

# Skeena Salmon & Climate Change

## *Adapting to an uncertain future*

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SkeenaWild Conservation Trust





About 500 km (310 miles) across

by Shutter



# The life cycle of Skeena wild salmon



## EGGS

Eggs are deposited in gravel beds in streams, creeks and rivers throughout the Skeena Watershed — from close to the ocean to the river's headwaters 570 kilometres upstream. The timing of spawning differs according to species and geography, ranging from early June to December. Did you know Chinook or Spring salmon are the first species to spawn? They're followed by Sockeye, Pink, Chum and Coho.



## FRY/PARR

Alevins eventually lose their yolk sacs and emerge from the gravel as fry, sometime between March and June. Pink and Chum fry migrate to the ocean immediately and spend up to two years in the estuary. Others remain in rivers and lakes for a year or more before heading to the ocean. Chinook fry, which are often territorial, remain in the river



## ALEVINS

Alevins hatch from eggs in late winter or early spring, depending on the ambient water temperature and spawning time. They grow beneath the spawning gravels for several months, feeding on their orange yolk sacs. Optimal water conditions are critical to the survival of alevins.



Source: SkeenaWild, 2009

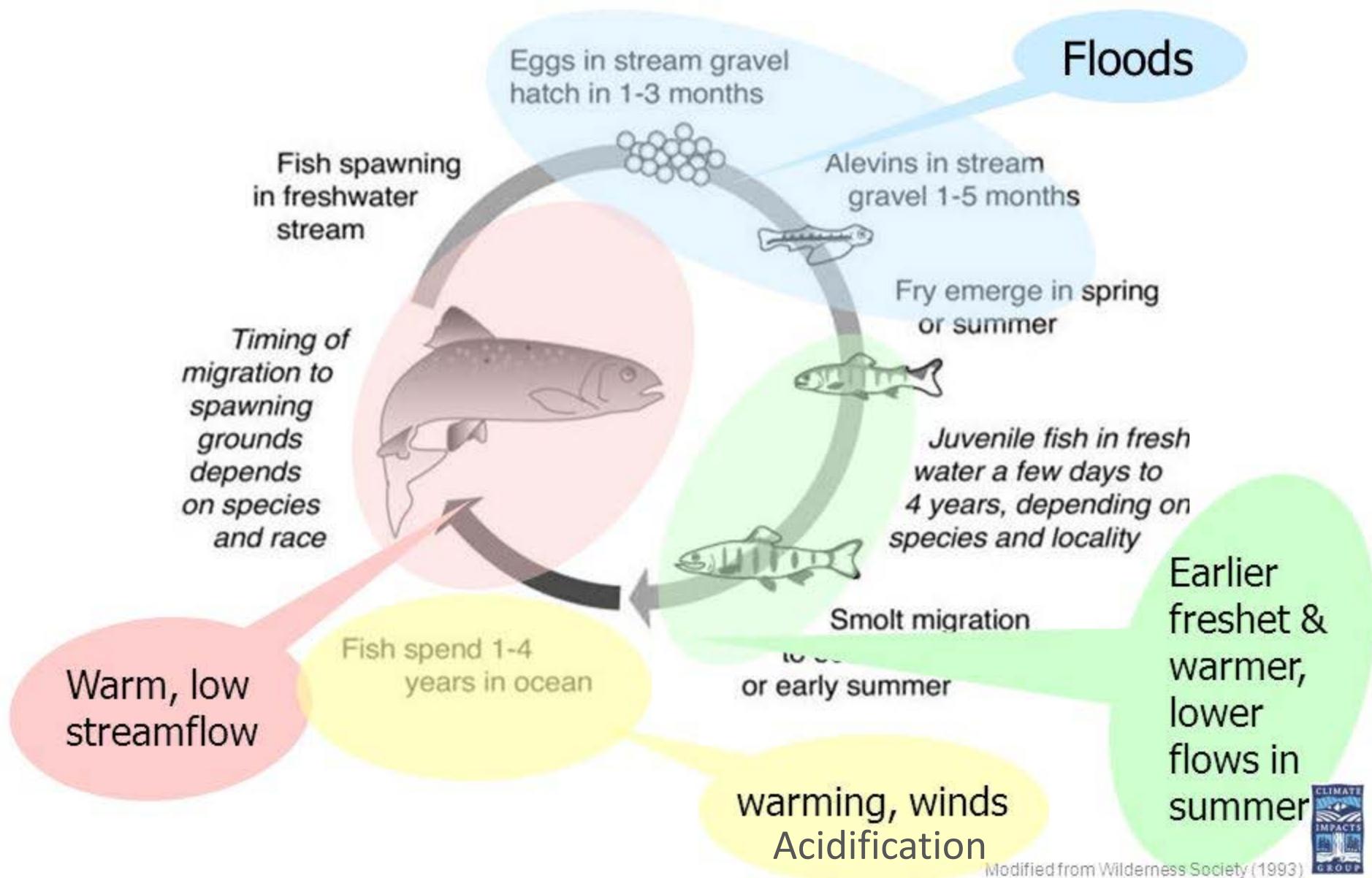
# The Story is Complex

The Skeena has 6 species, and over 300 individual populations

- Each species varies in how long they spend in freshwater, the estuary and ocean, and use slightly different habitats

Climate change impacts all of these environments, species and populations in different, complex, and often unpredictable ways.

## Salmon Affected Across Their Life-Cycle

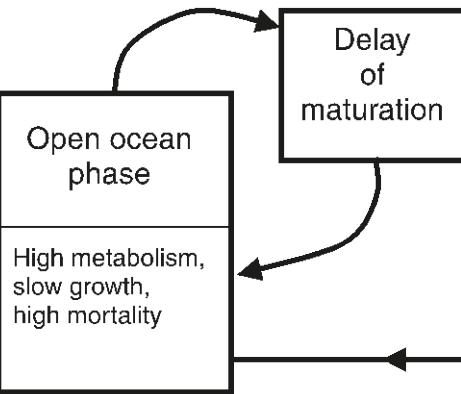


Modified from Wilderness Society (1993)

# How Does Climate Change Impacts Salmon?

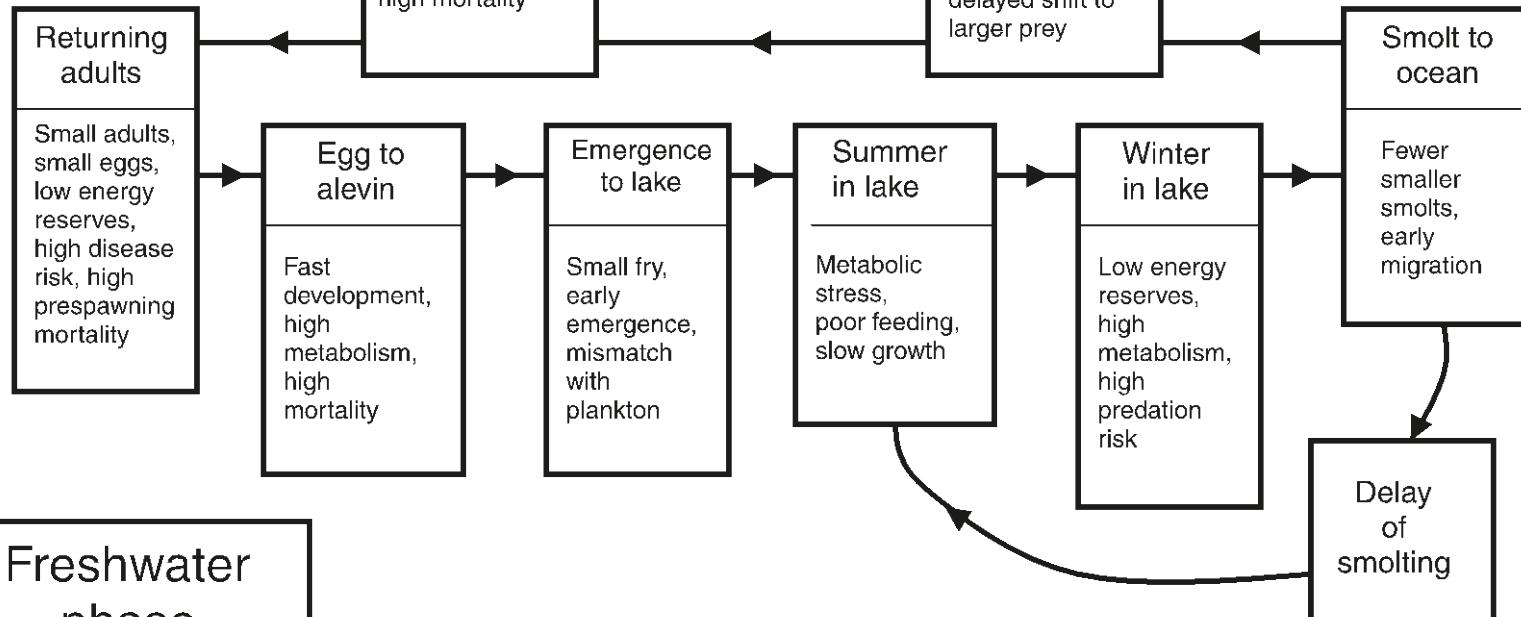
## Marine phase

Warm temperature  
Strong stratification  
Changed phenology  
Low productivity  
Acidification



## Estuary and coast

Timing mismatch with coastal plankton, slow growth, delayed shift to larger prey



## Freshwater phase

Warm temperature  
Strong stratification  
Changed phenology  
Changed species  
Winter freshet

Are we already seeing climate change impacts  
in the Skeena?

Mean annual temperature has increased by .5 °C from the 1961 – 1990 average

Extreme weather events seem to be more common

Glaciers are receding rapidly

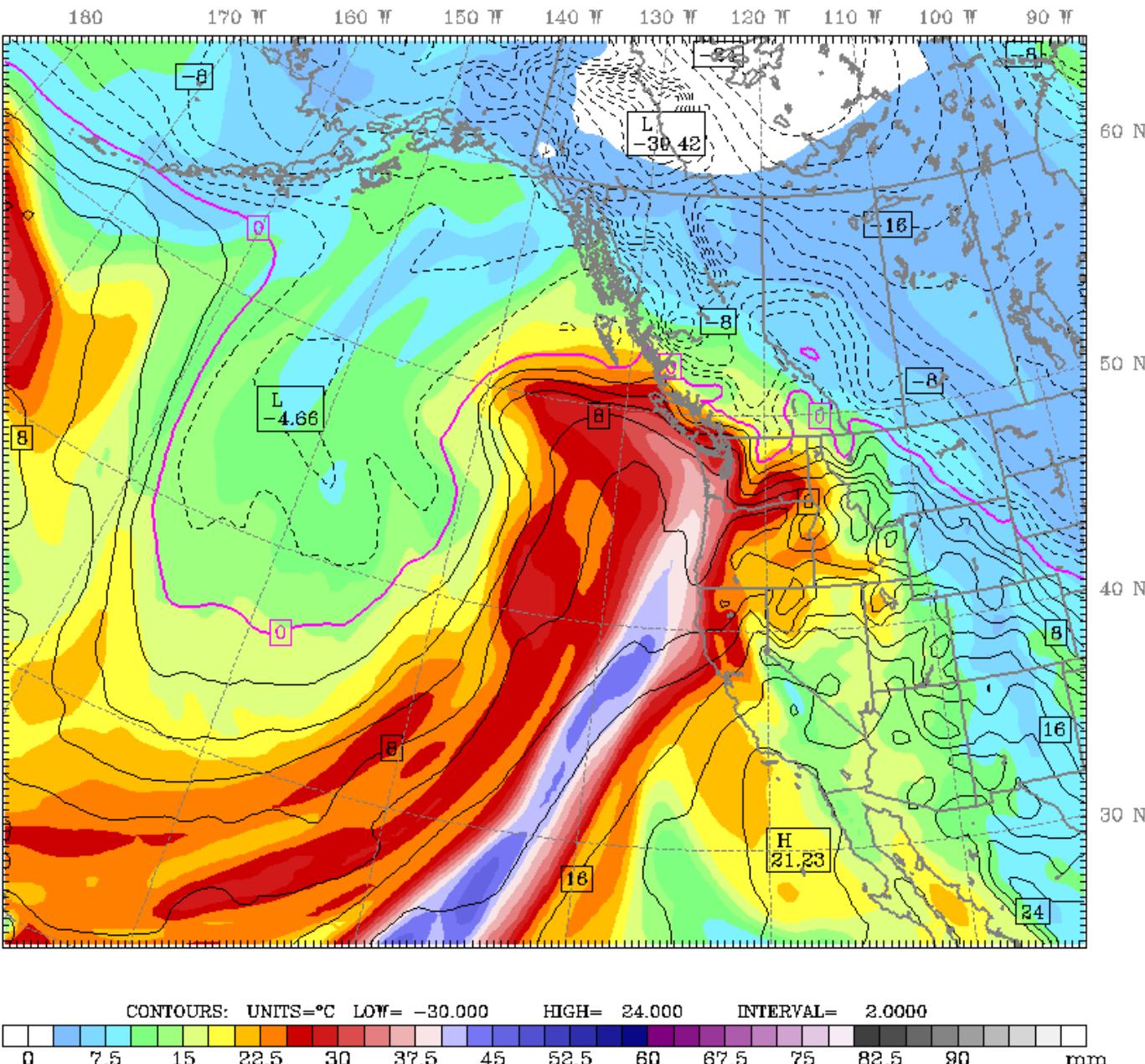
Mountain pine beetle epidemic & forest fires

