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Pacific Region

Canadian Science Advisory Secretariat
Science Advisory Report 2019/052

RECOVERY POTENTIAL ASSESSMENT - OKANAGAN CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*) (2019)

Chinook Salmon adult spawning phase.
Image credit: Fisheries and Oceans Canada

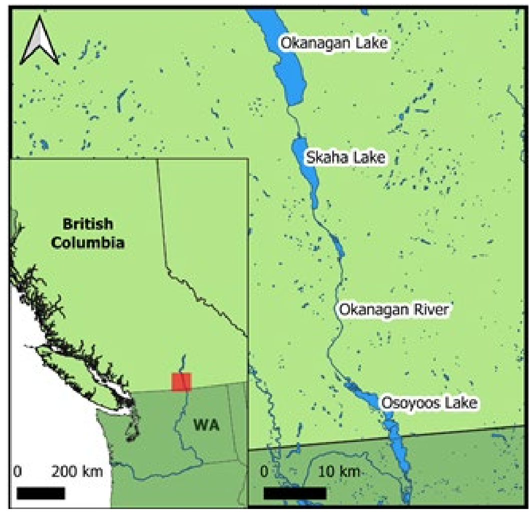

Figure 1. Map of the Okanagan River from the Okanagan Lake to the Canada/US border into Washington State.

Context:

Okanagan Chinook were assessed in May 2005 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, in an Emergency Assessment. This status was re-examined in April 2006 to be Threatened due to the potential for rescue from nearby Upper Columbia River Chinook populations. In 2010, the Federal Minister of Environment recommended that the Okanagan Chinook population not be listed under the Federal Species at Risk Act. Reasons for not listing this population included substantial losses in revenue to the British Columbia (BC) economy and, even in the complete absence of Canadian fisheries exploitation, the recovery potential being low. COSEWIC reassessed the status as Endangered in 2017, stating that rescue via straying from nearby populations is considered unlikely. Okanagan Chinook Salmon are listed by the province of BC as "apparently secure" – not at risk of extinction, however, the Designatable Unit has a relatively high conservation priority under the BC Ministry of Environment Conservation Framework Priority.

Since 2002, the Okanagan Nation Alliance (ONA) has been actively involved in the study and conservation of Okanagan Chinook. Their activities include enumeration, biological sampling studies, and habitat enhancement. ONA collaborated with Fisheries and Oceans, Columbia River Intertribal Fish Commission, and Summit Environmental to produce an Okanagan Chinook Recovery Potential Assessment (RPA) in 2006. ONA produced a subsequent RPA in 2016.

This Science Advisory Report is from the May 28-30, 2019 regional peer review on Recovery Potential Assessment – Okanagan Chinook (Oncorhynchus tshawytscha). Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada (DFO) Science Advisory Schedule](#) as they become available.

