APPENDIX 13-A

Fraser River Chinook Salmon Stock Nomenclature and Stock Status

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Appendix 13-A Fraser River Chinook Salmon Stock Nomenclature and Stock Status

Fraser River Chinook salmon stocks have experienced depressed production in recent years (DFO 2011a). Conservation of Chinook stocks of concern is a primary objective of DFO, along with the protection of freshwater and marine habitats on which Chinook salmon stocks depend (DFO 2011a).

Fraser River Chinook salmon are divided into five management units (MUs) or aggregates (as defined by the Pacific Salmon Commission (PSC) Chinook Technical Committee (CTC)), based on life history (i.e., ocean-type versus stream-type), and run timing in the lower Fraser River (Pacific Salmon Commission 2013). Run timing refers to the peak entry time of individual stocks as they migrate into the lower Fraser River (DFO 2011a). Spring-run populations peak into the Fraser River before July 15; summer-run populations enter the Fraser River between July 15 and August 31, and fall-run populations enter from September 1 onwards (DFO 2011a). The five CTC or PSC aggregates[1] are identified as follows:

Fraser spring run age 1.2 (i.e., spring 4_2);

Fraser spring run age 1.3 (i.e., spring 5_2);

Fraser summer run age 1.3 (i.e., summer 5_2);

Fraser summer run age 0.3 (i.e., summer 4_1); and

Fraser late (i.e., Harrison) (i.e., fall 4_1).

The Fraser fall-run stock group consists of Harrison River Chinook, which includes natural spawners in the Harrison River, and Harrison-origin fish that were introduced to the Chilliwack River and other smaller rivers. This group exhibits an ocean-type life history (DFO 2011a), while spring- and summer-run stocks tend to be stream-type. Exceptions are South Thompson and Lower Thompson summer Chinook and other stocks belonging to the age 0.3 aggregate, which exhibit an ocean-type life history (DFO 2011a). The five CTC or PSC aggregates are often further grouped and represented by only two aggregate model stocks: Fraser Early and Fraser Late (Pacific Salmon Commission 2014b).

[1] Chinook age and life history type are expressed as a group of numbers, with different nomenclatures representing different accepted formats. In the European format (e.g., 1.2), the number 1 represents the total number of complete years the fish spend in freshwater, and the number 2 represents the total number of years spent in the ocean. In the Gilbert and Rich, or G-R format (e.g., 4_2), the large number 4 represents the age of the salmon on its *next birthday*. The subscript 2 represents the year in which the fish migrated to the ocean (i.e., it migrated as a 1-year-old in its second year of life).

Fraser River Chinook stocks are sometimes referred to by geographic stock grouping based on spawning location. There are four geographic stock strata:

- Upper Fraser;
- Middle Fraser;
- Thompson River and its tributaries;
    - North Thompson;
    - South Thompson;
    - Lower Thompson; and
- Lower Fraser (numerically dominated by fall-returning Harrison-origin fish).

The lower Fraser River Chinook strata is numerically dominated by fall-returning, ocean-type Harrison-origin fish, but also includes relatively small stocks that migrate in the spring and summer and typically exhibit stream-type life histories (such as the Birkenhead population) (DFO 2011a).

The upper, middle, and Thompson Chinook are sometimes referred to as Interior Fraser River Chinook, all of which spawn above Hope. Within these regions, two migration times are recognised: spring-run and summer-run. There are no true fall-run Chinook populations in the interior Fraser River, and most are stream-type. Notable exceptions are South Thompson and Lower Thompson Chinook, which are ocean-type and migrate as smolts after approximately 90 to 150 days of freshwater residence (DFO 2011a).

