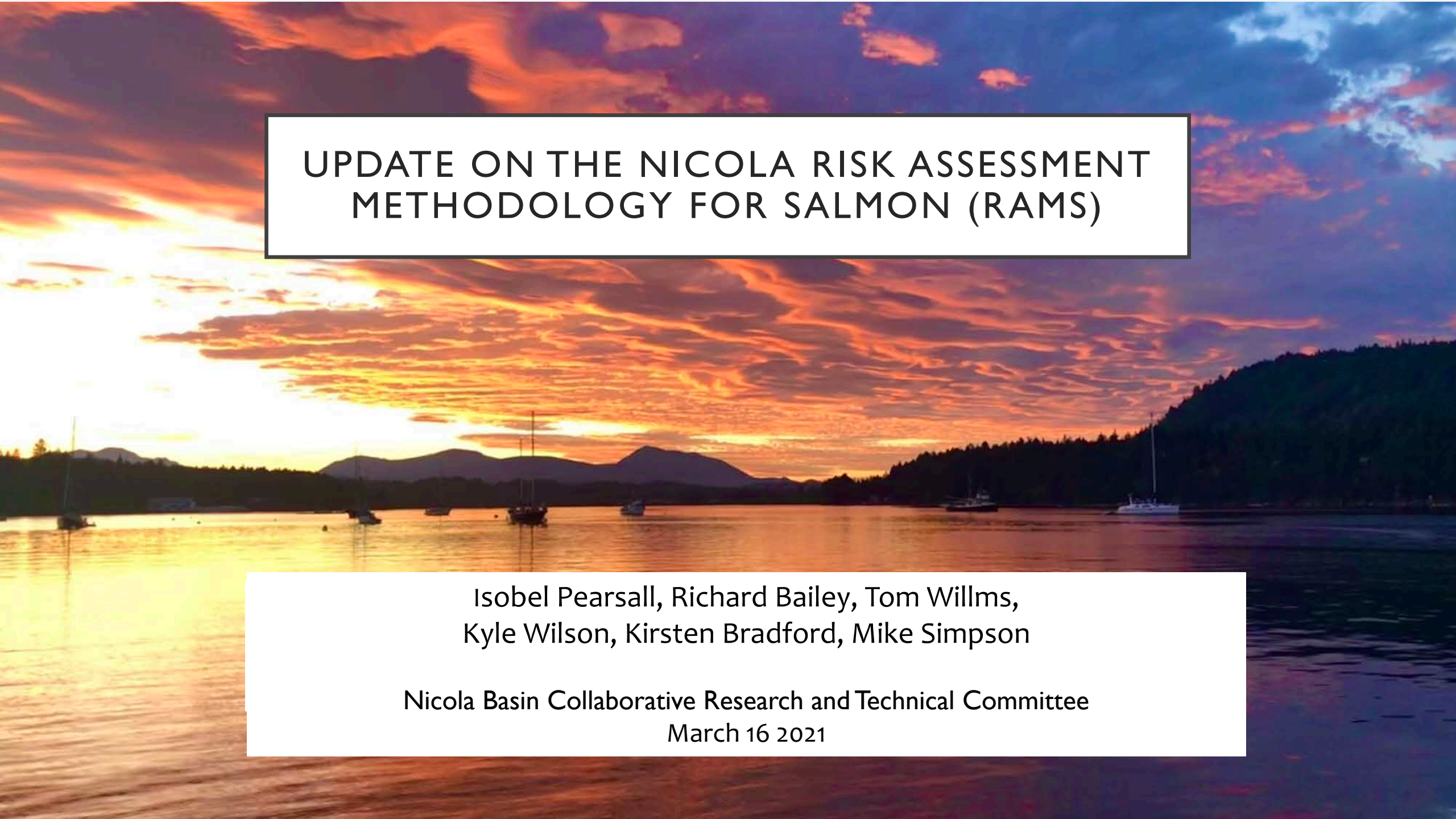




UPDATE ON THE NICOLA RISK ASSESSMENT METHODOLOGY FOR SALMON (RAMS)

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Nicola Basin Collaborative Research and Technical Committee
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RAMS

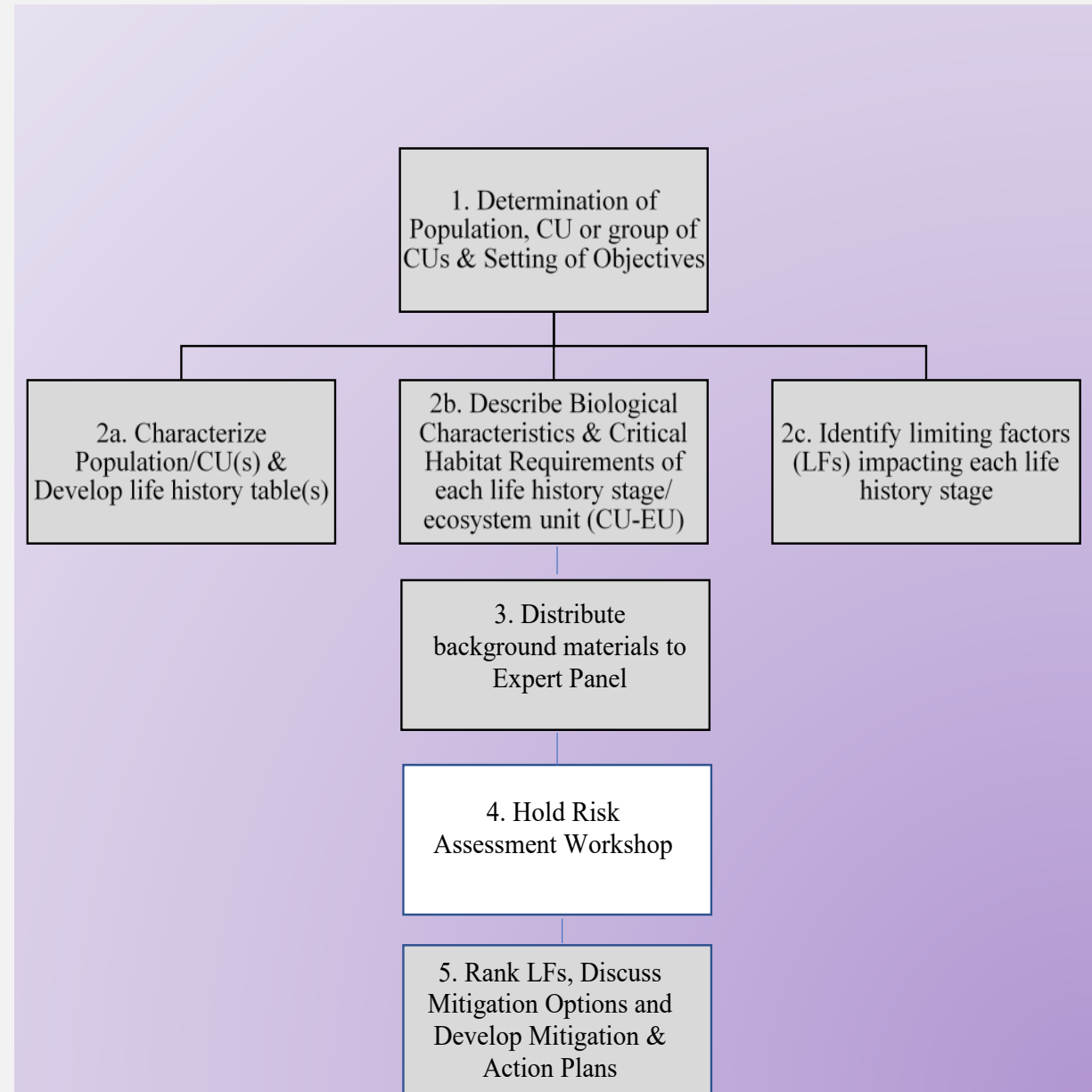
- What is RAMS?
 - A method designed to determine and prioritize the factors limiting the productive capacity of Pacific Salmon populations/stocks/CUs/MUs
 - Adapted from Hobday et al. (2007) approach
- Why?
 - Fisheries Act requirements under Bill C-68 - need to assess risk of cumulative impacts from multiple categories of threats
 - DFO's Wild Salmon Policy objectives
- How?
 - A process based on Vision/goals -> Status -> Limiting Factors -> Options -> Action Plans -> Strategic Plans
 - Integrating expertise from stock and habitat specialists with LEK/IK to achieve consensus on risks and actions
 - Simple, scalable, adaptive, precautionary and repeatable process



