Skeena Salmon & Climate Change

Adapting to an uncertain future

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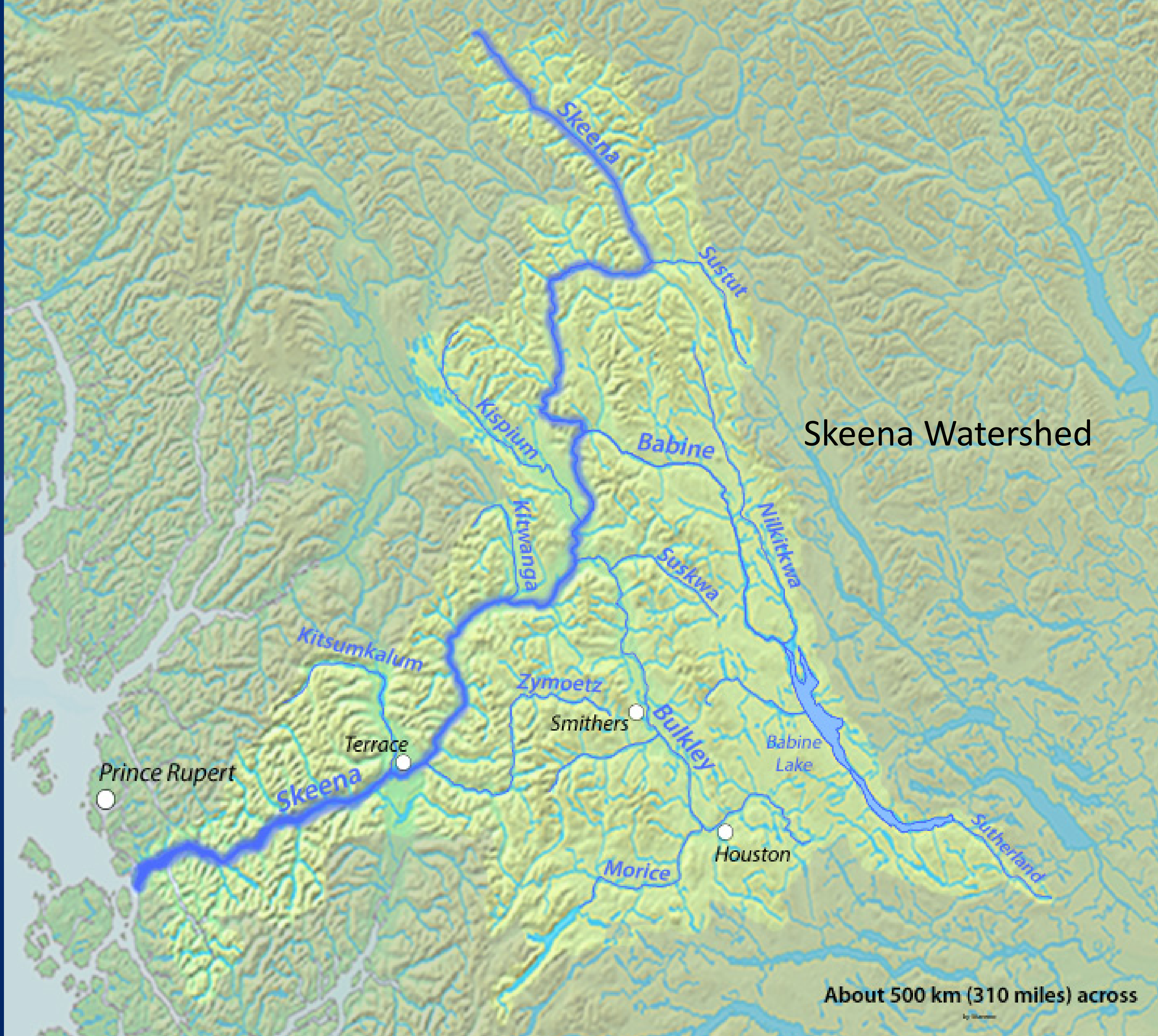
SkeenaWild Conservation Trust

Photo: Tavish Campbell, 2014

Skeena Watershed



Source: Ecotrust Canada, 2010

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.

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.

