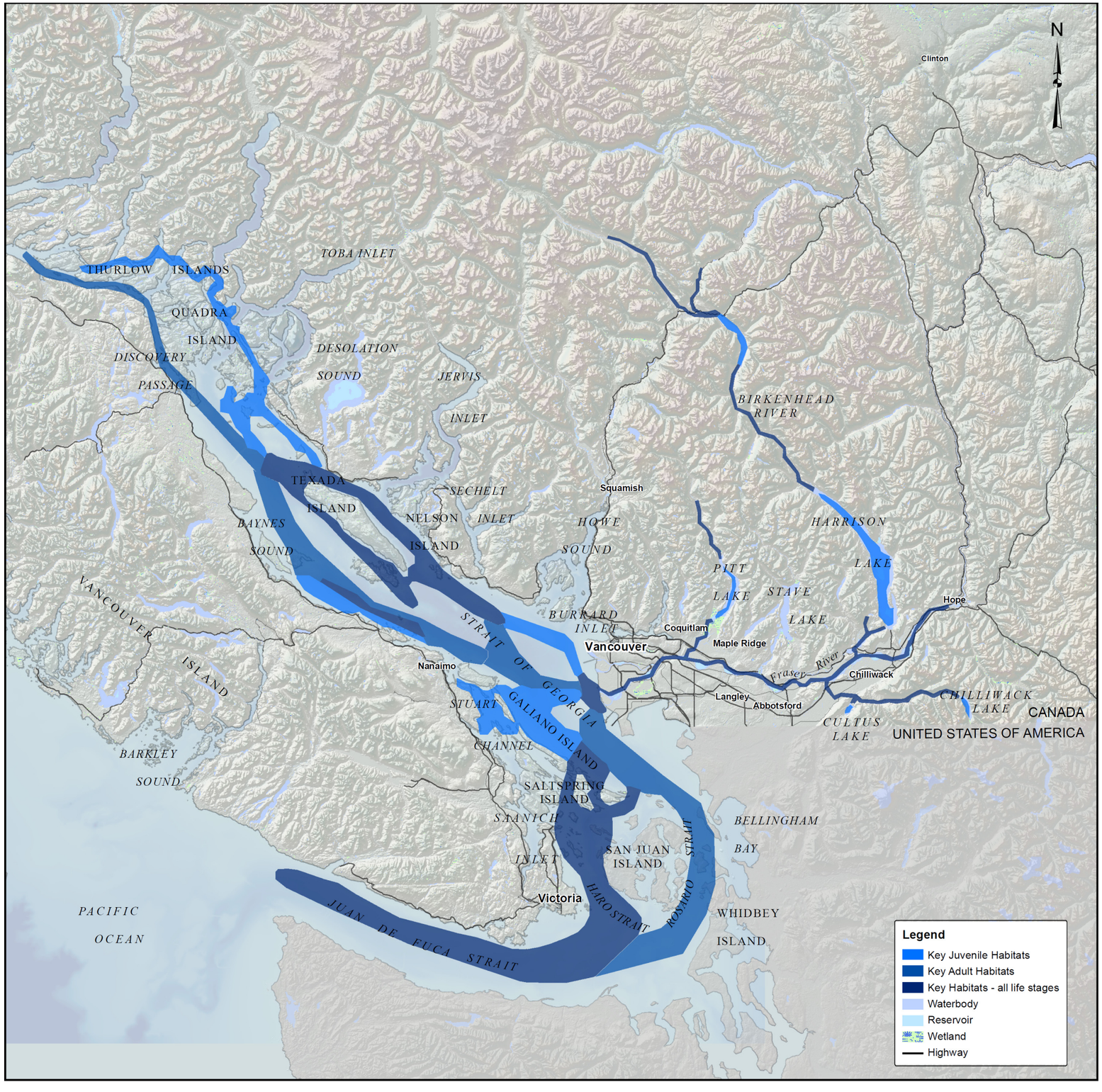


Map 15: Key Sockeye Habitats in the Lower Fraser River and Strait of Georgia

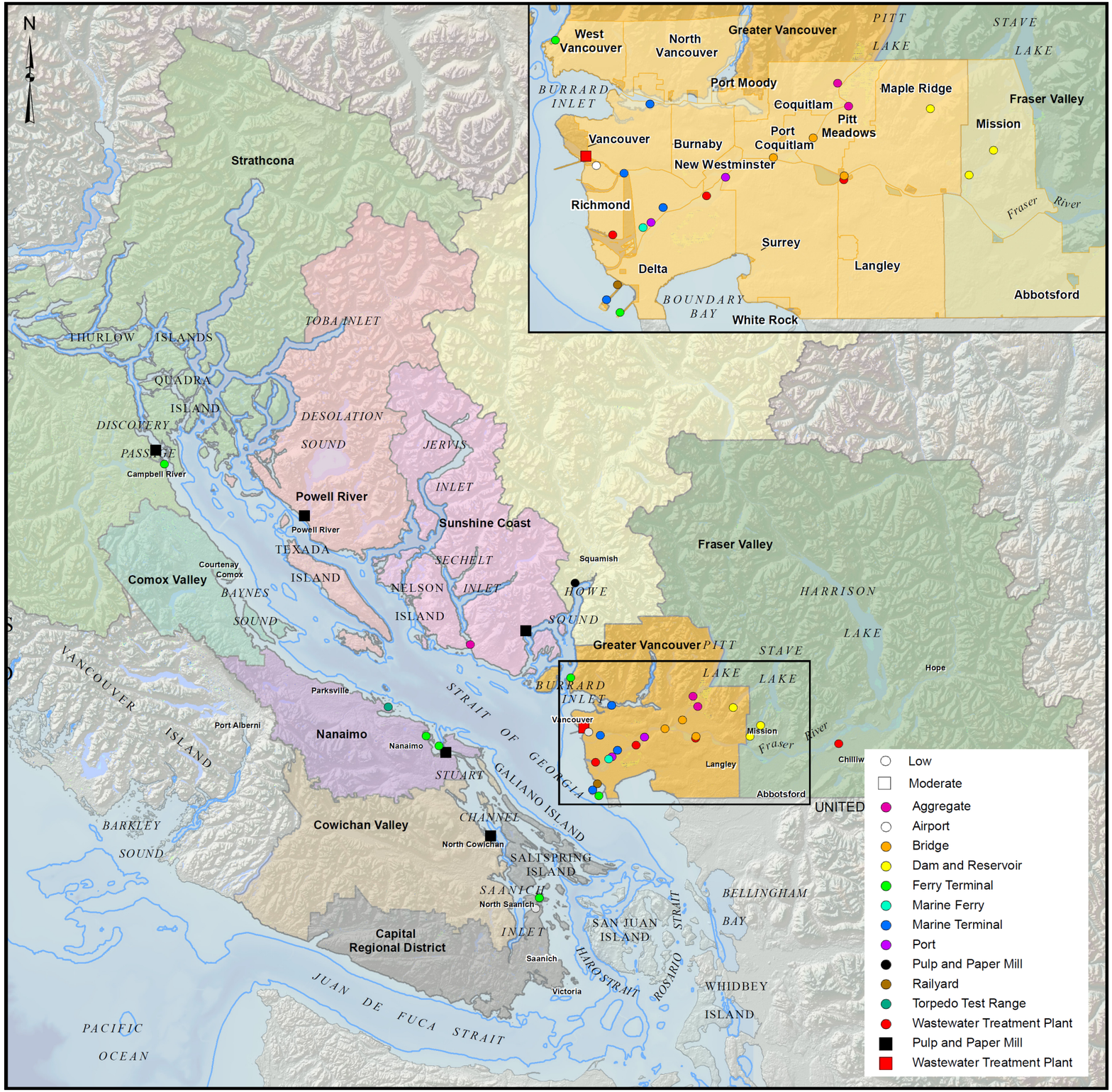
Illustration of key sockeye habitats was based on known distribution and residence period in a general habitat derived from existing literature, site specific catch or monitoring data reports and available georeferenced spatial information. Key habitats and habitat use were mapped as those having medium and high habitat use based on results for juvenile (Map 3-A-i; B-i; C-i) and adult (Map 3-A-ii; B-ii; C-ii; 3-D) sockeye.

Sockeye salmon freshwater distribution in the Lower Fraser River, from Hope to the Fraser River estuary, extends to 4 major watersheds including Harrison and Lillooet, Chilliwack, and Pitt Rivers, and so some limited extent the Coquitlam. Sockeye habitats in the Harrison, Chilliwack and Pitt watersheds are used for a residence period of 4 to 6 months by 0+ aged river-type sockeye (Harrison), and 1 or 2 years by lake-type sockeye for spawning, incubation and juvenile nursery rearing in Lillooet, Harrison, Chilliwack Cultus and Pitt lake areas . The 160 km portion of the lower Fraser River and estuary is used as a migratory pathway for smolts and adults with a residence period of often less than one week.