We also see climate change happening in many other places, indicating it is likely also happening here – a global phenomena

Since the 1980's:

- Arctic summer sea ice has decreased by 50%
- Hurricanes in the Caribbean have doubled in frequency and increased in intensity
- Ocean acidification has increased by 30%

*"Warm  
Temperature  
Records Will Fall  
As A Strong  
Atmospheric River  
Hits the Pacific  
Northwest"*  
– Nov 21, 2017

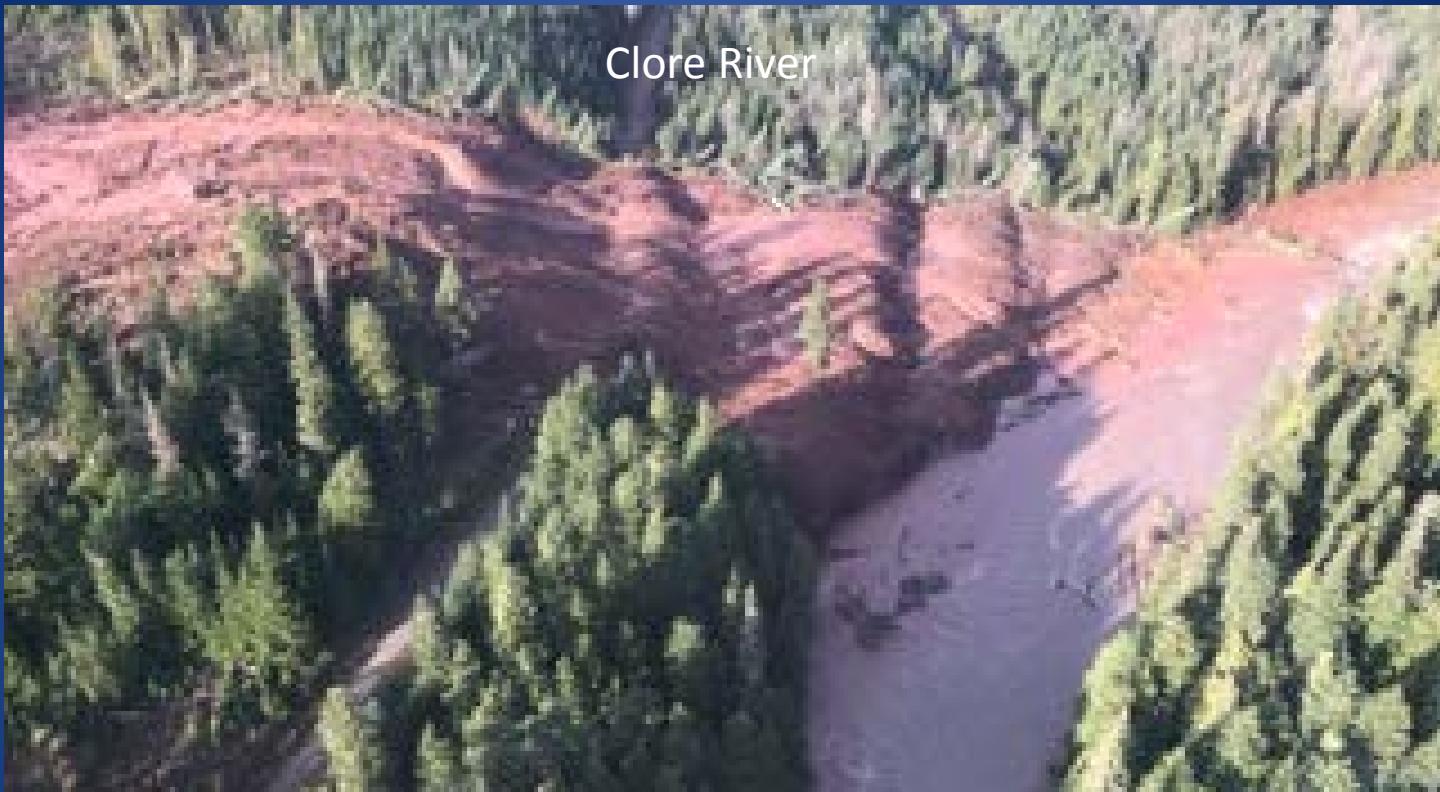


## Major Precipitation (Rain) Events



Large flood events can displace eggs, change river habitats, flush nutrients

# Land Slides

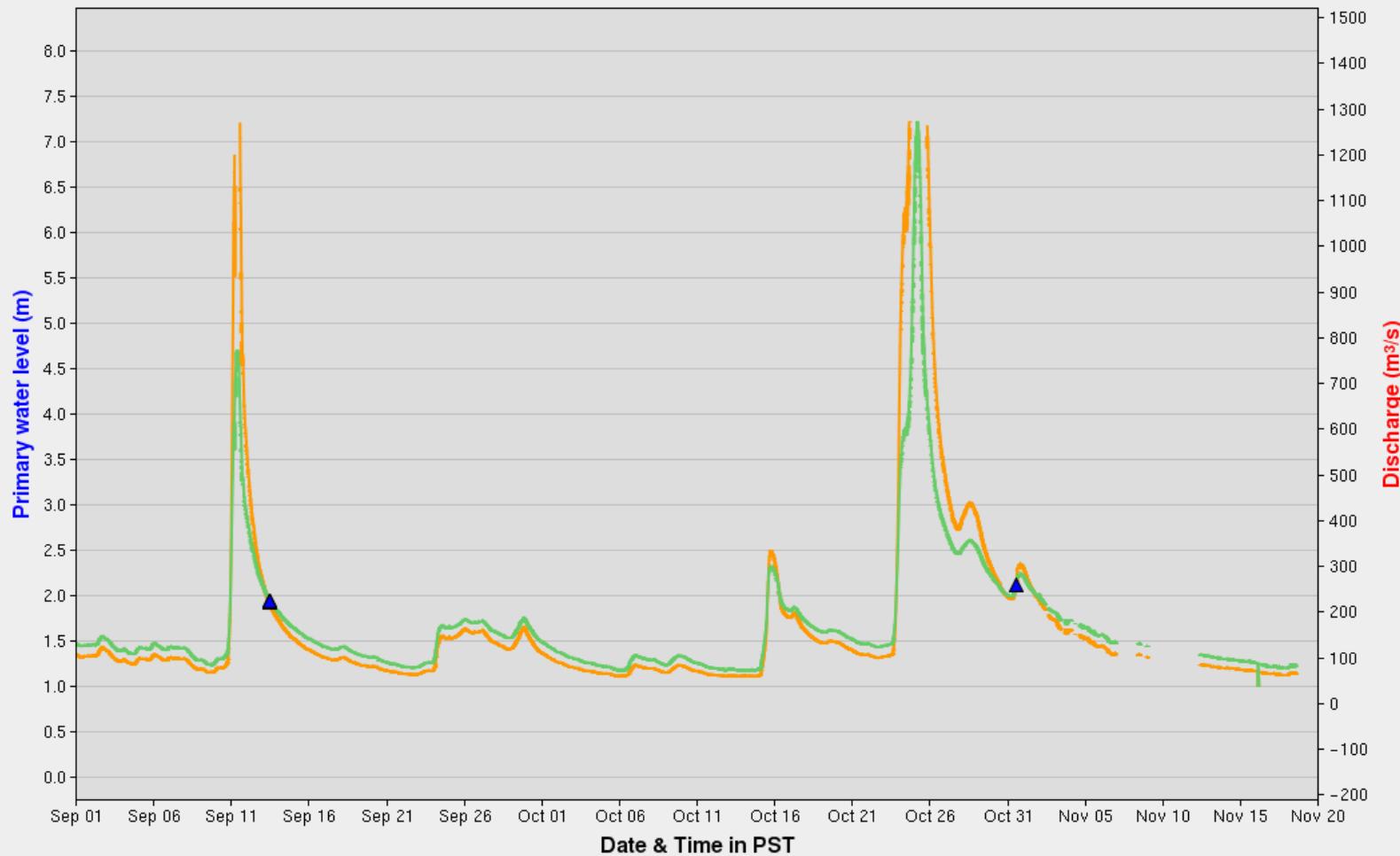


## Impacts from sedimentation

- Changing river geology
- Choking spawning gravels
- Water quality

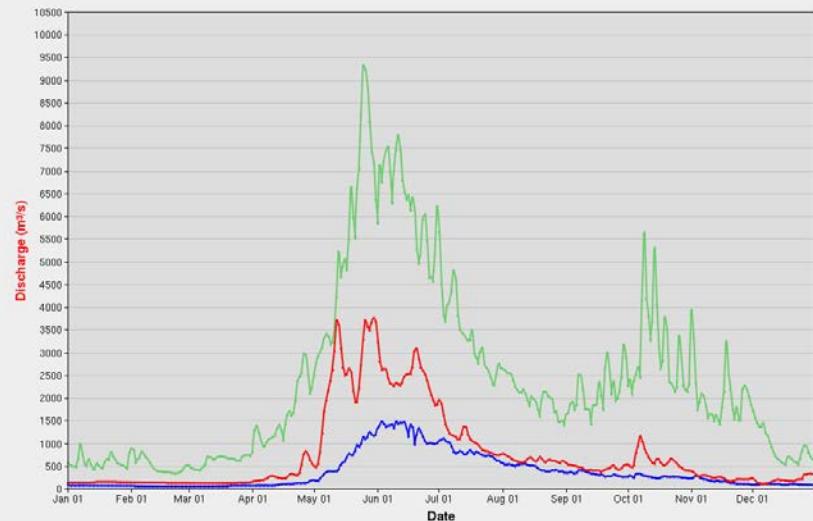
# Copper River Hydrograph – Fall 2017

▲ Stage Measurements      ▲ Discharge Measurements      — Primary Water Level Approved (100% Quality Controlled)  
— Primary Water Level Provisional (subject to change)      — Discharge Approved (100% Quality Controlled)      — Discharge Provisional (subject to change)



Source: Environment Canada, 2017

— 2013 Data — Maximum — Minimum

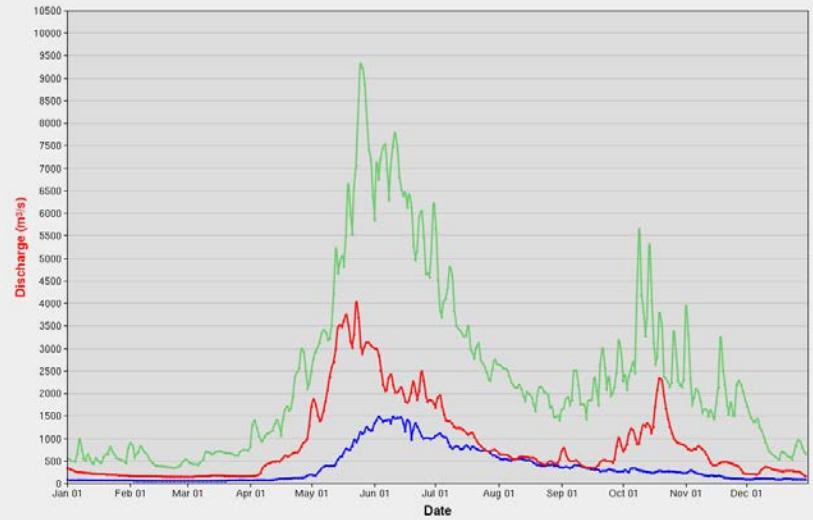


Skeena River at Usk - 2013

## Low summer flows

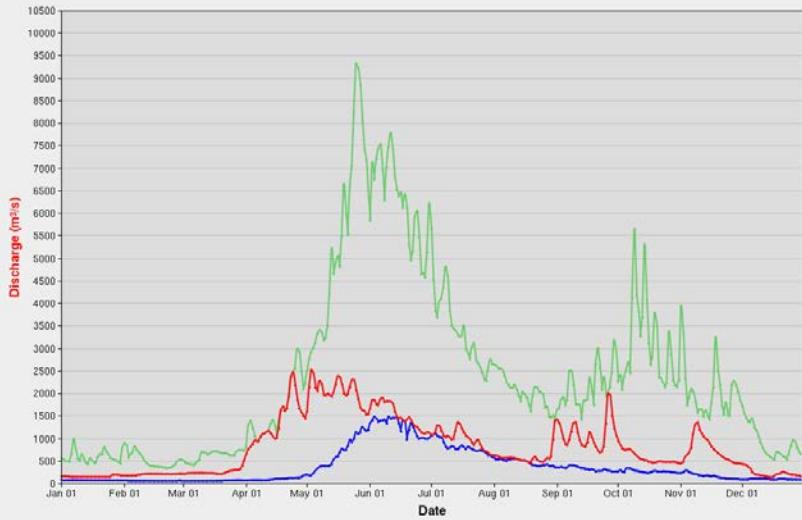
- Delays / changes in migration
- Increase vulnerability to fisheries
- Warmer temperatures