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

Source: SkeenaWild, 2009

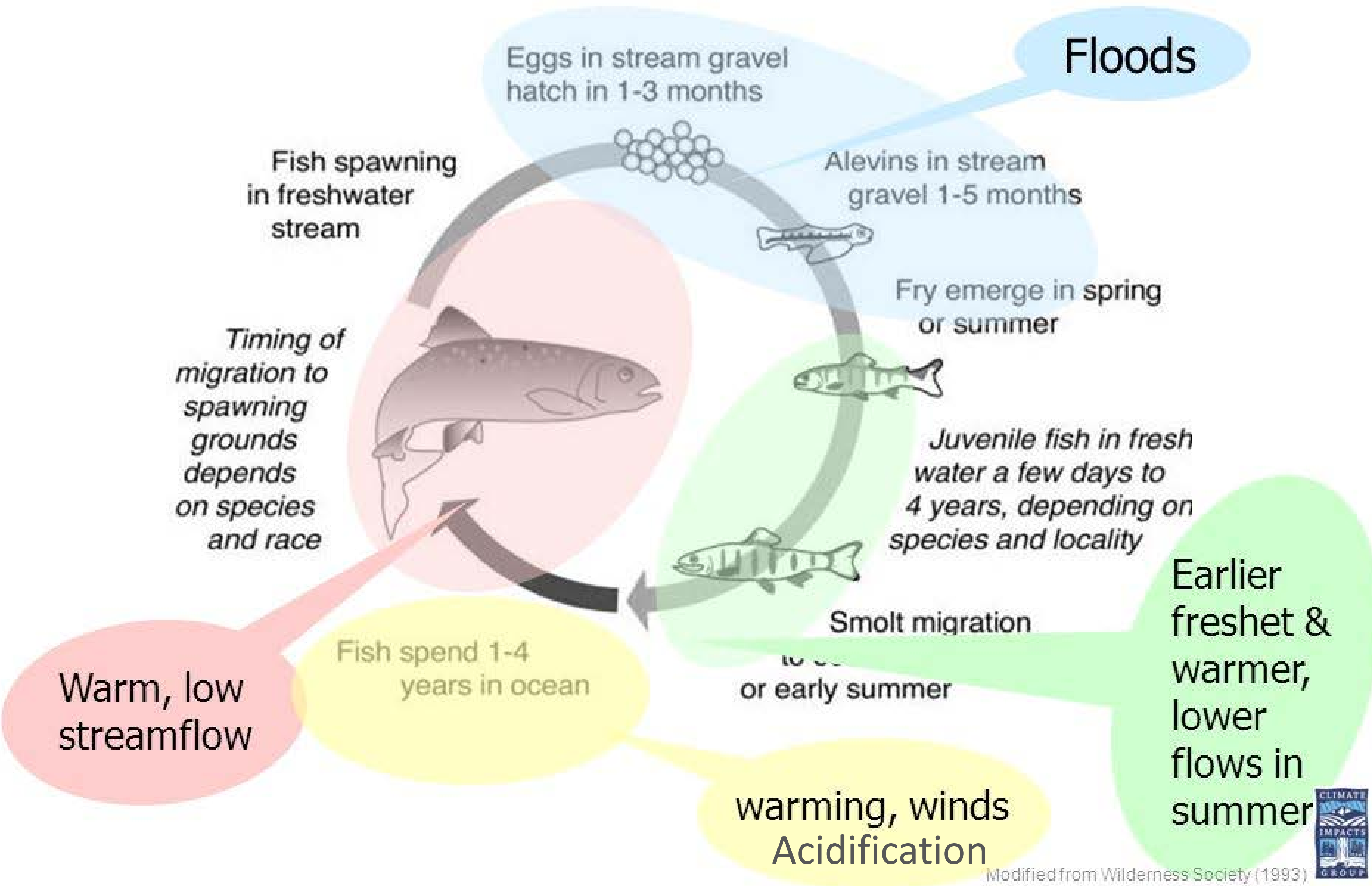
The Story is Complex

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

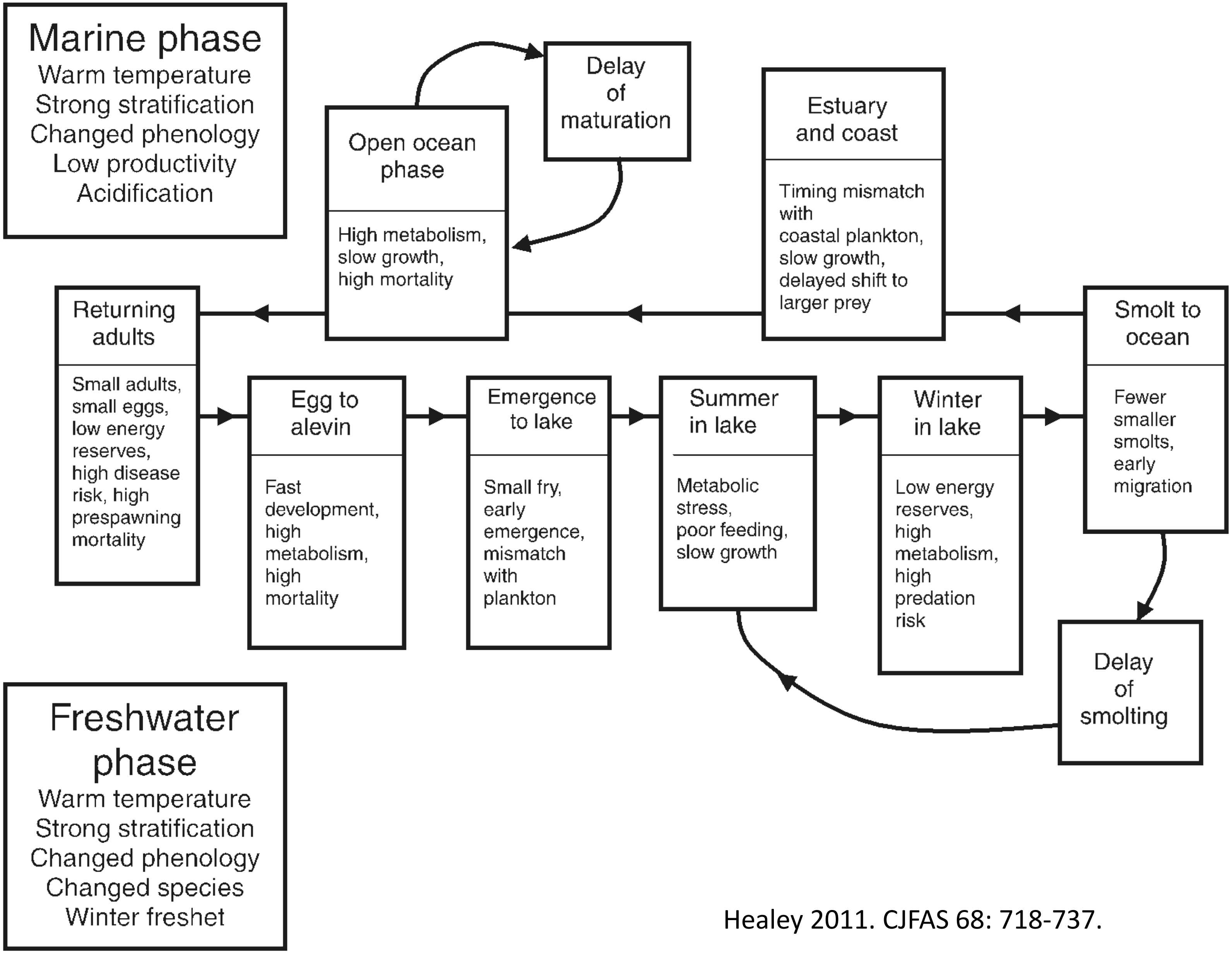
Climate change impacts all of these environments, species and populations in different, complex, and often unpredictable ways.

Salmon Affected Across Their Life-Cycle



Modified from Wilderness Society (1993)

How Does Climate Change Impacts Salmon?



Healey 2011. CJFAS 68: 718-737.