SUMMARY

- Summer, ocean-type, Okanagan Chinook are the Designatable Unit (DU) of Chinook Salmon (*Oncorhynchus tshawytscha*) that spawn in the Okanagan River above Osoyoos Lake in British Columbia (BC). This DU was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered in April 2017. No other life history forms, such as spring stream-type Okanagan Chinook, were assessed.
- Area-under-the-curve escapement estimates for Okanagan Chinook averaged nine non-adipose clipped individuals from 2009 – 2012, then averaged 50 individuals from 2013-2017. In 2018, the escapement estimate was 10 individuals.
- Genetic analysis indicates the Okanagan Chinook are part of the upper Columbia Summer Chinook meta-population from which wild and US hatchery-origin fish are known to stray into Canada. However, DNA analysis of samples collected from Okanagan Chinook indicate that some of the spawning fish in Canada result in progeny that return to Canadian spawning sites.
- High mortality rates are a major factor that inhibit the summer Okanagan Chinook DU's ability to recover. High riverine temperatures, passage at multiple dams, and interception in recreational and commercial fisheries all limit survival and production of the DU.
- Little is known specifically about habitat use in Canada; instead, much of the understanding must be inferred from what is known about the state of habitat for Sockeye Salmon in the Okanagan River and summer Chinook habitat use in the upper Columbia River. Spawning redds within the Okanagan River are defined as the residence for this DU.
- The main anthropogenic threats and limiting factors identified for summer Okanagan Chinook include: modifications to water ways (through dams, channelization, impoundment, water management, and temperature effects), fishery related mortality (largest component associated with US in-river fisheries), predation/competition from invasive species, land use changes in riparian zones, varying freshwater and ocean conditions. Climate change is anticipated to exacerbate the impact of these threats.
- A recovery target based on a 4-year geometric mean of 1,000 spawners was identified in the Recovery Potential Assessment (RPA) report. This recovery target represents a minimal viable population number for which maintenance of a trend toward positive population growth will be crucial.
- The population trajectory and probability that summer Okanagan Chinook reach the DU recovery target was explored using stock-recruit models and forward simulation. The results showed that the probability of reaching the recovery target in 12 years under current conditions is not likely.
- Simulation model results suggest the scenario that had the highest likelihood of reaching the recovery target was supplementing the population with hatchery Chinook from the upper Columbia River. Improved survival rates through freshwater habitat improvements would further support supplementation mitigation efforts (≥ 90% probability).
- Due to the limited information about this DU, significant sources of uncertainty include: meta population dynamics, fishery mortalities (i.e. targeted and bycatch), spawning habitat limitations, freshwater carrying capacity, life history parameters, and magnitude of reduced productivity in relation to specific threats/limiting factors.

- All sources of harm should be reduced to the maximum extent possible. No fishery related mortality is currently sustainable in Canadian waters. Although stock assessment, research, and mitigation actions are sources of potential mortalities, they are required to both facilitate and determine whether positive population grow towards the recovery target occurs.
- Although not quantified here, population growth of anadromous salmon is known to be particularly sensitive to habitat quality; therefore, human-induced impacts to freshwater habitat of Okanagan Chinook Salmon (i.e. downstream migration mortality through dams and reservoirs) should also be considered in addition to fishery mortality when considering allowable harm.

INTRODUCTION

Rationale for Recovery Potential Assessment

After the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses an aquatic species as Threatened, Endangered or Extirpated, Fisheries and Oceans Canada (DFO), as the responsible jurisdiction for aquatic species under the *Species at Risk Act* (SARA), undertakes several actions to support implementation of the Act. Many of these actions require scientific information on the current status of the species, threats to its survival and recovery, and the species' potential for recovery. Formulation of this scientific advice has typically been developed through a Recovery Potential Assessment (RPA) following the COSEWIC assessment. This timing allows for the consideration of peer-reviewed scientific analyses within SARA processes, including the decision whether or not to list a species on Schedule 1, and during recovery planning if the species is listed.

Summer Okanagan Chinook Salmon (*Oncorhynchus tshawytscha*) is the Designatable Unit of anadromous Chinook Salmon assessed under the COSEWIC guidelines as: the only Canadian spawning population of ocean-type Chinook from the Columbia River, reproductively isolated from other Canadian Chinook Salmon populations, and genetically discrete from all other Canadian Chinook Salmon populations. Throughout this report they will be referred to as summer Okanagan Chinook. Okanagan Chinook Salmon are anadromous, spawning in the Okanagan River north of Osoyoos Lake (Figure 1) and rearing in surrounding lakes and rivers. The fish then migrate to the North Pacific Ocean, where they share migration corridors and foraging habitat with other Chinook populations. They return to the Okanagan River at the end of their lifecycle to spawn. Okanagan Chinook Salmon are a first food and of high importance to the Syilx Okanagan Nation.

