Toward a Vision for Salmon Habitat in the Lower Fraser River

Prepared by Dave Scott, Ross Dixon, Misty MacDuffee

RAINCOAST
CONSERVATION FOUNDATION

Toward a Vision for Salmon Habitat in the Lower Fraser River

March 2020

fraserriver@raincoast.org
www.raincoast.org

ISBN: 978-1-9993892-1-5

Prepared by Dave Scott, Ross Dixon, Misty MacDuffee, with support from Riley Finn and Kristen Walters.

Art by Carrielynn Victor.

Funding by Vancouver Foundation, Bullitt Foundation, Real Estate Foundation, Sitka Foundation, Patagonia, and numerous private donors who have made this work possible.

Raincoast is a team of scientists and conservationists dedicated to safeguarding the land, waters, and wildlife of coastal British Columbia.

Our vision for coastal British Columbia is to protect the habitats and resources of umbrella species. We believe this approach will help safeguard all species, including people, and ecological processes that exist at different scales. Central to our efforts are long-term partnerships with Indigenous governments.

We investigate to understand coastal species and processes.

We inform by bringing science to decision makers and communities.

We inspire action to protect wildlife and wildlife habitat.

RAINCOAST
CONSERVATION FOUNDATION

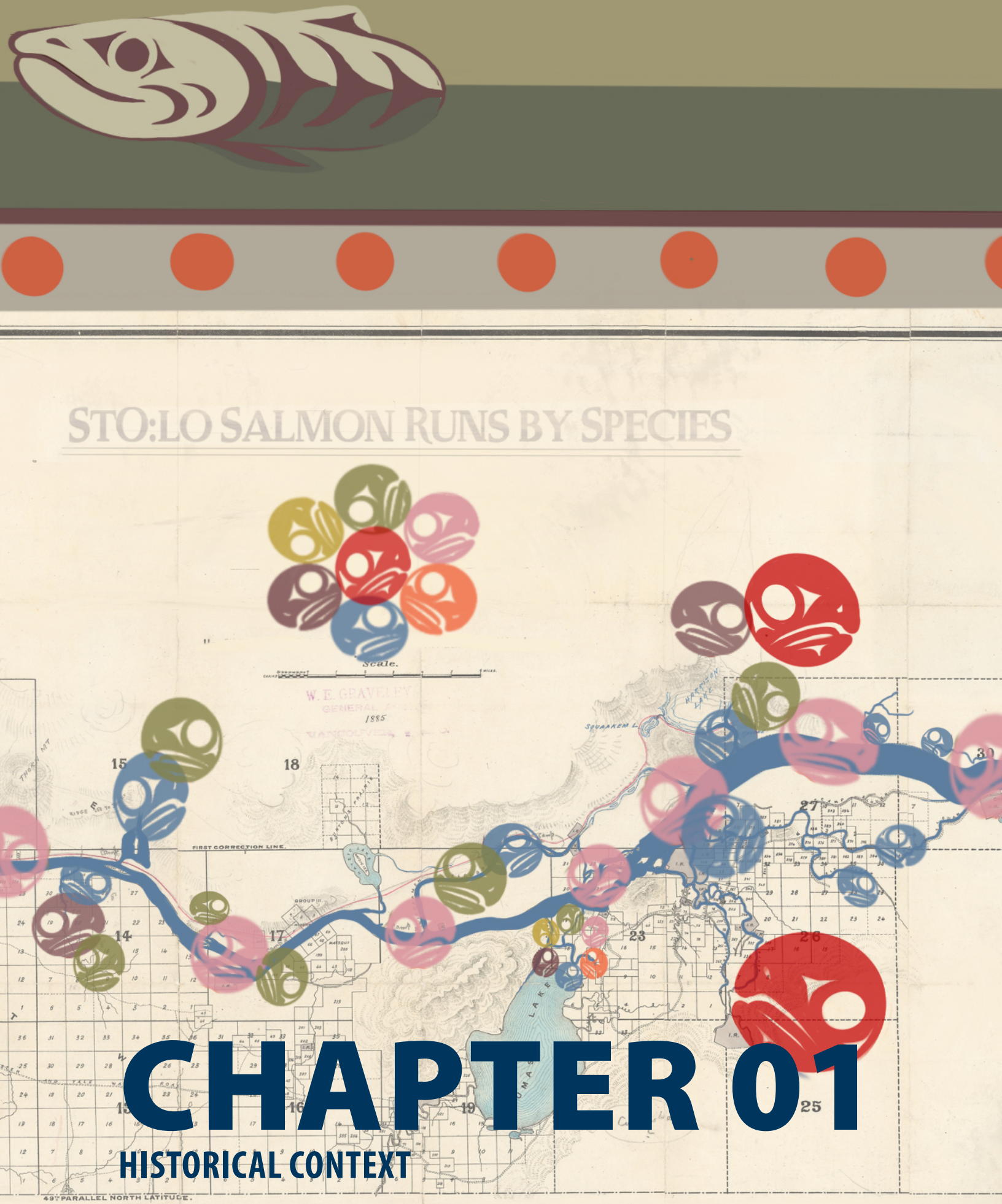
Contents

Continued on page vi.

Tables

Figures


ENGLISH BAY
BURRARD INLET
FIRST NARROWS
SECOND NARROWS
PORT MOODY
PITT LAKE
HASTINGS
PTGREY
PTATKINSON
SEA ISLAND
WESTHAM ISLAND
MUD BAY
BOUNDARY BAY
NORTH BLUFF
SEMIAHMOO BAY
BARNSTON ISLAND
LANGLEY TOWN
GULF OF GEORGIA
41
40
42
DRAWN BY F.G. RICHARDS Jr. AT L.&W. DEPT VICTORIA, B.C.



CHAPTER 01

HISTORICAL CONTEXT

Chapter 1: Historical context

Stó:lō, Dakelh, Lhtakoh, ?Elhdaqox. A river of such length has an equally long history. Long before the river's current namesake explorer, Simon Fraser, ever arrived, Indigenous communities shaped and were shaped by the river, of various names, and its salmon.

The Fraser is the largest river on Canada's west coast and continues to be one of the most productive salmon rivers in the world. The watershed provides a diversity of habitats that allow Chinook, chum, coho, pink, and sockeye to reproduce in large numbers. There is also a diversity of other fish species including steelhead, anadromous cutthroat trout, eulachon, and sturgeon, all valued by First Nations and recreational fishers. Although salmon populations spawn in areas throughout this enormous watershed, all must pass through the lower river and estuary. Many populations rely heavily on the estuary as a nursery for their juvenile life stage before embarking on their seaward migration and eventual return.

The mighty Fraser

The Fraser River is one of the world's great rivers, running over 1,300 km in length, with a watershed encompassing one quarter of British Columbia (Milliman 1980; Richardson et al. 2000). From the headwaters in the Rocky Mountains, hundreds of tributaries combine as the river moves across British Columbia towards the ocean to deliver an enormous amount of freshwater (avg. 3,410 m^3 per second), and sediment (approximately 17 million tonnes/year), into the Lower Fraser and Salish Sea (Milliman 1980; McLean et al. 1999). As these streams combine, the nature of the river changes, creating the diverse habitats that salmon have evolved with and adapted to. As a snowmelt driven system, spring brings a corresponding increase in river flows. In the Lower Fraser this results in a rise of several metres, temporarily connecting and creating habitats in the few areas where the river is unconstrained by dikes and armoring.

The salmon populations that exist in the Fraser began to colonize the watershed after the last glaciers retreated between 9,500 and 9,000 years ago (Shaepe 2001). Since then salmon have spread throughout the watershed, evolving over time with the unique local conditions in each stream, using their homing ability to migrate back to their natal spawning grounds as adults (Taylor 1991). Upon European arrival, the Fraser was the most productive salmon watershed in the world, boasting populations of Chinook, chum, coho, pink, and sockeye that were counted in the millions and originated from more than 1,070 spawning populations distributed throughout the mainstem and tributaries (Slaney et al. 1996). Despite intense harvest and development pressures, the Fraser continues to support runs of all five economically important salmon species, producing over 50% of Canada's wild Pacific salmon (Levy and Northcote 1982; Northcote and Atagi 1997; FRAP 1999). However, most salmon populations from throughout the watershed have declined, resulting in greatly reduced abundances and strictly managed fisheries.

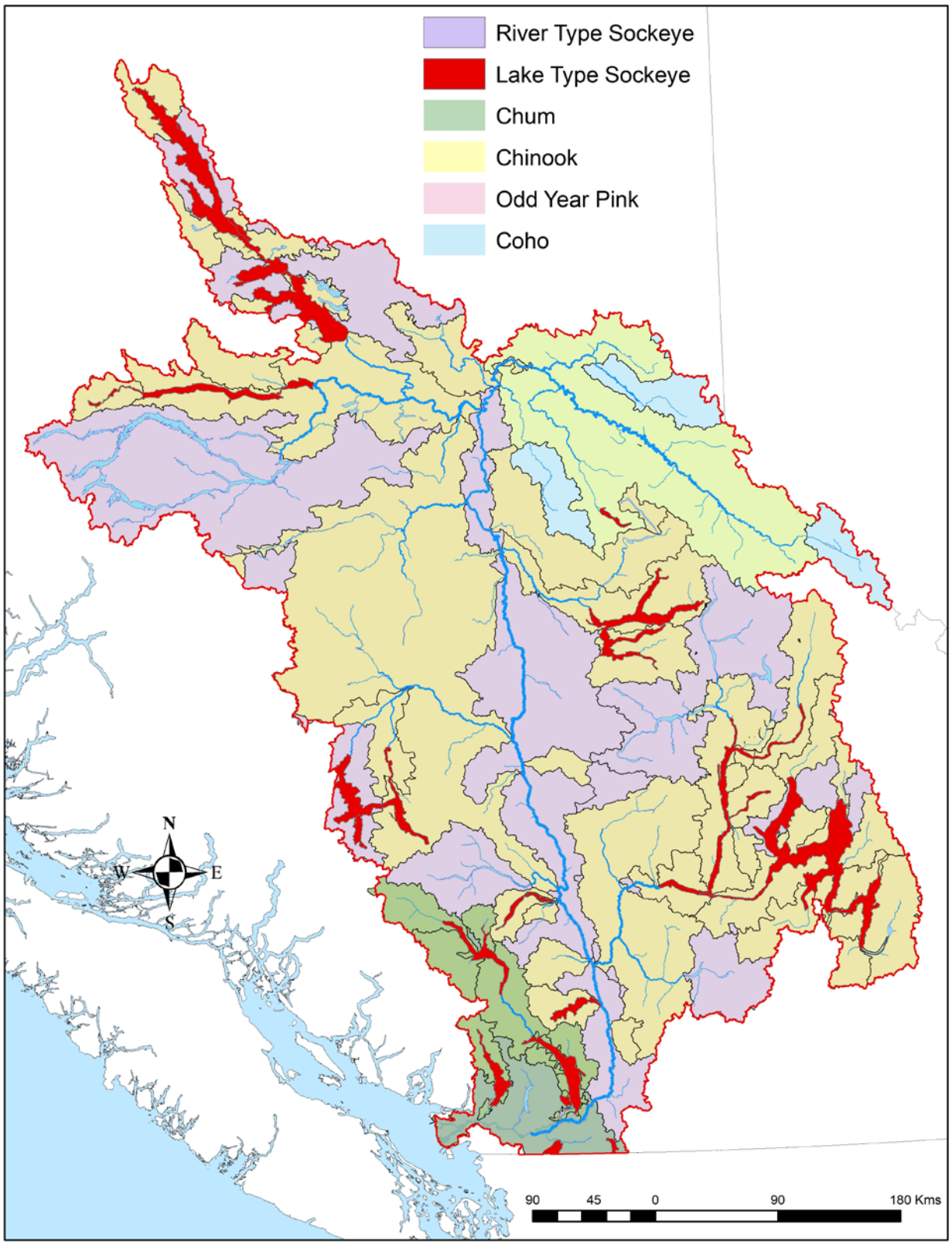


Figure 1.1. Fraser River watershed with major tributaries and distribution of Pacific salmonids.

The Lower Fraser and its estuary: A salmon nursery

All of the salmon that spawn in the Fraser watershed use the Lower Fraser and estuary as a migration corridor. Many further rely on the lower river, its tributaries, and estuary for rearing, spawning, and feeding. We define the Lower Fraser as the section of river flowing west from Hope, past Mission, through Metro Vancouver, and into the estuary where it meets the ocean. Despite the Lower Fraser watershed representing less than 5% of the Fraser Basin's size, this area supports more than half of the Fraser River's Chinook and chum, 65% of its coho, 80% of its pink, and significant stocks of sockeye salmon (DFO 1995, 1996).

As the river moves from Hope to the estuary, it is joined by a diverse network of tributaries from large rivers like the Pitt and Harrison to small streams like Musqueam Creek. Together, these watercourses drain the Lower Fraser watershed. Large tributaries like the Chilliwack/Vedder and Harrison rivers are home to diverse populations of salmon and some of the most productive spawning areas in the entire watershed. Conversely, the Coquitlam and Alouette rivers long ago had dams constructed on their mainstems, altering river flows and blocking sockeye and other salmon species from passage to upstream spawning grounds (Godbout et al. 2011). Along with large tributaries, there is an intricate network of mostly tidal freshwater tributaries that provide spawning, rearing, and overwintering habitats to Chinook, coho, and chum salmon (Levings et al. 1995). These small freshwater tributaries, along with the estuarine habitats at the mouth of the river, are crucial places for juvenile salmon while they transition from a freshwater to a marine life stage.

The Lower Fraser can be divided into three distinct sections, i.e. the gravel reach, the sand reach, and the estuary, based on changes in sediment and salinity. The Lower Fraser begins when the river emerges from its canyon just upstream of Hope, moving into a broad, flat valley. Known as the gravel reach, here the river slows, causing the majority of gravel the river is transporting to settle out. Over time, this process resulted in the formation of much of the Fraser valley, creating more than 625 km^2 of new land within the Strait of Georgia in the last 10,000 years (Groulx et al. 2004). This gravel habitat, from Hope to Mission, is important for many species including the millions of pink salmon which spawn directly in that gravel every second year (Grant and Pestal 2009).

Downstream of Mission, the gradient is further reduced and the river rises and falls with the tide. Here, most of the sand transported by the river begins to settle and makes up most of the river bottom. This island reach, stretching from Mission to New Westminster, is an important spawning habitat for the endangered Fraser eulachon (*Thaleichthys pacificus*), among other species (COSEWIC 2011). This is also the most industrialized area of the river, and much of the sand deposited each year is dredged out to maintain shipping channels.

The lower river and delta below New Westminster empties directly into the southern Strait of Georgia via the North and Main arms, creating a fresh-saline mixing zone that is the estuary of the Fraser River. The inner estuary consists of the North Arm, which splits further around Sea Island into the North and Middle Arms, and the Main Arm which splits further around the Woodward Island marsh complex into Canoe Pass and the Main Arm. The outer estuary is made up of

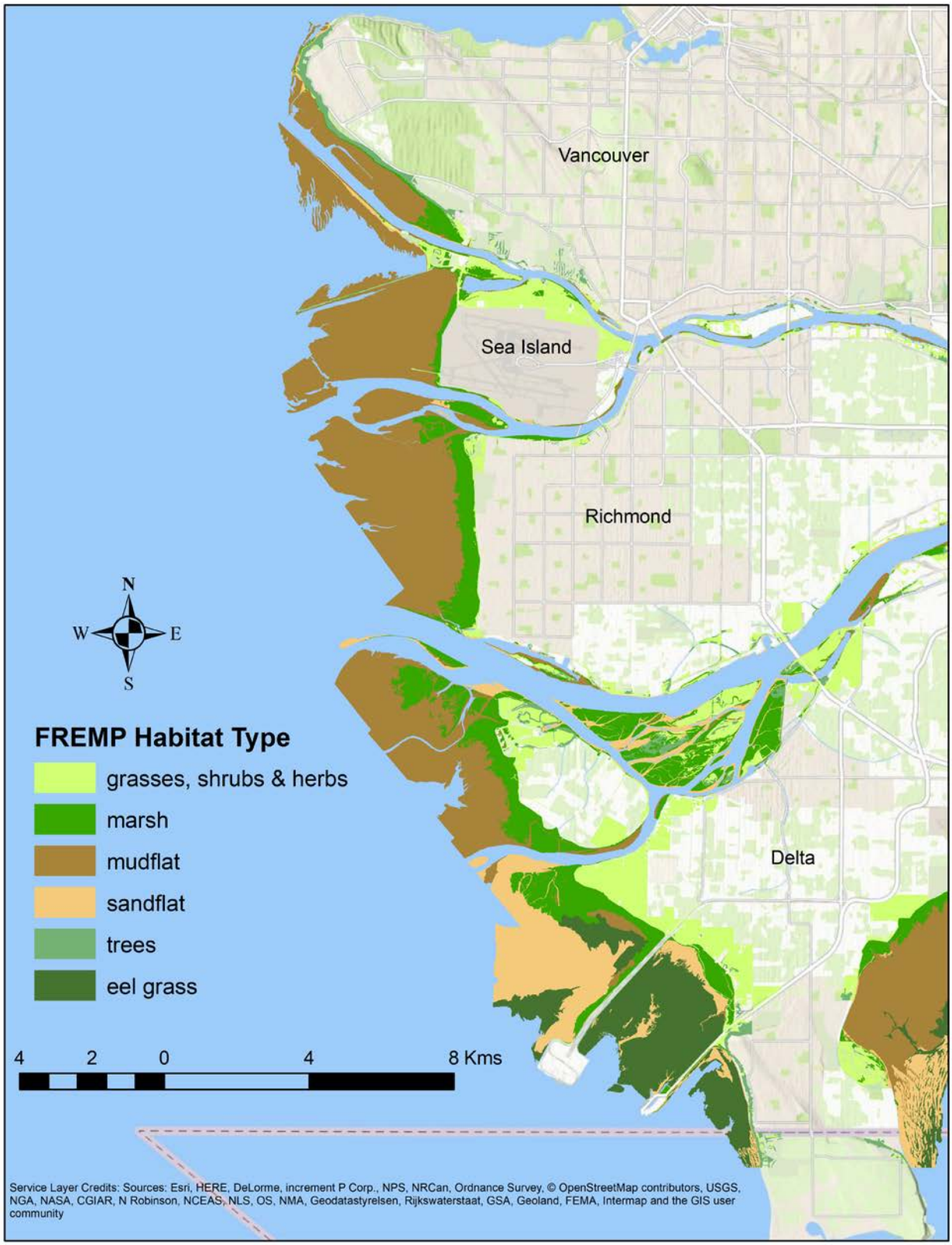


Figure 1.2. Habitat types in the Lower Fraser estuary (sand flat, mud flat, eelgrass, intertidal marsh). Data sourced from Fraser River Estuary Management Program and Feeney (1995).

Sturgeon and Roberts Banks, which are further divided by several jetties and causeways that alter the path of water, sediment, and fish. These outer deltas provide a variety of habitats including marsh, sand/mud flats, and eelgrass beds, all of which differ in salinity, sediment type, water depth, and their ability to support salmon (Harrison et al. 1999).

The Fraser estuary: connecting salmon, birds, and marine mammals

Estuaries are critically important habitats for salmon. The Fraser estuary is the largest on the west coast of North America at more than 21,000 hectares. It provides a long stretch of tidal habitat for hundreds of millions of juvenile salmon to migrate into each year. The near-shore environments of the Fraser estuary host a unique ecological zone. Saltmarsh and eelgrass beds, common in the delta, serve as nurseries for young salmon by offering shelter, food, and protection from predators during a vulnerable and stressful life stage as they transition to saltwater. Juvenile Chinook, chum, and pink salmon rear in tidal nearshore habitats in the Fraser estuary where they feed and grow before migrating to the open ocean (Levy and Northcote 1982; Levings et al. 1995; Chalifour et al. 2019). These shallow, nearshore zones also host an incredible diversity of other species, all tied together in a fragile food web. These shorelines boast much higher density of species and productivity than deep-water areas (Rowe et al. 1975).

Recognizing the importance of estuary habitats

In U.S. coastal marine waters, legal definitions mean virtually every estuary, river mouth, slough, bay, foreshore, and extended shoreline on the coast is classified as Essential Fish Habitat (EFH) for Salmon. The U.S. federal government has recognized the physical and structural features within these zones as being critical for salmon and, as such, offer them a higher level of protection (NOAA 2009). Essential Fish Habitat for Chinook salmon also includes estuarine and marine areas extending from the extreme high tide line in nearshore and tidal submerged environments within state waters. This higher level of protection for estuarine habitats in the U.S. does not have an equivalent in Canada.

The estuary ecosystem

The delta of the Fraser estuary is not only important for salmon, it also supports a diverse ecosystem of microorganisms, invertebrates, birds, mammals, and 55 species of fish (Levings 2004). The delta is recognized as an internationally Important Bird Area, supporting bird populations from three continents (Schaefer 2004) and providing a major stopover point along the Pacific Flyway for millions of birds migrating from Canada's Arctic and the eastern tip of Russia to wintering grounds in Central and South America (Butler and Campbell 1987). The delta provides a vital link in a chain that extends from wetlands in California to the Copper River Delta in Alaska (Schafer 2004).

The food web in the estuary relies on primary producers such as the microalgae (e.g. diatoms) and other microorganisms that create a nutrient rich biofilm on the surface of the mudflats (Harrison et al. 1999). Invertebrate communities in the estuary can comprise up to 300 species, but the main groups found

at Sturgeon and Roberts Banks are from 35 species of worms, bivalves, amphipods, isopods, decopods (shrimp-like), harpacticoid (benthic) copepods, nematodes, and oligochaetes (Otte and Levings 1975). These invertebrate prey items support the hundreds of millions of out-migrating juvenile salmon that move into the lower estuary each spring. They are also eaten by fish such as herring (*Clupea pallasii*), sand lance (*Ammodytidae spp.*), eulachon, and smelt (*Osmeroidei spp.*) (Levings 2004). These fish, along with juvenile salmon, are in turn prey for larger vertebrate predators such as marine mammals, thousands of migratory, resident, and overwintering waterfowl, shorebirds and raptors, and other fish (Figure 1.3.).

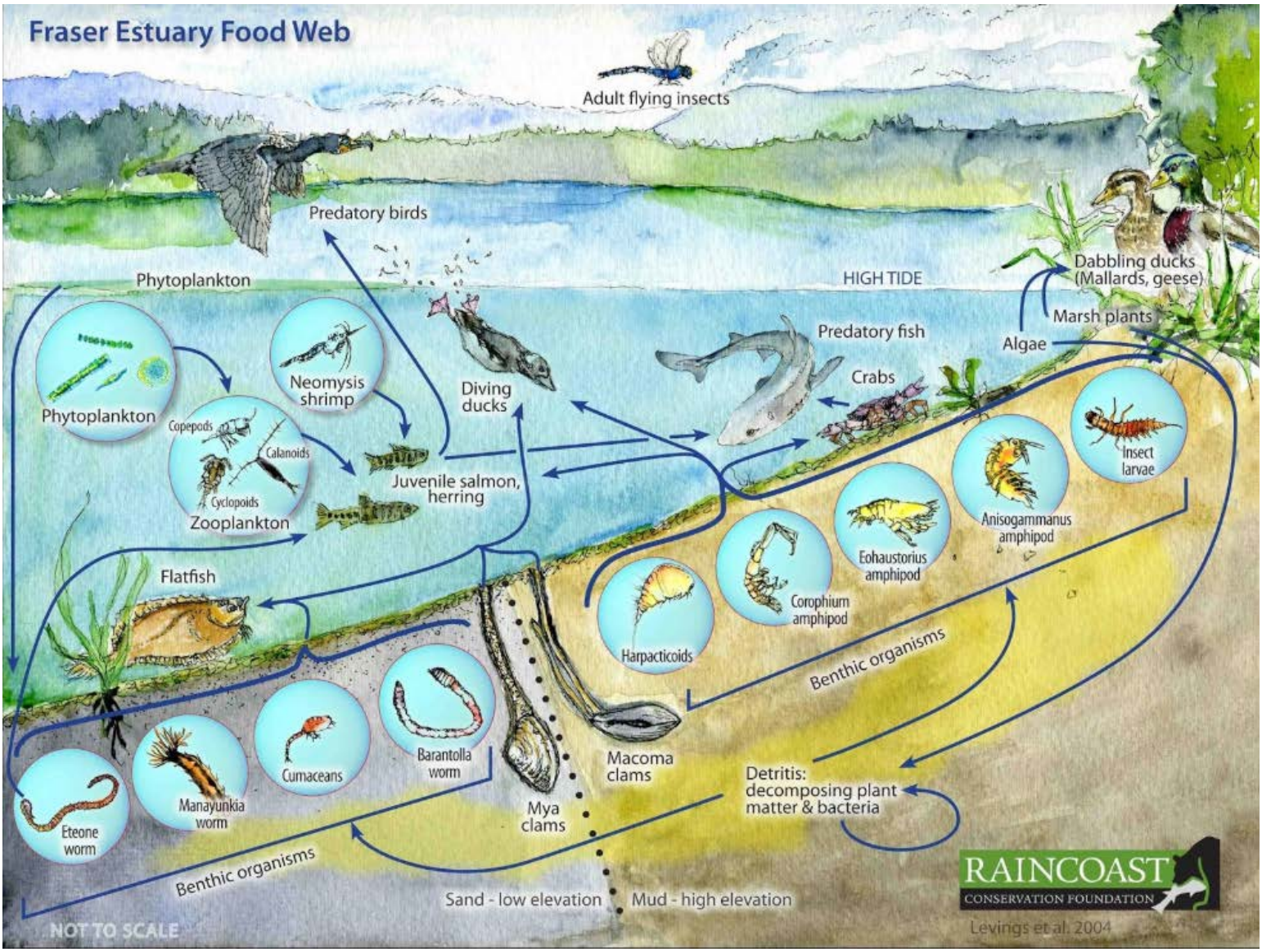


Figure 1.3. The food web of the Fraser River estuary, comprised of primary producers, invertebrates, prey fish, salmon, birds and marine mammals. Adapted from Levings et al. 2004.

A shared history: Salmon and people

First Nations communities flourished for centuries along the Fraser River, supported by the annual returns of highly nutritious salmon. The first documented sites of human occupation began appearing 10,000 to 8,000 years ago just as the glaciers were retreating (Shaepe 2001a). In the thousands of years that followed, people began creating more specialized tools, establishing permanent settlements with social structures, languages, and unique cultures (Shaepe 2001a). During the early contact/pre smallpox era, it is estimated that tens of thousands of Stó:lō (which translates as "river") lived in numerous settlements throughout the Lower Fraser (Shaepe 2001a). These communities lived off the river; they used unique fishing tools such as weirs, basket traps, dip nets, gill nets, and spears to catch sturgeon (*Acipenser transmontanus*), cod (*Gadus macrocephalus*), eulachon (*Thaleichthys pacificus*), salmon and trout (*Oncorhynchus* spp.). For some, salmon were prized above all other fish and were the economic, cultural, and spiritual heart of First Nations in the Lower Fraser River and throughout the basin.

There are at least 91 different First Nations bands spread throughout the Fraser watershed, all of which have relied on salmon from the river since long before colonization (Bennett 1973). Salmon are preserved through traditional methods to last for much of the year, and shared among members of the band (Bennett 1973). In 1947, Hewes estimated that the average member of a tribe in the Fraser watershed would consume 250 kg of fresh fish each year, primarily salmon. A follow up survey by Bennett in 1971 found that the salmon fishery continued to provide a food supply for a very high proportion of First Nations families throughout the watershed. Historically, access to the resource varied by location, with First Nations closer to the mouth having access to a diverse set of populations and therefore a larger more stable supply of salmon, compared with those in headwaters relying on fewer populations (Moore et al. 2015). Preservation techniques also varied, with those communities in the Fraser Canyon enjoying ideal conditions for wind drying, while those along the coast relied on salting and smoking (Carlson 2001a).

Over the years, First Nations have had to fight for access to the resource upon which they long relied. Harvest by commercial fisheries has greatly reduced the number of salmon making it upstream, and urbanization, including roads and railways, has eliminated fishing spots and forced the relocation of settlements (Shaepe 2001b). Government restrictions have also attempted to limit First Nations fisheries, including the Fisheries Act of 1888 which made it a crime for Stó:lō people to sell salmon (Carlson 2001c). These types of restrictions resulted in bitter fighting throughout the years, eventually culminating in a decision by the Supreme Court of Canada in the R v. Sparrow case, which now provides First Nations priority access to salmon for food, social, and ceremonial purposes (Sparrow, [1990] 1 S.C.R. 1075). Although this decision provides access to the resource, the overall abundance of Fraser salmon populations has declined significantly over time (Slaney et al. 1996), reducing the number of fish available to First Nations and other fisheries.

Salmon are not just a source of food, they an important part of First Nations economy and culture, considered by many to be an essential part of their identity (Bennett 1973). Many Indigenous creation stories, including those from around the Salish Sea, share common threads. Mythic descent is a common belief,

with salmon being the origin species of the Tsawwassen people (Carlson 2001a). Another is that 'personhood' is open to both humans and non-humans. Accordingly, when the Creator added humans to the mix of life on Earth, humans did not see themselves as anything different. Rather, the interdependence with all others was seamless. In many First Nations communities, ceremonies take place when the first salmon of the season is caught. This varies by band, but can include the salmon being placed on a bed of boughs and introduced to the Elders in an intricate ceremony (Fraser Basin Council 2013). Today, First Nations access to the resource, upon which they have so long relied, has been significantly affected by habitat loss and fisheries, as well as fishing regulations that have changed their ability to subsist as they once did. The loss of the wild salmon fishery would not only leave many without enough food, but would affect a culture developed over millennia.

The salmon capital of the world

As European settlers began colonizing the Lower Fraser area, they quickly realized the value of the large numbers of salmon that returned each year, particularly sockeye. The Hudson's Bay Company has anecdotal records of sockeye salmon abundance dating back to 1793, and in 1830 they established their first posts along the Lower Fraser and large-scale commercial exports of preserved salmon began (Carlson 2001b; Roos 1991). By the 1870s commercial harvesting and canning had begun and in 1873 records show 8,125 cases of sockeye were packed (Roos 1991). The town of Steveston began as a fishing camp in the 1870s, and by 1901 it was the "Salmon capital of the world" producing 375,000 cases of canned salmon, which were then shipped around the world (Yesaki et al. 2005).

R. v. Sparrow Case (Sparrow, [1990] 1 S.C.R. 1075)

Denying First Nations priority access to Fraser salmon went on for decades before being brought before the Supreme Court of Canada. Ronald Edward Sparrow, a member of the Musqueam Band, was caught fishing in Canoe Pass, a channel in the south arm of the Lower Fraser, with a drift net longer than permitted by the band's fishing license. Although Sparrow admitted to the charges, he argued he was exercising his Aboriginal right to fish. The judge agreed "that Mr. Sparrow was fishing in ancient tribal territory where his ancestors had fished from time immemorial in that part of the mouth of the Fraser River for salmon." Despite the ruling over the lower court, the Supreme Court justices unanimously agreed that Sparrow was exercising an "inherent" Aboriginal right that was guaranteed and protected by section 35 of the Constitution Act, 1982.

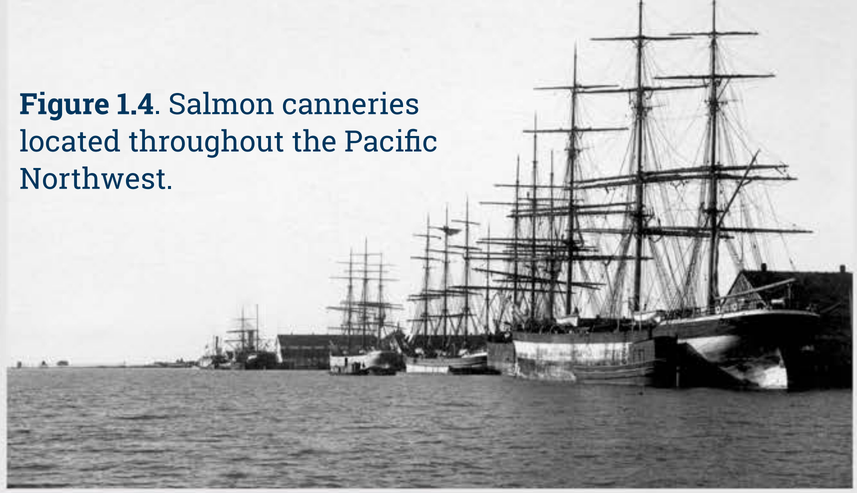
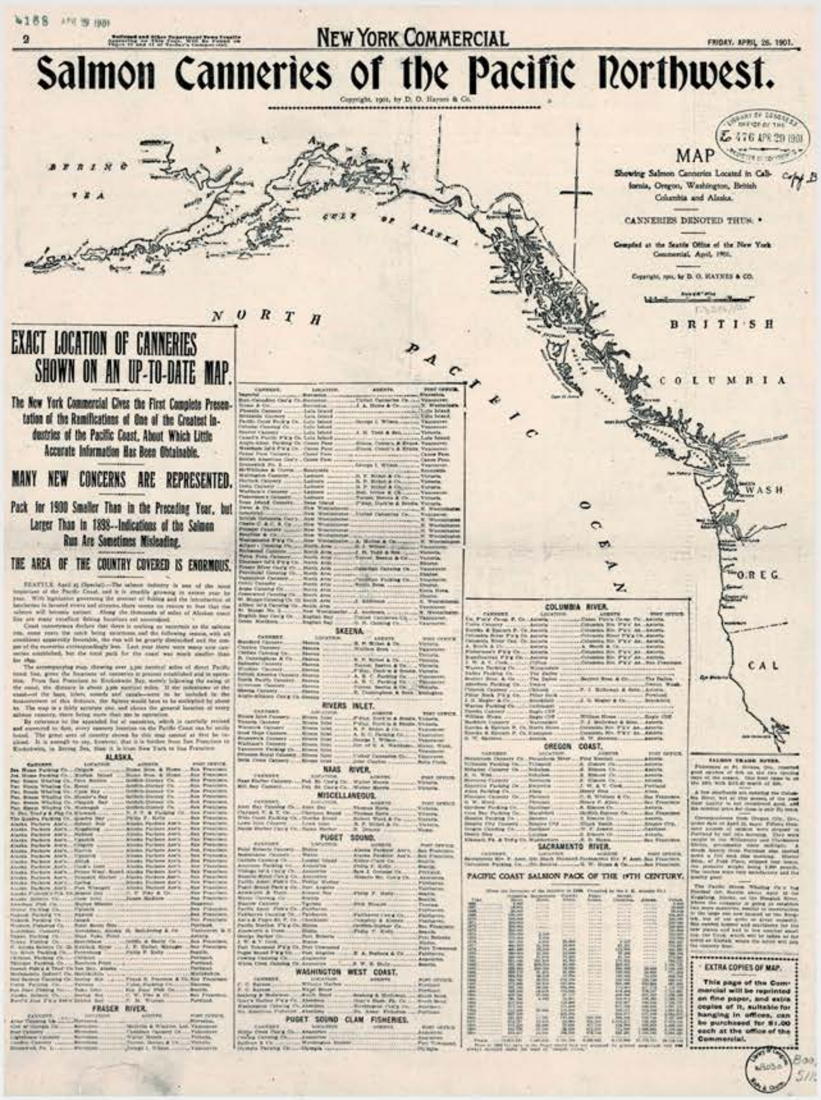


Figure 1.4. Salmon canneries located throughout the Pacific Northwest.



2 NEW YORK COMMERCIAL FRIDAY, APRIL 26, 1901.

Salmon Canneries of the Pacific Northwest.

Copyright, 1901, by D. O. Haynes & Co.

MAP

Showing Salmon Canneries Located in California, Oregon, Washington, British Columbia and Alaska.

CANNERIES DENOTED THUS: •

Compiled at the Seattle Office of the New York Commercial, April, 1901.

Copyright, 1901, by D. O. HAYNES & CO.

EXACT LOCATION OF CANNERIES SHOWN ON AN UP-TO-DATE MAP.

The New York Commercial Gives the First Complete Presentation of the Ramifications of One of the Greatest Industries of the Pacific Coast, About Which Little Accurate Information Has Been Obtainable.

MANY NEW CONCERNS ARE REPRESENTED.