— 2014 Data — Maximum — Minimum



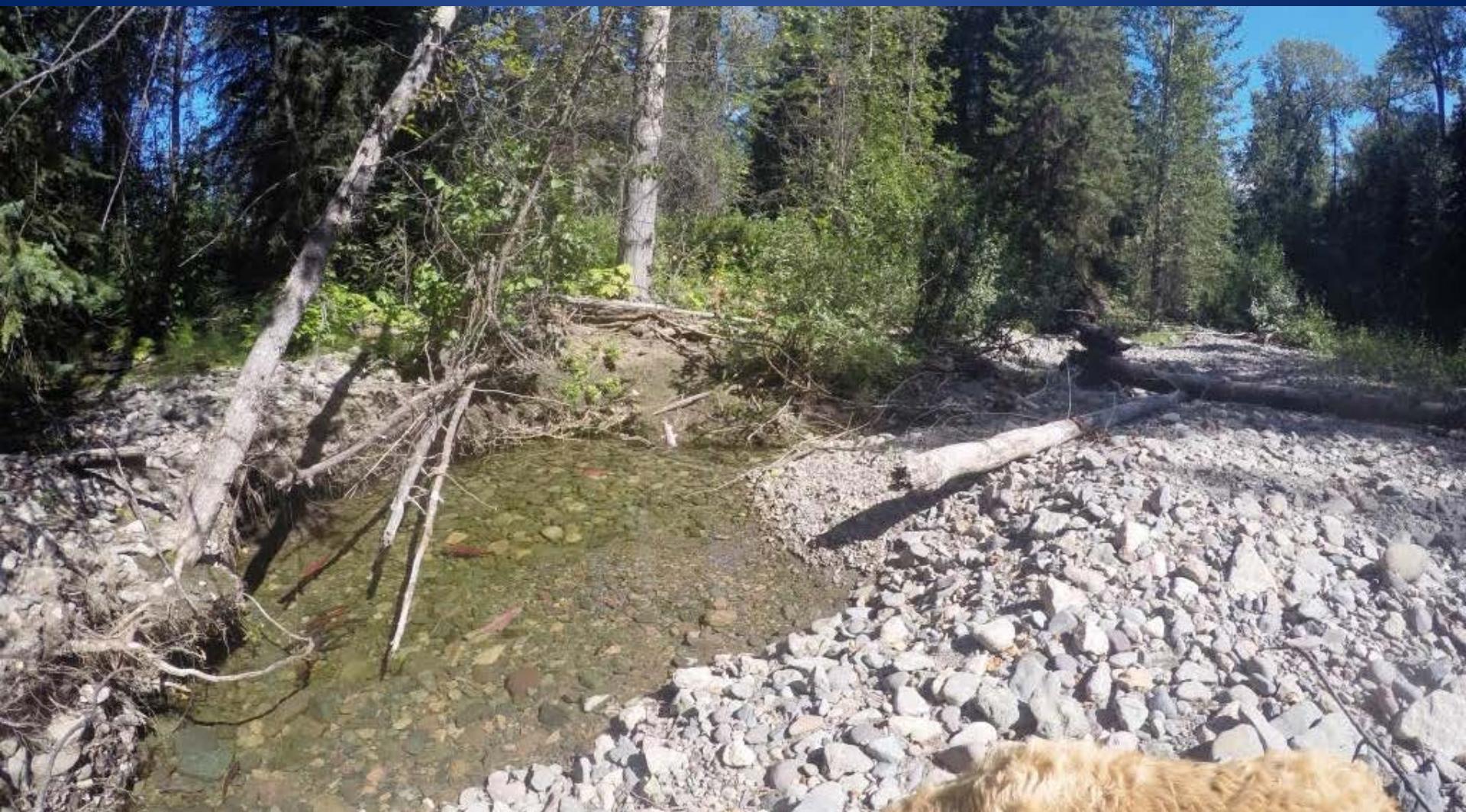
Skeena River at Usk - 2014

— 2016 Data — Maximum — Minimum



Skeena River at Usk - 2016

# Babine Experience



Low water can prevent spawning access, increase predation, increase stress



Photo: Lake Babine Nation Fisheries, 2016

# Kitwanga River



Photo: Gitanyow Fisheries Authority, 2016

# Pre-Spawn Mortality, Disease and Parasites

Issue for Skeena sockeye  
some years (Babine)

Increasing issue for  
Fraser sockeye

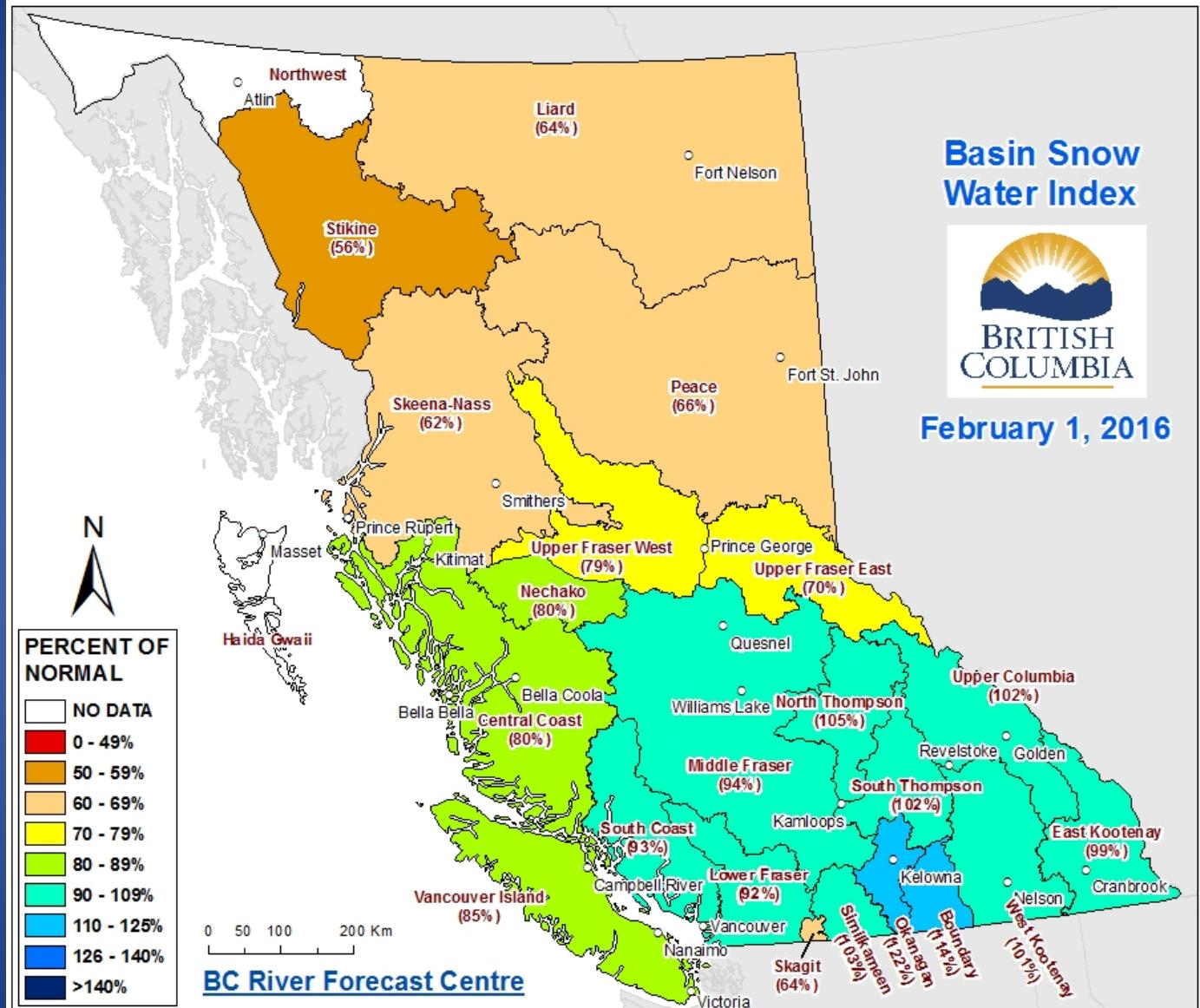


# Snow Pack

Decreased snowpack

Means lower water levels in July & August

Impact migration and spawning, susceptibility to fisheries



# Receding Glaciers

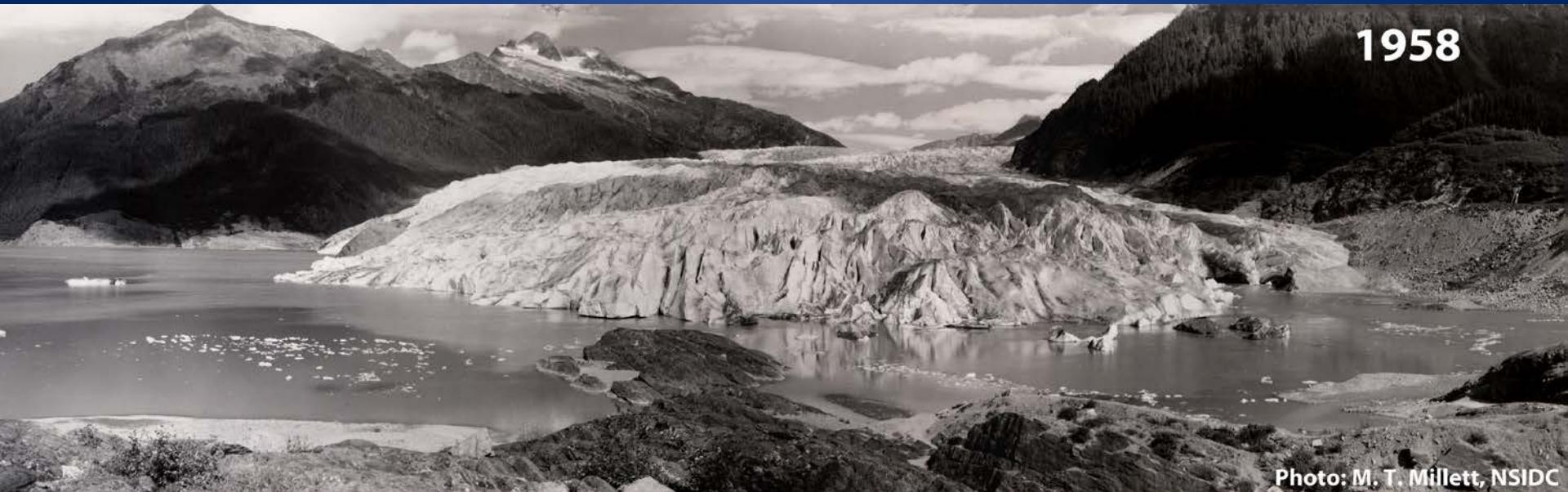
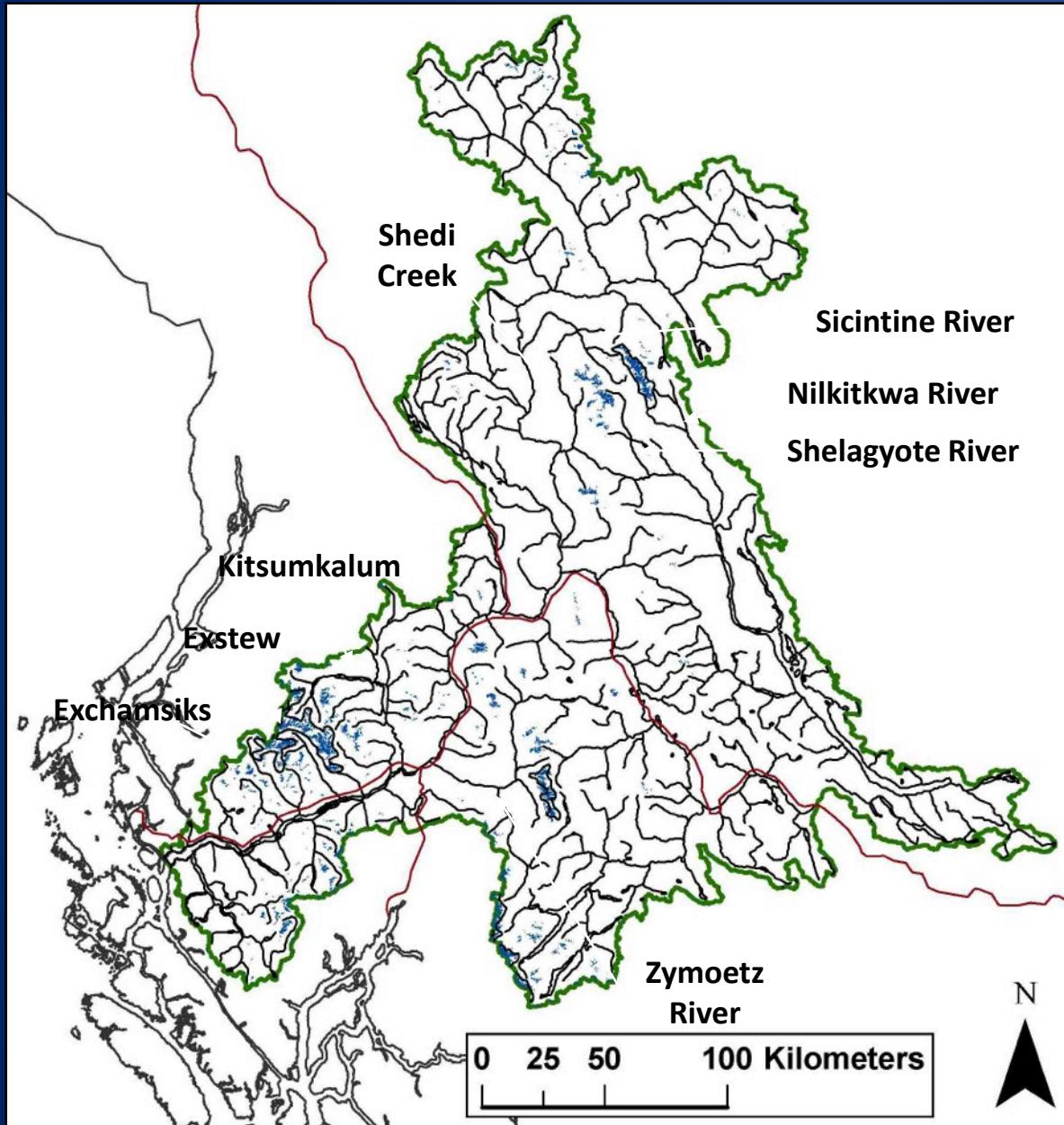