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

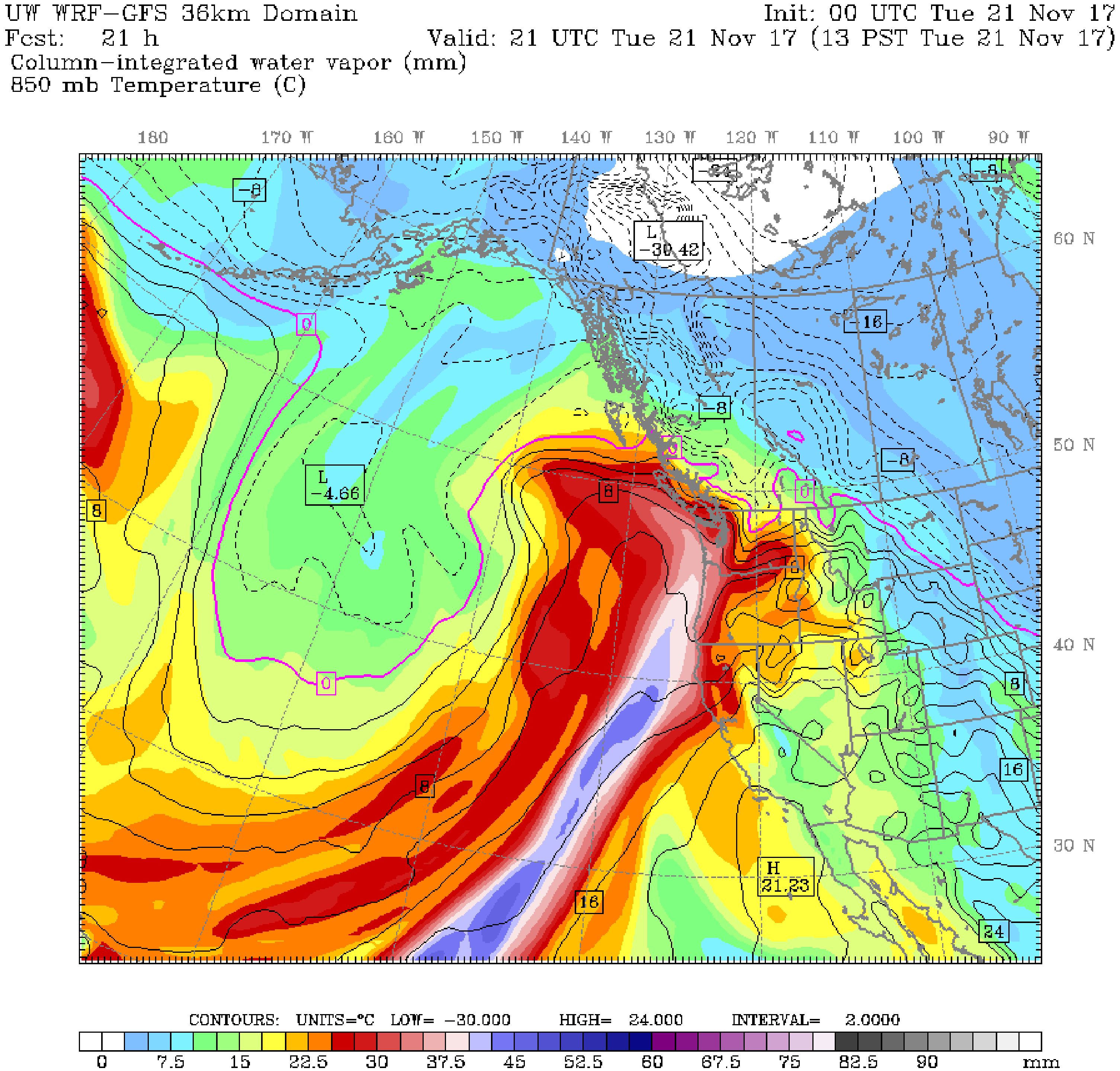
We also see climate change happening in many other places, indicating it is likely also happening here – a global phenomena

Since the 1980's:

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

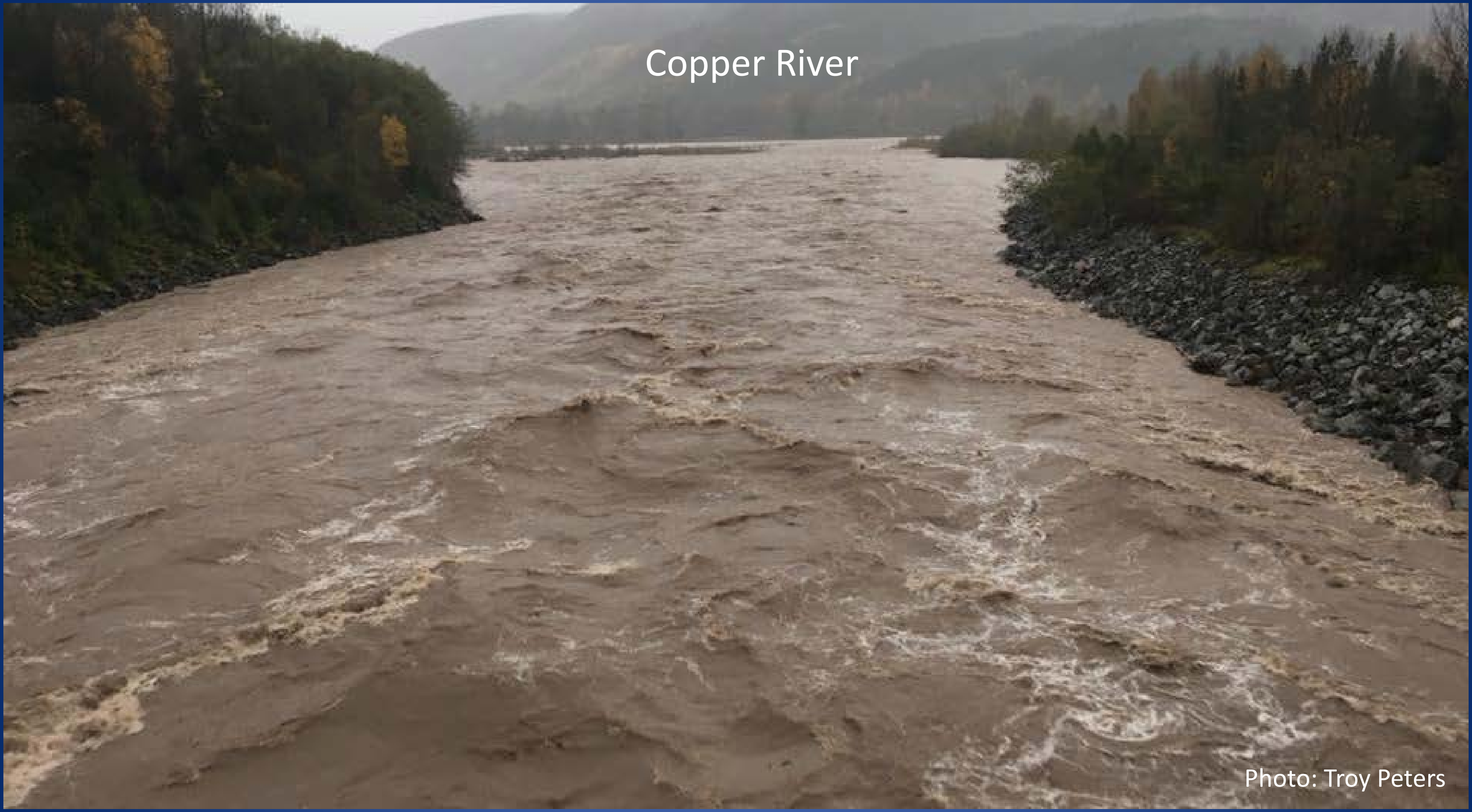
"Warm Temperature Records Will Fall As A Strong Atmospheric River Hits the Pacific Northwest"

