hire a Coordinator.

The role of the NEMC will include working together on the following responsibilities:

- Forge partnerships among the agencies to facilitate implementation of the NEMP,
- Agree to proceed using consensus-based decision-making principles without limiting the authority of any decision-making party,
- Oversee the monitoring component of the NEMP,
- Provide information to each other on proposed projects within the plan area and provide the NEMC the opportunity to comment,
- Coordinate activities within the estuary which are not under the jurisdiction of any agency,
- Make best efforts to financially support joint funding for NEMP coordination, monitoring, research and planning activities,
- Review the plan at least every 5 years, and update as required, and
- Work to integrate, to the greatest extent possible, the NEMP with other plans and policies.

1.0 BACKGROUND AND PLAN FRAMEWORK

1.1 The Study Area

This section provides a brief overview of the natural resources, human use, jurisdiction over use, and ownership within the study area. More detail on the natural resources is located in sections 2.0 and 3.0; more information on human use is described in section 4.0.

Natural Resources



The Nanaimo River estuary is the largest estuary on Vancouver Island and is a very significant regional feature. The major watersheds of the Nanaimo and Chase Rivers, plus the drainages of Wexford, Beck, Holden and York Creeks together drain an area of approximately 84,000 ha. The lower 12 kilometres of the Nanaimo River and its estuary lie within the Nanaimo Lowland, a relatively low area along the east coast of Vancouver Island underlain by sedimentary rocks comprised mainly of conglomerate, sandstones and shales (see Map 1).

The Nanaimo estuary area has a wide variety of oceanographic conditions related in part to a fairly complex shoreline and topographic configuration. The rivers and streams introduce a considerable amount of fresh water into Nanaimo Harbour from fall to spring. However, when the Fraser River is in freshet during May and June, fresh water can move into the Nanaimo area from the Strait of Georgia. Surface waters in the harbour are strongly influenced by winds, while the deeper waters have a significant tidal component. Wave action in the inner part of the estuary is limited by the protection of the islands and points, but northwesterly winds can affect the outer delta of the Nanaimo River. In general, the rate of flushing increases towards the north.

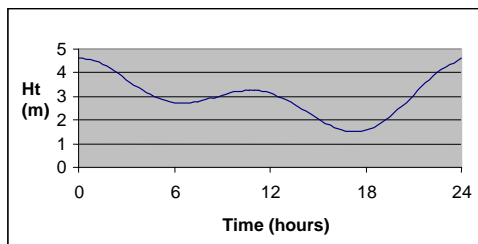


Figure 1: Typical Daily Tidal Curve in Nanaimo

Tides in the Nanaimo River Estuary are mixed and mainly diurnal, with two high and two low tides of different heights in a tidal day of about 25 hours. Tidal rise and fall corresponds to those in Georgia Strait. Currents in the estuary are mainly derived from winds and to some extent tides, but river runoff contributes little to circulation patterns except during peak run-off. At times, during large tidal amplitudes, currents from tides, particularly the ebb, can be quite strong.

Benthic invertebrates are a key link in the salmon-supporting, detritus-based food web of the Nanaimo estuary. Dungeness crab populations near Jack Point support fisheries, but bivalve shellfish harvesting has been closed since 1949 due to coliform contamination. Five species of Pacific salmon and two species of migratory trout historically occurred in

the estuary. The estuarine and near-shore environments are important in supporting the residency of juveniles. The Nanaimo estuary is also utilized by juvenile herring.

The estuary supports riparian, marsh and intertidal floral communities. Eelgrass beds occur over a large area in subtidal zone, extending up into the intertidal area. The upland vegetation, where recently undisturbed, is characteristic of the Coastal Douglas-fir moist maritime biogeoclimatic subzone.

The Nanaimo estuary, in conjunction with surrounding areas, is used by thousands of over-wintering birds. The estuary is critical to waterfowl survival during severe winter weather, and is part of the larger complex of estuaries that are vital feeding, resting and marshalling areas for migrating birds of the Pacific flyway. More than 200 bird species have been observed within the estuary, of which 18 are blue-listed and 15 are red-listed. Deer and other smaller mammals are also supported by the estuary.

Human Use



The first known human inhabitants of the area were the coast Salish Nation, who named the area Snuneymuxw. In 1850, they occupied several villages on Nanaimo Harbour and the Nanaimo River, and their population is roughly estimated to have been 3,000 to 5,000. The Nanaimo River estuary has always been an important spiritual and traditional use area to the Snuneymuxw First Nation (SFN or Snuneymuxw). Elders in the community refer to it as their “bread basket”.

The Hudson’s Bay Company established a base in Nanaimo in the mid 1850s to develop the Nanaimo coalfields. With the depletion of the coal resources in the 1950s, the economy of the area became dependent on the forest industry, forest products manufacturing, and tertiary industries. A small amount of farming still occurs in the watershed, limited by the availability of arable land.



Nanaimo has become a major service centre for Vancouver Island in keeping with its early role as a gathering place. The population of the City of Nanaimo was around 77,000 in 2001. It is projected to increase to almost 100,000 by 2015. The population of the Nanaimo Regional District was 128,000 in 2001. The SFN population is also rising. It was around 1,360 in 2001, with about 470 members living on reserve.

The port and the forest products industry are the principal industrial users of the study area. The estuary is used extensively for log storage as well as recreation, with a variety of other activities occurring to a lesser degree. The population growth of Nanaimo will likely place additional pressures on the estuary, as the increasing numbers of

people look to the estuary for recreation and a relatively natural sanctuary.

Jurisdiction over Use

A number of jurisdictions manage land and water use in and around the estuary. The City of Nanaimo's Official Community Plan (OCP) provides designations for land use within city boundaries (see Map 2). It designates a Waterfront use along the shoreline near the urban area, and calls for a combination of residential, park/open space, commercial and industrial uses in other locations.

The Snuneymuxw First Nation (SFN) has four of its six reserves sited around the estuary. They are currently working on a community plan to identify their plans for the future.

The Regional District of Nanaimo (RDN) includes land within the Nanaimo River mouth area and the upper watershed. The OCP designations from the regional plan are indicated on Map 2 outside of city boundaries.

The Nanaimo Port Authority is responsible for management of federal submerged lands, and manages port activities within the Nanaimo Harbour. They have prepared a Port Master Plan that designates uses within the estuary. The plan generally follows existing use. The log storage area (at the time the plan was prepared) is designated Port Transportation, and the remainder of the inter-tidal area in the estuary is designated Environmental Protection/Recreational. The Ministry of Transportation is responsible for head leases at major ports.

The Ministry of Agriculture and Lands (MAL) is the primary provincial agency responsible for the management of submerged provincial Crown land and for providing leases and licenses for the use of that submerged area based on specific guidelines and referral comments from other agencies. MAL is also responsible for coordination of land and water policies for British Columbia and, through the Integrated Land Management Bureau, is responsible for strategic land use planning. MAL has interests in the development of a management plan for the Nanaimo Estuary that balances human activity, economic development and environmental health.

The Ministry of Environment (MOE) has legislated responsibilities for management of wildlife and wildlife habitat (including hunting) through the Wildlife Act; legislated responsibilities related to waste discharges into the estuary; and jurisdiction over water quality, control and licensing. MOE is also the management authority for The Nature Trust lands.

Other agencies are responsible for the resources within the estuary. Fisheries and Oceans Canada (DFO) has jurisdiction over anadromous fish habitat. They also have responsibilities related to coastal zone planning under the auspices of the *Oceans Act*.

Two arms of Environment Canada (EC) are involved: Environmental Protection, which oversees protection of air and water quality with specific reference to pollution prevention, environmental assessment, and classification of shellfish growing waters; and Canadian Wildlife Service, which has a mandate to conserve and manage migratory bird populations. Regulation of the shellfish harvest is a shared responsibility by EC, DFO, and the Canadian Food Inspection Agency (CFIA).

Ownership

There are a number of different owners and managers of land in and around the estuary (see Map 3). Much of the estuary itself is provincial Crown land. There is also one federal parcel of land adjacent to the estuary, supporting the Nanaimo Assembly Wharf. The ownership of the beds of the Nanaimo, Beck and Chase Rivers are undetermined. Determining the ownership status of the beds of "streams" is very complicated, expensive and time consuming, and was not considered necessary for this plan.

A significant land mass near the head of the estuary is owned by The Nature Trust of British Columbia. Their mandate is to protect ecologically sensitive habitat throughout the province in an effort to conserve British Columbia's magnificent natural legacy. This land was purchased by the Pacific Estuary Conservation Program, under the auspices of the Pacific Coast Joint Venture, in recognition of the significance of the Nanaimo River Estuary for migratory birds on the Pacific Flyway. The estuary land is leased to the Ministry of Environment (MOE), and is managed by MOE along with another parcel of land in this area which is designated as a wildlife reserve.

Four SFN IRs (Indian Reserves) are located around the estuary. In front of IR #1, there is a parcel of intertidal land composed of IR and Crown Federal ownership. There is also a large property west of the Nanaimo River (previously owned by the Inuit) that has been acquired by the Crown as potential treaty settlement lands. On the east side of the estuary are two municipal parks; Biggs Park and Jack Point Park. Most of the remainder of the land around the estuary is privately owned.

In addition to outright ownership, there is a head lease to the Nanaimo Port Authority. Within that head lease, there are leases for log storage. Map 3 illustrates the head lease and the log storage area outlined in the 2002 Memorandum of Agreement between the Province and SFN.

1.2 Context for a Plan

“Given that Nanaimo River estuary is the largest on the east coast of Vancouver Island, the fifth largest in B.C., and the only major estuary on Canada’s west coast with no management plan to date, this process is long overdue.”

[All quotes in left margin are written comments received during public consultation.]

Estuary planning and management processes have been undertaken in a number of key estuaries in British Columbia within the past two decades. Prior to this Nanaimo Estuary Management Plan (NEMP), various studies had been undertaken within the Nanaimo estuary, but no integrated process to consider all resources and involve all interests had occurred.

The Snuneymuxw First Nation (SFN) has a keen interest in the Nanaimo estuary. They are interested in restoration of the estuary through a balance of uses and environmental protection and enhancement, and they see the estuary as critical to their community, economic development and culture. With this in mind, the SFN has, through the Georgia Basin Ecosystem Initiative (GBEI), now the Georgia Basin Action Plan, spearheaded: collection of information, water quality and benthic sampling programs, and a temporary estuary steward in collaboration with other government and non-government groups.

At the outset of this planning process, there was a head lease to the Nanaimo Port Authority due to expire in October 2002. In the fall of 2000, in anticipation of the expiry of the head lease, B.C. Assets and Land (BCAL, subsequently Land and Water B.C. Inc.) requested a meeting with the SFN to discuss the upcoming head lease and log storage lease renewals. At that meeting, the concept of an estuary management planning process was introduced to BCAL and the need for a formal steering committee was identified. A process to establish a steering committee, terms of reference, and the scope of the action plan was undertaken. All parties were in agreement that log storage was of primary concern, however as one portion of an overall management plan that would encompass all human activities and uses.

The Steering Committee (SC) was formed, and a log storage working group (LWG) was convened to address that issue (see sidebar). The Terms of Reference of the LWG were not met, in that the group did not reach a consensus recommendation. Three sectors (SFN, FIUG, and NCESC) produced minority “option” recommendations, which were presented to the public for comment and review.

The information and recommendations gathered during the LWG process were used to inform a decision by the Province and the SFN. In March 2002, two Memoranda of Agreement between the Province and the Snuneymuxw First Nation were signed; one regarding log storage locations and monitoring, and the other on wild shellfish harvesting areas. The agreements were “government to government”, and members of the LWG or the NEMP SC were not consulted. One of the provisions of the agreements was the continuation of the estuary management planning process.

LWG Members

Ministry of Sustainable
Resource Management and
Snuneymuxw First Nation,
Co-chairs
Fisheries and Oceans Canada
Environment Canada
City of Nanaimo
Nanaimo Port Authority
Forest Industry User’s Group
(FIUG)
Nanaimo Community Estuary
Support Coalition (NCESC)

A head lease was established and backdated to October 2002 along with subleases to the forest industry. The leases are subject to any future court action by the SFN.

Study Area Boundary

One of the first tasks of the Nanaimo Estuary Management Plan was to establish the study area boundary. In much of the literature available on the area (Karen Dunham, January 2000), the boundaries of the Nanaimo River estuary are generally reported to be the main coast of Vancouver Island on the west side and the rocky ridge of forested land on the east side, terminating at Jack Point. However, Sibert (1975) indicates that when the Nanaimo River is at its peak, its plume is detectable to the east as far as Entrance Island and to the north beyond Five Finger Island. The major study of information on the Nanaimo River Estuary (Bell and Kallman, 1976) used a significantly larger boundary, including the marine areas of Northumberland Channel, Fairway Channel to Entrance Island, and Departure Bay, Horswell Channel, and Rainbow Channel.

For the Nanaimo Estuary Management Plan, the SC expressed interest in extending the study area boundary up to Departure Bay. However, given the time constraints of the project, they decided to focus on the immediate estuary first, and to save the larger area for a later phase of work (see Map 4). The study area was therefore defined by:

- the high water mark along the shoreline,
- the extent of tidal influence up the river and creek channels, and
- the 10 m bathymetric contour along the seaward edge of the estuary.²

The 1000 ha extent described above is the area covered by the NEMP area designation plan. Since the estuary is part of a much larger biophysical and socio-cultural system, the analysis and recommendations in this plan also address that larger area of influence, e.g. upstream water resources, adjacent riparian areas, surrounding land uses.

²The 10 m bathymetric contour was chosen based on available bathymetry. The intent is to include the estuary to the outer extent of the eelgrass, and not to include the shipping channel.

1.3 Planning Process

The Nanaimo Estuary Management Plan (NEMP) was conducted by an interdisciplinary team of consultants guided by a multi-interest Steering Committee (SC). The planning process began in February 2002, and involved the following key steps (see Figure 2):

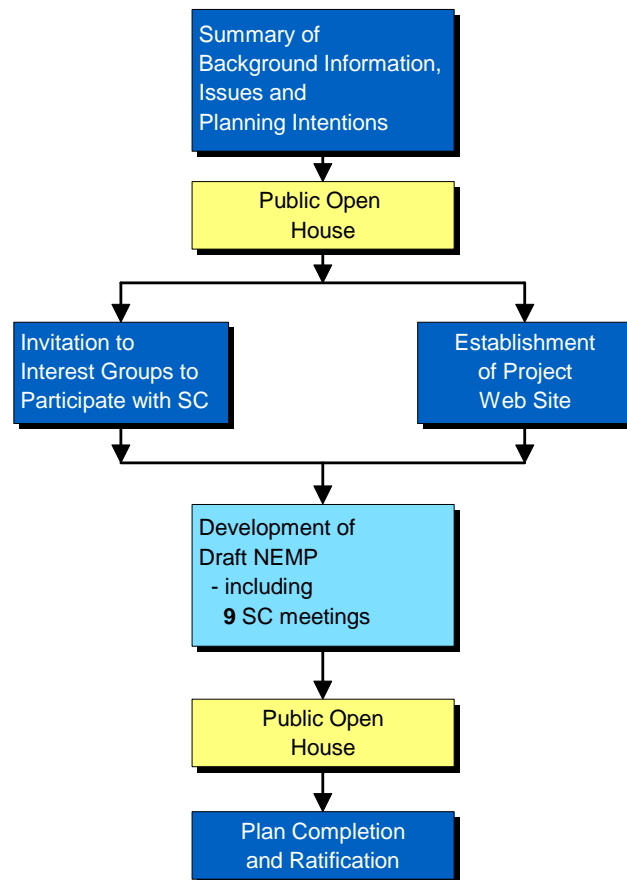


Figure 2: Planning Process

- Preparation of a summary of planning intentions, plan components, land and port uses, and major documented issues.
- Presentation of the above information at a public open house on April 11, 2002 with a request for comments on interests, issues and suggestions.
- Invitation to the primary interest groups to participate in SC meetings based on interest expressed during public consultation.



- Posting of all project-related information with a feedback form on a Web site, with periodic news releases and advertisements prior to public sessions.
- Preparation of draft NEMP report and maps in consultation with the SC (including nine SC meetings), using a consensus-based planning approach.
- Presentation of a draft NEMP report and maps to the public on November 26, 2002.
- Completion and ratification of the NEMP in the fall of 2005 following 4 additional SC meetings.
- Information on the NEMP planning process can be found on the Internet at <http://srmwww.gov.bc.ca/rmd/coastal/nanaimo>.

1.4 Plan Framework

The following plan framework was developed in collaboration with the SC, with input from the public.

Cooperation as the Core

The central focus of the plan reflects the desire for all governments, including the SFN, to work cooperatively together, with input from key interest groups, on a management regime within the estuary. The following are the vision, purpose, objectives and principles of the Nanaimo Estuary Management Plan.

Vision

The following is the vision for the study area. It is written in the present tense since it describes how it is hoped the estuary will be perceived in the future.



The Nanaimo River estuary, the largest estuary on Vancouver Island, has rich resources that include salmon, shellfish, intertidal vegetation and significant bird populations. The estuary is also the site of human activities including cultural, traditional, industrial, residential, agricultural and recreational uses that benefit the community as a whole.



“Everyone should try to look at what might not be here in the future due to the impacts we inflict today.”

Purpose

The purpose of planning and management is to restore the productivity and diversity of the natural resources in the estuary with consideration for social and economic returns and benefits to the community as a whole. The plan will provide a balanced approach to the future management and use of the Nanaimo River estuary, recognizing that it is one of the greatest natural assets in the region.

The plan will guide human activity including sustainable resource development, recreational use and habitat management in the Nanaimo River estuary, and lay a framework for ongoing co-ordinated management giving high priority to the health of the estuary and its living resources.

Planning Process Objectives

The objectives of the planning process were to:

1. evaluate the condition of the resources of the estuary and how they have been affected by past activities;
2. establish short and long-term guidelines for human activities in and upstream of the estuary that will prevent or mitigate negative impacts of human development and/or activities on water quality and aquatic and terrestrial ecosystems;
3. define a monitoring program to evaluate ongoing impacts, and recommendations for restoring degraded habitat and protecting existing functional habitat; and
4. establish an implementation plan for management of the estuary in the future, which includes responsibilities for monitoring and communication and collaboration among agencies, interest groups, and the public.

The objectives of the plan itself are contained in other sections of this document.

Principles

The following principles guided the planning process:

1. recognize current and historical biophysical characteristics of the estuary;
2. recognize the short and long-term socio-economic needs of the community as they relate to land and water use decisions;
3. recognize the cultural and heritage values of the plan area; and
4. develop the plan through an open process involving the public and all stakeholders in the estuary management plan area.

1.5 Plan Format

Figure 3 provides an illustration of the format of this document.

Section 1 provides the background and framework of the plan,

Sections 2, 3 and 4 discuss the three main topic areas: fish and wildlife habitat, water quantity and quality, and human activities. Within each of these sections, background information, issues and opportunities, objectives and proposed management strategies are provided. In some sections, these three topics are presented separately in their entirety. In the section on human activities, the issues and opportunities immediately follow each subsection to improve the flow of the discussion.

Sections 4, 5 and 6 present the designation plan, the monitoring plan, and the implementation plan.

Appendices provide background information.

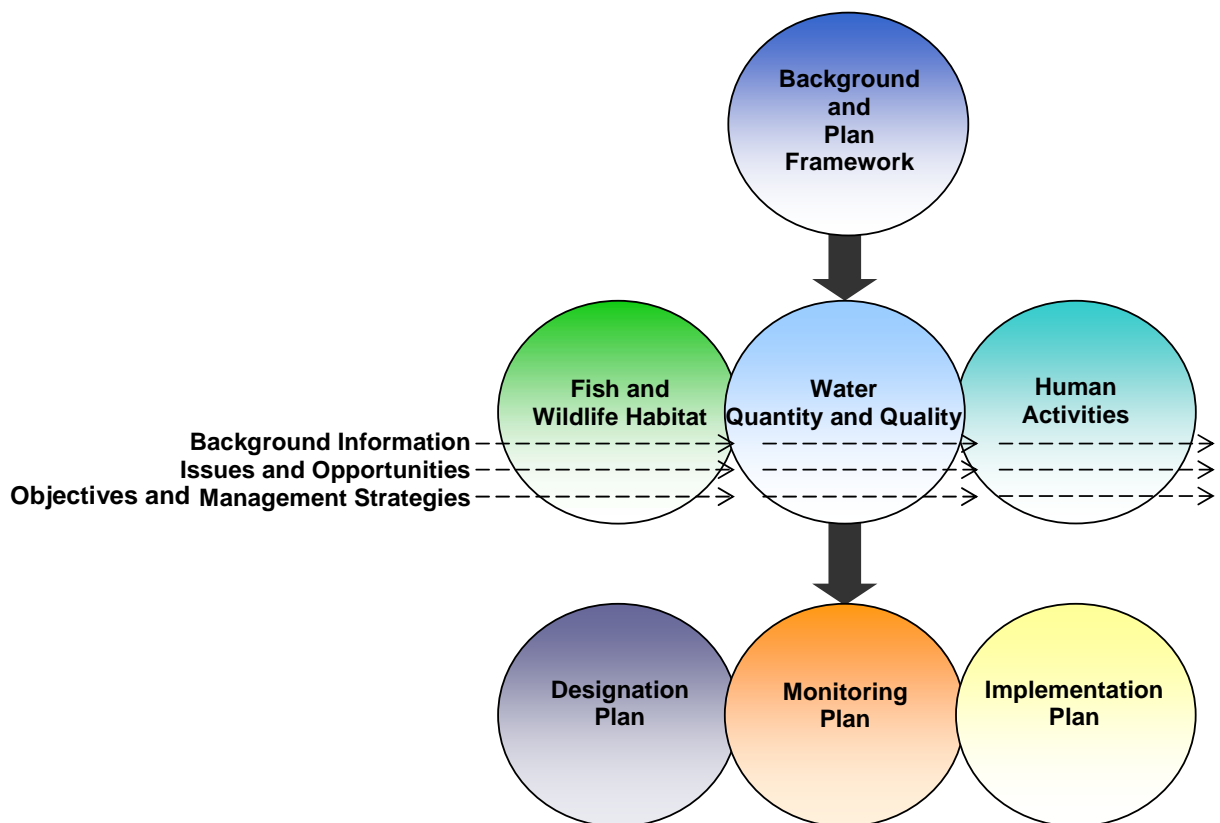


Figure 3: Plan Format

2.0 FISH AND WILDLIFE

2.1 Introduction



Estuaries provide essential habitat for many fish and wildlife species. The habitat is composed of all of the physical (e.g. substrate, soil, and water) and biological (e.g. flora, fauna) characteristics that make up the environment. These conditions together support a variety of mammal, bird, fish, reptile, amphibian and invertebrate populations.

The habitat in many of the estuaries in southern British Columbia has been significantly affected by various land uses (see Figure 4). For example, less than half of the original extent of the Nanaimo River estuary marshes exist today. Dyking the marshlands for agricultural uses or for urban expansion has had the largest impact on these important but rare systems.

Location	Extent of Estuarine Marshes		
	Past Area (ha)	Present Area (ha)	Change in Area (%)
Campbell River	23.00	26.00	+13.0
Courtenay	85.00	74.00	-12.90
Baynes Sound	122.00	117.00	-4.10
Little Qualicum	12.00	11.00	-0.80
Englishman	54.00	47.00	-12.90
Nanaimo	280.00	130.00	-53.60
Chemainus	155.00	121.00	-21.90
Cowichan	190.00	101.00	-53.10
Squamish	165.00	115.00	-30.30
Burrard Inlet	140.00	10.00	-92.90

Figure 4: Changes in Extent of Marshes and Estuaries in the Strait of Georgia

(From Dawe, 2001; originally from Levings and Thom 1994. Note that numbers for Nanaimo Estuary include all the way to Departure Bay.)

The Fraser River estuary followed a similar trend. Since the 1800s, dyking, draining, filling and dredging activities have resulted in an estimated 70% loss of natural habitats. Through habitat enhancement and creation projects between 1986 and 2000, there was a net gain of 109,732 metres of productive habitat (Monitoring the Estuary Management Program).

Estuarine habitat has been shown to be particularly valuable on a global scale. It is relatively straightforward to calculate the economic values associated with various forms of land development. According to Dawe, valuation of natural systems is more complex and challenging. Studies

that evaluate the economic worth of natural systems indicate that estuaries are particularly valuable (see Figure 5).



Biome	Area (ha • 10 ⁶)	Value/ha (\$ ha ⁻¹ yr ⁻¹)
Estuaries	180	22832
Swamps/Floodplains	165	19580
Seagrass/Algal Beds	200	19004
Tidal Marsh/Mangroves	165	9900
Lakes/Rivers	200	8498
Coral Reefs	62	6075
Tropical Forest	1900	2007
Temperate/Boreal Forest	2955	302
Grassland/Rangeland	3898	232
Croplands	1400	92

Figure 5: Global Area and Average Value of Annual Ecosystem Services in 1994 U.S. Dollars for Various Biomes

(From Dawe, 2001; originally from Costanza et al, 1997)

2.2 Upland Habitat



Upland habitats are situated primarily along the southern edge of the Nanaimo River estuary. Overgrown old fields adjacent to the estuary provide excellent habitat for numerous Townsend's Voles³ which are important prey for Red-tailed Hawk, the blue-listed Great Blue Heron (particularly in winter) and the blue-listed Short-eared Owl. Grassland species such as Savannah Sparrow are common during the breeding season. Hedgerows, dominated primarily by Pacific Crabapple, are also common in previously cultivated upland areas. Hedgerows are important breeding areas for songbirds such as Song Sparrow and Cedar Waxwing, and are used for hunting by raptors such as Cooper's Hawk.

In undisturbed areas between the two main channels of the Nanaimo River, a dense stand of riparian shrub vegetation is established. Common species include Pacific Crabapple, Nootka Rose, Rocky Mountain Juniper, and the invasive Scotch Broom. A mixed forest of Garry Oak and Bigleaf Maple, with a few coniferous trees, is also located in the area. A unique feature of the upland around the estuary is the abundance of Garry Oak, both along the riverbank and within forested areas. These riparian habitats support a high diversity of breeding bird species, including species such as American Robin, Spotted Towhee, Swainson's Thrush and Yellow Warbler.

³ See Appendix A for the scientific names of all species listed in this section. Scientific names are provided in this section only where no common names exist.



Sandstone outcrops within the upland habitat are unique features. The larger outcrop is dominated by a mixed coniferous and deciduous stand of Douglas-fir, Garry Oak, Arbutus, Bittercherry, Grand Fir, and Bigleaf Maple. Shrub species include Indian-Plum, Boxwood, Tall Oregon-Grape, Kinnickinnick, and Saskatoon. Herbaceous species of note include Common Camas, Northern Rice Root, and Pacific Sanicle. Several plant species found here (e.g., stonecrop) are found nowhere else within the estuary except on the similar rock outcrop along the west side of Jack Point. A smaller sandstone outcrop is dominated by herbaceous species, such as grasses and Common Camas, and Scotch Broom. Mixed coniferous and deciduous forests on the sandstone outcrops are utilized for breeding by species such as Golden-crowned Kinglet, Chestnut-backed Chickadee and Pacific-slope Flycatcher, and as roosting areas for raptors hunting in adjacent open areas.

2.3 Marine Habitat



The Nanaimo Estuary study area falls primarily within a marine environment influenced by tides. The marine area is composed of tidal marshes, sand and mud flats, and an eelgrass zone. The estuary is interlaced with temporary and permanent channels of water that are formed by a combination of riverine and tidal flows.

One of the primary ways to evaluate the health and productivity of an estuary is through consideration of the base of the food chain and its associated detritivores (organisms that live off detritus) and heterotrophs (bacteria). Supporting this food chain are macrophytes (“large” plants such as leafy algae and vascular plants). The primary organisms mentioned here are most prolific in certain habitat types. For example, areas where tidal marsh and eelgrass beds occur are typically very rich in detritivores and heterotrophs. Studies of the estuary in the past have shown there to be a wide variety in macrophytes (Foreman, 1975).

Foreman (1975) reported relatively high biomass levels within the eelgrass zones he sampled in the Nanaimo Estuary as compared to those reported for the Squamish and Fraser estuaries. Primary productivity rates were also measured on the mudflat in the summer of 1975 (Bell and Kallman, 1976). Both macroalgal and microalgal production were low, whereas bacterial (heterotrophic) production was high, representing about 88% of total production.

Eelgrass beds are productive habitats for a number of species, including waterfowl, Brant, Great Blue Heron, spawning substrate for herring, and habitat for crabs, other invertebrates and fish. Eelgrass also contributes to the detrital food web, stabilizes and prevents erosion of sediments,

and recycles phosphorus from the sediment into the water column (Bell and Kallman, 1976).

Eelgrass occurs in three relatively distinct zones in the Nanaimo estuary; the subtidal, the lower intertidal and along channels in the upper intertidal area. The upper intertidal zone has a lower density of eelgrass (mostly *Zostera japonica*; 10-20 shoots per m²) than the lower intertidal and subtidal zone (mostly *Zostera marina*; 30-40 shoots per m²), and has lesser amounts of epiphytic algae. The lower intertidal and subtidal more densely growing eelgrass zone also extends upwards in the permanent tidal channels. The native eelgrass *Zostera marina* provides important habitat for marine species. The Japanese eelgrass, *Zostera japonica* has become an important species for wildlife, particularly birds.

The eastern side of the estuary was chosen for eelgrass planting in 1979 because of the sparseness of the eelgrass and recently reduced log booming activity in that vicinity (Nanaimo Estuary Fish Habitat and Log Management Task Force, 1980; Connelly). Limited natural growth did occur, however it was determined that the transplant sites were of elevations not conducive to recolonization. Subjective observations by a federal fisheries officer indicated that eelgrass appeared to be increasing naturally in abundance (in Bell and Kallman, 1976:98).