Okanagan River

The Okanagan River is the Canadian portion of the Columbia River Basin that flows out of Okanagan Lake, passing through Skaha Lake, Vaseux Lake, and Osoyoos Lake before connecting with the Okanagan River in the US. Waters from the Okanagan River flow into the Columbia River and finally the Pacific Ocean, passing through 12 major dams, including three on the Okanagan River (Skaha, McIntyre, and Zosel) and nine on the Columbia River (Wells, Rocky Reach, Rock Island, Wanapum, Priest Rapids, McNary, John Day, The Dalles, and Bonneville).

Biology, Abundance, Distribution and Life History Parameters

Biology

Reproduction

Okanagan Chinook are anadromous salmon that migrate up the Columbia River and spawn in the Canadian Okanagan River. Although there is some indication that spring, stream-type, Okanagan Chinook are present, this RPA focuses on the summer ocean-type Okanagan Chinook. Summer Okanagan Chinook migrate to the sea after only two to five months in freshwater. They return to the mouth of the Columbia River in the summer and make their way back to the Okanagan River to spawn in the fall as age three to five year olds, but most commonly as age four. Other nearby populations in the US Columbia Summers Evolutionarily Significant Unit also spawn at ages two and six.

Genetic Population Structure

An important consideration in assessing the DU is the degree of isolation and genetic distinctiveness of summer Okanagan Chinook. The limited information regarding the genetic influence of US stocks, particularly the spawning success of hatchery strays, within the Okanagan River is a significant source of uncertainty in this RPA. DNA analysis of samples collected from Okanagan Chinook indicate that some of the spawning fish in Canada result in progeny that return to the Canadian spawning sites. Okanagan Chinook also have high levels of genetic variability indicating that they are not a small inbred or depauperate population, but part of a larger meta-population of Upper Columbia River Chinook (Ruth Withler, DFO, Nanaimo, BC, pers. comm.). Evidence of straying from the US is supported by observed hatchery (adipose-clipped) Chinook on the spawning grounds. Recovery target scenarios are based on summer Okanagan Chinook being part of the upper Columbia River summer Chinook meta-population.

Abundance and Trends

Estimates of the minimum number of non-adipose-clipped spawners has averaged approximately nine individuals from 2008 to 2012, increased to approximately 50 individuals from 2013 to 2017, and decreased to 10 spawners in 2018 (Figure 2). In addition to the non-adipose-clipped spawners, there was a small number of hatchery (adipose-clipped) spawners estimated. The proportion of total spawners there were adipose-clipped was less than 25% for all reported years (2008 to 2018) and less than 15% for most of the reported years.

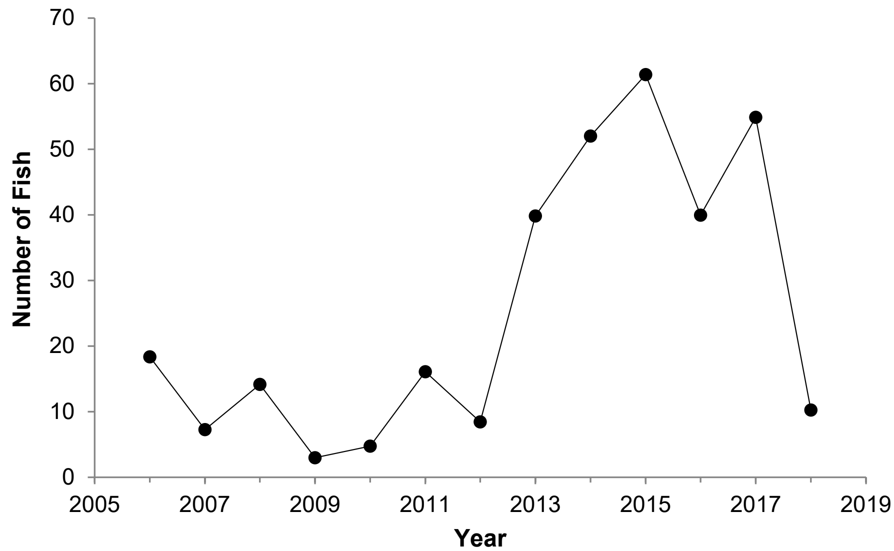

Figure 2. Area-under-the-curve escapement estimates for non-adipose-clipped summer Okanagan Chinook Salmon (2006-2018) Counts are composed of fish enumerated in the Skaha, 'index' and channelized sections of Okanagan River. Data courtesy of Okanagan Nation Alliance Fisheries Department.