Pack for 1900 Smaller Than in the Preceding Year, but Larger Than in 1898--Indications of the Salmon Run Are Sometimes Misleading.

THE AREA OF THE COUNTRY COVERED IS ENORMOUS.

ALASKA.

SKEENA.

RIVERS INLET.

NASS RIVER.

MISCELLANEOUS.

PUGET SOUND.

WASHINGTON WEST COAST.

FRASER RIVER.

PUGET SOUND CLAM FISHERIES.

COLUMBIA RIVER.

OREGON COAST.

SACRAMENTO RIVER.

PACIFIC COAST SALMON PACK OF THE 19TH CENTURY.

EXTRA COPIES OF MAP.

By 1892, the fleet had already grown so large that officials from Canada and the United States had to meet to discuss the harvest of Fraser River sockeye (Roos 1991). While salmon resources in the Fraser initially seemed limitless, the combination of advanced gear and increased numbers of fishing vessels began to take a toll on the valuable sockeye and other salmon populations. The "off year" sockeye runs began to decline from peak abundances during 1898-1900 to less than half their previous numbers by 1914-1916 (Yesaki et al. 2005). Freshwater habitat problems also began to become an issue in the late 1800s and early 1900s, as the first dams were built on Fraser tributaries and the first mines opened in the watershed. The "strong year" sockeye population appeared to be at all time high levels in 1913, with a commercial catch estimated at more than 32 million fish, before the rockslide at Hells Gate prevented millions of adults from reaching their spawning grounds, causing long term effects on the abundance of upriver populations (Yesaki et al. 2005; Ricker 1947).

Throughout the 1900s, and continuing today, high fishing pressure has targeted all five species of Pacific salmon that spawn in the Fraser. Low returns, which followed the Hells Gate slide for decades, and increased fishing intensity by Canada and the United States, eventually resulted in the formation of the International Pacific Salmon Fisheries Commission in 1937. Research and harvest measures began soon after, and sockeye runs began to recover between 1950 and 1980 (Roos 1991). However, these recoveries did not restore the previous century's abundance, as overfishing and other factors contributed to continued declines in all salmon species in the Fraser system.

At one time, a sizeable recreational fishery took place in the Salish Sea for coho and Chinook, with the latter being large and abundant. Today, fisheries are greatly reduced; the Salish Sea coho fishery has largely collapsed and Chinook abundances are at all-time lows. In 2009, sockeye runs were a fraction of their predicted size, which led to a federal inquiry into the disappearance of Fraser sockeye conducted by Justice Bruce Cohen. Cohen found that numerous factors were likely to blame, and laid out 75 different recommendations for the protection of sockeye. If implemented, the recommendations would likely provide significant benefits for all salmon in the Lower Fraser (Cohen 2012).

The transformation of the Lower Fraser watershed

Before the arrival of Europeans, the Lower Fraser watershed was much different than it appears today. Nearly two-thirds of the land base of the Lower Fraser was forested, and the remainder was comprised of wetlands and a large lake (Healey and Richardson 1996). European settlers arrived as early as 1850, and over the next one hundred years, most of the forest was logged and cleared (Healey and Richardson 1996). Following this, the wetlands were drained to create farmland, and to protect developments from flooding, dikes were constructed. As the population grew on the floodplain, so did the system of dikes. By the mid-20th century, the dikes cut the river off from approximately 70% of the floodplain (Healey and Richardson 1996). By the beginning of the 21st century, the forests and wetlands had been reduced to approximately one-tenth of the land base, with agricultural and urban land uses dominating the landscape (Healey and Richardson 1996).

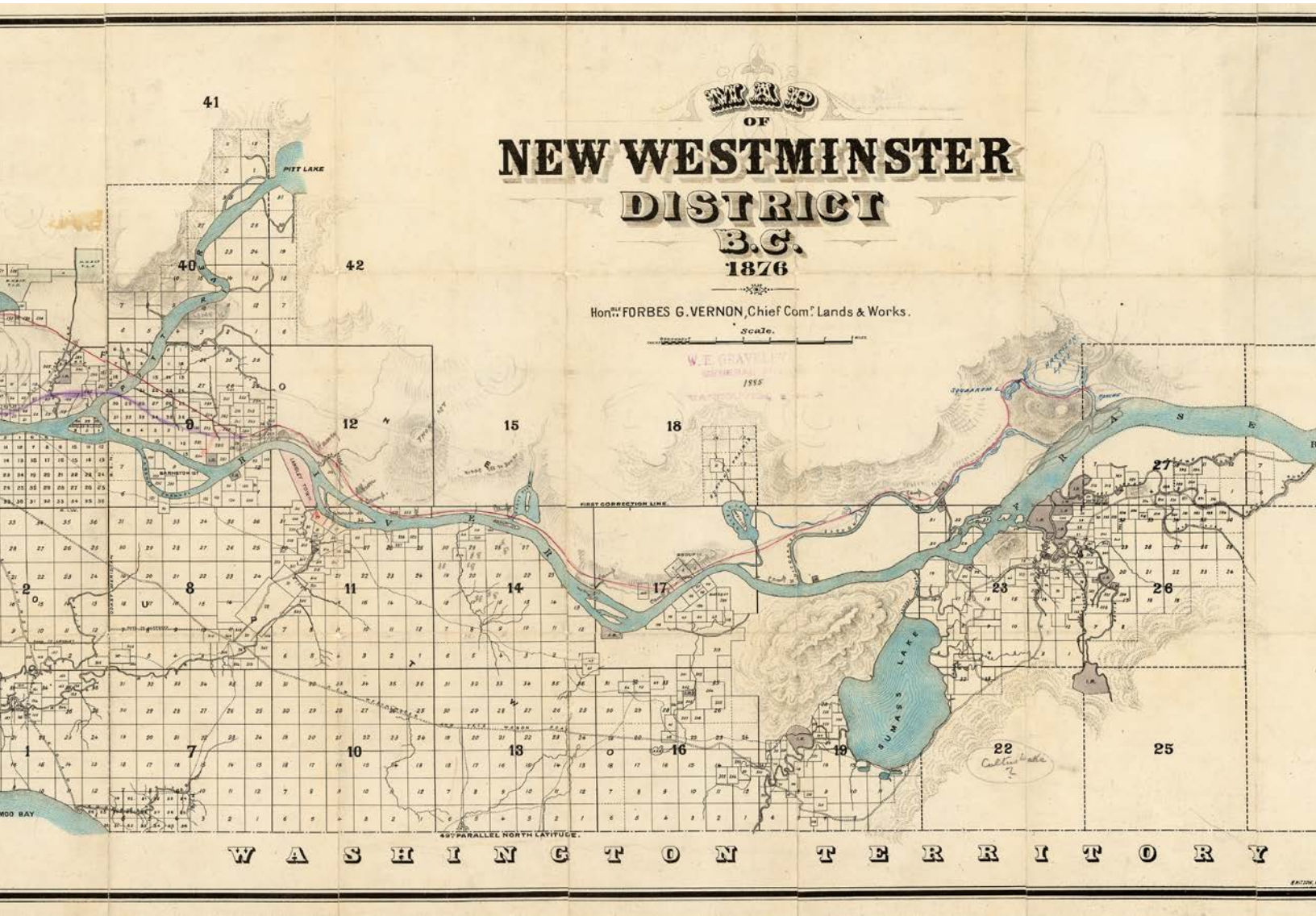


Figure 1.5. An early 20th century map showing the extent of the 10,000 acre Sumas Lake before it was drained in the 1920s.

The connections between rivers and their floodplains are crucial for ecosystem function (Junk et al. 1989; Ward et al. 1999). Without a system of dikes, rising waters each spring during the freshet would allow river water to spread out onto the floodplain, creating temporary connections between aquatic and terrestrial habitats. However, major flooding events have led to the widespread use of dikes that now run along 90% of the river bank in the Lower Fraser (Milliman 1980; NHC 2008). Together with other flood control infrastructure, floodplain inundation is generally prevented and connectivity between the mainstem and many of its tributary streams has been altered (Thomson 2005). Not only does this isolate temporary nursery habitats once used by young salmon, other fishes, and invertebrates (Junk et al. 1989), it also results in the loss of the influx of organic matter that helps fuel the aquatic food chain. Thus, the loss of floodplain connectivity in the Lower Fraser has resulted not only in

enormous habitat loss for salmon, but in a steep decline in organic carbon production from the floodplain, the base of the food web upon which many species rely (Healey and Richardson 1996).

Damming the Fraser?

Although most large river systems in North America have been dammed to create electricity and storage reservoirs (Dynesius and Nilsson 1994), the Fraser has remained free of dams on its mainstem. Following the catastrophic flood of 1948, some individuals attempted to seize the opportunity to build a dam on the Fraser, proposed on the mainstem just 30 km north of Lillooet at Moran Canyon (Hardwick 1958). In 1952, the proposed Moran Dam would have been the world's largest at over 250-metres high, backing the Fraser River up into a 260-km lake and completely obstructing passage to upstream spawning habitats. However, following significant opposition, the project was officially cancelled in 1972.

Although there are none on the mainstem, dams for hydroelectricity production do occur in at least 10 tributaries throughout the Fraser watershed (Hirst 1991). This includes those constructed in the early 20th century on Lower Fraser tributaries, which include the Stave, Alouette, and Coquitlam rivers. In the case of the latter two rivers, dam construction resulted in the extirpation of sockeye and other salmon populations that spawned upstream of the dams (Godbout et al. 2011). As a result, kokanee salmon, the freshwater ecotype of sockeye, have remained in these lakes since, a reminder of the sockeye and other sea run salmon populations which once existed in these systems.

Draining of Sumas Lake

In what can be considered the greatest single loss of productive aquatic habitat in the history of the Lower Fraser, Sumas Lake was diverted and drained during the early 1920s (Woods 2001). Using a system of canals, dikes, and pumps, the Vedder River was diverted, facilitating the draining of the lake, a measure designed to create farmland and prevent flooding (Cameron 1997). This eliminated important habitat for fish and wildlife (particularly coho) provided by the estimated 10,000 acre lake, which grew to 30,000 acres each spring, fed by freshet waters from the Chilliwack and Vedder rivers (Murton 2008). Draining the lake also eliminated a place of great cultural importance to the Stó:lō people, as it was the site of many transformation stories (Woods 2001). Today, this area is known as the Sumas prairie and is protected by a system of dikes and pumping stations which prevent the lake from reforming.

Hells Gate slide

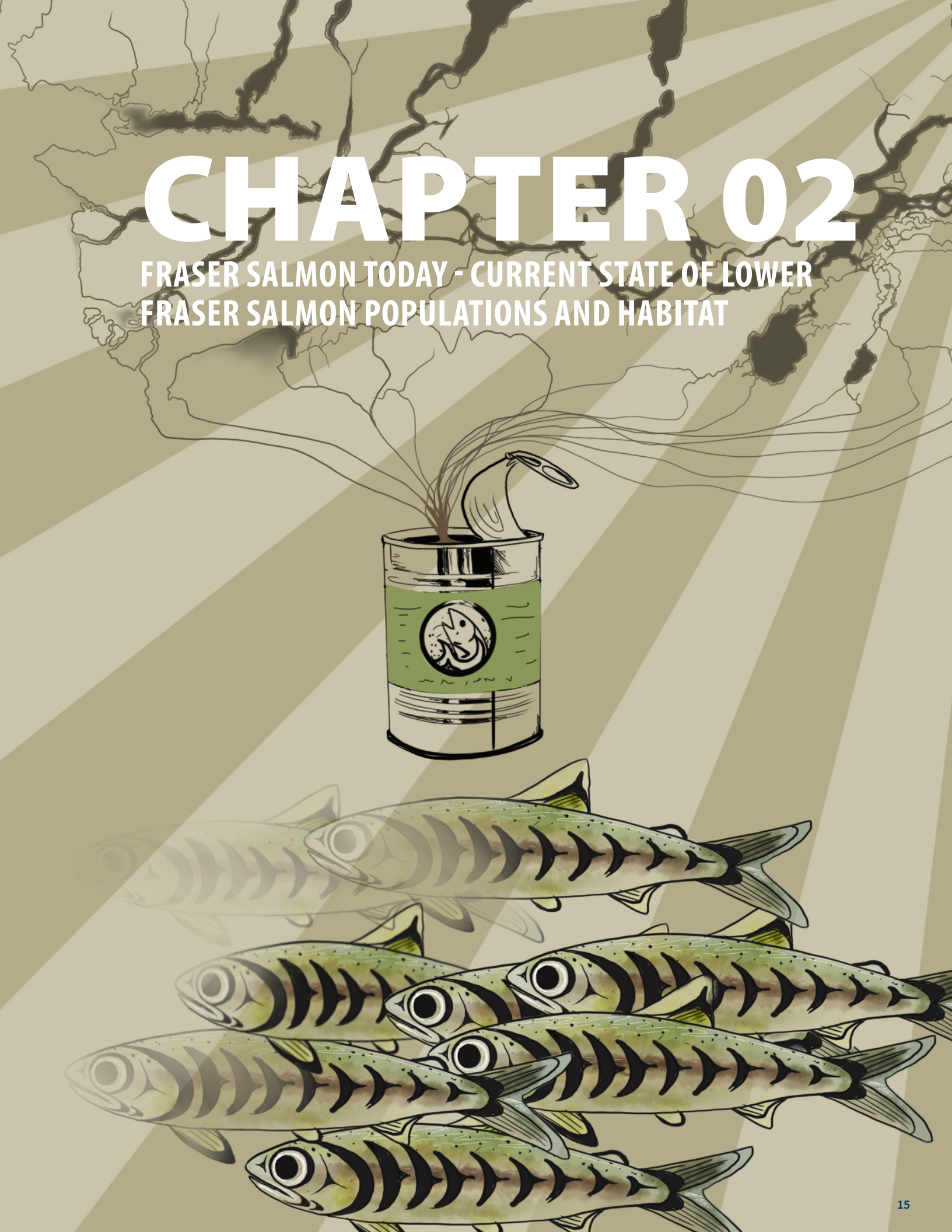
Located in the Fraser Canyon, Hells Gate is 260 km from the river's mouth and is an important physical feature of the Fraser River. It is a narrow rocky canyon where the river becomes fast, steep and turbulent. Between the winter low and summer high flows, the river levels rise by up to 30 metres and the speed increases, creating a serious challenge for salmon attempting to migrate upstream (Jackson and Talbot 1950; Hinch and Bratty 2000). First Nations who lived in the area relied on salmon from the Fraser, and Hells Gate was a prized fishing location. Here, fishers were able to use long dip nets to capture salmon taking refuge along the banks. These salmon had lost part of their fat content and could be preserved well for storage, sustaining communities throughout the long winter months (Evenden 2004).

While this section of river had always been a challenge for salmon, construction of the Canadian Northern Railway near Hells Gate led to a major rock slide in 1913 in which rocks and debris fell into the river, partially blocking the river and increasing its height and velocity. As a result, the slide made it much more difficult for most salmon to migrate upstream to their spawning grounds (Ricker 1947). The sockeye run that returned in 1913 was the dominant run in a four-year cycle, having the highest abundance of any sockeye run since recording had begun in 1877, with a commercial catch near 32 million fish (Yesaki et al. 2005). The majority of those that had escaped the fishery and made it to Hells Gate were unable to pass upstream, and died without spawning. This caused a near collapse of the salmon populations which spawned upstream, and despite the fact that some of the rock was removed the following year, catches remained below 5 million for that year class until 1945 (Hobbs and Wolfe 2008). In 1946, a fishway was completed that enhanced passage (Talbot and Jackson 1950), and upstream sockeye populations began to recover.

This lack of salmon resulted in serious and long-term consequences for the First Nations communities which lived upstream, some of which caught only a few fish in the year following the slide in areas where they typically see runs of thousands. Most sockeye in the Fraser follow a four-year life cycle, and when that same run came around four years later, commercial fishers who operated in the river mouth declared the fishery over (Evenden 2004). The loss of fish that typically spawned upstream of Hells Gate undoubtedly reduced the amount of food available to First Nations, and diminished their availability as prey for species like bears and wolves, and the nutrients which fertilize ecosystems. The Hells Gate slide is but one example of how industrial activities, including accidents which cannot be foreseen, can severely reduce the ability of the Fraser River to support salmon.

CHAPTER 02

FRASER SALMON TODAY - CURRENT STATE OF LOWER FRASER SALMON POPULATIONS AND HABITAT



Chapter 2: Fraser salmon today – state of Lower Fraser salmon populations and habitats

With the Lower Fraser's dramatic transformation from a forest and wetland ecosystem to a hub of industry for Metro Vancouver and BC, the status and management of Fraser River salmon has changed drastically. The urban region of the Lower Mainland is now home to more than 2.6 million people (over 50% of BC's population), as well as $50 billion worth of development (Richmond Chamber of Commerce 2014). The Lower Fraser is also home to the Port of Vancouver, one of the largest ports in North America (Richmond Chamber of Commerce 2014). This economic activity and urban development come with a host of adverse effects on water quality, water quantity, and physical habitats in arguably the coast's most important salmon habitat. Historic harvest on abundant and diverse wild populations has largely shifted to constrained harvest on many threatened populations of wild and hatchery salmon.

Protecting the resource: Conservation Units and the wild salmon policy

Various levels of government are responsible for protecting fish and their habitats, but Fisheries and Oceans Canada (DFO) is the main authority responsible for managing Pacific salmon. In 2005, DFO published the Wild Salmon Policy to preserve and restore populations within the five commercially harvested species of wild Pacific salmon. Even though most of the policy has yet to be implemented, one initiative that has been carried out is the establishment of Conservation Units (CUs), defined as "a group of wild salmon sufficiently isolated from other groups that, if extirpated, is very unlikely to recolonize naturally within an acceptable time frame" (DFO 2005). This classification recognizes and aims to protect the irreplaceable genetic and ecological diversity that is contained within thousands of BC's local streams and spawning populations (Holtby and Ciruna 2007).

The Fraser River has 54 unique CUs of federally managed salmon, including 16 in the Lower Fraser (Table 2.1 below). The current status and recent spawning escapements for each CU are outlined in Table 2.1. The status of provincially managed Interior Fraser steelhead (*Oncorhynchus mykiss*) is addressed in this report, but not listed in the tables. While the diversity of populations can buffer the Fraser fishery in any given year, individual CUs are much more susceptible to being adversely affected; particularly those that already exist at reduced abundance. Given this susceptibility, a random event, such as a large oil spill occurring during the juvenile outmigration of a dominant run, could be disastrous for salmon abundance and the cultural, commercial, recreational, and ecological value they represent (Raincoast 2015 and 2018).

Table 2.1. Summary of the 54 unique salmon Conservation Units within the five species of federally managed salmon returning to the Fraser River watershed. See Appendix A1 for a full alpha-numeric list of CUs.

Species	Total Fraser CUs	Lower Fraser CUs
Chinook	19	5
Coho	8	2
Chum	2	1
Sockeye (lake-type)	22	5
Sockeye (river-type)	2	2
Pink (odd year)	1	1
Total	**54**	**16**

Evaluating the resource: Characterizing trends in salmon abundance

Fraser River salmon are of high value to Canadians as they support commercial, recreational, and First Nations food, social, and ceremonial (FSC), and economic opportunity fisheries (Levy and Northcote 1982; Northcote and Larkin 1989; Healey 2009). Due to this importance, much is known about Fraser River salmon abundance and population trends. Fraser salmon are commercially harvested in Canadian and American waters, and are actively managed by the Pacific Salmon Commission under the Pacific Salmon Treaty of 1985. There are also 78 Fraser watershed and marine approach First Nations which are "Member Delegates" to the Fraser Salmon Management Council (Fraser River Aboriginal Fisheries Secretariat 2014), with constitutionally protected priority access to salmon for food, social, and ceremonial purposes. This makes for a complex, political, and fully exploited fishery that takes place on salmon en-route to their spawning grounds in the Fraser watershed.

Status of Fraser River salmon Conservations Units (CUs)

Many Fraser River salmon Conservation Units are populations of concern. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assess threatened and endangered wildlife populations. As of 2019, COSEWIC has evaluated 23 sockeye CUs (out of 24), 13 Chinook CUs (out of 19), interior Fraser coho (1 Designated Unit with 5 sub populations) and interior Fraser steelhead (2 populations). COSEWIC determined 17 CUs are endangered (7 Chinook, 8 sockeye, 2 steelhead), 7 are threatened (4 Chinook, 2 sockeye, and interior Fraser coho) and 6 are 'special concern' (1 Chinook and 5 sockeye CUs). (Table 2.2). In 2013, Raincoast Conservation Foundation assessed Lower Fraser salmon populations not examined by COSEWIC (Table 2.3).

Table 2.2. Status of 46 salmon Conservation Units (and populations) in the Fraser River watershed as evaluated by the Committee on the Status of Endangered Wildlife in Canada.

Species	Lower Fraser CUs					Other Fraser CUs (and populations)				
Status	Not at risk	Threat-ened	Endan-gered	Special concern	Not as-sessed	Not at risk	Threat-ened	Endan-gered	Special concern	Not assessed
Chinook	0	1	1	1	3	1	3	6	0	3
Coho (Interior)							1			
Sockeye (lake-type)	2	0	1	2	0	5	1	7	3	1
Sockeye (river-type)	1	1	0	0	0					
Steelhead (Interior)								2		
Total	**3**	**2**	**2**	**3**	**3**	**6**	**5**	**15**	**3**	**4**

Shifting baselines: Columbia River Basin Chinook salmon

Shifting baselines are a major problem when setting targets for the management of salmon populations that have faced long term declines, such as those in the Fraser. Although extensive data has been collected by salmon managers in recent decades, reconstructing historic abundance before colonization and exploitation is difficult. A study of Chinook abundance in the Columbia River Basin (Lichatowich and Williams 2015) demonstrates how recovery plans set using false baselines can severely undermine expectations regarding ecosystem production. By accepting a shifted baseline as the norm, managers can undervalue the potential recovery of their system and developers can ignore cumulative effects. If we hope to restore the Fraser system to its true potential, reconstructing past abundances will play an important role in setting goals towards historic levels of productivity.

Table 2.3. Status of five Conservation Units of chum, coho and pink salmon in the Lower Fraser River as evaluated by Raincoast in 2013 using COSWIC's A2 criteria.

Species	Lower Fraser CUs			
Status	Green	Amber	Red	Data Defi-cient
Lower Fra-ser Coho	0	0	2	0
Chum	0	0	1	0
Pink (odd-year)	0	0	0	1
Total	**0**	**0**	**3**	**1**

The status of Fraser River chum, pink, and Lower Fraser coho using COSEWIC's A2 criteria for abundance trends. The A2 criterion measures the population trend over the most recent three generations. Green CUs are not in decline over the last three generations (or 10 years). Amber CUs show < 30% decline over the last three generations (or 10 years) and may qualify for Special Concern due to their proximity to Threatened. Red CUs are classified as threatened (between 30% and 50% decline) or endangered (> 50% decline) over the last three generations (or 10 years). Data deficient (DD) CUs do not have enough enumeration data for assessment of current and/or long term means.

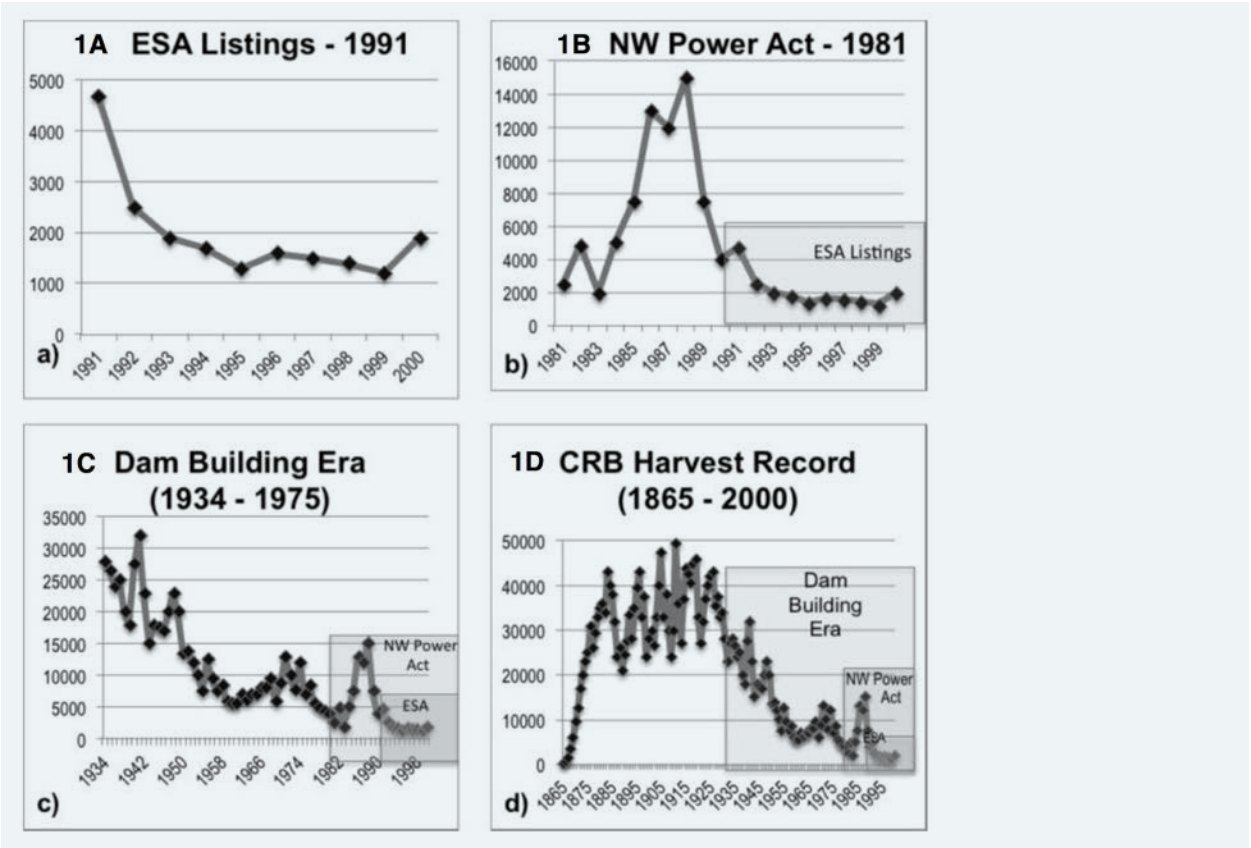


Figure 2.1. Chinook salmon harvest in the Columbia River Basin over times relative to a) their listing under the Endangered Species Act, b) enactment of the North West Power Act, c) Columbia River Dam Building Era, and d) Columbia River Basin Harvest that began in 1865. Figure from Lichatowich and Williams 2015.

Nursing the nursery: The current state of Lower Fraser salmon habitats

The most recent assessment of the salmon resources of the Lower Fraser was conducted in 1997 as part of the Fraser River Action Plan, an initiative of the Habitat and Enhancement Branch of Fisheries and Oceans Canada. This review resulted in the Lower Fraser Valley Streams Strategic Review (1999) and summary report, "Wild, Threatened, Endangered and Lost streams of the Lower Fraser Valley" and accompanying map (See Figure 2.1). Streams were evaluated based on the number of stressors they faced and classified as: wild (no stressors), threatened (one stressor), endangered (two or more stressors), or lost (culverted, paved over). As of 1997, they found that very few streams were wild (<4%, no stressors), 20% were already lost (culverted or filled), 63% endangered (two or more stressors), and 13% threatened (one stressor) (Wild Streams Map, PIBC 1997). Although Fisheries and Oceans Canada is responsible for protecting fish habitat in the Lower Fraser, a high percentage of land is privately owned, and much of the authority lies with the 24 municipalities and 2 regional districts that regulate land use decisions and stream protection (PIBC 1997).

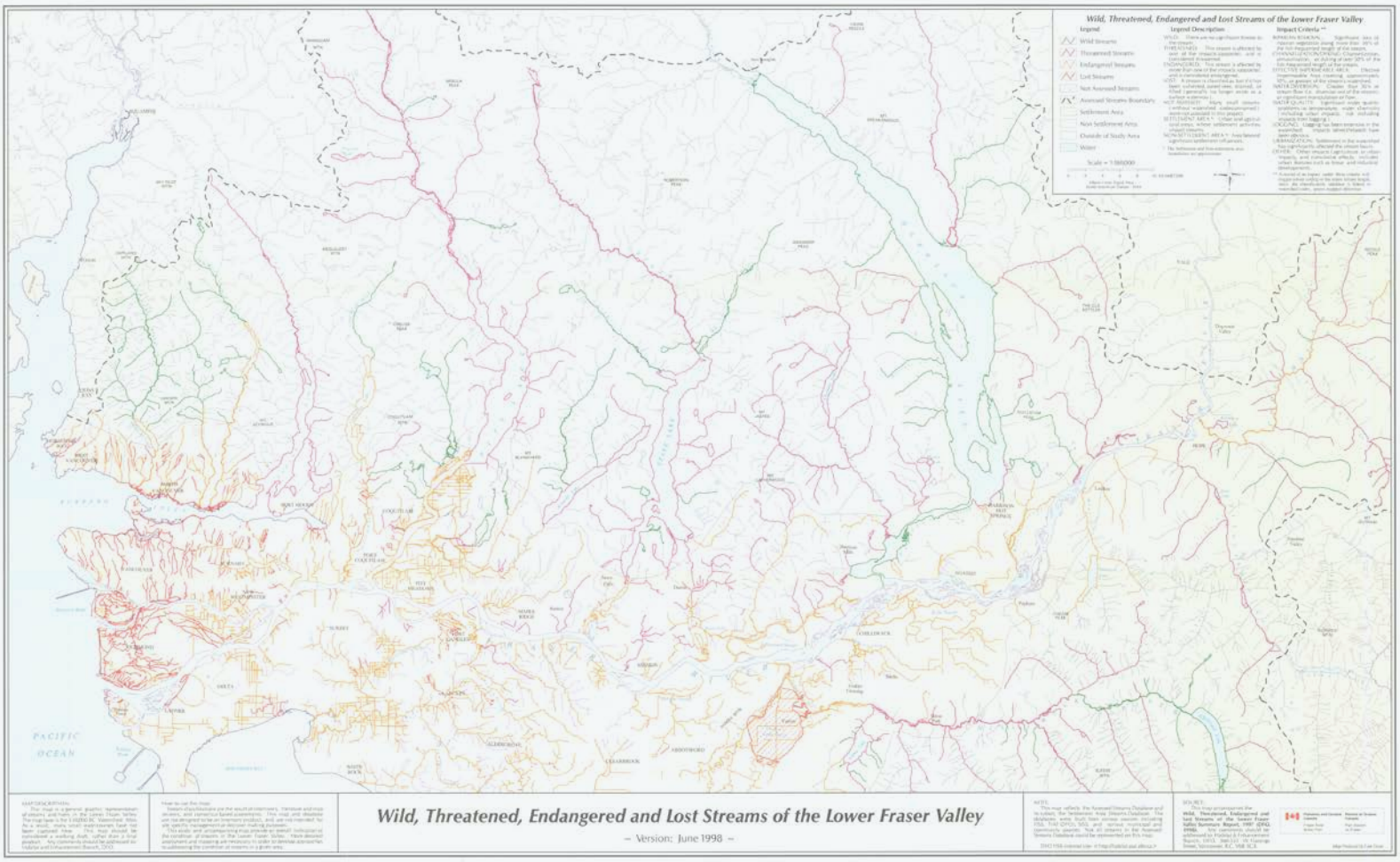


Figure 2.2. By 1997, most streams in the Lower Fraser Valley were considered lost (red; 20%), endangered (yellow; 63%), or threatened (yellow; 13%), with comparatively few wild (green; 5%). Source: PIBC 1997.

The Fraser estuary: A changing landscape

Like much of the Lower Fraser watershed, the Fraser estuary has been considerably altered since the late nineteenth century. Dike construction, which enables agriculture and other developments and lowers flood risk, is estimated to have removed 70% of the estuary's use by fish, aquatic invertebrates, and waterfowl (Hoos and Packman 1974). The mudflat and intertidal region of estuary is often the most ecologically important of these coastal habitats, yet protection of these areas in the Fraser estuary has been minimal (Elliott and Taylor 1989).

The various jetties and causeways constructed in the estuary have created significant barriers to fish migration and affected natural flow and sediment

patterns (Harrington et al. 1999). This is particularly significant for species of juvenile salmon that must swim around these structures, exposing themselves to deep, saltier waters during a vulnerable life stage of ocean entry when they would otherwise remain in the safer, nearshore areas. One such jetty, the Iona Jetty, is also the source of an average of 557 million liters of partially treated sewage that is pumped directly into the estuary each day (Metro Vancouver 2013). In 2019, Raincoast, in collaboration with Fisheries and Oceans Canada, began addressing the first of these structures by placing three breaches into the Steveston North Jetty.

Further south, construction of the Roberts Bank coal port and container terminal removed significant amounts of habitat from the estuary, and coal dust is found in ever increasing concentrations in the surrounding mudflats (Johnson and Bustin 2006). Expansion of the coal port in 1980 was described by DFO scientist Colin Levings (1985) as having "obliterated feeding areas, invertebrate communities, and possibly herring spawning areas from the local productions system." Cumulatively, these human activities appear to have likely severely compromised the ability of the estuary to support juvenile salmon and other species.

Renewing hope

Although Greater Vancouver's remaining streams are in poor health, there are many active community members dedicated to seeing them restored. In 2012, adult chum salmon returned to a small urban stream known as Still Creek for the first time in 80 years, after a fishway at the Cariboo Dam on the Brunette River was constructed. They have returned every year since to spawn in this degraded urban stream. Examples like this are bringing renewed hope for Lower Fraser salmon, and delighting local citizens who are now able to view spawning salmon right in their own neighborhood, next to a Skytrain station and a Canadian Tire store.

Salish Sea Marine Survival Project

Before the 1990s, the Salish Sea supported a valuable recreational fishery for coho, and Chinook marine survival was strong. However, over the past few decades Chinook, coho, and steelhead have shown consistently low returns in the Fraser and other parts of the Salish Sea. However, these trends were not observed in other areas of Washington or BC. This led many to conclude that the problem is within the Salish Sea itself. In response, the Pacific Salmon Foundation, together with Long Live the Kings in Washington State, launched an ambitious project to fund research investigating a variety of hypotheses into the decline in marine survival of Chinook and coho across the Salish Sea (marinesurvivalproject.org).