An eelgrass mapping project that used GPS, and an underwater video camera for the subtidal areas, (Snuneymuxw First Nation, 2002) provides an important baseline of the current distribution of eelgrass (see Map 4). This map indicates that, compared to mapping of eelgrass conducted by Ducks Unlimited in 1988, there is a considerable increase in eelgrass distribution on the northeast portion of the estuary, and a decrease in the northwest. Based on visual corroboration it appears that eelgrass growth in the subtidal area on the west side of the estuary may be limited in extent by debris accumulation on the sea bottom and propellor wash from 20 years of log handling in this area.

2.4 Wildlife



The diverse habitats within the Nanaimo River Estuary are utilized by numerous wildlife species, many of which are red- or blue-listed by the provincial Conservation Data Centre (see descriptions below). The estuary is a particularly important overwintering and staging area for water birds (i.e., waterfowl and shorebirds) migrating along the Pacific Flyway. Wildlife are attracted to marine and intertidal areas, extensive low and high marsh areas, rivers, hedgerows, overgrown fields, and both deciduous and coniferous forests.

Mammals



Marine and intertidal areas in the Nanaimo Estuary are utilized by a significant population of Harbour Seals, and in some months, large numbers of sea lions. Whales and porpoises have been seen, but are rarely observed within the estuary. Another marine-associated species is the River Otter that appears to be common throughout the estuary.

Mammal species occurring in upland areas include Townsend's Vole, abundant in low marsh and overgrown field habitats, Deer Mouse, Black-tailed Deer, and the introduced Eastern Cottontail and Black Rat. The red-listed Vancouver Island Ermine is another possible inhabitant of upland areas.

Birds



Of the more than 200 bird species observed within the estuary by the Nanaimo Field Naturalists, 18 are blue-listed and 15 are red-listed. Of these, the blue-listed Band-tailed Pigeon and the red-listed Purple Martin are known to nest in the estuary. The Great Blue Heron (blue-listed) has historically nested near the estuary, and the estuary is still a very important foraging area for herons in the Nanaimo area. Wintering and migrating populations of some species, such as Short-eared Owl and Least Sandpiper, are of regional and provincial significance.

Evidence indicates that populations of some species are declining coast-wide (Campbell et al 1988, Leach 1986). For example, the wintering population of Brant, which once numbered in the thousands in the estuary, are extirpated, and the red-listed Western Grebe no longer utilizes the estuary in great numbers (G. Monty, pers. comm., 2002). Declines in the amount of eelgrass following the initiation of log storage in 1948, and previous commercial and recreational harvest of Brant, are likely factors in population changes of Brant and other species (Campbell Prentice and Boyd 1988; Hutchinson et al. 1989). Scoters and scaups are also rare in the estuary now. These species were previously more abundant and are valuable indicator species since they depend on shellfish.

Several raptor species, including Cooper's Hawk, Red-tailed Hawk, Merlin, and Bald Eagle, breed in upland areas of the estuary. The three to four active Bald Eagle nest sites located around the estuary fringe are monitored on a regular basis (Blood 1989; Martin 1996; Cousens 1998). One pair of Ospreys has nested successfully on a piling within the estuary in the last few years (G. Monty, pers. comm., 2002). The estuary is also a very important foraging area for red-listed Peregrine Falcons that nest on nearby Gabriola Island.

A wide variety of songbird species nest in forests and shrublands of the study area, including neotropical migrant species such as Common

Yellowthroat, Willow Flycatcher, and Warbling Vireo. These riparian habitats are particularly important foraging areas for migrating passerine species during the fall and spring migration.

Amphibians and Reptiles

The most common amphibian species utilizing habitats within and adjacent to the estuary appear to be Rough-skinned Newt, Pacific Tree Frog, and Long-toed Salamander (Blood and Cousens 1995). The blue-listed Red-legged Frog and several species of terrestrial salamanders are also potential inhabitants.

All three species of garter snake occurring within British Columbia (i.e., Northwestern, Common, and Western Terrestrial) and the Northern Alligator Lizard have been observed within the estuary.



Terrestrial Invertebrates

Little information is available on the occurrence of terrestrial invertebrates within the estuary. The Nanaimo River estuary is known to provide habitats for the last known population of the Field Crescent Butterfly on Vancouver Island (Guppy and Shepard 2001).

Marine Invertebrates



The SFN has undertaken shellfish inventories in recent years as part of their investigations into the harvesting potentials of this resource. Since the surveys focused on locations with high densities of Manila Clams, the results do not necessarily represent the bivalve resources of the entire estuary. They do, however, indicate which bivalve shellfish are present in the locations surveyed. Pacific Oysters, a species introduced many years ago, were found to be plentiful, particularly on the central gravel/cobble reef. Clams, especially the Manila or Japanese Littleneck, the Native Littleneck, and the Varnish Clam, were also abundant in the locations inventoried. Of these, the Manila or Japanese Littleneck and the Soft Shell Clam were introduced many years ago; the Varnish Clam is a more recent introduction that is invasive. Less abundant native species including the Horse Clam, Nuttall's Cockles, Butter Clams and several species of Macomas were also found to be present.

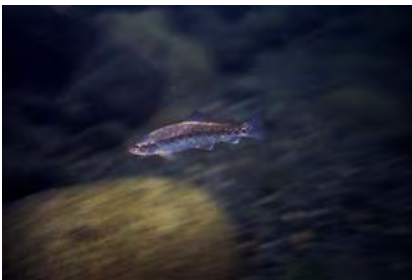
All bivalve fisheries have been closed since 1949 due to high levels of fecal coliform and other contamination, including dioxins, furans, PCB's, PAH's, pesticides and metals. The Snuneymuxw First Nation has been working with the Georgia Basin Ecosystem Initiative, now Georgia Basin Action Plan, to identify, monitor, assess and mitigate water quality and sources of contamination within the estuary. Since 2003, an annual

deputation⁴ fishery is permitted on the eastern portion of the estuary, which is farthest from the sources of contamination. The SFN is working to extend allowable depuration harvest boundaries to include the reef.

Both Dungeness and Red Rock Crabs are found in the estuary, although Dungeness are more abundant and have a higher commercial demand. Dungeness are recreationally fished quite intensively, particularly on the east side of the estuary, south-west of Jack Point. Members of the Snuneymuxw First Nation have observed that the numbers and sizes of crabs have been greatly reduced over the last 50 years. Commercial crab lines have also been noted to cause damage to eelgrass beds.

Non-commercial marine invertebrates (e.g., copepods, amphipods, decapods, isopods, and annelids) are important links in the estuary food web. Many of these species have been shown to be important food sources for juvenile Chum and Chinook salmon (Healey 1979, 1980). Studies have indicated the presence of dense populations of potential prey organisms near the sediment-water interface of the Nanaimo Estuary, however in spite of the apparent chemical homogeneity of water, large differences in densities of animal populations were found (Sibert, 1981). Analysis of fish diets indicated that the estuary may be important for larval shrimp and prawns (Nanaimo Estuary Fish Habitat and Log Management Task Force, 1980).

2.5 Fish



A diverse fish community exists in the Nanaimo River Estuary. Some studies indicated that 58 species of fish inhabit the estuary (Parker and Kask, 1974, Bell and Kallman, 1976), however, the study area for those investigations extended beyond the present management plan boundary. Commercially, recreationally and culturally important salmon species that use the estuary include Chum, Chinook, Coho, Pink Salmon, Steelhead and Sea-run Cutthroat. Pacific Herring was found to be the most abundant marine species in the estuary area. Important non-anadromous fish that are also present in the estuary include resident Cutthroat and Rainbow Trout, Starry Flounder, and Staghorn Sculpins.

Chum are the most abundant salmonid within the Nanaimo River system. Adult Chum start to arrive in late September and continue into October and December. Spawning occurs within the lower reaches of

⁴ Depuration is a process of purifying shellfish prior to consumption by allowing them to filter out toxins in purified (e.g., mechanical screening/UV filtration) saltwater tanks. There are separate standards for fecal coliform levels if the shellfish are to undergo depuration.

the river. Fry migrate to the sea within two weeks after hatching and spend a few weeks to months and up to a year rearing in the estuary. Chum are an important commercial and First Nations food fish.

“Everyone seems to forget that society (industry) have a choice as to where to store their logs, but fish do not have a choice and must use the estuary.”

Nanaimo River Chinook stocks have been heavily reduced, though regulations and enhancement projects are attempting to rebuild these stocks. The SFN have also greatly reduced their Chinook food fishery to assist in rebuilding stocks. There are three stocks of Chinook in the Nanaimo River: the fall run uses the lower river; the winter run spawns in the upper reaches of the river, but may already be extirpated from the Nanaimo system; the summer run is often found in deep pools and/or the lakes in the summer months and spawns downstream of First and Second Lakes.

Studies of Chum and Chinook juvenile habitat use in the Nanaimo Estuary have shown that Chum are present in the estuary between March and early June while juvenile Chinook reside between late April and early July (Sibert, 1975, Healey 1979, Healey 1980). At high tide, they form small schools along the landward edges of the estuary and occasionally enter the marsh on extremely high tides. At low tide, they retreat to channels that remain wetted in the marsh and across the sand flat. The eastern main channels of the Nanaimo River and Holden Creek, both found on the eastern side of the estuary, are critically important low tide refuges for Chum and Chinook fry (Healey 1979, 1980).

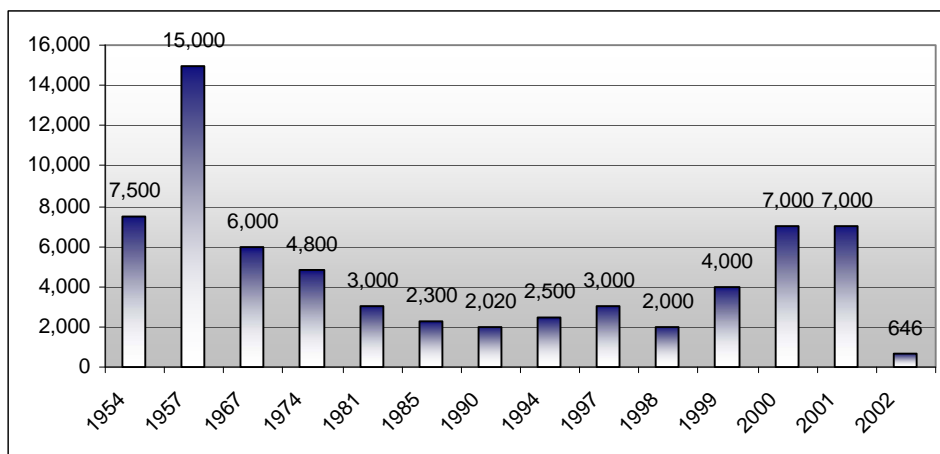


Figure 6: Coho Salmon Escapement Estimates in Nanaimo River 1954 - 2000

Coho stocks on the Nanaimo River have been heavily depleted over the past 100 years. Figure 6 shows the general downward spiral; the higher numbers in 2000 were likely a result of a ban on commercial fishing for coho, and the beginning of selective fishing programs. Unfortunately, for recent years, counting methods have been changed and the counting fence prior to the end of the coho runs has been removed. Coho enter the Nanaimo River later than most of the other fish and are thus very difficult to count during high water. In 2003 and in 2004 they were not "counted" but some were observed in the river.

Many projects and regulations are geared towards conserving and enhancing these stocks. Coho enter the Nanaimo River in September and continue through to December and even January. Spawning occurs throughout the mainstream of the Nanaimo River and almost all of its tributaries. Fry remain in the freshwater system typically for one year and up to two years before migrating to the estuary and then the sea.

Historically large numbers of Pink Salmon returned to the Nanaimo River every year, with runs of over 50,000 documented. It is believed that impacts from mining and forestry, as well as poorly managed fish harvesting, have all added to the rapid decline of the Nanaimo River Pink Salmon. Nanaimo River “pinks” seem to be slowly increasing but still only number in the hundreds. Spawning occurs in the lower reaches of the Nanaimo River and Haslam Creek during late August and September. Fry migrate to estuaries and near shore environments to rear immediately after hatching. Juvenile habitat use of the estuary is probably similar to use by Chum and Chinook.

Sockeye numbers within the Nanaimo River are reported as low, and are likely strays from other systems.

Once one of Vancouver Island’s most popular Steelhead rivers, the Nanaimo River’s wild stocks are now considered to be of extreme conservation concern, current numbers being below 400 adults. Historically the Nanaimo River supported healthy runs of Steelhead with catches in the late 1960s of up to 2,573 (Bell and Kallman, 1976). The Steelhead fishery on the Nanaimo has been closed since 1997, and is expected to remain closed until wild stocks are greater than 500 adult returns. Steelhead enter the river in late winter (January through April), with the bulk of the run entering in February through March. After spawning, adults remain in the river for some time prior to returning to sea. Fry emerge from June to July and remain within the river system for up to three years prior to migrating to sea.

Cutthroat Trout (regionally blue-listed by Ministry of Environment’s Vancouver Island Region), especially sea-run stocks, have been heavily impacted by development around Nanaimo River’s tributaries. Reports from long-time residents of the area indicated a healthy fishery existed in the river below the Haslam Creek confluence in the spring, and was concentrated on the tidal portion of the river around the Chase River confluence at other times of the year (Nanaimo River Water Management Plan, 1993).

Sea-run cutthroat spawn in early spring in the lower tributaries such as Haslam Creek, Thatcher Creek, Holden Creek, Chase River, Beck Creek and Wexford Creek. Sea-run Cutthroat are known to rear in both fresh and marine environments, particularly estuaries. Since Sea-run Cutthroat do not venture far from their natal streams, the marine habitat from Stevenson Point to Jack Point, comprising the physical and

biological boundaries of the Nanaimo River Estuary, is prime sea-run Cutthroat marine habitat. This area has been subject to intense foreshore development.

Juvenile Pacific Herring are also found distributed across the Nanaimo Estuary in high numbers (Bell and Kallman, 1976). Herring spawning near Jack Point is sporadic, and occurs approximately once every ten years. In addition to being a commercially important species, herring are important prey of many other fish as well as birds. In addition, archaeological evidence and comments from SFN elders suggest that herring was a highly valuable finfish in this area (Duke Point). Other important forage fish, such as smelt and sandlance, are also found in the Nanaimo River Estuary.

2.6 Habitat Classification

As a tool for summarizing habitat information and enabling analysis and planning, habitat types in the Nanaimo Estuary were classified based on physical and biological characteristics. The following paragraphs provide a description of the biophysical units.

Map 6 illustrates the distribution of the biophysical units. This map was derived from a combination of mapping conducted by Ducks Unlimited in 1988, air photo analysis, ground spot-checking, and an inventory of eelgrass conducted in the fall and winter of 2002⁵. The scope of this project did not allow for detailed fieldwork to confirm the boundaries of each unit (beyond the eelgrass mapping). The map should therefore be considered a general, not an exact, indication of distribution. The units most in need of refinement in the future include:

- Eelgrass – since this is such an important habitat type.
- Permanent Tidal Channels – image analysis of the 1999 air photo was used to determine these, however, some changes may have occurred since 1999.
- Sand and Gravel Flat vs. Mudflat – the flats of the estuary are very heterogeneous with sand and mud areas occurring with a high level of spatial and seasonal variability.

A review of conditions in the estuary over time (e.g. comparison of old air photos, Ducks Unlimited mapping, 1999 air photo, current conditions) illustrates how dynamic estuaries are. In particular, the river and tidal

⁵ The accuracy of the eelgrass mapping is about 8 metres, based on the precision of the GPS unit and the available receptions.

channels flow in varying pathways over time. Although more difficult to see, it is speculated that shifting of sediments also occurs.

There are no surficial sediment samples for the Nanaimo Estuary in depths less than 10m and only a few in depths greater than 10m. The available data suggests that subtidal sediments to the east are mud with some sand, and sediments to the west are sand with some mud (Luternaaurer 1985). More information on surficial sediments would assist in mapping the distribution of biophysical units.

Eelgrass Zone



The Nanaimo Estuary has a primary eelgrass zone in the lower intertidal and subtidal area (mostly *Zostera marina*) on unconsolidated sand to mud. Eelgrass also occurs within the upper intertidal zone (more *Zostera japonica*), particularly along tidal channels through the flats and along the east edge of the estuary. Eelgrass beds are typically productive habitats with many associated species of algae, invertebrates, and fish (Simenstad et al., 1991). Eelgrass also contributes to the detrital food web, stabilizes and prevents erosion of sediments, and recycles phosphorus from the sediment into the water column. The occurrence of other plant and animal species within the eelgrass zone is not well documented. There is some wood and bark debris in the vicinity of the log storage and handling locations.

Commonly associated species include: two species of eelgrass as noted above (*Zostera japonica* is imported and *Zostera marina* is native), Sea Lettuce, *Smithora*, crabs, Bay Pipefish, Chum Salmon, Crescent and Penpoint gunnels, Kelp, Striped and Shiner Surfperch, Lingcod, Pacific Herring, Snake Prickleback, Tube-snout (Simenstad et al., 1991), gulls, ducks, Great Blue Heron and Brant.

Gravel/Cobble Reef



The gravel/cobble reef in the estuary is composed of densely compacted glacial deposits at a higher elevation than the surrounding sand and gravel flat (Fry and Campbell 1988; Luternaaurer 1985). The hardpan area is mostly covered with gravel and other mixed coarse sediments including sand, pebble, cobble and some boulders. The reef is heavily used by a diversity of species.

Species typically associated with this type of substrate and exposure include: Barnacle, Boring Polychaete, Sea Lettuce, clams, Phoronid Worm, *Owenia fusiformis*, *Meiodomastus capensis* and *Notomastus tenuis* (Dethier, 1990).

Sand and Gravel Flat



Sand and gravel flats are intertidal landforms composed predominantly of sand but including minor components of gravel (pebbles, cobbles and boulders). The gravel often supports a patchy distribution of attached algae. Sand and gravel flats (Luternauer 1985, Fry and Campbell 1988) dominate the middle portion of the intertidal zone and sediments are relatively mobile, being commonly redistributed by wave-generated currents.

Commonly associated species include: eelgrass, Red Sea Spaghetti, Sea Lettuce, Nuttall's Cockle, Manila, Littleneck and Varnish clams, cumaceans, polychaetes, anemones, and Ghost Shrimp. Sandflats are used as nursery areas by young English Sole, Pacific Staghorn Sculpins, Bay Goby, Starry Flounder and as feeding areas of juvenile Chum and Chinook salmon (Dethier 1990). Starry Flounder is the dominant flat fish of the Nanaimo River estuary. Sand and gravel flats are also important roosting and loafing areas for waterbirds including gulls, shorebirds, ducks and cormorants.

Mudflat



Mudflats are an intertidal landform characterized by silt- and clay-sized sediments. The flats have very low gradients and retain high water content throughout the tidal cycle. They are not typically vegetated although diatom covers are common during the summer. Mudflats typically have high organic contents and anaerobic conditions just below the surface (Simenstad et al., 1991).

Commonly associated species include: clams, crustaceans, amphipods, Mud and Ghost Shrimp, Bent-nose Clams, and polychaetes *Polydora kempj japonica* and *Capitella capitata* (especially in polluted areas) (Dethier 1991). During migration, mudflats provide exceptional foraging opportunities for the many species of shorebirds (e.g., Western Sandpiper) migrating through the estuary.

Gravel Bar



Gravel bars are dynamic features associated with the active river channels in the upper (southwestern) part of the estuary. They consist of unconsolidated granule to cobble-sized materials that are moved and deposited during river freshet. Gravel bars are typically formed and shifted on an annual basis and only become stabilized once rooted vegetation such as willows begin to anchor the substrate.

The parts of the gravel bar above the water line are very unproductive because of the extremely dry and nutrient-poor conditions. However, parts of the gravel bar that remain submerged throughout most of the year support a diverse and productive community of benthic algae and

invertebrates that are vital to the channel and stream ecosystem. Commonly associated species include Killdeer and Spotted Sandpiper.

Tidal Marsh



Emergent marshes occur in the upper intertidal zone where erect, rooted, herbaceous vegetation that can tolerate submersion in seawater binds otherwise unconsolidated mud and sand with organic fibre. Perennial plant vegetation dominates during the growing season.

Marshes are sometimes divided into high and low marsh classes (Fry and Campbell 1988). The high marsh community is subject to flooding only during river freshet or high storm tides. The vegetation community is therefore comprised of species that are not as salt tolerant as low marsh species, and may include some tree and shrub species that can tolerate some degree of salinity. The low marsh community, which occurs lower within the intertidal zone, is flooded at least once each day by the tide. The vegetation is dominated by salt-tolerant emergent rooted plants, since the soil is too salty to support any tree or shrub vegetation. Because the high and low marsh areas in the Nanaimo Estuary are intertwined and overlapping, and because they are comparable in terms of their environmental value and planning implications, they have been considered as one biophysical unit in this plan.

The high and low marsh areas are situated between upland habitats and the intertidal mud and sand flats. By far the most common species in high marsh areas is Gerard's or Mud Rush, whereas American Glasswort is common in low marsh areas (Forbes 1973). Other common species in marsh habitats include Tufted Hairgrass, Seashore Saltgrass, Sea Arrow-Grass, Entire-leaved Gumweed, and Silverweed. There is an old record (1940s) of the blue-listed Chaffweed from salt marsh habitats of the estuary (CDC 1999). Wildlife species utilizing tidal marsh areas include Northern Harrier, Trumpeter Swan, and a wide variety of duck species. Juvenile salmonids and other estuarine fish access the tidal marsh habitat at high tide via tidal channels and sloughs to feed on the rich abundance of invertebrates present there.



Riparian Shrub

In undisturbed areas between the two main channels of the Nanaimo River, a dense stand of riparian shrub vegetation is established. This area is slightly higher in elevation than the tidal marshes so it is rarely flooded.

Common plant species in this area include Pacific Crabapple, Nootka Rose, Rocky Mountain Juniper, and the invasive Scotch Broom. Common breeding birds include Cedar Waxwing, Orange-crowned

Warbler, Song Sparrow, Spotted Towhee, Swainson's Thrush, and Yellow Warbler.

Riparian Forest



A small portion of the area between the two main channels of the Nanaimo River is characterized by a mixed deciduous and coniferous forest. There is additional riparian forest along the west shoreline of the estuary, but this is outside of the study area boundary.

Common species in this area include: Bigleaf Maple, Garry Oak, Douglas-fir, Western Red Cedar, Grand Fir, Pacific Crabapple, Indian-Plum, Salmonberry, and Red Elderberry. Bird species breeding in these habitats include American Robin, Black-throated Gray Warbler, Tree Swallow, and Warbling Vireo.

Rock Outcrop Forest



Unique features of the upland area are the sandstone outcrops found on "Oak Island" at the head of the estuary and along the northern part of the eastern shoreline. There are also some rock outcrops on the western shoreline of the estuary. At the head of the estuary a larger outcrop is dominated by a mixed coniferous and deciduous stand of Douglas-fir, Garry Oak, Arbutus, Bittercherry, Grand Fir, and Bigleaf Maple. Shrub species include Indian-Plum, Boxwood, Tall Oregon-Grape, Kinnickinnick, and Saskatoonberry. Herbaceous species of note include Common Camas, Northern Rice Root and Pacific Sanicle. The smaller sandstone outcrop shown on the map is dominated by herbaceous species, such as grasses and Common Camas, one Garry Oak tree, as well as the invasive Scotch Broom.

Common wildlife species occurring in these primarily coniferous forests include: small mammals such as Red Squirrel and Deer Mouse, and resident bird species including Chestnut-backed Chickadee, Golden-crowned Kinglet, Northern Flicker and Winter Wren.

River Channel



For the purpose of this study, the main channel of the Nanaimo River is defined as ending at the gravel bar where the river forms two primary channels. From this point downstream, the river channel bifurcates into two main forks and numerous smaller channels as it enters the open estuary. Upstream of Oak Island, the river channel is under tidal influence approximately up to the Cedar Road bridge, and is therefore included as a biophysical unit within the estuary.

The estuarine river channel is a productive reach of the Nanaimo River that supports a rich and diverse benthic algae and invertebrate community. In addition to serving as a migration corridor for fish, the

river channel supports important spawning habitat for Chum Salmon as well as rearing habitat and access for all of the salmon species inhabiting the Nanaimo River.

The riparian vegetation along the riverbank is an integral part of the river channel unit. A well-developed mixed deciduous-coniferous forest exists on the west side of the river channel. The riparian vegetation corridor along the east side is narrow and fragmented due to the presence of a dyke road (Raines Road) and various residential properties.

In addition to the Nanaimo River, there is some river channel habitat along York and Holden Creeks flowing into the east side of the estuary. These areas have similar features, but on a smaller scale. York Creek has a sizable freshwater marsh approximately 200 m in length parallel to the Nanaimo River outside of the study area boundary. On the southwest corner of the estuary, Chase River, Wexford Creek, Beck Creek and No Name Creek all flow directly into the estuary.

The wildlife community associated with the riparian vegetation of the river channels is diverse, including all of the species previously described for riparian shrub and forest units under the wildlife section. Other common species likely include: Barn Swallow, Belted Kingfisher, European Starling, House Finch, and Red-breasted Nuthatch. Numerous species of warblers, vireos, thrushes and flycatchers likely utilize these riverbank habitats during migration. Mammal species frequenting the banks and river channel of the river include Mink and River Otter.

Permanent Tidal Channel



Within estuaries, channels are defined as troughs within a tidal flat or marsh, which periodically or continuously contain moving water (Simenstad 1983, Dethier 1990). They vary in depth below the surrounding substrate, typically from several centimetres to around a metre, though some of the channels on the east side of the estuary are deeper. Channels are critical interfaces within the estuary, linking littoral and sublittoral, and riverine and marine habitats. Mainstream channels are important habitats for juvenile salmonids at low tide (Healey 1979, 1980) and they are also important for crabs that retreat to these channels at low tide. Channels are also used by shorebirds, herons, raccoons, otters, mink and other animals as forage areas.

Common species in the tidal channels include eelgrass, amphipods, the polychaetes *Hobsonia florida* and *Manayunkia aestuarina*, the Bent-nose Clam, Shore Crab, tanaiids, mysids, Chum, Coho and Pink salmon, Threespine Stickleback, Starry Flounder, Staghorn and Prickly sculpins, Shiner Surfperch, Snake Prickleback, Pacific Sandlance, Speckled Sanddab, and English Sole (Simenstad 1983, Dethier 1990).

2.7 Habitat Evaluation

In order to compare the relative environmental value of the biophysical unit types, a team of scientists familiar with the Georgia Basin developed a rating system (see Figure 7 and Map 7).

Biophysical Unit	Ecological Significance	Regional Representativeness	Rare or Uncommon Species	Fragility	Environmental Value
Eelgrass Zone	H	H	L	H	H
Gravel / Cobble Reef	H	L	L	M _L	M _H
Sand / Gravel Flat	M _H	M _L	L	M _H	M _L
Mudflat	M _L	M _H	L	M _H	M _H
Gravel Bar	L	L	L	L	L
Tidal Marsh	H	H	H	H	H
Riparian Shrub	M _H	M _H	H	M _H	H
Riparian Forest	M _L	M _L	M _L	H	H
Rock Outcrop Forest	M _L	L	M _H	H	H
Permanent Tidal Channel	H	H	L	H	H
River Channel	H	L	L	H	H

Figure 7: Habitat Evaluation

Figure 7 provides the ratings of each biophysical unit type. The following criteria were used to rate each type of unit.

Ecological Significance

To what degree does this type of unit play a significant role in maintaining or contributing to ecological processes or functions related to the foundation of the food chain in an estuary (detritivores and heterotrophs)?

Regional Representativeness

To what degree is this type of unit uncommon in the region (Georgia Strait)?

Rare or Uncommon Species

To what degree does this type of unit contain any plant or animal species which are red or blue listed by CDC, or other uncommon species that use the type of unit?

Fragility

To what degree is this type of unit particularly vulnerable to disturbance from human activities due to its biophysical composition or the species present?

Environmental Value

Figure 7 provides a rating of the biophysical units in relation to the above criteria. The coding is as follows:

- H – High
- MH – Moderate-High
- ML – Moderate-Low
- Low

A four-level scale was used because three-level scales used in many estuary studies have been criticized due to the fact that the moderate category includes such a wide range of values.

The final column, Environmental Value, was derived from an assessment of the other ratings. The rules applied to determine environmental value are as follows:

- High – 2 Highs or 1 High and 2 Moderates
- Moderate-High – one High and one Moderate (any) or 2 Moderate-High
- Moderate-Low – at least two Moderate (any)
- Low – remainder

2.8 Issues and Opportunities

The Nanaimo estuary has sustained significant losses and impacts to the productivity and diversity of fish and wildlife habitat. Some of the past activities that caused impacts on resources include:



- washing of coal from the 1880s to the 1930s,
- major dyking for agriculture in the 1900s and 1940s,
- sewage disposal beginning in the 1930s, with direct disposal until the 1950s,
- log storage starting in the 1950s,
- market hunting for waterfowl,

- introduction of invasive and undesirable species, e.g., Scotch Broom, Varnish clam, and
- filling and heavy industrial development, primarily due to mill construction.

Some of these activities have stopped (e.g., dyking, coal washing, market hunting), and others have reduced their impacts (e.g., sewage disposal, log storage). However, the after-effects of most of the original activities remain.

Current activities continue to cause impacts. Some of these, in addition to those from the above list that are still occurring, include:



- a variety of land uses in the watershed including residential, industrial and agricultural,
- dredging of mill pockets,
- drawing of water for various purposes along the rivers and major creeks,
- waterfowl hunting, and
- recreational use of the estuary by people and their dogs.



The primary impacts on fish and wildlife and their habitats from the past and current activities include:

- habitat reduction,
- habitat degradation,
- population reduction,
- water quality deterioration and changes to water flows (refer to section on water quality), and
- wildlife disturbance by humans and dogs.

Due to regional growth and development, cumulative impacts are increasing, and the trend is towards reduced habitat and populations.

Some impacts observed over time have included: stray logs causing sediment build-up, log boom tied up in eelgrass zone causing sediment build-up over the eelgrass at low tide, and compacted substrate in an area reported to be used for log storage approximately 20 years ago.