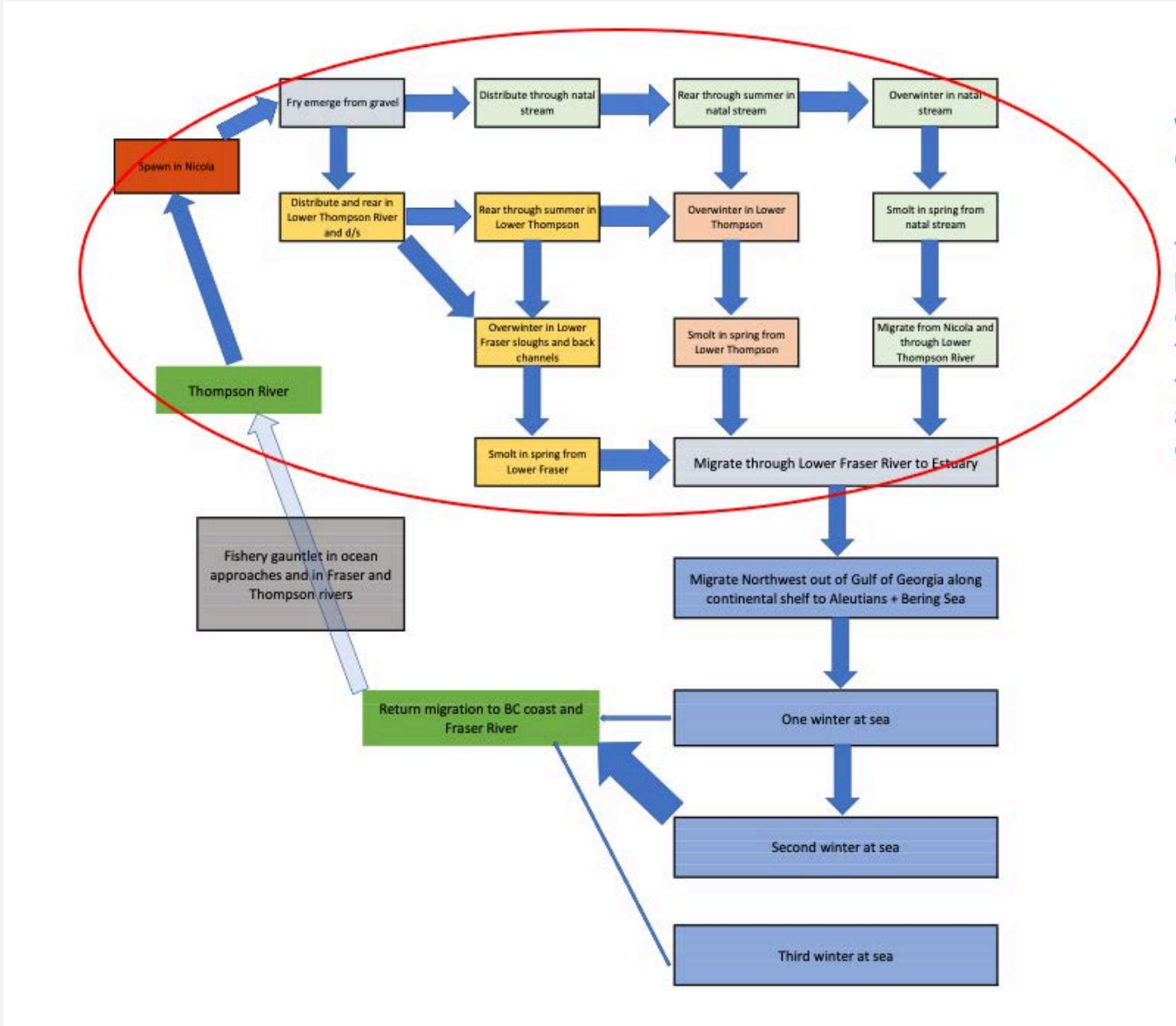
RAMS PROCESS SIMPLIFIED

Winning conditions require:

- Effective Governance
- Policy Framework
- Knowledge to id risks
- Willingness to act
- Funding
- Capacity to monitor



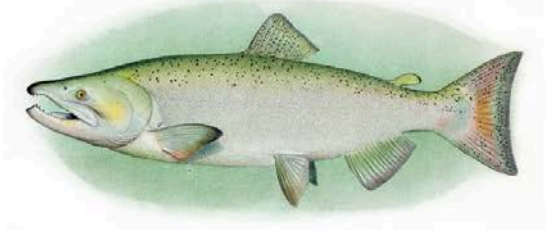
SCOPE OF RAMS FOCUS



- Nicola Basin Chinook: Guichon, Clapperton, Spius, Coldwater, Upper Nicola
- Terminal migration & spawning
- Incubation
- Freshwater Rearing

NICOLA BACKGROUNDER

NICOLA WATERSHED: BACKGROUNDER FOR RISK ASSESSMENT



Photograph By WIKIMEDIA CREATIVE COMMONS

Goals:

DFO has developed a risk assessment methodology to aid in the identification and prioritization of factors that limit salmonid production, both now and in the future under various climate change scenarios. This methodology has been adapted from an “Ecological Risk Assessment for the Effects of Fishing” (ERAEF) framework that was initially developed to inform an ecosystem-based approach to fisheries management in Australia (Hobday et al., 2011). The modified risk assessment methodology allows us to assess the biological risk posed by man-made and natural stressors acting on Pacific salmon throughout their life cycle in freshwater, estuarine and marine environments, utilizing a life history model approach to assess consequence of these

stressors on the productivity and capacity of the population and its habitat.