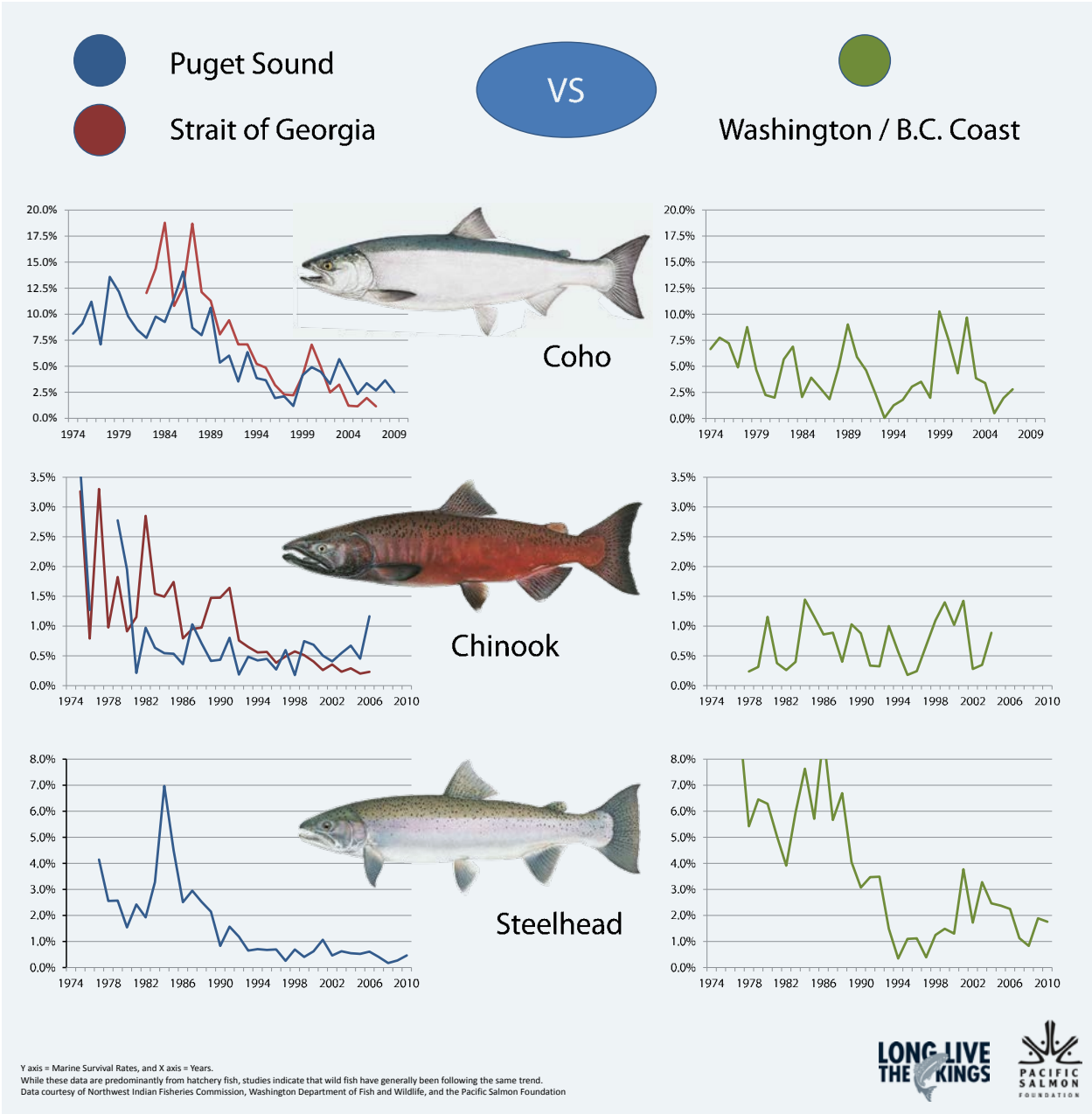


Figure 2.3. Decline of marine survival in coho, Chinook, and steelhead in the Salish Sea, and relative to other BC and Washington populations. Adapted from the Pacific Salmon Foundation, Salish Sea Marine Survival Project (marinesurvivalproject.org).

A nursery but no nanny: Jurisdictional challenges in a diverse watershed

Management of salmon harvest and habitat in the Fraser watershed exists in an incredibly complicated political landscape due to the sheer size of the watershed and the varying responsibilities of different levels of government, including First Nations. In terms of activities that have the potential to affect salmon in the Lower Fraser, regulations come from international treaties, the federal government, the provincial government, First Nations governments, and 16 different municipalities. To further complicate the landscape, there are diking districts formed by groups of citizens, some of which have collapsed, leaving orphaned infrastructure to be maintained by the province.

Various sets of laws and accompanying regulations, described in detail in Appendix Table A.3, which set out to protect fish and their habitats, are applicable to the Lower Fraser. Internationally, the Pacific Salmon Treaty between Canada and the United States sets rules for harvest of Fraser River salmon, and requires that Canada monitor and take action to maintain the health of populations. Federally, the Fisheries Act sets out several regulations to protect fish habitat including prohibitions against serious harm to fish habitat and deposition of deleterious substances. However, changes in 2012 weakened these prohibitions and removed protection for habitats that do not contain fish targeted by a fishery, or that is SARA listed (Favaro et al. 2012). Changes were also made to other relevant pieces of federal legislation, including the Navigable Waters Protection Act, which weakened federal protection of fish habitats. Amendments to reinstate the lost protections for habitat were placed back into the Act in 2019.

Recently, we have seen bills passed by the federal government to restore protection for fish and fish habitats through the passing of a new Fisheries Act Bill C-68, and changes to the environmental assessment process with a new Impact Assessment Act Bill C-69, both which received Royal Assent on June 21, 2019. The new Fisheries Act restores some of the habitat protections lost during changes made by the previous government in 2012, and adds new wording around the creation of recovery strategies for fish populations of concern. The Impact Assessment Act repeals the Canadian Environmental Assessment Act of 2012 and will replace the Canadian Environmental Assessment Agency with the Impact Assessment Agency of Canada.

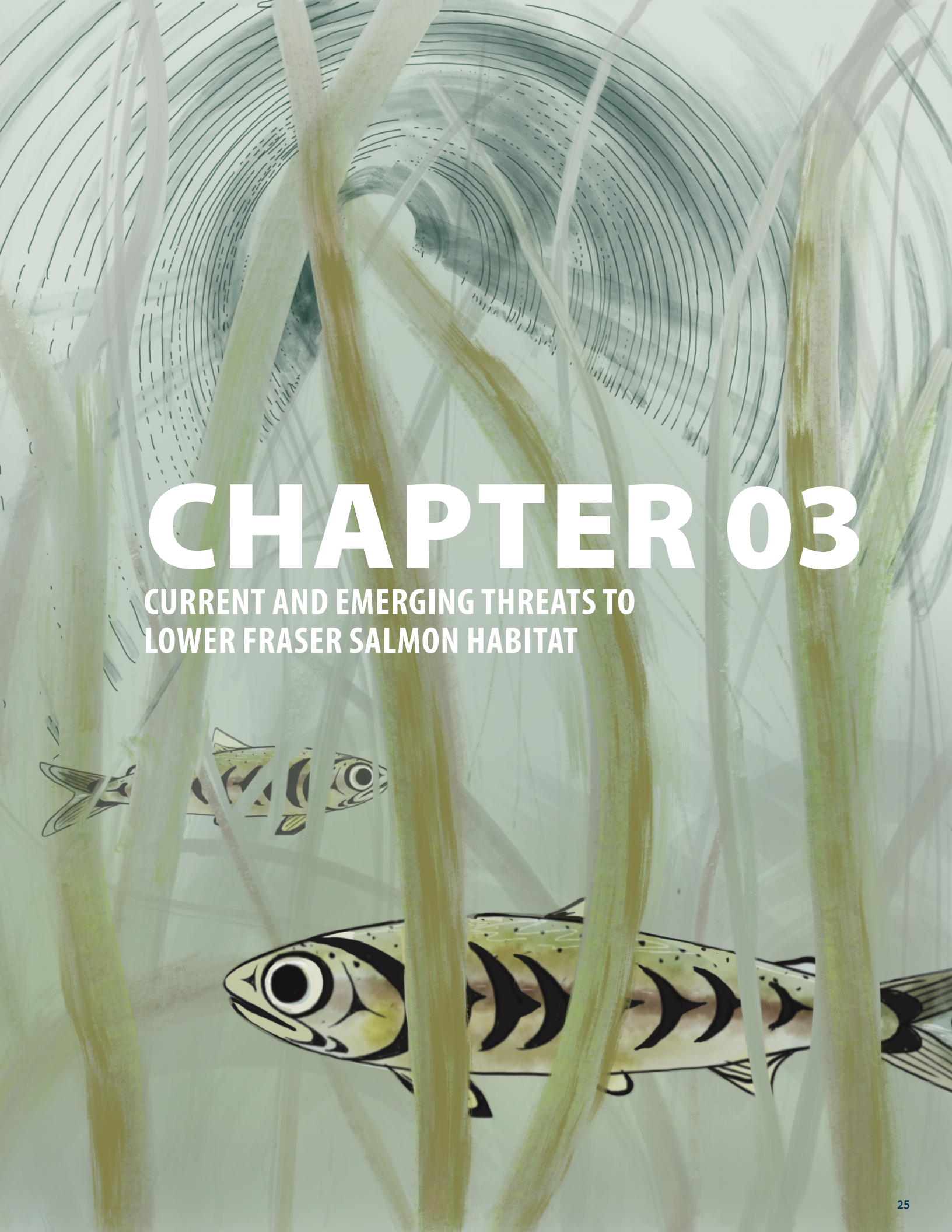
In British Columbia, the provincial Fish Protection Act was passed in 1997, which included sections prohibiting new dams on certain rivers, sensitive streams, fish protection orders, and provisions for riparian setback regulations. In 2016, the Water Sustainability Act was enacted and most of the former Fish Protection Act protections were incorporated. They were then repealed from the former Fish Protection Act, which was then renamed the Riparian Protection Areas Act and still contains the sections that include provisions for Riparian Areas Regulations (streamside habitats). The Riparian Protection Areas Act also allows municipalities to create their own bylaws which can provide greater protection to riparian zones and associated fish habitats.

Along with these various levels of legislation and regulations, which aim to protect productive fish habitats, the federal government also relies on the Species At Risk Act (SARA) to protect individual species or populations deemed at risk of extinction. For a species or population to be SARA listed it must

first be designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), a board of scientists from institutions across the country. Even though COSEWIC recommends species for SARA listing, the federal minister has the final say, and many species which are designated, particularly marine fishes, are never SARA listed, weighing economic costs ahead of conservation concern (Mooers et al. 2007; Findlay et al. 2009). A recent example is the denial of SARA listing for interior Fraser steelhead in July 2019.

Prevention is better than cure

Although it is important to recover species at risk, adapting a proactive stance on fish habitat is more effective. Already, the Fraser watershed has four species in 24 populations of salmon (Chinook, sockeye, coho, and steelhead) listed as threatened or endangered under COSEWIC. In British Columbia, we currently have the legislative tools in place to protect most habitat with the combination of the federal Fisheries Act, the provincial Water Sustainability Act, and the Riparian Areas Protection Act (though the latter is not always applicable to agriculture). These laws and regulations could be used to prevent the loss of salmon habitat and the degradation of the ecological processes that support salmon.



CHAPTER 03

CURRENT AND EMERGING THREATS TO LOWER FRASER SALMON HABITAT

Chapter 3: Current and emerging threats to Lower Fraser salmon habitat

Like all animals, salmon have evolved with, and adapted to, specialized habitat requirements that allow them to thrive. Salmon need ample amounts of cool water, with healthy concentrations of dissolved oxygen, and without pollutants that impair their life processes. Salmon also require an adequate source of prey and specific physical habitat features that provide cover from predators, aerated gravel to deposit their eggs, and natural water cycles to create site specific conditions and provide cues for key life stages.

Current stressors affecting salmon habitats in the Lower Fraser River

Salmon habitats in the Lower Fraser are confronted with nearly every stressor available. The one notable exception is the absence of dams on its mainstem. Many streams that once existed in the Lower Fraser have been lost entirely, and the majority of those that remain are considered threatened or endangered. Loss of streambank vegetation is widespread, reducing cover and food for fish, as well as shading that keeps streams cool. Other alterations include channelization and diking that change the flow of water, reduce connectivity, and eliminate complex habitats that fish need. Pollution from sewage plants and runoff from agricultural areas create serious water quality problems. Impermeable surfaces (e.g. roads, buildings, pavement) in the watershed cause rain events to quickly flood small streams, while preventing recharge of groundwater. Invasive plant and fish species have become dominant in many areas. These and other stressors adversely affect the three main characteristics of any aquatic environment that are important for salmon and all fish; water quantity, water quality, and physical habitat.

Holding back the river: Flood control structures

Since the beginning of development on the Fraser floodplain, flood control has become a major issue. Flood control in the Fraser started as far back as 1864 by private landowners in what is now Richmond (Thomson et al. 1999). The largest flood on record occurred in 1894, yet there was little damage owing to only a few vulnerable developments. However, when another large flood occurred in 1948 the damage was severe, and included the evacuation of 16,000 people, damage or complete destruction of about 2,000 homes, and $20 million in damages (1948 dollars) (NHC 2008).

Figure 3.1. Red cross rescue during the 1948 Fraser Valley flood. Vancouver Public Library.

The numerous small tributaries which flow into the Lower Fraser represent 'breaks' in the dike system. They are typically controlled by one-way floodgates, installed to prevent water from moving upstream and flooding onto developed lands. Floodgates alter connectivity and affect fish access to significant amounts of tributary stream habitat (Thompson 2005), sometimes resulting in upstream "dead zones" where impounded water exhibits oxygen concentrations below provincial safe minimum standards (Gordon et al. 2015). Floodgates have also been shown to be associated with significant decreases in abundance of chum and coho salmon and three other native species, as well as increases in invasive fish species (Scott et al. 2016). This loss of connectivity is a major stressor to salmon, as juveniles of species such as Chinook and coho require suitable rearing habitats to grow to a size adequate to survive the initial period of ocean entry.

A climate of increased flood protection?

Climate change and associated sea-level rise will require further expansion and upgrades to flood protection structures at an estimated $8.8 billion in projected costs just along the tidal portion of the Lower Fraser (Delcan 2012). Additionally, human populations along the Lower Fraser have increased by 150% over the last twenty years, and will continue to grow (Johannes et al. 2011). Many of the flood control structures that exist in the Lower Fraser are near or beyond their lifespan and in need of replacement. Integrating salmon habitat considerations into future infrastructure designs will be critically important. Currently, Raincoast co-chairs the Environmental Advisory Committee of the Lower Mainland Flood Management strategy. Our aim is to ensure that future flood management fully considers impacts to the environment, including protecting and restoring connectivity for salmon migrations.

Loss of riparian zones

A riparian zone is the shoreline and land adjacent to a body of water. These zones are a key component in determining the health of a small stream, providing shade, and the input of living and nonliving materials that help fuel the food web and provide the physical structures fish need. Riparian zones also provide buffering capacity that can reduce the amount of nutrient and chemical pollutants entering streams in agricultural and urban areas (Barling and More 1994). Loss of riparian vegetation has been widespread throughout the Lower Fraser, and most foreshore riparian forests and wetlands are gone (FRAP 1999).

Dike construction along the banks of the Lower Fraser translates into a lot of riprap (rock armor) and very few natural riparian habitats. For tributary creeks, riparian protection in the past was minimal and loss of tree cover in these areas was common, with many fields farmed right to the stream edge. Ditching, diking, and stream channelization to drain land typically accompany agriculture (Cohen et al. 2011a). Livestock can also damage riparian zones. Over the past few decades, stronger riparian protection rules have come into place that require new developments to leave setbacks, yet efforts to restore previously lost riparian areas have been slow, despite the efforts of various groups. Agricultural areas are also exempt from the Riparian Areas Regulations and instead have recommended setbacks which are much less stringent.

Dredging

Dredging for sediments has the potential to negatively affect physical habitats; it routinely takes place in two distinct forms in the Lower Fraser River. Sand and gravel removal is an annual activity that carries the potential to damage both habitat and the eggs of incubating salmon and eulachon. The ongoing effects of decades of sand removal and industrial activity have likely contributed to the decline of Fraser eulachon populations (COSEWIC 2011). In the sand reach, the yearly deposition of sand creates a major barrier to the transit of large ships, and as a result, the Port of Vancouver conducts an annual dredging program which removes around two million tons of sediment and gravel from the lower reaches (Milliman 1980).

Distinct from maintenance dredging is gravel mining, an activity that takes place in sections upstream of Mission. Contentious removal projects take place in the gravel reach, an area known to be important spawning areas for sturgeon and pink salmon. The potential for conflict between gravel removal and salmon habitat is exemplified by the loss of up to 2.25 million pink salmon in 2006 due to improper construction of a causeway to access one gravel removal site (Auditor General of Canada 2009).

Water pollution

The water quality in the Lower Fraser was recently rated as poor by the World Wildlife Fund in their Fraser River Watershed Report (WWF 2015) based on exceedance of water quality guidelines for aquatic health. The majority of pollutant load comes from permitted point source discharges into the river by pulp mills, sewage treatment facilities, and other industrial activities. Higher up in the watershed, five pulp mills (two at Prince George, two at Quesnel, and one at Kamloops) discharge effluent into the Fraser River (MacDonald et al. 2011). Discharge from these five mills contributes 75% of the permitted waste discharge upstream of Hope (McGreer and Belzer 1999; Nener and Wernick 1997), with an estimated total effluent of 410,000 m^3/day (McGreer and Belzer 1999). This discharge contains several compounds which are known to have lethal or sub-lethal effects on fish and invertebrates (e.g. metals, chlorophenolics, resin acids, polycyclic aromatic hydrocarbons), and excess nutrients which can lead to negative algal blooms (Culp and Lowell 1998). There are also five smaller mills in the Lower Fraser Basin near Vancouver (MacDonald et al. 2011).

Mining is also of concern for water quality in the Fraser watershed, with seven active metal mines in the Fraser River watershed, and all but one (an underground gold mine) are open-pit mines. Contaminants typically associated with mine effluent include nutrients (e.g. ammonia, phosphorus), metals (e.g. arsenic, copper, mercury, selenium), cyanides, polycyclic aromatic hydrocarbons (PAHs), and monoaromatics (e.g. BTEX) (MacDonald et al. 2011). Along with permitted discharges, accidents occur. The 2014 Mount Polley Mine disaster released an estimated 10 million cubic metres of tailings water and 4.5 million cubic metres of fine sand into Polley Lake when Imperial Metals' tailings pond dam breached, ultimately delivering this waste into the upper Fraser through Quesnel Lake (Government of BC 2014).

Like industrial operations, there are many harmful chemicals used in urban settings and agricultural operations that end up in nearby waterways. Runoff can not only introduce pesticides and other chemicals into

waterways, but can also increase biochemical oxygen demand, introduce pathogens, and increase nutrient concentrations (McGreer and Belzer 1999). Water is also diverted from many salmon bearing waterways, reducing the quantity available to fish, and when it is returned, it often carries harmful substances that are applied to crops.

Of particular concern in the Fraser valley are pesticide releases to waterways, including multiple herbicides, insecticides, and fungicides (McGreer and Belzer 1999). Over time, agricultural operations in the Fraser Valley have intensified, with cash crops such as blueberries and cranberries generating up to 62% of BC's farm revenues annually (Richmond Chamber of Commerce 2014). High livestock densities also result in the over production and application of manure, which then runs off into waterways, lowers oxygen concentrations, and leads to 'dead zones' in many Fraser Valley streams (Pearson 2015). At the same time, the urban population has grown rapidly, and cosmetic pesticide application has become an important issue. Although runoff continues to be an important issue in the Lower Fraser, it is also one that can be rectified with improved farming practices and bans on cosmetic pesticide use.

Another major issue is sewage. The urban population of Metro Vancouver produces millions of liters of sewage a day that is discharged directly into the Lower Fraser and estuary. Facilities at Annacis, Lulu, and Iona islands make up most of the daily sewage discharge into the system, with the remainder emanating from the 87 other sewage treatment facilities upstream of Langley (Johannessen and Ross 2002). Although the Annacis and Lulu plants were upgraded from primary to secondary treatment in 1996, these upgrades may not consistently reduce toxic effects due to the increasing volumes (McGreer and Belzer 1999). Additionally, research from Puget Sound has identified chemicals of emerging concern that are not addressed through secondary treatment and have been shown to impact salmon (Meador et al. 2016).

In addition to sewage treatment plants, there are also more than 50 combined sewer overflows (CSOs) in the Lower Basin (35 in Vancouver, five in Burnaby, and 13 in New Westminster; (Norecol, Dames and Moore Inc. 1996). In dry weather, combined sewer overflow is directed to and treated at sewage treatment plants. However, during storm events when pipe capacities are exceeded, untreated sewage and stormwater is discharged at designated 'relief points' (Norecol, Dames and Moore Inc. 1996). It has also been estimated that there are approximately 1,700 storm water outfalls in the Greater Vancouver Regional District, 925 of which discharge directly to fish-bearing waters (Norecol, Dames and Moore Inc. 1996).

Impervious surfaces

Impervious surfaces are a serious and generally unaddressed problem in the Lower Fraser watershed and in urbanized areas around the world. The 1,700 stormwater outfalls in Greater Vancouver drain an immense network of sewer intake drains throughout the urban areas. When it rains, the water runs across impervious surfaces such as roofs, paved roads, and parking lots, typically draining directly into streams. Instead of recharging groundwater sources and feeding streams in a more gradual manner, this quick flash of water enters all at once, disrupting physical habitats by scouring the streambed and potentially disturbing eggs deposited in the gravel (depending on timing and location) (Moscrip and Montgomery 1997). This

flashiness also means that after the rain has stopped there is no slow release of surface and groundwater to streams, resulting in low flows that can also negatively affect salmon. Impervious surfaces also alter water quality, as they are typically laden with contaminants originating from residential areas (e.g. pesticides, fertilizers) cars, roads and parking lots (e.g. oils, PAHs, metals, salts), which are then dissolved and transported into salmon streams (Jartun et al. 2008; Paul and Meyer 2008). Thus, impervious surfaces, like many of the stressors in the Lower Fraser, affect water quantity and quality, as well as the physical structures that salmon rely on.

Invasive species

Invasive species are common in the Lower Fraser, having been introduced both intentionally and unintentionally. They affect salmon directly through competition and predation, and indirectly by altering habitats, natural ecosystem structure, and function. Invasive fish compete with juvenile salmon for food and habitats, and some may prey on them directly. Nine non-native fish species that have established populations in freshwater areas of the Lower Fraser, including smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*), which may prey upon salmon during early life stages (Johannes et al. 2011). The threat of further invasions remains, despite recent changes in legislation that made a number of non-native fish species illegal to own in BC, including the already established brown bullhead (Scott et al. 2013).

Non-native plant species are also ubiquitous in the Lower Fraser watershed. Purple loosestrife (*Lythrum salicaria*), which has recently invaded marsh areas of the estuary, has altered the dynamics of detritus availability to the food webs upon which juvenile salmon rely (Grout et al. 1997). Himalayan blackberry is also widespread, forming dense thickets which are impenetrable to large animals and prevent the establishment of deep-rooted native shrubs which prevent erosion (Bennett 2006). These are just a few examples of the dozens of invasive plant species which have spread across the Lower Fraser, altering the ecosystem function of salmon habitats.

Cumulative effects

The stressors described above are only some of the activities that affect salmon productivity in the Lower Fraser. While these stressors have their individual causes and effects, salmon must deal them cumulatively, and the potential synergistic negative effect of all these pressures. The severity of these stressors depends on how each affects individual salmon species or populations. Another concern is how individual effects expand to populations, communities, and ecosystems, and ultimately undermine the socio-economic benefits we derive from these species and habitats. The difficulty in predicting real-world consequences is made greater by the vast number of natural and anthropogenic stressors that act on individual fish species and on the river as a whole. Cumulative effects can have unexpected and serious consequences for aquatic ecosystems (e.g. Arkoosh and Collier 2002, Jacobson et al. 2003). Cumulative effects may also vary in intensity according to existing stress levels associated with annual cycles of salmon migration, reproduction, feeding, and growth, in addition to environmental factors such as temperature, salinity, disease, and prey availability and quality.

Climate change

Climate change, and its associated changes in hydrology and water temperatures, are important factors

influencing salmon productivity. Changes to flows and temperatures are already being observed in the Fraser River. Data series collected since 1953 show that the spring freshet is arriving sooner and reaching half of its annual cumulative flow an average of nine days earlier than a century ago (Fraser Basin Council 2010b; Figure 3.2.). Low flows can create barriers to spawning salmon, and tributary streams that support juvenile coho may run dry during late summer. Summer mean water temperatures have increased over the past 50 years, equivalent to 2.2°C per century, and are predicted to rise another 1.9°C by 2080 (Morrison et al. 2002; Figure 3.2).

Rising water temperatures have negative effects on salmon survival through several pathways (e.g. Martins et al. 2011). Sockeye salmon returns have been below expected numbers (by an average of 32%) in all recorded years in which river temperatures were anomalously high (Gallaugher and Wood 2010). Increases in temperature also increase the likelihood of parasitic, bacterial, and fungal infections (Gallaugher and Wood 2010). Morrison et al. (2002) predict that future river temperatures will regularly reach thresholds that can lead to pre-spawn mortality in sockeye, 10 times more often by 2099 than today (Figure 3.3.). This means that in years in which river temperatures are warmer than usual, returning salmon are at a competitive disadvantage even before they face physical barriers and pollutants as they make their way up the river. Higher temperatures can also cause eggs to develop more quickly, creating a mismatch between the availability of prey sources and juvenile development. Climate change is already beginning to alter the natural cycles upon which salmon have evolved and rely, potentially with serious consequences for their long-term survival.

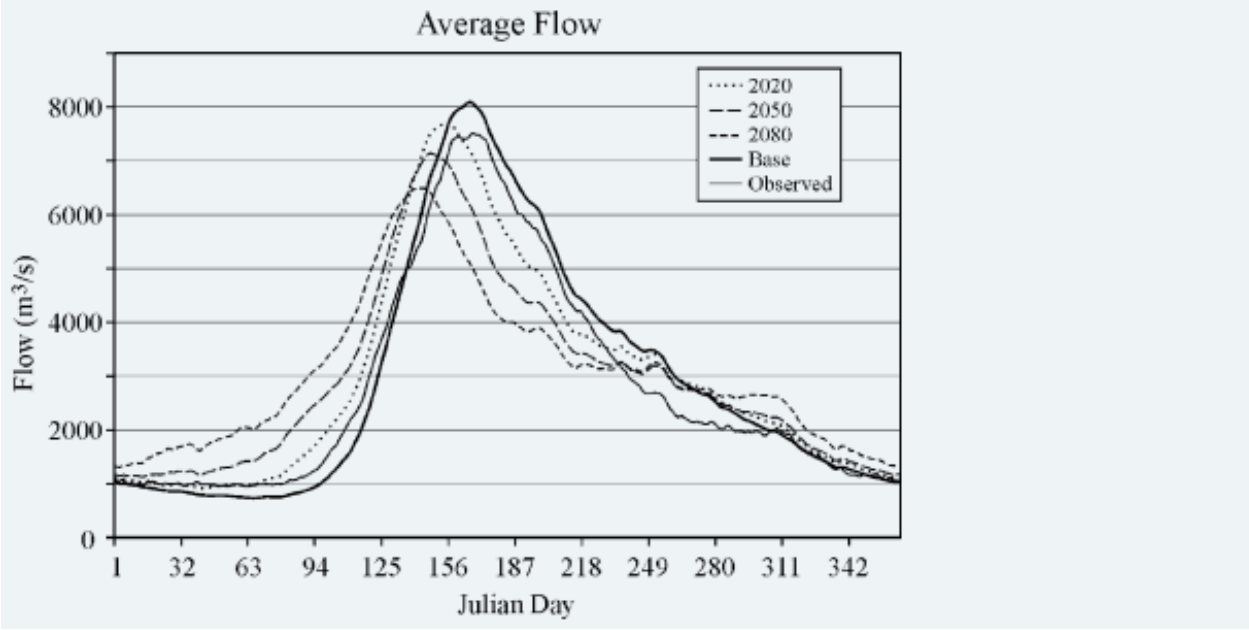


Figure 3.2. Projected changes to the hydrograph in the Lower Fraser River at Hope, BC based on modeling conducted in 2002 (from Morrison et al. 2002). Climate warming is associated with a reduced and earlier spring freshet and higher winter flows, as more precipitation is projected to fall as rain than snow (not contributing to snowpack). In the ensuing 20 years, this trend is being observed.

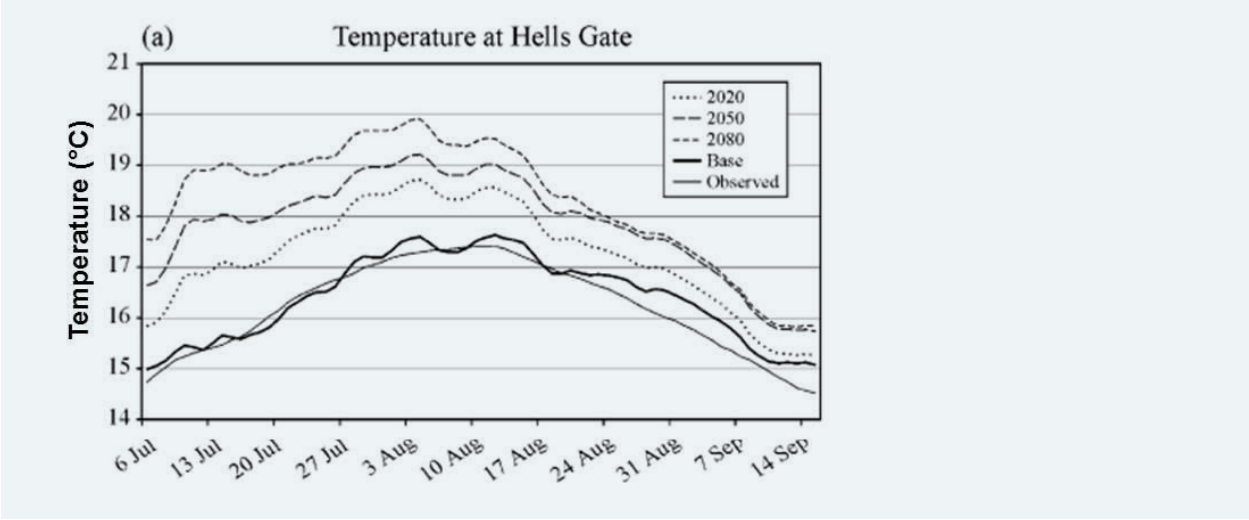


Figure 3.3. Projection for maximum high Fraser River temperatures at Hells Gate based on 2002 modeling (from Morrison et al. 2002). These temperatures are already being observed.

Emerging threats

The stressors described previously have long been affecting the quality and quantity of salmon habitats in the Lower Fraser and will need to be more effectively managed in the future. Despite these stressors, and likely owing to the resilience of salmon, the Lower Fraser has continued to support salmon from throughout the watershed, and millions of salmon still return each year. However, as has happened to wild salmon in the western U.S., the east coast of Canada, the eastern U.S., and Europe (Montgomery 2004), a tipping point can be reached where these fish can no longer persist at sustainable levels. With climate change making salmon survival even more problematic, ensuring their diversity, abundance, and resilience is more important than ever. We believe the impacts from a range of development proposals planned for the Lower Fraser could push wild salmon populations to a point where recovery is no longer possible.

Proposed fossil fuel export terminals

Despite a clear scientific consensus from the Intergovernmental Panel on Climate Change (IPCC), and Canada's House of Commons declaring a climate emergency, the extraction of fossil fuels continues. Not only does the extraction and consumption of fossil fuels lead to harmful changes for our climate, the extraction, transport and storage of these toxic substances poses an enormous risk to the environment, as demonstrated by the *Exxon Valdez* and the *Deepwater Horizon* oil spill catastrophes.

Currently, there are an array of proposals that would further establish the Lower Fraser and estuary as a major corridor for the transportation of fossil fuels. These proposals would transport a variety of products, each with distinct associated risks, including direct habitat loss, habitat disturbance, chronic pollution, and the increasing risk of a large hydrocarbon spill.

Beyond direct impacts to salmon and habitats, these projects are increasingly opposed for their role in exacerbating climate change and related impacts, both globally and locally.

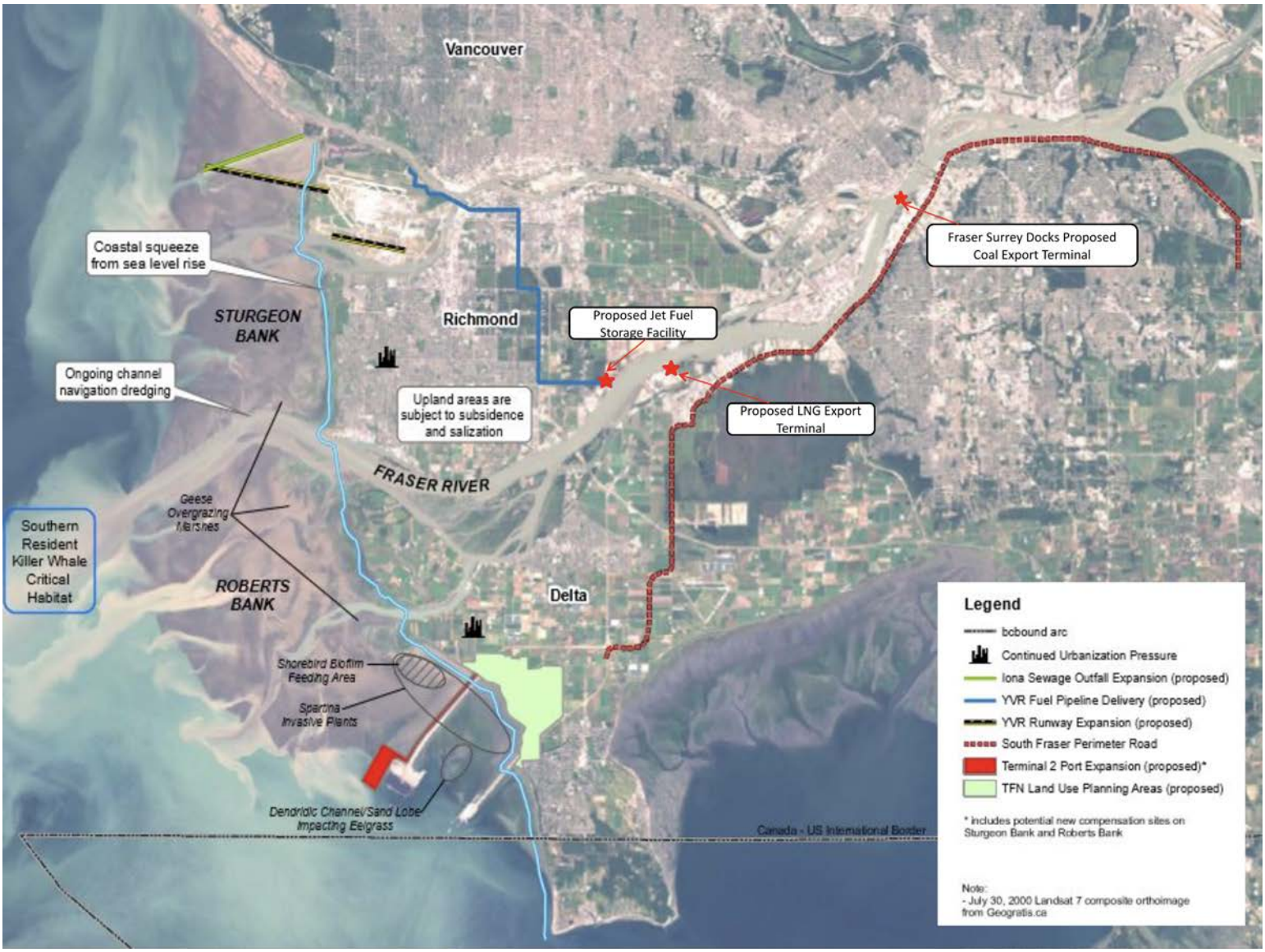


Figure 3.4. Fraser estuary with proposed industrial projects, sensitive areas and ongoing threats. From FREMP Backgrounder part 1, prepared by Northwest Hydraulic Consultants and GL Williams & Associates Ltd. 2009.

Looking at the evidence

In 2015, Raincoast submitted a 190 page review to the National Energy Board on the potential effects to Fraser River salmon from an oil spill associated with the Trans Mountain Expansion (TMX). The Trans Mountain pipeline is intended to carry primarily diluted bitumen products, which would be shipped from Alberta's tar sands by pipeline and exported from Vancouver by oil tanker. Bitumen differs from other petroleum products in that it is composed primarily of high molecular weight hydrocarbons and as such is 'heavier' than crude oil. In order to be of sufficiently low viscosity to be pumped through a pipeline, bitumen must be diluted with condensate or another solvent. The combined diluted bitumen product may be expected to cause fish kills similar in severity to those caused by spilled crude oil in the first hours and days following a spill. However, as weathering begins, the dilbit will revert toward its original bitumen product, and could submerge or sink and potentially cause long term toxicity to aquatic species (NASEM 2015).

Current proposals in the Lower Fraser river

Trans Mountain proposed pipeline expansion

Having been acquired by the Canadian government from Kinder Morgan in 2018, plans remain to expand (twin) the 1,150 km Trans Mountain pipeline that runs from Strathcona County, Alberta to Burnaby, British Columbia. The proposed expansion would consist of approximately 994 km of new pipeline, increasing the capacity from 300,000 barrels per day to 890,000 barrels per day. More than 500 watercourses would be crossed. The pipeline route runs through the Fraser watershed nearly its entire length, along much of the Thompson River before joining the Fraser River at Hope, where the route runs parallel to the Lower Fraser river for nearly 140 km before crossing the mainstem and reaching the terminus station in Burnaby. In the event of a rupture, it is likely oil would reach the mainstem of the Fraser River, where it could potentially bind with sediments and deposit on the river or estuary bottom (Raincoast 2015).