It is likely that new activities will be proposed within the estuary in the future. One potential activity that has been discussed is shellfish aquaculture. Any new activity will have impacts, especially given that

additional human activity is a disturbance to wildlife. Proposed new activities must be assessed to identify the potential impacts on fish and wildlife and their habitat. The activity should only be allowed to proceed if impacts can be minimized and/or there is adequate compensation, and if the benefits of the activity justify any impacts caused.

There are significant opportunities to improve the extent and quality of the fish and wildlife habitat. This will require planning, management, monitoring, and a high level of cooperation among government agencies, interest groups, and the general public.

2.9 Objectives

The following are the primary objectives related to fish and wildlife:

- Reduce and eventually stop the degradation of existing habitats, and in particular stop the loss and degradation of the high value biophysical units.
- Maintain and improve where possible the existing habitat base in the estuary to support viable and productive populations of fish, wildlife and plants, including invertebrates.
- Maintain a diversity of productive habitats within the Nanaimo River Estuary in order to sustain and improve the estuarine ecosystem.
- Increase fish and wildlife populations towards historical levels.

2.10 Management Strategies

“Mixed use is okay if decisions are science-based and scientifically defensible.”

The following are the primary management strategies proposed to meet the objectives related to fish and wildlife habitat. Please note that related management strategies will be listed in other sections of this report, e.g. water quality, log storage and handling.

- Protect the most important rearing areas for juvenile salmon by limiting log storage or other physical structures over and adjacent to the permanent tidal channels.
- Protect and improve the habitats that provide food sources for fish, birds and other species, including the quality and density of eelgrass beds, and tidal marshes.
- Explore and promote estuary restoration and habitat enhancement projects. Examples include:

- Removal of Scotch Broom and other invasive plants,
 - Native planting, particularly in the Riparian Shrub area, in hedgerows between agricultural fields (i.e., old and existing), along field margins, and on dykes,
 - Enhancement of the riparian shoreline edge within the context of existing policies, e.g. removal of rip rap and replacement with growing medium and native plants, using bioengineering if necessary, particularly in front of residential areas.
 - Placement of bird boxes (e.g., swallows, Purple Martin) and nesting areas (e.g., mini barns) for blue-listed Barn Owl,
 - Management of old field habitats (e.g., field renovations, removal of undesirable plants, control of noxious weeds, control of feral cats) to provide excellent living areas for Townsend's Vole which in turn provide foraging opportunities for raptors and Great Blue Heron,
 - Placement of perch poles for raptors in high marsh and old field habitats,
 - Removal of undesirable wood debris that is scouring low or high marsh areas and/or preventing growth of marsh vegetation in foreshore areas.
 - Investigation and possible implementation of eelgrass transplant initiatives.
 - Investigation of opportunities to restore estuary habitat lost as a result of dyking and other land use activities.
- Work with the Department of Fisheries and Oceans to review crab harvesting and to establish a plan that will ensure that the crab population is sustainable and that eelgrass beds are protected.
 - Encourage the City of Nanaimo and The Nature Trust of B.C., with input from the public and recreation user groups, to develop and implement a dog management plan for the estuary (including private, The Nature Trust, and public land), in order to reduce or eliminate the impacts of people and dogs on bird nesting/staging and on water quality (fecal coliforms). This should include garbage cans, signage, and some form of bags (e.g. dispenser or bag sharing station) for the removal of dog feces at Raines Road. A sign and dispenser have been installed at Biggs Park.
 - Develop policies for dog management on as much land as possible within the estuary
 - If any new activity or development is proposed in the plan area that could cause significant impacts on fish and wildlife and their habitat (e.g., shellfish aquaculture), share information, meet, and provide



collective comments as part of the environmental assessment process.

- Investigate current practices and impacts related to debris collection at mill sites and disposal of the debris material at sea. Work with Environment Canada, DFO, MWLAP, industry and others to develop best management practices to minimize impacts on fish and wildlife within and outside the estuary.
- Reduce the impacts of log storage on existing habitat (refer to Human Activities section 4.0 for more detail).
- Investigate water flows through the estuary and the potential environmental benefits of removing the gravel bar near the mouth of the Nanaimo River.
- Compile existing species inventory data, and support future inventories. This would include Christmas Bird Counts, college studies, and project-related environmental assessment inventories.
- Encourage and support interest groups who may want involvement in stewardship activities, such as habitat enhancement listed above, within the estuary.
- Develop a public education program (e.g. signage, brochure, news articles, school programs) regarding habitat significance, sensitivity, and protection measures.

3.0 WATER QUANTITY AND QUALITY

3.1 Water Quantity



The freshwater discharges from the Nanaimo River are an integral part of the estuarine ecology. This source of water provides the fresh and brackish conditions critical to the survival of many plant and animal species in the estuary. River flows also influence substrate and channel characteristics that are vital to the continued well-being of the estuary's fish and wildlife resources.

A Water Management Plan was prepared for the Nanaimo River in 1993. It provides a comprehensive overview of the water resources, demands for water use, fisheries resource management issues, and recommendations for managing the water resources. Contacts with the Water Management Branch of the provincial government indicated that the plan still stands. The minimum fish flows are still in place, and some experiments were conducted with pulse flow releases from the reservoirs to allow fish access to the upper portion of the river when low flow conditions create partial or complete barriers. The watershed is completely allocated, and no new licenses will be issued unless new water storage is provided.

The Nanaimo River at its mouth drains a watershed of around 813 square kilometres. The flow is measured by Water Survey of Canada (WSC) at station number 08HB034 near Cassidy, which has a drainage area of 665 square kilometres. The mean annual discharge at that location for the years 1966 to 2001 was 39.3 m³/second, or 1,240 million cubic metres. This stream flow site is located downstream of the storage and upstream of some of the diversion works. Water level, discharge and water temperature are reported by WSC for this site in a real-time format for public viewing on the internet: (<http://scitech.pyr.ec.gc.ca/waterweb/FullGraph.asp?stnID=08HB034>).

The natural flow regime of the Nanaimo River has been altered by licensed water storage and diversion, and through land use practices such as logging, residential development, and farming. The total licensed storage within the watershed amounts to 5% of the basin's natural runoff. The flow of the Nanaimo River varies both seasonally and annually. The daily extremes from 30 years of streamflow data collected by WSC at 08HB005, a site upstream from 08HB034, record the winter peak flow as 1,550 m³/second and the daily low flow in the summer as less than 1.0 m³/second.

The Nanaimo Lakes in the central portion of the basin create a moderating effect on the flow of the river originating upstream of the lakes. There are also three constructed reservoirs in the basin, two of which are owned and operated by the Greater Nanaimo Water District (GNWD), and one of which is owned and operated by Pope and Talbot Harmac Division. The total licensed storage within the watershed amounts to 5% of the basin's natural runoff.



The GNWD diverts water from the South Fork reservoir to provide the City of Nanaimo with its municipal water supply. Harmac controls the outflow from the Fourth Lake reservoir and withdraws water from the river downstream of the reservoir, pumping it to the Harmac pulp mill. The diversion takes place just downstream of the Island Highway #1. By regulating releases from their reservoirs, Harmac and the GNWD maintain a minimum residual flow of 1.38 m³/second in the lower Nanaimo River downstream of Harmac's water intake. This minimum flow, which is often exceeded to enhance flows for fish in the summer, is 3.5% of the mean annual discharge. Although the typical target is 10%, 3.5% is a good minimum flow for east Vancouver Island (Marion Lightly, pers. comm).

Historic data, collected by WSC at 08HB034, show that the regulated flows in the Nanaimo River above the Harmac point of diversion are higher in the month of August than the natural flows. This effect applies to the river upstream of the Harmac diversion, but not downstream of the diversion point. The most critical time for meeting demands on the water resource is during periods of low flow. Fish are particularly affected by low flows, which can reduce fish habitat value (e.g., appropriate vegetative cover and water temperature) and limit the ability of the fish to access habitats. Harmac and the GNWD work together to release flows in the summer to specifically enhance flows for fish.

The Nanaimo River Basin contains a significant and highly permeable sand and gravel aquifer, called the Cassidy Aquifer, which provides groundwater for industrial, domestic, irrigation, community, and fish hatchery uses. The extent of the Cassidy Aquifer has been identified and a quantitative assessment of the groundwater use and potential for development has been addressed. There appears to be a significant groundwater/surface water inter-relationship and potential for further flow supply problems as these sources are developed.

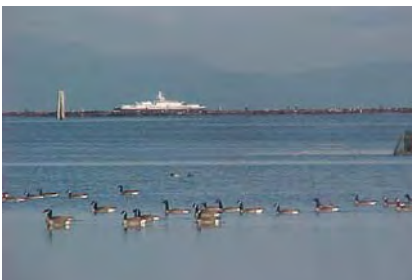
The GNWD is the only licensed municipal waterworks within the Nanaimo River watershed, and they use about 31% of the total extractive demands. Harmac's industrial pulp mill has licenses to draw water from an intake and wells, with licenses for almost 67% of the total extractive demands. Over the past decade, the company has reduced its water demands by 40% due to improved equipment and efficiencies in the mill, while maintaining instream flows for fish. Irrigation, domestic,

other industrial and conservation uses account for only 1.4% of the licensed extractive demands.

Minimum flow requirements, established by DFO and MOE (Freshwater Fisheries), have a target of 10% minimum Annual Discharge during the summer and one or two pulse flows if there is sufficient storage in Harmac's and GNWD's reservoirs. This is based on the best available knowledge, but there are gaps in available data and in the understanding of the fish needs. The requirements attempt to address the minimum flows needed to maintain habitat during summer and early fall, and pulse flows to trigger the migration of Coho up the Nanaimo River when fish are congregating at the mouth of the river. Proposed strategies and objectives for the recovery of steelhead stocks include examining water flows and temperature improvement opportunities below the reservoirs and a review of the implementation of the 1993 Nanaimo River Water Management Plan regarding conservation flow requirements.

On a smaller scale, the same principles apply to the Chase River and creeks, as for the Nanaimo River. Outflows need to be monitored and resources managed to protect habitat and fish and wildlife use. Holden Creek supports 70 small water licenses, most of which are for domestic use, with several for irrigation. On Haslam Creek, there are 45 water licenses. Most of these are for domestic or irrigation use, with a few for storage and stock watering. The Harmac pulp mill has a license on Haslam Creek for 0.28 m³/second. Chase River supports 10 water licenses. The primary one is to the GNWD for the municipal water supply, with the smaller licenses serving irrigation, land improvement and storage needs.

3.2 Water Quality



Water quality is a central issue in estuary management. Water is the one element that directly links urban development (including stormwater runoff and waste-water treatment), agricultural practices (including irrigation, livestock impacts, and agricultural/horticulture products), and industrial operations (including industrial effluents, log debris) with estuary water chemistry, sediment quality, aquatic organisms, wildlife, and recreation opportunities. Water quality is a key to the health of the estuary, particularly for fish, shellfish and wildlife resources, and also for human inhabitants.

Management of water quality can only be undertaken with consideration for the broader geographic context. Activities within the watershed have the potential to affect the water quality of the estuary downstream. Likewise, pollution in the marine environment north and south of the study area can flow into the estuary on rising tides.

A number of water quality measurements (e.g., temperatures, salinity, nutrients, turbidity, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), and chlorophyll A) can give a good background on the condition of the environment. Some of these parameters have been tested in the Nanaimo Estuary through special projects. When resources are limited, it can be more efficient to test the condition of the ecosystem through measurements of sediment chemistry and biota, since these are reliable and sensitive pollution indicators.

Estuaries by their nature have fluctuating levels of salinity. Salinity is affected by the ebb and flood of the tide, seasonal variations in freshwater influences, and the degree of evaporation caused by summer warming and strong winds. Winter storm events have the greatest effect on reducing salinity, while a secondary reduction in salinity is observed from snowmelt from high elevations within the Nanaimo River watershed in the spring (See Figure 7). Compared with other B.C. estuaries, the Nanaimo River estuary is unusually saline due to the ratio of freshwater input to geographical area.

The salinity chart describes data collected by the SFN as part of the Environment Canada monitoring program. The data was collected from 21 stations across the mudflat, but not from each station every time⁶. All data was collected on ebb (out-flowing) tides, which typically has lower salinity than the flood tide. The program was designed to capture fecal coliforms in the freshwater flowing into the estuary. Some sample dates targeted rainfall events; others were random.

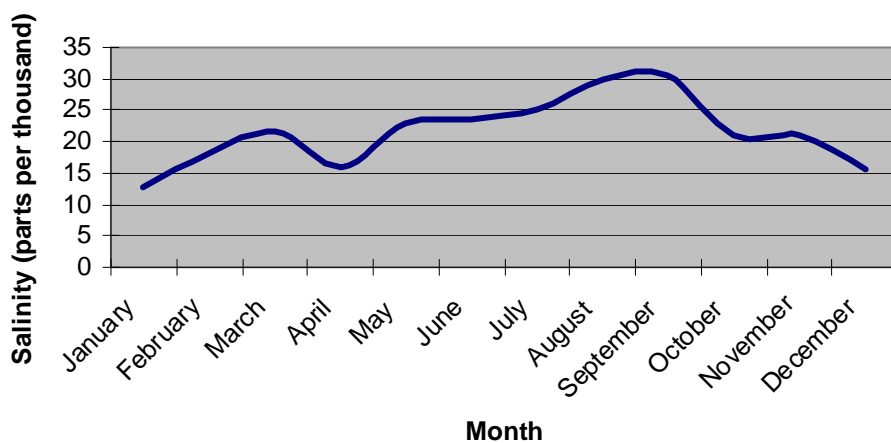


Figure 7: Average surface salinity by month, 1999-2005

⁶ Total number of samples = 904; Total number of sample dates = 83; Samples collected 15 cm below surface approximately monthly Nov 99-October 2005. All salinity data was divided by month and averaged for all sites for that month, i.e., all January data (2000-2005) was averaged from all stations.

Shellfish fisheries in the estuary have been closed since 1949 due to high fecal coliform counts. Prior to 1999, Environment Canada (EC) staff periodically conducted marine water quality sampling. However, due to limitations of EC resources, surveys were not conducted on a regular basis. The SFN have a strong desire to be able to harvest shellfish within the estuary as before. They have been working in partnership with Environment Canada within the parameters of the Georgia Basin Ecosystem Initiative, now Georgia Basin Action Plan, to monitor water quality in the Nanaimo River Estuary and its various inflows. Of primary concern are the fecal coliform counts (McNaughton, 2002).



The SFN have been working towards reclassification of the estuary to allow wild depuration shellfish harvests. Two separate bivalve shellfish closure classifications exist on the estuary. The area is **closed** (imposed by Environment Canada) due to high fecal coliform levels. There is also a **prohibited** closure (imposed by Health Canada) due to concerns of toxins other than fecal coliforms and naturally occurring biotoxins (red tide etc., which are a DFO responsibility). Fecal coliform data will address the **closed** status, while dioxin, furan, PCB, PAH's, pesticides and metals data will address the **prohibited** status. Reclassification would require both the closed and prohibited statuses to be addressed separately before a harvest could proceed.

Due to the work of the SFN, a portion of the estuary has been reclassified and now an annual depuration fishery is permitted on the eastern portion of the estuary. The balance of the estuary remains closed and prohibited, and recreational and Snuneymuxw bi-valve fisheries on all portions of the estuary remain closed outside of the depuration fishery.

In the fecal coliform monitoring program, marine and fresh water, biota (clam tissue), and sediments are analysed for fecal coliform levels. Additional information including salinity, river discharge and rainfall are used to correlate influences to the estuary on fecal coliform loading. New technologies are now allowing for DNA tracing of sources of the bacteria to the type of animal of origin, as a tool in identify sources and directing remediation. Details of the marine and fresh-water sampling conducted by the Snuneymuxw First Nation from the period 1999 to 2002 as well as the marine data collected by Environment Canada from 1990 to 1999 are found in McNaughton (2002). Annual water quality analysis reports prepared for Environment Canada are available in McNaughton (2004) and McNaughton (2005).

As the monitoring program matures, the emphasis and effort for various stations alters from time to time (see Map 8). For example, marine water sampling on the western portion of the estuary has been discontinued as this area is not considered for reclassification in the foreseeable future.

The following is a summary of the results to date of the sampling program:

Marine Water Sampling



- During the fall months, neither the approved nor the depuration standard is met for shellfish classification.
- During winter, spring and summer, the depuration standard is met, but not the approved standard.
- The greatest level of contamination occurs on the western edge of the estuary.
- According to the Canadian Shellfish Sanitation Program (CSSP), data from the whole year is used for classification. However, the SFN (and other groups along the coast of BC such as Baynes Sound and Barkley Sound) are seeking seasonal management of area closures.
- At times, fecal coliform levels far exceed swimming standards, although not during the summer, which is the typical swimming season. Other recreational or industrial users (e.g., hunters, kayakers, boom boat operators) could be affected if they have direct contact with the water.

Fresh-water Sampling

- Only six out of 33 fresh-water sites showed an influence of 24-hour rainfall on fecal coliforms.
- The Chase River, Nanaimo River and Holden Creek were the major sources of fecal coliforms to the Nanaimo River Estuary.
- Upstream sampling on the Chase River, Nanaimo River and Holden Creek found:
 - Incremental increases in fecal coliform readings with downstream progression on the Chase River.
 - Very low fecal coliform readings on the Nanaimo River, upstream of Highway #1. In the more developed and agricultural lower portions of the river, fecal coliform readings incrementally increased with downstream progression.⁷

⁷ The readings on the Nanaimo River are generally low, however the volume of water versus neighbouring watercourses, makes the Nanaimo a significant source of fecal coliforms.

- Small increments in fecal coliform readings upstream of the mouth of Holden Creek, where dramatic increases occur.

Shellstock and Benthic Samples



Shellstock and sediment samples were collected periodically from selected stations in the Nanaimo River Estuary by the SFN and were analysed as part of the fecal coliform analysis described above. Samples were also collected for the analysis of organics and metals (results pending).

Contamination Sources

The following potential non-point pollution sources of contamination were identified but not confirmed:

- Agriculture livestock and other practices, ranging from hobby-scale farms to commercial operations.
- Urban runoff including septic systems, leaks or cross-connections between sanitary and storm sewers. (Upgrades to the Chase River Pumping Station have reduced contamination concerns from that source. The City is replacing sewer lines in the older neighbourhoods, which will also reduce contamination.)
- Pets in residential areas and dog walking and training in the estuary.
- Recreational boating in the estuary and harbour, and live-aboards in the marinas of Newcastle Channel.
- Commercial shipping (illegal sewage discharge) and ineffective sewage treatment on the Gabriola Island ferry. (Upgrades to the ferry in 2002 have reduced contamination concerns from that source.)
- Direct discharge of sewage to the marine water from a small number (14 to 16) “cabins” on Protection Island.
- Natural sources of fecal coliform contamination from birds, marine mammals and terrestrial wildlife.



3.3 Issues and Opportunities

“We ask that the parties do not forget the need to minimize pollution and maximize fish and wildlife habitat in the Nanaimo River drainage basin as part of ongoing management programs. This will allow the estuary, and the whole aquatic ecosystem of which it is a part, to recover its former glory.”

As population in the Nanaimo area continues to grow, there will be increased pressures on the water resources. Monitoring of the water flows, monitoring of uses, and careful management will be required to ensure that the quantity of water in the Nanaimo River and other creeks does not limit the habitat quality and fish and wildlife use in the estuary. Unfortunately, limited resources have led to a reduction in flow monitoring in recent years.

The water quality of the Nanaimo estuary has declined significantly as the watersheds have undergone urban and agricultural development. There has likely been some improvement since the days of direct discharge of sewage to the mudflat. Since the time of recent testing (1990), the significant decline in water quality has abated.

Many inputs to the estuary have affected the water quality including: industrial effluents, log debris, stormwater, and pollutants from septic fields, livestock or agricultural/horticulture products used within the watersheds.

It is a challenge to identify pollution sources and to develop appropriate management strategies, especially for non-point source pollutants.

3.4 Objectives

The following objectives related to water quantity and quality address the estuary specifically, while recognizing that many of the influences derive from sources throughout the watershed:

- Support initiatives to maintain sufficient water quantity from the Nanaimo River and other watercourses to sustain fish and wildlife populations and habitat, with current flows as a minimum.
- Support initiatives to improve the water quality in the estuary and contributing watercourses for the benefit of fish, shellfish, and human health and safety.

3.5 Management Strategies

The following are the primary management strategies proposed to meet the objectives related to water quantity and quality. Many of these have been derived or adapted from McNaughton (2002).

- Collaborate as required to ensure the continued monitoring of water flows and water uses.
- Continue to implement pulse flows to encourage access by Coho and Chinook to the upper river reaches. Evaluate fish returns to determine if different minimum flow requirements might raise spawning numbers.
- Expand the water quality sampling program by increasing the frequency of testing through the spring and summer seasons in both freshwater and marine samples. The current short-term sampling program is lacking in data for those times and the current sampling regime does not provide sufficient information.
- Use bacterial source tracking and other methods to investigate the sources of fecal coliform bacteria within the smaller watercourses of the Nanaimo and Chase Rivers (and other locations as required), to attempt to explain high fecal coliform values within those watersheds and portions of the estuary.
- Improve the water quality to meet the depuration standard for shellfish production in the short term, and the approved standard for shellfish production in the longer term.
- Work with the City of Nanaimo, the Regional District of Nanaimo and relevant provincial agencies on the identification and management of pollution sources within the watershed⁷. Problems such as cross-connections between storm and sewer systems, agricultural runoff, and stormwater runoff need to be addressed at these levels.
- Encourage the City of Nanaimo and the Regional District of Nanaimo to implement their Stormwater Management Policies throughout the watershed, particularly measures related to infiltration at the source and protection and restoration of riparian areas.
- Work with the Department of Fisheries and Oceans, Environment Canada, the Nanaimo Port Authority and other relevant agencies on

⁷ The Ministry of Agriculture is working on Best Management Practices for agricultural runoff. The regional district is conducting watercourse and aquifer mapping.

the identification and management of pollution sources from the marine environment. Sewage from recreational boaters and commercial boat traffic need to be addressed at these levels.

- Develop a public education program to promote water conservation and to minimize water quality impacts from upstream agricultural, urban and industrial sources. This might include signage, brochures, and news articles regarding water quality and water use issues and impacts.
- Work with landowners in the watershed, including the forest industry, on the management of activities that could affect water quality and quantity.

4.0 HUMAN ACTIVITIES

4.1 Culture and Heritage



The Nanaimo River estuary has always been an important spiritual and traditional use area to the Snuneymuxw First Nation (SFN). Living historically in winter villages at Departure Bay and Nanaimo Harbour, and in villages on the Nanaimo River in the fall, the estuary was central to the SFN's life and culture. Elders in the community refer to it as their "bread basket".

Marine resources in the estuary were plentiful. Large quantities of chum salmon were caught using weirs and spears in the Nanaimo River, and salmon, lingcod, cod, flounder and dogfish were caught in open waters near the estuary. Intertidal marine resources were also abundant in the estuary. Clams, cockles, mussels, oysters, and crabs were available year-round, and were an essential part of the SFN subsistence. Marine resources were also used for other purposes, including trade, ceremony and recreation.

In addition to marine resources, land mammals such as deer, bear, wolf and elk were hunted there. Smaller animals such as raccoon, mink, marten and beaver were trapped. These animals were important for food as well as for their fur. Another important food source was the waterfowl and other birds that fed and nested in the estuary. The "black duck" (i.e., Brant) was very abundant during spring and fall, and it was preferred by the SFN for feasting and potlatching. Other birds hunted in and around the estuary were geese, swans, gulls, loons, grebes and other waterfowl. Bird eggs were also collected along the shoreline.

Plants were significant to the SFN for foods, medicinal and utilitarian purposes. The most important were berries. Salmonberry was abundant on Jack Point, and other berries included red huckleberry, black hawthorn, salal, black raspberry, and red elderberry. Soopolallie were also gathered in mid summer. Wintergreen, oregon grape and plantain were a few of the plants used as medicines. Grasses were used to make mats and baskets by SFN women. Skunk cabbage was common and was used for lining berry baskets, berry-drying racks and steaming pits. A variety of trees growing along the shoreline were used for fuel, carved utensils, bark for clothing, dyes, and medicinal uses.

To support the various harvesting activities, longhouses were situated in the estuary. The SFN traded for goods and services before contact, offering shellfish as a major commodity. The Nanaimo River estuary offered physical protection as well. During times of conflict, neighbouring nations would come to the estuary to fight off adversaries.



Cultural remains recorded in the area include midden sites, lithic scatters, culturally modified trees, and various other historic features and artifacts. Unfortunately, many of these have been lost as a result of development, but some important sites and artifacts remain, particularly in the Duke Point/Jack Point area. A petroglyph depicting a salmon at Jack Point was removed and placed in a museum when Duke point was developed. The SFN is working with the Nanaimo Museum, City of Nanaimo and others to return the petroglyph. It was considered important in guiding the salmon back to the river.

Today, the SFN has four of its six reserves sited around the estuary. The SFN are a Douglas Treaty Nation. Established in 1854, this Treaty gives the SFN the right to “fish as formerly”. An additional right to hunt on unoccupied land was later won through a case in the Supreme Court (*Crown vs. White and Bob*). Since the SFN have lived, hunted, harvested and gathered traditional medicinal, food and sacred plants and wildlife on the estuary for thousands of years, they have established cultural practices and links associated specifically with the estuary.

The SFN are actively engaged in work to monitor and protect the resources of the estuary. In partnership with the Georgia Basin Ecosystem Initiative, The Nature Trust, and the province, they have employed an estuary steward. They also have a fisheries consultant on staff. Through these staff and others, the SFN is involved in fresh water and marine water sampling, identification of point and non-point source pollution in the watershed, remedial work on York and Holden Creeks, and gravel removal to improve fish runs on the eastern arm of the Nanaimo River.

The SFN have already completed a library, data summary, and annotated bibliography of studies pertaining to the Nanaimo Estuary, and SFN is a key participant in the Estuary Management Plan. The SFN has a particular interest in restoring shellfish beds and establishing a shellfish aquaculture operation⁹ in the estuary.

After contact, the early settlers began to use the Nanaimo estuary area for coal and gravel extraction, and agricultural land. Dykes were built to restrict the tidal influence and to increase farmland. Visual remnants of the old coal and gravel operations still exist within the estuary.

Issues and Opportunities

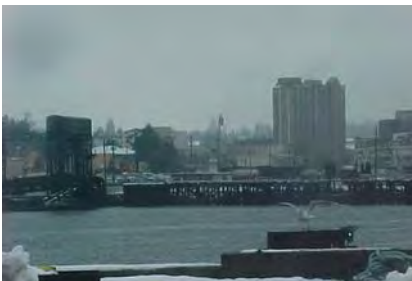
The SFN have sustained significant cultural, spiritual and economic losses as a result of the development and uses in and around the Nanaimo estuary. These losses include: decimation of cultural sites and

⁸ The initial goal is to be able to harvest shellfish from the existing resources. In the future, the SFN may become involved in actively growing shellfish.

artifacts, inability to practice traditions due to conditions in the estuary, and loss of important food sources, particularly shellfish.

The SFN are now being proactive in working towards restoration of the resources in the estuary. Their objectives include regaining the ability to conduct cultural practices and to harvest shellfish, and the return of important artifacts.

4.2 Industrial Development and Activities



There is a variety of industrial and urban development surrounding the estuary. Industrial development occupies the most land. There is a 40 acre deep-sea terminal on the northwest corner of the estuary. Western Forest Products Inc. (WFP - formerly Doman-Western Lumber Ltd.), located on the assembly wharf adjacent to the terminal, can only receive logs from the water. Their existing log storage grounds hold about one month's worth of inventory. Since their existing storage area will be removed with the new lease configuration, their storage will be relocated within the new lease area. CIPA Lumber Co. Ltd., previously also located on the assembly wharf, has ceased operations and the building has been removed.

Coastland Wood Industries Ltd. is located on the west shore of the estuary. On average, 30% of their logs are delivered by truck, with 70% arriving by water. They only have space for storage of 2 to 3 days worth of logs on land. A recent upgrade to the mill was based on the supply of logs from the water.



On Duke Point, there is a 350 acre industrial park. Four mills on Duke Point use logs that are stored in the in the estuary; WFP Duke Point Sawmill, WFP Duke Point Log Merchandizer, Pope and Talbot's Harmac Pulp Division, and Cascadia's (formerly Weyerhaeuser's) Island Phoenix Division Sawmill. Other industrial development on Duke Point does not have as direct a relationship with the estuary.

In addition to the existing industrial development, there are proposals for new industrial uses near the estuary. For example, a property above Holden Creek has recently been rezoned to heavy industry. A portion of that property, the Larry Hume Arboretum formerly known as the Grant Ainscough Arboretum, will become a municipal park.

Log storage and handling has been a use in the Nanaimo River estuary for many decades. Over that time, there have been changes to the area utilized and the activities undertaken.

In 1950, when the formal use of the estuary for log storage was first contemplated, water lot leases for the area were the responsibility of the

provincial government. The Province issued and managed water lot leases to various forestry-related companies through the 1950s and into the early 1960s. In 1961, the federal government created the Nanaimo Harbour Commission (NHC) to manage the Nanaimo Harbour. In 1962, an agreement was made for the NHC to manage certain provincial lands in the Nanaimo Harbour under a head lease covering much of the estuary, except for a small portion in front of IR #1. The provisions of this agreement were amended several times up to the present, with the current expiry date being October 31, 2002. The NHC, as a result of the Federal National Marine Policy introduced in 1995, became the Nanaimo Port Authority on July 1, 1999, under the *Canada Marine Act*.

From 1950 to 1972, water lots in the estuary were incrementally assigned to local forest industries as the mill capacity in the area grew. The historic air photos (see Map 9) illustrate the progressively intensive use of the estuary for log storage, with the most intense use in the 1975 era. The photos also indicate that the river flow pattern has changed over the past 25 years. Much of the river was formerly directed along the easterly shores of the estuary. The eastward flow was progressively blocked by a gravel bar in the river adjacent to the northeast corner of IR #3.