The primary goal of this upcoming RAMS workshop is to solicit input on the limiting factors that may affect Nicola Basin Chinook freshwater survival and to determine their relative impacts on production as well as identifying where critical knowledge gaps occur. Nicola Basin Chinook includes Chinook in the Nicola River, Spilus Creek, Coldwater Creek and the upper Nicola-Spahomin Creek populations. Ranking of the factors posing the highest risk to current productivity of Nicola Basin Chinook will allow for effective prioritization of management responses.

The second goal of this workshop is to discuss the current and possible future recovery measures/strategies to stimulate the possible recovery of Chinook of the Nicola Basin through remediation, restoration and/or conservation.

BACKGROUND:

The Nicola River is a tributary of the Thompson River and is a sixth order stream located in the interior of southern British Columbia (Figure 1). The entire Nicola watershed covers an area of 7211 km², with the mainstem approximately 188.5 km in length (MOE 2021). The Nicola River produces early-run Chinook, Coho, and steelhead to the Thompson and Fraser River. Important tributaries to the Nicola for salmonids include the Coldwater River and Spilus, Mako, Spahomin, Quilchena, Clapperton and Guichon creeks. The Coldwater River

is the largest tributary, draining an area of 914km and is the most important stream for Coho and early-run Chinook, as well as steelhead in the Nicola watershed.

Nicola Lake is the largest lake in the watershed (area 2,500 hectares), with its outlet controlled by a dam for irrigation purposes. The majority of salmonid production occurs downstream of Nicola Lake; although there is potential for production upstream, it is seasonally sporadic due to insufficient water during summer.

Historically, the Nicola River was an important contributor to interior Fraser River salmon production. However, current salmon escapement to the Nicola system is depressed: Interior Fraser River Coho stocks were COSEWIC listed in 2002, a designation which prompted the need for immediate recovery goals to be established by the Interior Fraser Coho Recovery Team (DFO 2006)¹. In addition, Bull Trout are listed as a Species of Concern by British Columbia Conservation Data Centre; and Nicola River steelhead, which are an important component of the Thompson River stocks, are regarded as an extreme conservation concern by the Ministry of Environment (MOE).

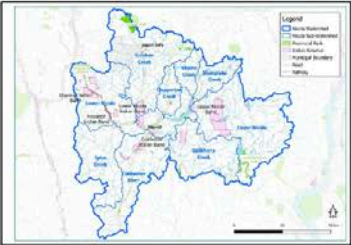


Figure 1. A map of the Nicola Valley showing sub-basins (blue), First Nation communities, parks and municipalities. From the Nicola Watershed Characterization report (ESSA Technologies Ltd. and Fraser Basin Council 2019)

Nicola Basin Climate & Vegetation:

Elevations in the Nicola Basin vary from approx 230 m at the Thompson confluence to 2,300 m near the Pennask Lake summit, resulting in a broad range of microclimates in this watershed. Most of the region is very arid, with very hot summers though the high altitude in this area results in cooler winters than in the surrounding basins. The entire basin also receives less rainfall than nearby areas, as it is in a rain shadow. The basin is also associated with three major valley surficial aquifers (Guichon, Coldwater and Nicola Valley) which provide base flows for the rivers.

Low elevation areas on the lee side of the Cascade Mountains are dry (precipitation between 200 to 300 mm per annum) with hot summers and cool winters, whereas higher elevations are relatively wet (upwards of 400 mm per annum) and cool in all seasons. Plateau areas have hot summers and cool winters, while valleys have daytime temperatures of more than 16°C for five months of the year and periods of hot weather with temperatures in excess of 32°C are frequent during July and August. This usually corresponds with low rainfall, high evaporation rates, and low river flows that places stress on the natural riverine ecology and on agricultural crops due to large moisture deficits. Occasionally in winter, Arctic air enters the area bringing clear skies and cold temperatures, sometimes as low as -35°C. Frost free periods range between 110-120 days in the Nicola Valley while growing degree days vary between 1500 and 1700. In the higher lying areas and in the Coldwater River Valley these values are about 10 to 20 percent lower.

Snow depths increase with elevation and have a significant influence on the potential supply of water in the Nicola River Basin. The hydrograph for the Nicola, Coldwater, and Spilus Creek are all driven by snowmelt. Generally, the largest snowpacks and therefore water yields occur in the Spilus Creek and Coldwater River, draining the Cascade Mountains. Lesser snowpacks occur in the Guichon, Clapperton and Upper Nicola sub-

¹ Interior Fraser Coho Recovery Team. 2006. Conservation Strategy for Coho salmon (*Oncorhynchus kisutch*), Interior Fraser River populations. Fisheries and Oceans Canada

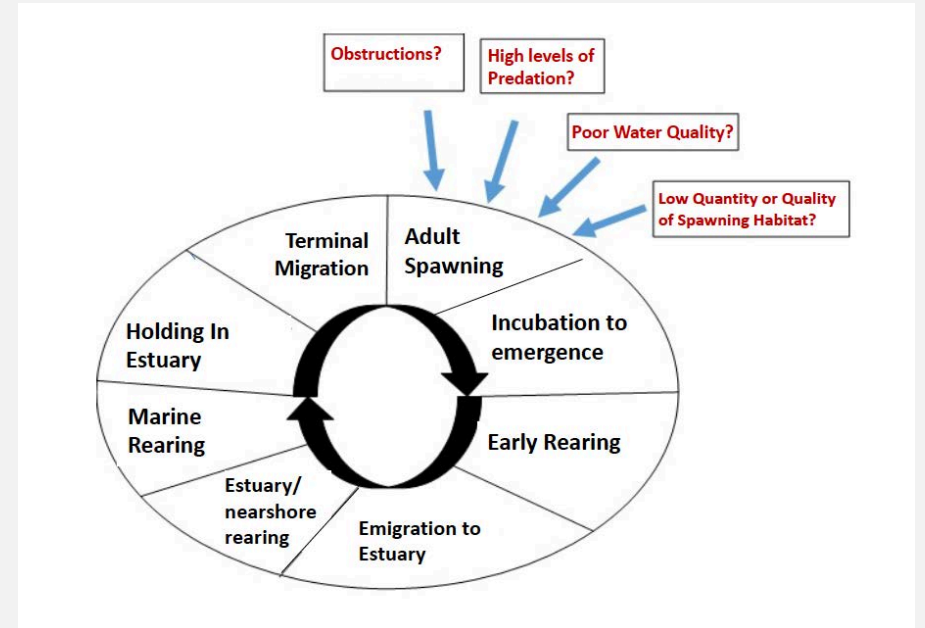
RAMS USES A LIFE CYCLE MODEL TO ASSESS BENEFIT OF REDUCING MORTALITY AT EACH LIFE STAGE