Photo: M. T. Millett, NSIDC



Photo: M. J. Beedle, JIRP

# Skeena River Watershed



1985: 972 km<sup>2</sup> (1.8%)

2005: 825 km<sup>2</sup> (1.5%)

-147 km<sup>2</sup> (-15%)

- Kalum: 151 km<sup>2</sup>
- Zymoetz: 94 km<sup>2</sup>
- Exstew: 70 km<sup>2</sup>
- Excham.: 39 km<sup>2</sup>
- 354 km<sup>2</sup> (43%)

Source: Matthew Beedle, 2017

# Glacier Change in Lower Skeena Watersheds

## Exchamsiks River:

- 1985: 43 km<sup>2</sup> (8.4% glacierized)
- 2005: 39 km<sup>2</sup> (7.6%)  
**- 4 km<sup>2</sup> (- 8%)**

## Exstew River:

- 1985: 88 km<sup>2</sup> (19%)
- 2005: 70 km<sup>2</sup> (15%)  
**- 18 km<sup>2</sup> (- 21%)**

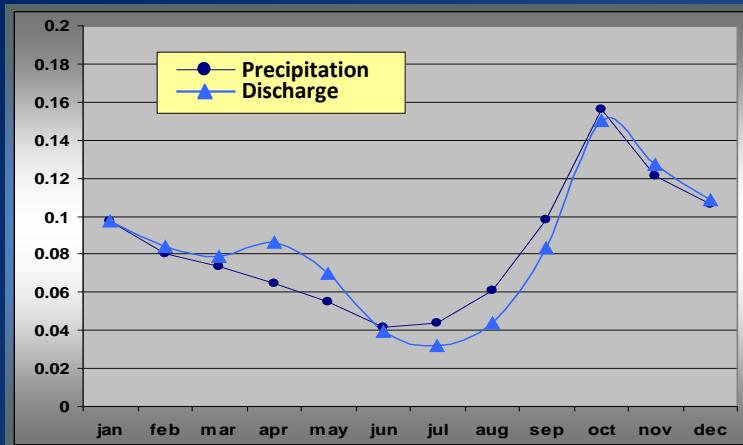
## Zymoetz River:

- 1985: 104 km<sup>2</sup> (3.4%)
- 2005: 94 km<sup>2</sup> (3.1%)  
**- 10 km<sup>2</sup> (- 10%)**

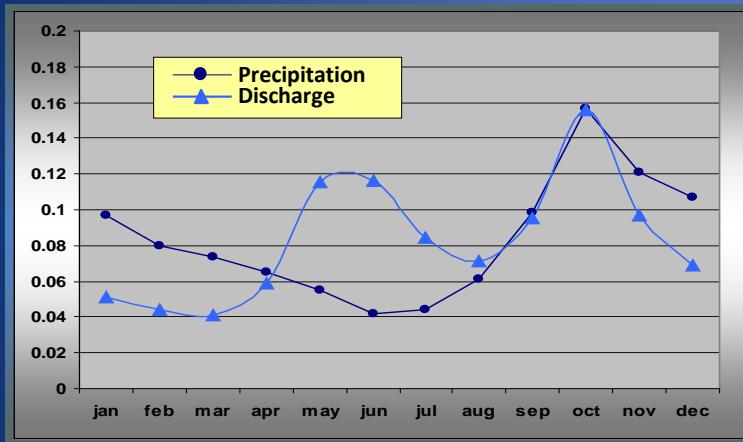
## Kitsumkalum River:

- 1985: 179 km<sup>2</sup> (8.1%)
- 2005: 145 km<sup>2</sup> (6.6%)  
**- 34 km<sup>2</sup> (- 19%)**

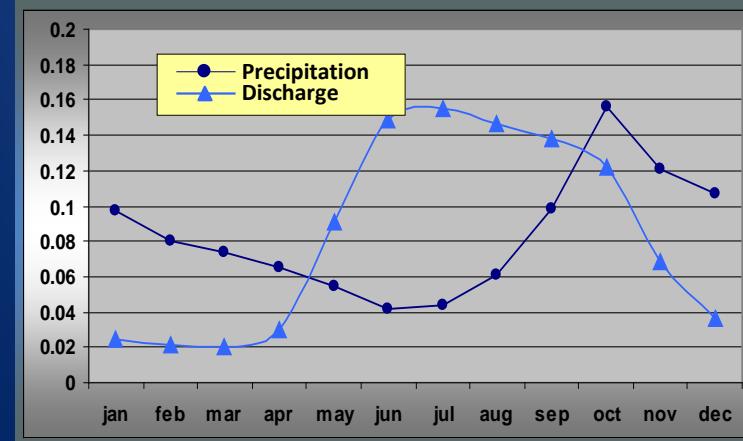
## Rain Fed



## Snow Fed



## Glacier Fed



Glaciers help provide cold water input in short term, which helps buffer against warm, dry summers

Once they melt, can dramatically change a river system.

- Less water in July and August
- Salmon have adapted over time to glacially fed rivers

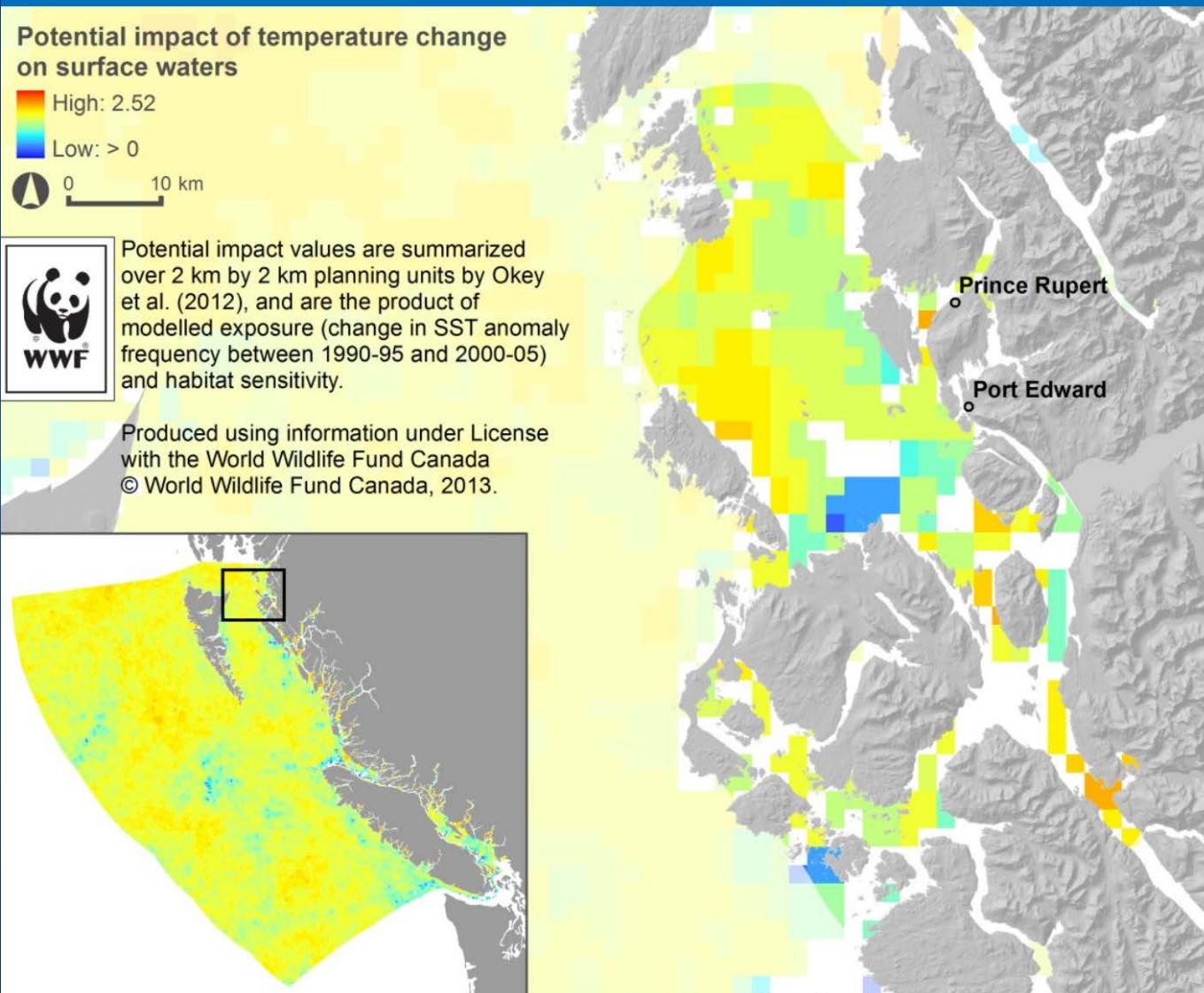
# Freshwater / saltwater intersection



Photo: Brian Huntington, 2014

# Climate Change in the Estuary

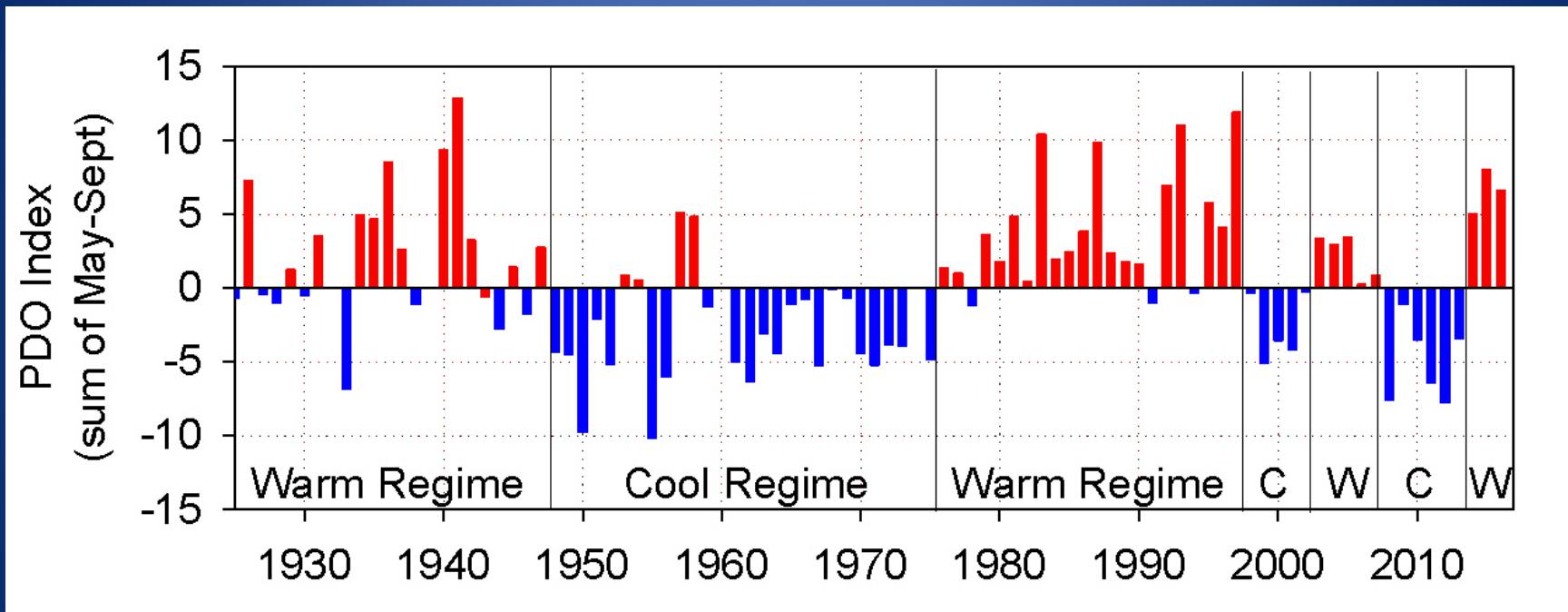
## Climate impacts—temperature (surface waters)