The status of Fraser River Chinook is assessed based on trends in spawner escapement data, mainly from annual aerial surveys for which relatively longtime series of data exist (Farwell et al. 1999, Pacific Salmon Commission 2013). Over the last decade, Fraser River stream-type Chinook escapements have declined, in some cases dramatically (DFO 2011a). Specifically, escapements to the three stream-type aggregates (i.e., spring 5_2, summer 5_2, and spring 4_2), making up the Fraser Early group, declined steeply between 2003 and 2009, and smolts that entered the ocean in 2005 and 2007 faired particularly poorly (Pacific Salmon Commission 2013). Recent escapements indicate that the declining trend in stream-type Chinook may have halted. Nevertheless, all three stream-type aggregates making up the Fraser Early group are still considered *stocks of concern* (Pacific Salmon Commission 2013). The rebuilding process has been particularly slow for spring 4_2, a stock aggregate with an early maturation schedule for a stream-type life history, resulting in smaller body size and lower fecundity compared to many other stocks groups (Pacific Salmon Commission 2013).

In contrast to escapements for stream-type Chinook, escapements for ocean-type Chinook have been increasing or showing no discernible trends (Pacific Salmon Commission 2013). Escapements to the Fraser summer 4_1 aggregate increased over the last decade until 2012, when they declined steeply like many other far-north migrating stocks. However, this aggregate is considered healthy and abundant (Pacific Salmon Commission 2013). Increased escapements of summer 4_1 Chinook support the notion that Chinook emigrating as fry may encounter more suitable ocean conditions, such as greater foraging opportunities and less predation, than those emigrating as smolts, perhaps as a result of medium- or long-term environmental change (Labelle 2009). Fraser fall 4_1 (i.e., Harrison) escapements have fluctuated substantially with no apparent trend in the time series (Pacific Salmon Commission 2013). Given the substantial declines experienced by stream-type Chinook in the last decade, management objectives continue to focus on the conservation of Fraser River Chinook, with a major objective being protection of a broad range of stocks to maintain biodiversity and genetic integrity (DFO 2011a).

APPENDIX 13-B

Chinook Abundance Index

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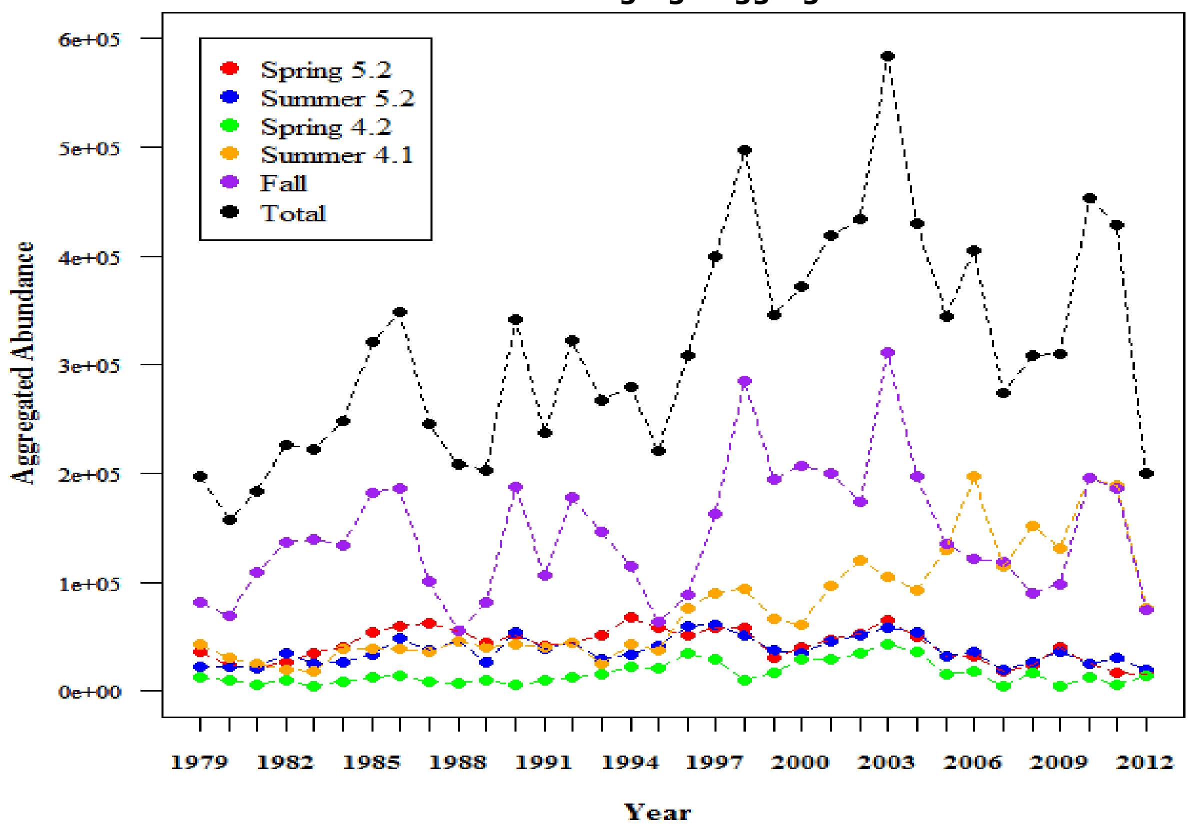
Appendix 13-B Chinook Abundance Index