Life History Parameters

There is very limited information about the life history parameters of summer Okanagan Chinook. For the purposes of this RPA, life history parameters were assumed to be consistent with upper Columbia River summer Chinook, except for carrying capacity being adjusted downward. These assumptions were identified as a source of uncertainty that could be addressed in future assessments of this DU.

ASSESSMENT

Habitat and Residence Requirements

The definition of habitat for summer Okanagan Chinook includes areas utilized for spawning, nursery, rearing, food supply, migration, and any other areas on which the population depends. Little is known specifically about habitat use and therefore, much of the understanding must be inferred from what is known about US summer Chinook stocks in the Upper Columbia River and Okanagan Sockeye. Spawning redds within the Okanagan River are defined as the residence for this DU.

The life cycle of summer Okanagan Chinook relies on habitats found in both freshwater and marine ecosystems. Freshwater habitats are utilized by juvenile rearing and spawning mature Chinook, while the marine habitat is where they spend much of their life migrating, rearing, and maturing before returning to freshwater habitat to spawn. Based on the small number of returning adults, spawning habitat would not appear to be a limiting factor in the recovery potential of this DU. All spawning habitat capacity estimates are much larger than the current population size. However, the substantial variability in the capacity estimates is a significant source of uncertainty when assessing the recovery potential of this DU.

Freshwater habitat loss is a significant concern for this DU, with much of the habitat alterations occurring between 1910 and 1950. Many of the naturally accessible river channels and much of the riparian vegetation has been lost, potentially contributing to summer water temperatures approaching sub-lethal or lethal limits for juvenile and adult Chinook. Recent restoration efforts have been made to improve freshwater habitat quality in the Okanagan River. However, only 16% (4.9 km) of the Okanagan River's course currently has been left in a natural or semi-natural state (i.e. the remainder has been engineered as a flood control channel).

Summer Okanagan Chinook spend most of their life (i.e. three to four years) in both Canadian and US marine waters. Currently there is no direct information about the behaviour of summer Okanagan Chinook in the marine environment; however, based on summer Columbia River Chinook stocks, they can be encountered in fisheries from Oregon to Alaska. In assessing the recovery potential for this DU, it is important to look at factors that affect Chinook in this environment, such as ocean conditions and fishery dynamics.

Threats and Limiting Factors to the Survival and Recovery

The significant threats and limiting factors to the survival and recovery of summer Okanagan Chinook are provided in the table below (Table 1). This table was developed based on guidance provided by DFO (2014). Both the threats (mainly anthropogenic) and limiting factors (mainly naturally occurring) are summarized in the following sections. When considering both threats and limiting factors, it was identified that anticipated future climate change will further exacerbate their potential risk.

Threats

One of the main identified anthropogenic threats was the modification of water ways through dams, channelization, impoundment, water management, effluent disposal, and modification of riparian zones. Freshwater habitat is an important element to the recovery potential of the DU. Modifications to this habitat can have significant impacts on juvenile survival, in particular the summer temperature and therefore oxygen regimes. Waters in the Okanagan area can reach temperatures that are stressful to rearing juveniles.

The potential of predation and/or competition from invasive species in freshwater was also identified as posing a high threat risk, particularly for juvenile Chinook Salmon. Freshwater invasive species in the Okanagan system include Yellow Perch, Largemouth Bass, Smallmouth Bass, Pumpkinseed Sunfish, Carp and Black Crappie, which may be either competitors or predators (Hyatt and Stockwell, 2019). In addition, Water Milfoil, an invasive aquatic plant, has potentially altered habitat structure to favour invasive fish species relative to indigenous salmonids. Although there is uncertainty as to the specific influences of invasive species on the carrying capacity and mortality rates of juvenile Chinook Salmon in riverine and lacustrine habitats, invasive species represent potentially very important threats to the recovery potential of this DU and warrant clarification.