In 1984, all of the leases were reviewed and redistributed based on an environmental review of fish habitat (Nanaimo Estuary Fish Habitat and Log Management Task Force, 1980). The log storage area was reduced by 22.5% and shifted to the west side of the estuary at that time.

The water lot leases are used to store logs for the following reasons: accumulation of inventory prior to its sale, in anticipation of a strike, when logging operations are shut down due to weather conditions, to facilitate long runs of a particular species through a mill, for market cycle accommodation, and for mills that buy logs on the open market and need a stockpile of logs for continuous operation. The lease areas have been used over the years for some activities in addition to log storage for the local mills, including:

- Interim storage of logs being transported to other destinations (e.g., Fraser River and Chemainus),
- Receiving logs, which are sorted, made into booms, and delivered to a mill or sold,



The Nanaimo River estuary has become a strategic “warehouse” for logs from a multitude of sources because: there are limited locations where log storage is allowed on the east coast of Vancouver Island, especially ones with protection and fresh water flushing; and because the restructuring of the forest industry and limited log supply have caused cooperation among forestry-related companies. Recently, demands for storage on this estuary are increasing even more, partly

because log storage in other estuaries has been reduced or eliminated due to environmental concerns.



There are five forest companies relying on log storage in the estuary, that together form the Nanaimo Forest Industry User's Group (FIUG). The following is the general industry perspective related to log storage in the estuary (R.G. Fuller & Associates Ltd., 2000).

- According to the FIUG, the most economical method of transporting logs is by water. For most of the forest operations that have located in the Nanaimo area, a key factor has been the convenient, quality storage and handling capabilities provided by the estuary. The estuary provides protection from inclement weather, and reduces the damage to logs by teredos due to the fresh water from the Nanaimo River¹⁰ and the ability of the logs to dry out during daily low tides. Fresh water also reduces salt accumulation in the bark, which results in less release of dioxins and furans.
- If log storage and handling was reduced or eliminated in the Nanaimo River estuary, there would be an increased dependence on land-based storage and handling, and truck transport of logs. This would cause additional capital and operating costs for the mills related to: obtaining land-based storage and sorting space (which may not be available), changes to mill head works to be able to receive logs from land, lost log value due to increased handling, and increased transportation and log handling costs. There would also be impacts related to increased logging truck traffic on provincial and city roads.

Figure 8: Forest Industry Perspective on Log Storage

“Drastically reduce log storage. In particular, only allow logs for Nanaimo mills’ use, with a phase-out plan formed. Times are changing. What was acceptable yesterday may not be today.”

In anticipation of the expiry of the head lease, a Log Storage Working Group (LWG) was established to provide recommendations on log storage and handling in the estuary. The LWG held three working sessions between September and December 2001 and a public open house was held in December 2001. A record of the discussions of this group and three options for log storage are summarized in the Final Report of the Log Storage Working Group (January 22, 2002).

The Terms of Reference of the LWG were not met, in that the group did not reach a consensus recommendation. Three sectors (SFN, FIUG,

⁹ Generally, long-term practice suggests storage in the estuary reduces the effects of toredo infestation and extends the storage period from 6 weeks up to 6 months. However, there is no evidence that the Nanaimo River contributes sufficient fresh water to the estuary for that purpose, due to the high marine water influxes. High salinity counts have been documented during summer, which is the critical period for teredo reproduction.

and NCESC) produced minority “option” recommendations, which were presented to the public for comment and review.

The information and recommendations gathered during the LWG process were used to inform a decision by the Province and the SFN. In March 2002, two Memoranda of Agreement between the Province and the Snuneymuxw First Nation were signed; one regarding log storage locations and monitoring, and the other on wild shellfish harvesting areas. The agreements were “government to government”, and members of the LWG or the NEMP SC were not consulted. One of the provisions of the agreements was the continuation of the estuary management planning process.

The MOA also includes an agreement to provide funding for SFN to carry out monitoring over the next five years to collect information on: the source of logs coming into the estuary, their destination upon leaving the estuary, the volume of logs entering and leaving the estuary by source and destination, and the location of logs stored during the tenure term compared to the log storage area allocated to each sub-lease. In addition, the Nanaimo River Estuary Log Storage Association (previously called the Forest Industry User’s Group) is committed to a set of Best Management Practices that have been previously utilized within the Fraser River corridor.

The Province has re-issued the Head Lease to the Nanaimo Port Authority and has designated the areas for log storage, in accordance with the MOA between the Province and the SFN. The Port Authority has, in turn, re-issued new subleases to the industry users based on the new reduced log storage areas as set out in the Head Lease and the MOA.

Other commercial activities within the estuary are related to fishing and shellfish harvesting. Commercial crab licences for the Nanaimo Harbour include portions of the estuary. The SFN operate a wild depuration clam fishery in the estuary.

The SFN are exploring the potential for a shellfish aquaculture industry in the future. Additional work required prior to initiation would involve assessment of potential environmental and other impacts.

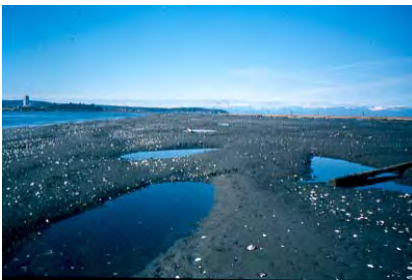
Issues and Opportunities

The forest industry is an important contributor to the economy of the province and the City of Nanaimo. Hundreds of millions of dollars have been invested in mills in Nanaimo as a result of the availability of the estuary for log storage. However, log storage activities impact intertidal and shallow sub-tidal habitats within estuaries:

- The physical shading of habitat by booms results in decreased primary productivity by algae and eelgrass.



- The physical grounding and abrasion by booms at low tide results in compaction of sediments, scouring and physical disruption of habitats.
- Bark and debris are deposited and accumulate on bottom sediments from the working of logs against each other within the bundle. The debris can collect under the logs and it can be carried elsewhere by water and wind, accumulating in various parts of the estuary. Persistence periods are typically in the range of decades. This in turn creates anaerobic conditions within these accumulation areas.
- Towed booms can scour eelgrass beds, particularly if logs are askew within the bundle underwater.
- There are effects on intertidal marsh areas from escaped logs, such as deposition and scouring.
- Propeller wash from tow boats and boom boats can scour sediment, disrupting regeneration of eelgrass and other benthic organisms.
- Boom boats and booms can increase turbidity in the water column as they pass over tidal flats.
- Logging tows can catch crab trap lines and drag them through the eelgrass.
- Log booms can have the positive effect of providing protection for some aquatic life from predators.



Although more difficult to describe and quantify, log storage in the estuary can also have economic and social impacts. Some examples are as follows:

- There are “opportunity” costs with respect to other activities that could occur on the estuary if log storage was reduced or eliminated, e.g., fisheries, tourism, shellfish harvesting.
- There is an economic cost, in effect a subsidizing of industry, by not having the industry assume responsibility for environmental damage.
- The storage of logs in the estuary makes the local forest products industry more competitive.



Industry's reliance on the Nanaimo Estuary as a "strategic warehouse" for logs has arisen partly due to the fact that log storage has been drastically reduced or eliminated from other estuaries due to the activity's various impacts. Some perceive that this has placed an undue burden on the Nanaimo Estuary.

There is interest in reducing the impacts of log storage, particularly where logs are stored over habitat that is more environmentally sensitive. Best management practices will help in reducing some of the effects, however they won't address all of the impacts.

In addition to environmental impacts, log storage has visual and recreation/cultural impacts. The SFN and others have at times looked over a sea of logs from their community at IR #1, with minimal water surface visible. In addition, the SFN have at times found access to their reserve by boats, canoes and float planes limited by log booms. The MOA has eliminated log storage from directly in front of IR #1, however these impacts could still occur to a lesser degree. The extent of the log storage area also affects the aesthetic and recreational experiences of other user and interest groups, many of whom visit the estuary as one of the more natural marine environments within the City of Nanaimo.

There is a desire to pursue opportunities to reduce the effects of log storage on the ecology of the estuary. Some possibilities for accomplishing this may include eliminating log movements that don't use local facilities or the use of alternative storage methods and locations.

Establishment of a shellfish aquaculture industry in the estuary could raise concerns. The primary concerns relate to impacts on the native shellfish resources, and the effects on wildlife of the increased activity that could take place in the estuary. Establishment of a shellfish industry will be subject to a prior review process, as noted previously.

4.3 Other Land Uses



Next to industry, the SFN is the second largest occupier of land around the estuary. Their IR #1 with their primary community of residences, administration building and associated uses is located on the west shore of the estuary. At IR #3, there is a small residential community along Raines Road. IR #2 is west of the Nanaimo River, and IR #4 is east of IR #3. The large property west of IR #3 (previously owned by the Inuit) has been purchased by the Crown and is being held for treaty.

There is additional residential use within the City of Nanaimo in the form of single and multi-residential housing and mobile home developments across Haliburton and Esplanade Roads from the estuary, and in the Chase River/Wexford Creek area.



Other land uses around the estuary include: a forested private campground/retreat centre just east of the mouth of the Chase River, a significant parcel of vacant land previously owned by the Inuit and recently purchased by the Crown, agricultural land, some of which is managed by The Nature Trust for wildlife, and two municipal parks. Biggs Park on the south-west shoreline of Duke Point is inaccessible, and Jack Point Park on the north-west shoreline of Duke Point has a trail out to the point.

The City of Nanaimo's Official Community Plan (OCP) calls for uses that are generally consistent with existing uses. Two major portions of the estuary shoreline are designated Waterfront. The objectives of this designation include provision of public access and a waterfront trail while respecting marine activity and protecting habitat. The large vacant property (previous Inuit property purchased by the Crown for treaty) is designated Rural Resource Lands.

The Regional District of Nanaimo includes land within the watershed south-east of IRs #2, #3 and #4. This area is primarily designated a combination of rural, resource and low-density residential uses.

In 1997, the Nanaimo Harbour Commission prepared a Port Master Plan. In the estuary, the designations of the plan are consistent with existing use. The Port of Nanaimo is the largest export centre on Vancouver Island, with three deep-sea berths at the Nanaimo Assembly Wharf, and a fourth at Duke Point. The Port Transportation Use designation, which includes the Assembly Wharf and the entire (previous) log storage area, is intended to protect navigation.

Dredging is conducted as required to maintain safe access for large vessels at the deep-sea berths and channels, outside of the estuary study area. Within the estuary, maintenance dredging is undertaken at the log pockets at Western Forest Products, Coastland and at the assembly wharf. There is no regular dredging near the log storage areas or the river, but there is periodic removal of submerged or stray logs by a crane and barge.

Issues and Opportunities

Pressures for development and use are increasing as the City of Nanaimo and the region experience population growth. Both the City and the Regional District have interests in Growth Management.

As this growth occurs, it will be essential to ensure that new development respects and protects the natural resources of the estuary in addition to supporting appropriate economic objectives.

4.4 Recreation



The estuary provides opportunities for a variety of recreational activities.¹¹ Random recreational surveys were performed by the Province and SFN throughout 1998 to help document the range of activities that occur in the estuary. The following are the activities that were noted during those surveys:

Model Airplane flying*	Model Rocket Flying*
Kite Flying	Walking
Dog walking	Dog training
Waterfowl hunting	Rabbit hunting
Fishing	Motor Cycle riding
Four-by-four driving	Nature walks
Bird viewing	Photography
Dog trials	Camping*
Target shooting	Kayaking
Recreational crab fishing	Plant harvesting
Flight Training (helicopter and fixed wing)*	Collecting (e.g., plants, butterflies, shells)
Picnicking	Canoeing

Source: Mark Kissinger. 1999-2000

*As of 2002, these activities no longer occur in the estuary.

Figure 9: Recreation Activities

A more recent tally of recreation use by the estuary steward on 35 separate days from December 30, 2001 to February 13, 2002 provides an indication of the extent of the various winter uses. The following were the activities and participation observed:

¹⁰ The most complete summary of recreational use is contained in the draft plan prepared for the Nature Trust (Kissinger, 2002). That report was used as a primary source in this section, with supplementary information from data collected by the estuary steward.

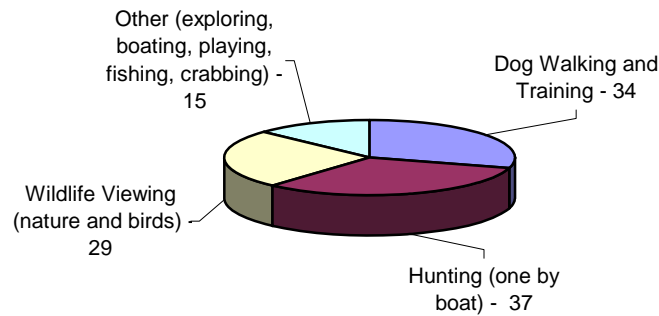


Figure 10: Observed Winter Recreation Use
(number of observations)

From this information, it can be seen that the most popular activities in winter are hunting, dog walking, and nature walking/bird watching. Although there are no statistics available for summer use, anecdotal information indicates that the boating and fishing uses are higher, with walking and wildlife viewing activities also popular. The following paragraphs provide a summary of the primary activities in the estuary.

Hunting

Hunting took place on the Nanaimo River estuary prior to European contact and still continues today. The hunting that occurs here is primarily waterfowl hunting, regulated by both the Provincial Wildlife Act and the Migratory Bird Convention Act. Only waterfowl hunting is permitted.

Studies conducted by A.I. Barnard found approximately 560 waterfowl hunter days during the 1990-91 season. Although current hunting use data is not available, it is likely that hunting use is decreasing due to lower hunting popularity, an ageing population of local hunters, and low recruitment of young hunters. Most (96%) of the hunters that used the Nanaimo River estuary resided in the Nanaimo area (Barnard 1991). Many of these people, some of whom are SFN members, have grown up hunting on this estuary. There is a strong interest by hunters to continue hunting here.

Waterfowl hunting on the Nanaimo River estuary occurs generally between early October and late January, with the possible additions of early and late goose openings. Although weekends and holidays seem to be the most popular periods for hunting, a number of local hunters use this area for day trips before or after work. The estuary can be accessed from several points, the most popular being the end of Raines Road. Most hunters travel on foot, but some use boats. The Nature Trust's central estuary property off of Raines road is by far the most

popular area for hunting. This area received the vast majority of hunter days in the 90-91 season (Barnard 1991), and remains the most heavily used area.

There are a number of regulations that govern hunting on the estuary:

- The federal *Migratory Bird Convention Act* establishes the maximum number of days for migratory bird hunting.
- The provincial *Wildlife Act* provides more specific annual regulations including dates of openings and bag limits for each species. The Act limits the discharge of firearms on lands outside the City limits to shotgun and bow only for the purpose of hunting.
- The City of Nanaimo bylaw 5121 regulates the area on the estuary in which the discharge of shotguns and bows is legal (see Map 10).

Hunting by First Nations is not restricted to the openings established in the Wildlife Act. SFN members respect the City's spatial restriction for safety reasons.

There has been some public disfavour of the City's bylaw allowing discharge of firearms in the estuary, due to perceived safety and conservation issues. Aware of these views, local Fish and Game club members have been working to help reduce the number of unethical, unsafe and illegal hunter practices occurring on the estuary. One method is through participation in a provincial Wilderness Watch Program. Through this program, the Fish and Game Club installed a sign on hunting regulations, they inform their members of hunting regulations, they conduct informal monitoring, and there is a toll-free 24-hour telephone line for reporting infractions.

Some of the hunting that has occurred in the estuary is illegal, such as occasional shooting of species other than waterfowl (e.g., protected and unprotected birds and mammals). The discharge of firearms for anything other than waterfowl is illegal within City limits. There is also occasional target shooting, likely using rifles. Rifle use is not legal.

In 2001 and 2002, the SFN, through the GBEI, employed an estuary steward in monitoring hunting and other activities in the estuary. That program is no longer in place.

Dog Walking and Training



Dogs are primarily present on the estuary for three reasons: walking, training, and hunting. Dog walking is permitted as long as the dog is on a leash and under control. Dog owners found with their dogs off leash can be fined under Nanaimo's bylaw number 4923 "Licensing and Control of Animals Bylaw". Dog owners who allow their animals to chase, harass or disturb wildlife can be charged under the B.C Wildlife Act, Migratory Bird Convention Act and Canadian Wildlife Act.

Despite these restrictions, dogs are often off leash in the estuary since it is an attractive location for people to exercise their dogs. For example, the majority of people using Biggs Park are dog walkers, and most of these allow their dogs off leash (McNaughton, pers. comm.). Private dog training also takes place on estuary lands without permission. Both off-leash dog walking and private training occur all year, including during the bird-breeding season. These activities have the potential to cause major disturbances to wildlife, and there are concerns about fecal coliforms related to off-leash dog use, including use in adjacent upland areas such as Biggs Park.

The use of dogs for waterfowl hunting is permitted. Hunting with dogs does not include training, trials or competition. Conditions for the use of dogs as hunting aids are outlined in the Provincial Wildlife Act. Dogs used for hunting must still be under the control of their owner.

Nature Walking and Bird Watching

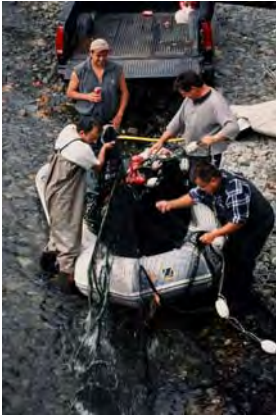


A significant number of people visit the estuary for nature walking and bird watching. Most of these people access the estuary from the parking lot at the end of Raines Road. A major path leads from the parking lot to the viewing tower east of the old gravel pit pond. From the viewing tower, there are informal routes but no distinct or signed trails.

There is a significant demand for more access and walking opportunities. At the public open house for this project held on April 11, 2002, a number of people suggested that public access be provided near Holden Creek. This suggestion is not considered acceptable to The Nature Trust, MOE, SFN or the Nanaimo Field Naturalists for the following reasons:

- there are concerns about potential wildlife disturbance since the* area is managed as winter habitat for birds,
- there are concerns about potential impacts of public use on First Nations cultural resources, and
- there are concerns about potential conflicts with agricultural activities and private land trespass.

Finfish and Shellfish Harvesting



A number of finfish and shellfish populations are present in the estuary in harvestable densities, including salmon and trout, bivalves, herring, and crab species. Each group has a set of regulations which govern the harvest of that group. The management of multiple species for commercial, recreational interests and Aboriginal Rights, considering the biology, behaviour, seasonal timing, food safety and public safety concerns, while maintaining conservation goals, can be complex and challenging.

Harvesting activities occur from the shorelines and from boats in the estuary. There is a significant SFN food fishery within the estuary. SFN have an active fisheries program including aboriginal fisheries officers to help monitor fisheries-related activities and resources. Recreational finfish fishing on the Nanaimo River is restricted to upstream of the Cedar Road bridge.

Opportunities to harvest bivalves are limited, as explained in more detail in section 3.2, due to elevated fecal coliform bacteria levels and concerns about other pollutants. SFN has conducted bivalve stock assessments on the harvestable density areas of the estuary. A portion of the estuary was re-opened to depuration harvesting of shellfish in 2003.

Recreational, commercial and Aboriginal harvests of Dungeness Crab occur year-round on and near the estuary. There appears to be a viable crab population to sustain this fishery. In 2004, sufficient herring populations were present to attract commercial harvest in the herring roe fishery near Jack Point. Anecdotal evidence suggests that there has been little or no herring spawning in the estuary for the past number of decades, and that the attraction of herring could be an indicator of improving estuarine health.

Kayaking and Canoeing



Kayaking and canoeing take place both within the estuary, and along the Nanaimo River. The estuary provides sheltered shallow water with opportunities to view wildlife and it is therefore used as a destination in itself. It is also an attractive terminus to a trip down the Nanaimo River. The greatest use of the estuary for these purposes is during the summer.



The SFN hosts an annual weekend of traditional canoe races each summer on the estuary. SFN members also practice canoeing from early spring until late summer. The First Nations canoeing typically takes place near the foot of Needham Street, except when logs are stored in that area. When there are logs in the way, canoeists paddle on the Nanaimo River against the current where the power lines cross the river (canoeists remain fairly stationary).

Other Activities

A number of other activities take place in the Nanaimo River estuary. Motorized uses occasionally take place within the estuary, including motorcycle, ATV and four-by-four riding. Access is typically across the gravel bar near the end of Raines Road, now that access from the Holden Creek area has been prevented with a gate. Motorized use is not specifically disallowed under the Wildlife Act, but there is a sign saying “pedestrian use only”. The primary concerns are trespass and damage to habitat. MOE will likely change its regulations to make all vehicular use illegal within the estuary.

Some plant harvesting and collecting occurs within the estuary, by SFN and others. Feral asparagus is harvested from the salt marsh by SFN and non-native harvesters. SFN members are allowed to collect plants for cultural purposes. However, collection of native vegetation can be damaging to habitat, especially on Oak Island, where some relatively rare species exist. More explicit signage could help to prevent impacts on sensitive species.

Some previous uses of the estuary have been discontinued. Near the end of Raines Road, there used to be a model airplane landing strip. It was removed in 1999 due to the noise and disruption of wildlife. Activities associated with the landing strip (that no longer occur) included model rocket flying, vehicular access, and camping. Previous to this, perhaps in the 1900’s, portions of the current salt marsh were dyked for agricultural purposes. These dykes have since been naturally breached. Other uses have included orchards, gravel extraction and cement production. A number of fruit trees remain.

Issues and Opportunities

The opportunities for a variety of recreational activities on the estuary are significant, however conflicts among activities and impacts on fish and wildlife can occur. One of the primary causes of conflicts is that nature viewing and hunting occur largely in the same area. In fact, the wildlife-viewing tower is located within a designated hunting area. This has led to situations such as hunters using the tower as a blind. The fact that hunting and birdwatching occur in the same area has led to concerns about public safety. As a result, managing hunting is challenging and it is an extremely high priority issue since the safety of the public is paramount.

“When choosing between the needs of user groups and significant ecosystem impact, the ecosystem should win.”

On the east side of the estuary, there is confusion about the specific location of the Discharge of Firearms boundary (see Map 10). The City of Nanaimo and MOE are working to resolve this issue.

There are also enforcement issues. Those with an enforcement mandate include: MOE Conservation Officers, Canadian Wildlife Service, the RCMP, and the City bylaw enforcement officer. These agencies have not had a strong presence in the estuary, and decreasing resources make it difficult for them to follow up quickly in response to concerns.

The Resource Management Officer Technology (RMOT) program of Malaspina University College has involved students in estuary monitoring in the winter and spring occasionally since 2001. RMOT students are still available.

A primary issue is illegal and inappropriate recreational activities in the estuary, e.g. unethical hunting practices, uncontrolled dog disturbances, motorized vehicle use. Without monitoring, the extent of these activities is unknown. A significant and growing issue is the negative impact of recreational activities on resources, particularly disturbances to wildlife. Waterfowl and shorebirds congregate in the estuary to gather nutrients while expending as little energy as possible. The presence of a person, a dog, or a kayak generally evokes two reactions from waterfowl and shorebirds: a) they stop feeding and monitor the approaching threat; and b) they move away from the threat. Any disruption from feeding can be costly, especially if limited calories are burned to evade a perceived threat.

The specific impacts of public access and other activities on the resources of the estuary are not well known. It would be beneficial to have more information, especially given that pressure for use will undoubtedly increase with population growth. In the meantime, there may be opportunities to reduce potential impacts through changes to public access, increased on-site information, clarification of regulations and appropriate uses, and increased monitoring and enforcement.

One of the primary challenges is that regulations and guidelines for various recreational uses are not clearly communicated to estuary visitors. Additional information could help to minimize conflicts between users and impacts on environmental resources.

The estuary has been closed to bivalve shellfish harvesting for some time. If it were to be reopened, there would likely be some public interest in recreational shellfish harvesting. This would need to be addressed in the context of the overall shellfish resources in the estuary and their use.

As part of its overall recreational function, the estuary is an important visual resource. Any changes to public access or new development around the estuary should consider views of the estuary, views from the

estuary, landscape character, and visual features, e.g. Garry Oak tree near the end of Raines Road.

4.5 Objectives



The following are the primary objectives related to human activities:

- Protect and restore the resources of the estuary while providing opportunities for public recreational use and SFN cultural, spiritual and food collection practices that are compatible with fish and wildlife conservation.
- Minimize the impacts of log storage and handling on the environmental, recreational, economic and cultural resources of the estuary.
- Work with other agencies to ensure that new development respects and protects the natural resources of the estuary in addition to supporting appropriate economic objectives.
- Balance needs to support water-dependent industrial use with needs for habitat protection.

4.6 Management Strategies

The following are the primary management strategies proposed to meet the objectives related to human activities:

- Continue to work with other agencies to return estuarine cultural artifacts to the SFN.
- Take appropriate measures to protect cultural sites and to support cultural activities.
- Reduce the impacts of log storage on existing habitat. Management strategies that will be important include:
 - Monitor log handling practices in the estuary to ensure that best management practices (BMPs) for log storage are implemented. Conduct an annual review of the implementation and results of the BMPs, in consultation with the Nanaimo River Estuary Log Storage Association, and use adaptive management and the best available knowledge to refine the BMPs and their implementation.

- Monitor to ensure that log storage is in compliance with lease boundaries.
 - Monitor log movements as established by the Memorandum of Agreement and use the results to recommend any modification of log storage lease areas at the 5-year reviews.
 - If log storage areas are reduced based on monitoring of log movements, reduce log storage as a first priority in areas of high environmental value.
 - Monitor sites with previous and current log storage to determine how conditions are changing over time; inventory and monitor locations remote from the storage sites to assess debris impacts (e.g., the eelgrass zone).
 - Explore options for increasing the productivity of areas affected by log storage and log debris, e.g. removal of log debris, de-compaction of sediments.
 - Encourage the forest industry to explore alternative facilities and practices to reduce the impacts of log storage and handling on the estuary.
- Work with the City of Nanaimo in investigating opportunities for public access around the estuary in keeping with the objectives of this plan.
 - Maintain or improve ecosystem functioning and ecological integrity in the riparian zone adjacent to the estuary by ensuring that any development plans which would affect the estuary are consistent with the objectives of this plan.
 - Assist enforcement agencies in fulfilling their mandate of providing enforcement of regulations in the estuary.
 - Support the provision of more personnel dedicated to monitoring and enforcement within the estuary, including SFN initiatives.
 - Increase stewardship of the estuary.
 - Work with Malaspina University College and MWLAP to increase the efficiency of monitoring through the RMOT program, in cooperation with the estuary steward.
 - Develop a standardized method for collecting information on recreation and other human use of the estuary (see monitoring section).

- Collaborate with SFN, the City, and MOE to support safe hunting practices within the estuary, potentially including reconfiguration of the designated hunting area, and respecting the size of the existing hunting area.
- Designate Oak Island as a sensitive habitat area, with no unauthorized access. Block vehicular access beyond the road and designated parking lot.
- Provide an interpretive kiosk near the parking lot with information on the resources of the estuary and regulations. The signs should include information on: the hunting area and relevant hunting regulations, spatial and temporal hunting openings and closures, wildlife viewing opportunities, seasonal changes, proper etiquette for viewing wildlife, native and invasive plants, rare species, and the sensitive areas to be avoided.
- Prohibit collecting of rare or threatened plant species, other than SFN harvesting and authorized scientific collections.

5.0 DESIGNATION PLAN

5.1 Designation Plan Categories

The following are the primary management designation categories proposed, along with permissible uses and guidelines for each. Refer to Map 11 for the designation plan.¹² As noted in section 7.6, the map should be updated at the 5-year reviews.

	Description	Permissible Uses	Objectives	Guidelines
C _E	Conservation – native eelgrass beds, highly sensitive	Boating Marine Transportation	Protect the integrity of the eelgrass beds.	No anchoring. Minimize boating at low tide to minimize damage from propeller wash. No log storage. Remove, relocate or improve use of temporary log tie-up.
C _S	Conservation - shellfish reserve – gravel/cobble reef, sensitive area due to high density of shellfish and extensive use by birds	Recreation (including boating), Controlled depuration shellfish harvest, Shellfish aquaculture*	Protect the environmental integrity of the reef habitat. Provide opportunities for shellfish harvest (possibly including aquaculture) as a secondary priority, if water quality standards can be met.	Special provisions to protect habitat and species on reef.
C ₁	Conservation – sensitive river channel, tidal channels, marshes and mudflats	Boating, other recreation, Marine Transportation Hunting where permitted	Protect the habitat values of the river channel, tidal channels, marshes and mudflats.	Activities to respect existing habitat, fish and wildlife species.
C ₂	Conservation – less sensitive, large gravel bars, unstable, adjacent to and within river channel	Recreation – non-motorized only	Recognize the instability of the gravel bars and their importance to river processes.	Use should not interfere with river channels. No structures or construction.
R	Recreation, main area – includes parking lot, trails, viewing platform, interpretive signage	Recreation	Provide opportunities for wildlife viewing and associated low-impact recreational activities.	No hunting. Dogs on leash only. No motorized use beyond parking lot.

¹¹ Although this plan recommends a change to the hunting area, that is not indicated on this plan since modification of that boundary will require extensive consultation with SFN and others, that would extend beyond the time frame available for the development of this plan.