Available over a long time series, estimates of total return of Chinook salmon to the Fraser River, by stock aggregate and individual stock, show the variability in aggregate or stock size among years. The fundamental building blocks for DFO's run reconstruction analysis are estimates of: (1) in-river harvests; (2) tributary-specific escapement numbers and timing; and (3) upstream migration rates (English et al. 2007). Standard deviations[1] for timing age aggregates range from 10,372 (for spring 4_2) to 60,131 (for fall); the standard deviation for all Fraser stock aggregates considered together is very large (100,969). Differences between the maximum and minimum estimates of total return for each timing age aggregate range from 38,390 (for spring 4_2) to 256,134 (for fall); the difference between the maximum and minimum estimate of total return for all Fraser stock aggregates considered together is 425,940 salmon[2].

Figure 13-B Annual Estimates of the Total Return of Chinook Salmon to the Fraser River for Each Timing Age Aggregate from 1979 to 2012



Source: Parken 2014, unpublished data

1 Standard deviation measures the amount of variation or dispersion from the average, where a low standard deviation indicates that the data points tend to be very close to the mean (also called the expected value) and a high standard deviation indicates that the data points are spread out over a large range of values.

2 DFO's Fraser Chinook salmon run reconstruction model is used as an index to estimate trends in the total return of Chinook to the Fraser River; as such, abundance estimates (i.e., which tend to under-estimate total fish abundance) should not be considered representative of the absolute number of fish returning to the Fraser River (Parken, unpublished data, 2014).

APPENDIX 13-C

Rationale for Inclusion/Exclusion of Other Certain and Reasonably Foreseeable Projects and Activities in the Cumulative Effects Assessment of Marine Fish

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Appendix 13-C Rationale for Inclusion/Exclusion of Other Certain and Reasonably Foreseeable Projects and Activities in the Cumulative Effects Assessment of Marine Fish

The assessment included consideration of the potential for an interaction between a potential Project-related residual effect on marine fish and the effects of other certain and reasonably foreseeable projects and activities on that VC. The rationale for the inclusion or exclusion of each certain and reasonably foreseeable project and activity identified in **Table 8-8 Project and Activity Inclusion List**, from the cumulative effects assessment is presented in **Table 13-C1**.

Table 13-C1 Rationale for Inclusion/Exclusion of Other Certain and Reasonably Foreseeable Projects in the Cumulative Change Assessment of Marine Fish