In addition to threats from freshwater habitat modification, mortalities from freshwater and marine fisheries pose a major threat to the recovery potential of summer Okanagan Chinook. Based on the exploitation rates derived from indicator stocks of summer Columbia River Chinook indicator stocks, this DU may experience annual exploitation rates of 24% in marine fisheries and 45% exploitation rates in terminal (freshwater) fisheries. The majority of this fishery-related mortality is within the US in Southeast Alaska (SEAK), US Individual Stock-Based Management (ISBM.US), and US Terminal (Terminal.US) fisheries (Figure 3).

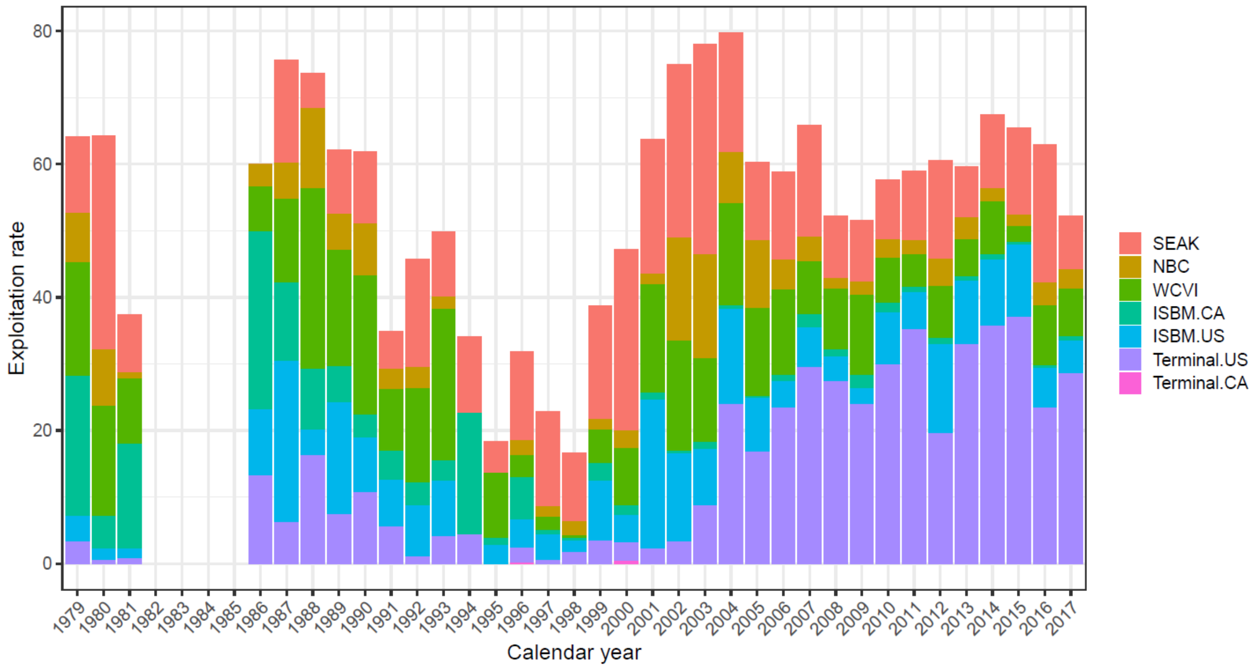

Figure 3. Exploitation rates based on mortality distribution tables for the summer Columbia River Chinook indicator stock, estimated by the Pacific Salmon Commission Chinook Technical Committee for the following fisheries: Southeast Alaska (SEAK), Northern British Columbia (NBC), West Coast Vancouver Island (WCVI), Individual Stock-Based Management fisheries in Canada (ISBM.CA) and US (ISBM.US), and Terminal fisheries in Canada (Terminal.CA) and US (Terminal.US).