L ₁	Log storage area – sand flats, least sensitive	Log Storage, Recreation (including boating)	Provide opportunities for log storage in these areas with less environmental sensitivity.	Lowest priority for removal of log storage. Follow log storage BMPs.
L ₂	Log storage area – mudflats, moderately sensitive	Log Storage, Recreation (including boating)	Provide opportunities for log storage as a second priority in these areas with moderate environmental sensitivity.	Second priority for removal of log storage. Follow log storage BMPs. Change designation to Conservation if/when log storage is removed.
L ₃	Log storage area – eelgrass beds and tidal channels, highly sensitive	Log Storage, Recreation (including boating)	Protect the eelgrass beds and tidal channels from the impacts of log storage.	Highest priority for removal of log storage. Follow log storage BMPs. Change designation to Conservation if/when log storage is removed.
S	Shellfish reserve – sand/gravel flat	Recreation (including boating), Controlled depuration shellfish harvest, Shellfish aquaculture*, Hunting where permitted	Provide opportunities for shellfish harvest (possibly including aquaculture) as a high priority, if water quality standards can be met. Protect environmental integrity.	Activities to respect existing habitat, fish and wildlife species.
I	Industry – loading and transportation areas related to mills and port	Industry, Recreation (including boating)	Support the needs of adjacent industry.	Activities to respect existing habitat, fish and wildlife species.

*pending compliance with required standards. Water quality standards must be met.

Figure 12: Designation Plan Categories

Future shellfish harvesting will need to comply with minimum setbacks as follows: 300 metres from a major sewage or industrial outfall, and 125 metres from certain permanent or floating structures which may be the source of contamination.

6.0 MONITORING PLAN

6.1 Context for Monitoring



The Nanaimo Estuary Management Plan has established a set of objectives and management strategies that should be measured and used to assess changes in the estuarine environment. This can be achieved by developing an environmental monitoring program that uses estuarine performance indicators and measures of use. The performance indicators should be scientifically-based calculations and measurements that address specific objectives and management strategies.

A completely integrated monitoring program for the Nanaimo Estuary will take some time to develop. A comprehensive description of monitoring procedures is therefore beyond the scope of this report. Moreover, some detailed monitoring procedures already exist for the Nanaimo Estuary¹³, but need to be integrated into an overall comprehensive monitoring program. A framework for the comprehensive monitoring plan is outlined here. This will be developed and put in place by the NEMC, which will also assign responsibilities for reporting on and evaluating the results of the program.

Purpose

The purpose of this section is to provide a framework and guidelines for a comprehensive and integrated biophysical monitoring program to complement the Nanaimo Estuary Management Plan.

Monitoring Goal and Principles

The overall goal of the monitoring program is to assess the long-term health and integrity of the Nanaimo Estuary, and the success of habitat restoration and enhancement initiatives.

The proposed monitoring program is based on the following principles:

- Monitoring objectives are clearly stated and include measurable indices against which to measure change.
- A thorough baseline of existing conditions is provided.

¹² E.g., SFN water quality and shellstock monitoring programs, bird counts.

- Key biophysical components and functions of the estuarine ecosystem are represented in the monitoring plan.
- The plan has a good spatial as well as temporal coverage of the estuarine habitats and the ecological processes.
- Partnerships are developed with existing government and non-government organizations that are involved in estuarine/marine monitoring efforts.
- Periodic workshops are organized to help establish and strengthen coordinated estuarine monitoring partnerships that include the Nanaimo Estuary.
- A panel of local and regional estuarine experts develop specific monitoring protocols, establish priorities, evaluate results, provide quality controls, and generally guide the direction of the monitoring program.
- The estuarine performance indicators selected for the monitoring plan are based on specific standards or criteria to which results can be compared.
- Monitoring includes measures related to recreation and industrial use.
- The monitoring program includes searching out the causes related to the monitoring results.
- The monitoring program is linked to an adaptive management plan so that recommendations based on the results of the monitoring work can be acted upon.
- The results of monitoring are made available to the public.

Estuarine Performance Indicators

As previously indicated, estuarine indicators must represent the key biophysical components and functions of the estuarine ecosystem. The indicators should therefore serve as sentinels of the health of the estuarine ecosystem. They should also be sensitive and responsive to the effects of human activities so that the monitoring program can serve as an early warning system for the ongoing estuary management and planning process. Finally, the estuarine indicators should be relatively easy and inexpensive to measure so that excessive costs don't become a deterrent to maintaining a continuous and comprehensive monitoring program.

Given the criteria and conditions described above, the monitoring plan provides goals, objectives and other criteria required for measurement of performance indicators related to the following list of resources and uses. These are provided to help with the development of an environmental monitoring plan.

- River Flow
- Water Quality
 - Sediment Toxicity
 - Bivalve Toxicity
 - Fecal Coliform Contamination
 - Bivalve Abundance and Diversity
- Vegetation
 - Marsh, and Riparian Trees and Shrubs
 - Lower Intertidal and Eelgrass
- Fish
- Wildlife

Measures of Use

As a tool in evaluating the impacts of various uses on natural resources, it is important to measure the primary uses occurring in the estuary. This will support evaluation of the relationships between these uses and biophysical conditions. The primary uses to be monitored include:

- Recreation Use
- Log Storage

6.2 River Flow Monitoring

The freshwater discharges from the Nanaimo River are an integral part of the estuarine ecology. This source of water provides the fresh and brackish conditions critical to the survival of many plant and animal species in the estuary. River flows also influence substrate and channel characteristics that are vital to the estuary's fish and wildlife resources. The natural hydrology of the Nanaimo River is sensitive to human activities in the watershed and should therefore be closely monitored as part of the estuary management plan.

River flow and temperature monitoring are already in place. The results should be acquired and reviewed as part of the NEMP monitoring program. There is a chance that river monitoring will be reduced due to limited government resources. This should also be tracked.

Partnership Abbreviations	
City	City of Nanaimo
CWS	Canadian Wildlife Service
DFO	Dept of Fisheries and Oceans
EC	Environment Canada
LSA	Nanaimo River Estuary Log Storage Association
MAL	Ministry of Agriculture and Lands
MOE	Ministry of Environment
NFN	Nanaimo Field Naturalists
NPA	Nanaimo Port Authority
RDN	Regional District of Nanaimo
SFN	Snuneymuxw First Nation
TNT	The Nature Trust

Goals	<ul style="list-style-type: none"> • Maintain a flow regime that will sustain the estuarine biota and also provide an adequate year-round water supply for the proper movement of fish populations.
Objectives	<ul style="list-style-type: none"> • Assess significant long-term changes in hydrology
Parameter	Flows
Biophysical Component	River Channel
Measurement	Total and seasonal discharges
Sampling Location	Existing flow gauging stations
Sampling Frequency	Continuous data logging
Remedial Action	<ul style="list-style-type: none"> • Identify causal factors. • An integrated watershed management plan should be implemented to address significant hydrological issues
Partnerships	SFN City EC MOE

6.3 Water Quality Monitoring



Pollutants transported into the estuary by the Nanaimo River and adjacent watersheds, municipal storm sewers, and tides are detrimental to fish and wildlife resources. Because of the complex patterns of tides, river flows, and mixing in the estuary, general water quality sampling is not recommended, with the exception of fecal coliform sampling in connection to the shellfish assessment and water quality program. Instead, water quality should be inferred from sediment chemistry and biota, since those are much more reliable and sensitive pollution indicators. Fine, organic sediments associated with mudflats are efficient traps for toxic metals and organic pollutants. Filter-feeding invertebrates such as bivalves are particularly good pollution indicators for metals, organic pollutants, and bacteria. The abundance and diversity of bivalves also provides an indication of general water and sediment quality.

Sediment Toxicity

Goals	<ul style="list-style-type: none"> • Reduce contamination levels in the sediments that may present a risk to the estuarine biota 						
Objectives	<ul style="list-style-type: none"> • Comply with Canadian Sediment Quality Guidelines¹⁴ 						
Parameter	Sediment Chemistry						
Biophysical Component	Sand Flat, Mudflat, Eelgrass Zone, Marsh						
Measurement	Metals (Cd, Cu, Ni, Zn, Pb, and Mn) Organics (PAHs, PCBs, chlorophenols, pesticides, dioxins, TOC)						
Sampling Location	Sandflats, mudflats, eelgrass zone, marshes						
Sampling Frequency	Annual spot checks with more comprehensive sampling every five to ten years						
Remedial Action	<ul style="list-style-type: none"> • Identify causal factors • Source control • Integrated stormwater management • Watershed management 						
Partnerships	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">SFN</td> <td style="width: 50%;">EC</td> </tr> <tr> <td>DFO</td> <td>MOE</td> </tr> <tr> <td>RDN</td> <td>City</td> </tr> </table>	SFN	EC	DFO	MOE	RDN	City
SFN	EC						
DFO	MOE						
RDN	City						

Bivalve Toxicity

Goals	<ul style="list-style-type: none"> • Reduce tissue burdens of contaminants in bivalves that may be consumed by humans and/or wildlife
Objectives	<ul style="list-style-type: none"> • Comply with Canadian Tissue Residue Guidelines¹⁵ • Comply with Depuration Fecal Standards¹⁶
Parameter	Bivalve Tissue Residues
Biophysical Component	Sand Flat, Mud Flat
Measurement	Metals: (Cu, Ni, Zn, Pb, As, and Mn) Organics: (PAHs, PCBs, chlorophenols, pesticides, dioxins) Bacterial: Fecal coliforms
Sampling Location	Existing sampling stations established by Environment and Health Canada
Sampling	Annual spot checks with more comprehensive

¹³ CCREM. Canadian Environmental Quality Guidelines. Chapter 6. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life.

¹⁴ CCREM. Canadian Environmental Quality Guidelines. Chapter 8. Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota.

¹⁵ Environment Canada and Fisheries and Oceans Canada, Canadian Shellfish Sanitation Program

Frequency	sampling every five to ten years; every three years if depuration harvest is taking place (per DFO requirements)								
Remedial Action	<ul style="list-style-type: none"> • Identify causal factors • Integrated stormwater management • Agricultural Best Management Practices 								
Partnerships	<table> <tr> <td>SFN</td> <td>EC</td> </tr> <tr> <td>DFO</td> <td>MOE</td> </tr> <tr> <td>MAL</td> <td>RDN</td> </tr> <tr> <td>City</td> <td></td> </tr> </table>	SFN	EC	DFO	MOE	MAL	RDN	City	
SFN	EC								
DFO	MOE								
MAL	RDN								
City									

Fecal Coliform Contamination

Goals	<ul style="list-style-type: none"> • Reduce fecal coliform contamination in marine and freshwater sources. 		
Objectives	<ul style="list-style-type: none"> • Comply with Standards set out in the Canadian Shellfish Sanitation Program 		
Parameter	Microbiological		
Biophysical Component	Eegrass Zone, Gravel/Cobble Reef, Sand/Gravel Flat, Mudflat, Gravel Bar, Tidal Marsh, River Channel, Permanent Tidal Channel.		
Measurement	Total Fecal Coliforms		
Sampling Location	Use existing stations of the S.F.N. Water Quality Program		
Sampling Frequency	Sample bimonthly during winter, spring, and summer.		
Remedial Action	<ul style="list-style-type: none"> • Identify causal factors • Source control • Integrated stormwater management • Watershed management 		
Partnerships	<table> <tr> <td>SFN</td> <td>EC</td> </tr> </table>	SFN	EC
SFN	EC		

Bivalve Abundance and Diversity



Goals	<ul style="list-style-type: none"> • Monitor the health of the estuarine clam population in terms of diversity and abundance
Objectives	<ul style="list-style-type: none"> • Document species and relative abundance of clams • Delineate the spatial distribution and abundance within the estuary • Detect changes in either abundance or diversity, including invasive species (e.g., the varnish clam)
Parameter	Clam (Bivalve) Diversity and Abundance
Biophysical Component	Sand and Gravel Flat; Mudflat

Measurement	Inventory bivalve species and abundance using protocol developed by the Marine Ecology Station (MES) ¹⁷
Sampling Location	Several; sampling grid should be designed with a monitoring objective
Sampling Frequency	Every five years with some stations monitored more frequently, preferably quarterly Stock assessments for clam wild depuration harvests to be conducted annually
Remedial Action	• Relate results to other monitoring programs
Partnerships	SFN DFO Marine Ecology Station Georgia Strait Alliance Malaspina College EC MOE

6.4 Vegetation Monitoring



Aquatic and riparian vegetation provides the foundation of the estuarine food web. A healthy and diverse estuarine flora ensures the continuity of the estuary's detritus-based food web, and the productivity and diversity of the fauna that it supports. Changes to the vegetation community may occur on a small scale due to shoreline developments; however, the cumulative effect of this habitat loss can be significant in the long-term. Larger scale changes may also occur due to environmental factors such as global warming. These vegetation changes must be monitored to determine if the overall vegetation habitat balance of the estuary alters over time.

Marsh, and Riparian Trees and Shrubs

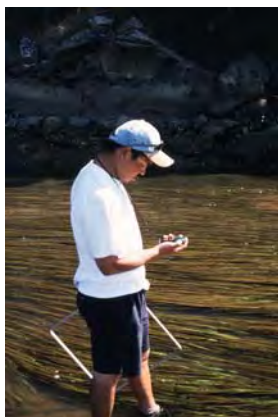
Goals	<ul style="list-style-type: none"> • Maintain, and if feasible, enhance the amount of marsh and riparian forest and shrub vegetation. • Maintain the overall floristic species diversity.
Objectives	<ul style="list-style-type: none"> • To determine the amount and distribution of emergent and riparian vegetation communities • To determine the species diversity of the emergent aquatic flora
Parameter	Emergent and upland vegetation areas
Biophysical Component	Marsh, Riparian Forest, Riparian Shrub
Measurement	Photo-interpretation with ground truthing. Incidence, health and extent of vulnerable plant

¹⁶ Marine Ecology Station, Sidney, BC. This protocol is especially amenable to volunteer or stewardship groups. SFN currently follows Gillespie, G.E. and A.R. Kronlund. 1999. A manual for intertidal clam surveys. Can. Tech. Rep. Fish. Aquat. Sci. 2270:144

	species. Extent of invasive species. Satellite image analysis, provided that high-resolution images can be obtained.
Sampling Location	Upper estuary
Sampling Frequency	Every five years
Remedial Action	• Habitat restoration and enhancement initiatives
Partnerships	SFN DFO NFN
	MOE City

Lower Intertidal and Eelgrass

There is presently no published documentation of the subtidal habitats of the Nanaimo Estuary. Mapping of the distribution of eelgrass is currently underway. There is no documentation of substrate type or the degree of disturbance of the nearshore from wood debris. For example, bark is known to be widely distributed on the Nanaimo Harbour and Duke Point seabed but there is no information on its occurrence within the planning area.



Goals	• Ensure that the areas of high-valued habitats (e.g., eelgrass) are increasing and that degraded habitats are minimized or being improved.
Objectives	• Determine the distribution of lower intertidal habitats including substrate, vegetation, faunal communities and man-made debris.
Parameter	Lower intertidal and eelgrass vegetation and habitats
Biophysical Component	Intertidal and eelgrass zone
Measurement	Biophysical unit maps derived from photo-interpretation and ground truthing using GPS Cover estimates based on intertidal transects. Underwater video survey to establish the lower perimeter of growth
Sampling Location	Lower estuary
Sampling Frequency	Every five years
Remedial Action	<ul style="list-style-type: none"> • If habitat value is not found to be improving as a result of the recommended management practices, re-evaluate causal factors and linkages • Remedial action may be required to improve habitat (for example, wood debris is currently dredged from the Tacoma estuary and disposed of on land to reduce the potential for anaerobic seabed conditions)

	<ul style="list-style-type: none"> Habitat restoration and enhancement initiatives should be considered a last resort since eelgrass transplanting efforts have not been very successful elsewhere in coastal B.C.
Partnerships	SFN DFO Malaspina College

6.5 Fish Monitoring



The production and diversity of fish populations, especially resident species will be maintained (and possibly enhanced) if the previous performance indicators show positive results for the overall health of the estuary. However, the production of migratory fish stocks such as herring and salmon are also significantly influenced by environmental factors outside of the estuary, such as ocean survival and harvesting. Therefore, fish are not the most sensitive, reliable, and easily measured performance indicator of the estuary. Nevertheless, the available pool of fish data should be examined in order to monitor the trends in fish abundance and diversity.

Goals	<ul style="list-style-type: none"> Maintain and enhance the production and diversity of fish
Objectives	<ul style="list-style-type: none"> To determine the trend in fish abundance and diversity
Parameter	Resident and Migratory Species
Biophysical Component	All biophysical components but especially River Channel and Permanent Estuarine Channel
Measurement	Existing Escapement Data Existing research and study results
Sampling Location	River Channel Permanent Estuarine Channels
Sampling Frequency	Year-round
Remedial Action	<ul style="list-style-type: none"> Integrated Watershed Management Estuarine Management Stock Harvesting Management
Partnerships	SFN DFO MOE City

6.6 Wildlife Monitoring



The abundance and diversity of wildlife populations is dependent on the health and abundance of the estuary's habitats. Therefore, river flow, water quality, and vegetation performance indicators would be adequate surrogate indicators for the overall health of wildlife. In spite of this, birds are a good performance indicator because they are so easily observed. However, migratory birds are influenced by life history characteristics such as breeding that occurs outside of the estuary. Nevertheless, bird census data over time should be examined in order to monitor the general trends in population abundance and species diversity of migratory birds in using the estuary.

Goals	<ul style="list-style-type: none"> • Maintain and enhance the abundance and diversity of birds 								
Objectives	<ul style="list-style-type: none"> • To determine the trend in bird abundance and diversity 								
Parameter	Birds and Small Mammals (including wintering waterfowl, migratory birds [i.e., shorebirds and waterfowl], breeding birds)								
Biophysical Component	Entire estuary								
Measurement	Census data								
Sampling Location	Entire estuary								
Sampling Frequency	Bird counts using existing data sources such as Christmas Bird Counts and Coastal Waterbird Survey Mammal count at high tide every 5 years								
Remedial Action	<ul style="list-style-type: none"> • Habitat restoration and enhancement • Local hunting quotas • Liaison with international initiatives to protect breeding habitats 								
Partnerships	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">SFN</td> <td style="width: 50%;">CWS</td> </tr> <tr> <td>MOE</td> <td>NFN</td> </tr> <tr> <td>B.C. Hydro</td> <td>City</td> </tr> <tr> <td>Malaspina College</td> <td>TNT</td> </tr> </table>	SFN	CWS	MOE	NFN	B.C. Hydro	City	Malaspina College	TNT
SFN	CWS								
MOE	NFN								
B.C. Hydro	City								
Malaspina College	TNT								

6.7 Recreation Use Monitoring



Recreation use can have significant impacts on the wildlife and vegetation resources in the estuary. To better understand potential impacts of recreation use on resources in the future, a monitoring program would be beneficial.

Goals	<ul style="list-style-type: none"> • Ensure that recreation does not have undue negative impacts on resources • Eliminate illegal, unethical and inappropriate activities 								
Objectives	<ul style="list-style-type: none"> • To determine the patterns and trends in recreation use 								
Parameter	Major categories of recreation use, e.g., hunting, dog walking and training, wildlife-viewing, other								
Biophysical Component	Entire estuary								
Measurement	Numbers of participants								
Sampling Location	Entire estuary divided into discrete areas illustrated and named on a map								
Sampling Frequency	Daily at varying times. Include all seasons, weekends and weekdays.								
Remedial Action	<ul style="list-style-type: none"> • Revise area designations • Improve signage and other education • Increase monitoring 								
Partnerships	<table> <tr> <td>SFN</td> <td>CWS</td> </tr> <tr> <td>MOE</td> <td>NFN</td> </tr> <tr> <td>RMOT Program</td> <td>TNT</td> </tr> <tr> <td>City</td> <td></td> </tr> </table>	SFN	CWS	MOE	NFN	RMOT Program	TNT	City	
SFN	CWS								
MOE	NFN								
RMOT Program	TNT								
City									

6.8 Log Storage Monitoring



Log storage is known to cause direct impacts to habitat through shading, compaction of sediments and addition of organic loading that promote anaerobic conditions within the surficial sediments. Indirect impacts include damage to habitat through handling operations (tows to and from the storage site) and damage to adjacent habitats from wood debris (e.g., bark) that commonly originates from storage sites. The overall goal of the management plan is to reduce impacts of the log storage on the estuarine ecosystem.

The MOA includes a program for monitoring log movements and the Nanaimo River Estuary Log Storage Association is committed to use of Best Management Practices in log management. It will also be critical to monitor log storage patterns, and the recovery of areas previously affected directly and indirectly by log storage.

Goals	<ul style="list-style-type: none"> • Reduce the impacts of log storage on the estuarine ecosystem • Promote impact recovery through remediation projects 								
Objectives	<ul style="list-style-type: none"> • Assess the 5-year monitoring results to identify opportunities for reduction and/or relocation of log storage in the estuary • Ensure that log storage is in compliance with lease boundary • Ensure that best management practices (BMPs) are followed • Measure recovery of areas previously affected by log storage (e.g., bivalve monitoring program) 								
Parameter	<p>Log storage areas in use Log debris Recovery of areas previously affected by log storage</p>								
Biophysical Components	Eelgrass, mudflat, marsh, tidal channels, sand and gravel flat								
Measurement	<p>Inventory lower intertidal and eelgrass areas of estuary for wood debris accumulations Document extent of area being used for log storage in relation to lease area as measured on ground Conduct periodic audits of BMPs Measure bivalve abundance and diversity in decommissioned storage areas (see Bivalve Abundance and Diversity) Measure surface vegetation cover in decommissioned areas</p>								
Sampling Location	Lower intertidal and eelgrass zones								
Sampling Frequency	<p>One time survey of lower intertidal and eelgrass zones; repeat in five years for selected sub-habitats Quarterly checks on storage boundaries Semi-annual audits of BMPs Annual measurements of surface vegetation</p>								
Remedial Action	<ul style="list-style-type: none"> • Initiate compliance and/or enforcement action for non-compliance with the sublease • If monitoring shows little to no recovery of impacted sites, implement remediation plan and/or factor into 5 year review of the sub-leases 								
Partnerships	<table> <tr> <td>SFN</td> <td>LSA</td> </tr> <tr> <td>DFO</td> <td>MOE</td> </tr> <tr> <td>NPA</td> <td>City</td> </tr> <tr> <td>MAL</td> <td></td> </tr> </table>	SFN	LSA	DFO	MOE	NPA	City	MAL	
SFN	LSA								
DFO	MOE								
NPA	City								
MAL									

7.0 IMPLEMENTATION PLAN

7.1 A Commitment to Work Together



The agencies and organizations that participated in the preparation of the Nanaimo Estuary Management Plan endorse the plan and will work cooperatively together to implement the provisions of the plan in accordance with their respective jurisdictions and interests. Some other agencies, who were not part of the Steering Committee, also agree to endorse the plan and to work cooperatively on its implementation.

Unlike an Official Community Plan for a municipality, the Nanaimo Estuary Management Plan will be carried out by a number of agencies and organizations. Those agencies and organizations are the same ones that were involved in preparation of the plan, plus the City of Nanaimo¹⁸ and the Ministry of Transportation¹⁹. The proposed Nanaimo Estuary Management Committee (NEMC) includes the agencies with a jurisdiction or mandate related to management of the estuary. It is recognized that some of the agencies below may change with reorganization; those with a relevant jurisdiction or mandate are expected to participate:

- Snuneymuxw First Nation
- Fisheries and Oceans Canada
- Environment Canada
- Ministry of Environment
- Ministry of Transportation
- Ministry of Agriculture and Lands
- The Nature Trust of B.C.
- Regional District of Nanaimo
- Nanaimo Port Authority
- City of Nanaimo

Based on the process used in the development of the NEMP by the Steering Committee, the two primary interest groups will be included in NEMC, based on the protocol for participation developed for the SC (see Appendix C). The two interest groups will include:

¹⁷ The City of Nanaimo participated in the early stages of estuary planning, and will participate fully in the implementation of the NEMP through participation in the NEMC.

¹⁸ The Ministry of Transportation now manages the head lease to the Nanaimo Port Authority.

- Nanaimo River Estuary Log Storage Association
- Nanaimo Community Estuary Support Coalition

Should the composition or names of interest groups change in the future, the groups will be adjusted accordingly.

Implementation of the NEMP will not require any new jurisdictions, regulations or bylaws. To ensure that the plan is implemented, the NEMC members will work together to implement the provisions of the plan in accordance with each member's existing jurisdiction, legislation, regulations, policies and procedures and bylaws (see Appendix B). The NEMC will appoint their own Chair for a time interval determined by them. The NEMC will hire a Coordinator.

The SFN are working towards Treaty, and are in the final stages of development of an Agreement in Principle (AIP). Once a Treaty is in place, subsequent Treaty Settlement Legislation will be enacted which may impact upon the management role of the NEMC.

The role of the NEMC will include working together on the following responsibilities, which are described more fully in the sections following this list:

- Forge partnerships among the agencies to facilitate implementation of the NEMP (section 7.2),
- Agree to proceed using consensus-based decision-making principles without limiting the authority of any decision-making party (section 7.3),
- Oversee the monitoring component of the NEMP (section 7.4),
- Review proposed projects within the plan area and provide comments and recommendations related to their level of compliance with the NEMP (section 7.5),
- Coordinate activities within the estuary which are not under the jurisdiction of any agency (e.g., plant collecting) (section 7.5),
- Make best efforts to financially support joint funding for NEMP coordination, monitoring, research and planning activities (section 7.6),
- Evaluate and update the plan on an ongoing basis (section 7.7), and
- Work to integrate, to the greatest extent possible, the NEMP with other plans and policies e.g. Nanaimo and Regional District OCPs, Nanaimo Port Authority's Port Master Plan.

7.2 Partnerships

Numerous sections in the NEMP, in addition to the Monitoring section, refer to the importance of establishing partnerships. Partnerships can play a role in estuary stewardship, monitoring, enforcement, and special projects such as provision of interpretive signage, or habitat restoration and enhancement efforts.

Special mechanisms that formalize partnerships may be useful in advancing implementation. This could include mechanisms such as shared projects, joint funding applications, and Memoranda of Understanding.

7.3 Decision-making Process

The decision-making process of the NEMC will be based on the following Terms of Reference:

Terms of Reference for the Nanaimo Estuary Management Committee

The participants in the Nanaimo Estuary Management Plan (NEMP) agree to be guided by the plan, provided that said provisions do not fetter the jurisdiction, statutory decision-making mandate or any other rights or responsibilities of the respective organizations.

The effectiveness and legitimacy of the Nanaimo Estuary Management Plan lies in:

- finding options to meet the plan's purpose that are acceptable to all those concerned, including those who must implement them, and
- where a mutually-acceptable solution cannot be found, providing an informed report on the issues underlying the problem for possible future resolution.

The following statements describe the purpose, conduct and responsibilities of the NEMC.

1. The purpose of the NEMC is to guide the implementation of the NEMP as per the provisions of the plan, including the vision, objectives, management strategies, and the monitoring, area designation, and implementation plans.
2. The NEMC is composed of representatives from all levels of government, including federal, provincial, local and First Nations. A list of member agencies and their statements of interest and jurisdiction, are provided in the plan.

3. The NEMC will appoint its own Chair for a period of two years, and this decision will be reviewed every two years. The NEMC will outline the responsibilities of the Chair.
4. The NEMC will select a coordinator. The NEMC will develop a Terms of Reference for the coordinator.
5. The NEMC is responsible for its own process, and members are expected to participate in good faith, conducting themselves reasonably and respectfully without relying on a rigid set of procedural rules.
6. Contact with the media will be done through a single spokesperson designated as the Chair of the NEMC. Individual members do not speak on behalf of the NEMC.
7. The NEMC will meet quarterly or more frequently as needed. To hold a meeting, six members must be present. Alternates or proxies are acceptable.
8. The NEMC, by its nature, cannot create or take away existing legal rights, or interfere with the jurisdiction or legislated mandate of governments, nor can it make decisions outside the mandates of individual representatives. The Snuneymuxw First Nation is participating on a government to government basis.
9. Because decisions must be acceptable to all concerned, the NEMC makes recommendations affecting the interests of its participants by consensus.
 - Consensus is reached when each participant accepts the combined effect of all the parts of a proposed action or recommendation.
 - A member who cannot accept a proposed action or recommendation should explain how it would adversely affect the agency's interests, and should propose an alternative which satisfies all interests.
10. If a problem cannot be solved by consensus, the participants may agree to disagree about certain issues. If/when such disagreements occur, minority opinion(s) together with supporting information, will be included with any recommendation(s) and become a part of the public record. The NEMC may, at its discretion, appoint subcommittees to address specific topics and report back to the NEMC. Members of subcommittees may include individuals or representatives of organizations that are not part of the NEMC.
11. The NEMC will put in place, on a priority basis, a list of key projects with targets and timelines, including reporting milestones, as essential components of the action plan for the implementation of the NEMP.
12. Since the NEMP was developed in consultation with interest groups and the public input, the NEMC has a responsibility to consult with

those parties if major changes to the NEMP are proposed, or if a proposed project or activity may be inconsistent with the provisions of the NEMP.

13. The term of the NEMC is unlimited.

No business conducted by the NEMC will abrogate or derogate from the aboriginal or treaty rights of the Snuneymuxw First Nation or give any government agency a justification for infringing aboriginal or treaty rights.

7.4 Monitoring



As noted in section 6 of this plan, monitoring of the estuary will be a key to measuring the strengths and weaknesses of the NEMP, and in determining how it will need to change over time. In order to implement the monitoring program, the following will be required:

- Establish a Monitoring Sub-Committee with representatives of the NEMC as well as other local and regional estuarine experts, with a Terms of Reference for the Sub-Committee to be established by the NEMC,
- The Monitoring Sub-Committee will refine the monitoring program, including performance indicators, sampling locations, sampling frequency, reporting procedures, and remedial actions.
- The Monitoring Sub-Committee will coordinate responsibilities for monitoring, including forging of partnerships to support the monitoring program.
- The Monitoring Sub-Committee will review the results of monitoring efforts and report the results to the NEMC.

7.5 Coordination of Activities

The NEMC has an interest in being made aware of potential development or other projects within the estuary, and in having the opportunity to comment collectively on the social, economic and environmental impacts of these projects on the estuary. A formal project review process is not envisioned as part of the NEMC's scope.