Other Certain and Reasonably Foreseeable Project /Activity	Inclusion (I)/ Exclusion (E)	Rationale for Inclusion/Exclusion
Project		
BURNCO Aggregate Project, Gibsons, B.C.	E	No potential for cumulative interaction due to distant location from Roberts Bank, and number of vessels in Strait of Georgia is anticipated to be small compared to overall traffic (**Table 8-8**); therefore, any cumulative change is not anticipated to be measurable.
Centerm Terminal Expansion, Vancouver, B.C.	E	Potential for increased disturbance to Pacific herring from underwater noise from container traffic within the Strait of Georgia; however, the number of vessels is anticipated to be small compared to overall traffic (**Table 8-8**), and any cumulative change would not be measurable.
Fraser Surrey Docks Direct Coal Transfer Facility, Surrey, B.C.	I	Potential for behavioural disturbance to Pacific herring from underwater noise associated with barge and vessel traffic transiting through the Strait of Georgia.
Gateway Pacific Terminal at Cherry Point and associated BNSF Railway Company Rail Facilities Project, Blaine, Washington	I	Potential for behavioural disturbance to Pacific herring from underwater noise associated with barge and vessel traffic transiting through the Strait of Georgia, and potential for permanent loss of subtidal habitats for Pacific sand lance and flatfish.
Gateway Program - North Fraser Perimeter Road Project, Coquitlam, B.C.	E	Not relevant to marine fish assessment due to land-based nature of project.

Other Certain and Reasonably Foreseeable Project /Activity	Inclusion (I)/ Exclusion (E)	Rationale for Inclusion/Exclusion
George Massey Tunnel Replacement Project, Richmond and Delta, B.C.	E	Project relevant to marine fish assessment through potential water quality and sedimentation effects. Mitigation will likely be implemented; however, a lack of pertinent publicly available information limits its inclusion as part of this assessment.
Kinder Morgan Pipeline Expansion Project, Strathcona County, Alberta to Burnaby, B.C.	I	Potential for behavioural disturbance to Pacific herring from underwater noise associated with tanker traffic transiting through the Strait of Georgia, and potential for permanent loss of subtidal habitat for Pacific sand lance and flatfish.
Lehigh Hanson Aggregate Facility, Richmond, B.C.	E	Project relevant to marine fish assessment through potential water quality and sedimentation effects; however, any influence or change to marine fish productivity would likely be negligible. Project is expected to have a negligible contribution to future underwater noise levels.
Lions Gate Wastewater Treatment Plant Project, District of North Vancouver, B.C.	E	No potential for cumulative interaction due to land-based project, and any underwater noise generated from discharges to Burrard Inlet are expected to be negligible.
North Shore Trade Area Project - Western Lower Level Route Extension, West Vancouver, B.C.	E	Not relevant to marine fish assessment due to land-based nature of project.
Pattullo Bridge Replacement Project, New Westminster and Surrey, B.C.	E	Project relevant to marine fish assessment through potential water quality and sedimentation effects (i.e., elevated TSS and sedimentation anticipated during construction as a result of dredging for access by construction equipment and barges and installation of bridge support structures). Mitigation will likely be implemented; however, a lack of pertinent publicly available information limits its inclusion as part of this assessment.
Southlands Development, Delta, B.C.	E	Not relevant to marine fish assessment due to land-based nature of project.
Vancouver Airport Fuel Delivery Project, Richmond, B.C.	I	Potential for cumulative interaction with RBT2 as project will contribute to underwater noise from tanker and barge traffic within the Strait of Georgia. Potential for permanent loss of subtidal habitat for forage fish and flatfish.
Woodfibre LNG Project, Squamish, B.C.	E	No potential for cumulative interaction due to distant location from Roberts Bank, and number of vessels in Strait of Georgia is anticipated to be small compared to overall traffic (**Table 8-8**); therefore, any cumulative change is not anticipated to be measurable.

Other Certain and Reasonably Foreseeable Project /Activity	Inclusion (I)/ Exclusion (E)	Rationale for Inclusion/Exclusion
Activity		
Incremental Road Traffic Associated with RBT2	E	Not relevance to marine fish assessment due to land-based activity.
Incremental Train Traffic Associated with RBT2	E	Not relevance to marine fish assessment due to land-based activity.
Incremental Marine Vessel Traffic Associated with RBT2	I	Potential for cumulative interaction with RBT2 as the activity will contribute container vessel traffic within the Strait of Georgia.