Limiting Factors

Limiting factors (threats that are not primarily from anthropogenic sources) were also identified as important to assessing the recovery potential of the summer Okanagan Chinook DU. Although several limiting factors were identified, the key factors that were assessed to be high threat risks were: varying freshwater (i.e. floods, droughts) and ocean conditions (Pacific Decadal Oscillation [PDO], El Niño-Southern Oscillation [ENSO] or other regime shifts that influence production) and, to a lesser extent, predation from non-invasive species. When assessing and potentially mitigating the recovery of this DU, it is important that these limiting factors are considered.

Table 1. Threats assessment for summer Okanagan Chinook Salmon. Refer to DFO (2014) for detailed descriptions of each factor level in the table. The bracketed number following the Threat Risk ranking represents the Causal Certainty rank. Examples are not inclusive of all threat aspects. Greyed out rows represent more specific threats that are not individually broken out, and are captured in the overall threat category.

Threat		Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Mining & quarrying	T3	Remote	Low	Low	Low (4)	Historical	Single	Restricted
Habitat impacts due to transportation and service corridors	T4	Known	High	Medium	High (3)	Historical/ Current/ Anticipatory	Continuous	Restricted
Roads and railroads								
Utility and service lines								
Shipping Lanes								
Population decline due to biological resource use Fishing and harvesting (i.e., Commercial, Recreational, FSC)	T5	Known	High	Very High	High (1)	Historical/ Current/ Anticipatory	Continuous	Extensive
Natural system modification	T6							
Fire & fire suppression	T6	Known	Low	Medium	Low (3)	Historical/ Current/ Anticipatory	Recurrent	Restricted
Dams & water management/use	T6	Known	High	High	High (2)	Historical/ Current/ Anticipatory	Continuous	Extensive
Other Ecosystem Modifications: (e.g. Modifications to Catchment Surfaces, Linear development)	T1	Known	Medium	High	Medium (2)	Historical/ Current/ Anticipatory	Continuous	Extensive
Pollutants	T7	Known	Medium	Medium	Medium (3)	Historical/ Current/ Anticipatory	Continuous	Extensive
Household sewage & urban waste water								
Industrial & military effluents								
Agricultural & forestry effluents								

Threat		Likelihood of Occurrence	Level of Impact	Causal Certainty	Threat Risk	Threat Occurrence	Threat Frequency	Threat Extent
Invasive Species & Genes	T9							
Invasive non-native/Alien species		Known	Medium-High	Medium	High (3)	Historical/ Current/ Anticipatory	Continuous	Extensive
Introduced Pathogens and Viruses		Known	Unknown	Very Low	Unknown (5)	Anticipatory	Continuous	Narrow
Aquaculture - Hatchery Supplementation								
Introduced genetic material	T2	Likely	Low	Very Low	Low (5)	Historical/ Current/ Anticipatory	Recurrent	Narrow
Geological Events (i.e., landslides)	T10	Unlikely	Medium-High	High	Medium (2)[1]	Anticipatory	Single	Extensive

Limiting Factors		Likelihood of Occurrence	Level of Impact	Causal Certainty	Risk	Occurrence	Frequency	Extent
Varying Ocean/ Freshwater Conditions	T8	Known	High	High	High (2)	Historical/ Current/ Anticipatory	Continuous	Extensive
Competition		Known	Unknown	Medium	Unknown (3)	Historical/ Current/ Anticipatory	Continuous	Extensive
Predation		Known	Medium	Medium	Medium (3)	Historical/ Current/ Anticipatory	Continuous	Extensive
Avalanches/landslides		Likely	Low	Medium	Low (3)	Historical/ Current/ Anticipatory	Single	Narrow
Biological & Physiological Limits		Known	Low	Very High	Low (1)	Historical/ Current/ Anticipatory	Continuous	Extensive
Native Parasites & Pathogens		Known	Unknown	Low	Unknown (4)	Historical/ Current/ Anticipatory	Continuous	Extensive

[1] Erratum: Low (2) in green shading now correctly reads Medium (2) in yellow shading.