Source: World Wildlife Fund, 2013

# Climate Change in the North Pacific

## Potential Breakdown in Pacific Decadal Oscillation



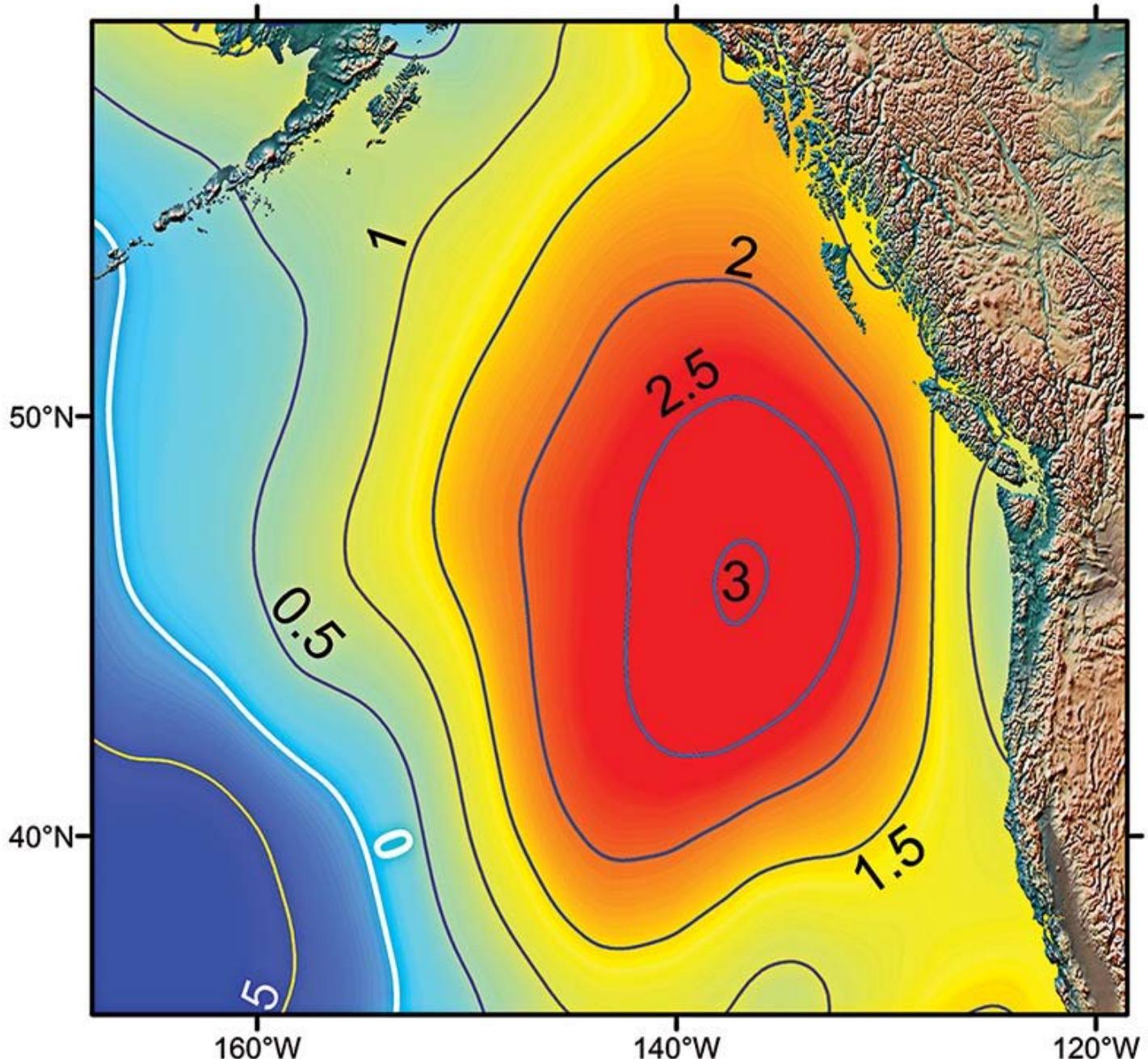
Source: Northwest Fisheries Science Center, 2017

# The “Blob”

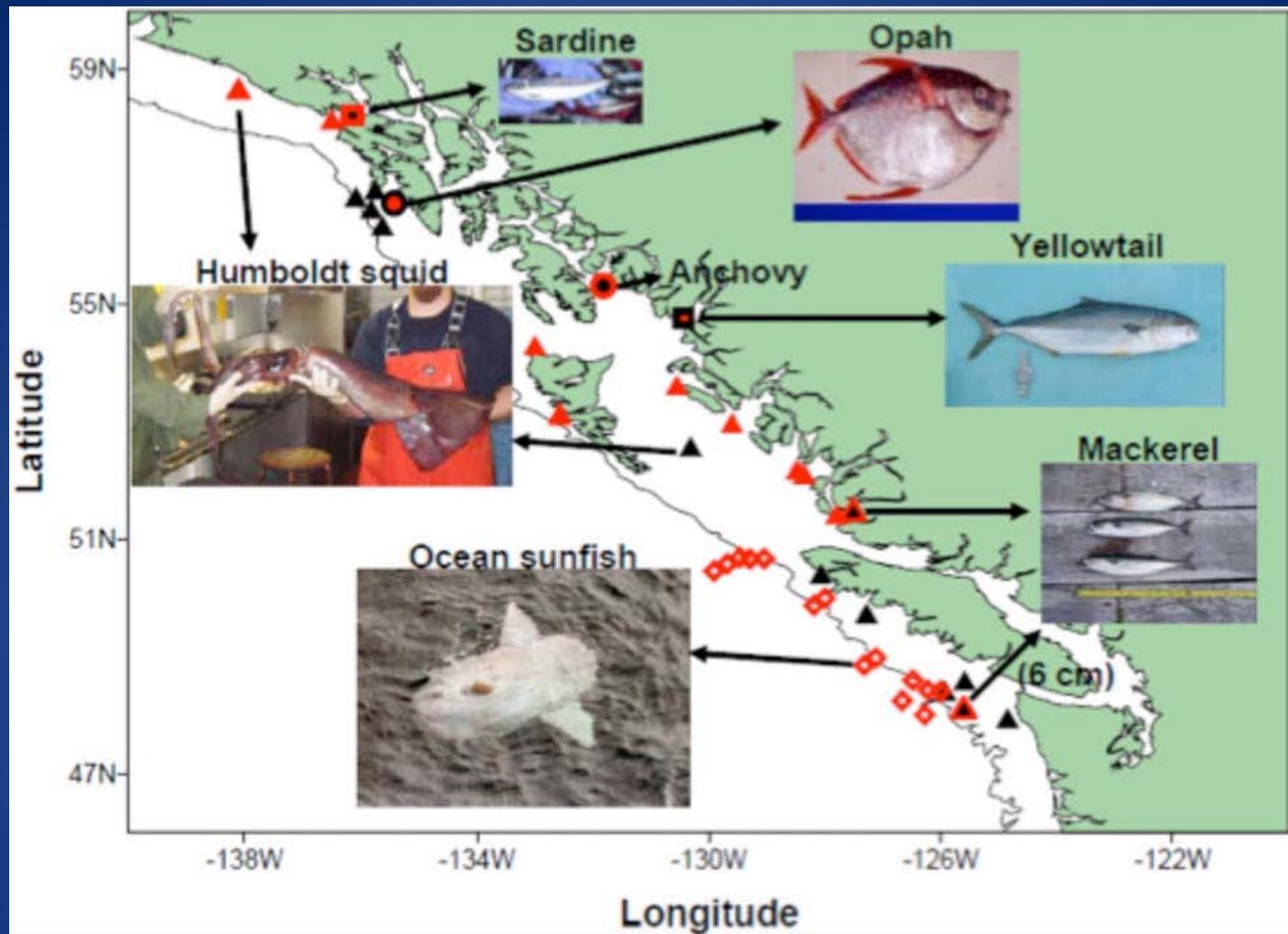
2013 - 2016

Warm water =

- less food
- Less nutrient rich food
- Shifts in predators



Source: Ocean Networks Canada, 2015



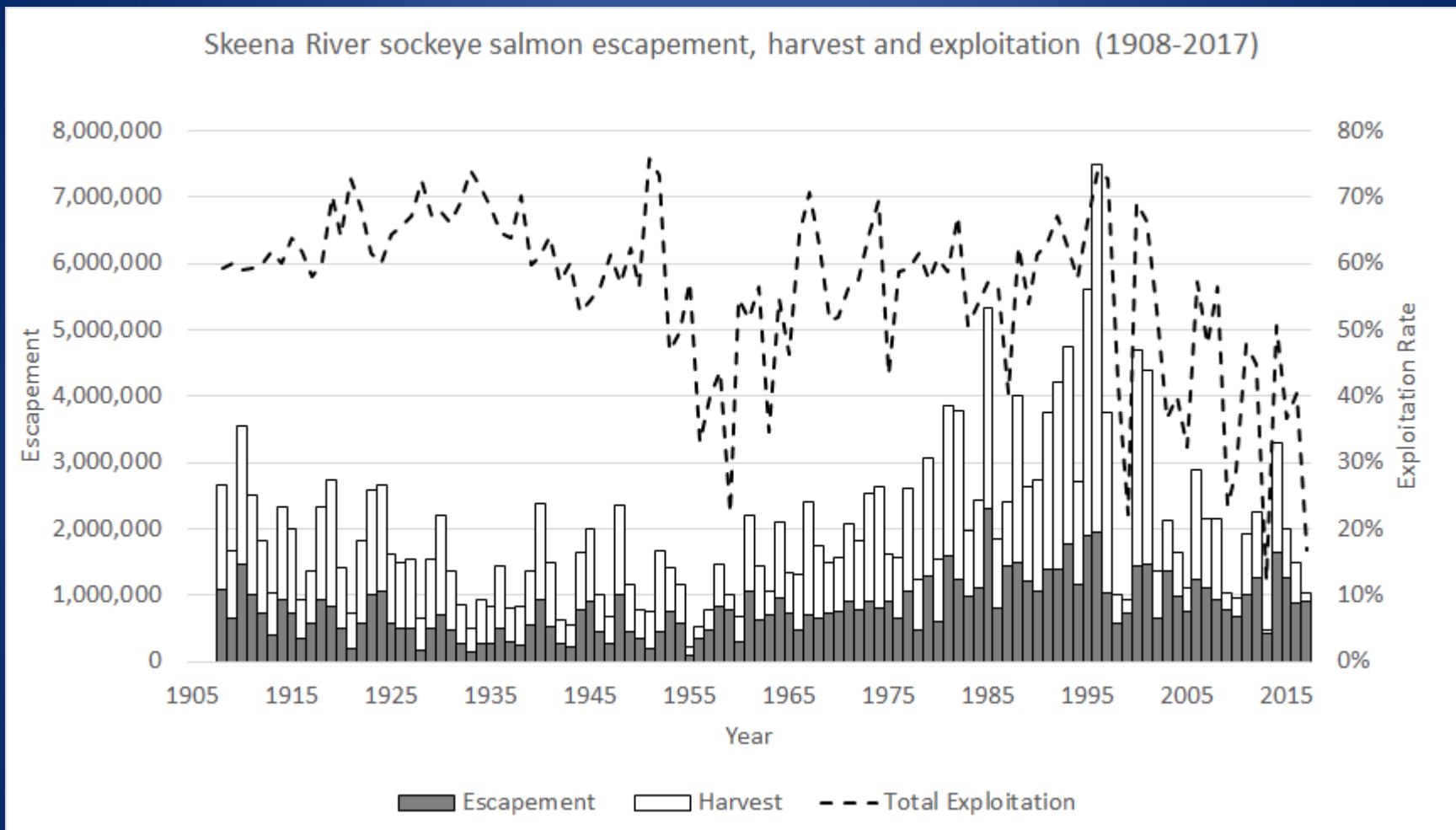
Documented occurrences of warm-water species of fishes and squid in British Columbia and southeast Alaska in 2004 and 2005.