The coordinator will be responsible for facilitating implementation of the NEMP, particularly the provisions that do not fall within the mandate of the respective agencies. This will include:

- Coordination of the monitoring program,
- Informing NEMC members about potential development projects and organizing the collection of comments,
- Preparation of an annual summary report on projects completed under the NEMC umbrella, including progress, budgets, issues encountered, and the making of these reports available to the public,
- Preparation of project and budget reports, with more detail than the annual summary report, if applicable,
- Coordination of plan updating,
- Developing, in consultation with the NEMC, and implementing a communications strategy with respect to the NEMP and its implementation, and
- Developing guidelines, in consultation with the NEMC for activities which are not under the authorization of any agency (e.g., collecting), and providing authorization for such uses.

The NEMC will expand the role of the coordinator if necessary based on experience over time.

7.6 Funding

“The estuary is one of the greatest natural assets in the region and it is important to ensure that this resource is protected to yield the best social and economic returns.”

The NEMP builds on existing programs and relies on strengthening partnerships, with the intent of optimizing the use of funds and maximizing resources from government and non-government agencies. The NEMP provides a framework for more effective coordination of funding partners and identification of opportunities for linkages among participants.

Two types of costs are involved in carrying out the NEMP: non-capital costs and capital projects.

Non-capital costs will be incurred for activities associated with coordination, research, planning, monitoring and evaluation.

Capital projects such as interpretive signage, and habitat restoration and enhancement efforts will require dedicated project funds.

One of the roles of the NEMC will be to solicit funds from among NEMC and others, and to develop cost-sharing agreements. The requirements for funding will need to be determined during the early stages of plan implementation.

7.7 Plan Review and Updating

The NEMP will be reviewed at least every 5 years, and updated if necessary at that time, unless there is a trigger that leads to the need for an earlier update. The NEMC will decide if an earlier update is required.

Updating of the plan will involve the following primary tasks:

- Review of the plan vision, objectives and principles to confirm that they still apply or to modify them if required,
- Preparation of a “state of the estuary” report, to be made available to the public, outlining current fish and wildlife habitat, water quantity and quality, and human activities conditions based on monitoring, and any changes to use of the estuary that have occurred since the previous plan was prepared,
- Review of the objectives and management strategies in each section of the plan to confirm that they still apply or to modify them if required,
- Review and report on the utilization and outputs of any funding that has been provided to the NEMC in order to evaluate cost-effectiveness and to determine future funding,
- Update of the Designation Plan based on any new biophysical and human activity information, and the results of monitoring,
- Update of the Monitoring Plan, if required, and
- Update of the Implementation Plan, if required.

At least one public session should be held to allow for review and comment on proposed changes to the NEMP.

APPENDIX A: COMMON AND SCIENTIFIC NAMES

Part 1

Part 1 of this appendix provides the scientific names for the common species names mentioned in this plan. It is by no means an all-inclusive list of the species found in the Nanaimo Estuary.

VEGETATION

Upland

COMMON NAME	SCIENTIFIC NAME
American Glasswort	<i>Salicornia virginica</i>
Bigleaf Maple	<i>Acer macrophyllum</i>
Bittercherry	<i>Prunus emarginata</i>
Boxwood	<i>Pachistima myrsinites</i>
Chaffweed	<i>Centunculus minimus</i> or <i>Anagallis minima</i>
Common Camas	<i>Camassia quamash</i>
Douglas-fir	<i>Pseudotsuga menziesii</i>
Garry Oak	<i>Quercus garryana</i>
Arbutus	<i>Arbutus menziesii</i>
Gerard's or Mud Rush	<i>Juncus gerardii</i>
Grand Fir	<i>Abies grandis</i>
Gumweed	<i>Grindelia integrifolia</i>
Indian-Plum	<i>Oemleria cerasiformis</i>
Kinnickinnick	<i>Arctostaphylos uva-ursi</i>
Nootka Rose	<i>Rosa nutkana</i>
Northern Rice Root	<i>Fritillaria camschatcensis</i>
Pacific Crabapple	<i>Malus fusca</i>
Pacific Sanicle	<i>Sanicula crassicaulis</i>
Rocky Mountain Juniper	<i>Juniperus scopulorum</i>
Saskatoon	<i>Amelanchier alnifolia</i>
Scotch Broom	<i>Cytisus scoparius</i>
Sea Arrow-Grass	<i>Triglochin maritimum</i>
Seashore Saltgrass	<i>Distichlis spicata</i>
Silverweed	<i>Potentilla pacifica</i>
Tall Oregon-Grape	<i>Mahonia aquifolium</i>
Tufted Hairgrass	<i>Deschampsia cespitosa</i>

Submergent and Emergent

COMMON NAME	SCIENTIFIC NAME
American Glasswort	<i>Salicornia virginica</i>
Arrow-Grass	<i>Triglochin maritimum</i>
Clubrush	<i>Eleocharis spp</i>

Lyngby's Sedge	<i>Carex lyngbyei</i>
Mud or Gerard's Rush	<i>Juncus gerardii</i>
Pacific Silverweed	<i>Potentilla pacifica</i>
Seashore Saltgrass	<i>Distichlis spicata</i>

Subtidal

COMMON NAME	SCIENTIFIC NAME
Japanese Eelgrass	<i>Zostera Japonica</i>
Common Eelgrass	<i>Zostera marina</i>
Sea Lettuce	<i>Ulva sp.</i>
Red Sea Spaghetti	<i>Gracilaria pacifica</i>

WILDLIFE

Amphibians and Reptiles

COMMON NAME	SCIENTIFIC NAME
Common Garter Snake	<i>Thamnophis sirtalis</i>
Long-toed Salamander	<i>Ambystoma macrodactylum</i>
Northern Alligator Lizard	<i>Elgaria coerulea</i>
Northwestern Garter Snake	<i>Thamnophis ordinoides</i>
Pacific Tree Frog	<i>Hyla regilla</i>
Red-legged Frog	<i>Rana aurora</i>
Rough-skinned Newt	<i>Taricha granulosa</i>
Western Terrestrial Garter Snake	<i>T. elegans</i>

Marine Invertebrates

COMMON NAME	SCIENTIFIC NAME
Amphipods	<i>Corophium salmonis, Paramoera columbiana, and Eogrammarus spp</i>
Barnacle	<i>Balanus glandula</i>
Boring Polychaete	<i>Polydora proboscidea</i>
Buried Anemone	<i>Anthopleura artemisia</i>
Chironomid (insect) larvae	<i>Chononidae</i>
Clams:	
Manila or Japanese Littleneck	<i>Venerupis philippinarum</i>
Bent-nose Clams	<i>Macoma nasuta, Macoma balthica</i>
Soft-shell Clam	<i>Mya arenaria</i>
Pacific or Native Littleneck	<i>Protothaca staminea</i>
Nuttall's Cockle	<i>Clinocardium nuttalli</i>
Horse and Gaper Clam	<i>Tresus capax and T. nuttalli</i>
Varnish Clam	<i>Nuttallia obscurata</i>
Cumacean	<i>Cummella vulgaris</i>
Dungeness Crab	<i>Cancer magister</i>
Ghost Shrimp	<i>Callinassa californiensis</i>
Lewis' Moonsnail	<i>Euspira lewisii</i>
Mud Shrimp	<i>Upogebia pugettensis</i>
Mudflat snail	<i>Battilaria sp</i>
Oysters	<i>Crassostrea gigas</i>
Phoronid Worm	<i>Phoronopsis harmeri</i>

Polychaetes	<i>Hobsonia florida</i> and <i>Manayunkia aestuarina</i> , <i>Polyadora kempj japonica</i> and <i>Capitella capitata</i> , <i>Pygospio elegans</i> and <i>Nephtys</i> spp, <i>Owenia fusiformis</i> , <i>Meiodomastus capensis</i> and <i>Notomastus tenuis</i>
Red Rock Crab	<i>Cancer productus</i>
Shore Crab	<i>Hemigrapsus oregonensis</i>

FISH

COMMON NAME	SCIENTIFIC NAME
Bay Goby	<i>Lepidogobius lepidus</i>
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>
Chum Salmon	<i>Oncorhynchus keta</i>
Coho Salmon	<i>Oncorhynchus kisutch</i>
Cutthroat Trout	<i>Oncorhynchus clarki clarki</i>
Crescent Gunnel	<i>Pholis laeta</i>
English Sole	<i>Pleuronectes vetulus</i>
Green Sturgeon	<i>Acipenser medirostris</i>
Kelp Surfperch	<i>Brachyistius frenatus</i>
Lingcod	<i>Ophiodon elongatus</i>
Pacific Herring	<i>Clupea pallasii</i>
Pacific Sandlance	<i>Ammodytes hexapterus</i>
Pacific Staghorn Sculpin	<i>Leptocottus armatus</i>
Penpoint Gunnel	<i>Apodichthys flavidus</i>
Pink Salmon	<i>Oncorhynchus gorbuscha</i>
Prickly Sculpin	<i>Cottus asper</i>
Shiner Surfperch	<i>Cymatogaster aggregata</i>
Snake Prickleback	<i>Lumpenus sagitta</i>
Sockeye Salmon	<i>Oncorhynchus nerka</i>
Speckled Sanddab	<i>Citharichthys stigmaeus</i>
Staghorn Sculpin	<i>Leptocottus armatus</i>
Starry Flounder	<i>Platichthys stellatus</i>
Steelhead	<i>Oncorhynchus mykiss</i>
Striped Surfperch	<i>Embiotoca lateralis</i>
Three-spine Stickleback	<i>Gasterosteus aculeatus</i>
Tubesnout	<i>Aulorhynchus flavidus</i>

Part 2

Part 2 of this appendix provides a list of all mammal, bird, reptile, amphibian and butterfly species known to occur within or immediately adjacent to the Nanaimo River Estuary. Based on review of existing literature and unpublished sighting records (see list of sources below each table). Superscripts 'B' = blue-listed and 'R' = red-listed.

WILDLIFE

Mammals

COMMON NAME	SCIENTIFIC NAMES	OBSERVERS OR SOURCES ¹
SHREWS		
Vagrant Shrew	<i>Sorex vagrans</i>	BC,GM
BATS		
Big Brown Bat	<i>Eptesicus fuscus</i>	GM
California Myotis	<i>Myotis californicus</i>	GM
Little Brown Myotis	<i>Myotis lucifugus</i>	GM
Western Long-eared Myotis	<i>Myotis evotis</i>	GM
COTTONTAILS		
Eastern Cottontail	<i>Sylvilagus floridanus</i>	BC,GM
SQUIRRELS		
Red Squirrel	<i>Tamiasciurus hudsonicus</i>	BC,GM
OTHER RODENTS		
American Beaver	<i>Castor canadensis</i>	BC,GM
Black Rat	<i>Rattus rattus</i>	GM
Deer Mouse	<i>Peromyscus maniculatus</i>	BC,GM
House Mouse	<i>Mus musculus</i>	GM
Muskrat	<i>Ondatra zibethicus</i>	GM
Norway Rat	<i>Rattus norvegicus</i>	GM
Townsend's Vole	<i>Microtus townsendi</i>	BC,GM,MG
CATS		
Cougar	<i>Felis concolor</i>	GM
MUSTELIDS		
Marten	<i>Martes americana</i>	GM
Mink	<i>Mustela vison</i>	GM
River Otter	<i>Lontra canadensis</i>	GM,MG
BEARS AND PROCYONIDS		
Black Bear	<i>Ursus americanus</i>	GM
Raccoon	<i>Procyon lotor</i>	GM
SEA LIONS AND SEALS		
California Sea Lion	<i>Zalophus californianus</i>	GM
Harbor Seal	<i>Phoca vitulina</i>	GM
^R Northern Sea Lion	<i>Eumetopias jubatus</i>	GM
CERVIDS		
Black-tailed Deer	<i>Odocoileus hemionus columbianus</i>	BC,GM
WHALES AND PORPOISES		
^B Harbor Porpoise	<i>Phocoena phocoena</i>	GM
^B Orca	<i>Orcinus orca</i>	GM

Observers or sources include Blood and Cousens 1995 (BC), Guy Monty (GM), and Martin Gebauer (MG)

Birds

COMMON NAME	SCIENTIFIC NAMES	OBSERVERS OR SOURCES ¹
LOONS		
Common Loon	<i>Gavia immer</i>	BC,BSC,CBC,GM,NN,VL
Pacific Loon	<i>Gavia pacifica</i>	CBC,GM,NN
Red-throated Loon	<i>Gavia stellata</i>	BSC,NN
Yellow-billed Loon	<i>Gavia adamsii</i>	GM,NN
GREBES		
Eared Grebe	<i>Podiceps nigricollis</i>	GM,NN
Horned Grebe	<i>Podiceps auritus</i>	BC,BSC,CBC,GM,NN,VL
Pied-billed Grebe	<i>Podilymbus podiceps</i>	GM,NN,VL
Red-necked Grebe	<i>Podiceps grisegena</i>	BSC,GM,NN,VL
^R Western Grebe	<i>Aechmophorus occidentalis</i>	BSC,CBC,GM,NN,VL
CORMORANTS		
^R Brandt's Cormorant	<i>Phalacrocorax penicillatus</i>	BSC,CBC,GM,NN
^R Double-crested Cormorant	<i>Phalacrocorax auritus</i>	BSC,CBC,GM,NN,VL
Pelagic Cormorant	<i>Phalacrocorax pelagicus</i>	BSC,CBC,GM,NN,VL
BITTERNS AND HERONS		
^B American Bittern	<i>Botaurus lentiginosus</i>	GM,NN
^B Great Blue Heron	<i>Ardea herodias</i>	BC,BSC,CBC,GM,MG,NN,VL
Great Egret	<i>Ardea alba</i>	GM,NN
^B Green Heron	<i>Butorides striatus</i>	BSC,GM,NN
SWANS AND GEESE		
Brant	<i>Branta bernicla</i>	BSC,GM,NN,VL
Canada Goose	<i>Branta canadensis</i>	BC,BSC,CBC,GM,MG,NN,VL
Greater White-fronted Goose	<i>Anser albifrons</i>	GM,NN
Mute Swan	<i>Cygnus olor</i>	BSC,GM,NN
Snow Goose	<i>Chen caerulescens</i>	GM,NN
^B Trumpeter Swan	<i>Cygnus buccinator</i>	BC,BSC,CBC,GM,NN,VL
Tundra Swan	<i>Cygnus columbianus</i>	CBC,GM,NN,VL
DUCKS		
American Black Duck	<i>Anas rubripes</i>	GM,NN
American Wigeon	<i>Anas americana</i>	BC,BSC,CBC,GM,NN,VL
Barrow's Goldeneye	<i>Bucephala islandica</i>	BSC,CBC,GM

		,NN,VL
Black Scoter	<i>Melanitta nigra</i>	GM,NN,VL
Blue-winged Teal	<i>Anas discors</i>	GM,NN
Bufflehead	<i>Bucephala albeola</i>	BC, BSC,CBC,GM ,NN,VL
Canvasback	<i>Aythya valisineria</i>	GM
Cinnamon Teal	<i>Anas cyanoptera</i>	GM,NN
Common Goldeneye	<i>Bucephala clangula</i>	BC, BSC,CBC,GM ,NN,VL
Eurasian Wigeon	<i>Anas penelope</i>	BC, BSC,CBC,GM ,NN
Gadwall	<i>Anas strepera</i>	BSC,CBC,GM ,NN,VL
Greater Scaup	<i>Aythya marila</i>	GM,NN,VL
Green-winged Teal	<i>Anas crecca</i>	BC, BSC,CBC,GM ,NN,VL
Harlequin Duck	<i>Histrionicus histrionicus</i>	GM,VL
Lesser Scaup	<i>Aythya affinis</i>	BC, BSC,GM,NN
^B Long-tailed Duck	<i>Clangula hyemalis</i>	BSC,GM,NN, VL
Mallard	<i>Anas platyrhynchos</i>	BC, BSC,CBC,GM ,MG,NN,VL
Northern Pintail	<i>Anas acuta</i>	BC, BSC,CBC,GM ,NN,VL
Northern Shoveler	<i>Anas clypeata</i>	BC, BSC,GM,NN
Ring-necked Duck	<i>Aythya collaris</i>	BC,GM,NN
^B Surf Scoter	<i>Melanitta perspicillata</i>	BC,CBC,GM, NN,VL
White-winged Scoter	<i>Melanitta fusca</i>	GM,NN,VL
Wood Duck	<i>Aix sponsa</i>	BC,GM,NN
MERGANSERS		
Common Merganser	<i>Mergus merganser</i>	BC, BSC,CBC,GM ,MG,NN,VL
Hooded Merganser	<i>Lophodytes cucullatus</i>	BC, BSC,CBC,GM ,NN,VL
Red-breasted Merganser	<i>Mergus serrator</i>	BC, BSC,CBC,GM ,NN,VL
VULTURES, OSPREYS AND EAGLES		
Turkey Vulture	<i>Cathartes aura</i>	BC, BSC,GM,MG, NN,VL
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BC, BSC,CBC,GM ,MG,NN,VL
Golden Eagle	<i>Aquila chrysaetos</i>	GM

Osprey	<i>Pandion haliaetus</i>	BSC,GM,NN, VL
HAWKS AND FALCONS		
American Kestrel	<i>Falco sparverius</i>	GM,NN
Cooper's Hawk	<i>Accipiter cooperii</i>	CBC,GM,NN
^B Gyrfalcon	<i>Falco rusticolus</i>	GM,NN
Merlin	<i>Falco columbarius</i>	BC,GM,NN
^R Northern Goshawk	<i>Accipiter gentilis</i>	GM,NN
Northern Harrier	<i>Circus cyaneus</i>	BSC,CBC,GM ,NN
^{B,R} Peregrine Falcon	<i>Falco peregrinus</i>	BC, BSC,CBC,GM ,NN
Red-tailed Hawk	<i>Buteo jamaicensis</i>	BC,BSC,CBC, GM,MG,NN,V L
Rough-legged Hawk	<i>Buteo lagopus</i>	CBC,GM,NN
Sharp-shinned Hawk	<i>Accipiter striatus</i>	BC,CBC,GM, NN
^R Swainson's Hawk	<i>Buteo swainsoni</i>	GM,NN
GROUSE AND PHEASANTS		
California Quail	<i>Callipepla californica</i>	BC,CBC,GM, NN
Blue Grouse	<i>Dendragapus obscurus</i>	GM,NN
Ring-necked Pheasant	<i>Phasianus colchicus</i>	BC,GM,NN,VL
Ruffed Grouse	<i>Bonasa umbellus</i>	GM,NN
CRANES AND RAILS		
American Coot	<i>Fulica americana</i>	GM,NN,VL
^R Sandhill Crane	<i>Grus canadensis</i>	GM,NN
Sora	<i>Porzana carolina</i>	GM
Virginia Rail	<i>Rallus limicola</i>	GM,NN
PLOVERS AND SANDPIPERS		
^R American Avocet	<i>Recurvirostra americana</i>	GM,NN
^B American Golden Plover	<i>Pluvialis dominica</i>	GM,NN
^R Baird's Sandpiper	<i>Calidris bairdii</i>	GM,NN
Black Oystercatcher	<i>Haematopus bachmani</i>	BSC,GM,NN, VL
Black Turnstone	<i>Arenaria melanocephala</i>	BSC,CBC,GM ,NN
Black-bellied Plover	<i>Pluvialis squatarola</i>	BSC,GM,NN
Dunlin	<i>Calidris alpina</i>	BSC,CBC,GM ,NN
Greater Yellowlegs	<i>Tringa melanocleuca</i>	BSC,GM,NN
Killdeer	<i>Charadrius vociferus</i>	BC,BSC,CBC, GM,MG,NN,V L
Least Sandpiper	<i>Calidris minutilla</i>	GM,NN
Lesser Yellowlegs	<i>Tringa flavipes</i>	BSC,GM,NN
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	GM,NN,VL
Pacific Golden Plover	<i>Pluvialis fulva</i>	NN
Pectoral Sandpiper	<i>Calidris melanotos</i>	GM,NN
Ruff	<i>Philomachus pugnax</i>	GM,NN
Sanderling	<i>Calidris alba</i>	GM,NN

Semipalmated Plover	<i>Charadrius semipalmatus</i>	GM,NN
Semipalmated Sandpiper	<i>Calidris pusilla</i>	GM,NN
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	GM,NN
^B Short-billed Dowitcher	<i>Limnodromus griseus</i>	GM,NN
Solitary Sandpiper	<i>Tringa solitaria</i>	GM,NN
Spotted Sandpiper	<i>Actitis macularia</i>	GM, MG, NN, V L
Stilt Sandpiper	<i>Calidris himantopus</i>	GM,NN
Surfbird	<i>Aphriza virgata</i>	CBC, GM, NN
Wandering Tattler	<i>Heteroscelus incanus</i>	GM
Western Sandpiper	<i>Calidris mauri</i>	GM,NN
Whimbrel	<i>Numenius borealis</i>	GM,NN
Wilson's Snipe	<i>Gallinago delicata</i>	BC, CBC, GM, NN, VL
GULLS, JAEGERS AND TERNS		
Black-legged Kittiwake	<i>Rissa tridactyla</i>	GM,NN
Bonaparte's Gull	<i>Larus philadelphia</i>	GM,NN
^B California Gull	<i>Larus californicus</i>	BSC, CBC, GM, NN, VL
^B Caspian Tern	<i>Sterna caspia</i>	GM,NN
Common Tern	<i>Sterna hirundo</i>	GM,NN
Glaucous Gull	<i>Larus hyperboreus</i>	GM,NN
Glaucous-winged Gull	<i>Larus glaucescens</i>	BC, BSC, CBC, GM, MG, NN, VL
Herring Gull	<i>Larus argentatus</i>	CBC, GM, NN
Iceland Gull	<i>Larus glaucoides</i>	GM,NN
Mew Gull	<i>Larus canus</i>	BSC, CBC, GM, NN, VL
Parasitic Jaeger	<i>Stercorarius parasiticus</i>	GM,NN
Ring-billed Gull	<i>Larus delawarensis</i>	BSC, GM, NN
Thayer's Gull	<i>Larus thayeri</i>	BSC, CBC, GM, NN
Western Gull	<i>Larus occidentalis</i>	BSC, CBC, GM, NN
ALCIDS		
^B Ancient Murrelet	<i>Synthliboramphus antiquus</i>	GM,NN
^B Cassin's Auklet	<i>Ptychoramphus aleuticus</i>	VL
^R Common Murre	<i>Uria aalge</i>	GM,NN
^R Marbled Murrelet	<i>Brachyramphus marmoratus</i>	BSC, GM, NN, VL
Pigeon Guillemot	<i>Cephus columba</i>	BSC, GM, NN, VL
Rhinoceros Auklet	<i>Cerorhinca monocerata</i>	GM,NN
PIGEONS AND DOVES		
^B Band-tailed Pigeon	<i>Columba fasciata</i>	GM,NN
Mourning Dove	<i>Zenaida macroura</i>	GM,NN
Rock Dove	<i>Columba livia</i>	CBC, GM, NN, VL
OWLS		
^B Barn Owl	<i>Tyto alba</i>	GM,NN
Barred Owl	<i>Strix varia</i>	GM

Great Horned Owl	<i>Bubo virginianus</i>	GM,NN
Long-eared Owl	<i>Asio otus</i>	GM,NN
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	GM,NN
^B Short-eared Owl	<i>Asio flammeus</i>	CBC,GM,NN, VL
Snowy Owl	<i>Nyctea scandiaca</i>	GM,NN
GOATSUCKERS		
Common Nighthawk	<i>Chordeiles minor</i>	GM,NN
SWIFTS		
Black Swift	<i>Cypseloides niger</i>	GM,NN
Vaux's Swift	<i>Chaetura vauxi</i>	GM,NN
HUMMINGBIRDS		
Rufous Hummingbird	<i>Selasphorus rufus</i>	BC,GM,NN,VL
KINGFISHERS		
Belted Kingfisher	<i>Ceryle alcyon</i>	BC, BSC,CBC,GM ,NN,VL
WOODPECKERS		
Downy Woodpecker	<i>Picoides pubescens</i>	BC,CBC,GM, MG,NN
Hairy Woodpecker	<i>Picoides villosus</i>	BC,GM,NN
Northern Flicker	<i>Colaptes auratus</i>	BC,CBC,GM, MG,NN,VL
Pileated Woodpecker	<i>Dryocopus pileatus</i>	BC,CBC,GM, MG,NN
Red-breasted Sapsucker	<i>Sphyrapicus ruber</i>	CBC,GM,NN
FLYCATCHERS		
Eastern Kingbird	<i>Tyrannus tyrannus</i>	
Hammond's Flycatcher	<i>Empidonax hammondi</i>	GM,NN
Olive-sided Flycatcher	<i>Contopus cooperi</i>	GM,NN
Pacific-slope Flycatcher	<i>Empidonax difficilis</i>	BC,GM,MG,N N
Say's Phoebe	<i>Sayornis saya</i>	GM,NN
Western Wood-Pewee	<i>Contopus sordidulus</i>	GM,NN
Willow Flycatcher	<i>Empidonax traillii</i>	GM,NN
DIPPERS		
American Dipper	<i>Cinclus mexicanus</i>	GM,NN
SHRIKES		
Northern Shrike	<i>Lanius excubitor</i>	CBC,GM,NN
VIREOS		
Cassin's Vireo	<i>Vireo cassinii</i>	GM,NN,VL
Hutton's Vireo	<i>Vireo huttoni</i>	GM,NN
Red-eyed Vireo	<i>Vireo olivaceus</i>	GM,NN
Warbling Vireo	<i>Vireo gilvus</i>	GM,MG
CROWS AND JAYS		
Black-billed Magpie	<i>Pica hudsonia</i>	GM
Common Raven	<i>Corvus corax</i>	BC,CBC,GM, MG,NN,VL
Northwestern Crow	<i>Corvus caurinus</i>	BC,CBC,GM, MG,NN,VL
Steller's Jay	<i>Cyanocitta stelleri</i>	BC,CBC,GM, NN
LARKS		
^R Horned Lark	<i>Eremophila alpestris</i>	GM,NN
SWALLOWS		

Barn Swallow	<i>Hirundo rustica</i>	GM, MG, NN
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	GM, MG, NN, V L
North. Rough-winged Swallow	<i>Stegidopteryx serripennis</i>	GM, NN
^R Purple Martin	<i>Progne subis</i>	GM, NN
Tree Swallow	<i>Tachycineta bicolor</i>	BC, GM, NN
Violet-green Swallow	<i>Tachycineta thalassina</i>	BC, GM, MG, N N
CHICKADEES AND BUSHTITS		
Bushtit	<i>Psaltriparus minimus</i>	BC, CBC, GM, MG, NN
Chestnut-backed Chickadee	<i>Poecile rufescens</i>	BC, CBC, GM, MG, NN
CREEPERS AND NUTHATCHES		
Brown Creeper	<i>Certhia americana</i>	BC, CBC, GM, NN
Red-breasted Nuthatch	<i>Sitta canadensis</i>	CBC, GM, MG, NN
WRENS		
Bewick's Wren	<i>Thryomanes bewickii</i>	BC, CBC, GM, NN
House Wren	<i>Troglodytes aedon</i>	NN
Marsh Wren	<i>Cistothorus palustris</i>	CBC, GM, NN
Winter Wren	<i>Troglodytes troglodytes</i>	BC, CBC, GM, MG, NN
KINGLETS AND THRUSHES		
American Robin	<i>Turdus migratorius</i>	BC, CBC, GM, MG, NN, VL
Golden-crowned Kinglet	<i>Regulus satrapa</i>	BC, CBC, GM, MG, NN
Hermit Thrush	<i>Catharus guttatus</i>	GM, NN
Mountain Bluebird	<i>Sialia currucoides</i>	GM, NN
Ruby-crowned Kinglet	<i>Regulus calendula</i>	CBC, GM, NN
Swainson's Thrush	<i>Catharus ustulatus</i>	GM, MG, NN
Townsend's Solitaire	<i>Myadestes townsendii</i>	GM, NN
Varied Thrush	<i>Ixoreus naevius</i>	BC, CBC, GM, NN, VL
^R Western Bluebird	<i>Sialia mexicana</i>	GM, NN
THRASHERS, MOCKINGBIRDS, STARLINGS AND MYNAS		
Crested Myna	<i>Acridotheres cristatellus</i>	GM, NN
European Starling	<i>Sturnus vulgaris</i>	BC, CBC, GM, MG, NN, VL
Gray Catbird	<i>Dumetella carolinensis</i>	GM
^R Sage Thrasher	<i>Oreoscoptes montanus</i>	GM, NN
PIPITS AND WAXWINGS		
American Pipit	<i>Anthus rubescens</i>	GM, NN
Bohemian Waxwing	<i>Bombycilla garrulus</i>	GM
Cedar Waxwing	<i>Bombycilla cedrorum</i>	GM, MG, NN
WARBLERS		
Black-throated Gray Warbler	<i>Dendroica nigrescens</i>	GM, MG, NN
Common Yellowthroat	<i>Geothlypis trichas</i>	BC, GM, NN
MacGillivray's Warbler	<i>Oporornis tolmiei</i>	GM, NN
Orange-crowned Warbler	<i>Vermivora celata</i>	BC, GM, MG, N N