time period	life stage	Chinook	Mortality	Potential limiting factors
March - July	terminal return	500	10.0%	LF1: estuary predation
April - July	upstream migration		3.0%	LF2: delay or limited access; LF3: obstructions; LF4: aggradation; LF5: loss of habitat
April - July	upstream migration		1.0%	LF6: high temp; LF7: water quality
May - June	upstream migration		7.0%	LF8: illegal fishing
Sept - Oct	Spawning		8.0%	LF9: habitat quality; LF10: Disturbance; LF11: disease
Sept - Oct	Spawning	350	1.0%	LF12: spawner predation
Oct - Feb	egg incubation	700,000	33.7%	LF13: sediment; LF14: early emergence; LF15: dewater redds; LF16: scour
Oct - Feb	egg incubation		8.0%	LF18: overspawn; LF19: natural egg predation
Oct - Feb	egg incubation		0.0%	LF20: redd disturbance (non-human); LF21: redd disturbance (human)
Feb - July	early rearing		12.0%	LF22: water quality; LF23: instream complexity; LF24: low water; LF25: high water
Feb - July	early rearing		18.0%	LF26: lack of food; LF27: competition - invasive species; LF28: competition - native species; LF29: predation
Feb - July	early rearing		5.0%	LF30: disturbance; LF30.5: Aquifer drawdowns
Feb - July	early rearing		2.0%	LF31: disease
Feb - July	early rearing	114,450	5.0%	LF32: hatchery introgression
April - July	estuary rearing		25.0%	LF33: lack of food; LF34: predation; LF35: competition/predation from exotics
April - July	estuary rearing		25.0%	LF37A-C: foreshore, intertidal and subtidal habitat;
April - July	estuary rearing	56,081	1.0%	LF38: industrial affects; LF39: disturbance
Aug - Year 2	early ocean rearing		25.0%	LF40: lack of food; LF41: water quality
Aug - Year 2	early ocean rearing	2,289	22.0%	LF42: competition; LF43: nearshore predation
Year 2 - 4	Ocean rearing		0.7%	LF44: offshore predation; LF45: competition with invasives
Year 2 - 4	Ocean rearing	801	0.6%	LF46: offshore habitat; LF47: pollutants; LF48: disease; LF49: harmful algae blooms
Year 2 - 4	Ocean rearing	500	37.6%	LF50: fishing
	Terminal return	500		
	Rate of Change	0.0%		

Assess biological impact by eliminating or reducing that source of mortality.

WHAT ARE LIMITING FACTORS?

- Alternative hypotheses for losses of productivity and capacity resulting in declines
- LFs impact critical habitat and different life history stages of Pacific salmon



CRITICAL HABITAT REQUIREMENTS & LIMITING FACTORS TABLES

INFORMATION TABLES FOR CRITICAL HABITAT REQUIREMENTS, GENERIC LIMITING FACTORS, BENCHMARKS AND INDICATORS FOR NICOLA STREAM TYPE CHINOOK SALMON

Stream type Chinook

ADULT TERMINAL MIGRATION & SPAWNING * NOTE, EACH INFORMATION TABLE IS FOLLOWED BY A COPY OF THE SAME TABLE BUT WITH SPECIFIC INFORMATION FOR THE SYSTEMS IMPORTANT TO CHINOOK WITHIN THE NICOLA WATERSHED

Critical Habitat Requirements	Limiting Factors	Factors Affecting Habitat Features	Benchmarks	Potential Indicators	Details
1. Safe holding habitat in confluence of Thompson-Nicola prior to upriver migration into the Nicola River	LF1: Unscheduled fisheries in the confluence of Thompson- Nicola	-Lack of suitable holding habitat -Lack of riparian cover -Low water levels allowing easy access to migrating fish -High water temperatures delaying migration -Lack of escape habitat -Lighting -Poaching, lack of monitoring and enforcement	-Hicks (2002) suggested that barriers to migration exist for Chinook salmon when maximum daily water temperatures are greater than 21-22°C	-Area of habitat -Riparian cover -Water temperatures & flows -Presence of poachers	-Chinook may wait for ideal temperature or flow levels before entering into a system to start their freshwater migration- thus warming waters or low water depths may cause delays and increase ability for fishers to catch adults. Therefore, this factor is linked to LF2 and 3.
2. Adequate flows to facilitate upstream passage of spawners	LF2: Limited or delayed spawner access	-Lack of storage -Drought conditions -Water diversion for industrial, domestic, resource development e.g. logging -Reservoir operation -Sediment aggradation reduces	-Maximum sustained current velocity for adult upstream migration is 240 cm/s. (Thompson, 1972 in Allen and Hassler 1986). -Obstacle current maximum during adult upstream migration is 610 cm/s (Weaver, 1963 in Allen and Hassler, 1986). -Observed spawning at velocities ranging from 30 -76 cm/s (Briggs, 1953 in Healey, 1991). Observed Chinook spawning at velocities ranging from 37 to 189 cm/s and averaging over 100 cm/s (Chapman et	-Discharge (cms) -Water withdrawals -Road density -Level of discharge in cms -Density of road crossings -Volume of water extraction -Land alteration	-Drought conditions and low river water levels can result in slowed migration rates, leaving fish vulnerable to predation/poaching etc. as well as increased pre-spawn mortality.