# How has all of this been impacting returns?

## **Difficult to measure**

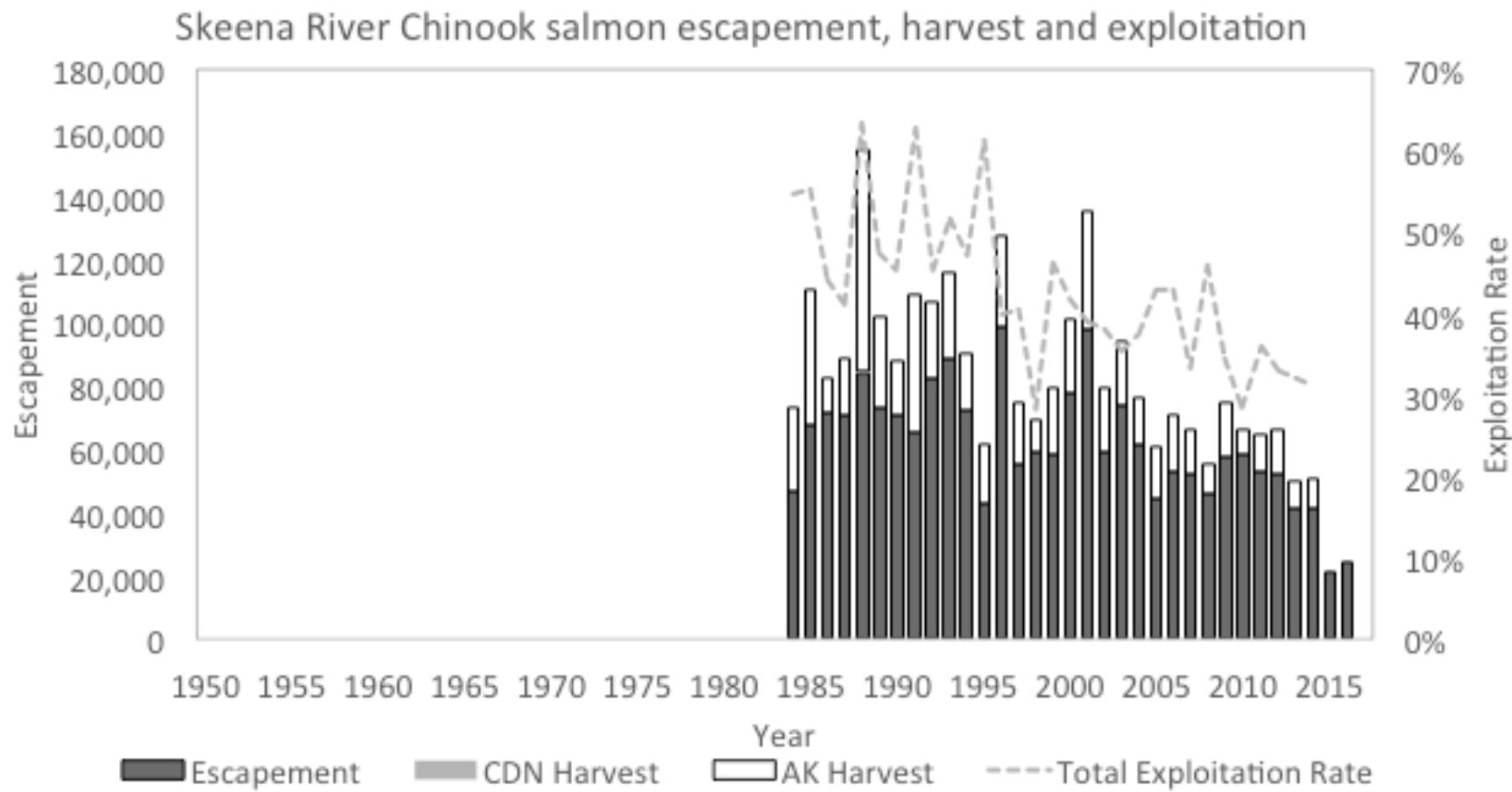
- Variation in conditions and returns is normal, but productivity of populations used to be more stable
- Increasing variability in returns of some species & populations
- Smaller size of returning adults = fewer eggs
- Sockeye and Chinook issues
- Ongoing Chum concerns