Palm Warbler	<i>Dendroica palmarum</i>	GM,NN
Townsend's Warbler	<i>Dendroica townsendii</i>	GM,NN
Wilson's Warbler	<i>Wilsonia pusilla</i>	GM,NN
Yellow Warbler	<i>Dendroica petechia</i>	BC,GM,MG,NN
Yellow-rumped Warbler	<i>Dendroica coronata</i>	BC,GM,NN
SPARROWS		
American Tree Sparrow	<i>Spizella arborea</i>	GM,NN
Chipping Sparrow	<i>Spizella passerina</i>	GM,NN,VL
Dark-eyed Junco	<i>Junco hyemalis</i>	BC,CBC,GM,NN,VL
Fox Sparrow	<i>Passerella iliaca</i>	BC,CBC,GM,NN
Golden-crowned Sparrow	<i>Zonotrichia atricapilla</i>	CBC,GM,NN
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	GM,NN
Harris' Sparrow	<i>Zonotrichia querela</i>	GM,NN
Lapland Longspur	<i>Calcarius lapponicus</i>	CBC,GM,NN
Lincoln's Sparrow	<i>Melospiza lincolni</i>	CBC,GM,NN
Savannah Sparrow	<i>Passerculus sandwichensis</i>	CBC,GM,MG,NN
Snow Bunting	<i>Plectrophenax hyperboreus</i>	GM
Song Sparrow	<i>Melospiza melodia</i>	BC,CBC,GM,MG,NN
Spotted Towhee	<i>Pipilo maculatus</i>	BC,CBC,GM,MG,NN
Swamp Sparrow	<i>Melospiza georgiana</i>	GM,NN
^R Vesper Sparrow	<i>Pooecetes gramineus</i>	GM,NN
Western Tanager	<i>Piranga ludoviciana</i>	GM,NN
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	BC,CBC,GM,MG,NN
White-throated Sparrow	<i>Zonotrichia albicollis</i>	GM,NN
BLACKBIRDS		
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	CBC,GM,NN
Brown-headed Cowbird	<i>Molothrus ater</i>	GM,NN
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	BC,CBC,GM,MG,NN
^R Western Meadowlark	<i>Sturnella neglecta</i>	CBC,GM,NN
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	GM,NN
FINCHES		
American Goldfinch	<i>Carduelis tristis</i>	GM,MG,NN
Common Redpoll	<i>Carduelis flammea</i>	CBC,GM,NN
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	GM,NN
House Finch	<i>Carpodacus mexicanus</i>	CBC,GM,MG,NN
Pine Siskin	<i>Carduelis pinus</i>	BC,CBC,GM,MG,NN
Purple Finch	<i>Carpodacus purpureus</i>	BC,CBC,GM,NN
Red Crossbill	<i>Loxia curvirostra</i>	CBC,GM,MG,NN

OLD WORLD SPARROWS		
House Sparrow	<i>Passer domesticus</i>	GM, MG

Observers or sources include Blood and Cousens 1995 (BC), Bird Studies Canada Surveys, 2000-2002 (BSC), Christmas Bird Counts, 2000 and 2001 (CBC), Guy Monty (GM), Martin Gebauer (MG), Nanaimo Field Naturalists' observations since 1972 (NN), and Vaudry and Land 1973 (VL)

Amphibians and Reptiles

COMMON NAME	SCIENTIFIC NAMES	OBSERVERS OR SOURCES ¹
AMPHIBIANS		
Long-toed Salamander	<i>Ambystoma macrodactylum</i>	BC
^B Red-legged Frog	<i>Rana aurora</i>	BC
Rough-skinned Newt	<i>Taricha glanulosa</i>	BC
REPTILES		
Garter Snake spp.	<i>Thamnophis</i> spp.	BC

Observers or sources include Blood and Cousens 1995 (BC)

Butterflies

COMMON NAME	SCIENTIFIC NAME	OBSERVERS OR SOURCES ¹
SKIPPERS		
^B Propertius Duskywing	<i>Erynnis propertius</i>	GM
Woodland Skipper	<i>Ochlodes sylvanoides</i>	GM
SWALLOWTAILS		
Anise Swallowtail	<i>Papilio zelicaon</i>	GM
Pale Swallowtail	<i>Papilio eurymedon</i>	GM
Western Tiger Swallowtail	<i>Papilio rutulus rutulus</i>	GM
WHITES, MARBLES AND SULPHURS		
Cabbage White	<i>Pieris rapae rapae</i>	GM
Pine White	<i>Neophasia menapia tau</i>	GM
Sara's Orangetip	<i>Anthocharis sara flora</i>	GM
SULPHURS		
^B Western Sulphur	<i>Colias occidentalis occidentalis</i>	GM
COPPERS		
Purplish Copper	<i>Lycaena helloides</i>	GM
HAIRSTREAKS		
Grey Hairstreak	<i>Strymon melinus atrofasciatus</i>	GM
^B Moss Elfin	<i>Incisalia mossii mossii</i>	GM
BLUES		
Western Spring Azure	<i>Celastrina echo echo</i>	GM
METALMARKS		
Green Comma	<i>Polygonia faunus rusticus</i>	GM
Milbert's Tortoiseshell	<i>Aglais milberti milberti</i>	GM
Mourning Cloak	<i>Nymphalis antiopa</i>	GM
Painted Lady	<i>Vanessa cardui</i>	GM

Red Admiral	<i>Vanessa atalanta rubria</i>	GM
Satyr Anglewing	<i>Polygonia satyrus</i>	GM
CHECKERSPOTS		
Field Crescent	<i>Phyciodes pratensis pratensis</i>	GM
Mylitta Crescent	<i>Phyciodes mylitta mylitta</i>	GM
ADMIRALS		
Lorquin's Admiral	<i>Limenitis lorquini ilgae</i>	GM
SATYRS		
^B Common Woodnymph	<i>Cercyonis pegala incana</i>	GM

Observers or sources include Guy Monty (GM)

APPENDIX B: AGENCY AND OTHER GROUP INTERESTS AND JURISDICTION

The following are the primary interests and jurisdictions of the proposed NEMC members.

Environment Canada (Canadian Wildlife Service)

Interests

- Conservation, management and restoration of migratory bird habitats through partnered acquisitions, habitat restoration, project review, providing tools to decision makers, promoting stewardship and engaging the interested public.
- Ongoing performance evaluation through periodic population monitoring.

Mandate

- Conservation and management of migratory bird populations under the Migratory Birds Conservation Act.
- Partnerships for conservation of wildlife and their habitat under the Canada Wildlife Act.
- Some interest and probably future mandate in the recovery of species at risk under the Species at Risk Act.

Existing Plans, Bylaws or Legal Agreements

- Development of management plan for upland and wetland holdings under the Vancouver Island Wetland Management Program.

Environment Canada (Environmental Protection)

Interests

- Preserve and improve the quality of the environment
- Protect public health through reducing risks associated with the consumption of molluscan shellfish, and re-open or reduce closed shellfish growing areas (Shellfish Water Quality Protection Program)

Mandate

- To protect and restore Canada's natural environment

- To anticipate and prevent environmental problems
- To control unavoidable pollution stresses
- To initiate enforcement actions or emergency procedures
- To monitor and classify the water quality of shellfish growing areas (Shellfish Water Quality Protection Program)

Existing Plans, Bylaws or Legal Agreements

- Nanaimo River Estuary Water Quality Assessments agreement with Snuneymuxw First nation

Fisheries and Oceans Canada

Interests

- Sustainable development and safe use of Canadian waters
 - Safe and accessible waterways;
 - Healthy and productive aquatic ecosystems; and
 - Sustainable fisheries and aquaculture.
- Net gain of fish habitat is a present and future interest.
- Coastal zone planning under the auspices of the *Oceans Act*.

Mandate

- Developing and implementing policies and programs in support of Canada's scientific, ecological, social and economic interests in oceans and fresh waters.
- Administering the *Oceans Act*, which charges the Minister with leading oceans management and providing coast guard and hydrographic services on behalf of the Government of Canada.
- Administering the *Fisheries Act* which includes management of fisheries, habitat and aquaculture.

Existing Plans, Bylaws or Legal Agreements

- *Fisheries Act*
- *Canadian Environmental Assessment Act*
- *Oceans Act*
- *Species at Risk Act*
- National Habitat Policy
- Aquaculture Policy Directive
- Wild Salmon Policy
- MOU, City of Nanaimo/DFO
- MOU, Regional District of Nanaimo/DFO

Snuneymuxw First Nation

Interests

- To begin the process to restore the estuary to a premium level of environmental health.
- The re-opening of the estuary to shellfish harvest.
- Future: repatriation of the Nanaimo River Estuary as part of the Treaty Settlement package. It is envisioned this will include governance and management of human activities in the Estuary.

Existing Plans, Bylaws or Legal Agreements

- Royal Proclamation of 1793, recognizing Aboriginal Title and Right
- Section 35 of the Constitution
- Supreme Court recognition of the Douglas Treaty White/Bob vs. Regina
- Current BC Treaty Comprehensive Treaty Negotiation Process
- Memorandum of Agreement re: shellfish
- Memorandum of Agreement re: Log Storage

Note: this list is representative and is not exhaustive.

Ministry of Environment

Interests

- Keep the environmental sensitivity, productivity and value foremost in any new land use projects, designations or uses
- Provide a forum for a holistic approach for the use of the estuary which can take into account impacts to the natural system from multiple sources around the estuary and recommend options which are the least damaging to the environment while allowing necessary economic development.
- Provide education to the public (and decision-makers) about the value of the estuary and how various activities impact natural processes.
- Seek remediation to the natural state of the estuarine environment.
- Provide a mechanism for seeking compensation for damage from new development.

Mandate

- Responsible for the management of The Nature Trust lands in the estuary, which have been leased to the ministry.

- Manages the Wildlife Reserve parcel - the current designation of that property is a mandatory step prior to declaration of a Wildlife Management Area. The ministry may be interested in pursuing that designation in the future.
- Responsible for hunting (Wildlife Act) and non-tidal fishing regulations.
- Legislated responsibilities related to waste discharges into the estuary and water quality issues.
- Legislated responsibility to provide permission (rights) to use surface water from a stream as defined under the Water Act. Water rights are obtained by licence or by an approval (permit) under the Water Act. The estuary watershed is completely allocated and no new water licences will be issued unless new water storage is provided.

Existing Plans, Bylaws or Legal Agreements

- Nanaimo River Water Management Plan (July 1993) completed by the former Ministry of Environment, Lands and Parks.

Ministry of Agriculture and Lands

Interests

- On Provincial Crown land, to create economic growth in a sustainable, balanced manner that reflects sound economic and environmental principles.
- Leading the development and ongoing management of Sustainable Resource Management Plans for the provincial government, to provide for balanced decision-making and sustainable resource development.

Mandate

- Allocating Crown land resources for the benefit of all British Columbians.
- Responsible for allocating Crown land (as defined under the Land Act) both within and adjoining the estuary. The Crown land outside of the head lease with the Nanaimo Port Authority will remain under direct jurisdiction of the Ministry of Agriculture and Lands.

Ministry of Transportation

Interests

- The Ministry of Transportation plans transportation networks, provides transportation services and implements transportation policies, and administers many transportation-related acts and regulations.
- The Ministry of Transportation ensures that British Columbia's ports are gateways for economic growth and development.

Mandate

- The Ministry of Transportation manages the head lease between the Province and the Nanaimo Port Authority.

Regional District of Nanaimo and City of Nanaimo

Mandate

- The RDN is a partnership of the three municipalities of Nanaimo, Parksville, and Qualicum Beach and eight unincorporated electoral areas, and is one of 27 regional governments in B.C. The RDN's responsibilities and services include regional and community planning, transit, liquid and solid waste treatment, recreation and parks, building inspection and bylaw enforcement, water and sewer utilities, general administration and emergency planning.

Existing Plans, Bylaws or Legal Agreements

- Regional Growth Management Plan
- Electoral Area A Official Community Plan
- RDN Land Use and Subdivision Bylaw No. 500, 1987
- Plan Nanaimo (Bylaw 1996 No.6000)
- Other RDN plans, bylaw, or agreements may also be relevant to the Nanaimo Estuary

Nanaimo Port Authority

Mandate

- The Nanaimo Port Authority operates under the *Canada Marine Act* to provide Canada with a marine infrastructure that offers effective support for the achievement of local, regional and national social and economic objectives and will promote and safeguard Canada's competitiveness and trade objectives. The Nanaimo Port Authority manages marine transportation, infrastructure and services within Nanaimo Harbour in a commercial manner that meets the needs of local users.
- The Port administers the Nanaimo Federal Harbour and foreshore under its letters Patent and approximately 160 hectares of Provincial Harbour located on the westerly side of the Nanaimo River Estuary under a Head Lease with the Province.

Existing Plans, Bylaws or Legal Agreements

- Canada Marine Act
- Nanaimo Port Authority Letters Patent
- Port Authorities Operations and Regulations
- Nanaimo Port Authority Port Master Plan

The Nature Trust of B.C.

Interests

- The Nature Trust of BC holds title to approximately 160 ha of the Nanaimo River estuary. These lands are managed by the Ministry of Water, Land and Air protection (Wildlife Section) through a 99 year lease agreement along with a 20 ha Wildlife Reserve.
- The Nature Trust lands were purchased through the Pacific Estuary Conservation Program and as such other conservation partners like Ducks Unlimited, Habitat Conservation Trust Fund, and the Canadian Wildlife Service all share a common vision – to preserve the ecological integrity of this key estuary and to allow for public use as long as deemed compatible with fish and wildlife conservation. Cultural and traditional uses will be sustained where possible.

Existing Plans, Bylaws or Legal Agreements

- The Nature Trust has a 99 year lease agreement with MOE to manage Nanaimo River Estuary Conservation Area
- Holden Creek Farm Lease with Dr. B. White
- MOU with the Snuneymuxw First Nations in draft form, but this document has not been officially endorsed.

Nanaimo Community Estuary Support Coalition

Member Groups

- Canadian Naturalists
- Chase River Community Association
- Friends of the Cat Stream
- Georgia Basin Ecosystem Assessment and Restoration Society
- Georgia Strait Alliance
- Mid Island Stewardship Trust
- Nanaimo Field Naturalists
- Nanaimo Fish and Game
- South End Community Association
- Trout Unlimited
- UFAWU
- Non-affiliated concerned citizens

Interests

- The NCESC is committed to ensuring that public consultation is a key component of any Estuary Planning process.
- The estuary ecosystem should be maintained and rehabilitated towards historic levels, as the basis for maintaining social and economic values.

Nanaimo River Estuary Log Storage Association

Member Groups

- Cascadia Forest Products Ltd.
- Coastland Wood Industries
- Western Forest Products Inc.
- Pope and Talbot Ltd.

Interests

- The Nanaimo River Estuary Log Storage Association is committed to a balanced approach of protecting and restoring the Nanaimo River estuary through best management practices and continuous improvement, while maintaining and enhancing the socio-economic benefits to the community.

APPENDIX C: PARTICIPATION PROTOCOL

Participation in the Nanaimo Estuary Management Planning Process

The Process Terms of Reference for the Nanaimo Estuary Management Plan acknowledges the importance of participation in the process of all who believe their interests affect, or are affected by, land and water uses within the plan area. In keeping with that statement, three interest groups, the Nanaimo Community Estuary Support Coalition, The Nature Trust of BC, and the Nanaimo River Estuary Log Storage Association will be invited to participate in Steering Committee meetings. The following will be the protocol for participation:

- The interest groups will be invited to participate in all Steering Committee discussions.
- A maximum of two representatives of each interest group will be invited to attend Steering Committee meetings.
- The interest group and Steering Committee representatives are expected to provide a liaison role with their constituents, including communication of the planning process to their member groups, and communication of the interests of their member groups back to the Steering Committee.
- If a Steering Committee or interest group member disagrees with an item under discussion, they should make their disagreement known to the Steering Committee at the meeting where the topic is discussed, or as soon as possible afterwards if the disagreement is not known at the meeting time.
- The March 2002 Memorandum of Agreement between the Province and the Snuneymuxw First Nation will not be revisited or reopened for discussion during the development of the estuary management plan.
- If an interest group representative has a concern with subjects being raised at a Steering Committee meeting, they shall make their views known to the Steering Committee and make every effort to have their concerns addressed through the Steering Committee prior to any communication on the topic with the press.
- The Steering Committee will attempt to reach consensus with the involvement and support of the interest groups. If the concerns of the interest groups are a barrier to consensus, the Steering

Committee government members only, at their discretion, will try to reach consensus. If this occurs, the concerns of the dissenting interest groups will be noted in the plan. Should full consensus not be reached among government agencies, the process outlined in the Steering Committee Terms of Reference will apply.

June 18, 2002

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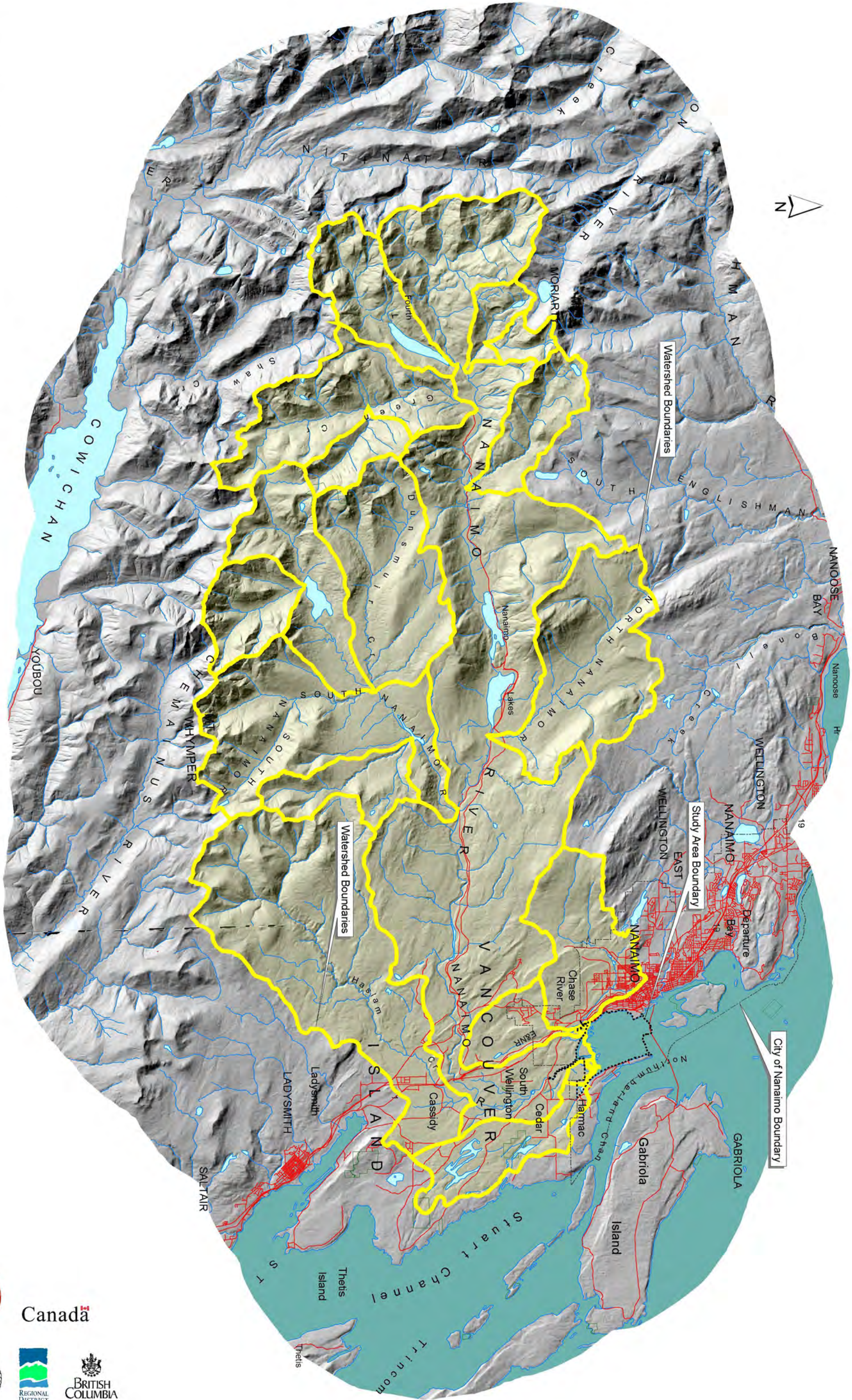
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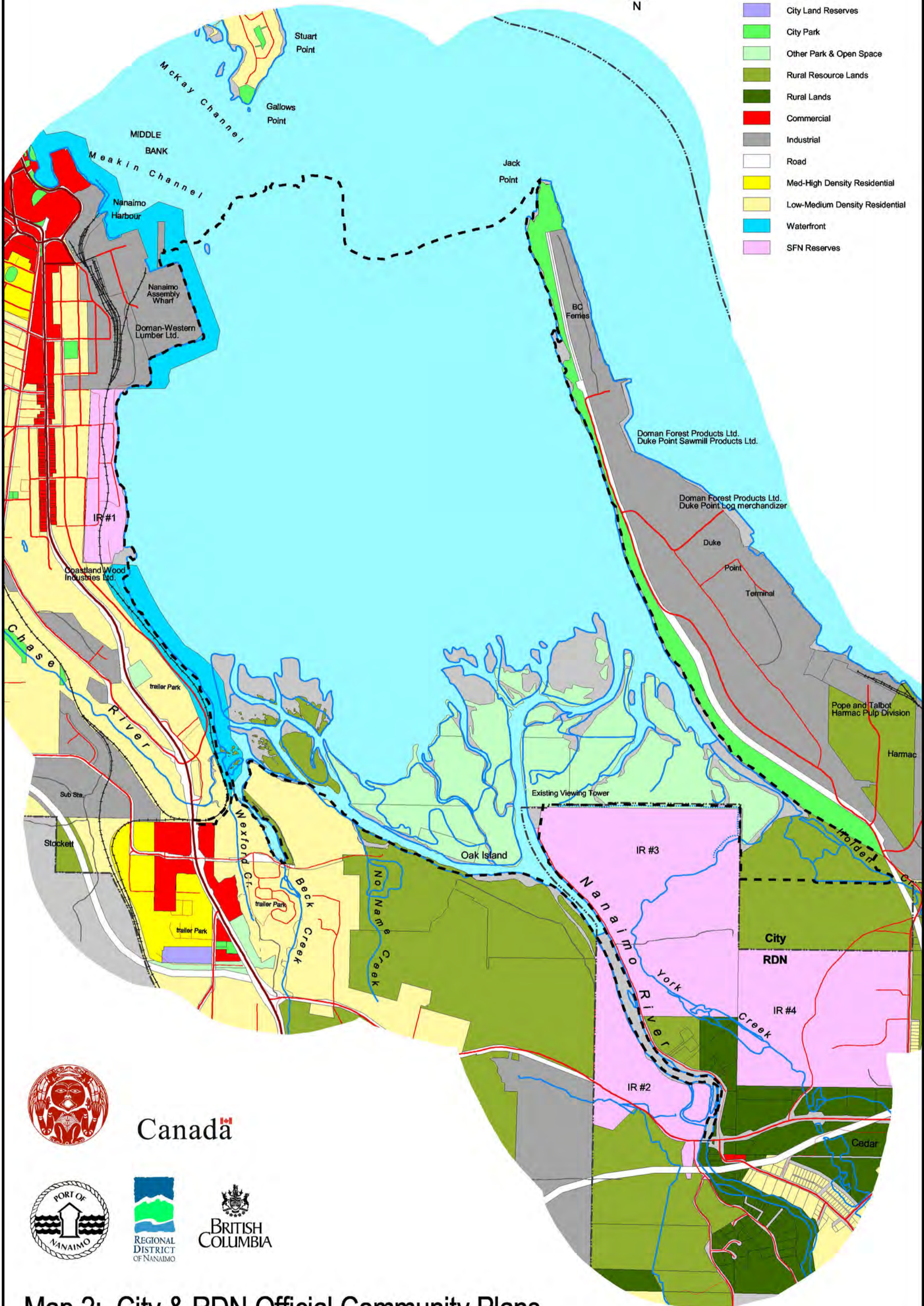
Map 1: Nanaimo River Watershed Nanaimo Estuary Management Plan

500 0 500 Meters



Legend

-  Study Area Boundary
-  City Boundary
-  City Land Reserves
-  City Park
-  Other Park & Open Space
-  Rural Resource Lands
-  Rural Lands
-  Commercial
-  Industrial
-  Road
-  Med-High Density Residential
-  Low-Medium Density Residential
-  Waterfront
-  SFN Reserves



Canada

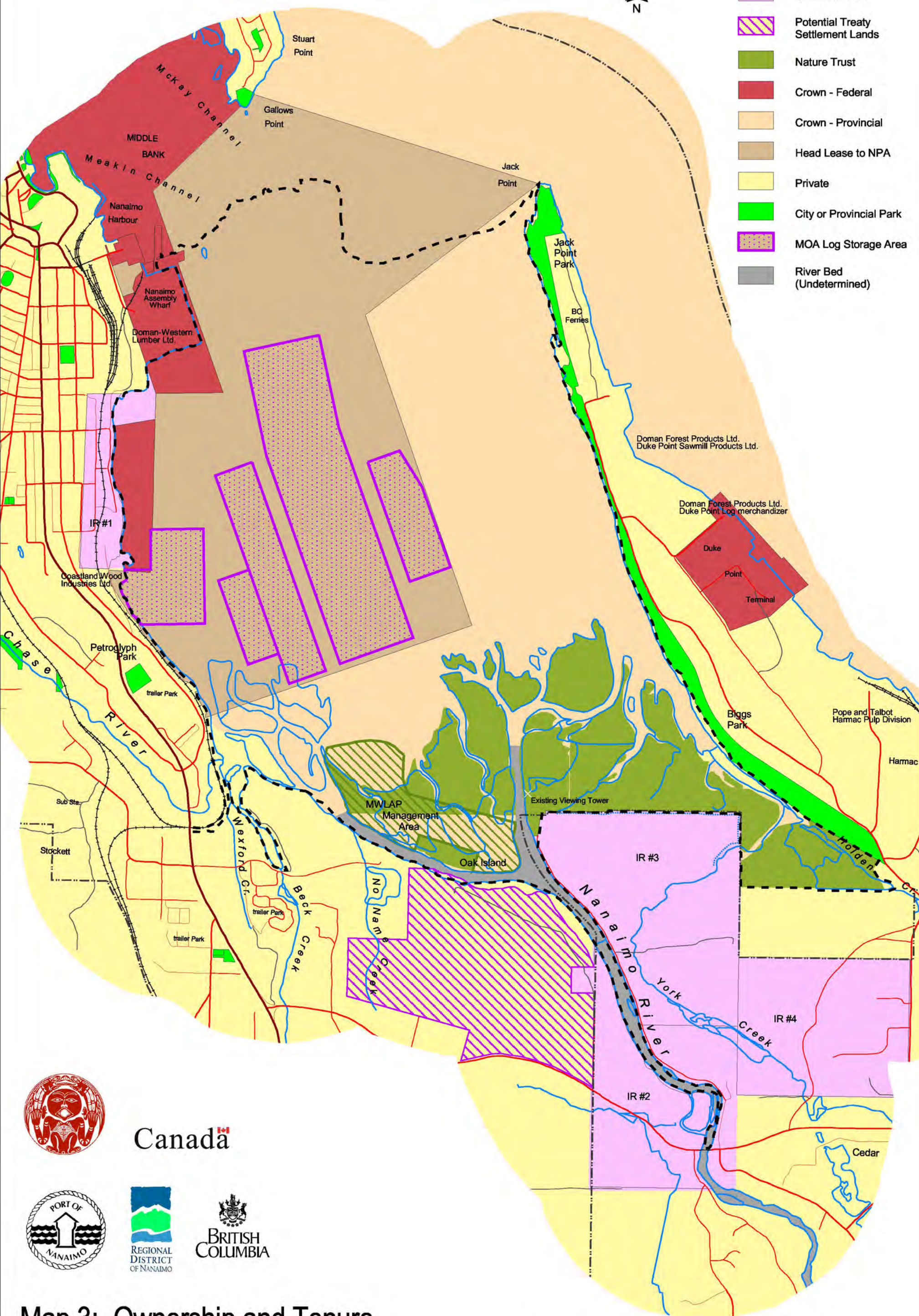


Map 2: City & RDN Official Community Plans Nanaimo Estuary Management Plan



Legend

- Indian Reserve
- Potential Treaty Settlement Lands
- Nature Trust
- Crown - Federal
- Crown - Provincial
- Head Lease to NPA
- Private
- City or Provincial Park
- MOA Log Storage Area
- River Bed (Undetermined)






Canada



Map 3: Ownership and Tenure Nanaimo Estuary Management Plan

500 0 500 Meters

Legend

-  Study Area Boundary
-  City Boundary
-  Bathymetric Contour



Canada



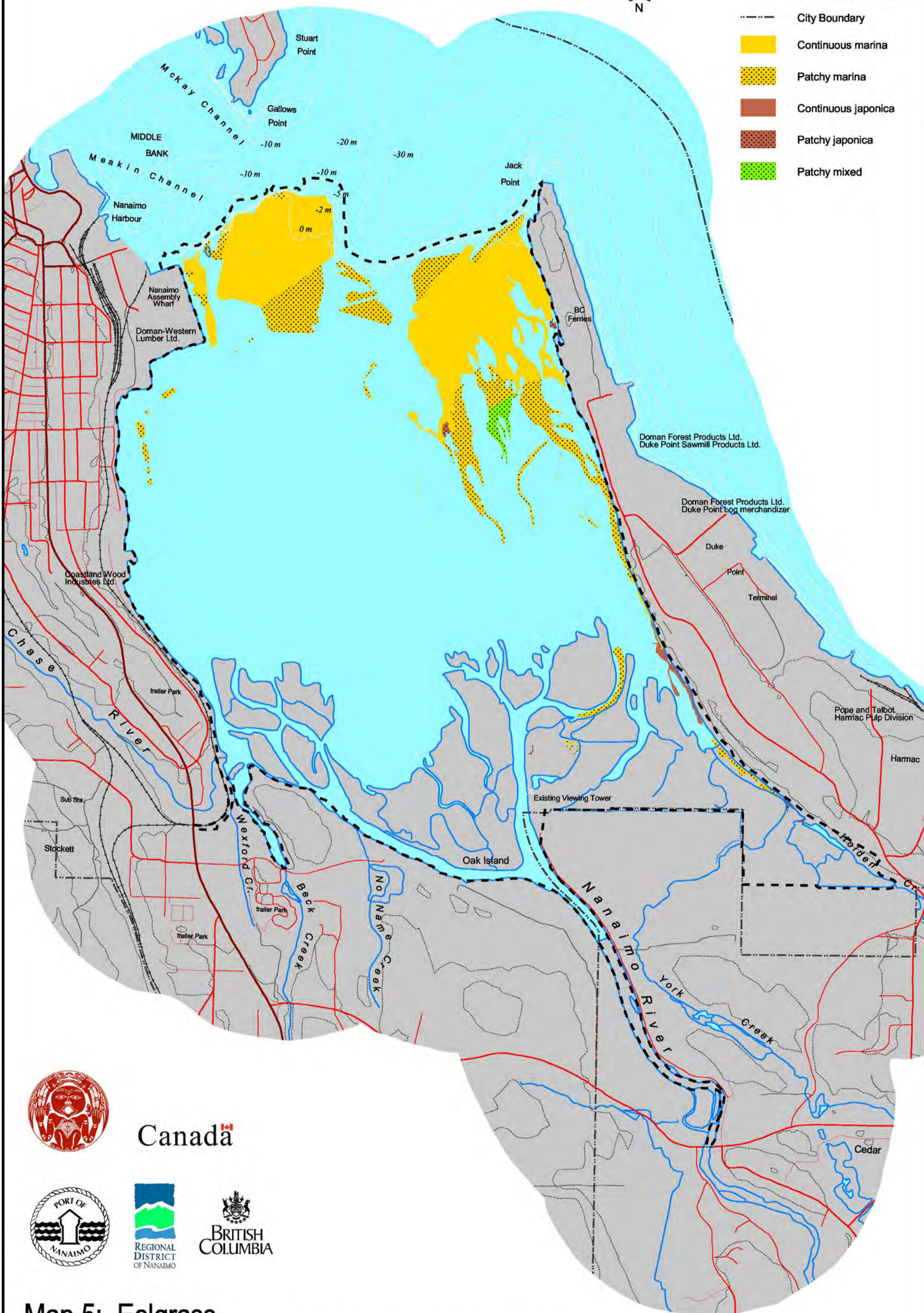
Map 4: Aerial Photograph Nanaimo Estuary Management Plan