Recovery Targets

A recovery target based on a 4-year geometric mean of 1,000 spawners within 12 years (most Chinook return by 4 years of age) was identified in the RPA report, and it is one of the criteria (D1) that COSEWIC uses to identify restricted Canadian total populations as Threatened. In a review of Population Viability Analysis (PVA) model and its application to setting conservation targets, Bradford and Wood (2004) concluded that demographically-based conservation goals in the order of 1,000 spawners was only adequate if there was an additional objective of maintaining positive population growth. The committee supported the recovery target and emphasized that the values are minimally adequate (i.e. based on a measure of a minimal viable population number) and maintenance of positive population growth is crucial to the recovery process.

Scenarios for Mitigation of Threats and Alternatives to Activities

The likelihood of meeting the recovery target of 1,000 spawners within 12 years and positive population growth was assessed using a PVA model. In addition to assessing the potential of summer Okanagan Chinook achieving or exceeding the recovery target given existing conditions (baseline), several other scenarios were assessed (Table 2). To assess improvements that may result in the population take longer than 12 years to meet recovery targets, such as survival rate improvements due to habitat restoration work, an additional 30-year assessment was provided.

To assess the potential effect of habitat improvements, several potential and arbitrary reductions in juvenile mortality (10%, 30%, and 50%) were used in the PVA model to assess their likelihood in supporting the DU in achieving or exceeding the recovery target. Habitat associated juvenile mortality reductions were based on reductions to observed dam mortality rates, which respectively works out to a 1.2, 1.6 and 1.9 times increase in out migrating smolts relative to the baseline scenario. In addition to potential juvenile mortality reductions, several hatchery supplementation levels from 50,000 to 500,000 juveniles were also evaluated. Finally, several scenarios, including complete cessation of fishery mortality, combinations of reduced juvenile mortality and hatchery supplementation, and doubling DU productivity, were evaluated. All of these evaluations and the resulting uncertainty were summarized using the likelihood scale identified by the Intergovernmental Panel on Climate Change guidance note on treatment of uncertainty (Mastrandrea et al. 2010).

Results of the PVA for the baseline scenario identified that the DU is “very unlikely” to achieve the recovery target in either the short term or long term, even if juvenile mortality was reduced by 50%. Hatchery supplementation provided a “very likely” certainty of achieving the recovery target with supplementation releases at or above 250,000 juvenile Chinook per year. The likelihood of achieving the recovery target was improved at lower hatchery supplementation levels when combined with juvenile mortality rate reductions, such as supplementing with 150,000 Chinook per year and reducing juvenile mortality by 30% (e.g. through habitat restoration and improved juvenile).

Table 2. Results of the Population Viability Analysis model in assessing the likelihood of achieving the recovery target with a positive population trend based on status quo (i.e. baseline) and several potential mitigation scenarios.

Mitigation Scenario	Recovery Target[1]		Population Trend[2]		Description
	Short-term (12 years)	Long-term (30 years)	Short-term (12 years)	Long-term (30 years)	
Baseline	Very Unlikely	Very Unlikely	Negative	Negative	No action take (i.e., status quo)
Postulated Habitat Improvements					
10% Juvenile Mortality Reduction	Very Unlikely	Very Unlikely	Negative	Negative	See Element 16 for proposed approaches
30% Juvenile Mortality Reduction	Very Unlikely	Very Unlikely	Positive	Positive	
50% Juvenile Mortality Reduction	Very Unlikely	Very Unlikely	Positive	Positive	
Hatchery Supplementation					
50,000 per year	Very Unlikely	Very Unlikely	Positive	Positive	Number of full fitness hatchery releases per year over the duration of the simulation period
100,000 per year	Very Unlikely	Very Unlikely	Positive	Positive	
150,000 per year	Unlikely	Likely	Positive	Positive	
250,000 per year	Very Likely	Very Likely	Positive	Positive	
500,000 per year	Very Likely	Very Likely	Positive	Positive	
Additional Scenarios					
No Harvest	About as likely as not	Very Likely	Positive	Positive	Complete fishery cessation [3]
Productivity 2x	Very Unlikely	Very Unlikely	Positive	Positive	Doubling of spawners to juvenile recruitment [4]
Hatchery 150K + 30% Mort Reduction	Very Likely	Very Likely	Positive	Positive	150,000 hatchery releases combined with a 30% reduced juvenile mortality
Hatchery 150K + No Harvest	Very Likely	Very Likely	Positive	Positive	150,000 hatchery releases combined with complete fishery cessation
No Harvest + 30% Mort Reduction	Very Likely	Very Likely	Positive	Positive	Fishery cessation with a 30% reduced juvenile mortality