River-type sockeye aged 0+ originating from Harrison Lake (Harrison rapids) use various sloughs and off channel areas in the lower Fraser River above the tidal area, for rearing for a period of 2 to 6 months (Appendix 3). The Harrison river-type sockeye fry are small sized and rear / migrate slowly out of the Fraser River and estuary across the Strait of Georgia to use rearing habitats around the southern Gulf Islands for a residence period of 4 to 6 months. Harrison river-type sockeye juveniles were observed in the Juan De Fuca Strait and west coast Vancouver Island in February through June , one year after emergence.

Larger sized sockeye post smolts (juveniles) from the upstream mixed Fraser sockeye stock (Chilko, Stuart, Adams etc) have a short residence period (< 2 days) throughout the Fraser estuary and use a northern migration route through the Strait of Georgia to Queen Charlotte Sound ranging from 20 to 30 km / day in travel speeds. Specific eastern (preferred) and western migration routes and residence periods in specific habitats varies based on swimming speed, sockeye size, prevailing winds, surface currents, heterogeneity of plankton prey and general cool / warm biophysical characteristics of the Strait of Georgia. The residence period across the Strait of Georgia ranges from April to August with limited use in September and highest use in May and early June.

Adult sockeye use two alternative migration routes through the Strait of Georgia including a southern route through Juan De Fuca Strait, with holding areas above the southern Gulf Islands and Fraser plume and estuary, and a second northern diversion route through Johnstone Strait and Discovery Passage along an western route in the Strait of Georgia to holding areas in the Fraser plume and estuary. Migration residence periods for an individual migrating adult are often less than 1 month in the Strait of Georgia and lower Fraser River.



Map 16-A: Potential Interaction between Large Industrial and Public Projects, Sites and Infrastructure in the Lower Fraser River and Strait of Georgia with Key Fraser Sockeye Salmon Habitats

Human development across the Georgia basin has seen large changes in population size and density in urban centres. Most of the population and project development is centred in the lower mainland and south-eastern Vancouver Island. Changes in population reflects increasing pressures on the environment because of the potential for higher levels of residential and industrial water use and pollution, nutrients and contaminants from wastewater and runoff, conversion of vegetated lands (natural, forests, agricultural) to urban and industrial areas.

During that same time, environmental management programs have been in place to curb and manage runoff and human related discharges. Contaminants in the Strait of Georgia show a general improvement over time, with decreases associated with effluent regulation and improved treatment in recent years.

The physical construction of development projects adjacent to sockeye habitats has also been regulated over the period of study and there is evidence that habitat conservation efforts, through regulatory review and through restoration of previously impacted habitats, have resulted in habitat gains in the Fraser River estuary over the period of study for this report (1990 – 2010). However, some of the earlier habitat projects, carried out prior to the present period of study, were not successful at achieving “no net loss” of fish habitat. There is evidence that information learned from those projects has been incorporated into successful compensatory designs on contemporary projects in the Fraser estuary, underlining the importance of continued scientific learning regarding habitat ecology.

Map 16-B: Potential Interaction between Large Industrial and Public Projects, Sites and Infrastructure in the Lower Fraser River and Strait of Georgia with Key Life History Based Fraser Sockeye Salmon Habitats

Changes in the level of human activity in the lower Fraser River and Strait of Georgia were compared against spatial and temporal habitat use by Fraser River sockeye salmon to evaluate the potential past, current and future risk of loss or degradation to juvenile and adult Fraser sockeye salmon habitats as a result of these activities. The risk of loss or degradation of sockeye habitats is used here as a qualitative (ordinal) metric and provides one approach to classify the current and / or future change or impacts to sockeye habitats based on interaction or overlay with factors used to express changes in human activities in the lower Fraser River and Strait of Georgia. Potential interactions were reviewed over the 1990 to 2010 period across six general habitat areas.