500 0 500 Meters



Legend

- - - Study Area Boundary
- · - · - City Boundary
- Continuous marina
- Patchy marina
- Continuous japonica
- Patchy japonica
- Patchy mixed



Canada



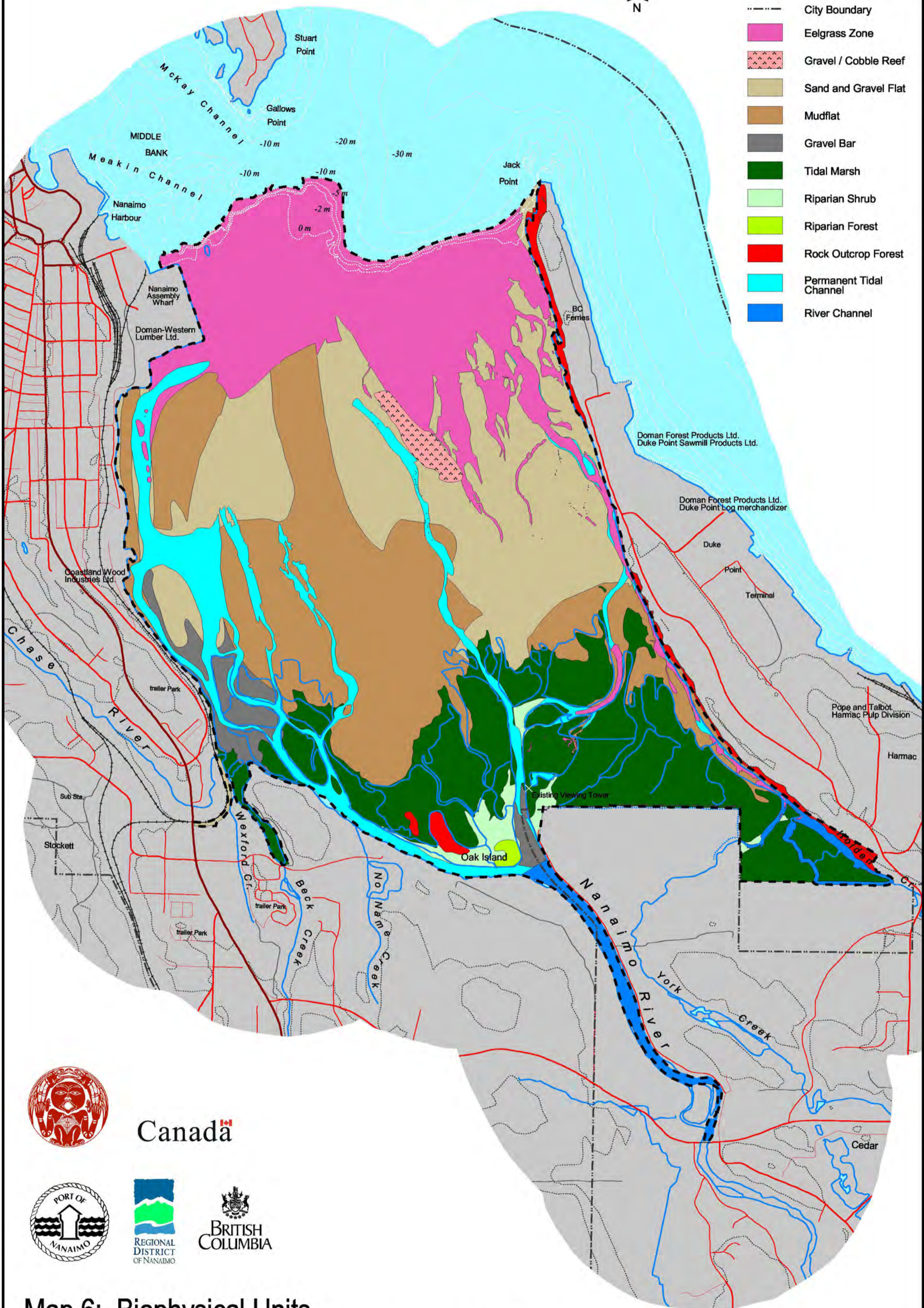
Map 5: Eelgrass Nanaimo Estuary Management Plan

500 0 500 Meters



Legend

-  Study Area Boundary
-  City Boundary
-  Eelgrass Zone
-  Gravel / Cobble Reef
-  Sand and Gravel Flat
-  Mudflat
-  Gravel Bar
-  Tidal Marsh
-  Riparian Shrub
-  Riparian Forest
-  Rock Outcrop Forest
-  Permanent Tidal Channel
-  River Channel



Canada









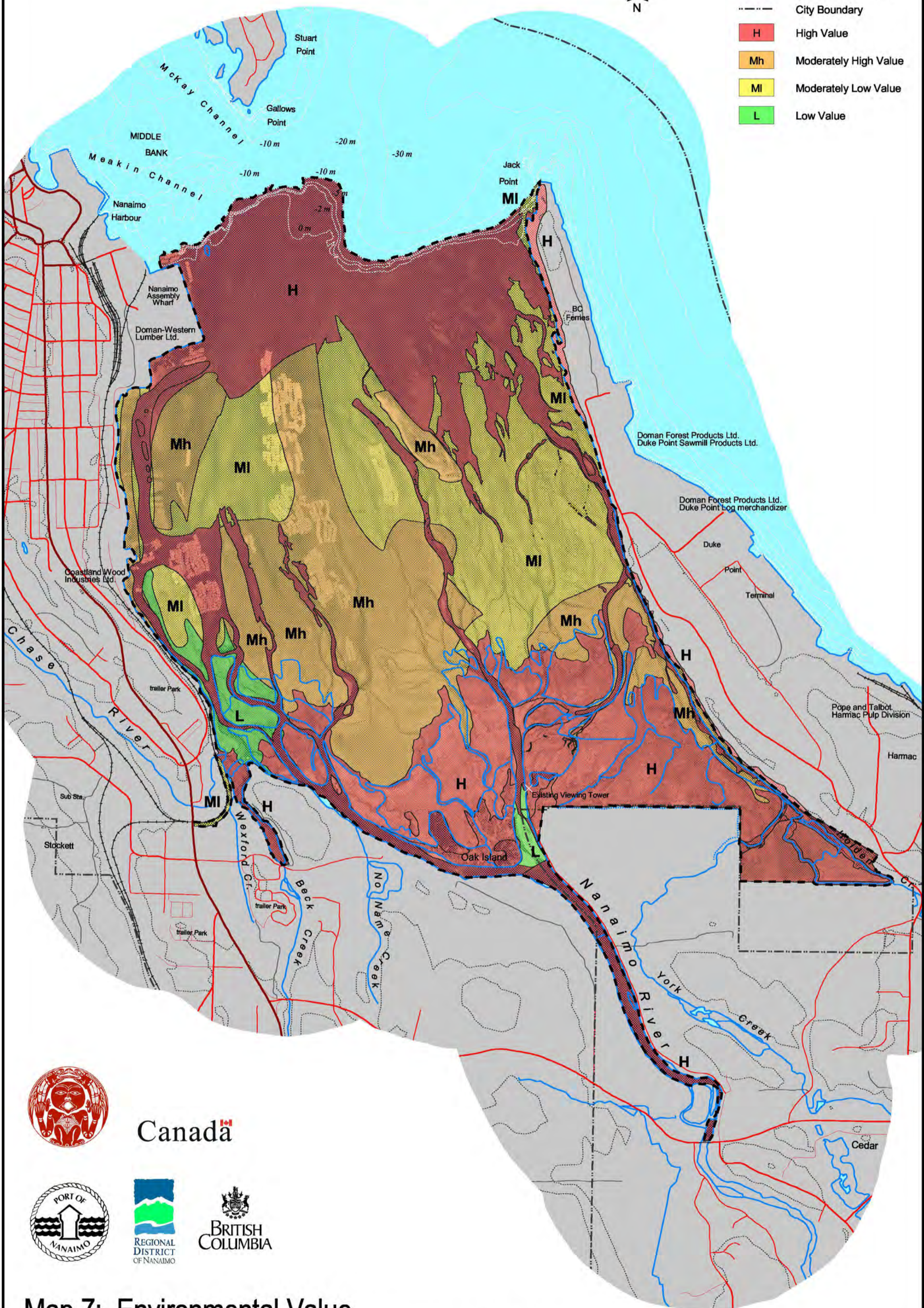
Map 6: Biophysical Units Nanaimo Estuary Management Plan

500 0 500 Meters



Legend

-  Study Area Boundary
-  City Boundary
-  H High Value
-  Mh Moderately High Value
-  MI Moderately Low Value
-  L Low Value



Canada



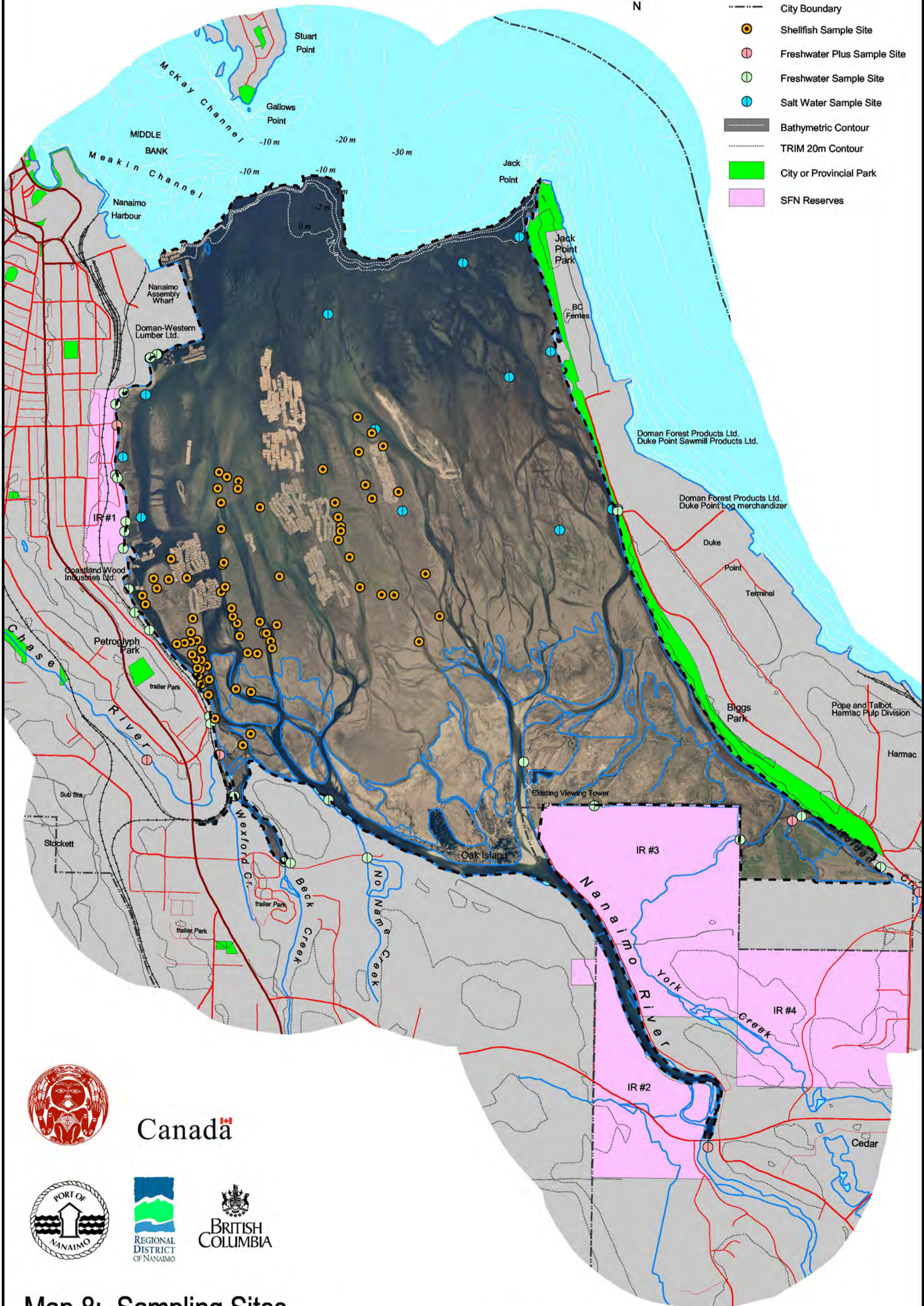
Map 7: Environmental Value Nanaimo Estuary Management Plan

500 0 500 Meters



Legend

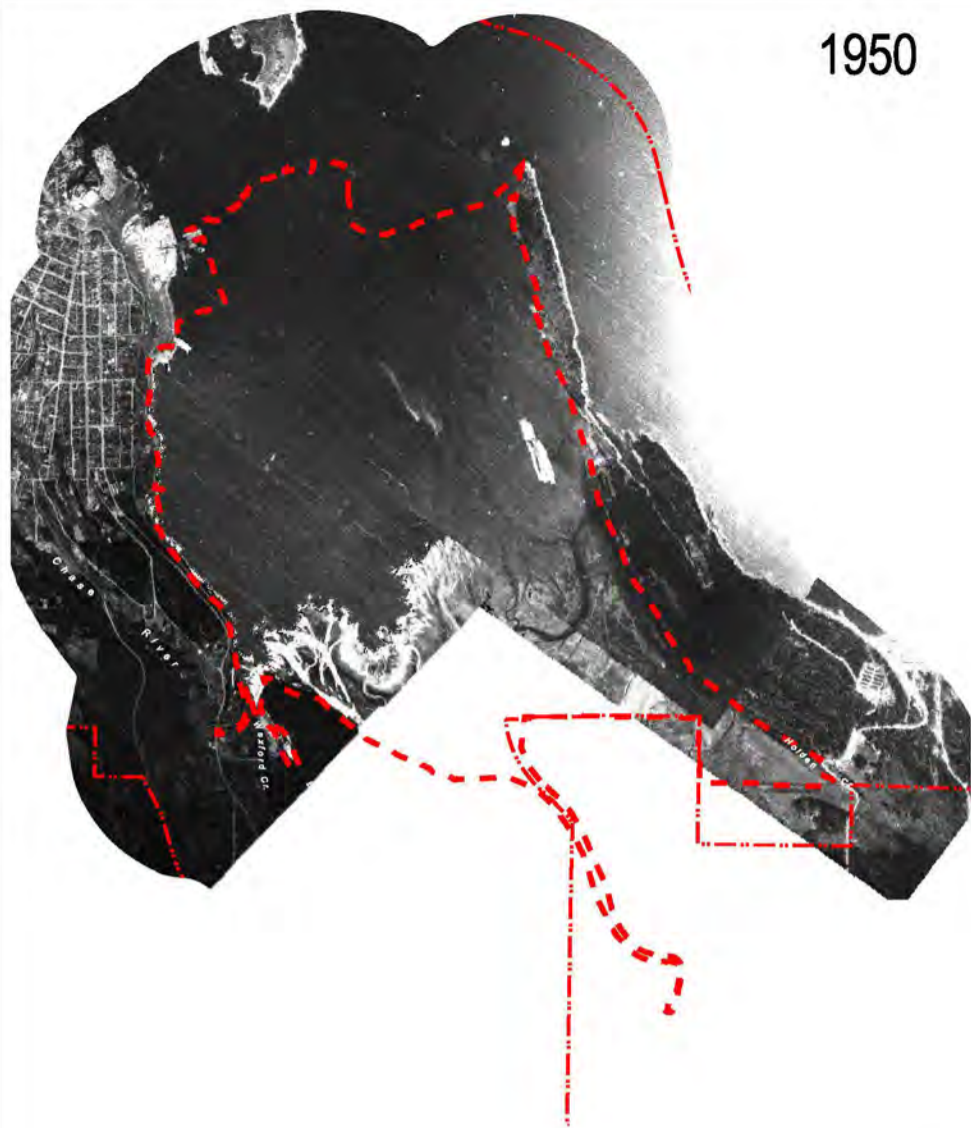
- Study Area Boundary
- City Boundary
- Shellfish Sample Site
- Freshwater Plus Sample Site
- Freshwater Sample Site
- Salt Water Sample Site
- Bathymetric Contour
- TRIM 20m Contour
- City or Provincial Park
- SFN Reserves



Canada



Map 8: Sampling Sites Nanaimo Estuary Management Plan



1950

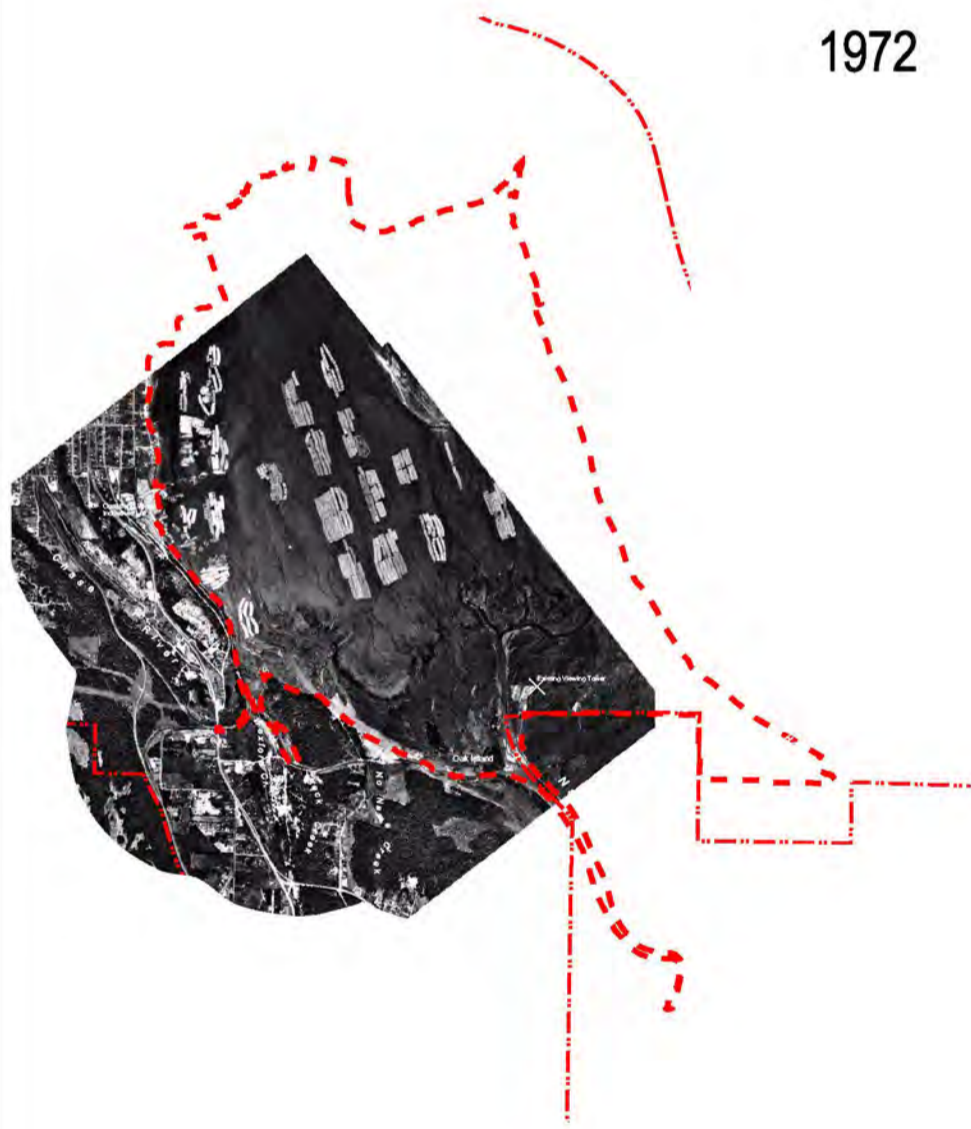


Legend

- - - Study Area Boundary
- · - · - City Boundary



1962



1972



1984



Canada



Map 9: Historical Aerial Photographs Nanaimo Estuary Management Plan

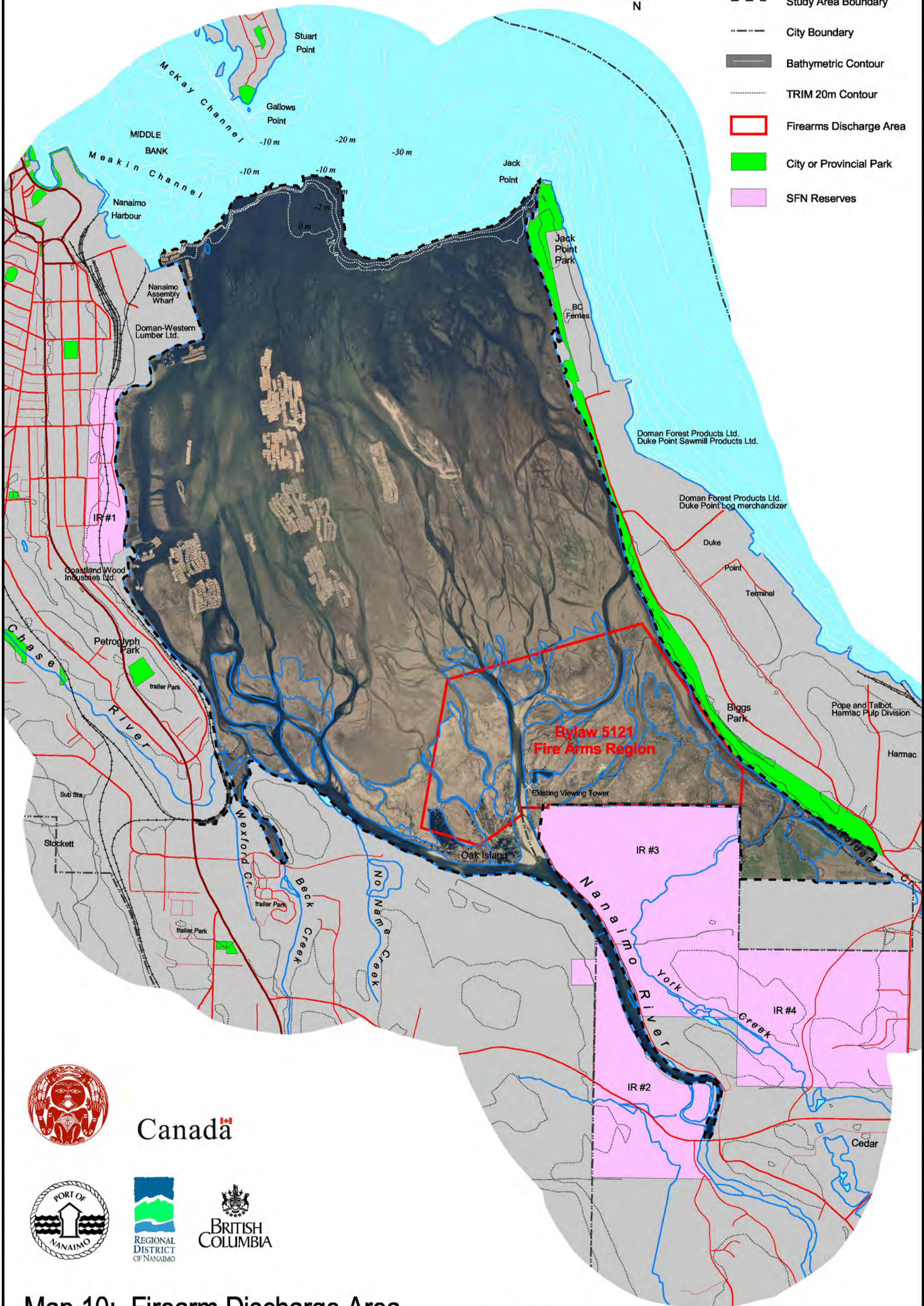
1000 0 1000 Meters

500 0 500 Meters



Legend

-  Study Area Boundary
-  City Boundary
-  Bathymetric Contour
-  TRIM 20m Contour
-  Firearms Discharge Area
-  City or Provincial Park
-  SFN Reserves



Canada



Map 10: Firearm Discharge Area

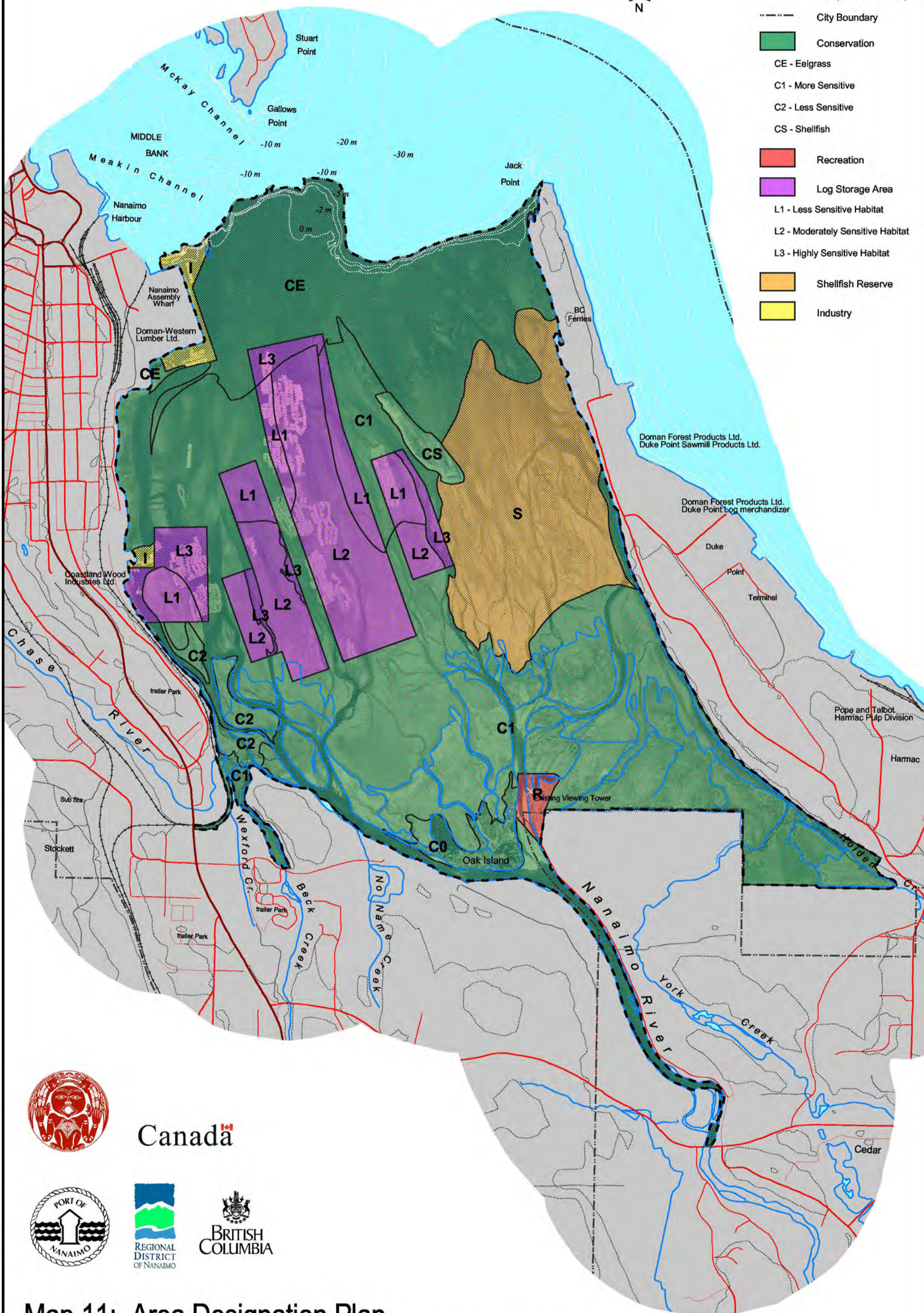
Nanaimo Estuary Management Plan

500 0 500 Meters



Legend

- Study Area Boundary
- City Boundary
- Conservation
 - CE - Eelgrass
 - C1 - More Sensitive
 - C2 - Less Sensitive
 - CS - Shellfish
- Recreation
- Log Storage Area
 - L1 - Less Sensitive Habitat
 - L2 - Moderately Sensitive Habitat
 - L3 - Highly Sensitive Habitat
- Shellfish Reserve
- Industry



Canada



Map 11: Area Designation Plan

Nanaimo Estuary Management Plan