[1] The International Panel of Climate Change adopted several risk/certainty categories (Mastrandrea et al. 2010) that are now widely used to categorically describe probabilities of scenarios occurring. Very likely ≥ 0.90, Likely ≥ 0.66, About as likely as not 0.33 – 0.66, Unlikely ≤ 0.33, Very Unlikely ≤ 0.10.

[2] Trends were estimated as the log linear trend on the 4-year geometric mean rolling averages.

[3] No Canadian or international fishery mortality

[4] Reflects per spawner fecundity (alpha parameter in the Rickers curve)

Allowable Harm

All sources of harm should be reduced to the maximum extent possible. No fishery-related mortality is currently sustainable in Canadian waters. Although stock assessment, research and mitigation actions are sources of potential mortalities, they are required to both facilitate and determine whether positive population growth towards the recovery target occurs. Although not quantified here, population growth of anadromous salmon is known to be particularly sensitive to habitat quality; therefore, impacts to freshwater habitat of Okanagan Chinook Salmon (i.e. downstream migration mortality through dams and reservoirs) should also be considered in addition to fishery mortality when considering allowable harm.

Sources of Uncertainty

- The degree of isolation of summer Okanagan Chinook from other upper Columbia River Chinook stocks, such as the influence of hatchery straying, is not well understood.
- Limited information on life history parameters is available for summer Okanagan Chinook. To inform this analysis, much of the life history was based on summer Chinook stocks of the upper Columbia River in the US. However, this DU may not face the same freshwater rearing conditions (e.g. thermal regimes or range of suitable freshwater habitat) as other upper Columbia River Chinook.
- The role of invasive species on the freshwater survival rates of juvenile Chinook in both Canadian and US waters was identified as an important source of uncertainty. Although limited information was available on the specific interactions between summer Okanagan Chinook juveniles and invasive species, information from other Chinook stocks suggests that it may be a significant factor affecting freshwater survival.
- Although all spawning habitat capacity estimates are much larger than the current population size, there is substantial variability in the capacity estimates.
- The impacts of fisheries (i.e. targeted and bycatch mortalities) are a significant component of this analysis. Currently, bycatch information in some non-targeted fisheries is limited or unknown. Furthermore, no direct information is known of this DU’s ocean migration and Columbia River summer indicator stocks are assumed to represent them, as well as other stocks in the evolutionarily significant unit.

LIST OF MEETING PARTICIPANTS

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SOURCES OF INFORMATION

This Science Advisory Report is from the May 28-30, 2019 regional peer review on Recovery Potential Assessment – Okanagan Chinook (*Oncorhynchus tshawytscha)*. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available. The computer source code that supported this analysis is available on GitHub.[2]

Bradford, M. and C. Wood. 2004. A review of biological principles and methods involved in setting minimum population sizes and recovery objectives for the September 2004 drafts of the Cultus and Sakinaw Lake sockeye salmon and Interior Fraser coho salmon recovery plans. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/128. 1 + 48 p.

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[2] Erratum: Sentence added, now reads: The computer source code that supported this analysis is available on GitHub.

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