– Nov 21, 2017



Source: US National Oceanic & Atmospheric Administration

Major Precipitation (Rain) Events



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

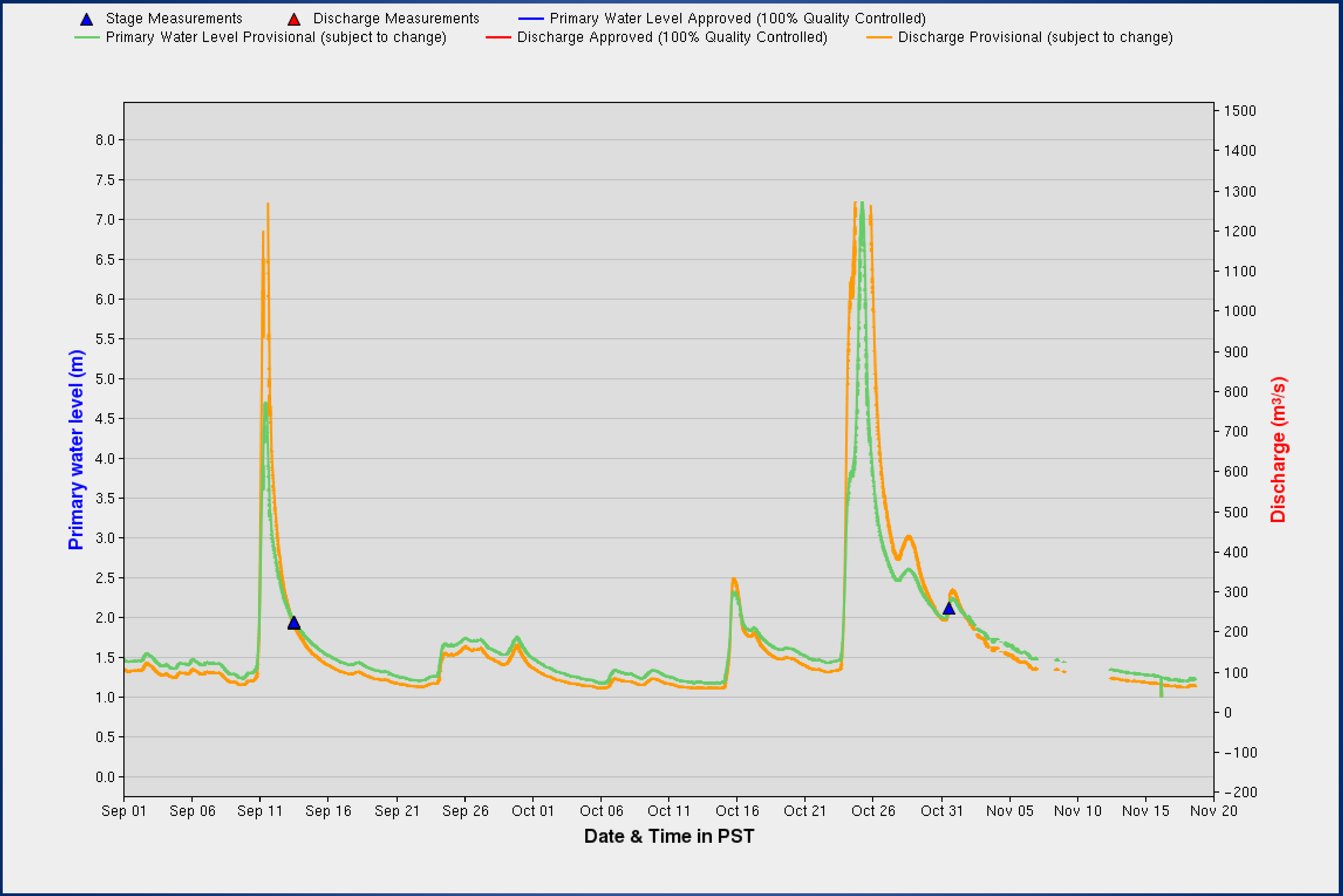
Land Slides

Impacts from sedimentation

- Changing river geology
- Choking spawning gravels
- Water quality

Photo: BC Ministry of Environment

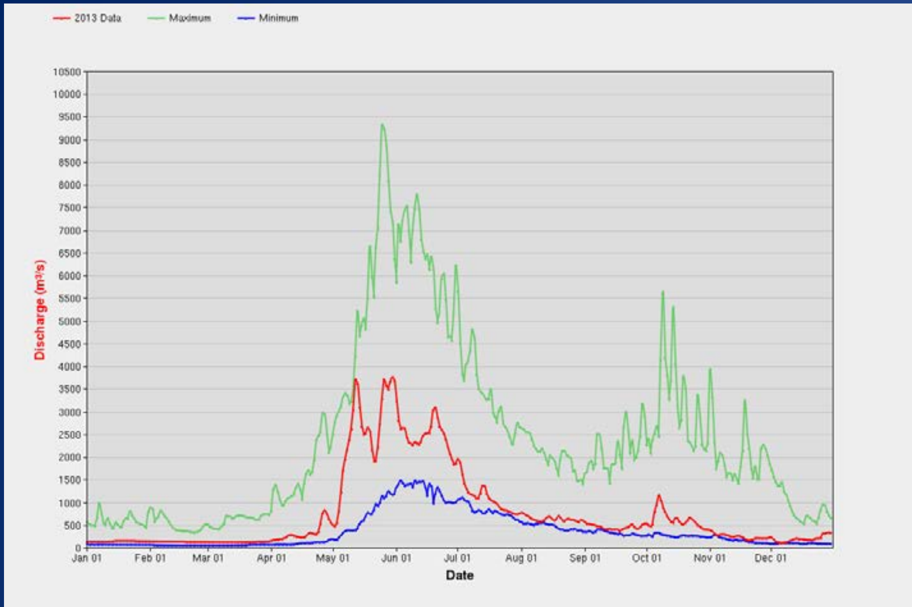
Copper River Hydrograph – Fall 2017



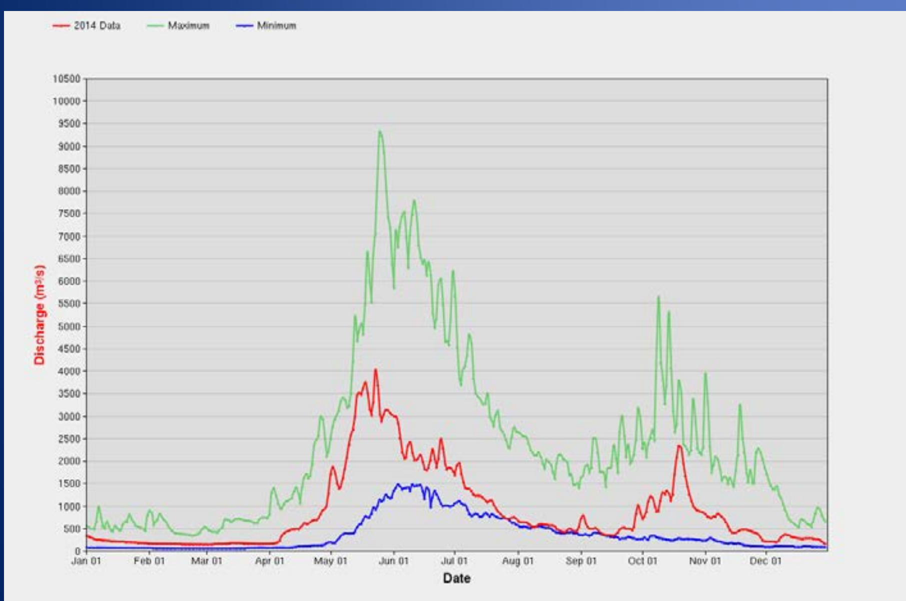