WestPac LNG

As part of the interest in developing BC's Liquified Natural Gas (LNG) potential, a proposal has been put forth for a LNG export facility at the existing Fortis BC Tilbury LNG Plant in Delta, about 15 km upstream from the mouth of the river. This expansion into the South Arm of the Lower Fraser would include a loading platform (dock), an access trestle and walkway, and individual breasting and mooring dolphins to secure ships in dock. The project would service annually an estimated 90 LNG barge calls and up to 122 LNG carrier calls (of various sizes) at the jetty per year.

Currently, the project has received approval from the National Energy Board and is moving towards the environmental assessment process. The province of BC applied to the federal government to have a provincial environmental assessment instead of a federal review. The federal government announced that it had accepted this and the environmental assessment is now in process by the BC Environmental Assessment Office. In March 2019, the company filed an application for an Environmental Assessment Certificate with the BC Environmental Assessment Office.

Vancouver Airport Fuel Facilities Corporation (VAFFC): Jet fuel terminal

The Vancouver Airport Fuel Facilities Corporation is proposing to store large quantities of jet fuel just 1.5 km from the proposed LNG terminal, on the opposite bank of the river in Richmond. The proposed jet fuel import and storage facility would include creation of a marine terminal to service tankers ranging in size from small barges to Panamax class size. The proposal also includes the construction of a fuel storage facility with the capacity around 80 million litres (500,000 barrels). A pipeline will transfer fuel from the marine terminal to a fuel storage facility and then from the storage facility to the existing VAFFC fuel facilities at YVR. After a judicial review of the decision by the province to grant an Environmental Assessment Certificate on June 24th, 2015 the Supreme Court of British Columbia ruled in favour of the VAFFC and construction of this project is currently underway.

Fraser Surrey coal docks

The Port of Vancouver, which has federal jurisdiction over activities on their own lands, had granted a permit to Fraser Surrey Docks to handle up to 4 million tonnes of coal each year. The project would allow 80 transits of Panamax class dry bulk vessels leaving from Fraser Surrey Docks filled with coal, being transported down the Fraser River before being shipped to overseas markets. This would add to existing coal export operations that shipped 38.1 million tonnes in 2013 from Westshore and Neptune terminals. The project did not trigger federal or provincial environmental reviews, and instead was subject to the Port's review process, which is limited to the terminal footprint and the portion of the Lower Fraser over which it has jurisdiction. Despite receiving the necessary permits, Fraser Surrey Docks has yet to begin coal export operations, due to opposition from local communities and environmental groups. Locally, the project is likely to have environmental health risks associated with the release of coal dust that would further degrade water quality in the Lower Fraser. Approval by the Port of Vancouver for an export permit was challenged in Federal Court and the application for judicial review was dismissed in January 2018. In February 2019, the Port of Vancouver cancelled the project permit for failure to meet with conditions.

Roberts Bank and proposed Terminal II expansion

Along with the expansion of the fossil fuel export capacity in the Lower Fraser and estuary, Port Metro Vancouver is planning to greatly expand its capacity for importing and exporting containers through the proposed Terminal 2 expansion project. The original Roberts Bank terminal was completed in 1969, and added to impacts for fish passage and sediment deposition created by the construction of the Tsawwassen Ferry Terminal causeway in 1960 (Levings 1985). Westshore Terminals opened the following year in 1970, and has

been exporting coal ever since, reaching a peak of 30 million tonnes in 2013, more than all other Canadian export facilities combined (www.westshore.com). In 1997, GCT Deltaport began operating a container facility on Roberts Bank, and in 2009 completed a $400 million expansion to create what is now a 85-hectare (210-acre) facility with three contiguous berths. The terminal was built at the end of a long causeway over a shallow bank, originally as a 20-hectare (49-acre) plot of reclaimed land, but is now four times that size.

The expansion of the coal terminal in 1981 and 1982 resulted in the filling in of 115 hectares of intertidal and subtidal habitats, dredging of 95 hectares, and the loss of 62 hectares of eelgrass. Coal dust concentrations in the sediments around the terminal doubled between 1977 and 1999, likely with impacts to benthic plants and animals (Johnson and Bustin 2006). Despite this, the area has not lost its importance for juvenile Chinook, chum, and pink from the Fraser (Conlin et al. 1982; Levings 1985; Gordon and Levings 1984; Triton 2004; Thuringer et al. 2013a, 2013b). The proposed expansion is for another three-berth container terminal that could handle 2.4 million twenty-foot equivalent units of capacity. The project footprint is another 44 hectares, directly in the heart of the Fraser estuary.

Terminal construction would take 5 years, with dredging and other habitat disruption and alterations occurring in an area where juvenile Chinook and chum rear. The terminal itself will likely further alter the movements of juvenile salmon in the estuary. The Canadian Environmental Assessment review process is near completion and will lead to a decision in 2020. Public hearings took place in May 2019. In October 2016 and again in February 2019, Raincoast submitted detailed information on the potential impacts to salmon and the insufficiency of the information provided by the proponent for providing for an adequate assessment of potential impacts to juvenile salmon. In particular, our comments focus around the unknown effects of terminal location on juvenile salmon migration pathways in the estuary, as well as potential impacts from project associated increases in noise and light pollution.

Cumulative increase in container and tanker traffic

To fully assess the impact of these projects, they should be considered in the context of the current state of the ecosystem, including stressors, and with consideration of other proposals being advanced. The approval of the above-mentioned projects would represent an average increase of almost five new vessel transits per day in the Lower Fraser and estuary (Table 3.1). Vessel studies on the Salish Sea have shown a significant increase in the risk of an oil spill (Vessel Traffic Risk Assessment; Van Dorp and Merrick 2014), with large quantities of fossil fuels passing through the estuary daily. This translates to an ongoing risk to salmon habitat and large increases in underwater noise, potentially affecting the ability of fish and marine mammals to carry out essential life processes.

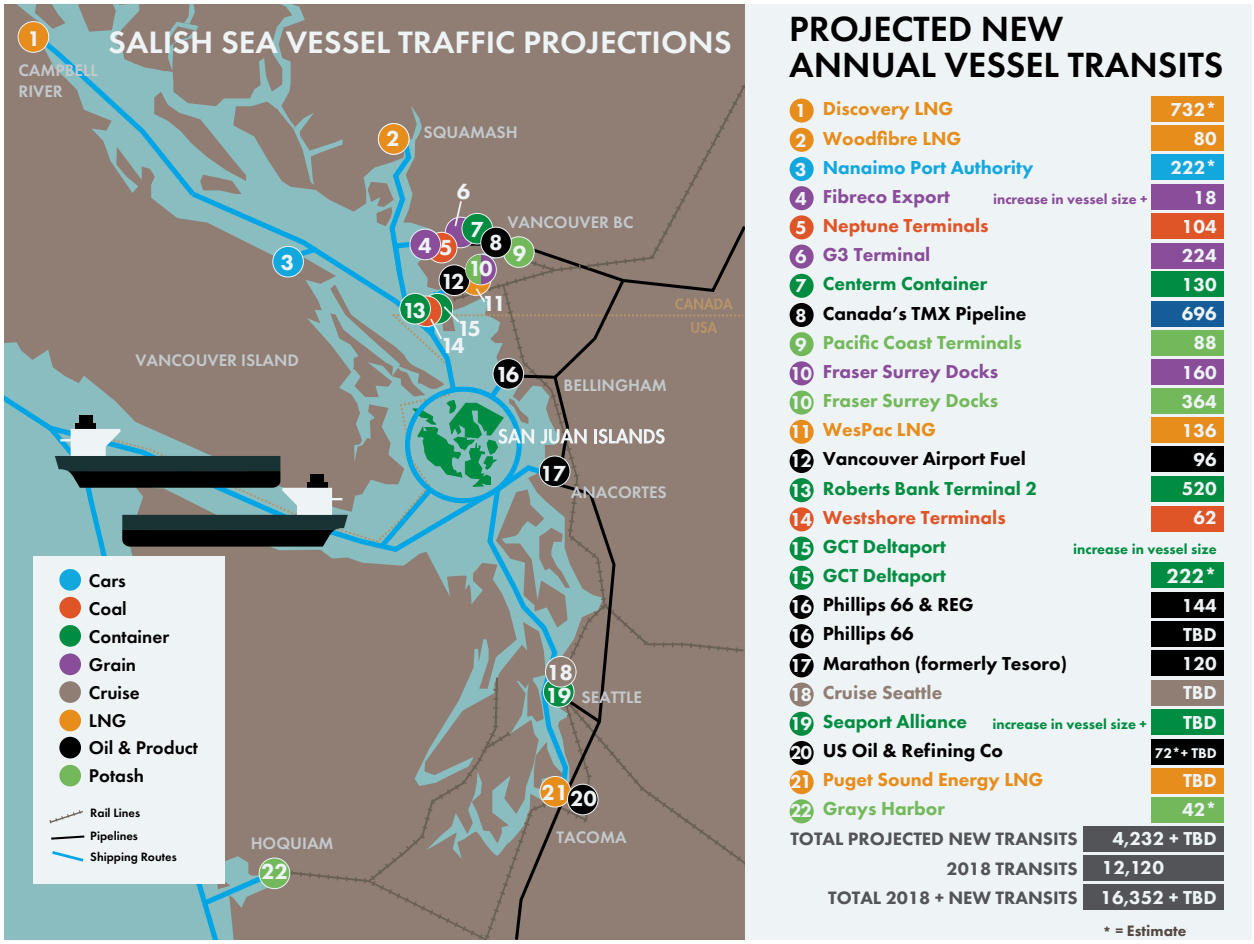


Figure 3.5. Salish Sea vessel traffic projections and new annual vessel transits expected. Figure from The Friends of the San Juans. (www.sanjuans.org/safeshipping/)

Table 3.1. Projected increase in vessel transits in the Lower Fraser and estuary from currently proposed projects. (http://georgiastrait.org/issues/vessel-traffic/)

New and Expanding Terminals	Current Vessel Transits	Proposed, Approved, and Recent Increases	Project Status
Port Metro Vancouver (PMV): Fraser Surrey Docks – Coal	0	160	Project permit issued in August '14. Application amended to direct-load ocean-going vessels. Project permit cancelled February 2019.
PMV: WesPac LNG	0	244	LNG export license issued in 2015. Environmental Assessments underway.
PMV: Westridge Terminal – Crude Oil	120	696	Currently awaiting federal cabinet approval after reconsideration by the National Energy Board and their recommendation for approval February 2019.
PMV: Deltaport Terminal – Containers	538	86	Construction and increases in TEUs underway
PMV: Roberts Bank 2 Container Terminals	0	520	Environmental Impact Statement filed in March '15.
PMV: WestshoreTerminals – Coal	540	86	Project permit issued in January '14.
Total New, Approved, & Proposed Vessel Transit Increases		**1,772 = New vessel transits proposed in the Lower Fraser and estuary**	

When community concerns are heard

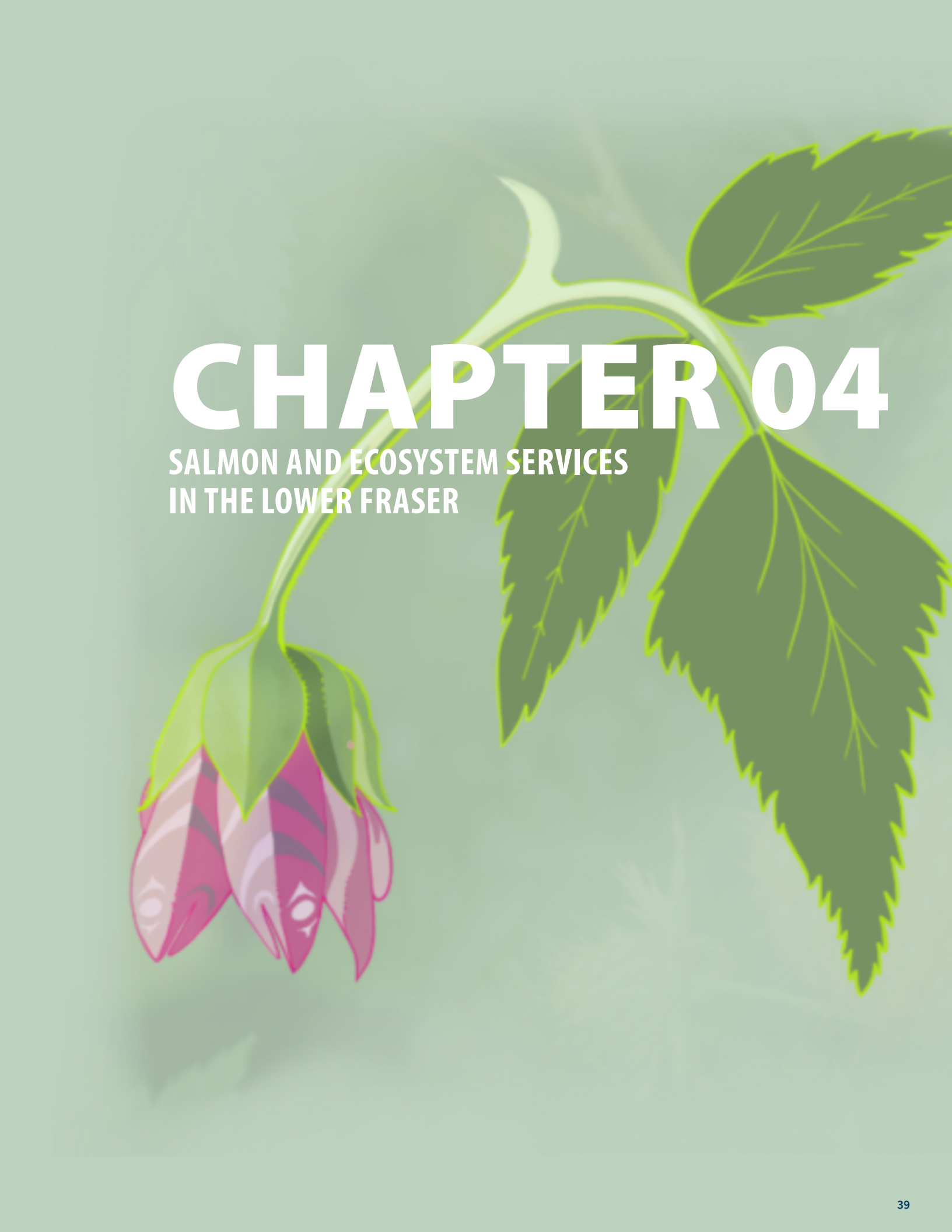
Case Study: Coalition halts Hazardous Waste Facility on the banks of the Fraser River, Chilliwack (2013-2015).

In November 2013, Watershed Watch Salmon Society joined forces with concerned citizens, the Stó:lō First Nations, and the recreational fishing community to take a stand against the building of a facility to recycle hazardous materials on the banks of the Fraser River in Chilliwack. The group became known as the Protect the Fraser Coalition. It was Ernie Crey from the Stó:lō Tribal Council who first alerted the environmental and recreational fishing communities to the proposal. From November 2013 to the day the Coalition stopped the proposal in 2015, opposition grew to more than 50 organizations and groups representing upwards of 150,000 people.

From the onset, the Coalition was clear in their messaging – the facility is much needed in the lower mainland, but not on the banks of the Fraser River. The Coalition was concerned that setting such a precedent could open the door for similar industry in the region known as the 'Heart of the Fraser'. Watershed Watch became involved when they learned the proposed project was in the Fraser River floodplain just 150-200 metres from the river; a location where pink salmon spawn in the gravel reaches, where adults migrate through on the way to their way to upstream spawning grounds, where sturgeon reside, and where out-migrating salmon fry congregate as they move downstream on their seaward journey. At no stage in their life cycle would it be safe for adults and offspring to be exposed to hazardous chemicals.

Community concerns focused on public safety, local First Nations rights and title to protect the land, and the potential impact on the river, especially salmon. Subsequently, this brought support from subsequent local businesses and tourism interests that also rely on salmon. The Stó:lō Tribal Council directed their efforts at the provincial government. Watershed Watch and other organizations focused on the local and regional governments such as the City of Chilliwack and Metro Vancouver.

This issue raised a much larger concern amongst members of the Coalition, bringing to light the frustrations of communities too overwhelmed to keep track of the numerous projects planned for their region. It highlighted the need for a comprehensive vision for the banks of the Fraser River, which considered its Heritage River status and the abundance it supports as the world's largest salmon river. Justice Bruce Cohen pointed out that it is not possible to maintain a healthy fish-bearing stream without a healthy riparian zone; the banks of the Fraser River in the lower mainland are in severe need of protection and restoration.



CHAPTER 04

SALMON AND ECOSYSTEM SERVICES IN THE LOWER FRASER

Chapter 4: Salmon and ecosystem services in the Lower Fraser

The ongoing and proposed activities that diminish salmon habitats in the Lower Fraser River and estuary threaten the persistence of wild salmon populations. The economic forces driving these projects are typically strong when only the short-term benefits are considered, but proponents tend to neglect the environmental costs associated with a given project, creating 'negative externalities' in economic terms. Even though the environmental costs of a given project may turn out to be significant ecologically, damages are often difficult to attribute and evaluate, leaving them unanticipated or ignored. This has led to the loss of ecosystem services and created costs borne by communities and subsequent generations for restoration, cleanup, and lost options. To address this problem and properly account for the consequences of habitat degradation, an ecosystem services approach can be useful for identifying the economic value of ecosystem protection and the public benefits natural habitats provide to people.

Concept of ecosystem services

The ecosystem services approach endeavours to provide people with personal and financial reasons to value the planet's ecosystems. Although classifying and commodifying 'nature' as a support system for humans often fails to influence us to change our current disconnect with the natural world, understanding our reliance on nature might help increase awareness of the cycles, processes, and interconnectedness of nature's systems. It might also provide full cost accounting of ecological protection and damage.

Ecosystem services are the benefits humans derive from the workings of the natural world. We take almost all of them for granted, but they are crucial to our survival, and to the social and economic wellbeing of societies. Throughout human history people have understood that their well-being is linked to the functioning of the world around them (Brauman et al. 2007). However, the true value of the services that healthy ecosystems provide has long been undervalued, allowing short term gains to trump long term sustainability. The inherent flaw in this approach is being increasingly understood, so in an attempt to use the same monetary language, a dollar value has been placed on the processes that created those services.

At a basic level, ecosystem services are the series of natural processes that create benefits such as clean air, pollination, flood regulation, climate regulation, and recreational and tourism opportunities. If properly managed, they yield a flow of vital services, including the production of goods (such as seafood and timber), life support processes (such as pollination and water purification), and life-fulfilling conditions (such as a sense of community and tradition, Daily et al. 2000). The motivation behind the concept is to promote the continued delivery of these services, by ensuring they are properly represented in a system dominated by economic interests (Daily 1997). As it is

difficult to assign monetary values to many of the services ecosystems provide, there is no universally agreed upon method, however, we believe our approach allows us to highlight the magnitude of the value of the ecosystem services we rely on.

Types of ecosystem Services

Ecosystem services are commonly divided into categories, either by functional grouping or otherwise (Millennium Ecosystem Assessment 2005). These typically fall under the following types of descriptions:

(i) Provisioning (material goods, like food or metals, produced by ecosystems),

(ii) Supporting (nutrient cycling, primary production and soil formation),

(iii) Regulatory (climate regulation, flood control, water purification),

(iv) Cultural (recreational, spiritual, religious, heritage, etc.).

Provisioning services are the things we harvest from the earth, from plants to animals to materials. These services are typically easy to place a value on because they have a market price. For Fraser salmon this appears easy, as each of the five Pacific salmon species are sold on open markets, with a market price that varies depending on the season and year. However, for the remaining categories, their value must be determined indirectly, using methods such as willingness to pay, avoided costs, hedonic pricing, and other methods.

Supporting services are the basic ecosystem processes, including nutrient cycling and primary production, the

Priceless and irreplaceable

Raincoast believes that our connection with the natural world is not properly comprehended as a monetary and self-interested relationship. Notably, however, ecosystem service based conservation does not need to replace or conflict with this conviction. Appropriately understood and applied, it can complement the widely held moral perspective that the natural world is priceless, irreplaceable, and inherently valuable.

foundation of ecosystem function. Regulating services, such as climate regulation and water purification, maintain the conditions upon which both human societies and ecosystems rely on to function effectively. Intact estuaries provide supporting services in the form of nutrient cycling and regulating services in the form of flood buffering. Although supporting and regulating services do not have direct market values, they can be estimated using indirect measures. For example, flood buffering has a value that can be estimated by the cost that would otherwise be incurred constructing and maintaining flood control structures.

Cultural services are things such as the recreational and spiritual benefits obtained from nature; salmon is a prime example. Huge numbers of people spend money on gear, guides, and travel to areas like the Lower Fraser to fish for salmon recreationally, and many participate in catch and release fisheries where the enjoyment comes regardless of whether they end up with a fish to keep. Salmon are also extremely valuable part of BC's cultural identity; this is particularly true for First Nations. Undoubtedly these cultural services have value, but they are much more difficult to put into terms of dollars and cents.

The value of ecosystem services

Regardless of the definition, the concept of ecosystem services or nature's benefits are rooted in economic cost/benefit analysis. Although valuing nature's worth within an economic framework has its limitations (Gatto and Leo 2000; Ludwig 2000), it creates a context within which humans can quantify the results of nature's complex processes and functions. For example, in 1997 global ecosystem services or benefits were estimated to be worth US$16-54 trillion per year, about double the global Gross Domestic Product in 1997 (Costanza et al. 1997). An update to this assessment increased the value of global ecosystem services to approximately $135 trillion annually (Costanza et al. 2014). Despite the relative uncertainty in these monetary estimates, it is unequivocal that nature's benefits carry enormous economic, societal, and cultural value.

What is an ecosystem worth?

Every ecosystem or biome on earth provides ecosystem services, although the type and potential value can vary greatly depending on biotic and abiotic factors. Systems in which primary productivity is naturally high unsurprisingly tend to provide the highest value services, and marine and freshwater environments tend to be more productive than terrestrial habitats. In particular, studies have shown that estuaries and coastal floodplains provide some of the highest value ecosystem services per hectare, and at the same time are the rarest making up the least land area compared with other ecosystem types. They are also among the most threatened by human activities, with an estimated 50% of saltmarshes and 29% of seagrasses already lost or degraded worldwide (Barbier et al. 2011).

Ecosystem services of salmon and salmon habitat in the Lower Fraser and delta

The provider of life: Cultural services and salmon

The importance of salmon to Indigenous communities throughout the Pacific Northwest is hard to overstate. Recognized as a symbol of instinct, resilience, strength, and determination, salmon remain central to the cultural identity of Indigenous communities along the Fraser River and the Pacific coast. Many recognize salmon as relatives, a belief evident in many inherently sustainable fishing practices that acknowledge a shared lineage.

The cycles of salmon through the Fraser each year help shape a significant component of cultures that co-evolved with salmon. Fishing remains a way of life for some, rather than a past time, and provides a means to reconnect with place, trade with neighbors, and share critical knowledge between generations. For these reasons, Pacific salmon feature prominently in various forms of art, literature, song, and dance of Lower Fraser First Nations. The 24 First Nation bands with territories directly along the banks of the Lower Fraser from Yale to Langley are collectively known as the Stó:lō people, which translates to 'river people'. In their culture, salmon are invaluable, considered by some to be a gift from the Creator that they have a duty to protect.

The Stó:lō people follow their own lunar calendar, with four of their twelve months named based on what was occurring with salmon in that time of year. These include the first month 'Tempo:kw' which means 'time for Chehalis spring Chinook salmon'; the seventh month, around April, called 'Temkwikwexel' which means "time for baby sockeye salmon; the eleventh month, around August, called 'Temtheqi' which means 'sockeye salmon time' because sockeye salmon bound for the Adams River are migrating at that time; and the last month called 'Temkw'o:lexw' which means 'dog salmon time' (Coqualeetza Cultural Education Centre, www.coqualeetza.com).

Today, salmon remain an important part of Indigenous economy and culture, demonstrated by annual events such as the re-established First Salmon Ceremony hosted by the Kwantlen First Nation each spring to celebrate the return of the first adult salmon to the river. Along with the bands which make up the Stó:lō, there are also a number of other Coast Salish First Nations along the Lower Fraser including the Tsleil-Waututh, Tsawwassen, and Musqueam Bands whose traditional territories include the mouth of the Fraser and the estuary. While it is impossible to put a dollar value on the importance of salmon to First Nations culture in the Lower Fraser, it is clearly a value that should be considered and protected.

A contemporary salmon culture

Along with the First Nations, salmon have also been important for immigrant British Columbians. Polling in 2011 identified salmon as important to British Columbians as the French language to Quebec (Watershed Watch 2011). The poll further reported that British Columbians value salmon so highly that 86% of respondents agreed that "economic growth and development should not come at the expense of wild salmon habitat. This ranged from a low 84% of voters who voted Conservative in the last federal election to a high 92% of citizens who had voted Green-an astounding level of agreement" (Watershed Watch, 2011). The importance of salmon to British

Columbians is further exemplified by the multitude of salmon related festivals that take place in communities around the Lower Fraser. These range from large events, such as seven decades of the annual Steveston Salmon Festival, four decades of the Ambleside Coho Festival and the Rivershed Society's Fraser Fest, to smaller events organized by local groups such as the Hyde Creek Salmon Festival, Great Salmon Send-off at Stoney Creek, Harrison Salmon Festival, and the Pink Salmon Festival. These are just a few of the events centered on salmon that provide recreational opportunities for people of all backgrounds. The motivated individuals who organize these events are a testament to the intangible cultural value of having salmon in our local streams and tributaries to the Lower Fraser River.

Recreational fishing in BC: An important economic element

Recreational fishing is an iconic BC past time enjoyed by residents and non-residents, some of which travel long distances and spend significant amounts of money to come to the Lower Fraser area to fish for salmon. Recreational fishing in BC occurs in both tidal waters, which are managed federally, and freshwaters, which are managed provincially. Due to their migratory lifestyles, Fraser salmon are targeted in both tidal and freshwater areas, therefore falling under the jurisdiction of two different authorities and two different types of licences. Regardless of where the fish are targeted, recreational fishers contribute to expenditures on licences, equipment, guides, accommodation, and travel.

A survey from Fisheries and Oceans Canada found that anglers contributed a total of $8.3 billion to the economy of Canadian provinces and territories in 2010 (Available at: www.dfo-mpo.gc.ca/stats/rec/canada-rec-eng.htm). This includes $2.5 billion to cover direct recreational fishing expenditures during fishing trips, such as package deals, lodging, fishing services, and fishing supplies, while the remaining $5.8 billion was invested in boats, motors, real estate, and other goods related to recreational fishing activities. According to DFO, fishing in BC accounted for 15% of the total number of resident anglers in Canada, of which 59% fished in freshwaters and 41% in tidal waters. They also found that the main species caught by BC anglers in freshwater were rainbow and cutthroat trout, whereas in tidal waters the top catch was Chinook, coho, and sockeye salmon.

Licence sales alone generate significant revenue for the province and the federal government, some of which is used for conservation purposes. In the Pacific region, Fisheries and Oceans Canada takes in an average of $6.35 million from licence sales (see table 4.1). Licence holders fishing for salmon must also buy a salmon stamp, with revenue supporting conservation efforts via the Pacific Salmon Foundation (averaging $1.4 million per annum), allowing them to fund salmon enhancement projects. Over the past 15 years, an average of 71% of license holders have purchased salmon stamps.

Table 4.1. Average annual tidal water recreational license sales in the Pacific Region for the fiscal years 1999/2000 to 2018/2019.

License sales for Tidal Waters Sport Fishing in BC	
Residents	251,207
Non-residents	65,250
Salmon stamps	225,469
Annual direct Salmon stamps value	$1,417,359
Annual direct license value	$6,358,930

Available at: http://www-ops2.pac.dfo-mpo.gc.ca/vrnd-rneb/index-eng.cfm?pg=RecRptSelect

Freshwater anglers (non-tidal) primarily target salmonids in rivers and streams throughout BC. A 2010 study commissioned by the Freshwater Fisheries Society of BC showed the freshwater sport fishery had a total economic impact of nearly a billion dollars ($957 million), with 20% of the activity occurring in the Lower Mainland (Bailey and Sumaila 2012). This resulted in an estimated 3.8 million angler-days of activity, $545 million in angler expenditures, and over 7 million fish caught, of which three-quarters were released. In 2005, the average angler spent $120 per day whereas guided days were much more valuable, at an average $480 (GS Gislason & Associates Ltd. 2009). Based on creel surveys, Fisheries and Oceans Canada estimates that along the Lower Fraser mainstem and Chilliwack River recreational fishers catch an average of just under 90,000 salmon each year during more than 600,000 hours spent fishing (accessed from www.pac.dfo-mpo.gc.ca/fm-gp/fraser/index-eng.html).

Guided anglers are much more likely to target salmon, and typically fish in rivers as opposed to lakes. Guided operations are mostly focused in the Lower Mainland, along with the Cariboo and Skeena regions. In these regions, fishing expenditures are a combination of freshwater and tidal fishing, and employ significant numbers of people as guides and other associated staff. Although these numbers are BC wide, the highest concentration of angler effort is on the Lower Fraser and its major tributaries (Chilliwack-Vedder, Harrison, and Chehalis), estimated at over 450,000 angler days in 2005 (GSGislason & Associates Ltd. 2009). This study also estimated that fishing in the Lower Mainland region, which primarily targets Fraser salmon, was worth $18.6 million in wages and benefits, 600 employment-person years, and $19.5 million in taxes. Also, in the Lower Mainland alone, there are 41 fishing lodges/resorts, 153 charters/guides, 37 marinas, and 33 sport fishing retail businesses, all of which make an important contribution to the local economy.

Value of harvested salmon: Provisioning services and salmon

Due to their high value, commercial fisheries have long been an important part of the economy of BC, providing an array of jobs including harvest, processing, and transportation. As the five commercially harvested species have market values, we can calculate the value of the ecosystem services they provide, whether harvested by commercial, First Nations, or recreational fishers. Applying the value of commercially sold fish to those harvested by First Nations and recreational fishers allows a better estimation of the monetary value that Fraser salmon provide to the region relative to only including those commercially sold.

The commercial fishery has been an important economic driver in the region since the late 1890s and was a key component of regional trade long before European arrival. Focused primarily on sockeye, the commercial fishery has evolved over time and continues to this day, providing employment and revenue to the area. Landed values for the commercial fishery, which takes place at the mouth of the Fraser (Area 29), average just under $5.2 million, ranging from a peak at over $18 million in 2010 to a low of only $186,250 in 2013 (Table 4.1). As this only

includes salmon captured in the Area 29 fishery (Fraser mouth), it largely underestimates the total commercial value of Fraser salmon as a significant portion are captured in other South Coast fisheries. The commercial fishing industry is also an important employer in BC. Estimates show they provided an average of 5,181 jobs in harvest and 3,138 jobs in processing from 2010-2013 (available at: www.dfo-mpo.gc.ca/stats/cfs-spc/tab/cfs-spc-tab2-eng.htm).

Total catch for First Nations fisheries is less focused on sockeye (relative to commercial fisheries), but follows similar catch patterns. Lower Fraser First Nations harvested an average of 843,000 salmon per year from 2005 to 2013 with a peak in 2011 of 1.5 million and a low in 2008 of around 375,000 salmon (Table 4.1; www.pac.dfo-mpo.gc.ca/fm-gp/fraser/index-eng.html).

Recreational fishing is not as well documented relative to the other fisheries; however, Fisheries and Oceans Canada has conducted creel surveys of recreational fishers on the mainstem Fraser and the Chilliwack River for most years between 1984 and 2011. Based on the results of these surveys, they can generate estimates of catch and total hours spent fishing, and found that between these two areas an average of just under 90,000 salmon are captured each year.

Table 4.2. Average annual catch statistics for the five species of Fraser salmon harvested commercially, recreationally, and by First Nations, their average commercial value per piece, and the total ecosystem services values derived from their capture in Area 29 (Lower Mainland, Sunshine Coast, Fraser River).

	First Nations	Recreational	Commercial (*Area 29 only)	Average commercial value per piece	Total commercial value	Direct ecosystem services value
Chinook	22,230	12,897	6,865	$30.85	$211,779.54	$1,295,487.81
Sockeye	399,702	36,749	415,048	$11.31	$4,692,952.33	$9,627,915.53
Chum	87,832	8,620	40,060	$5.53	$221,542.41	$754,943.90
Coho	1,202	15,454	356	$6.11	$2,176.04	$103,926.18
Pink	332,319	14,104	54,140	$0.95	$51,379.16	$380,138.94
Total	**843,284**	**87,824**	**516,468**	**Average Total Value:**	**$5,179,829.48**	**$12,162,412.36**

*Compiled from Fisheries and Oceans Canada website (www.pac.dfo-mpo.gc.ca/fm-gp/fraser/index-eng.html) accessed on October 15th, 2015. Commercial fisheries statistics represent catch from Area 29, but does not take into account salmon captured in other areas that originate in the Fraser system. Commercial catch is the average for the years 1996 to 2013. Value per piece was determined by dividing the total number of pieces by the total value each year. First Nations catch data represents Lower Fraser First Nations only and is the average of years 2004-2013. Recreational fishing data are the sum of average yearly catch determined from creel surveys conducted on the mainstem Fraser (1984-2011) and Chilliwack River (1985-2010).

Based on the available data, Fraser salmon provide an enormously valuable ecosystem service at a combined average value of more than $12 million per year (see Table 4.2). Although there are several assumptions that go into our calculations, these can be taken as a reasonable estimate for the direct ecosystem services provided by salmon harvested in the Lower Fraser. Although the value of harvested salmon originating from the Lower Fraser remains significant, it is only a fraction of their true potential. As described previously, most populations have suffered long declines in abundance that continues today, drastically reducing the quantity of salmon harvested and the ecosystem services provided.

Indirect benefits of salmon and their habitats

Along with the direct monetary value attributable to salmon harvested from the Lower Fraser, salmon and their habitats provide a variety of other valuable services. These ecological services range from nutrient cycling by adult salmon, to nursery habitats in intact estuaries, to water quality buffering from riparian zones.

Supporting services

Salmon play an incredibly important role in nutrient cycling in the ecosystem where they occur (Cederholm et al. 1999; Schindler et al. 2003). Juvenile salmon migrate to the ocean taking nutrients with them that originated in freshwaters, and when they return as adults they are several orders of magnitude larger in size, and almost all of the nutrients they carry are from the marine ecosystem. While only a small percentage of salmon successfully return to spawning grounds, those that do provide important nutrients to the freshwater and nearby terrestrial ecosystems where they decompose (Cederholm et al. 1999). This benefits the whole ecosystem, from predators like grizzly (*Ursus arctos*) and black bears (*Ursus americanus*) and wolves (*Canis lupus columbianus*) that consume them directly, to increased productivity for the juvenile salmon that emerge the following spring, to increased tree growth and bird density in the surrounding terrestrial landscape (Cederholm et al. 1999; Gende and Willson 2001; Helfield and Naiman 2001). The loss of salmon, therefore, is a major detriment to the ecosystems which depend on the yearly delivery of salmon nutrients that escape the fishery and reach their spawning grounds.

Regulating services

Estuaries and coastal floodplain ecosystems provide important nursery habitats that contribute to the production of salmon and other fisheries, and provide a variety of other valuable ecosystem services (Barbier et al. 2011). In the Lower Fraser estuary these habitats come in a variety of forms; from freshwater creeks, sloughs, and wetlands in the upper estuary, to marsh and eelgrass beds in the lower estuary. As a primary benefit these habitats provide juvenile salmon with food and protection, and provide adults with conditions to lay eggs and incubate embryos. They also provide an incredible spectrum of other ecosystem services that humans benefit from. These are often less considered, but likely equally valuable.

Freshwater habitats in the Lower Fraser serve as important spawning habitats for adult salmon and nurseries for juvenile coho, chum, and Chinook. An analysis by Knowler et al. (2003) found that freshwater

stream habitat in the South Thompson region was worth up to $7,010 per km of stream length measured in terms of direct monetary value obtained from coho production alone, if the stream is kept from being degraded. Freshwater streams also provide ecosystem services by supplying water for irrigation and other uses, providing drainage for rainwater, allowing for transportation, and creating recreational and cultural sites (Wilson 2010).