A classification was first applied to potential interactions between human activities, identified as "factors", and sockeye habitats generalized to six areas. A classification of "likely", "limited" or "nil" was assigned to define the interaction. Where interactions were identified either as being "likely" or "limited", they were further ranked to assign a level of interaction between that human activity and sockeye habitats. This ranking was based on the extent of geographic overlap, magnitude of the interaction and duration of effects used as interaction criteria between human activity and overlap with sockeye habitats (Table 1). The level of interaction between human activities and habitat areas were evaluated across an ordinal scale from nil, low, moderate or high level of interaction. A summary ranking combined predicted geographic, magnitude and duration effects to an overall level of past, current and potentially future risk of loss or degradation (interaction and overlap) of juvenile and adult (Table 2) sockeye habitats associated with human development and activities. Rankings for each of the six general habitat areas were assigned through a combination of expert opinion, the results for the factor being evaluated and an overall ranking based on the interaction criteria (Table 1). Ranks assigned to the potential for loss/degradation of sockeye habitat from human activities over the 1990 to 2010 period are detailed in Table 2 and 4, and summarized in Map 17.

- Low - freshwater juvenile and adult sockeye habitats
- Low - marine juvenile sockeye habitats
- Low - marine juvenile and adult sockeye habitats
- Moderate - marine juvenile sockeye habitats
- Moderate - marine juvenile and adult sockeye habitats

Map 17: Potential Risk of Loss or Degradation of Sockeye Habitats in the Lower Fraser River and Strait of Georgia

Summary Risk of Loss or Degradation of Sockeye Habitats	General Areas of Sockeye Habitats					
	Lower Fraser Watersheds	Lower Fraser River	Fraser River Estuary	Central Strait of Georgia	Northern Strait of Georgia	Juan de Fuca Strait
1. Population	Low	Low	Low	Nil	Nil	Nil
2. Land use	Mod	Nil	Nil	Nil	Nil	Nil
3. Industrial and Infrastructure Projects	Nil	Low	Low	Nil	Nil	Nil
4. Waste	Nil	Low	Low	Nil	Nil	Nil
5. Shipping and Vessel Traffic	n/a	n/a	Nil	Nil	Nil	Nil
6. Dredging, Diking, Disposal at Sea	n/a	Low	Low	Nil	n/a	n/a
7. Strait of Georgia Water Properties	n/a	n/a	Low	Mod	Mod	Nil
8. Strait of Georgia Biological Properties	n/a	n/a	Nil	High	High	Nil
9. Contaminated Materials	Nil	Low	Low	Nil	Nil	Nil
10. Non Indigenous Species Introductions	Low	Low	Low	Nil	Nil	Nil

Summary ranks were derived through consideration of the level of significance expressed across interaction criteria (Table 1) for each human activity factor (Table 2, 4) assigned to the potential for loss/degradation of sockeye habitat from human activities over the 1990 to 2010 period. Professional judgement was used to review final summary ranks to the extent of the space and time interaction and overlap for each human activity factor relative of the area and timing of sockeye habitat use. Factors used to express changes in human activities werepresented in Maps 5 to 14 and used to evaluate the extent of spatial or temporal overlap (Maps 16-A, 16-B) with key sockeye habitats (Maps 3, 4 and 15).

Increasing population size, urban density, industrial and infrastructure development and associated land use and waste as factors in the decline of Fraser sockeye were ranked as having low to moderate potential for impacts on juvenile and adult sockeye habitats in the lower Fraser River and adult sockeye habitats in the Fraser estuary. As a result of regulatory pressures and technological changes and despite population growth, solid waste, wastewater, contaminants and non indigenous species introductions appear to have remained mostly stable over the time covered by this review, in contrast to Fraser sockeye production which has declined. Changes in urban and rural land use have implications on increased sediment and erosion, nutrient, contaminant and stormwater runoff which could affect sockeye habitat use in the lower Fraser River, particularly in habitats used in locations off of the main channel.

In many areas where human activities and development are concentrated, sockeye often have limited residence periods in adjacent habitats. Historically (i.e., over the past century), many human activities may have had moderate to severe effects on sockeye habitats, but these impacts have not been generally observed during the last 2 decades and importantly, these impacts have not been observed to coincide with the decline of the Fraser River sockeye. The human activities often exhibited limited spatial and temporal (duration, timing) overlap with spatial and temporal sockeye habitat use. In a number of instances, additional regulatory controls (agricultural and forestry practices, shipping, ballast discharge, regulatory review of project development, non indigenous species introductions), improvements to industrial and municipal practices (solid and liquid waste management), and management regimes and protocols (urban development, agricultural and forestry practices, project development, dredging, dikes) have resulted in reduced or declining potential effects and reduced interactions and risk of loss or degradation of existing sockeye habitats relative to periods prior to the last two decades.