ADULT TERMINAL MIGRATION & SPAWNING

NOTES FOR NICOLA

Critical Habitat Requirements	Limiting Factors	Potential Indicators	Nicola, Spius, Guichon, Clapperton, Coldwater, Spahomin
1. Safe holding habitat in confluence of Thompson-Nicola prior to upriver migration into the Nicola River	LF1: Unscheduled fisheries in the confluence of Thompson-Nicola	-Area of estuarine habitat -Riparian cover -Water temperatures & flows -Presence of poachers	For Nicola- the "estuary" is the confluence of the Thompson and Nicola Rivers.
2. Adequate flows to facilitate upstream passage of spawners	LF2: Limited or delayed spawner access	-Discharge (cms) -Water withdrawals -Road density -Year and level of discharge < ____ cms between fall and spring (may vary by system) -Density of road crossings -Volume of water extraction -Land alteration	- In the Nicola, climate change is having a very significant effect on the precipitation patterns and hydrology in the Nicola Watershed leading to drier and more prolonged periods of low flows through the summer and winter in some years. -There are low flows in April, and low summertime and fall flows that affect Chinook. Migration barriers can occur on both the mainstem and tributaries because of low flows through fall- pulses of water are required to mitigate this issue. -Attraction flows for Chinook migration in Aug to early Sept in the mainstem require adequate cold water to be effective. -Flows in this region have been impacted by forest harvesting and mountain pine beetle (MPB) is an added concern: decreases in forest cover due to MPB results in more snow accumulation in dead forests, and in clearcut areas. -Earlier snowmelt leads to increased, faster and earlier runoff, which is also less synchronized at different elevations - During typical drought periods (1 in 10 year event), every sub-basin in the Nicola Watershed has a water deficit through the summer and fall (July to October) and therefore there is insufficient water to meet irrigation and instream flow requirements even when dam storage is factored in. -Upstream migration is likely fine as long as flows >4cms but there are times when mainstem passage can be compromised by low flow issue is much more temperature, except in upper Nicola, lower Coldwater and lower Spius (R Bailey pers. comm) -The Nicola River hydrograph exhibits a pattern typical of snow-dominated regimes. Peak flows are experienced in late April – early May. -Fall flooding, characteristic of rain-dominated hydrographs of coastal BC, have historically been minimal but risk of flooding is much higher now as a result of MPB salvage harvesting which has resulted in elevated Equivalent Clearcut Area (ECA) and harvesting adjacent to streams in higher elevation Sub-basins, Basins and Watersheds (Lewis 2016) -Key flow information from Warkentin et al. (2020) for the Nicola Watershed (as related to habitat):

INCUBATION

Critical Habitat Requirements	Limiting Factors	Factors Affecting Habitat Features	Benchmarks	Potential Indicators	Details
I. Good water quality conditions	LF17a: High suspended sediment loads that reduce egg to fry survival and emergence of alevins LF17b: Non-optimal water temperatures that reduce fry survival by changing emergence time in relation to food availability LF17c: High levels of pollutants or toxins that reduce egg to fry survival LF17d: Low DO which reduces egg to fry survival	-Riverside development and natural erosion -Unstable and eroding channel banks that release fine sediments -Logging, landslides -Lack of riparian cover -Climate change -Industrial and human development	-TSS < 25 mg/L in 24 hrs when background is ≤ 25 mg/L (Stalberg et al., 2009) at established sampling sites in the middle and lower reaches of the mainstem -Target WQ parameters: DO: 5-9 mg/L Egg mortality increases rapidly at DO concentrations below 13 ppm averaging 3.9% at 13 ppm and 37.9% at less than 5 ppm (Gangmark and Bakkala, 1960 in Healey, 1991). As percent saturation decreases during incubation, growth decreases and abnormalities and mortality increase. Lower lethal limit = 1.6 mg/l (Silver et al., 1963 in Allen and Hassler, 1986). The lower limit of DO concentration for developing embryos is 2.5 mg/l at temperatures less than 7 °C; optimal levels are greater than 8 mg/l at temperatures between 7 and 10 °C and greater than 12 mg/l at temperatures over 10 °C (Raleigh et al., 1986). -Minimum requirements of dissolved oxygen for eyed or hatched fish eggs from October to May (minimum of 11.2 mg/L), and alevins or juvenile fish from June to September (minimum of 8.0mg/L) (Obee, 2011). As percent saturation decreases during incubation, growth decreases and abnormalities and mortality increase. Lower lethal limit = 1.6 mg/l. -Temperature range for the incubation of Chinook eggs is from 4.5 to 12.8 °C.	-Total suspended solids during high flows -Depth of fine substrates over redds -Linear measure of eroding silt banks -% Egg to emergent fry survival -mg/L of DO -Water temperatures at emergence - Permitted waste management discharges -Level of intact riparian area -Road density -Water chemistry	-Pacific salmon eggs have a high surface area to volume ratio so are sensitive to reduced oxygen levels -Incubation temperatures outside the ideal range can cause hatching and emergent times that reduce survival. -In extreme cases, freezing of redds can result in the loss of all eggs in the affected areas. Although Chinook eggs and alevins can withstand a wide fluctuation in temperature, decreased survival and impaired development occurs at incubation temperatures below 5.0 °C and above 15 °C. -Healthy riparian vegetation helps moderate extreme high and low temperatures.

INCUBATION

Critical Habitat Requirements	Limiting Factors	Potential Indicators	Nicola, Spius, Guichon, Clapperton, Coldwater, Spahomin
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EARLY REARING