Moving into the estuary, marshes, which are abundant in the upper intertidal zone of the Fraser estuary, and eelgrass meadows, which are common at Roberts Bank in the mid and low intertidal zone, provide an array of valuable services to humans including erosion control, storm protection, water purification, and carbon sequestration (Barbier et al. 2011). Marshes stabilize sediments; they increase the height of the intertidal zone and, along with eelgrass meadows, provide structures that reduce the impact of waves, protecting coastal zones from storms and erosion (Barbier et al. 2011). This coastal protection can be extremely valuable, with salt marshes in the United States estimated to be worth $8,236 per hectare per year in reduced hurricane damages (Costanza et al. 2008). Marshes and eelgrass meadows also act to filter the water entering the estuary by absorbing nutrients and promoting the deposition of suspended sediments, improving its quality for human use and nearby ecosystems (Barbier et al. 2011). As areas with extremely high primary productivity, they also sequester significant amounts of carbon, which benefits humans on a global scale.

Marshes and eelgrass meadows are also known to be key areas for other commercially harvested fish and invertebrate species along with juvenile salmon. Due to the protection offered by their tightly packed and complex plant structure, they provide excellent habitat for the growth and survival of young fish and invertebrates (Boesch and Turner 1984). The eelgrass at Roberts Bank is home to harvested species such as herring and Dungeness crab, and important forage fish such as surf smelt and sand lance. Eelgrass meadows also support abundant and diverse ecological communities that create unique recreational opportunities such as snorkeling and scuba diving. These can further provide services by attracting tourism (Barbier et al. 2011), however these opportunities are currently limited in the Fraser estuary.

Riparian zones

Along with benefitting fish habitats, there are a variety of ecosystem services provided by salmon habitats that benefit all of us. Intact riparian zones are important in maintaining the quality of stream habitat. They provide fuel for the food chain in the form of leaves, larger woody pieces that create complex habitats, and canopy cover that provides shade to keep streams cool. Ensuring tributary streams have ample shade is becoming increasingly important as river temperatures rise to levels which threaten migrating adults. Along with these benefits for salmon, intact riparian zones provide numerous other valuable ecosystem services, such as preventing pollutants from entering small streams and enhancing the in-stream processing of pollutants, thereby reducing their impact on downstream rivers and estuaries (Sweeney et al. 2014). This buffering capacity is incredibly important in agricultural and urban areas, where runoff can lead to eutrophication of streams, contamination of groundwater, and the loss of salmon and other species (Berka et al. 2001; Rosenau and Angelo 2005).

A study of riparian corridors in the Fraser Valley showed they provide a wide variety of services including habitat for native species, food in the form of native berries, moderation of extreme weather by reducing wind damage and local flooding, air and water pollution mitigation, habitat for pollinators, reduction of erosion, access for recreational fishers, and mental health benefits provided by intact natural areas (Quayle and Hamilton 1999). This is only a portion of the additional ecosystem services provided by riparian zones in the Lower Fraser Valley, many of which have been lost, but could potentially be restored.

While riparian zones are one component of quality salmon habitats, the whole ecosystem must function effectively to protect salmon. There are many processes that interact to create a healthy watershed which, in turn, results in a multitude of benefits for humans (aside from salmon).

Values across the watershed

In a study of BC's lower mainland, aquatic nearshore services such as flood protection, water supply, and fish and wildlife habitats, were estimated to provide between $30 and $60 billion in benefits each year (Molnar et al. 2010). Land-based services such as climate regulation, water filtration, flood protection, clean air, waste treatment, and water supply are estimated to provide $5.4 billion in benefits each year. If we compare that to the broad values used by Costanza et al. (1997), the Fraser estuary, at 21,000 hectares in size, would provide approximately $480 million in services each year; while the Lower Fraser floodplain at 700 hectares, with its functions intact, would provide $13 million in services each year. These estimates take

Value of riparian greenways to property values

Corridors of Green and Gold: Impact of Riparian Suburban Greenways on Property Values, (Quayle and Hamilton 1999). Riparian zones not only provide benefits to wildlife, but also have been shown to provide intangible ecosystem services to people as a place to go, interact with and enjoy nature. Moreover, a study prepared for the Fraser River Action Plan in 1999 showed that having a riparian greenway near your home could lead to a substantial financial benefit in terms of property values. They studied three greenways located across the Lower Mainland and found that proximity to a greenway resulted in a 10-15% increase in property value. Higher property values, which translate to higher property tax revenue, are associated with riparian greenways and benefit the community (Little, 1990).

Reversing the nature deficit: Benefits of stream-daylighting and urban habitat restoration

In 2005, author Richard Louv coined the term "nature deficit disorder". His book *Last child in the woods* highlights the decreasing amount of time individuals are spending outdoors and the effects of this on health and happiness. This is particularly true in large metropolitan areas such as BC's Lower Mainland, where most of the wildlife habitat has been replaced with concrete and metal. Here, lost and endangered streams represent a huge opportunity to provide urban greenspaces that are easily accessible and still inspire the feeling of being in nature, away from the hustle and bustle of modern life.

into consideration not only the value of harvested fish, but also the other services provided by healthy ecosystems which are typically ignored. They highlight the enormous monetary values that are provided by the Lower Fraser and watershed.

Protecting ecosystem services in the Lower Fraser

Despite the value of ecosystem services provided by salmon and their habitats in the Lower Fraser, it will take a large effort to preserve them into the future. According to a report prepared for the David Suzuki Foundation (Wilson 2010), in the 10 years between 1999 to 2009, 579 hectares of Lower Fraser wetlands were converted to agricultural lands, and another 781 hectares were converted to developed land use. Based on the differences in ecosystem services provided by wetlands versus agriculture versus developed land, they valued the overall loss in ecosystem services at $11.1 million per year. This is based on a loss of ecosystem services of $7,153 per hectare converted to agriculture (total of $4.1 million), and $9,008 per hectare converted to developed lands (total of $7 million).

These recent losses make up only a fraction of the land use change that has occurred around the Lower Fraser since European colonization. A 1996 study by Healey and Richardson found that 400,000 hectares of the Lower Fraser Valley have been drastically modified since European colonization, turning a landscape which was once dominated by forests (70%) and wetlands (30%) into agriculture (62%) and urban developments (24%). This ratio has changed since 1996, with more land converted to urban development. A study by Boyle et al. (1997) documented an even greater loss of forest and wetlands throughout the Lower Fraser Basin. If we consider land conversion incurred since the early 1830s, roughly 71,000 hectares of wetlands and almost 150,000 hectares of forests have been lost (Boyle et al. 1997). Applying the values assigned by Wilson/DSF (2010) to these figures of 20 years ago, this massive land conversion has resulted in a loss of ecosystem services valued at $1.5 trillion annually.

Protection of the estuary

While ecosystem services continue to be lost, there has been some progress in terms of protection. These areas include 20,682 hectares of delta habitat as a Ramsar Wetland of International Significance, including Burns Bog, the Wildlife Management Areas of Sturgeon Bank, South Arm Marshes, Boundary Bay, Serpentine, and the former Alaskan Ramsar site on Westham Island. Although this provides some protection for parts of the estuary, much more needs to be done if we hope to maintain and restore ecosystem function. One approach gaining momentum is the concept of payment for ecosystem services, which rewards landowners for following best practices.

Payment for ecosystem services

One challenge in the effort to restore ecosystem services is that it can require individuals to change their land use practices. This can come with personal costs, lost revenue or expenditure. To combat this problem, the concept of payment for ecosystem services has been gaining popularity, as individuals are compensated for activities on their private lands that help preserve or restore ecosystem services. This approach has primarily been used to protect freshwater resources. It gained

much traction after an enormous investment by the City of New York to protect its drinking water, an investment that also saved taxpayers billions of dollars. While there are many challenges associated with this, not least of which is funding and land-owner participation, payment for ecosystem services may be a potentially effective approach for protecting and restoring streams in the Lower Fraser watershed.

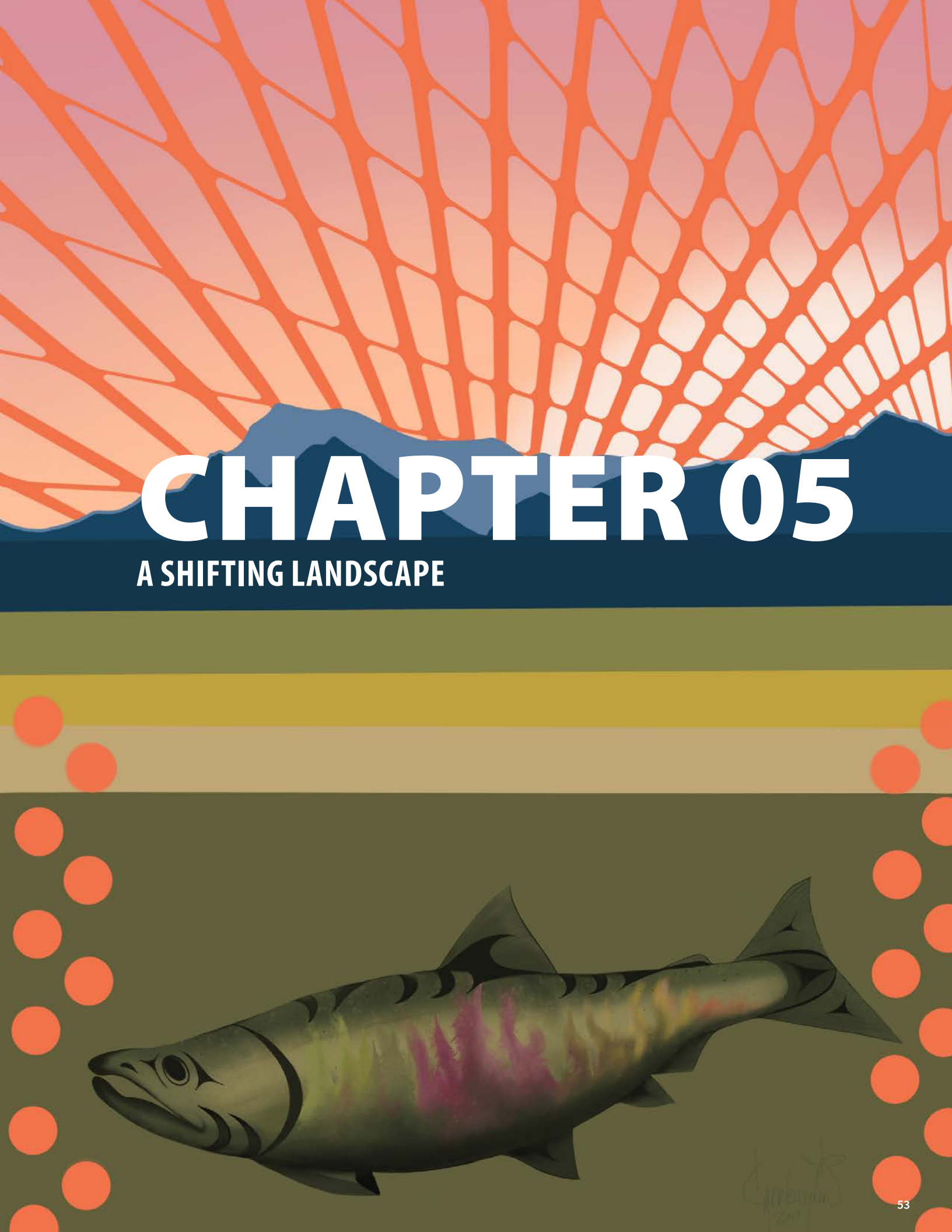
In British Columbia, traditional agricultural practices can have negative effects on streams, yet farmers have been given little incentive to change their practices. To deal with this problem, the British Columbia Ecological Services Initiative (BCESI) was created, spearheaded by farmer David Zehnder. Their objective was to create a voluntary incentive-based model that encourages farmers to adopt or maintain Beneficial Management Practices, such as fencing to exclude livestock from riparian zones, and preserve and enhance ecosystem services (Chopra et al. 2011). Led by the Windermere District Farmers Institute, they now have 20 sites across BC and Alberta where they are establishing biological and economic monitoring protocols to help demonstrate the benefits of establishing Paid Ecosystem Services in BC.

New York City invests in ecosystem services and saves taxpayer money

In the 1990s, New York City was faced with building a water purification plant at a cost of $6 billion and a further $250 million a year in operating expenses (Grolleau and McCann 2012). Instead, they adopted a plan to pay those in the watershed for ecosystem services in the form of maintaining the quality of the water supply. In 1997, the City created an agreement with 30 watershed communities to pay farmers and others an estimated $1.4 billion to implement changes in farming and land use practices to preserve water quality (Grolleau and McCann 2012). These investments are spread between a variety of initiatives, including the purchase of 28,328 hectares of land, investments in sewage treatment facilities and septic tanks, and voluntary payments to farmers. This voluntary strategy has been adopted by nearly everyone in the watershed and is helping New York save billions of dollars that would have been spent on filtration facilities and operations. It is a great example of the economic benefits that arise from protecting ecosystem services.

CHAPTER 05

A SHIFTING LANDSCAPE



Chapter 5: A shifting landscape

Beyond ecological declines in physical habitat, growing political and societal shifts set a broader context for our efforts to identify a vision for salmon habitat in the Lower Fraser. Shifting attitudes and policy relating to Indigenous rights, environmental assessment, and watershed planning are especially important if we are to avoid past failures and fully address systemic issues that have resulted in what many describe as a crisis for Fraser River salmon.

Recognition of Indigenous rights

In September 2007, the United Nations General Assembly adopted the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). With 144 member states in favour, only four voted against (Australia, Canada, New Zealand and the United States) and all have since endorsed the declaration. UNDRIP addresses both individual and collective rights relating to culture, education, health, language, and other rights. Importantly, UNDRIP also affirms the rights of Indigenous people to self-determination. This includes the right to freely determine political status and advance economic, social, and cultural development via distinct institutions. It also retains the right to fully participate in aspects of life governed by the state.

Many of the rights in the declaration will require new approaches to global issues, including development and multicultural democracy. This shift is apparent in conservation and evidenced in the Durban Accord (IUCN 2005), which identifies a new paradigm in the context of parks and protected areas. The Accord outlines different methods for establishing and governing parks that equitably integrate the interests of all affected people across multiple generations. It highlights the importance of recognizing and respecting the rights of Indigenous people and local communities regarding plans for natural resource and biodiversity conservation, issues of direct relevance to the Lower Fraser.

UNDRIP and Canada

In 2016, the Canadian government officially adopted UNDRIP and announced its support for implementation. Indigenous people and Canadian governments have a history of jointly managing protected areas, and using independent models of governance to steward their resources and protect them from development pressures (Murray and King 2012). With examples like the Great Bear Rainforest, areas conserved by Indigenous communities can support a range of objectives beyond biological conservation, such as the preservation and development of cultural values and economic opportunities (Artelle et al. 2019). Court decisions also continue to affirm Indigenous rights and title in Canada and shifting public attitudes increasingly value the re-establishment of First Nations as stewards of their traditional territories. In November 2019, the British Columbia government became the first Canadian province to table legislation intended to implement UNDRIP.

With findings and recommendations from the Truth and Reconciliation Commission still emerging, the federal government appears to be seeking additional Indigenous engagement in conservation efforts. In 2015, and working towards its commitments to help meet

2020 global biodiversity targets (Aichi targets[1]), Canada adopted national political targets that includes the goal that "*By 2020, at least 17% of terrestrial areas and inland water, and 10% of marine and coastal areas, are conserved through networks of protected areas and other effective area-based conservation measures*" (Parks Canada, 2016). These targets raise complex questions as to what is biologically required, what designations count, and how Indigenous involvement can best be achieved.

As Indigenous protected areas become more prominent, a 2018 report by the Indigenous Circle of Experts called *We Rise Together: Achieving Pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas,* was created in the spirit and practice of reconciliation (Parks Canada 2018). It identifies features necessary to support a broader shift in conservation, which respects Indigenous knowledge and rights. In addition to a long-term conservation commitment, the report identifies a need for dedication of adequate time and resources, innovative funding models, and new partnerships. Despite some positive progress, a review of Indigenous engagement in species recovery planning (Hill et al. 2019) found more than 50% of documents reviewed included no detectable involvement of Indigenous Peoples (Hill et al. 2019).

Death by a thousand cuts

Canada's Department of Fisheries of Oceans has seen drastic funding cuts over the last decade. With little, if any, enforcement capacity, and weakened legislation, DFO has failed to fulfill its mandate. Only small steps have been taken to deliver the Wild Salmon Policy and other policy recommendations, including those from the Cohen Enquiry. In 2008 and 2017, Raincoast documented the steady decline in monitoring of spawning streams (since the 1980s) on BC's north and central coast (Price et al. 2008; 2017). This decline in salmon assessments has been observed coast wide. There are some signs of federal reinvestment, including a focus on Indigenous involvement, but systemic problems are not being resolved.

The 2016 Oceans Protection Plan

Despite opposition within British Columbia to the Enbridge Northern Gateway proposal and the Trans Mountain expansion, industry pressure to increase fossil fuel exports continues. Opposition to these projects comes from Indigenous Nations, cities, the province, the public, and others concerned about climate change, oil spill risk, noise and environmental impacts to species at risk, including the Southern Resident killer whales (*Orcinus orca*). Widely considered a response to these problems, the federal government launched its Oceans Protection Plan with a goal to "keep Canadian waters and coasts safe and clean, for today's use and for future generations" (Government of Canada, 2016), committing $1.5 billion over five years. While some money ($75 million) was directed to habitat restoration, including projects in the Lower Fraser, much of the BC money was for improved capacity around spill response given the projections for a consequential increase in tankers and other ship traffic into Vancouver ports. Implementing a long overdue management plan for the Fraser River Estuary was not identified.

1. Aichi targets were established by the United Nations Convention on Biological Diversity to address underlying causes of biodiversity loss.

Figure 5.1. Transport Canada / Government of Canada, Canada's Oceans Protection Plan

Available online: https://www.tc.gc.ca/en/campaigns/oceans-protection-plan-funding-graphic.html

Four Coastal Restoration Fund projects are underway in the Lower Fraser. Raincoast is undertaking habitat restoration to improve ecological connectivity in the Fraser estuary through removal of physical barriers that limit juvenile fish migration and sever natural estuary processes. Ducks Unlimited was awarded funding to restore coastal shoreline habitat around Delta and Richmond. This project will involve the breaking of dikes and modification of water controls to enhance the movement of tidal waters in the estuary. Additionally, the Fraser Valley Watersheds Coalition is restoring the Tom Berry gravel pit. The project will restore a 14.5 hectare gravel pit back to high value salmon habitat while also conserving known culturally important features. More recently, the Lower Fraser Fisheries Alliance was funded to develop a Lower Fraser River wetland conservation and restoration plan.

Canada Nature Fund 2019

Focused on ecosystem protection, biodiversity and species at risk, the $1 billion Canada Nature Fund matches $500 million of government money with $500 million from the philanthropic sector. This program is split into two main components. “Spaces” is focused on conserving 17% of Canada’s land and freshwater in support of 2020 biodiversity targets. This includes support for establishing Indigenous Protected and Conserved Areas (IPCAs) and acquisition of private lands for new protected areas. A second stream is focused on aquatic species at risk, with the Fraser system one of the priority areas.

A provincial interest in wild salmon: British Columbia’s Salmon Restoration and Innovation Fund

In 2018, the province of British Columbia marked a shift in provincial interest with regard to salmon by establishing a Wild Salmon Advisory Council that recommended the formation of a BC Wild Salmon Strategy (Province of British Columbia, 2019). The council indicated that a BC Wild Salmon Strategy should have wild salmon and their habitats as an important priority. The British Columbia Salmon Restoration and Innovation Fund is a contribution program funded jointly by the federal and provincial government that has committed up to $142.85 million over five years to support BC’s fish and seafood sector, and to ensure the sustainability of wild Pacific salmon and other BC fish stocks. A first round of projects was announced in July 2019 that included support for Watershed Watch’s *Connected Waters* initiative aimed at addressing the impact of flood infrastructure on fish habitat in the lower mainland.

Reassessing environmental assessment

In July 2012, the federal government introduced sweeping changes to environmental assessments via omnibus Bill C-38. The bill directly affected the Canadian Environmental Assessment Act (CEAA), the Fisheries Act, National Energy Board Act, and the Species at Risk Act (SARA). The move was widely criticized as driven by the interests of resource extraction industries. Changes to CEAA included a reduction in the number and scope of assessments subject to federal review, strict timelines for the completion of environmental assessments and restrictions on public participation. Of direct relevance to salmon habitat, Bill C-38 significantly reduced protections for fish habitat that previously prohibited the Harmful Alteration, Disruption, or Destruction of fish habitat, known as the HADD provisions.

Next generation of environmental assessment?

Just four years later, under a different federal government, 2016 saw the announcement of the federal review of environmental laws including the acts that were gutted by Bill C-38. After two years of consultations, Bill C-68 (which amended the Fisheries Act) and Bill C-69 (which amended the Impact Assessment Act and the Canadian Energy Regulator Act), received Royal assent in June 2019. Bill C-68 largely restored the HADD provisions in the Fisheries Act. The acts include further requirements for consideration of Indigenous knowledge, consideration

of viable alternatives, and considerations about project impact of Canada's climate change commitments. Many of the changes reflect contemporary thinking.

Many conservation and environmental groups have been broadly positive of Bill C-68, especially around restoring the HADD provisions, creation of public registry, and greater recognition of Indigenous rights and knowledge. Despite push-back from regulated industries, Bill C-69 does appear to strike a balance between a range of interests with conflicting views. West Coast Environmental Law (WCEL, Johnston 2016) suggest that a next generation assessment regime should include sustainability as a core objective, regional cumulative effects assessment, an independent body, the right of public appeal, climate assessments, and consideration of various options. They also suggest that decision-making should be collaborative, based on nation-nation dialogue and meet the obligation to secure the free, prior, and informed consent of Indigenous People.

Paddling together

The idea of modernizing environmental assessment has also led to further calls for improvement in broader scale regional, strategic, and cumulative effects assessment. In-line with the principles of UNDRIP, WCEL have set out criteria in their 2017 report, Paddling Together: Co-Governance Models for Regional Cumulative Effects Management (Clogg et al. 2017). This report identifies key criteria for success that includes a commitment to use the best available scientific and Indigenous knowledge and the concept of *Two-eyed seeing*, which gives equal weight to Indigenous and academic ways of knowing. They also identify a need for structured co-management that upholds both Indigenous and Canadian law.

Watershed governance

In 2016, the Water Sustainability Act was brought into force in British Columbia to ensure a sustainable supply of fresh, clean water to meet the needs of BC residents today and in the future. The new act enables the creation of water sustainability plans to help address water use conflicts. Importantly, these provisions introduce the possible delegation of statutory decision-making that could support more locally based plans in areas like the Lower Fraser River, including specific objectives for water quality and quantity.

Working with various experts, the POLIS Project on Ecological Governance has identified 10 winning conditions for successful watershed governance in BC (Brandes and O'Riordan 2014). These include: (1) Enabling powers in legislation for watershed entities; (2) Co-governance with First Nations; (3) Support from and partnership with local government; (4) Sustainable long-term funding; (5) A functional legal framework for sustainable water and watershed management; (6) Availability of data, information and monitoring; (7) Independent oversight & public reporting; (8) Assessing cumulative effects; (9) Continuous peer-to-peer learning and capacity building. As development pressures continue in the Lower Mainland and elsewhere in BC, 2019 polling by the Real Estate Foundation of British Columbia indicates broad public support for land use aligned with conservation and habitat protection. Specifically, the top five land use priorities for British Columbians were identified as (1) Habitat for birds,

fish, and wildlife -66%, (2) Local food security -62%, (3) Large-scale wind, solar, and geothermal power - 61%, (4) Parks and protected areas - 60%, and (5) Natural watersheds- 54% (Real Estate Foundation 2019).

From Indigenous rights to investment in restoration and shifts in watershed governance, changes are needed in the Lower Fraser, a region with intense development pressure and habitat loss. Importantly, as development pressures have increased, oversight capacity has been lost.

The loss of the Fraser River Estuary Management Program

In 1985, the Fraser River Estuary Management Program (FREMP) was established to help coordinate activities of numerous agencies operating in the Lower Fraser. Federal agencies, including Environment Canada, Fisheries and Oceans Canada, and Transport Canada partnered with the BC Ministry of the Environment, Fraser River Port Authority, North Fraser Port Authority, and Greater Vancouver Regional District to conduct research and evaluate development proposals for the lower river and estuary through FREMP. In conjunction with the Burrard Inlet Environmental Action Program (BIEAP), FREMP worked collaboratively toward a goal of preserving the ecological values of these areas.

In 1994, FREMP partner agencies developed a plan called *A Living, Working River* (FREMP 2006). Updated in 2003, the plan's vision was 'A sustainable Fraser River estuary characterized by a healthy ecosystem, economic development opportunities and a continued quality of life in and around the estuary.' The plan's stated goals were to: (1) Conserve and enhance the environmental quality of the estuary to sustain healthy fish, wildlife, plants and people; (2) Respect and further the estuary's role as the social, cultural, recreational and economic heart of the region; (3) Encourage human activities and economic development that protect and enhance the environmental quality of the estuary.

These programs were funded by a combination of federal, provincial, and regional governments as a variety of projects were working toward improved sustainability in the Lower Fraser estuary. One such project, the FREMP habitat classification system, mapped habitats along the banks of the lower Fraser River to help identify high quality areas important to salmon that should be protected from development. However, despite support from a range of stakeholders for FREMP and BIEAP, FREMP was shut down in 2013 after 28 years of working together to slow the loss of habitat, including salmon habitat, in the lower Fraser.

A review of past estuary governance

In 2018, a team led by the University of British Columbia and the University of Victoria, conducted a review of FREMP via an online survey and a workshop (Kehoe et al. in review). Most respondents agreed that FREMP was 'moderately effective' in achieving its stated vision of a living working river, but no respondents deemed it to be 'very effective'. The positive achievements of FREMP (1985-2013) included a greater balance of healthy ecosystems and development opportunities, time and resource savings, habitat coding, and classification that improved understanding of areas at risk and, for a period

in the mid-1990s, a strong management committee with senior representatives from member agencies.

At the same time, the review also identified numerous failures including the prioritization of industry and development. 100% of respondents reported a level of clash of mandates between agencies. The review highlighted a complete lack of First Nations representation and insufficient direction from a senior management committee. The former Vancouver Fraser Port Authority and industry were deemed to have had too great an influence and there was no legislation to ensure program funding persisted through time. Respondents also identified inadequate habitat protection and restoration, and specific inadequacies in the habitat banking program, which resulted in no overall net gain in functioning habitat.

Current oversight in the Lower Fraser

The loss of FREMP as an oversight body in 2013 followed the amalgamation of the three previously existing port authorities into the Port of Vancouver. In 2015, permitting in the provincial region of the Fraser River became the responsibility of the BC Ministry of Forests, Lands, and Natural Resource Operations (FLNRO), with development proposal reviews managed by the BC Environmental Assessment Office. Proposals located in the federally-controlled region of the Fraser River are managed by the Port of Vancouver who now overseas both development and environmental assessment.

Currently, a memorandum of understanding between Fisheries and Oceans Canada and the Port of Vancouver has created a habitat-banking plan which facilitates further industrialization of the Lower Fraser in exchange for compensation projects elsewhere. The Port of Vancouver has identified a number of projects to offset the habitat loss that occurs with port development. Potential site locations include the McDonald Tidal Marsh Project on Sea Island where approximately five hectares of mudflat habitat would be converted into marsh habitat. At Point Grey, a proposed tidal Marsh Project located near the mouth of the Fraser's North Arm would convert approximately 40 hectares of intertidal mudflat habitat into intertidal brackish marsh. The proposed South Arm Jetty Tidal Marsh Project at the mouth of the Fraser River's South Arm on the southern edge of Sturgeon Bank, would convert approximately 43 hectares of sand flat habitat into marsh habitat.

Unfortunately, neither the 'no net loss' policy or the habitat banking have been effective. Precedence is still placed on economic development, in the form of port expansion, without adequate consideration of the significant value and loss of remaining habitat or the potential benefits of habitat restoration.

A review of compensation sites within the FREMP area (Lievesley et al. 2016) assessed their success based on both the proportion of target habitat established and the proportion of native species compared with reference sites. Only 33% of wetland compensation were ranked as 'good' in both criteria. With regard to the proportion of target habitat established, 18% of sites were classified as 'poor' and 18% 'fair'. With regard to the proportion of native species compared with a reference site, 22% were classified as

'poor' and 28% 'fair'. Other studies have identified that while compensation and offsetting can be effective tools, they need to be embedded with broader natural resource and land use policies (Prommer 2012).

The value of co-governance in the Fraser estuary

Governance is broadly accepted to be of benefit to conservation (Biermann et al. 2012, Green et al. 2016, Kehoe et al. in review). Since 2016, Raincoast has partnered with the University of British Columbia, the University of Victoria, Environment Canada, and Fisheries and Oceans Canada to prioritize conservation actions in the Fraser River estuary aimed at ensuring ecological resilience and specifically, protecting 102 at-risk species. This research indicates that within the Fraser Estuary, when co-governance is implemented, only two-thirds of the management resources are required to achieve the same conservation impact. To conserve all species groups at a 50% threshold (i.e. 50% chance of species survival) without co-governance, all conservation strategies were required at a total cost of $346M. Whereas, when including co-governance, only four management strategies were needed - Public Land Management, Green Infrastructure, Pollution Control, and Aquatic Habitat Restoration - costing an estimated $222M and saving $124M. The improvement in cost-effectiveness was driven by an average increase in the feasibility of all strategies by 10% under co-governance. This research further demonstrates that, while complex, the preservation of biodiversity in urbanized areas like the Lower Fraser is still possible and will require investments in strategic planning, governance, and large-scale investment.

CHAPTER 06

TOWARD A VISION FOR THE FUTURE

Chapter 6: Toward a vision for the future

Raincoast's commitment to the Lower Fraser

As a non-governmental organization (NGO), Raincoast's mission is to safeguard the lands, waters, and wildlife of coastal British Columbia. Having historically focused on the Great Bear Rainforest, Raincoast's work for well over a decade has increasingly concentrated on the Salish Sea. The importance of Chinook salmon to the Southern Resident killer whales is a major component of this work, along with the goal to further the recovery of these endangered whales. Our work to stop the Trans Mountain expansion has allowed us to better understand the complex ways salmon interact with the Lower Fraser and estuary. It has also provided us the opportunity to engage with the First Nations, NGOs, and myriad of individuals focused on salmon conservation in the Lower Fraser.

Our *Wild Salmon* Program aims to protect the diversity, population structure, and abundance of wild salmon throughout their historic range and run timing, as well as accommodate the wildlife that depend on healthy salmon runs. Our efforts to reform salmon management and habitat policies are intended to build ecological resilience. In 2016, we initiated a Lower Fraser Salmon Conservation Program with a goal to secure healthy populations of wild salmon returning to the Lower Fraser.

Dealing with systemic issues

Given its history, the Lower Fraser faces numerous complex issues that have contributed to the existing degraded state of salmon habitat. Such issues are challenging to address without identifying the systemic roots that have enabled them. Identifying root causes, however, can provide a starting point for reversing the trend in habitat loss.

Root causes and fragmented efforts

The coordinating efforts of FREMP (Fraser River Estuary Management Plan) and the role played by agencies like Environment Canada, the Canadian Wildlife Service, and DFO, were dissolved in 2012. Decades of budget and resource cuts to DFO have affected science, and the enforcement and protection of salmon habitat. With governing bodies removed, eroded or replaced, the Port of Vancouver became a key decision-making authority in the Lower Fraser. This transition of power has culminated in serious losses to salmon habitat due to the lack of priority placed on conserving or restoring fish habitat. These losses have been driven by anachronistic thinking, which dictates environmental protection is a choice between the economy or the environment. This belief constrains solutions and limits new approaches to innovative problem solving.

In response to the degradation of habitat, First Nations, community groups, and NGOs continue to conduct conservation efforts. Empowered by legal recognition of their rights and title, some First Nations are taking leadership roles on conservation issues, but are under-resourced and often focus at a sub-regional level. Conservation groups often tackle larger issues, but have not stopped cumulative and systemic problems. Similarly, many groups focus on single issues, species, or streams. Community actions to protect habitat are also diffuse, as groups working in the estuary can be disconnected from those working in the sand and gravel reaches located upriver. Without an overarching plan and the financial resources required for investment in restoration, monitoring or coordination, any progress is vulnerable to shifting political agendas, federally and provincially.

To date, we have not identified a coordinated effort or overarching mandate that guides conservation efforts in the Lower Fraser. Collectively, First Nations, NGOs, community groups, recreational interests, businesses, and municipalities could yield significant political influence if their conservation agendas were aligned. As such, a community driven vision could be a powerful force for conservation that has long-term benefits ecologically, socially, and economically.

Case study: The Cowichan Watershed

There are initiatives that have tackled similar issues in other places (provincially, nationally, internationally) that can be drawn on for guidance. The Cowichan Basin Water Management Plan is one example of how different interests can work together to protect a shared resource. The Cowichan Basin plan is a collaboration between the Cowichan Valley Regional District, BC Ministry of Environment, Fisheries and Oceans Canada, Catalyst Paper Corporation, Cowichan Tribes, and the Pacific Salmon Foundation.

The Cowichan watershed is a 930 km^2 catchment located on Vancouver Island. It drains three municipalities (Duncan, Lake Cowichan, and North Cowichan) and five electoral areas (www.cowichanwatershedboard.ca). Water management in the Cowichan Basin prior to 2004 consisted of an ad hoc Cowichan River committee making in-season flow management decisions during annual drought crises. However, in 2004 the committee recognized that the approach was inadequate to deal with the complex and long-term issues facing the Basin, and advocated for the development of a Water Management Plan. The goal was to move beyond crisis decision making, prepare responses to the effects of climate change, and plan proactively for water needs. The group created a forum that was able to bring diverse sets of interests together to develop a vision of a desirable future. The vision states “The Cowichan Basin community conserves and manages water to ensure reliable supplies for human use, thriving ecosystems, and a healthy economy”. Using this vision, the community created the Cowichan Watershed Board in 2010 which has been working ever since to protect and enhance the watershed.

Why create a vision?

In an effort to develop a collaborative plan to guide habitat restoration and ensure remaining habitat is protected, Raincoast began a series of workshops following extensive one-on-one meetings with groups that share common interests. Participants expressed interest and enthusiasm for developing such a Vision and shared their views on what it should include. Since 2016, we have engaged with more than 100 organizations or individuals that are making important contributions to salmon habitat conservation in the Lower Fraser. The following represents those we have engaged with to date. Descriptions of other aligned conservation initiatives conducting habitat restoration in the Lower Fraser are in the box below.

Who have we engaged?

First Nations

We have actively reached out to various nations across the Lower Fraser and will continue to prioritize First Nations in our ongoing engagement. We held some of our workshops with local Nations and were fortunate to be hosted by the Kwantlen and the Tsawwassen First Nations. We also partnered with the Lower Fraser Fisheries Alliance to host a workshop at the Stó:lō Resource Center. Without the leadership, support, and involvement of First Nations, no conservation initiative for salmon habitat in the Lower Fraser can be effective.

Non-governmental organizations

There is a diverse group of non-governmental organizations (NGOs) active in the Lower Fraser, many of whom are closely engaged in protecting salmon, salmon habitat or related conservation objectives. The Pacific Salmon Foundation plays a lead role in supporting local stewardship groups, as well as funding smaller scale enhancement via the community salmon program. Some larger NGOs, like the World Wildlife Fund and David Suzuki Foundation, are also engaged in the Lower Fraser, but with a more national focus.

In addition to Raincoast Conservation Foundation, there are many national and regionally based NGOs, including the BC Wildlife Federation, Ducks Unlimited, Watershed Watch Salmon Society, Fraser Watershed Initiative, and others whose activities have a direct or indirect relevance to salmon or salmon habitat conservation. Supported by the Pacific Streamkeepers Federation, there are numerous local streamkeeper groups stewarding local streams and supporting various conservation initiatives. This includes active local groups such as the Abbotsford Ravine Park Salmon Enhancement Society, Alouette River Management Society, Byrne Creek Streamkeepers, Cougar Creek Streamkeepers, Fraser Valley Watersheds Coalition, Fraser River Keepers, Kanaka Education and Environmental Partnership Society, the Langley Environmental Partners Society, the Salmon River Enhancement Society, Stoney Creek Environment Committee, Silver Creek Streamkeepers, Still Creek Streamkeepers, the Water Wealth Project, and many more local groups improving the state of their local salmon streams.