Source: Environment Canada, 2017

Low summer flows

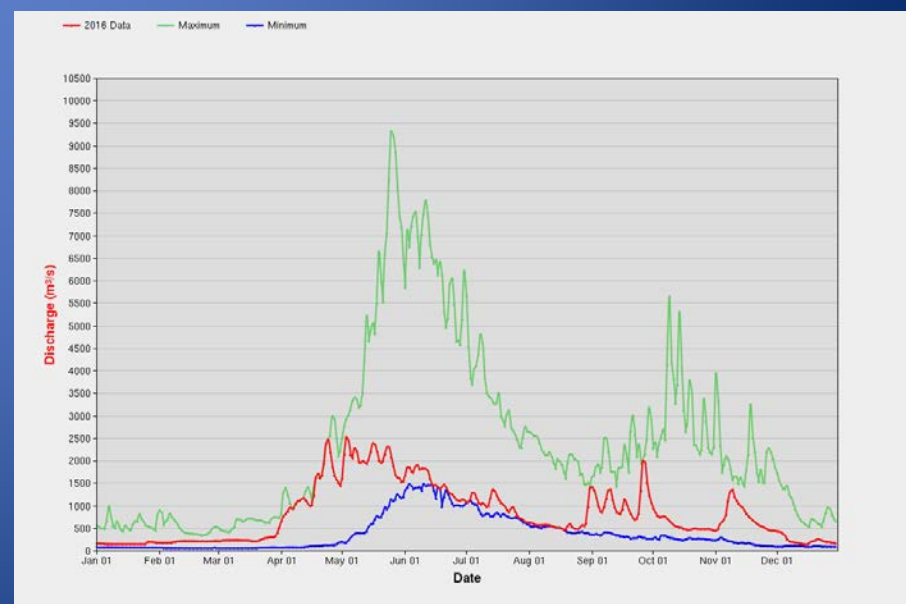
- Delays / changes in migration
- Increase vulnerability to fisheries
- Warmer temperatures



Skeena River at Usk - 2013



Skeena River at Usk - 2014



Skeena River at Usk - 2016

Babine Experience

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

Photo: Lake Babine Nation Fisheries, 2016

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)