# Sockeye



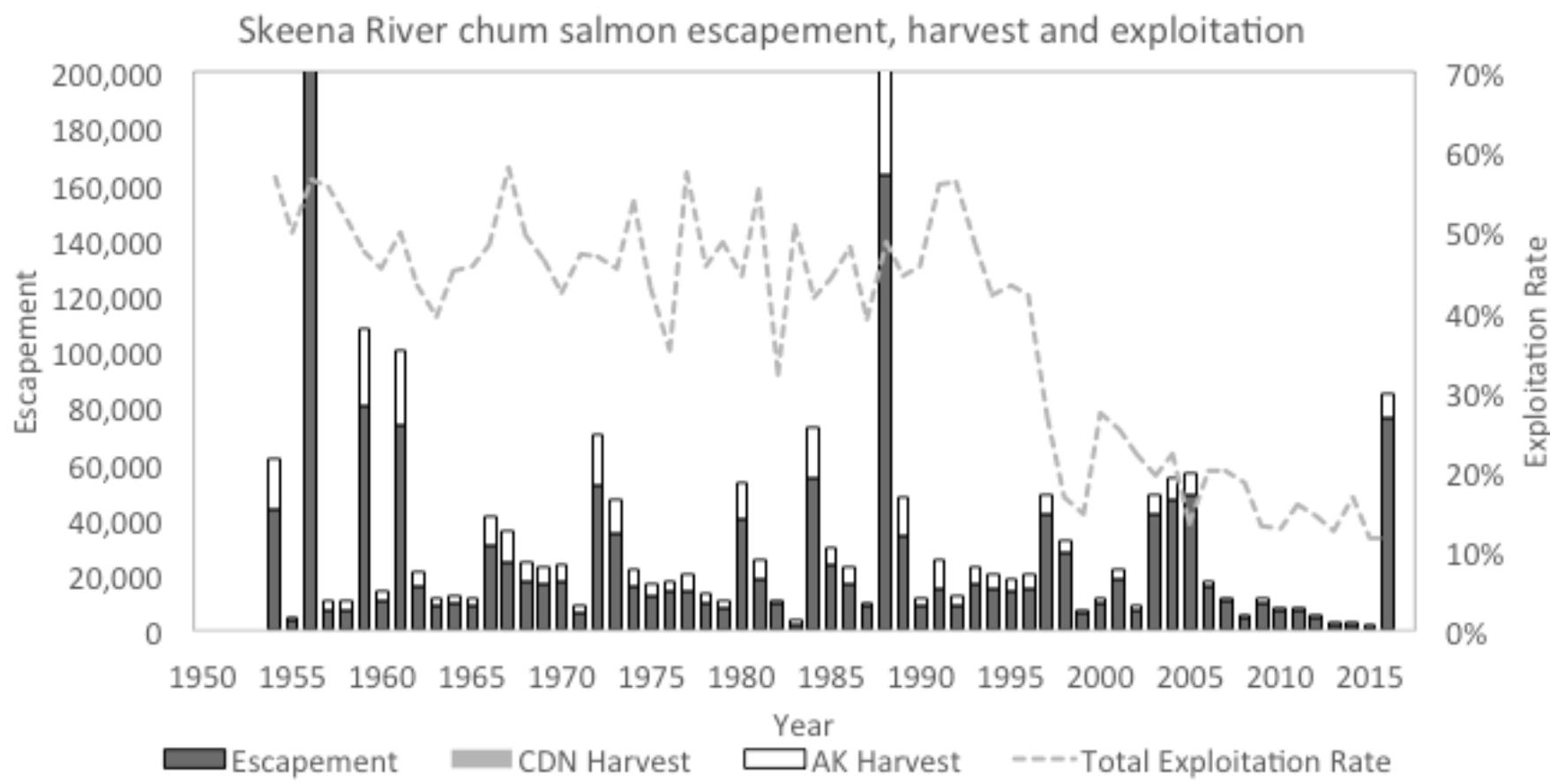
Source: SkeenaWild, 2017

# Chinook



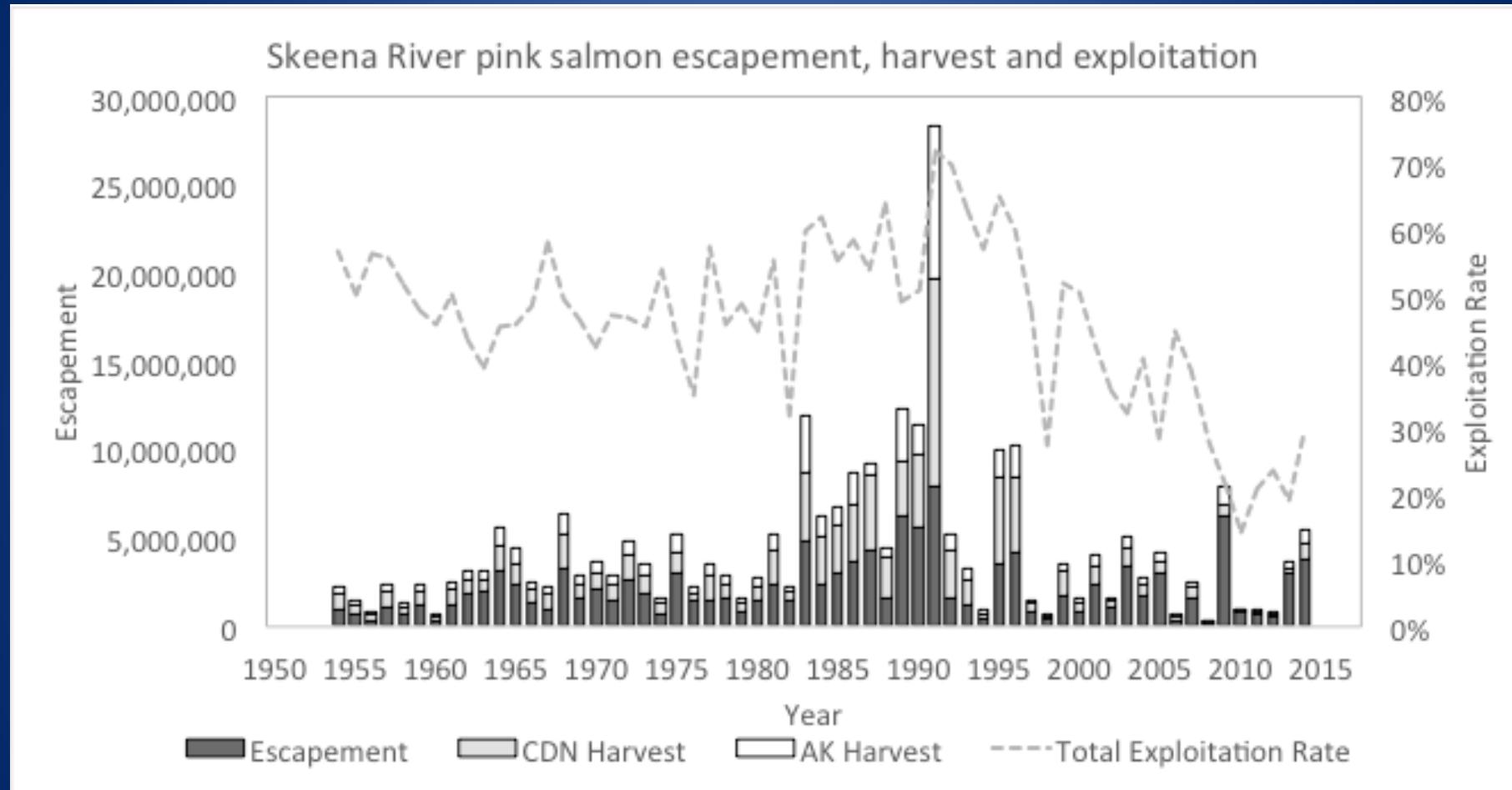
Source: SkeenaWild, 2017

# Chum



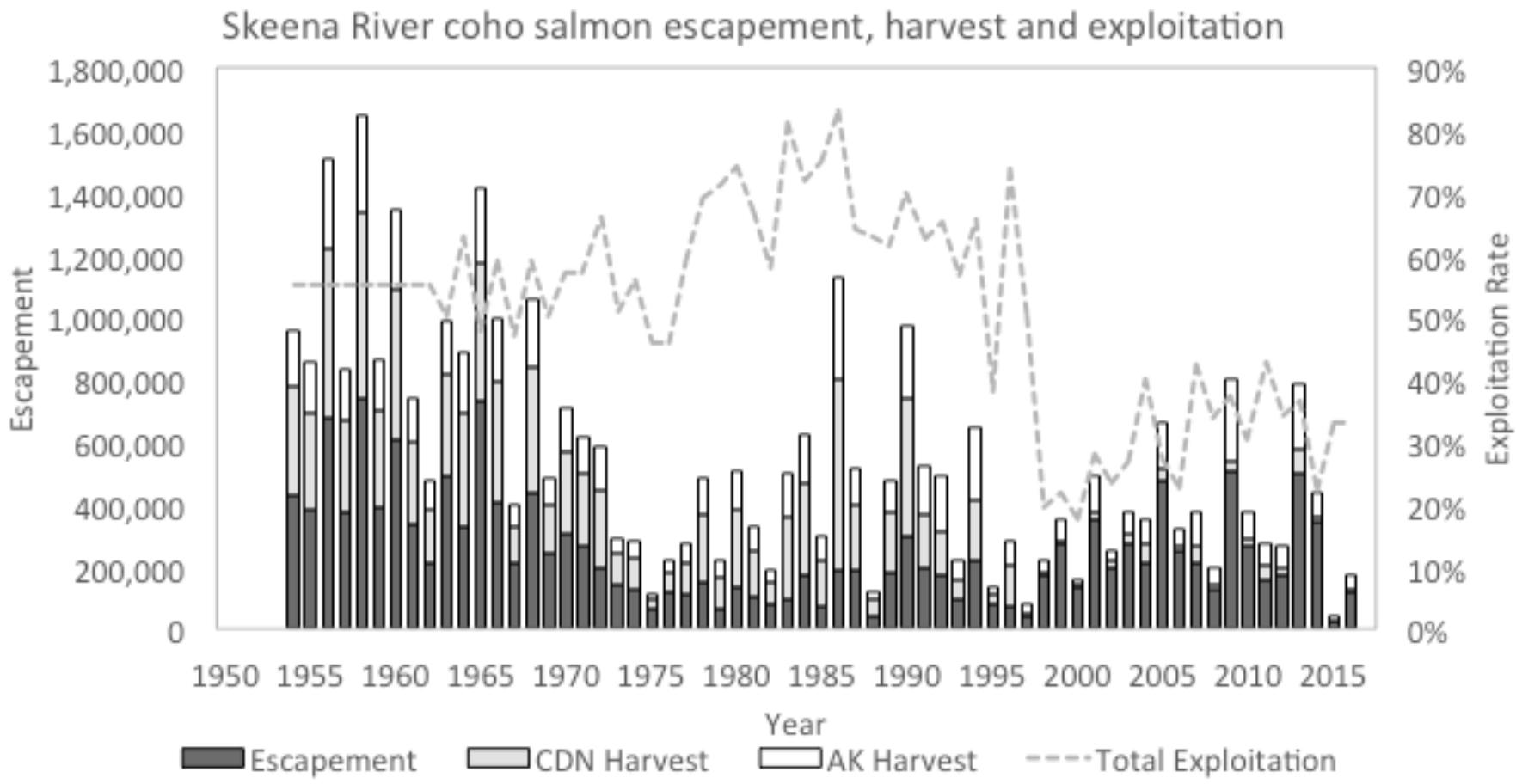
Source: SkeenaWild, 2017

# Pink



Source: SkeenaWild, 2017

# Coho



Source: SkeenaWild, 2017

# Skeena salmon are already at risk

High Extent of management intervention Low

Lower Benchmark Higher Benchmark

Red Zone

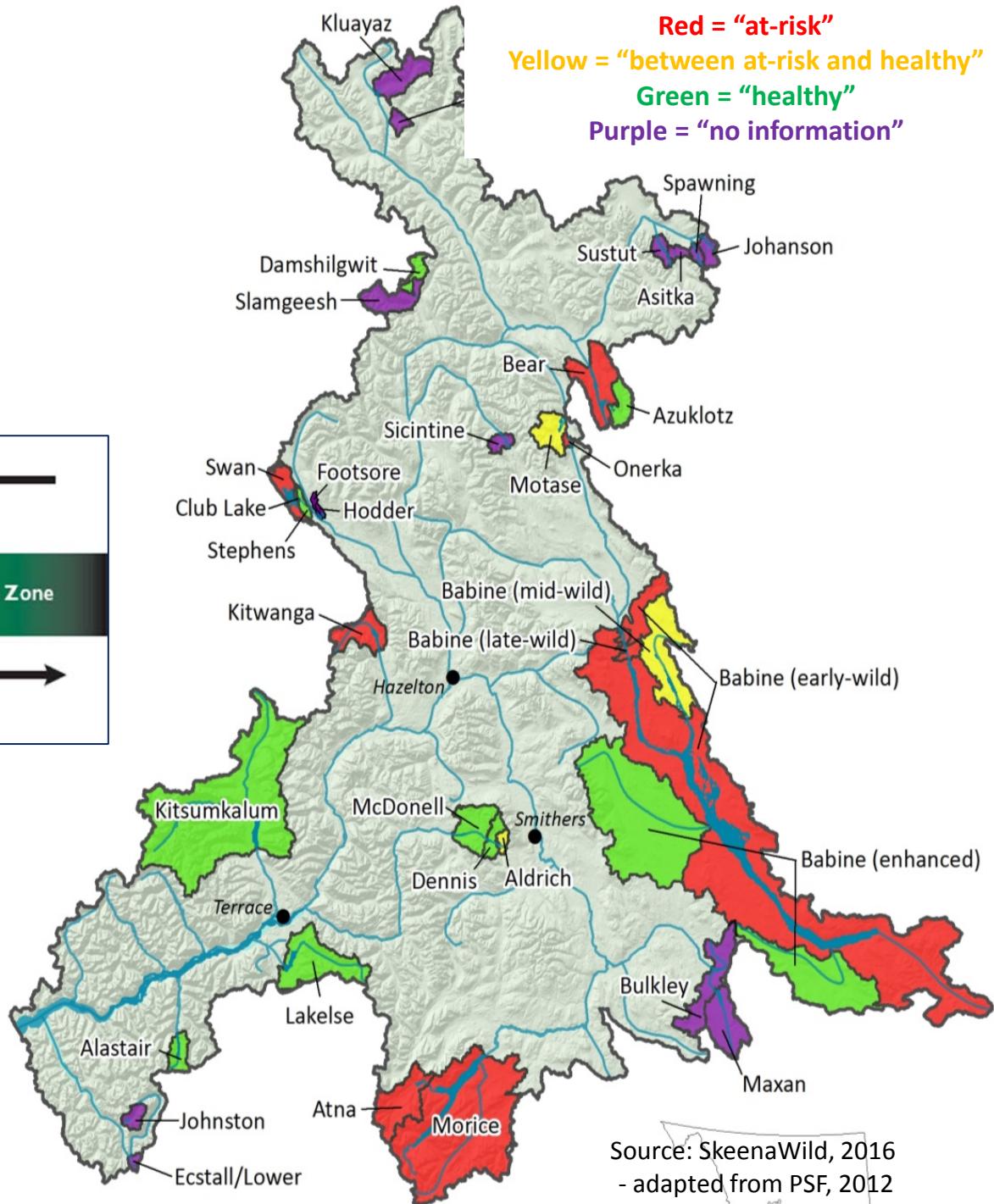
Amber Zone

Green Zone

Low Spawning abundance and distribution High

Source: DFO, 2005

Red = "at-risk"  
Yellow = "between at-risk and healthy"  
Green = "healthy"  
Purple = "no information"



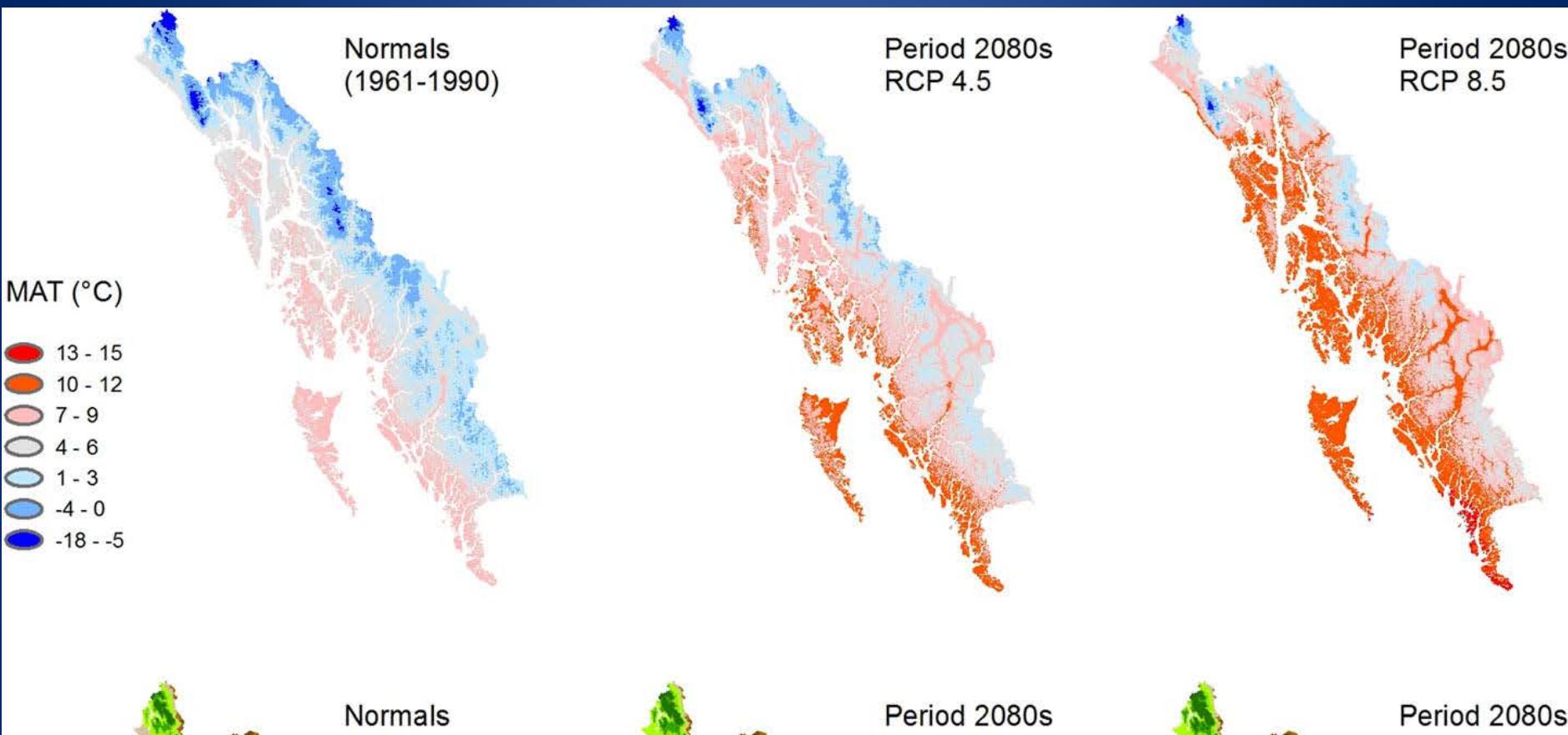
What Changes can we expect to see over the coming decades?

# Climate Change Projection for Kitimat-Stikine in the 2050's

Climate Variable	Season	Projected Change from 1961-1990 Baseline	
		Ensemble Median	Range (10th to 90th percentile)
Mean Temperature (°C)	Annual	+1.7 °C	+1.1 °C to +2.5 °C
Precipitation (%)	Annual	+7%	+3% to +12%
	Summer	+1%	-7% to +10%
	Winter	+8%	-1% to +16%
Snowfall* (%)	Winter	-10%	-18% to +5%
	Spring	-59%	-71% to -10%
Growing Degree Days* (degree days)	Annual	+237 degree days	+150 to +369 degree days
Heating Degree Days* (degree days)	Annual	-637 degree days	-904 to -409 degree days
Frost-Free Days* (days)	Annual	+24 days	+13 to +36 days

Source: Pacific Climate Impacts Consortium, 2012

# Projected Increase in Mean Annual Precipitation - 2080

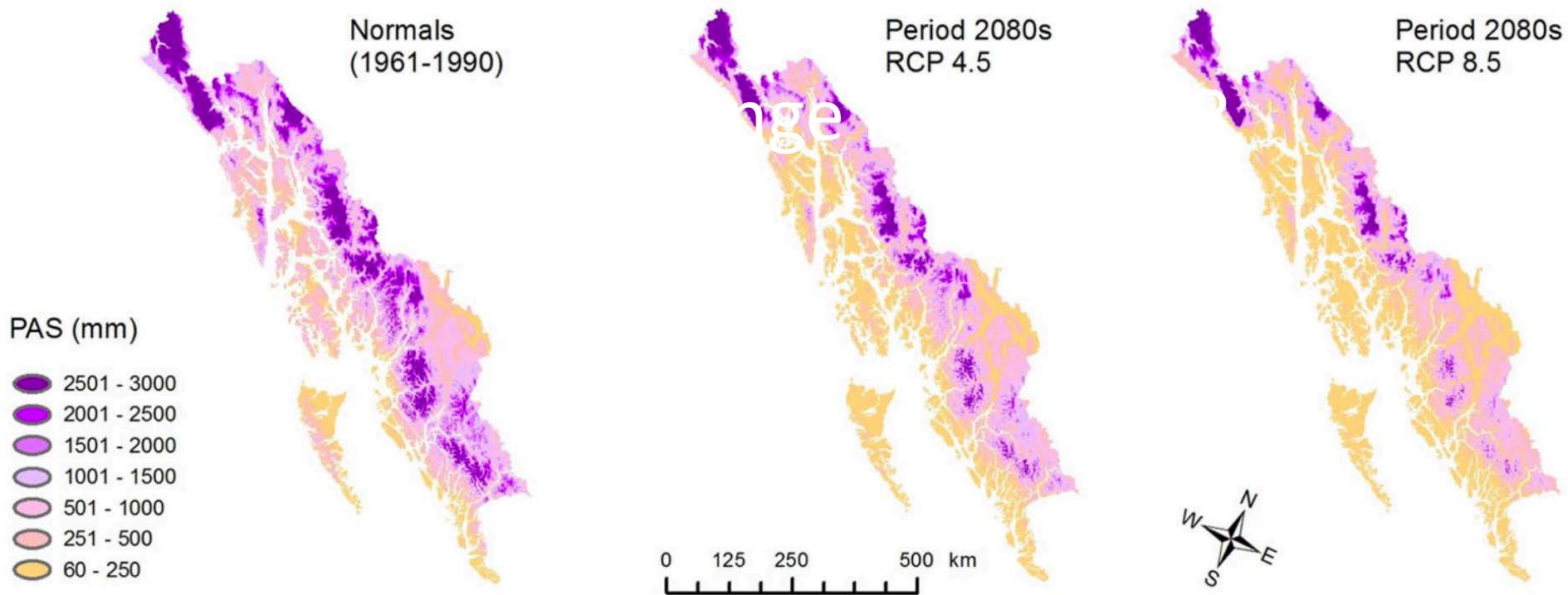


Precipitation increasing from 3130 mm to:

- 3210–3400 mm (3–9 % increase) - RCP4.5 scenario
- 3320–3690 mm (6–18 % increase) - RCP8.5 scenario
- Atmospheric rivers – predicted to increase in frequency and severity (28% increase in extreme precipitation days by 2080 – 2100 (USGS))