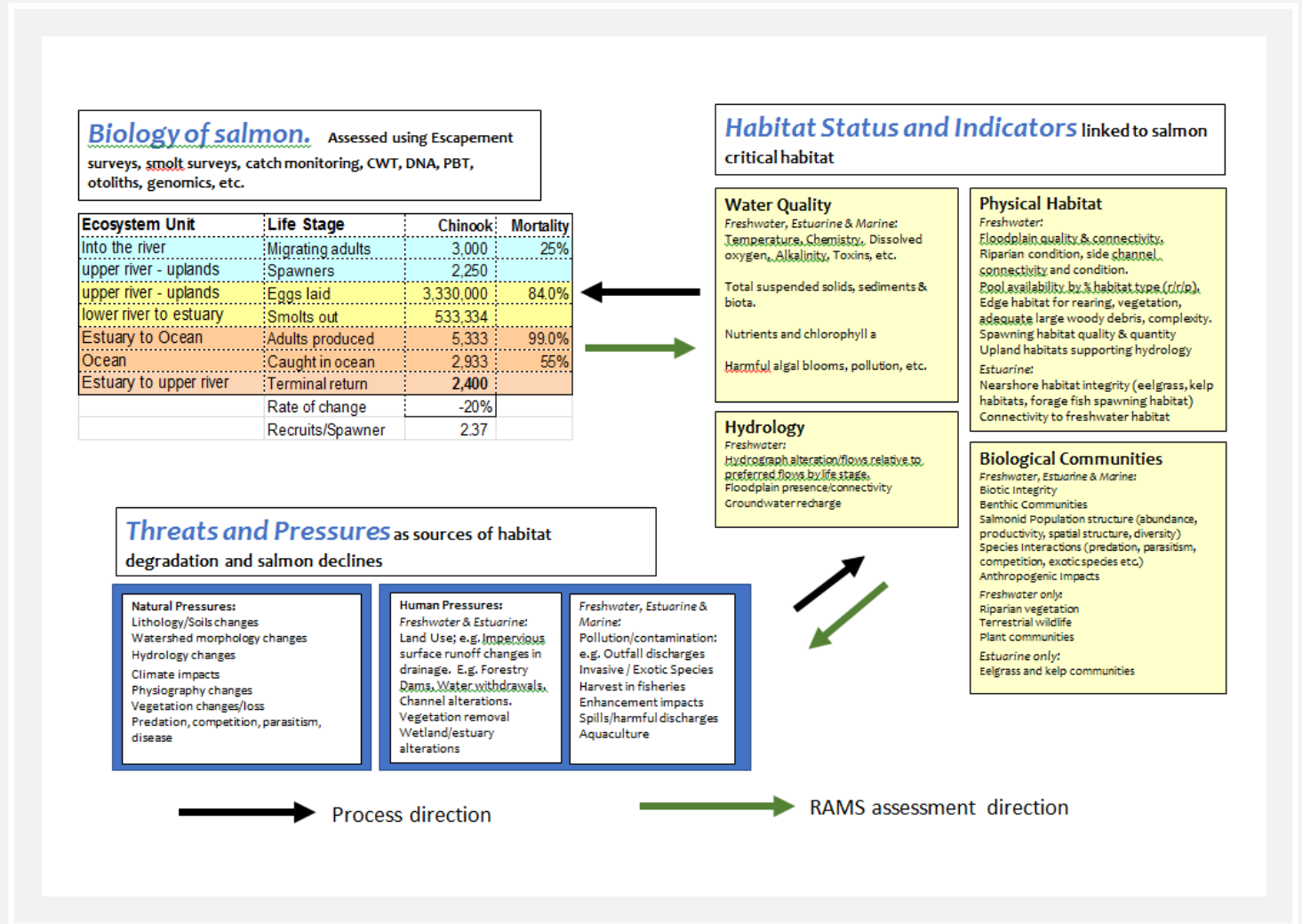
Critical Habitat Requirements	Limiting Factors	Factors Affecting Habitat Features	Benchmarks	Possible Indicators	Details
1. Suitable water temperature, TSS, dissolved oxygen levels, pH, hardness, supersaturation	<p>LF25: a) High water temperature combined with low DO in the lower mainstem river and off channel areas can suffocate fry or reduce overall fitness during the early summer/fall</p> <p>b) High water temperature in the mainstem and off channel areas</p> <p>LF 26: Toxic water quality conditions can increase fry mortality or reduce fitness.</p>	<p>-Industrial development, waste discharge, spills, input from sewage, septic systems and agriculture</p> <p>-Bank erosion and suspended sediment loads can be exacerbated by forestry, rural land clearing and urban development</p> <p>-Air temperature, nitrogen and pH levels, municipal/ domestic sewage discharge, agricultural activities, urban development, effluent from fish hatchery operations throughout the watershed</p> <p>-Climate change</p> <p>-Acid Rain</p>	<p>-Target WQ parameters: DO: 5-9 mg/L, water Temp: Rearing: 15C (Richter and Kolmes, 2005). Chinook upper optimum temp (UOTR) is 14C, Impairment Temp (IT) is 20 C.</p> <p>-Positive growth of juveniles occurs between 4.5 and 19.1°C, maximum growth occurs at 14.8°C, distribution is limited >22C and upper lethal limit occurs when temperatures >25.1°C (McCullough, 1999).</p> <p>-Observed temperature range for juvenile Chinook is from 0 to 24°C with an optimal range of from 12 to 18 °C (Raleigh <i>et al.</i>, 1986).</p> <p>-Sedimentation: Levels of 509 to 1217 ppm are fatal to juveniles. Levels of 500 ppm result in stress responses. Levels of 100 to 300 ppm result in reduced feeding.</p> <p>-Suspended sediment levels of 100-300 ppm result in reduced feeding of juveniles, level of 500 ppm result in stress response in juveniles and levels >500 ppm are fatal to juveniles (Lloyd, 1987).</p> <p>-The BC generalized depth and velocity habitat suitability index curves for Chinook suggest optimum Chinook stream rearing habitats would have depths ≥ 18 cm and velocities ranging from 15–50 cm/s (Burt, 2006).</p> <p>-Davis (1975) noted that fry/juveniles function without impairment at DO levels of 7.75 mg/l, show initial oxygen distress at 6.00 mg/l, and widespread impairment</p>	<p>-Water quality monitoring that includes water temperature, DO levels and suspended sediment levels.</p> <p>- Permitted waste management discharges</p> <p>-% watershed altered by development</p> <p>type, road density</p>	<p>-Once hatched, alevins are sensitive to dissolved oxygen and carbon dioxide concentrations. They will migrate towards adequate DO levels if necessary (>6 mg/L). As well, a buildup of CO₂ around an alevin induced “ventilation” swimming to circulate more water and dissipate the CO₂ (Barnes, 1969 in Quinn, 2005).</p> <p>-Conversely, some water turbidity as a result of sediment may be beneficial due to reduced visibility of the juveniles to predators</p> <p>-Road density results in greater sedimentation</p>

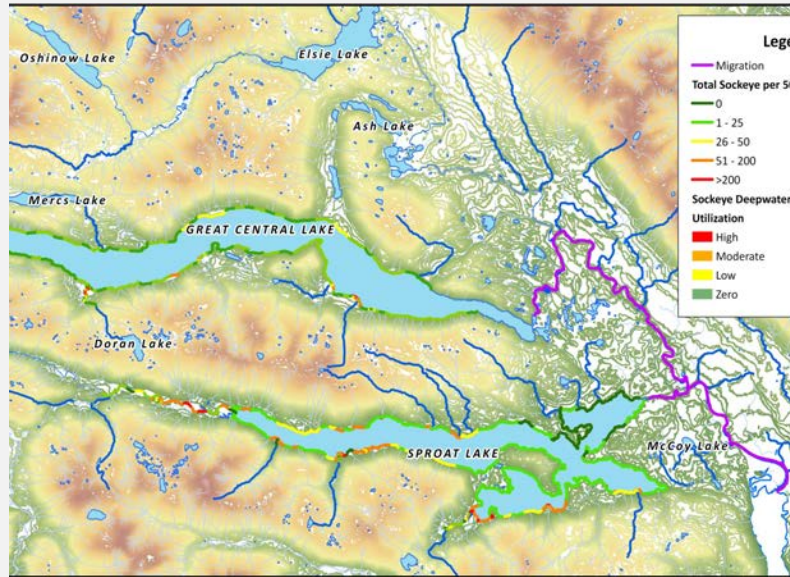
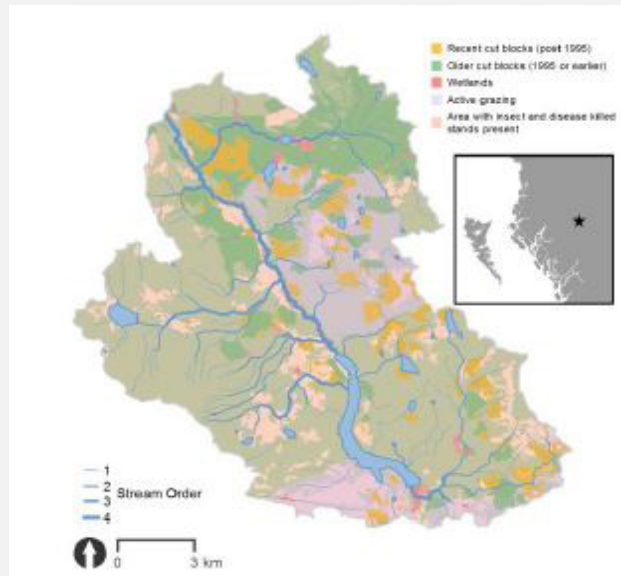
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2. Adequate food supply	<p>LF27: Mortality or fitness impacts as a</p>	<p>-Abundance and composition of drifting and</p>	<p>- Nicola Dam has attenuated high peak flows over a longer time- so high flows during freshet have increased. This has led to increased erosion and turbidity that may decrease aquatic productivity downstream.</p> <p>-In general, however, these systems are productive, not like coastal rivers. The Nicola is also eutrophied by treated sewage and agricultural runoff (R. Bailey, pers.comm)</p>