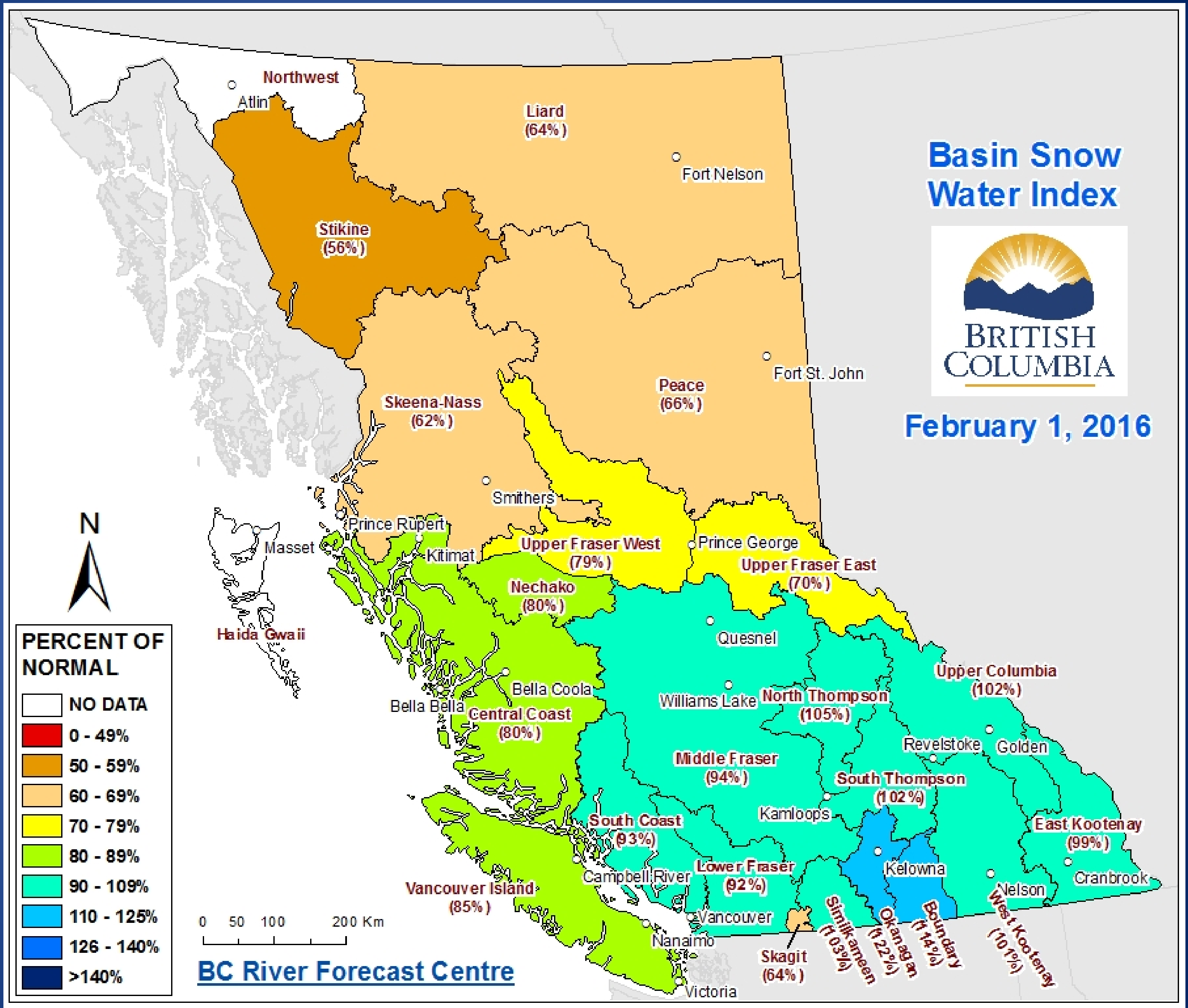
Increasing issue for Fraser sockeye

Snow Pack

Decreased snowpack

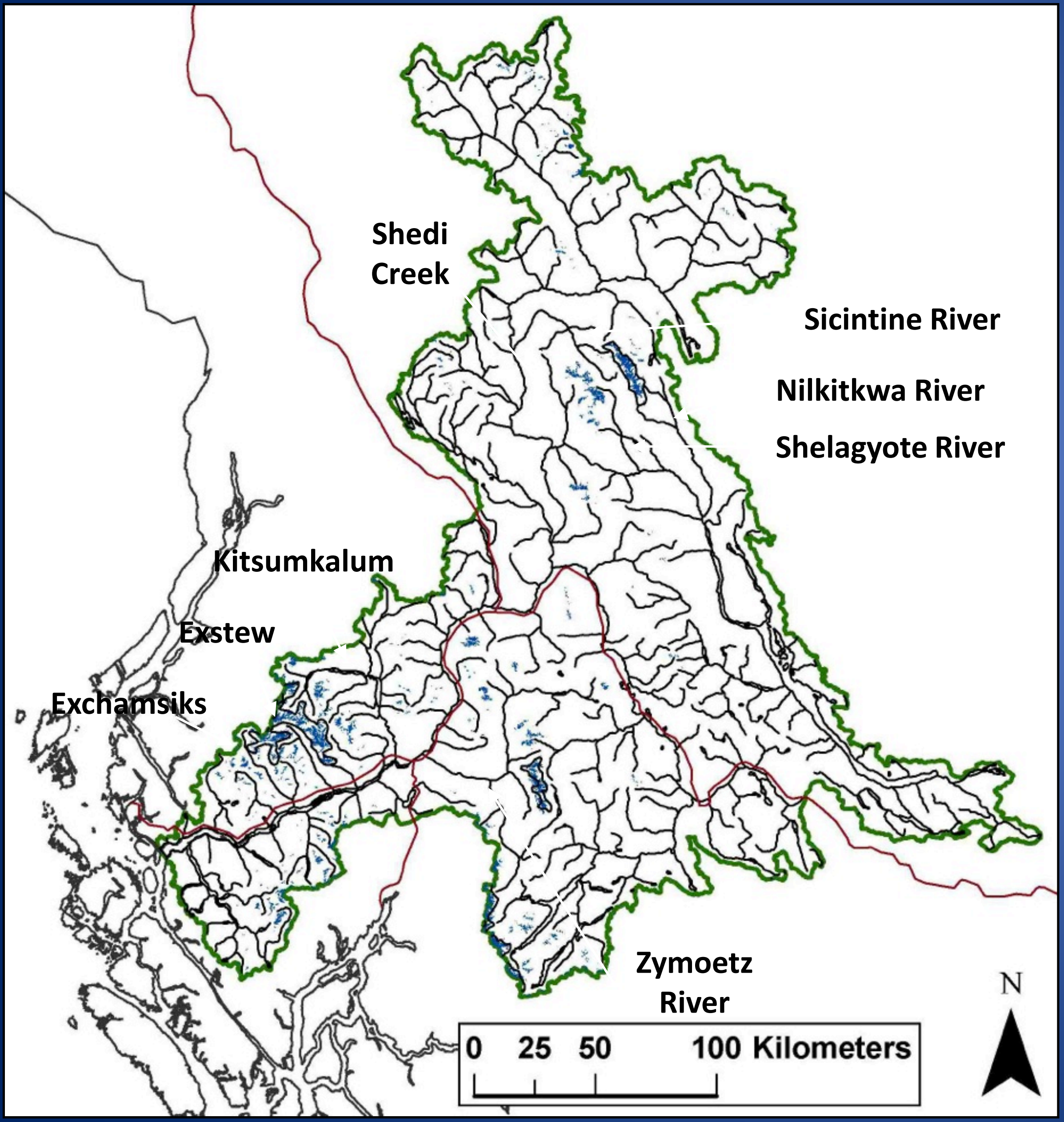
Means lower water levels in July & August