Community focused organizations

Numerous community-led groups have emerged over the last few years to voice concerns over a range of development proposals adjacent to the Lower Fraser. While these concerns relate to a variety of issues, including climate change, air pollution, and public safety, all the projects impact salmon habitat or have the potential to do so. This includes groups opposed to the Trans Mountain expansion project, including Pipe-Up (Fraser Valley), North Shore NOPE (North Vancouver), and Burnaby Residents Opposed to Kinder Morgan Expansion (BROKE). Similarly, a group exists to oppose Jet Fuel Expansion, Vancouver Airport Fuel Project Opposition for Richmond (VAPOR).

Municipalities

The lower mainland has an extremely diverse set of municipalities that are located along the banks of the Fraser River, including eight of the ten most populated municipalities in BC. All these municipalities have the ability to regulate some measure of activities that take place in the watershed. From the City of Vancouver to the District of Maple Ridge, these municipalities range significantly in size and in the scale of effort being undertaken to protect salmon habitat. Across the region, there are examples of leadership such as Surrey's Salmon Habitat Restoration Program (SHARP) program, the Coquitlam Watershed Roundtable which involves the cities of Coquitlam and Port Coquitlam, and Vancouver's growing efforts to daylight and restore lost streams.

Building a vision

Starting with a workshop hosted by the Kwantlen First Nation in October 2016, we have held four workshops throughout the Lower Fraser region. Our second workshop was held in Vancouver in September 2017. Our third workshop was also held in September 2017 in partnership with the Lower Fraser Fisheries Alliance and our fourth was hosted by the Tsawwassen First Nation, in December 2017.

Our workshops began with a welcome and territorial acknowledgement from our host Nations. The workshops included participants with diverse perspectives and backgrounds, but all shared values to preserve and restore salmon habitats. Discussion was focused on aspirations for salmon habitat at varying time frames, from the short term (2020), the medium term (2050) and the long term (2100). Potential political support, leadership, funding mechanisms, and governance were also discussed, as these are necessary components of a vision. Ultimately, a broad set of aspirations was conveyed by First Nations, conservation groups, municipalities, and concerned individuals. After each event, input was compiled and then reported back to all participants, inviting their feedback.

Key themes

While recognizing that the workshops specifically sought out solutions for governance and funding issues, core themes also emerged around education,

protection, restoration, policy, research, and Indigenous involvement. Throughout the four workshops, we found shared values and common goals despite differences in backgrounds and beliefs. Here, we present a summary of key themes based on a compilation of all the feedback we received at the workshops. For a complete list of notes on the ideas and statements expressed in each workshop see Appendix A4.

Key theme: Involvement of Indigenous Nations and people.

Meaningful involvement of First Nations was a recurring theme throughout each of the workshops and was common across each of the key themes. Within this context, the concept of Indigenous guardianship programs to lead habitat monitoring, restoration, and enforcement was repeatedly highlighted.

Key theme: Fish friendly policy solutions

The most common theme mentioned throughout the workshops were issues related to policy. Many of the suggestions, particularly in the short term, related to reforming existing policies. Suggestions included:

1. adding the regulation of environmental flows to the Water Sustainability Act,
2. ensuring salmon species that have been listed by COSEWIC are listed under SARA,
3. replacing the "no-net-loss" policy with a "net-gain" policy,
4. and the Fisheries Act having enforceable standards regarding habitat restoration projects that includes a 25 year follow-up period.

Others suggested changes to existing regulations or recommended new ones. These ideas include changing legislation to encourage the use of open-bottom culverts and bridges in road crossings rather than traditional culverts, regulating waste dumping and livestock density on the agricultural land reserve, and making all flood infrastructure fish friendly.

For the longer-term aspirations, participants had a vision of policies that used historic salmon abundances as a benchmark, mandated that all development be salmon safe, and include a life-cycle view of salmon in environmental assessments. Granting the Fraser River personhood and conferring rights of protection was suggested multiple times, as this approach has been taken in New Zealand and India. The creation of a Fraser Estuary Act that would cover the River from Yale to tide water was a similar mechanism that was suggested as one means of establishing a collaborative governance structure for the area. The use of ecosystem services to design rules around land use and management was also identified.

Key theme: Habitat protection and restoration

In the short term, workshop participants had a wide variety of ideas around how the existing habitat in the Lower Fraser could be immediately improved. The establishment and restoration of natural flow regimes was frequently mentioned. This included the maintenance of environmental flows in smaller creeks where water is being extracted, as well as restoring the natural flow patterns of the estuary and the connection of the floodplain to the mainstem of the Fraser. Different approaches to protection were also brought up that included speculation and development on the Agricultural Land Reserve, as well as other undeveloped foreshore and wetlands.

Habitat restoration and protection measures became much more ambitious with longer time frames. In the medium to long term, actions like creating a green corridor down the length of the Fraser mainstems were mentioned numerous times. Riparian setbacks were identified for all the creeks and tributaries of the Lower Fraser. At the 2050 timeline, using our adaptation to climate change was identified as an opportunity for positive influences on salmon habitat.

Limits on urban expansion into agricultural land and the extent of impervious surfaces were identified as land use approaches to improving and protecting habitat. The rewilding of streams to accompany riparian buffers included making drainage ditches into potential habitat for fish and wildlife. In the long term, ideas for restoration and protection shifted toward the functioning of ecosystem processes. Ideas like ensuring all rain water is directed toward aquifers, restoring sediment delivery processes in the estuary, and setbacks that allow the river to wander and create new channels were all aspirational visions for habitat in the Lower Fraser. The re-flooding of Sumas Lake was also a specific project that was highlighted as a possibility for the long term.

Key theme: Rebuilding monitoring and research capacity

One of the most common, recurring themes of the workshops was the need for increased capacity to monitor environmental conditions and form a base of knowledge from which effective management decisions can be made. Rebuilding capacity for (restored) monitoring of water quality and salmon escapement was singled out as a short term goal. Specific actions including restoring the community operation and responsibility of the counting fence on the Salmon River, as well as pursuing and incorporating data collected through citizen science initiatives. Other short term actions included evaluation of management approaches that are currently employed to manage salmon. These included improved evaluation of impacts and effectiveness of hatcheries on salmon returns, the history and success of habitat protection legislation, more effective incorporation of salmon escapement numbers into fisheries management, and adjusting catch numbers.

In the medium to long term, establishing a network of indicator streams throughout the Lower Fraser was listed as a potential mechanism to collect systematic and comprehensive data to inform management. Further knowledge on the extent of historic and existing salmon habitat was also cited as important knowledge to acquire. Specifically, mapping is needed to document important rearing habitats and convey the ecological history of the area. Throughout the workshops, a range of participants stressed the importance of, and a desire for, increased appreciation and respect for traditional ways of knowing, and Indigenous knowledge, which could inform the exploration of alternative fisheries techniques such as terminal fisheries.

Key theme: Education for all ages

Establishing a physical and cultural connection between the people of the Fraser Valley and Lower Fraser River was identified as important for workshop participants. In the short term, an emphasis on the inclusion of salmon habitat, the salmon life cycle, and First Nations cultural connection to salmon, in public education programs were cited as good ways of educating youth. The inclusion of these themes in the public school curriculum, accompanied with increasing access to the Fraser River, were mentioned as concrete ways of

implementing education around salmon in a consistent and comprehensive way. This idea was captured in, "bring people to the habitat, rather than the habitat to people".

In the medium to long term, workshop participants talked about cultural and value shifts in public awareness and political leadership. The adoption of core principles of sustainability by governments and the public, as a result of greater engagement with the natural environment, were mentioned as potential outcomes of educational initiatives. Other educational goals were the development of effective and easily accessible sources of information on salmon and salmon habitat, along with the use of traditional languages for place names. These educational efforts had a goal of ingraining the ecological and socioeconomic importance of salmon in public awareness and, in turn, would support communities' food security, livelihoods, and well-being.

Key theme: Co-governance and regional planning

There was strong agreement among workshop participants that a short-term goal included the need for a regional planning body that was inclusive and had power to enforce its decisions. The establishment of a 'FREMP-like' body was raised multiple times, or at least the guidelines that were developed through FREMP for management of streams in the estuary. In addition to the need for a FREMP-like mechanism, there was a recognition of a need for salmon advocates to increase collaboration. The consolidation of effort among groups was raised; this could be facilitated through a more formal planning body.

In the medium to long term, the development of a Guardian program, Nation to Nation communication, and respect for the stewardship role of Indigenous nations were identified as important to achieving good governance. Also identified was the broad and comprehensive implementation of ecosystem-based management. It was recognized that establishing these considerations, as well as a science-based decision-making framework that considers intrinsic and holistic values, are the foundations of ecological governance.

What is needed to realize this vision?

Participants identified that realization of this vision requires political support, garnered through education of politicians and communities. It requires a model of governance based on collaboration, where First Nations and all levels of government work together to use their legislative powers to enact strong policies to restore and protect salmon habitat, starting with the Wild Salmon Policy. It requires stable and sufficient funding for restoration, research, and long-term monitoring, including that which enables the role of local First Nation communities. Economic opportunities that enhance and benefit ecosystem sustainability are pursued. Ultimately, this Vision will see a shift in paradigms, to one where protected salmon habitat benefits communities, governments, and First Nations who work together to ensure salmon populations persist for future generations. The vision requires political champions who work with First Nations, communities, and governments to make conservation and sustainability a top priority.

Existing initiatives

In addition to the workshops, our one-one meetings identified a range of habitat protection and restoration initiatives already active and imagined throughout the region. Many of these initiatives represent immediate opportunities for the protection and restoration of wild salmon habitat in the Lower Fraser. Some are now advancing ideas that were identified in the visioning workshops.

FIRST NATIONS

The Tsleil-Waututh Nation, already experiencing restrictions on access to traditional foods due to contamination and other risks, including the Trans Mountain pipeline expansion, are demonstrating leadership in improving regional ecosystem health. The Nation's Burrard Inlet Action Plan has a broad goal of improving the environmental health and integrity of Burrard Inlet by 2025, with six priority actions that include updating water quality objectives, installation of water quality monitors, reducing stormwater runoff, mapping nearshore habitat and forage fish spawning beaches, conserving nearshore habitat, and recovery of shellfish beds.

LOWER FRASER FISHERIES ALLIANCE LFFA

The Lower Fraser Fisheries Alliance (LFFA) wants to improve the quality and integrity of fish habitat in the Lower Fraser River and work with Lower Fraser First Nations to ensure this happens. In 2016, the LFFA received funding from DFO's Fish Habitat Restoration Initiative (FHRI) to support 30 First Nations communities (from the estuary to Yale) to initiate and conduct fish habitat restoration projects within their territories. Their goal is to protect and re-establish fish populations to a level where First Nations can continue or reinstate fishing, particularly in terminal areas. They are also leading a First Nations Fish Habitat Strategy for the Lower Fraser River.

FIRST NATIONS FISHERIES LEGACY FUND

Established in the Spring of 2013 with support from the BC Ministry of Transportation and Infrastructure's Gateway program, the fund aims to help six First Nations collaborate to address impacts to fish and fish habitat from increased industrialization and urbanization in the Lower Fraser and Burrard Inlet. The $2 million contribution is co-managed by Katzie, Kwantlen, Kwikwetlem, Musqueam, Tsawwassen, and Tsleil-Waututh First Nations.

CONNECTED WATERS

A campaign of Watershed Watch Salmon Society, *Connected Waters*, aims to restore salmon habitat by upgrading to fish-friendly flood infrastructure to improve the movement of water and fish, and with restoration works like riparian plantings and removing invasive species. In 2018, the Union of BC Municipalities passed a resolution to consider fish and fish habitats in their oversight of flood infrastructure and to provide funding for installing fish-friendly flood control infrastructure. In July 2019, Watershed Watch received support under the British Columbia Salmon Innovation and Restoration Fund to further progress of this initiative.

PACIFIC SALMON FOUNDATION

In 2016, the PSF launched the Pacific Salmon Explorer, an online data visualization tool that presents information on a suite of salmon indicators including estimates of spawner abundance, harvest, productivity, trends in abundance, as well as assessments of biological status and habitat status. In 2020, the Pacific Salmon Explorer will have information online for all 450+ CUs in British Columbia, including the Fraser Watershed.

RAINCOAST CONSERVATION FOUNDATION

Raincoast will continue to research salmon and conduct habitat restoration in the Fraser River estuary. Our ongoing, multi-year research is characterizing the use of estuary habitats by different species of juvenile salmon. This work helps us understand the impact that jetties and causeways have on juvenile salmon movement and informs our restoration efforts. We have also begun improving the connectivity of rearing habitats in the Fraser River estuary by leading a $2.7 million habitat restoration project to put openings into the Steveston Jetty barrier that have previously prevented the movement of juvenile salmon.

RAINCOAST'S OTHER EFFORTS

Watershed Watch, Raincoast and UBC have begun assessing, prioritizing, researching and developing a plan for the removal of barriers to fish passage based on the cost and expected benefit to salmon recovery.[1] We are also collaborating with partners that include the Lower Fraser Fisheries Alliance, Fisheries and Oceans Canada, the Pacific Salmon Foundation, and others to support the prioritization of recovery actions for all salmon in the Lower Fraser River.

Led by Dr. Tara Martin at UBC, a Priority Threat Management project will identify and prioritize salmon management strategies that seek to recover salmon populations. This research will help determine the cost to recovering all salmon Conservation Units within the region (including the Lower Fraser), what management strategies are likely to recover the most Conservation Units per dollar invested; how many Conservation Units can be recovered for a given budget and which Conservation Units are unlikely to be recovered regardless of investment.[2]

THE HEART OF THE FRASER

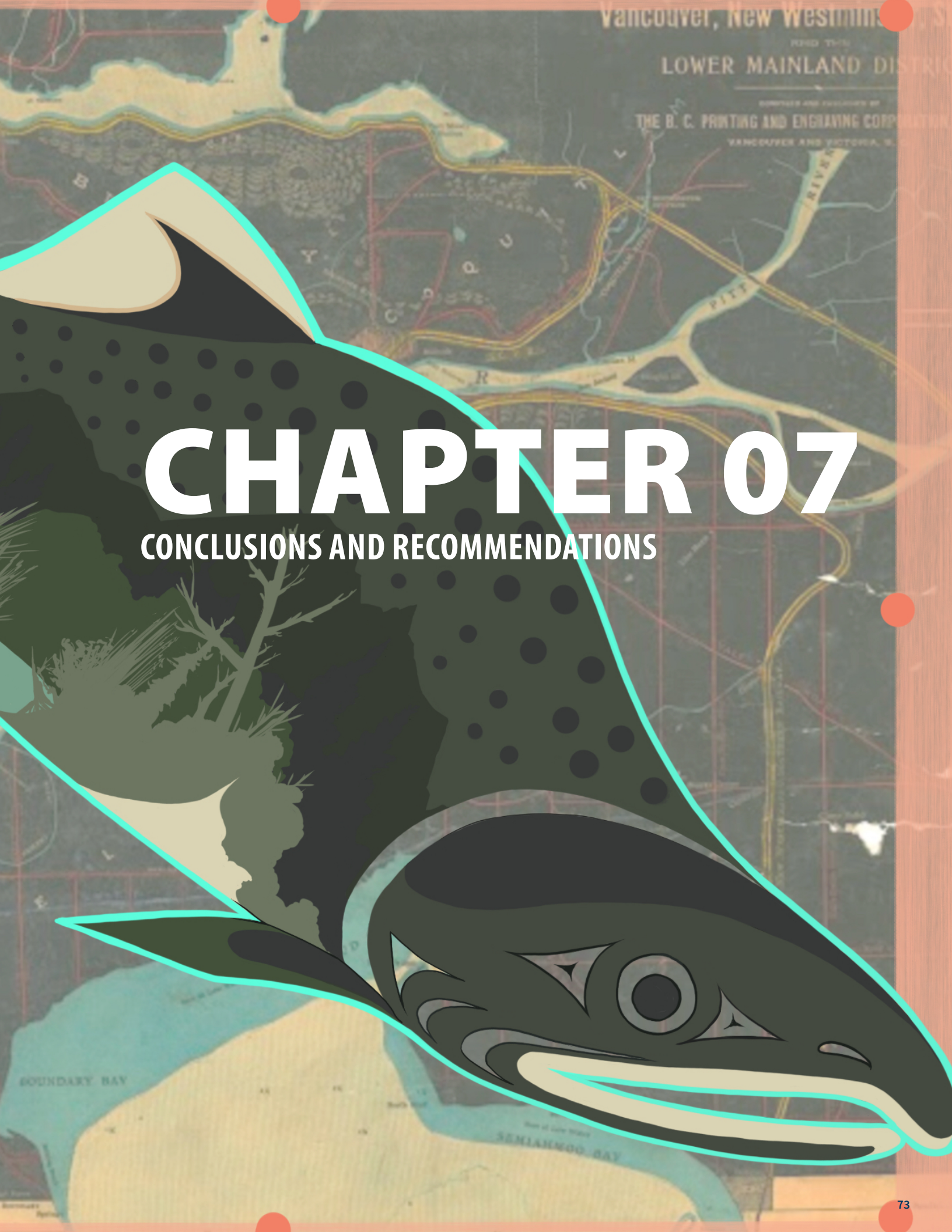
Long recognized as a critical ecological component of the Lower Fraser, the Heart of the Fraser is the gravel reach that runs between Mission and Hope. It is the prime spawning habitat for salmon and white sturgeon and serves as an annual nursery for millions of juvenile salmon. Conservationists have long advocated for the area's protection. A coalition of environmental groups are working to protect two large islands, Herrling and Carey that are threatened with development.

THE FRASER WATERSHED INITIATIVE

The Fraser Watershed Initiative (FWI) is a multi-year campaign focused on the Fraser River Watershed. The FWI is working with First Nations, NGOs, and local governments across BC to 'Heal and Protect' the mighty Fraser River Basin. The FWI offers a path forward to address identified threats. By bringing together Indigenous & Non-Indigenous decision-makers, local community, conservation, and philanthropic leaders in a dialogue around watershed restoration, collaborative government-to-government land use planning, and conservation of critical habitats and cultural treasures. The objective of the FWI is to transition the Fraser Watershed to a more culturally and economically prosperous and ecologically intact future. In support of this initiative, efforts are underway to assemble a $500 million dollar trust fund to support a decade long, watershed-wide habitat restoration effort within the Fraser Watershed.

1 Obstructions to fish passage disconnect more than 70% of previously accessible rearing habitat.

2 This project builds on a previous collaboration led by Dr Martin and her team to identify the most cost-effective management strategies to recover 102 at-risk species within the Fraser River Estuary (Kehoe et al. in review).



CHAPTER 07

CONCLUSIONS AND RECOMMENDATIONS

Chapter 7: Conclusions and recommendations

Salmon habitats in the Lower Fraser are highly degraded and contribute to the decline in salmon health. We provide recommendations to help address this decline. Raincoast's frame of reference takes into account the initiatives of various other organizations and the findings of this report. These findings include a summary of how a range of organizations and individuals have envisioned a future for the Lower Fraser River. Our recommendations are paired with tangible next steps that can begin to address the threats facing salmon and their habitat in the Lower Fraser River. Our intention is that these recommendations and next steps can put salmon, and their habitat, on a trajectory that enables their ecological resilience.

We will be distributing this report to everyone who participated in the process, to regional First Nations, federal, provincial, and municipal governments with responsibilities for, and interests in, wild salmon in the Lower Fraser River. To move toward a shared vision of salmon in the Lower Fraser River we recommend the following:

1. Collaborative efforts on habitat conservation and restoration

Hundreds of individuals, dozens of First Nations, NGOs, community groups, government agencies, businesses, and others have taken steps to protect and restore the Lower Fraser since its conversion from functioning habitats began 150 years ago. The need for strategic coordination and collaboration that reverses the trajectory of salmon and their habitat has never been more acute, and Raincoast is committed to playing a role in supporting this effort.

Since 2017, Raincoast has been working with the Lower Fraser Fisheries Alliance (LFFA), West Coast Environmental Law (WCEL), and the University of British Columbia (UBC) to explore pathways towards ecosystem-based management that ensures the resilience of species and people reliant on the Lower Fraser River. This dialogue has been guided by the LFFA Strategic Plan and a 'Blueprint for Ecological Resilience'.

We see an opportunity for those with an interest in salmon and ecological resilience to support First Nations, and call on federal, provincial, and municipal governments for conservation and restoration decision making in the Lower Fraser.

Recommendation

We recommend that the Blueprint principles guide prioritization of conservation, restoration, and watershed planning efforts, including a First Nations and LFFA-led Lower Fraser Fish Habitat Strategy.

Our next steps

To support the development and successful implementation of a Lower Fraser Fish Habitat Strategy, led by Lower Fraser First Nations, LFFA, and their respective governments.

Five key principles of a Blueprint for Ecological Resilience

01. A commitment to sustainability that spans seven generations.
02. Governance that honours Aboriginal rights and title and the principles of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).
03. Clear regulatory and enforcement mechanisms to ensure ecological resilience.
04. Sustainable funding for governance and ecosystem-based management.
05. Respect for the opinion, voices, experiences, and culture of others.

2. Implement fish first policy

First Nations, federal, provincial, and municipal governments play a key role in land use planning and local decision making that influences freshwater habitats and processes vital to wild salmon. We have identified the need to prioritize restoration, reconnection, and protection of salmon habitat in land use planning and processes like the Lower Mainland Flood Management Strategy.

Recommendation

We recommend that those determining land use and water policies should prioritize the broader benefits and ecosystem services supported by fishfirst policies. Fish first policies would prioritize the interests of wild salmon and their habitat above other economic pursuits in decision-making processes. These policies are our best chance to ensure that wild salmon persist over their historic range at spawner abundance levels suitable to meet the needs of wildlife, ecosystems, and people.

Our next steps

In 2020, we will continue to actively engage local governments in the Lower Fraser to advance the adoption of fish first policy in key areas including flood infrastructure, stormwater management, climate adaptation, and land use planning.

3. A legislated Fraser watershed plan

The United Nations Declaration on the Rights of Indigenous People (UNDRIP) affirms the right of Indigenous people to self-determination. In 2016, the Canadian government officially adopted UNDRIP and in 2019 the province of British Columbia initiated a process to enact UNDRIP within provincial law.

The federal government holds responsibility for salmon management, species at risk, and biodiversity. The province can delegate responsibilities for freshwater, land use, and wildlife management. The province holds powers under the Water Sustainability Act for watershed planning and creation of watershed plans. Local governments manage the development of growth, urban infrastructure and development, stormwater treatment, and flood infrastructure at local and regional scales.

Recommendation

We recommend that all levels of government cooperate across jurisdictions to develop a watershed plan for the entire Fraser River. Such a plan could deliver aspirations identified in this report and address issues relating to water quality, water quantity, and ecosystem health, which are all critical to wild salmon.

Our next steps

Building support for Indigenous-led planning and decision-making process across the entire Fraser watershed.

4. Sustainable funding

Tackling the crisis faced by wild salmon in the Lower Fraser requires significantly increased and long-term financial resources. We encourage funding sources, including all levels of government, industry, and the philanthropic sector, to consider the key themes identified in the visioning process.

Working with the LFFA, WCEL, and UBC, Raincoast has begun to assess a range of funding and finance mechanisms that could support long-term conservation and restoration priorities identified in a First Nations and LFFA led Lower Fraser Fish Habitat Strategy.

Recommendation

We recommend that funding agencies support the implementation of the Lower Fraser Fish Habitat Strategy.

Our next steps

In 2020, we will publish a report outlining options that could support long-term funding and finance for a Lower Fraser Fish Habitat Strategy and watershed scale planning.

5. Rebuilding monitoring and research capacity

Given the resurgence of Indigenous guardianship, and recognized gaps in the monitoring of salmon populations and their habitats, we recommend that increased resources for environmental monitoring capacity be made available to First Nations to conduct this work in their territories. This effort should determine changes from historic baselines to inform effective management decisions. This approach should be informed and guided by the best available science and indigenous knowledge.

Recommendation

We recommend that research and scientific organizations collaborate further to ensure research in the Lower Fraser River is available to, and informed by, the interests and priorities of local Nations.

Our next steps

In 2020, we will support efforts to convene scientists, Indigenous knowledge holders, streamkeepers and Indigenous guardians to discuss best practices and further develop links between scientists and Indigenous guardians active in the Lower Fraser River.

6. Investment in wild salmon education and youth engagement

Numerous projects and programs have successfully delivered educational outreach that provides children and youth with knowledge of salmon and exposure to their habitats. However, the public remains largely unaware of the magnitude of the threats facing wild salmon and their habitats in the Lower Fraser, and the actions they can take to address these issues.

Recommendation

We recommend that funding agencies and educators expand support for learning that focuses on wild salmon and their ecological roles. Such programs should incorporate Indigenous knowledge and expertise, as well as the latest thinking around experiential, nature-based and place-based learning.

Our next steps

In 2020, we will convene educators, funders, Indigenous knowledge holders and others to discuss experiential and nature-based programs in support of education around wild salmon.

Our thanks

We offer our thanks to the previous generations who have worked to protect and restore Stó:lō, the Fraser River. We thank everyone who has contributed to the efforts reflected in this document and the larger body of knowledge that this report reflects.

We also thank our funders, the Vancouver Foundation, Bullitt Foundation, Real Estate Foundation, Sitka Foundation, Patagonia, and numerous private donors who have made this work possible.

References

Attard, M. E., Venditti, J. G., and Church, M. 2014. Suspended sediment transport in Fraser River at Mission, British Columbia: New observations and comparison to historical records. Canadian Water Resources Journal 39(3): 356-371.

Archipelago. 2014. Technical Data Report, Roberts Bank Terminal 2 Project, Marine Fish, Juvenile Salmon Surveys. Technical Data Report, Prepared by Archipelago Marine Research Ltd., Prepared for Hemmera Envirochem Inc., Victoria, BC

Arkoosh, M. R. and Collier, T. K. 2002. Ecological risk assessment paradigm for salmon: analyzing immune function to evaluate risk. Human and Ecological Risk Assessment 8(2): 265-276.

Artelle, K.A., Zurba, M., Bhattacharyya, J., Chan, D.E., Brown, K., Housty, J., Moola, F. 2019. Supporting resurgent Indigenous-led governance: A nascent mechanism for just and effective conservation. Biological Conservation.240: 108284.

Auditor General of Canada 2009. Report of the Commissioner of the Environment and Sustainable Development. Office of the Auditor General of Canada Spring 2009. Ottawa, Ontario.

Bailey, M. and Sumaila, U. R. 2012. Freshwater angling and the BC economy. Report prepared for the Freshwater Fisheries Society of BC 54 pp.

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., and Silliman, B. R. 2011. The value of estuarine and coastal ecosystem services. Ecological monographs, 81(2): 169-193.

Barling, R. D., & Moore, I. D. 1994. Role of buffer strips in management of waterway pollution: a review. Environmental Management 18(4): 543-558.

Bennett, M.G., 1973. "Indian Fishing and its cultural importance in the Fraser River System." Fisheries Service, Pacific Region, Department of the Environment and Union of British Columbia Indian Chiefs. Brookhouse Consultants Inc, 2000.

Bennett, M. 2006. Managing Himalayan blackberry in western Oregon riparian areas. Corvallis, Or.: Extension Service, Oregon State University.

Berka, C., Schreier, H., and Hall, K. 2001. Linking water quality with agricultural intensification in a rural watershed. Water, Air, and Soil Pollution, 127(1-4): 389-401.

Biermann, F., Abbott, K., Andersen, S., Backstrand, K., Bernstein, S., Betsill, M.M., Bulkeley, H., Cashore, B., Clapp, J., Folke, C., Gupta, J., Haas, P.M., Jordan, A., Kanie, N., Kluvankova-Oravska, T., Lebel, L., Liverman, D., Meadowcroft, J., Mitchell, R.B., Newell, P., Oberthur, S., Olsson, L., Pattberg, P., Sanchez-Rodriguez, R., Schroeder, H., Underdal, A., Camargo Vieira, S., Vogel, C., Young, O.R., Brock, A., and Zondervan, R. 2012. Navigating the Anthropocene: Improving Earth System Governance. Science 335(6074): 1306-1307.

Boesch, D. F. and R. E. Turner. 1984. Dependence of fishery species on salt marshes: The role of food and refuge. Estuaries 7:460–468.

Boyle, C. A., Lavkulich, L., Schreier, H., and Kiss, E. 1997. Changes in land cover and subsequent effects on Lower Fraser Basin ecosystems from 1827 to 1990. Environmental Management 21(2): 185-196.

Brandes, M., and O'Riordan, J. 2014 A Blueprint for Watershed Governance in British Columbia. POLIS Project on Ecological Governance, University of Victoria. Victoria, BC. Available from https://poliswaterproject.org/polis-research-publication/blueprint-watershed-governance-british-columbia/

Brauman, K. A., Daily, G. C., Duarte, T. K. E., and Mooney, H. A. 2007. The nature and value of ecosystem services: an overview highlighting hydrologic services. Annu. Rev. Environ. Resour., 32: 67-98.

Butler, R.W. and Campbell, R.W. 1987. The birds of the Fraser River delta: populations, ecology and international significance. Canadian Wildlife Service Occasional Paper No. 65. Delta, British Columbia. 73p.

Cameron, L. 1997. Openings: a meditation on history, method, and Sumas Lake. McGill-Queen's Press-MQUP.

Carlson, K.T. 2001a. Expressions of collective identity. In K. T. Carlson (Ed.), A Stó:lō-Coast Salish historical atlas. Vancouver and Chilliwack: Douglas and McIntyre and the Stó:lō Nation.

Carlson, K.T. 2001b. Stó:lō Migrations and Shifting Identity, 1782-1900. In K. T. Carlson (Ed.), A Stó:lō-Coast Salish historical atlas. Vancouver and Chilliwack: Douglas and McIntyre and the Stó:lō Nation.

Carlson 2001c. History Wars: Considering contemporary fishing disputes. In K. T. Carlson (Ed.), A Stó:lō-Coast Salish historical atlas. Vancouver and Chilliwack: Douglas and McIntyre and the Stó:lō Nation.

Cederholm, C. J., Kunze, M. D, Murota, T., Sibatani, A. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries. 24(10):6-15.

Clague, J. J. and James, T. S. 2002. History and isostatic effects of the last ice sheet in southern British Columbia. Quaternary Science Reviews, 21(1):71-87.

Clogg, J., Smith, G., and Carlson, D. 2017. Paddling Together: Co-Governance Models for Regional Cumulative Effects Management. West Coast Environmental Law. Vancouver, BC. Available from https://www.wcel.org/sites/default/files/publications/2017-06-wcel-paddlingtogether-report.pdf.

Cohen, B. (Commissioner) and Carey, J., Paradis, S., Walls, L., Crowe, M., Salomi, C., Wilkerson, S. (Witnesses). 2011. Effects on the Fraser River Watershed – Urbanization (Interview Transcript). Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River, June 7, 2011. Retrieved from: http://www.watershed-watch.org/resources/cohencommission-hearing-transcripts-june-7-2011/.

Cohen, B. (Commissioner). 2012. The uncertain future of Fraser River sockeye, Vol 2: Causes of the decline, Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River, October 2012.

COSEWIC. 2011. COSEWIC assessment and status report on the Eulachon, Nass / Skeena Rivers population, Central Pacific Coast population, and the Fraser River population (*Thaleichthys pacificus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xv + 88 pp.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., ... and Turner, R. K. 2014. Changes in the global value of ecosystem services. Global Environmental Change, 26: 152-158.

Costanza, R., R. d'Arge, R.S. de Groot, S. Farber, M. Grasso, B. Hannon, ... and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature. 387: 253–260.

Daily, G.C., T. Söderqvist, S. Aniyar, K. Arrow, P. Dasgupta, P.R. Ehrlich, ... and B. Walker. 2000. The value of nature and the nature of value. Science 289: 395-396.

Daily, G.C. editor. 1997. Nature's services: societal dependence on natural ecosystems. Island Press, Washington, DC.

Delcan. 2012. Cost of adaptation - sea dikes & alternative strategies. Report to British Columbia Ministry of Forests, Lands and Natural Resource Operations. ii +23pp + Appendices A-D.

Department of Fisheries and Oceans. 1995. Fraser River chinook salmon Prep. By Fraser River Action Plan, Fishery Management Group. Vancouver, BC. 24 p.

Department of Fisheries and Oceans. 1996. Fraser River coho salmon Prep. By Fraser River Action Plan, Fishery Management Group. Vancouver, BC. 20 p.

DFO. 2005. Canada's policy for conservation of wild Pacific salmon. Fisheries and Oceans Canada, 401 Burrard Street, Vancouver, BC V6C 3S4. 49 p.

Department of Fisheries and Oceans. 2014. New Salmon Escapement Data Base (NuSEDS).

Dynesius, M., & Nilsson, C. 1994. Fragmentation and flow regulation of river systems in the northern third of the world. Science. 266(5186): 753-753.

Elliott, M. and Taylor, C. J. L. 1989. The production ecology of the subtidal benthos of the Forth Estuary, Scotland. Scientia Marina 53(2-3): 531-541.

Evenden, M. 2000. Remaking Hells Gate: Salmon, Science, and the Fraser River, 1938-1948. BC Studies: The British Columbian Quarterly (127): 47-82.

Favaro, B., J. D. Reynolds, and I. M. Côté. 2012. Canada's weakening aquatic protection. Science 337:154.

Findlay, C. S., Elgie, S., Giles, B., and Burr, L. 2009. Species listing under Canada's species at risk act. Conservation Biology, 23(6): 1609-1617.

Fraser Basin Council. 2010a. Environmental Protection in Flood Hazard Management: A Guide for Practitioners. The Fraser Basin Council. Vancouver, BC.

Fraser Basin Council. 2010b. The Fraser: a Canadian heritage river. Prepared by The Fraser Basin Council with the British Columbia Ministry of Environment, Victoria, British Columbia, Canada. 84 pp.

Fraser Basin Council 2013. Bridge between nations: A History of First Nations in the Fraser River Basin. The Fraser Basin Council. Vancouver, BC.

FRAP (Fraser River Action Plan) 1999. Lower Fraser Valley streams strategic review. Lower Fraser Valley Stream Review 1. Habitat Enhancement Branch, Fisheries and Oceans Canada, Ottawa, ON.

Fraser River Estuary Management Program (FREMP). 2006. A Living, Working River Monitoring Report Update. Available from http://www.dfo-mpo.gc.ca/library/349044.pdf.

Gallaugher, P., and Wood, L. 2010. Proceedings: Summit on Fraser River sockeye salmon: understanding stock declines and prospects for the future. March 30-31, 2010. Simon Fraser University, Continuing Studies in Science and Centre for Coastal Studies. 212 pp.

Gatto, M., and G. De Leo. 2000. Pricing biodiversity and ecosystem services: the never-ending story. Bioscience 50:347-355.

Gende, S. M. and Willson, M. F. 2001. Passerine densities in riparian forests of southeast Alaska: potential effects of anadromous spawning salmon. The Condor, 103(3): 624-629.

Godbout, L., Wood, C. C., Withler, R. E., Latham, S., Nelson, R. J., Wetzel, L., ... and McKeegan, K. D. 2011. Sockeye salmon (Oncorhynchus nerka) return after an absence of nearly 90 years: a case of reversion to anadromy. Canadian Journal of Fisheries and Aquatic Sciences, 68(9): 1590-1602.

Government of Canada, Office of the Prime Minister, Canada's Oceans Protection Plan. Available online: https://www.tc.gc.ca/media/documents/communications-eng/oceans-protection-plan.pdf. Accessed February 15, 2019.

Government of Canada / Parks Canada website, Available at: https://www.canada.ca/en/parks-canada/news/2016/12/2020-biodiversity-goals-targets-canada.html. Accessed February 10 2019.

Grant, S. and G. Pestal. 2009a. Certification Unit Profile: Fraser River Chum Salmon. Can. Man. Rep. Fish. Aquat. Sci. 2874: vii + 40p.

Green, O.O., Germestani, A.S., Albro, S., Ban, N.C., Berland, A., and Burkman, C.E. 2016. Adaptive governance to promote ecosystem services in urban green spaces. Urban Ecosystems 19(1): 77-93.