Source: Shanley et al., *Journal of Climatic Change*, 2015

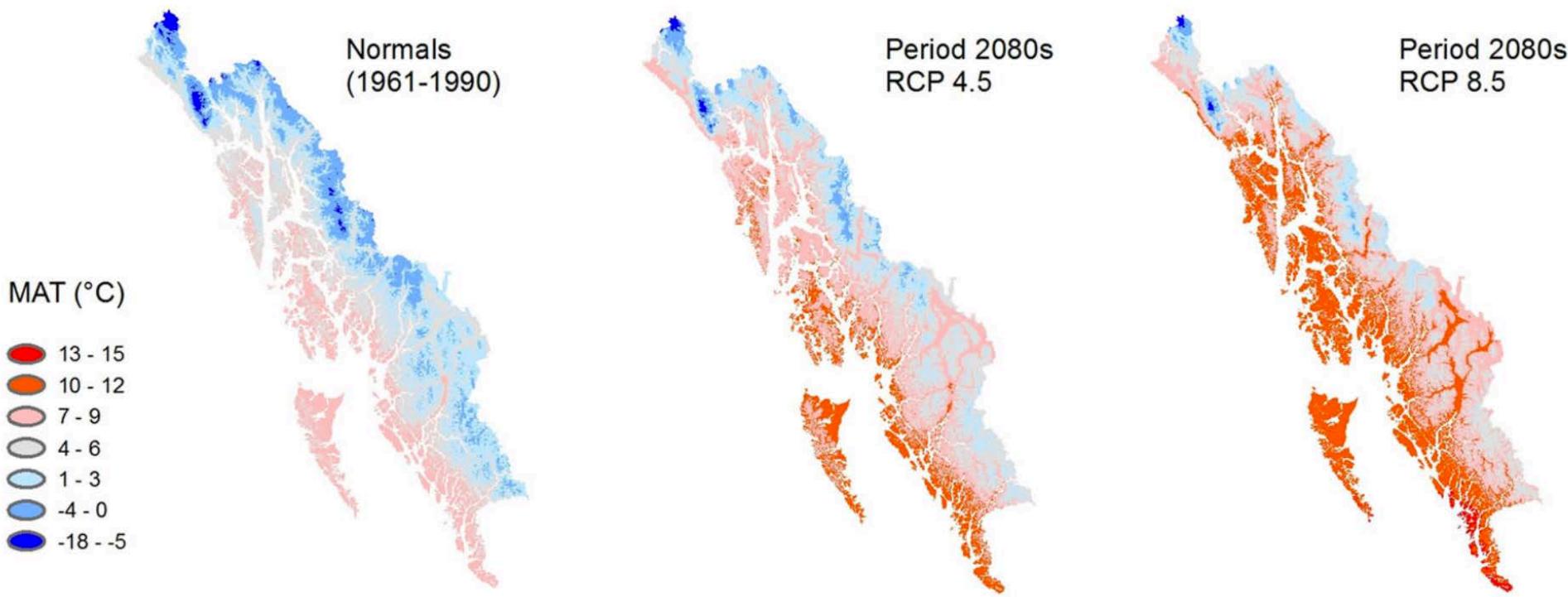
# Projected Decrease in Mean Annual Snowpack - 2080



Snow decreasing from 1200 mm to;

- 940–720 mm (22–40 % decrease) - RCP4.5 scenario
- 720–500 mm (40–58 % decrease) - RCP8.5 scenario

# Projected Increases in Mean Annual Temperature - 2080



1961 – 1990 mean annual temp =  $3.2^{\circ}\text{ C}$

- to  $4.9\text{--}6.9^{\circ}\text{ C}$  (RCP4.5 scenario, 2080)
- or  $6.4\text{--}8.7^{\circ}\text{ C}$  (RCP8.5 scenario, 2080)

**+1.7° C to 5.5° C by 2080s**

# OCEAN ACIDIFICATION

HOW WILL CHANGES IN OCEAN CHEMISTRY AFFECT MARINE LIFE?

CO<sub>2</sub> absorbed from the atmosphere



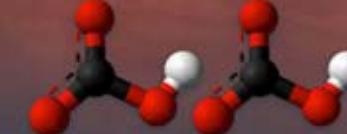
carbon  
dioxide



water



carbonate  
ion



2 bicarbonate  
ions

consumption of carbonate ions impedes calcification

Schematic diagram of ocean acidification processes in the sea (image provided by the NOAA Pacific Marine Environmental Laboratory Carbon Group in collaboration with the University of Washington Center for Environmental Visualization).

1/3 of CO<sub>2</sub> we release is absorbed by oceans – reacts to form carbonic acid

Impacts a primary food source for Salmon

- Makes it hard for krill and zooplankton to form their shells (pull calcium carbonate out of seawater) – *osteoporosis of the sea*

# How do we deal with this?

*We can help our salmon adapt and help our communities continue to benefit*

**Better Monitoring** – stream counts are at historic lows

**Don't kill too many**

- Better in-season assessments
- Set clear management actions to deal with uncertainty and greater fluctuations – start with Chinook, but do ABMP's for all species.
- Develop & Implement Rebuilding Plans for populations in the red zone

**Protect their habitat**

- Land use planning with a salmon lens
- Estuary management planning
- Participate in environmental assessments
- Citizen science
- Education

**Benefit by being adaptable**

- Change our harvest year to year to focus on species & populations that are healthy
- Protect those that are not

# What can be done to reduce impacts?

 **Global efforts to reduce carbon emissions** can help to mitigate impacts on coastal communities.

 **Southern species shifting northwards**, such as sardines and manila clams\*\*, may offer new opportunities to supplement commercial and subsistence harvests.



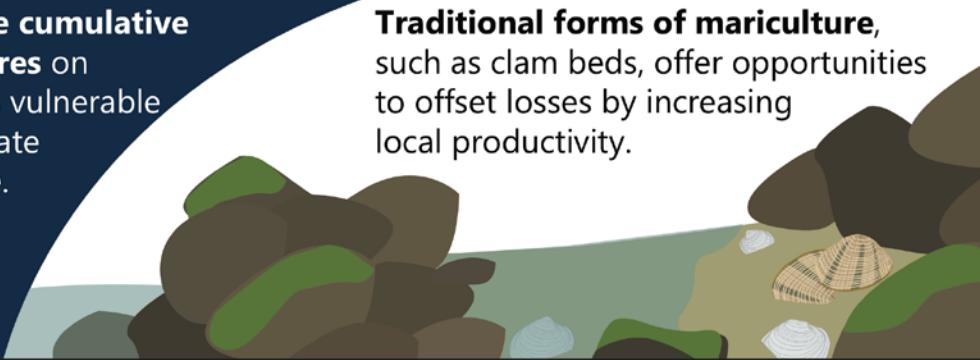
**Joint management of key resources**, such as herring and salmon, referring to traditional knowledge.



**Reduce cumulative pressures** on species vulnerable to climate change.



**Proactive planning** for resource management under climate change scenarios.

 **Traditional forms of mariculture**, such as clam beds, offer opportunities to offset losses by increasing local productivity.

\*\*Catch potential for sardines is projected to increase by 42% (RCP 2.6) and 44% (RCP 8.5); for manila clams, these estimates are +6% and +15%, respectively.

**Source** Weatherdon LV, Ota Y, Jones MC, Close DA, Cheung WWL. (2016). Projected scenarios for coastal First Nations' fisheries catch potential under climate change: management challenges and opportunities. PLOS ONE. doi: 10.1371/journal.pone.0145285

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**Design** Graphic by Lauren Weatherdon



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 a place of mind  
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Source: Weatherdon et al, 2016

# Will Skeena Salmon Be Able to Adapt?

*There's Hope!*

**Salmon are resilient**

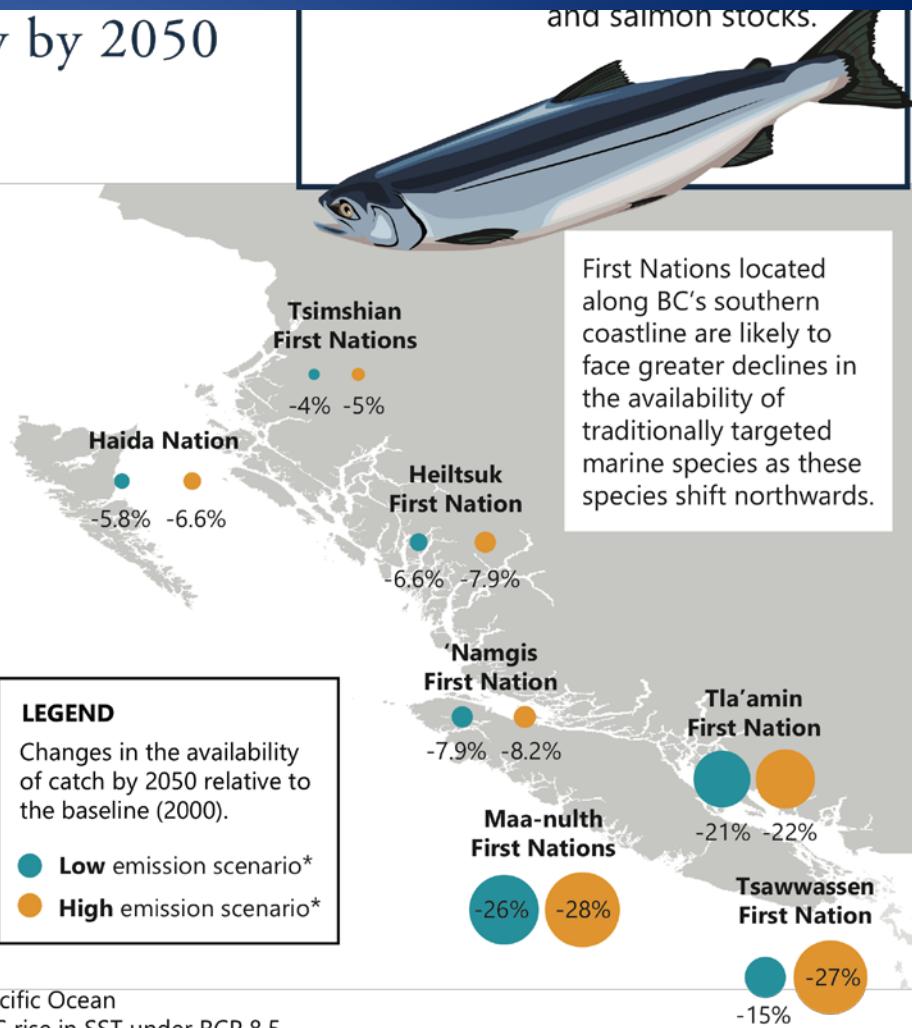
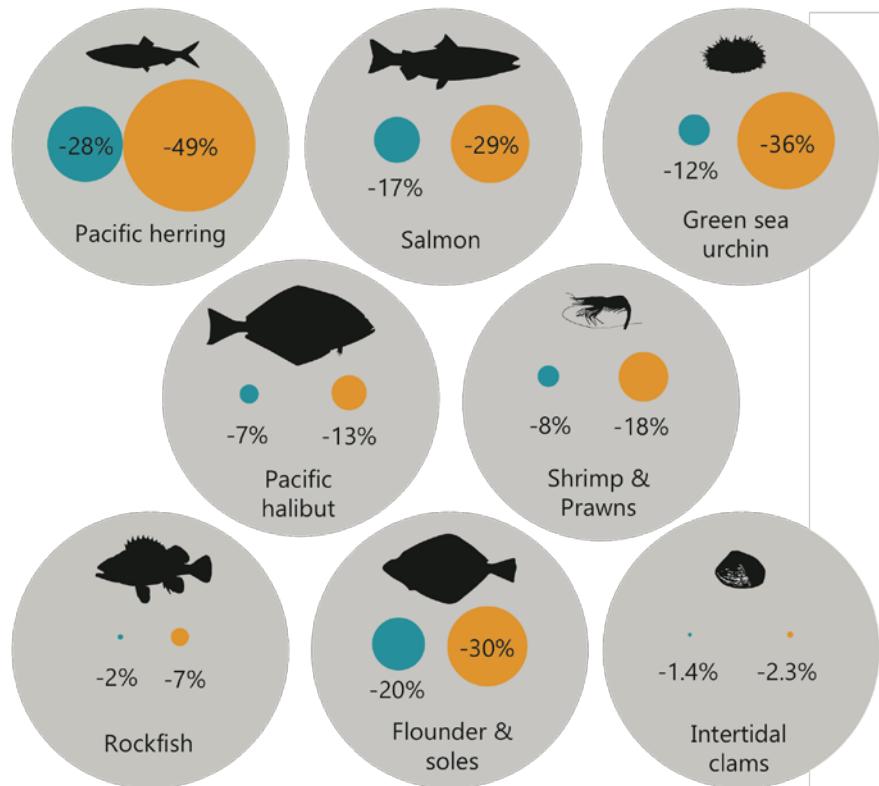
**Skeena salmon are well positioned**

- Large diversity – species, genetics, habitats
- Northern location

**Some populations may actually become more productive**

- Need to make sure they have the opportunity

# How might declines in catch availability by 2050 differ by fishery and by region?



\*Low emission scenario = 0.5°C rise in sea surface temperature (SST) in the Northeast Pacific Ocean  
(under Representative Concentration Pathway [RCP] 2.6) | High emission scenario = 1.0°C rise in SST under RCP 8.5.