Impact migration and spawning, susceptibility to fisheries



Receding Glaciers

Skeena River Watershed



1985: 972 km^2 (1.8%)

2005: 825 km^2 (1.5%)

-147 km^2 (-15%)

- Kalum: 151 km^2
- Zymoetz: 94 km^2
- Exstew: 70 km^2
- Excham.: 39 km^2
- 354 km^2 (43%)

Source: Matthew Beedle, 2017

Glacier Change in Lower Skeena Watersheds

Exchamsiks River:

- 1985: 43 km^2 (8.4% glacierized)
- 2005: 39 km^2 (7.6%)

- 4 km^2 (- 8%)

Exstew River:

- 1985: 88 km^2 (19%)
- 2005: 70 km^2 (15%)

- 18 km^2 (- 21%)

- Zymoetz River:
- 1985: 104 km^2 (3.4%)
- 2005: 94 km^2 (3.1%)

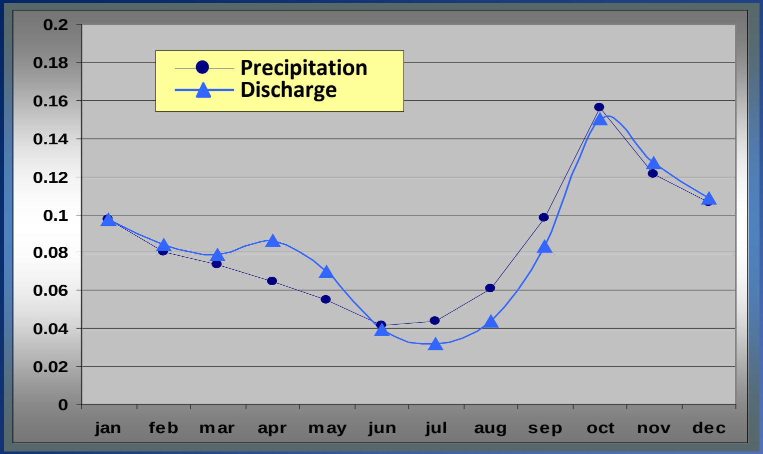
- 10 km^2 (- 10%)

- Kitsumkalum River:
- 1985: 179 km^2 (8.1%)
- 2005: 145 km^2 (6.6%)

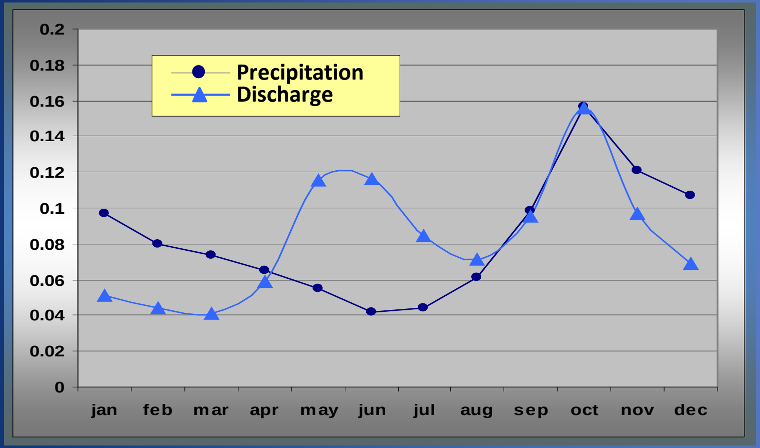
- 34 km^2 (- 19%)