Grolleau, G., and McCann, L. M. 2012. Designing watershed programs to pay farmers for water quality services: Case studies of Munich and New York City. Ecological Economics 76: 87-94.

Groulx B. J., Mosher, D. C., Luternauer J. L., and Bilderback, D. E. 2004. Fraser river delta, British Columbia: Issues of an urban estuary. Geological Survey of Canada Bulletin 567.

Groot, C. and Margolis, L. 1991. Pacific Salmon Life Histories. UBC Press 564 pp.

Grout, J.A., Levings, C.D., and Richardson, J.S. 1997. Decomposition rates of purple loosestrife (Lythrum salicaria) and Lyngbyei's sedge (Carex lyngbyei) in the Fraser River estuary. Estuaries 20(1): 96-102.

GSGislason and Associates Ltd. 2009. Freshwater sport fishing in British Columbia: Sending ripples through the provincial economy. Prepared for Freshwater Fisheries Society of BC. 71 pp.

Hardwick, W. G. 1958. The effect of the proposed Moran Dam on agriculture within the middle Fraser region, British Columbia. Doctoral dissertation, University of British Columbia.

Harrison PJ, Yin K, Ross L., Arvai J, Gordon K, Bendell-Young L, Thomas C, Elner R, Sewell M, and Shepherd P. 1999. The delta foreshore ecosystem: past and present status of geochemistry, benthic community production and shorebird utilization after sewage diversion. Chapter 3.10 in Health of the Fraser River Aquatic Ecosystem, Volume 1: A Synthesis of Research Conducted Under the Fraser River Action Plan. Gray, C. and Tuominen, T, eds. DOE-FRAP 1998. Environment Canada, Vancouver, BC.

Healey, M. C. and Richardson, J. S. 1996. Changes in the productivity base and fish populations of the lower Fraser River (Canada) associated with historical changes in human occupation. Large Rivers 10(1-4): 279-290.

Helfield, J. M. and Naiman, R. J. 2001. Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity. Ecology, 82(9): 2403-2409.

Hewes, G. 1973. "Indian Fisheries Productivity in Pre-Contact Times in the Pacific Salmon Area". Northwest Anthropological Research Notes 7(2): 133–154.

Hill C.J., Schuster, R., and Bennett, J.R. 2019 Indigenous involvement in the Canadian species at risk recovery process. Environmental Science and Policy 94: 220-226.

Hinch, S. G., and Bratty, J. 2000. Effects of swim speed and activity pattern on success of adult sockeye salmon migration through an area of difficult passage. Transactions of the American Fisheries Society, 129(2): 598-606.

Hirst, S.M. 1991. Impacts of the operation of existing hydroelectric developments on fishery resources in British Columbia. Inland fisheries news. Volume 1. Can. Manuscr. Rep. Fish. Aquat. Sci. 2093.

Hobbs, W. O. and Wolfe, A. P. 2008. Recent paleolimnology of three lakes in the Fraser River Basin (BC, Canada): no response to the collapse of sockeye salmon stocks following the Hells Gate landslides. Journal of Paleolimnology, 40(1): 295-308.

Holtby, L.B. and Ciruna, K.A. 2007. Conservation units for Pacific Salmon under the Wild Salmon Policy. Can. Sci. Advis. Sec. Res. Doc. 2007/070. viii + 350 pp. http://www.dfompo.gc.ca/csas-sccs/publications/resdocs-docrech/2007/2007_070eng.htm

Hoos, L.M. and Packman, G.A. 1974. The Fraser River estuary: status of environmental knowledge to 1974. Special Estuary Series No. 1. Estuary Working Group, Environment Canada, Vancouver: 518 p.

International Union for the Conservation of Nature (IUCN). 2005. The Durban Accord, Available online:https://cmsdata.iucn.org/downloads/durbanaccorden.pdf . Accessed, February 20, 2019.

Jacobson, K. C., Arkoosh, M. R., Kagley, A. N., Clemons, E.R., Collier TK, and Casillas E. 2003. Cumulative effects of natural and anthropogenic stress on immune function and disease resistance in juvenile chinook salmon Oncorhynchus tshawytscha. Journal of Aquatic Animal Health 15:1-12.

Jartun, M., Ottesen, R. T., Steinnes, E., and Volden, T. 2008. Runoff of particle bound pollutants from urban impervious surfaces studied by analysis of sediments from stormwater traps. Science of the Total Environment, 396(2): 147-163.

Johannessen, D.I., and Ross, P.S. 2002. Late-run sockeye at risk: An overview of environmental contaminants in Fraser River salmon habitat. Canadian Technical Report of Fisheries and Aquatic Sciences 2429. x + 108 p.

Johannes, M.R.S., Nikl, L. H., Hoogendoorn, R. J. R., and Scott, R. E. 2011. Fraser River sockeye habitat use in the Lower Fraser and Strait of Georgia. Golder Associates Ltd. Cohen Commission Technical Report 12: 114 p & 35 maps. Vancouver, BC.

Johnston, A. 2016 Federal Environmental Assessment Reform Summit Executive Summary. West Coast Environmental Law. Vancouver, BC. Available from https://www.wcel.org/sites/default/files/publications/ WCEL_FedEnviroAssess_ExecSum%2Bapp_fnldigital.pdf.

Johnson, R., and Bustin, R. M. 2006. Coal dust dispersal around a marine coal terminal (1977–1999), British Columbia: The fate of coal dust in the marine environment. International Journal of Coal Geology, 68(1): 57-69.

Junk, W. J., Bayley, P. B., and Sparks, R. E. 1989. The flood pulse concept in river-floodplain systems, In Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106. p. I10-I27.

Levings, C. D., Boyle, D. E., and Whitehouse, T. R. 1995. Distribution and feeding of juvenile Pacific salmon in freshwater tidal creeks of the lower Fraser River, British Columbia. Fisheries Management and Ecology 2(4): 299-308.

Levings, C.D. 2004. Knowledge of fish ecology and its application to habitat management. In: Fraser River Delta, British Columbia: Issues of an Urban Estuary, (ed.) B.J. Groulx, D. C. Mosher, J.L. Luternauer, and D.E. Bilderback. Geological Survey of Canada, Bulletin 567, p. 213-236.

Levy, D. A. and Northcote, T. G. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. Canadian Journal of Fisheries and Aquatic Sciences 39(2): 270-276.

Lichatowich, J. and Williams, R. N. 2015. Faith in Nature: The missing element in salmon management and mitigation programs. The Osprey. 81: 1-8.

Lievesley, M., Stewart, D., Knight, R., and Mason, B. 2016. Assessing habitat compensation and examining limitations to native plant establishment in the Lower Fraser River Estuary. BC Conservation Foundation and Community Mapping Network. Available from https://www.cmnbc.ca/wp-content/uploads/2018/11/Assessing-Habitat-Compensation_2016Appendix-I-IV.pdf.

Ludwig, D. 2000. Limitations of economic valuation of ecosystems. Ecosystems 3:31-35.

MacDonald, D., Sinclair, J., Crawford, M., Prencipe, H., and Meneghetti, M. 2011. Potential effects of contaminants on Fraser River sockeye salmon. MacDonald Environmental Sciences Ltd. Cohen Commission Tech. Rep. 2: 164 p + appendices. Vancouver, BC.

Martins, E. G., Hinch, S. G., Patterson, D. A., Hague, M. J., Cooke, S. J., Miller, K. M., ... and Farrell, A. P. 2011. Effects of river temperature and climate warming on stock-specific survival of adult migrating Fraser River sockeye salmon (Oncorhynchus nerka). Global Change Biology, 17(1): 99-114.

McGreer, E. R. and Belzer, W. 1999. Contaminant sources. Chapter 2.0 in Health of the Fraser River Aquatic Ecosystem, Volume 1: A Synthesis of Research Conducted Under the Fraser River Action Plan. Gray, C. and Tuominen, T, eds. DOEFRAP 1998. Environment Canada, Vancouver, BC.

McLean, D. G., Church, M., & Tassone, B. 1999. Sediment transport along lower Fraser River: 1. Measurements and hydraulic computations. Water Resources Research 35(8): 2533-2548.

McPhail, J. D. 2007. Freshwater Fishes of British Columbia (The) (Vol. 6). University of Alberta.

Metro Vancouver 2013. Wastewater: The Greater Vancouver Sewerage & Drainage District Environmental Management and Quality Control Annual Report. ISSN 1496-9602

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: Synthesis. Island Press, Washington. 155pp.

Milliman, J. D. 1980. Sedimentation in the Fraser River and its estuary, southwestern British Columbia (Canada). Estuarine and Coastal Marine Science 10(6): 609-633.

Molnar, M., Kocian, M. and D. Batker. 2012. Valuing the Aquatic Benefits of British Columbia's Lower Mainland: Nearshore Natural Capital Valuation. Prepared for: David Suzuki Foundation and Earth Economics. Available at http://www.davidsuzuki.org/publications/downloads/2012/DSF_aquatic_lower%20mainland_med_res_for_website.pdf.

Mooers, A. Ø., Prugh, L. R., Festa-Bianchet, M., and Hutchings, J. A. 2007. Biases in legal listing under Canadian endangered species legislation. Conservation Biology, 21(3): 572-575.

Moore, J. W., Beakes, M. P., Nesbitt, H. K., Yeakel, J. D., Patterson, D. A., Thompson, L. A., ... and Atlas, W. I. 2015. Emergent stability in a large, free-flowing watershed. Ecology, 96(2): 340-347.

Morrison, J., Quick, M. C., and Foreman, M. G. 2002. Climate change in the Fraser River watershed: flow and temperature projections. Journal of Hydrology, 263(1): 230-244.

Moscrip, A. L., and Montgomery, D. R. 1997. Urbanization, flood frequency, and salmon abundance in Puget lowland streams. Journal of the American Water Resources Association. 33(6): 1289-1297.

Murray, G. and King, L. 2012. First Nations Values in Protected Area Governance: Tla-o-qui-aht Tribal Parks and Pacific Rim National Park Reserve. Human Ecology. 40(3). 385-395.

Murray, C. B., and Rosenau, M. L. 1989. Rearing of juvenile Chinook salmon in nonnatal tributaries of the lower Fraser River, British Columbia. Transactions of the American Fisheries Society 118(3): 284-289.

Murton, J. 2008. Creating Order: The Liberals, the Landowners, and the Draining of Sumas Lake, British Columbia. Environmental History, 13(1): 92-125.

NASEM (National Academies of Sciences, Engineering, and Medicine) 2016. Spills of Diluted Bitumen from Pipelines: A Comparative Study of Environmental Fate, Effects, and Response. Washington, DC: The National Academies Press.

Nener, J. C. and Wernick, B. G. 1997. Fraser River Basin Strategic Water Quality Plan: Lower Fraser River. Department of Fisheries and Oceans, Vancouver, BC.

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

NHC (Northwest Hydraulic Consultants). 2008. Comprehensive review of Fraser River at Hope: Flood hydrology and flows–scoping study. British Columbia Ministry of Environment, Victoria, British Columbia, Canada.

NOAA (National Oceanic and Atmospheric Administration). 2009. Identification and description of Essential Fish Habitat, adverse impacts and recommended conservation measures for salmon. Appendix A: Amendment 14 to the Pacific coast salmon plan. Pacific Fishery Management Council, Portland, OR.

Norecol, Dames and Moore, Inc. 1996. Non-point source pollution: problem definition. Prepared for Ministry of Environment, Lands and Parks, Water Quality Branch. Job No. 26699-022. xvi + 148 p. Vancouver, BC.

Northcote, T. G. and Atagi, D. Y. 1997. Pacific salmon abundance trends in the Fraser River watershed compared with other British Columbia systems. In Pacific Salmon & their Ecosystems (pp. 199-219). Springer US.

Otte, G. and Levings, C. D. 1975. Distribution of macro invertebrate community on a mudflat influenced by sewage, Fraser River Estuary. Fisheries and Marine Service Technical Report 476, Environment Canada, West Vancouver, British Columbia.

Parks Canada. We rise together: achieving pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas in the spirit and practice of reconciliation. 2018. Gatineau, QC. Available from http://publications.gc.ca/collections/collection_2018/pc/R62-548-2018-eng.pdf. Accessed February 14 2019.

Paul, M. J., and Meyer, J. L. 2008. Streams in the urban landscape. In Urban ecology (pp. 207-231). Springer US.

PIBC (Precision Identification Biological Consultants). 1997. Lower Fraser Valley Stream Review (Vol. 3): Wild, Threatened, Endangered and Lost Streams of the Lower Fraser Valley. Prepared for Fraser River Action Plan. Available from http://www.dfo-mpo.gc.ca/library/229864.pdf.

Price, M.H.H., English, K.K., Rosenberger, A.G., Macduffee, M., and Reynolds, J.D. 2017. Canada's Wild Salmon Policy: an assessment of conservation progress in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 74: 1507-1518.

Prommer, M. 2012. Benefits and minimising risks of the 'no net loss initiative. CEEweb for Biodiversity. Budapest, Hungary. Available from http://www.ceeweb.org/wp-content/uploads/2012/02/NNL_study2.pdf.

Province of British Columbia, 2019. BC Wild Salmon Advisory Council Recommendations for a Made-in-BC Wild Salmon Strategy. Available online: https://engage.gov.bc.ca/app/uploads/sites/426/2019/03/Wild-Salmon-Advisory-Council-Report.pdf. Accessed February 2019.

Quayle, M and Hamilton, S. 1999. Corridors of Green and Gold: Impact of Riparian Suburban Greenways on Property Values. Prepared for: Fraser River Action Plan, Department of Fisheries and Oceans, Vancouver, BC.

Real Estate Foundation of BC. 2017. Sustainable Land Use Public Opinion Highlights on Land Use, Sustainability, and Rural Planning in British Columbia. Available from https://www.refbc.com/sites/default/files/REFBC-SLU-Opinion-Highlights-2019.pdf.

Richardson, J. S., Lissimore, T. J., Healey, M. C. and Northcote, T. G. 2000. Fish communities of the lower Fraser River (Canada) and a 21-year contrast. Environmental Biology of Fishes, 59(2): 125-140.

Richmond Chamber of Commerce. 2014. The Economic Importance of the Lower Fraser River. Prepared by the Richmond Chamber of Commerce with D.E. Park and Associates. 67 pp.

Ricker, W. E. 1947. Hell's Gate and the sockeye. The Journal of Wildlife Management 11(1): 10-20.

Rosenau, M. L. and Angelo, M. 2005. Conflicts between agriculture and salmon in the eastern Fraser Valley. Pacific Fisheries Resource Conservation Council.

Roos, J. F. 1991. Restoring Fraser River salmon. Pacific Salmon Commission. Vancouver, BC.

Rowe, G. T., Clifford, C. H., Smith Jr, K. L., and Hamilton, P. L. 1975. Benthic nutrient regeneration and its coupling to primary productivity in coastal waters. *Nature*, 255(5505): 215.

Schaefer, V. 2004. Ecological setting of the Fraser River delta and its urban estuary. In: Fraser River Delta, British Columbia: Issues of an Urban Estuary, (ed.) B.J. Groulx, D.C. Mosher, J.L. Luternauer, and D.E. Bilderback. Geological Survey of Canada, Bulletin 567, p. 35-47.

Shaepe, D. M. 2001a. The land and the people: glaciation to contact. In K. T. Carlson (Ed.), A Stó:lō-Coast Salish historical atlas. Vancouver and Chilliwack: Douglas and McIntyre and the Stó:lō Nation.

Shaepe, D. M. 2001b. Village arrangements and settlement patterns. In K. T. Carlson (Ed.), A Stó:lō-Coast Salish historical atlas. Vancouver and Chilliwack: Douglas and McIntyre and the Stó:lō Nation.

Schindler, D. E., Scheuerell, M. D., Moore, J. W., Gende, S. M., Francis, T. B., Palen, W. J. 2003. Pacific salmon and the ecology of coastal ecosystems. Front Ecol Environ. 1(1):31-37.

Scott, D., Moore, J.W., Herborg, L.M., Murray, C.C., and Serrao, N.R. 2013. A non-native snakehead fish in British Columbia, Canada: capture, genetics, isotopes, and policy consequences. Management of Biological Invasions 4(4): 265-271.

Scott, D. C., Arbeider, M., Gordon, J., and Moore, J. W. 2016. Flood control structures in tidal creeks associated with reduction in nursery potential for native fishes and creation of hotspots for invasive species. Canadian Journal of Fisheries and Aquatic Sciences, 73(999): 1-11.

Slaney, T. L., Hyatt, K. D., Northcote, T. G., and Fielden, R. J. 1996. Status of anadromous salmon and trout in British Columbia and Yukon. Fisheries 21(10): 20-35.

Talbot, G. B., and R. I. Jackson. 1950. (I) A biological study of the effectiveness of the Hell's Gate fishways. II. Variations in flow patterns at Hell's Gate and their relationships to the migration of sockeye salmon. International Pacific Salmon Fisheries Commission Bulletin 3.

Taylor, E. B. 1991. A review of local adaptation in Salmonidae, with particular reference to Pacific and Atlantic salmon. Aquaculture 98(1): 185-207.

Thomson, A. R. and Associates, and Confluence Environmental Consulting. 1999. Study of flood proofing barriers in lower mainland fish bearing streams. Prepared for the Department of Fisheries and Oceans Habitat and Enhancement Branch, Pacific Region.

Thomson, A.R. 2005. Flood box management in southwestern British Columbia. Consultant's report prepared for Ministry of Water Land and Air Protection, Surrey, BC.

Van Dorp, J. R. and Merrick, J. 2014. Vessel Traffic Risk Assessment 2010, Synopsis of Scenario Comparison (Preliminary), The George Washington University, Prepared for Washington State Puget Sound Partnership.

Ward, J., Tockner, K. and Schiemer, F. 1999. Biodiversity of floodplain river ecosystems: ecotones and connectivity. River Research and Applications 15: 125 – 139.

Welch, D.W. and Noakes, D.J. 1993. Trends in catch and average size of Pacific salmon in Canada, with a report on 1992 escapement levels. NPAFC Doc. 29. 47 pp. Department of Fisheries and Oceans Biological Sciences Branch, Pacific Biological Station. Nanaimo, BC

Wilson, S.J. 2010. Natural Capital in BC's Lower Mainland: Valuing the benefits from nature. Prepared for the David Suzuki Foundation and the Pacific Parklands Foundation

WWF (World Wildlife Federation). 2015. Freshwater Watershed Report for the Fraser Mainland Watershed. WWF-Canada.

WWF (World Wildlife Federation) et. al. 2018. Submission on Bill C68: An Act to amend the Fisheries Act and other Acts in consequence, Submitted to the Standing Committee on Fisheries and Oceans May 7, 2018. Available online: http://muskiescanada.ca/wp-content/uploads/Bill-C68-submission-may2018.pdf . Accessed February 25 2019.

Yesaki, M., Steves, H. and Steves, K. 2005. Steveston Cannery Row: an illustrated history. Peninsula Publishing Company, Vancouver, British Columbia.

Appendices

Appendix A1. Fraser River Conservation Units

Table A1. Alpha numeric names of the 54 unique Conservation Units within the five species (7 types) of commercially managed salmon returning to the Fraser River.

Species	Lower Fraser CUs	Other Fraser River CUs
Chinook	5	16
Chinook CU Name and Number	03-Lower Fraser River_FA_0.3, 04-Lower Fraser River_SP_1.3, 05-Lower Fraser River-Upper, Pitt_SU_1.3, 06-Lower Fraser River_SU_1.3, 07-Maria Slough_SU_0.3,	08-Middle Fraser-Fraser, Canyon_SP_1.3, 09-Middle Fraser River-Portage_FA_1.3, 10-Middle Fraser River_SP_1.3, 11-Middle Fraser River_SU_1.3, 12-Upper Fraser River_SP_1.3, 13-South Thompson_SU_0.3, 14-South Thompson_SU_1.3, 15-Shuswap River_SU_0.3, 16-Suth Thompson-Bessette Creek_SU_1.2, 17-Lower Thompson_SP_1.2, 18-North Thompson_SP_1.3, 19-North Thompson_SU_1.3, 82-Upper Adams River_SU_1.x, 9004-Fraser-Miscellaneous, 9006-Fraser-Cross-CU Supplementation Exclusion, 9008-Fraser-Harrison fall transplant_FA_0.3.
Coho	2	6
Coho CU Name and Number	16-Lower Fraser-A, 17-Lower Fraser-B,	09-Fraser Canyon, 15-Lillooet, 21-Lower Thompson, 23-Middle Fraser, 27-North Thompson, 35-South Thompson.
Chum	1	1
	12-Lower Fraser	06-Fraser Canyon
Sockeye (all types)	7	17
Sockeye (lake-type)	5	17
Sockeye: Lake CU Name and Number	01-Cultus-L, 02-Harrison-(D/S)-L, 03-Harrison-(U/S)-L, 04-Pitt-ES, 22-Chilliwack-ES	05-Taseko-ES, 06-Bowron-ES, 07-Nahatlatch-ES, 08-Chilko-ES, 09-Chilko-S, 10-Quesnel-S, 11-Seton-L (de novo), 12-Takla-Trembleur-EStu, 13-Takla-Trembleur-Stuart-S, 14-Shuswap Complex-L, 15-Kamloops-ES, 16-North Barriere-ES (de novo), 17-Anderson-Seton-ES, 18-Francois-Fraser-S, 19-Shuswap-ES, 20-Lillooet-Harrison-L, 21-Nadina-Francois-ES.
Sockeye (river-type)	2	0
Sockeye: River CU Name and Number	24-Widgeon, 25-Harrison.	
Pink sub type odd-year	1	0
	03-Fraser River	

Appendix A2. Classification critera and status of Conservation Units

Table A2. Description of classification criteria used by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for their A2 ranking.

Classification	COSEWIC Criteria A2	Threshold
GREEN	CUs that are not Endangered, Threatened or Special concern over the last three generations (over 10 years)	increase in escapement/abundance (>0%)
AMBER	CUs that may qualify for Special Concern due to proximity to Threatened threshold over the last 3 generations (or 10 years)	between 30% decline and no change (0%) in escapement/abundance
RED	CUs that are classified as ENDANGERED (>50% decline) or THREATENED (between 30% and 50% decline) over the last three generations (or 10 years)	> 30% decline in escapement/abundance
DATA DEFICIENT	CUs that do not have enough enumerations data for assessment in recent trends	Insufficient data

Table A3. A status assessment of 54 salmon Conservation Units within the Fraser watershed undertaken in 2012 by the Raincoast Conservation Foundation using the A2 criteria.

Conservation Unit	Species	COSEWIC ranking
Lower Fraser-A	coho	-69%
Lower Fraser-B	coho	-88%
Lower Thompson	coho	33%
Middle Fraser	coho	-18%
North Thompson	coho	-20%
South Thompson	coho	-9%
Fraser Canyon	coho	-60%
Lillooet	coho	DD
Fraser Canyon	chum	-80%
Lower Fraser	chum	-56%
Fraser – odd	pink	DD
Harrison – river	sockeye-river	3635%
Widgeon – river	sockeye-river	433%
Anderson/Seton-Early Summer Lake	sockeye-lake	-20%
Bowron Lake - Early Summer	sockeye-lake	-82%
Chilko - Lake Early Summer	sockeye-lake	DD
Chilko - Lake Summer timing	sockeye-lake	-49%
Chilliwack - Lake Early Summer	sockeye-lake	-39%
Cultus Lake - late timing	sockeye-lake	-33%
Harrison - Lake downstream-Late-migrate	sockeye-lake	5%
Harrison - Lake upstream-Late-migrating	sockeye-lake	-12%
Kamloops - Lake Early Summer	sockeye-lake	-9%
Lilooet/Harrison - Lake late	sockeye-lake	37%
Nahatlatch - Lake Early Summer	sockeye-lake	-72%
Pitt- Lake Early summer	sockeye-lake	-64%

Conservation Unit	Species	COSEWIC ranking
Quesnel - Lake Summer timing	sockeye-lake	-93%
Shuswap Lake Complex-Late	sockeye-lake	-9%
Shuswap Lake Early summer	sockeye-lake	-15%
Takla/Trembleur/Stuart-Summer	sockeye-lake	-81%
Takla/Trembleur- Lake Early Stuart	sockeye-lake	-70%
Taseko-Lake Early Summer	sockeye-lake	-88%
Lower Fraser -fall(white)	chinook	-40%
Lower Fraser – spring	chinook	181%
Lower Fraser - Upper pitt	chinook	DD
Lower Fraser-summer	chinook	DD
Maria Slough	chinook	DD
Fraser Canyon-Nahatlatch	chinook	-62%
Middle Fraser River-Portage	chinook	DD
Middle Fraser River-spring	chinook	-82%
Middle Fraser River-summer	chinook	-43%
Upper Fraser River-spring	chinook	-57%
South Thompson -summer age 0.3	chinook	165%
South Thompson -summer age 1.3	chinook	-29%
Shuswap River -summer -age0.3	chinook	-7%
South Thompson-Bessette Creek	chinook	-93%
Lower Thompson - spring -age1.2	chinook	-82%
North Thompson spring -age1.3	chinook	-85%
North Thompson summer -age1.3	chinook	-69%
South Thompson-Adams –Upper	chinook	86%

Appendix A3. Legislation and salmon habitat

Table A3. Legislation relevant to the protection of salmon and their habitat

Level	Laws / Regulations	Relevant Sections	Prohibitions and requirements
International	Pacific Salmon Treaty 1985	Article IV	Canada must provide pre-season information including on the estimated size of the run, the spawning escapement required, and the estimated total allowable catch.
		Article VI -Fraser River	The Fraser River Panel is responsible for harvest decisions regarding Fraser pink and sockeye (currently gives US fishers 16.5 and 27.5 percent of Fraser sockeye and pink respectively).
		Article X - Research	The Parties shall conduct research to investigate the migratory and exploitation patterns, the productivity and the status of stocks of common concern.
Federal	Fisheries Act 1986 (Modified 2012)	Section 35- Serious Harm to Fish	"No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery"
		Section 36 - Deposit of deleterious substance prohibited	"No person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance may enter any such water"
	Navigation Protection Act (formerly Navigable Waters Protection Act)	Section 4 - Prohibition	"It is prohibited to construct, place, alter, repair, rebuild, remove or decommission a work in, on, over, under, through or across any navigable water that is listed in the schedule". Altered in 2012 to only protect the 97 lakes and portions of 62 rivers listed in the schedule.
Provincial	Water Sustainability Act 2014 - came into force on February 29, 2016	Section 15 – Environmental flow needs	(1) Except in relation to an application exempted under the regulations, the decision maker must consider the environmental flow needs of a stream in deciding an application in relation to the stream or an aquifer connected to that stream.
		Section 43 - Water objectives	For the purposes of sustaining water quantity, water quality and aquatic ecosystems, regulations can be established for water objectives for a watershed, stream, aquifer or other specified area to sustain water quality and water quantity required to sustain aquatic ecosystems.
		Section 45 - No new dams on protected rivers	Prohibits the construction of mainstem dams on protected rivers including the Fraser, and some of its major tributaries including; Thompson, North Thompson, South Thompson, Adams, Blackwater, Clearwater and Stuart River's.
		Section 46 – Prohibition on introducing foreign matter into a stream	Unless authorized a person must not introduce debris, refuse, carcasses, human or animal waste, pesticides, fertilizers, contaminants or another matter or substance into a stream, or an area adjacent to a stream, in such a quantity or in such a manner as to cause a significant adverse impact to the aquatic ecosystem of the stream.
		Section 86 – Declaration of significant water shortages	If the minister considers that one or more streams in an area have fallen or are at risk of falling below their critical environmental flow thresholds, the minister may make a temporary order declaring a significant water shortage in the area designated in the order.
		88 – Fish population protection orders	If the minister considers that the flow of water in a specified stream is or is likely to become so low that the survival of a population of fish in the stream may be or may become threatened, the minister may make an order respecting the diversion, rate of diversion, time of diversion, or use, including storage and time of storage, of water from the specified stream, or a specified aquifer hydraulically connected to the stream.

Level	Laws / Regulations	Relevant Sections	Prohibitions and requirements
Provincial	Riparian Areas Protection Act (1997; *former Fish Protection Act*)	Section 12 - Provincial directives on streamside protection	Previously part of the Fish Protection Act repealed with the introduction of the Water Sustainability Act. Allowed for the creation of the Riparian Areas Regulation, also allows for local governments to create stronger streamside protection bylaws.
		Riparian Areas Regulation	**Requires that a qualified environmental professional determine that development is implemented as proposed there will be no harmful alteration, disruption or destruction of natural features, functions and conditions that support fish life processes in the riparian assessment area, which is a 30 meter wide strip on either bank of a stream or ravine <60m wide.
	Land Title Act	Section 9 -	Requires approvals and notifications for changes "in and about a stream" in accordance with part 7 of the Water Regulations which require either notification or a Water License or Order.
		Section 86(1)(c)(v)	States that an approving officer may refuse to approve the subdivision plan if the officer considers that the area is subject, or could reasonably be expected to be subject to flooding.
	Local Government Act	Section 910	A local government may adopt a flood plain bylaw that designates an area as a flood plain, and specify development levels and setback requirements in a designated area.
		Section 215	Covenants can be created to protect fish habitat on privately owned land. The landowner enters into an agreement with the Ministry of Environment to protect riparian habitat on their property. Actual wording of document varies by municipality.
Municipal	Riparian Areas Protection Act (BC)	Section 12	Local government must: a) include in its zoning and rural land use bylaws riparian areas protection provisions in accordance with the RAR, or b) ensure that its bylaws and permits under Local Government Act Part 26, or Vancouver Charter Part XXVII, as applicable, provide a level of protection, that in the opinion of the local government, is comparable to or exceeds that established by the RAR.

*Unless authorized to by the minister.

**Riparian Areas Regulation replace the Streamside Protection Regulations which are considered tougher and which some municipalities still use, including Surrey, Maple Ridge, Langley and Delta.

Appendix A4. Vision for salmon habitat workshop summaries

Raincoast Kwantlen Workshop October 27th, 2016: Summary and feedback

We would like to thank our hosts the Kwantlen First Nation and our Master of Ceremonies Brandon Gabriel for doing a fantastic job throughout the day. We were honoured to gain further understanding and share in Kwantlen First Nation traditional practices. We would also like to thank Ashley Doyle from the Seyem' Qwantlen Business Group for coordinating the event, the Canadian Freshwater Alliance for assistance with funding, and Lina Azeez from Watershed Watch Salmon Society for assisting with organizing and facilitating.

Attendees

Brandon Gabriel and Ashley Doyle – Kwantlen First Nation;

Les Antone – Kwantlen First Nation Councillor;

Johnny Savino, Charlie Savino, Barry Brown – Kwantlen First Nation Elders;

Ross Dixon, Misty MacDuffee and Dave Scott – Raincoast Conservation Foundation;

Lina Azeez – Watershed Watch;

Christine Mettler – Fresh Water Alliance;

Fred Hulbert – Kwikwetlem First Nation Councillor;

Kelsey Taylor – Kwikwetlem First Nation;

Janson Wong – Lower Fraser Fisheries Alliance;

Genevieve Layton-Cartier – First Nations Fisheries Council

Nicole Marples – Langley Environmental Partners Society;

Matt Foy, Fred Trzaskowski – Salmon River Enhancement Society;

Justin St. Andrassy – Township of Langley Environmental Coordinator;

Liana Ayatch – City of Surrey Environmental Technologist;

Chantal Chan – Evergreen;

Raw feedback

WHAT'S YOUR VISION FOR SALMON HABITAT IN…2020?

- Integrate natural resource management into school system, starting early!
- Create exciting programs for youth, public awareness campaigns to educate on fish and fish habitat. Government initiatives, Funding from provincial and federal government.
- More accountability on government. Board to monitor government enforcement.
- Educate public about the harm of fish farms, and educate folks where their fish comes from.
- Government funds natural resource management jobs, or FN's / ENGO's.
- Make natural resource management jobs more accessible and attractive
- Apolitical body that coordinates efforts and ensures communication
- Complete cohesion/collaboration of resources between all groups -> NGO, FN, Government
- Full recognition of aboriginal rights and title: Guardian Watchmen Program
- Increased environmental and cultural tourism
- Issue: little to no water "all dammed up" Water Quantity and Quality
- No pipelines in habitat protection areas in Fraser corridor
- Re-activate 80% of decommissioned hydrometric monitoring stations in Fraser and tributaries
- Overcome siloes -> Apolitical organization ex. Rivers coalition – a new type of FREMP?
- Duty to consult and FPIC (free, prior and informed consent) of First Nations and resourcing and capacity for consultations on all projects affecting habitat
- Implement WSP -> habitat protection and rehabilitation -> id salmon habitat
- Restore HADD!! "no net loss"
- Enforcement on cargo and barges, tankers: -ex. Organisms in ballasts –invasive species
- Cumulative Impacts –better modelling (ex. Fish Water Management Tool in Okanagan
- Modelling for climate change – localized models -> drill down to the hot spots
- Land acquisition in the Lower Fraser: tidal reach plus ½ meter – high value wetlands –flood control mechanisms –No loss of land purchase
- Education: -value systems from birth – must be ingrained –be an active citizen –majority of people must be on board
- Cumulative effects assessment of major projects
- Education for public on importance of salmon habitats, how to treat them respectfully (school programs)
- Counting fence on Salmon River, community operated
- Establishing habitat baselines using storytelling
- Municipal – level support (education, money, policy) for homeowners (SFH) to retrofit their homes for increasing salmon friendly, SW mgmt.
- "Ecological services initiative" that subsidizes/supports transition to sustainable land use practices
- Identify incentive structure for agriculture, other industries to protect habitat
- Recognizing that salmon status/ health are connected to land use water quality and quantity
- Salmon health is fundamental to community/OCP planning
- Increasing salmon habitat emphasis in sustainable watershed management plans
- Metro Van/ Lower Fraser ban on microplastics
- Delta – raingardens at all schools –extend across Lower Fraser
- Re-engage DFO and province on habitat protection and restoration including planning and strengthened Fisheries Act
- Climate change considerations and plans
- Salmon friendly flood and stormwater management -cap on impervious surfaces
- FREMP like process restored
- Enforcement (adequate) of fish habitat protection

WHAT'S YOUR VISION FOR SALMON HABITAT IN…2030? (ADDITIONAL CATEGORY CREATED BY ONE OF THE GROUPS)

- Active engagement and capacity building/resourcing for First Nations to lead habitat restoration work
- Other planning processes ->municipalities, federal, provincial governments etc.
- Localization: -re-establish Salmon River fish counting fence –re-establish at other local streams, focus on lower Fraser coho
- De-carbonize –district energy – IPP's –Solar, wind, etc…
- "No net loss" hierarchy is weighted…so that offset is 4x,…etc.

WHAT'S YOUR VISION FOR SALMON HABITAT IN…2050?

- Proper structural land management and practices to implement sustainable growth on municipal level
- Bring people to the habitat, not habitat to people (ex. Sturgeon)
- Bring education to the outdoors, rather than indoors to Vancouver aquarium or Tsawwassen Mills mall (ex. Sturgeon)
- Linguistic resurgence (place names, use of language)
- FN consent (meaningful decision-making role for First Nations)
- Better understanding and training of regulators approving projects on the land of ramifications and permanence these projects will have on the environment. ->Regular field classes and pertinent contacts for areas responsible for.
- Authority, enforcement and resource management by First Nations governments and NGO's in partnerships
- Monitoring board should have ability to issue fines, etc.
    - 1) Water Act
    - 2) Education
    - 3) Accountable biologists to environment vs. political
- Processing plants canning, smoking, freezing etc – Our own in BC not to USA- Value Added = $
- Improve environmental laws and regulations, and enhanced enforcement
- Remove creosote timbers –Millions cubic meters in river
- Old infrastructure to be cleaned up, funding for restoration , restore habitat industry responsible for funding
- improved infrastructure that allows access to water
- Salmon habitat restoration and monitoring in full effect
- Phase out salmon farms – transition to more sustainable, healthy industry that focuses on wild salmon
- Enforcement –fish trawlers / seiners
- Salmon and fish's need for water are a priority on par with human need for water –environmental flow models reflect this
- Models -100 year scale –model for salmon habitat id. Marshes, accessible waters
- Is there compensatory actions we can do to protect land ex. Tidal marshes?
- Indicator streams for Lower Fraser Salmon (only: Inch Creek – coho, Chilliwack – Chinook)
- Implement Cohen Commission Recommendations
- Land acquisition net gain on foreshore ~25% -create a green corridor
- Management of salmon fisheries with First Nations at the table
- Exploration of alternative harvesting opportunities including terminal fisheries
- Efforts to localize the fishery and restoration -> terminal fisheries
- Develop a guardianship program (localized) – create a sustainable model
- Intrinsic societal value placed on habitat (private pptn) coupled with better enforcement/habitat protection mechanisms in place ->localized enforcement, people on the ground
- All five species of salmon in Coquitlam River
- Shift in governance
- Public engaged with their environment (including how they can effect it), aware of acting sustainability
- Cultural and value shift
- Capped impervious surfaces in watersheds and disconnected, undone previous surfaces
- Salmon health becomes a guiding principle in planning
- Return coho to unnamed creek opposite Kanaka
- Restore Salmon River and monitoring, wild indicator stream
- Greater understanding of salmon habitats including network of indicator streams, science based assessment of habitats and mechanisms for protection
- Actively daylighting streams, creeks and rivers
- Realtor training awareness program that connects land sales with land use with habitat
- Incentive structures in place to protect natural capital
- Historic abundance as a benchmark
- Complete knowledge of historic habitats including important rearing habitats for Chinook, and abundances –Use Harrison as indicator

WHAT'S YOUR VISION FOR SALMON HABITAT IN…2100?