HOW TO VIEW RISK

- Stock specialists focus on salmon stocks
- Habitat specialists focus on habitat indicators
- RAMS focus on salmon interactions with critical habitat
- SARA focus on threats





STOCK, HABITAT & ECOSYSTEM STATUS

- Collate historical and current stock status and biological characteristics
- Gather information such as fishery impacts, hatchery influence, etc.
- High level habitat indicator status (e.g. ESSA report cards, Pacific Salmon Explorer) -> detailed Habitat Status Reports
- Status of critical habitat and changes over time
- Pressure and State indicators
- Climate projections

STOCK CHARACTERIZATION- RICHARD BAILEY



NICOLA BASIN RAMS

Chinook Stocks, Life
Histories

&

Stock Assessment
Information

Richard Bailey

HABITAT CHARACTERIZATION- TOM WILLMS



HABITAT PRESSURE AND STATE INDICATORS |

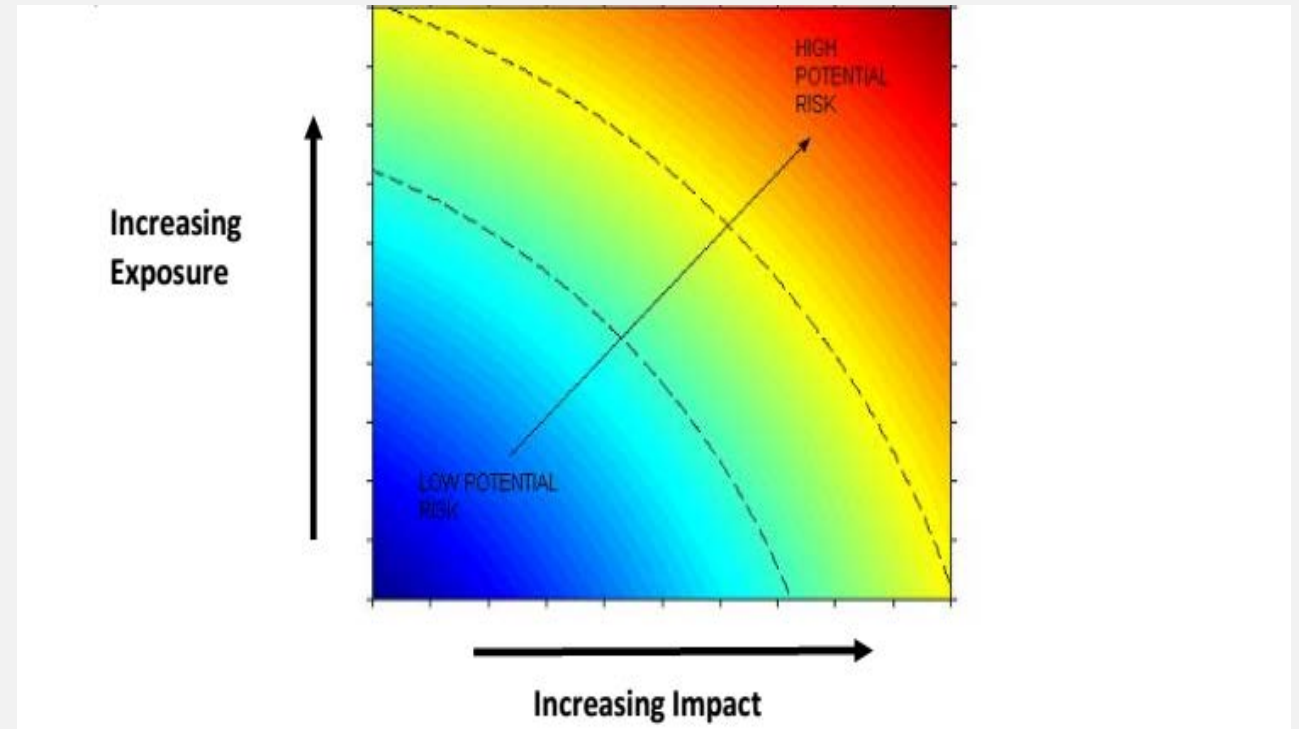
Indicators collated from Smith et al. (2016)
Stream & Lake Pressure Indicators

Indicator	Why is it important?	How to obtain	How to calculate	Benchmarks
Land Cover Alterations	Total land cover alteration captures potential changes in cumulative watershed processes such as peak hydrologic flows and sediment generation that can affect downstream spawning and rearing habitats. Alterations can be categorized by agriculture, urbanization, forestry, fire disturbance, mining activity, and road development.	Watershed statistics can be obtained from DataBC , Baseline Thematic Mapping (BTM), Vegetation Resource Index (VRI), Freshwater Atlas (FWA) Wetlands, RESULTS Openings, Historical Fire Polygons, forest age layers, Google Earth, orthophotos or satellite imagery e.g. Esri DigitalGlobe VIVID 2016 satellite imagery.	Metric is percent by land use.	The total area of land cover alteration in the watershed can be used to assess the risk to the watershed posed by this pressure indicator. This can be done comparing watersheds/ systems as having high, medium or low levels of land cover alterations.
Watershed Road Development	Watershed road density is positively correlated with land-use within a watershed and is an indicator of overall watershed development. Road construction in a watershed may increase fine sediment deposition into streams and lakes, reduce aquatic invertebrate diversity, affect aquatic connectivity, and channel morphology (Tschaplinski 2010; Brown et al. 2013).	GIS layers can be obtained from the LDRW, local forestry companies, e.g. the Digital Road Atlas layer; Forest Impervious roads; satellite imagery of the CU/watersheds such as Esri DigitalGlobe VIVID 2016; high resolution orthophotographs.	Road development densities can be determined by dividing the total length of roads in each watershed by the watershed area. Thus the metric is road density in km/km ²	Stallberg et al. (2009) suggested the following benchmarks: <0.4 km/km ² = lower risk >0.4 km/km ² = higher risk
Stream Crossing Density	Stream crossings have the potential to impede fish passage through interfering with or blocking access to upstream spawning or rearing habitats (and therefore reducing the total amount of habitat salmonid habitat in a watershed (Harper and Quigley, 2000)). These crossings have also been known to increase sediment delivery to streams through the provision of direct pathways to aquatic habitats (Brown et al. 2013).	Stream crossing information may be obtained from the Provincial Stream Crossing Inventory System (PSCIS). Stream and lakes may be mapped using the DataBC , "TRIM Stream Lines - 1:5,000" and "Freshwater Atlas Lakes" layers.	Stream crossing density can be calculated for each sub-basin /watershed by dividing the total number of crossings present in each sub-basin/watershed by the sub-basin/watershed area.	Watershed stream crossings density can be compared among watersheds/basins/sub-basins