- Ample healthy wild fish stocks for future generations
- Damage from fish farms fully cleaned up
- Link salmon habitat to food security
- Implement Cohen commission recommendations, approx. 20 court cases: Sparrow, Tŝilhqot'in, etc
- Funding mechanism through business inputs in each community of the lower mainland to support habitat restoration and protection (ex. Permit fees tied to business licensing -> to local habitat projects)

- Nation to nation decision making
- Land acquisition – net gain ~50%
- No more production of hydrocarbons! (all vehicles are electric)
- Management plan for the River – holistic picture
- New economic regime
- Long term funding: ex. Salmon fund – Enhance, restore, protect the lower Fraser tidal reach" need core funding
- Fully resourced and localized protection and enforcement for habitat conservation
- Importance of salmon ingrained in society, full ecological role understood and appreciated
- Overall ecosystem health improved for salmon and other species
- Natural flood regimes restored with access for salmon
- Practices which protect ecological services commonplace
- Armored shorelines transformed back to riparian zones in North and South Arms
- Historic abundance of salmon back in Coquitlam River

WHAT IS NEEDED IN TERMS OF…POLITICAL SUPPORT:

- Province – Water Sustainability Act
- Port of Vancouver
- Political understanding of how development is impacting salmon habitats
- Connection between actions, salmon, environment
- Increased power for local decision making and action (eg Guardian Watchmen)
- Goals
- Confidence that Vision is attainable
- Public engagement (eg Adopt a River)
- FN's assert decision making power –legal challenges over rightful authority
- Salmon watchdogs on municipal council
- Municipalities and industry should provide funds for salmon habitats

WHAT IS NEEDED IN TERMS OF…FUNDING:

- Conservation fund
- Real estate tax
- Land transfer tax
- Stable funding source
- Accounting for ecological services associated with salmon habitats
- Mechanism and training to identify and build capacity for monitoring habitats and salmon stocks
- Mechanism to charge permit fees or levy costs on industry or development practices within a community and use these funds to forward local restoration and enhancement projects
- Mechanism of funds distribution conducted similar to HCTF -> portion of angling license fees goes toward project applications
- How to tap into federal grants
- Make federal funds easier to access: relax reporting requirements for AFSAR

WHAT IS NEEDED IN TERMS OF…LEADERSHIP:

- Diversity represented
- Supported by funding
- What entity has the weight or power to make the recommendation implemented? Ways to make a recommendation legal? In BC: WSA's water management plan->can give more clout. What's the incentive to bring everyone to the table?
- Champion
- Critical mass of supporters
- Increase capacity for local stewardship groups
- Diverse leadership, everyone has a role to play

WHAT IS NEEDED IN TERMS OF…GOVERNANCE:

- model: -roundtable-> key stakeholders & monthly public meetings –FREMP like model
- OBWB (Okanagan Basin Water Board) is interesting model, but:
  - they don't have decision making power (recommendations only)
  - very little interface with community members/public
  - coalition should have: 1) permanent staff members 2) interface/two-way dialogue with public (grassroots/ decision makers)
- Rivers Coalition: -clearly defined process and terms of reference
  - FN, streamkeepers, all levels of government (Federal, provincial, regional, Port, municipalities)
  - industry –what kind? –KM –Ag
  - interested community, stakeholders
  - legal agreements
  - scientists
- build a consortium -> leader by members to regulate
  - groups recommendations need to have teeth
  - funding needs to be sustainable
  - salaries needed but must be short terms (seconded)
  - Sub coalitions- represented of existing bodies
- Enforcement

Raincoast Vancouver Workshop September 14th, 2017: Summary and feedback

We would like to thank all of the participants and a special thanks to Gabriel George from Tsleil-Waututh Nation for welcoming us, sharing his knowledge and setting the context for the day's discussions. Also thanks to Lina Azeez from Watershed Watch Salmon Society for assisting with organizing and facilitating.

Attendees

Bridget Doyle, Hillary Hyland – Tsleil-Waututh Nation

Dianne Ramage – Pacific Salmon Foundation

Zo Ann Morten – Pacific Streamkeepers Foundation

Lina Azeez, Charly Caproff – Watershed Watch Salmon Society,

Coree Tull – Canadian Freshwater Alliance,

Christianne Wilhelmson – Georgia Strait Alliance,

James Casey – Bird Studies Canada

Deborah Carlson – West Coast Environmental Law

Judy Williams – Wreck Beach Preservation Society

Rob Knight – Community Mapping Network

Ross Dixon, David Scott – Raincoast Conservation Foundation

WHAT'S YOUR VISION FOR SALMON HABITAT IN THE LOWER FRASER RIVER . . . BY 2020?

- Wild salmon policy implemented.
- Review process of Federal law results in stronger CEAA, NEBA, Fisheries Act, and NPA.
- Use of a precautionary approach for land use planning if data is deficient.
- Cohen commission recommendation implemented.
- Prioritizing waterfront planning.
- Moratorium on development.
- Enforcement with sufficient sustainable funding.
- Independent reviews on development.
- Net environmental gain with follow-up program post-operational.
- Strategic fisheries closures and openings.
- Salmon information developed and implemented through curriculum.
- Add forage fish habitat mapping and protection to Municipal and Federal database.
- Forage fish fisheries limits, closures, compliance, and enforcement.
- Forage fish habitat restoration.
- Raise awareness of forage fish ecology, elevate public perception of importance of ecological management.
- Moratorium on all development until a comprehensive plan is put in place.
- Get salmon SARA-listed.
- Decommission of Point Grey disposal at sea site to improve water quality.
- Shift foundation of future values for future economic/industrial development.
- Physical/cultural connection to the Lower Fraser. Canoe/portage access to Fraser fishing ground necessitates habitat creation/restoration.
- Ecosystem-based management approach.
- Change the arena to elevate environmental voice in legislative reform.
- Cohen recommendations, public comments, wild salmon policy must be incorporated in legislative reform and regulations/policies.
- Understanding the connection between built infrastructure and the environment (docks, dykes, industry, etc.)
- Lower Mainland covered by riparian area regulations.
- Restoration of natural flow patterns in estuary.
- Restoration plans that consider long-term sustainability.
- Open-pen net farms removed from the Pacific, changed to closed containment.
- Port has set salmon relevant threshold to constrain development to respect the health of the Fraser.
- Shift in habitat regulation towards "net gain".
- Change in legislation away from professional reliance, strengthened regulations, open data.
- Implement expert panel recommendations on changes to Environmental Assessment process.
- Ecosystem flow needs for health of estuary.
- Environmental flow needs regulations under Water Sustainability Act.

WHAT'S YOUR VISION FOR SALMON HABITAT . . . BY 2050?

- More robust data gathering on all ecosystem indicators to limit data gaps.
- Giving the Fraser River legal personhood.
- Shoreline plans implemented, including restoration and protection of the shore to meet habitat connectivity and needs.
- Carrying capacity of Lower Fraser established and incorporated into planning at all levels of government.
- Easily accessible salmon information through education.
- Obligation to nature.
- Use City of Vancouver's eventual need to address sea level rise as an opportunity to create more habitat as well as counteract climate change.
- Watershed plans completed for every watershed in Canada for sustainable watersheds with intact/functional aquatic habitat.
- Climate Change plans implemented to meet or exceed national targets.
- All development "salmon safe".
- Shift government and public consciousness, values and world-views. North American cultural change because of knowledge.
- Government-government joint decision making with Federal, Provincial, and Municipal governments.
- Freedom of domain-fish passage and wildlife prioritized over development for all life stages.
- Enable bio-engineering industry to replace/restore riparian.
- Early Nation to Nation communication about strategic Environmental Assessment.

- Build estuaries and adapt restoration plans to isostatic rebound and sea level rise.
- Shift public behaviour.
- Food security for First Nations traditional foods.
- Preservation of farmland and urban densification/relocation of people. Urban developments planned with Climate Change in mind.
- Local governments enact riparian area regulations which strengthen existing protections.
- Bring lifecycle view into Environmental Assessment process.
- Fraser Estuary Act – Hope to Tide Water non-jurisdictional collaborative body established.
- Water temperature strategy.
- World leader in sustainable transportation of good prioritizing conservation respecting health of Fraser.
- A shift that happens before it is too late/before it is a necessity.

WHAT'S YOUR VISION FOR SALMON HABITAT … BY 2100?

- Slow the rate of Climate Change.
- All needs of humans, marine mammals, and ecosystem are met.
- Habitat connectivity.
- Ecosystem approach to Lower Fraser planning.
- Salmon-centric laws for coastal and riparian areas.
- Food and water security to support environmental refugees with domestic resources (including salmon).
- Industrial corridors, get rid of transmission lines.
- Shift to solar/renewable power sources.
- Cultural knowledge exchange with Indigenous science received on same level with western science.
- Change value of land to balance human needs with salmon needs.
- Comprehensive watershed plans to conserve terrestrial habitat.
- Protection/restoration of wetlands.
- Reimagine industrial developments with a focus on densification, solar panels, ad green roofs.
- Moratorium on all Port development unless and until there is a comprehensive plan in place.
- Broader cultural understanding of importance of salmon rivers and streams to our survival and livelihoods.
- All human infrastructure is providing habitat and/or ecological function.
- Agriculture that works with the environment, allows natural floodplain inundation. PES.
- River is actively re-connected to floodplain and human habitat is more flexible.
- Empowerment of local stewardship and ENGO's increased funding.

OUR VISION…

- Collaboration
- Ecosystem based
- Common vision
- Sustainable watershed
- Local control
- Spiritual
- Nation to Nation
- Long-term
- Reconciliation
- Resilience
- Co-governance, Indigenous and other levels
- Thrive not Survive
- Education
- Diversity
- Salmon
- Connection
- Lower Fraser
- Ecological connectivity
- Net ecological gain
- Traditional diet/sustenance
- Appreciation
- Healthy communities
- Connectivity
- Community
- Watershed level
- Ubiquitous
- Ceremony
- Cultivate abundance
- Restored
- Intact watershed function
- Habitat growth
- Trophic levels
- Abundance
- Healthy ecosystems
- Fully functioning salmon ecosystem
- Healthy riparian zone

WHAT IS NEEDED IN TERMS OF … POLITICAL SUPPORT?

- Populous decision making.
- Informed, engaged citizenry pushes for the vision at all levels of government.
- Targeted political campaigns.
- Letter of patent revisited for the Port – integration into public space, transparency.
- Local government (Metro Vancouver), PSF.
- Political scan to look for champions (elected and bureaucrats).
- Need to build more amongst the other cultures in the community.

- Trudeau starts walking the walk.
- Resources to litigate Federal government.
- Capacity at Provincial level to support stewardship groups and activities, and to work with them to ensure the best possible projects are supported.
- Campaign against the Port for 2020, change authority/practice and give $.

WHAT IS NEEDED IN TERMS OF …FUNDING?

- Reallocation of existing tax dollars.
- Identify cost of development.
- Governments: Provincial and Federal – land and water users.
- Independent funding to remove bias from funder.
- Conservation Planning Endowment, open to any funding source but managed by board.
- Pacific Habitat joint venture – Wetland Habitat Canada
- Property Tax transfer.
- Public/private foundations
- Van City triple bottom lending bank.
- Less than 1-5% of Port revenue goes to environment fund.

WHAT IS NEEDED IN TERMS OF …LEADERSHIP?

- Equal representation, like Haida Gwaii, with half First Nations and half Federal/Provincial representatives.
- Revitalized and reimagined FREMP, with a focus on research and advocacy.
- Engaging members of all cultural communities.
- First Nation's lead FREMP 2.0.
- Grassroots movements, ENGO's, stewardship groups, First Nations all working together.
- Engaged and informed public to set social licence.

GOVERNANCE

- Watershed planning (WSA) – Amplify the ISMP's
- Nation-to-Nation.
- Meaningful Nation-to-Nation conversations.
- How to mitigate and manage threats while First Nations-Federal conversations going on.
- Measurable objectives.
- New direction: Mandate for Fraser multijurisdictional basin council.
- Framework for Federal government to follow in regards to getting consent from Firs Nation's groups.
- Federal government needs to take responsibility and not rely on Port or Province.
- Move away from proponent-led Environmental Assessment process, independent third party review, including Port assessments. CEAA Reform.
- Fisheries Act – Restore HADD.
- Public salmon campaigns (eg. Like anti-gang and public health campaigns).

Lower Fraser Fisheries Alliance and Raincoast, Fraser Valley Workshop, Stolo Resource Center, Chilliwack September 22th, 2017: Summary and feedback

A special thanks to the Sto:lo Research and Resource Management Center for hosting our event and to Terrington Prest and Chris Silver for providing a welcoming ceremony, Lina Azeez from Watershed Watch Salmon Society for assisting with organizing and facilitating, and Janson Wong and Mat Point for assisting with organizing and facilitating.

Attendees

Janson Wong, Jeanne Hughes – Mat Point, LFFA

Lina Azeez – Watershed Watch Salmon Society

Ken Malloway – Tzeachten/Kwakwa'apilt Nation

Carleen Thomas, Hillary Hyland – Tsleil-Waututh Nation

Dominic Hope, Terina Hope – Yale First Nation

Robert Gladstone – Shx:way Village

Kim Charlie – Sts'ailes Nation

Misty Macduffee, David Scott – Raincoast Conservation Foundation

Eileen Jones and Leah Honka – Pacific Salmon Foundation

Ian Stephens – Water Wealth Project

Mike Pearson – Pearson Ecological

WHAT'S YOUR VISION FOR SALMON HABITAT … BY 2020?

- Balancing fisheries to be sustainable.
- Moratorium on Fraser gravel removal.
- Protect sturgeon spawning grounds- "no go zone" for angling.
- Establish regulations on ALR for waste and livestock density management.
- Political will to move forward on making all flood infrastructure fish friendly.
- Laws and regulations to enforce nutrient management on farm land – specify limits on amount of manure applied and timing.
- No more development on the flood plain (outside the dyke gets re-wilded).
- Reinstate Who spawning at Unsworth Road (remove culvert?).
- Cultus Lake salmon (especially sockeye) – manage human waste outfall into the lake and protect the limited sockeye spawning areas, needs a watershed plan.
- Change in legislation on culverts used in forestry, railways, and municipalities to allow for bridges and natural bottom culverts.
- Maintain and restore E-flows.
- Mapping of all "closed off sloughs" throughout Fraser Valley for relocation/restoration.
- Baseline information on what used to exist in terms of abundance for canyon chum.
- Proactive plan for Chilliwack Lake and Valley that protects salmon.
- Determining impacts of log booms and woody debris.
- Ecosystem and baseline approach to habitat restoration and management.
- Establish E-flows.
- Public understanding of cumulative effects on the environment and salmon habitat from human activities – Cohen Report.
- Thermal map- cool the water.
- Getting funders at the table and listen to what is needed – Bridge the gap.
- Collaboration to work together through the long term.
- Better incorporation and utilization of citizen science.
- Culverts in streams need to be removed and replaced with bridges (access to private property).
- Re-establish Guardian program with an emphasis on habitat, restoration, authority, and sufficient funding.
- Implement Wild Salmon Policy and Cohen recommendations with increased First Nations focus.

- Break down silos between "Tier 1", "Tier 2", and "Tier 3" and work together to bring resources back.
- Sharing of knowledge and data.
- Transparency around processes and data.
- Better science on impacts of hatchery programs and if they are effective.
- Threats to salmon habitat: risks, stressors, indicators.
- Juvenile and escapement monitoring on populations.
- Data gap on salmon and population dynamics: juveniles, seal predation.
- Sockeye listed as endangered, stop fishing pressure.
- Bring back aboriginal fisheries guardians and rangers.
- Better catch monitoring in recreational and commercial sectors.
- Education on fisheries – develop school curriculum to learn about the river, fisheries and culture.
- Aboriginal guardian program, AFO to manage and protect.
- Strong public education program to connect habitat to the resource, funding for school programs.
- Education and acknowledgement of First Nations rights and title.
- Better understanding on salmon returns and being proactive in fisheries management to adjust catch numbers.

WHAT'S YOUR VISION FOR SALMON HABITAT … BY 2050?

- Healthy ecosystem, predation on salmon.
- Buying back private land outside the dike (for re-wilding).
- Re-wild ditches- treat them like streams for salamanders, rainbow trout etc.
- No more urban expansion into Chilliwack Valley, needs to be protected from industry and logging. Prevention of erosion and gravel aggregation downstream.
- All Lower Mainland dike infrastructure upgraded to fish friendly.
- Restoration of fish and flushing flows into sloughs.
- Understanding the limits of nature and where we fit into the system.
- Future generations educated and connected to nature, learn by being out in the environment.
- Infrastructure should enhance habitat.
- Habitat connectivity.
- Reverse damming structures.
- Green infrastructure flood management.
- Climate change adaptation and resilience of populations.
- First Nations working together to protect fish.
- Joint decision-making.
- Recognize Fraser River as having rights for better protection, respect for river as a living system.
- Communication strategy-education.
- Effective governance and management that is truly collaborative and respects First Nations as decision-makers.
- First Nation's management, licencing of fisheries.
- Reinstate First Nations culture as a priority for land use and management in Chilliwack watershed.
- Effective legislation, policies, and programs that are environmentally responsible.
- Re-flood Sumas Lake natural flood cycles.
- Log boom removal, storage reform (move to land?).
- Restored habitat for salmon in canyon.
- Restored abundance and fishing opportunities.
- Dumps relocated from reserve proximity, managed differently, implications for water quality.

WHAT'S YOUR VISION FOR SALMON HABITAT … BY 2100?

- Living document for salmon productivity and habitat restoration and conservation.
- Commitment to meet or exceed set goals for salmon productivity/ habitat restoration.
- Thriving salmon populations, genetic diversity and abundance.
- Food security, ensure fish for generations.
- Restoration of extirpated stocks.
- reduce/eliminate reliance on hatcheries.
- Sustainable use of our resources which supports a healthy ecosystem.
- All 6 species of salmon abundant.
- Clear water in the river to support torch lighting fishing method.
- Future generations have access to resources at levels ancestors experienced.
- Local governance to work with Federal government.
- Renewable energy that protects fish.
- Sumas lake restoration for fish and flood management.
- Land use/infrastructure development carrying capacity in the Fraser to account and understand cumulative effects.

- Manage developments not as baseline needs but what can allow fish to thrive.
- Agreement similar to US timber, fish and wildlife agreement to protect habitat.
- Every historical stream has a 30m buffer/riparian zones (RAR).
- Need setbacks 100's of meters away from the Fraser River.
- Reinstate natural flood plain that allows river to move.
- Implement the Conservation Land Reserve ie. Take land out of development.

OUR VISION...

- Salmon
- Clean water
- Cooperation
- Reconciliation
- Implementation
- Wellness
- Collaboration
- First Nation-led
- Abundance
- Database
- Communication
- Indigenous
- Habitat
- Respect
- Guardians
- Long-term
- Connection
- Nautsamawt (one heart, one mind)
- Collaboration
- Corridors
- Integrity
- Knowledge
- Commitment
- Restoration
- Plan
- Legislation
- Environmentally conscious
- Connectivity
- Transparency
- [snuwhyulh] (Indigenous laws and teachings)
- Culture
- Biodiversity
- Protection
- Fishable, swimmable waters
- Education
- Holistic
- Fish forever
- Sustainable
- Love
- Re-wilding
- Species interdependence
- Resilience
- Support ecosystems
- Reverence
- Diversity

WHAT IS NEEDED IN TERMS OF ...POLITICAL SUPPORT?

- Governments need to recognize First Nation's wins in court and act meaningfully.
- Progressive legislation adopted through a "ground-fathered" approach. Eg. Riparian easements on agricultural land.
- Move from lease to conservation covenants.
- PMU, understanding their letter patent.
- Federal Advisory Committee to Minister of Fisheries – 50% and 1 seat for First Nations.
- No muzzling of scientists-Freedom!
- NGO's support and push political leaders for accountability.
- Community engagement with MP's and public to get political support.
- Implementation of research and conservation plans.
- Water governance, stronger political will and support against industry.
- Examine Cohen Commission recommendations, Wild Salmon Policy.
- Examine Pacific Salmon Treaty, align with domestics policies such as Wild Salmon Policy.
- Federal and Provincial Governments need to work together, not pass the buck back and forth.

WHAT IS NEEDED IN TERMS OF ...FUNDING?

- Indigenous communities need meaningful support funding the recognizes rights and title. Eg. Portion of property taxes to First Nations.
- Payment for ecosystem services-funding: $/parcel of land.
- Percent of conservation fund goes to Endowment fund.
- Long-term funding dedicated to work, away from project-based/grant-based funding – log-term projects.
- Federal and Provincial funding, better alignment.
- Funding should be separated from industry influences.
- Transparency around funding and political pressures.
- Aligning funding with long-term goals and objectives – legacy funds.
- Better alignment of academic research and funding.
- Involvement of community on research such the projects/science can be implemented.

- Scholarships for students to attract them into the field.
- Independent funding beyond government funding.
- NGO's to help align funding.
- Consolidated pots of money (long-term) with low administrative burden, not so many hoops.
- New paradigm that is not so competition-based. Feeding frenzies make it hard to work together.
- Lower Fraser Habitat Restoration Endowment.
- Funding for baseline studies to understand fisheries.

WHAT IS NEEDED IN TERMS OF …LEADERSHIP?

- Farming community: progressive land use practices, good stewards, ethics.
- Municipalities: need one or two to take the first steps, we need to advise, support and lobby, include relationships to the regional districts.
- Federal: Identify an internal "cheerleader" at Sr. staff level (DFO, Ag, Infra, INAC), Similar with the province (FLNRO, Enviro, Ag).
- First Nations: Inherent in the whole structure in leading their initiative.
- Haida Gwaii model: 50% First Nations, 50% Federal and Provincial government.
- Engage Ministers, bring them out here, have representatives for Minister to be made up of regional representatives.
- Communications, better engage First Nation's leadership to push plans and recommend.
- Breeding future leaders- Educate!
- Leaders to rock the boat, support the leaders and coordinate efforts.
- Legal support for leadership.
- Leadership can host/have groups come in to support agendas and support leadership (Education).
- Strategy for restoring salmon created by all levels of government with First Nations leading.
- Local communities in leadership role, working together.
- Salmon guardians/champions.
- ENGO's work to support First Nations, form agreements to facilitate.
- National First Nations leadership.
- Have a plan! Not just handing out money.

WHAT IS NEEDED IN TERMS OF …GOVERNANCE?

- Reconciliation Act: See report by Bryn Gray Ministerial Special Rep. report: building relationships and advance reconciliation.
- Lower Fraser Conservation Act: co-governance model, dictate funding, policy, and legislation, mandate to implement the Vision.
- Municipalities adopt watershed boundaries.
- FREMP 2.0: environmental mandate, First Nations decision-makers.
- PMV not a decision-maker but as a TWG committee group.
- Recognizing First Nation's self governance.
- Accountability of Governments. Process too influenced by industry and not with what public is saying.
- Non-proponent led EIA's, proponent pays but does not influence the EIA.
- Third-party EIA's open, data needs to be transparent.
- First Nation's to government, commitment to dialogue.
- Scientific panel to advise and support decision-makers on all sides.
- Aboriginal knowledge to be incorporated into governance.
- First Nations in decision-making role.
- Accountability.
- Water policy.
- Consistent legislation despite election cycles (Proportional Representation).
- Protect key remaining habitats.
- Protection and consideration for all fish stocks, moving away from only considering commercially harvested species and stocks.
- Change Fisheries Act.

Raincoast Conservation Foundation, Tsawwassen/Delta Workshop, Tsawwassen First Nation, December 4th, 2017: Summary and feedback

We would like to thank the Tsawwassen First Nation for hosting our event and Steve Stark for helping to organize. We would also like to thank Merle Williams for welcoming us to Tsawwassen First Nations lands and providing a greater context for the day's discussions.

Attendees

Laura Cassidy, Kyle Flindt, Erin Weckworth, – Tsawwassen First Nation

Lina Azeez – Watershed Watch Salmon Society

Vicki Huntington – Former Independent MLA for Delta

Hillary Rowe and Cherry Tam – Burns Bog Conservation Society

Mary Taitt – Friends of Semiamhoo Bay

Anne Murray – Delta Naturalists

Deborah Jones – Cougar Creek Streamkeepers

James Casey – Bird Studies Canada

Deborah Carlson – West Coast Environmental Law

Lynn Armstrong – Council of Canadians Delta-Richmond Chapter

Lyn ter Borg – Fraser Voices

Doug Massey,

Dave Scott, Misty MacDuffee, Ross Dixon

– Raincoast Conservation Foundation

WHAT'S YOUR VISION FOR SALMON HABITAT. . .:IN 2020?

- Site drainage, by provincial law, must be planned before, or concurrently with, site planning for all developments
- pursue legal status for the whole Fraser River watershed (River and estuary) –ex New Zealand, India 2017
- Legally mandated agency for ensuring environmental assessment of all development proposals, including: 1) Cumulative assessment 2) Application of precautionary principle –this agency will call on independent experts in all aspects of the development proposal
- return it program for cigarette butts -non-profits can use it as fundraiser
- fast track for projects that promote direct/indirect increase in salmon habitat –approval system designed by educated experts
- Fisheries Act has enforceable standards re: restoration and mitigation including follow up (25 years)
- We understand the full impacts of colonization in the Fraser, we are keeping track of climate change impacts and vulnerability and we are managing for ecosystem resilience
- habitat mitigation projects need to be more cohesive and monitored long term –how can you prove that you have created a functioning ecosystem?
- WSA – as part of its groundwater management policy, BC announces that all new development must use rainwater runoff to recharge groundwater on site, or by building an off-site amenity (pond, etc)
- funding per student of place based education programs for K-12 focused on ecosystems with direct/indirect benefit to salmon
- recognition of our micro wetlands they need to be protected too
- legal protection enacted for existing ecosystems and restored areas that directly or indirectly support salmon habitat
- MK Delta lands transferred to conservation
- Compare FREMP Atlas with losses since then –need visuals

- reinstate the guidebooks/ guidelines for stream management developed by FREMP and influenced to municipalities, stream stewardship books
- Work with and support First Nations
- Boots on the ground for compliance and enforcement, Guardian program re-instated – Why is there a limit?
- Shift in government attitude away from self-enforcement – Consolidation of enforcement powers
- moratorium on any further development on agricultural land and marsh/foreshore/nearshore
- evaluation of the history and success of our habitat protection legislation
- holding port to account on habitat -Fraser watershed study and authority
- education program for governments and people to recognize importance of habitats and ecosystems
- Consolidation of effort of the many groups and individuals working in the Lower Fraser and estuary
- Hold federal government to deliver on promises -Independent of stakeholders, ecosystem comes first
- all development first considers impacts to water and watershed
- change in governance, remove Port from control and reinstate regional planning body oversight
- Coordinated media campaign and public education effort from all ENGOs
- SLR –threat zone mapped out for estuary for local government flood management strategies
- Re-wild the Lower Fraser -Stop extirpation of species, stop population declines
- Reconnecting floodplains -riparian buffers -Outlaw speculation on ALR lands
- Complete overhaul of Port mandate to include prioritizing environment over business profits
- Map out and maintain places where you can connect with the river
- Point Roberts – bring US into vision
- Branding for estuary to get people more attached to place
- High level of community awareness of ecosystem issue -restore the mudflats and biofilm
- Breach the causeway –No T2, Jet fuel, Bridge, LNG, coal exports
- Strong network of community volunteers monitoring local area
- New stronger governance of Fraser River Estuary
- Prioritize wild salmon over farmed salmon -real restoration of estuary habitats
- Achieve the U.N. Sustainable goals -Turn around climate change transition to renewable energy
- have commitment to “living infrastructure” -Crab fisherman able to support lifestyle
- trail along river is completed -Ecological function at core of vision

IN 2050?

- Soften the Fraser riparian zones – setbacks purchase land
- All habitats in the Fraser River ecosystem healthy and salmon populations recovering
- Required training for engineers and planners to keep up to date on current issues and best practices in ecosystem conservation –overseen by professionals with regular updates based on current research
- All development laws have an ecosystem based management approach and are subject to an overarching plan with regulatory teeth
- Ecosystem-first approach implemented
- All fish species habitat mapping and protection along the Fraser and its tributaries
    - 1) New economic model!!
    - 2) The issue with real estate- slow down, develop social housing
- Public and governments understand and embrace sustainability
- Conservation declarations have meaning, respected by governments
- International Treaty (Pacific Salmon Treaty) lived up to enhancement requirements
- Education on the economic value of a healthy ecosystem
- consideration and protection of ecosystem values, supporting tourism and ability of First Nations to harvest
- Consider all areas that support salmon, migration routes -Roberts Bank eco-tourism industry
- Ecological history of the Fraser estuary preserved and understood
- Good PR campaign with visuals to convey message to the public
- Provincial ministries consolidated: FLNRO + MOE + Ministry of Mining
- Stop dredging? -Federal declaration to address river health (nutrients, habitat, sediment)

- Address urban pollution in watershed of eg. Boundary Bay -Rivers: Serpentine, Nicomekl, Little Campbell
- Catch and release sport fishing issues, bycatch issues (Sturgeon, Steelhead, etc.)
- Linked to habitat protections
- Alaksen reconnected to Fraser as move natural bird/salmon habitat
- River protected areas –live marine protected areas -especially for fry
- Living dike project –raising tidal flats and dike
- More rearing and resting habitat for juveniles and migrating
- Secure "core habitats" –with quality management plan –canoe passage –Brunswick point – Westham island –serpentine -nicomekl
- Adaptation plan with ecological function as a goal

IN 2100?

- Established and put into use a researched and supported development decision –making framework that takes into account intrinsic and holistic ecosystem values and usage
- All rainwater that falls on impervious surfaces will either be guided to cisterns for later use or infiltrated in on-site landscaping or infiltrated in community amenity landscaping (ie parks, ponds)
- Reversed GHG emissions and seeing the benefit
- human development is happening responsibly at a rate of growth that considers sustainable development models and a "one planet thinking"
- The whole Fraser River watershed protected, habitats restored all salmon and wildlife populations recovered
- Human population has started to decline after decades of pro-active family planning publicity by governments and non-profits
- Use ecosystem services to design the rules – use SARA to protect estuary (Chinook-orca)
- Restore natural processes –not just dump dredge material
- proud and happy of what we have done to protect and restore
- restored migration pathways along nearshore habitats
- water security authority ex. Manitoba
- Restored salmon runs
- Fully functioning estuarine ecosystem
- No causeways on Roberts bank
- River and salmon have equal respect and standing as corporations

WHAT IS NEEDED IN TERMS OF……:POLITICAL SUPPORT?

- MP's – surge of accountability, not anti- development, pro collaborative works, cumulative effects
- Our vision needs to show benefits to government and politicians, they need to sign on and support our vision
- We need more people at the table who can influence different sectors
- How do you affect change? A champion, consultation, definition, establishing guidelines, appeal to regulating bodies, adoption of guidelines, regulation of practice, re-evaluation and adaptation-being open to change
- Make it easy for people to sign on
- Is there critical mass? Common threat to galvanise around? –what is the critical mass?
- Include other interests fishing, farming , waterfront industry
- take vision to grass roots first then up to leaders
- Make sure First Nations and other stakeholders are on board, united front required
- Established through demonstrating what can be done – pilot projects proof of concept
- Need to understand importance
- Awareness of economic value of the ecosystem
- DFO support for Guardian Watchmen program, ability to enforce regulations, needs funding
- SARA listings -Official declaration protecting river and sockeye salmon –Implement Cohen recommendations
- Migration corridors protected from structures and negative ecological impacts

FUNDING?

- Demonstrate the economic return of investing in habitat protection and restoration
- Big funding organizations and/or corporations to pay for marketing campaign
- Per child funding for access to place based education programs – Federal? Provincial? Municipal?
- Payments for ecosystem services
- Incorporate money for ecological restoration and monitoring into proponent budgets
- funding for project follow up and monitoring – is restoration work successful?
- carbon offsets as a mechanism (credits)
- compensation for farmers giving up land/revenue

- "Fraser funders" bucket of funders, started with discussion from POLIS, RBC, REFBC, -based on water funders
- Buying and re-selling with protective covenants
- Land banking (ie DU)
- Nature trust ex. Of buying, placing easement, re-sell

LEADERSHIP?

- People working to set an example as leaders "in the field" and promoting "best practices"
- Habitat mitigation must be led by a neutral organization not proponent
- First Nations Leadership –LFFA, coastal First Nations, Fraser River Aboriginal Fisheries Secretariat
- Cross interest platform/coalition communication organization group –need a coordinator body
- People leading a group and enforcing accountability of actions to meet best practices and work to update these practices as necessary
- Federal enforcement
- First Nations have the power to leverage –have ear of government, industry, public eg: Port won't consult with ENGO's but they will consult First Nations
- Nation-nation consulting –more leverage when working collectively with other nations
- legally required
- Water leader group: statement of expectations – take elements of vision, convene various leaders to reate expectations document
- Environmental service (Kootenays) through taxes
- tax incentive for residential areas (won't work in ALR)
- Buying development rights – Purchase development rights? (Central Saanich)
- examine options of covenants, development rights
- Marketing campaign to educate public about importance of protecting habitats (think Smokey the Bear)
- "Save a ditch, save a salmon" – Involve youth –get them inspired
- Branding/marketing mascot –Sammy the salmon -Theme song: "have to have a habitat" (a children's song)
- Marketing strategy for an environmental conscious
- set goals for society and create public desire to work to achieve these goals

COMMUNITY ENGAGEMENT?

- Big fun, social campaign: "hug your river" around Rivers day
- Appeal to a new generation of supporters, multicultural inclusive
- find ways to connect by volunteering that are meaningful

GOVERNANCE?

- establishing ecology and ecological sustainability as a Canadian value
- need policies for monitoring and enforcement of: 1) no net loss of habitat 2) two-for-one for losses 3) cumulative impact assessment 4) use of precautionary principle 5) SARA directives 6) climate change issues
- FREMP 2.0 –with more power to regulate
- land needs to be bought and leased back to farmers
- cumulative effects assessment of the "gateway strategy"
- inventory of the state of habitat
- Vision: stop rezoning of industrial land back to residential
- massive changes in habitat function occurring now and effecting birds/ migrating flocks
- go back to FREMPs classification to assess
- compare Prince Rupert and PMV economically in terms of moving things to Prince George
- hold industry to same standard as private landowners
- New authority/body – Not Port
- Community monitoring -Bottom up
- Politicians need to be able to operate independent of corporate interests
- No new development below sea-level
- Strengthen the network of volunteer organizations and individuals –network weaving

OPERATIONS?

- Technical staff on the ground
- civilian conservation cores
- enforcement on the water of existing rules
- Support First Nations in restoration and protections, support their rights and title
- Drainage plans created before approvals are given, incorporate settling ponds and rain gardens to filter water

Investigate. Inform. Inspire.

Raincoast Conservation Foundation
PO Box 2429, Sidney, BC V8L 3Y3
fraserriver@raincoast.org
www.raincoast.org

RAINCOAST
CONSERVATION FOUNDATION