HOW TO ASSESS RISK-SCORING METHODOLOGY

ISOBEL PEARSALL

- Risk = Exposure*Consequence
- Exposure (likelihood) 1-5- spatial, temporal
- Consequence (impact) 1-5
- 2 time passes- current & 50 years into future



DEVELOP BACKGROUND MATERIALS FOR WORKSHOP

			IDENTIFIED RISKS. These factors will affect the productive capacity of Nicola Basin Chinook			Pressure Risk Assessment						State Indicator Risk Assessment											
ccosystem Unit:	Life History Phase:	Life History category	Life History Requirement - Critical Habitat	Limiting Factor	LF_ID	Estuary Habitat Disturbances	Permitted Waste Management Discharges	Riparian Disturbance	Total land cover alterations	Water Extraction	Watershed Road Density	Cumulative Risk (Pressures)	Accessible Stream Length	Channel Stability	Estuary Chemistry & Contaminants	Estuary Dissolved Oxygen	Estuary Habitat Area	Habitat Composition	Key Spawning Areas	Large Woody Debris	Stream Discharge	Wadeable	
estuary	adult	terminal adult migration and spawning	Safe holding habitat in confluence of Thompson-Nicola prior to upriver migration into the Nicola River	LF1: Predation of adults in the estuary and lower river by pinnipeds	1	Low	Moderate	Very High	High	Moderate	Very High	2.7	#N/A	Very High	#N/A	#N/A	Very High	Very High	#N/A	#N/A	Low		
lower river	adult	terminal adult migration and spawning	Adequate flows to facilitate upstream passage of spawners	LF2: Limited or delayed spawner access	2	Low	Moderate	Very High	High	Moderate	Very High	2.7	Moderate	Very High	#N/A	#N/A	#N/A	Very High	#N/A	#N/A	Low		
upper river	adult	terminal adult migration and spawning	Unrestricted access	LF3: Potential delays in upstream migration due to the physical barriers (natural or anthropogenic)	3	#N/A	#N/A	Very High	High	Moderate	Very High	3.3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	Low		
lower river	adult	terminal adult migration and spawning	Stable channel morphology, maintenance of channel capacity and natural level of sediment transport	LF4: Aggradation creates a migration barrier in the lower river during summer and early fall period.	4	#N/A	Moderate	Very High	High	Moderate	Very High	3.0	Moderate	Very High	#N/A	#N/A	#N/A	Very High	#N/A	#N/A	#N/A		
lower river	adult	terminal adult migration and spawning	High quality migration route with adequate refuge habitat	LF5: Loss of safe migration route through the lower rivers due to channelization, loss of habitat complexity and instream cover features	5	#N/A	Moderate	Very High	High	Moderate	Very High	3.0	Moderate	Very High	#N/A	#N/A	Very High	Very High	#N/A	Low	#N/A		
lower river	adult	terminal adult migration and spawning	Suitable water quality	LF6: High water temperatures in the lower river and estuary during the late summer/early fall migration period can increase migration mortality and sublethal stress.	6	#N/A	#N/A	Very High	High	#N/A	#N/A	3.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A		
lower river	adult	terminal adult migration and spawning	Suitable water quality	LF7: Poor water quality conditions during the late summer/early fall migration period (low DO, coliform levels, deleterious substances)	7	#N/A	Moderate	Very High	High	#N/A	Very High	3.3	#N/A	#N/A	Low	Low	#N/A	#N/A	#N/A	#N/A	#N/A		
lower river	adult	terminal adult migration and spawning	An agreed-upon and Enforceable Fishing Plan	LF8: Mortality due to unsanctioned fishing	8	#N/A	Moderate	Very High	High	Moderate	Very High	3.0	Moderate	Very High	#N/A	#N/A	#N/A	Very High	Low	#N/A	Low		
lower river	adult	terminal adult migration and spawning	Availability of high-quality and sufficient quantity spawning habitat	LF9: Lack of high quality and quantity of spawning habitat	9	#N/A	Moderate	Very High	High	Moderate	Very High	3.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	Low	#N/A	#N/A		
upper river	adult	terminal adult migration and spawning	Lack of anthropogenic disturbance	LF10: Disturbance to natural spawning activity due to anthropogenic impacts	10	#N/A	#N/A	Very High	High	Moderate	#N/A	3.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	Low		
Pressure_State_Risk		Linking Limiting Factors		Cumulative Risk		RiskAssessment-Main		Lifestage Model		Parameter Lookups		+											

RAMS WORKSHOP GOALS

- **Identify who should be involved-** include technical, local & traditional expertise
- Develop common understanding
- Identify and rank the major limiting factors posing risk to the productivity of salmon in the watershed/CU
- Identify knowledge gaps
- Develop a plan to mitigate high-risk components through a series of action items
- Identify funding sources

NEXT STEPS

April

- Distribute the Nicola Backgrounder to NBCRTC
- Distribute LF tables to NBCRTC for comments and additions
- Post the Stock Characterization, Habitat Characterization and Scoring Methodology Videos to: https://www.fraserbasin.bc.ca/Nicola_Basin_Collaborative.html

May-June

- Collation of indicators/spatial information for habitat
- Organize workshop

July-August

- Complete the LH model component
- Hold first RAMS workshop, complete workshop report and recommendations



OUTPUTS / LEGACY

- General consensus ranked list of factors limiting productivity and knowledge gaps
- Strategic Plan ‘owned’ by local group. Incorporates prioritization and sequencing of appropriate restoration actions
- Specific action plans for highest risks, e.g. fishery plans, hatchery plans, restoration plan, water use plan, etc.