Source: Matthew Beedle, 2017

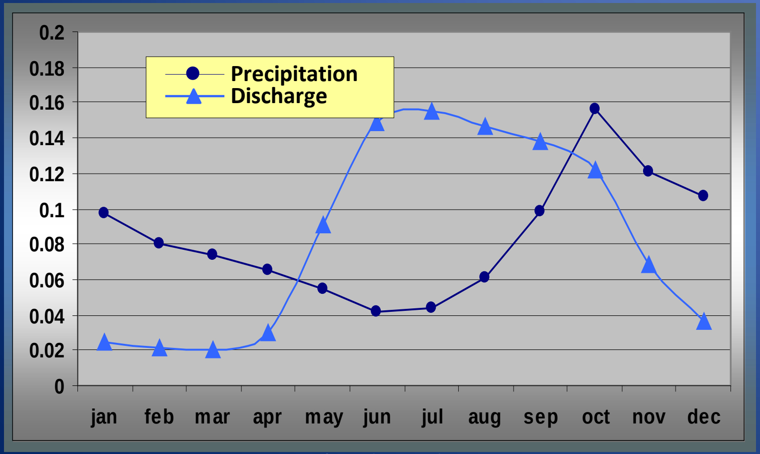
Rain Fed



Snow Fed



Glacier Fed



Source: Rick Edwards, PNW FSL

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

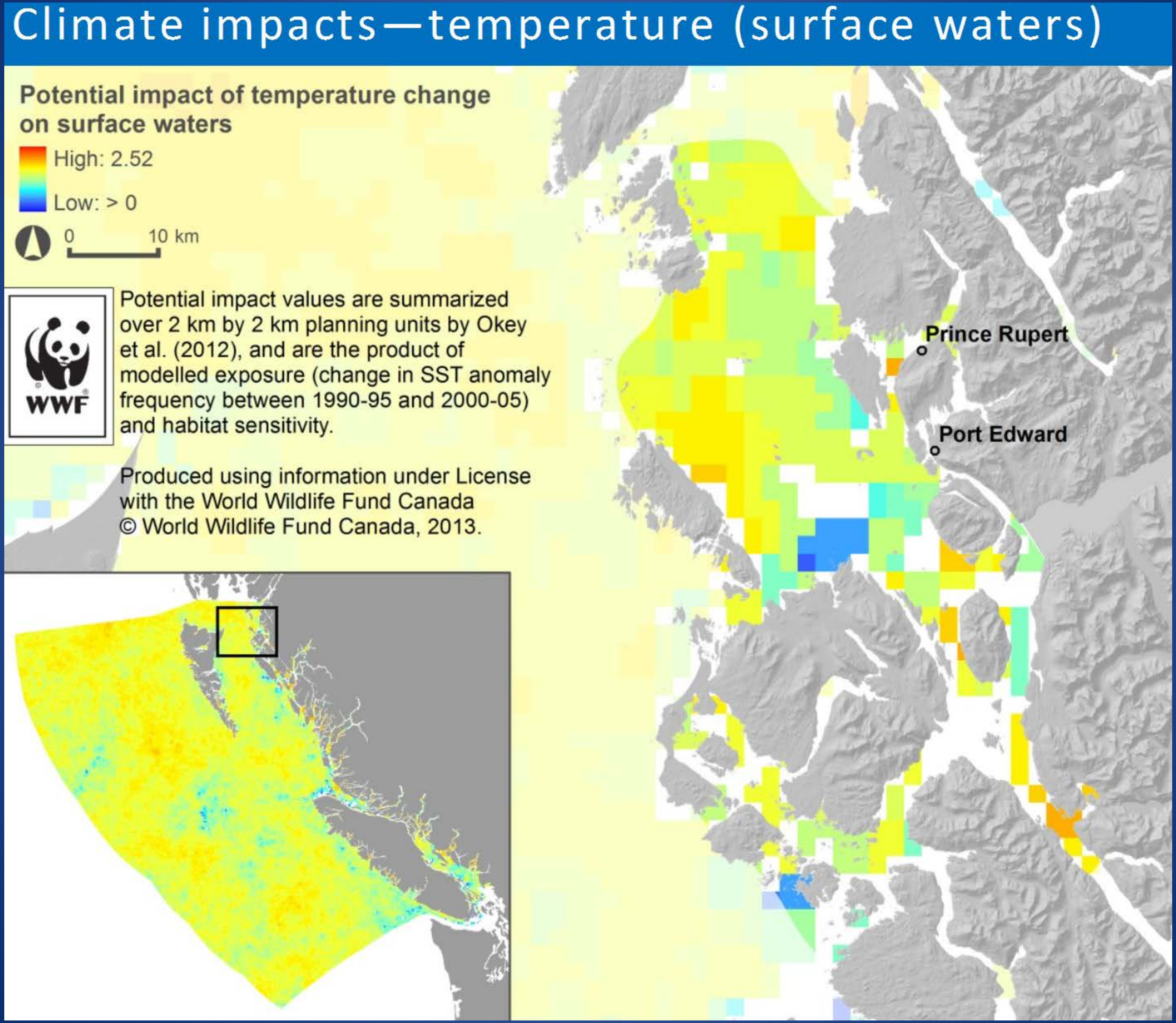
Once they melt, can dramatically change a river system.

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

Freshwater / saltwater intersection

Photo: Brian Huntington, 2014

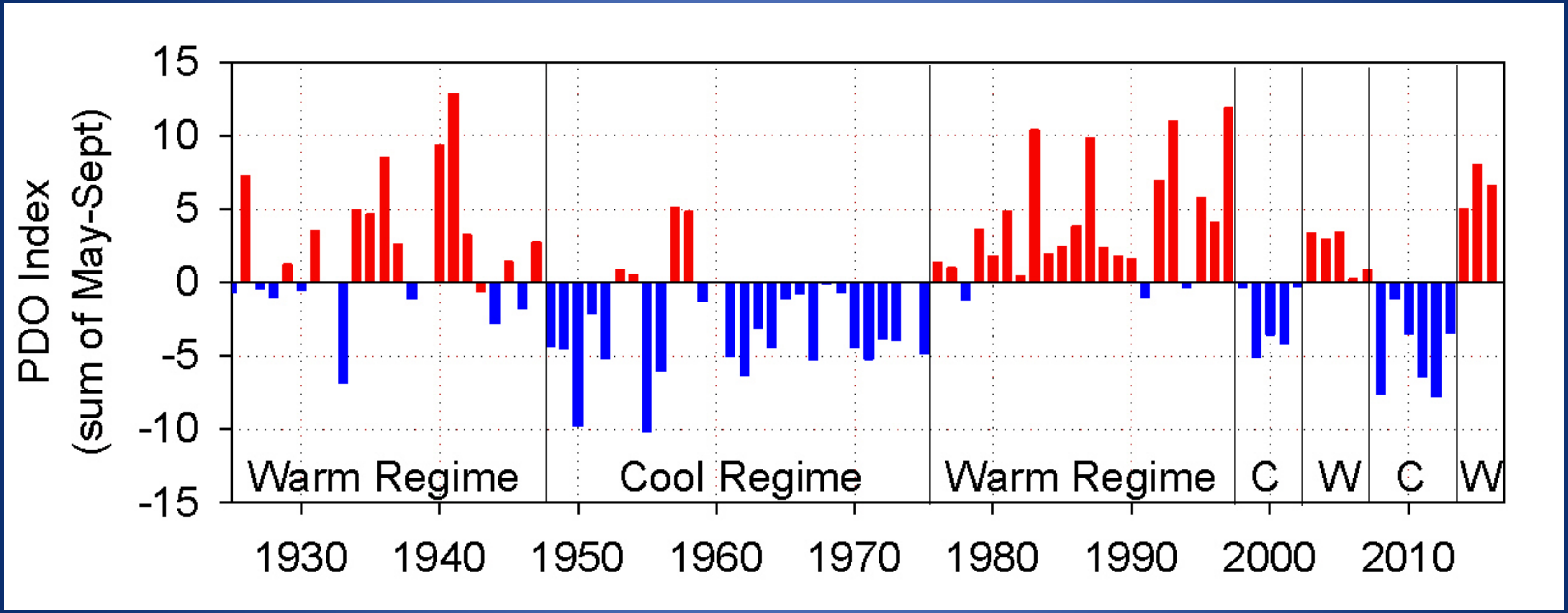
Climate Change in the Estuary



Source: World Wildlife Fund, 2013

Climate Change in the North Pacific

Potential Breakdown in Pacific Decadal Oscillation

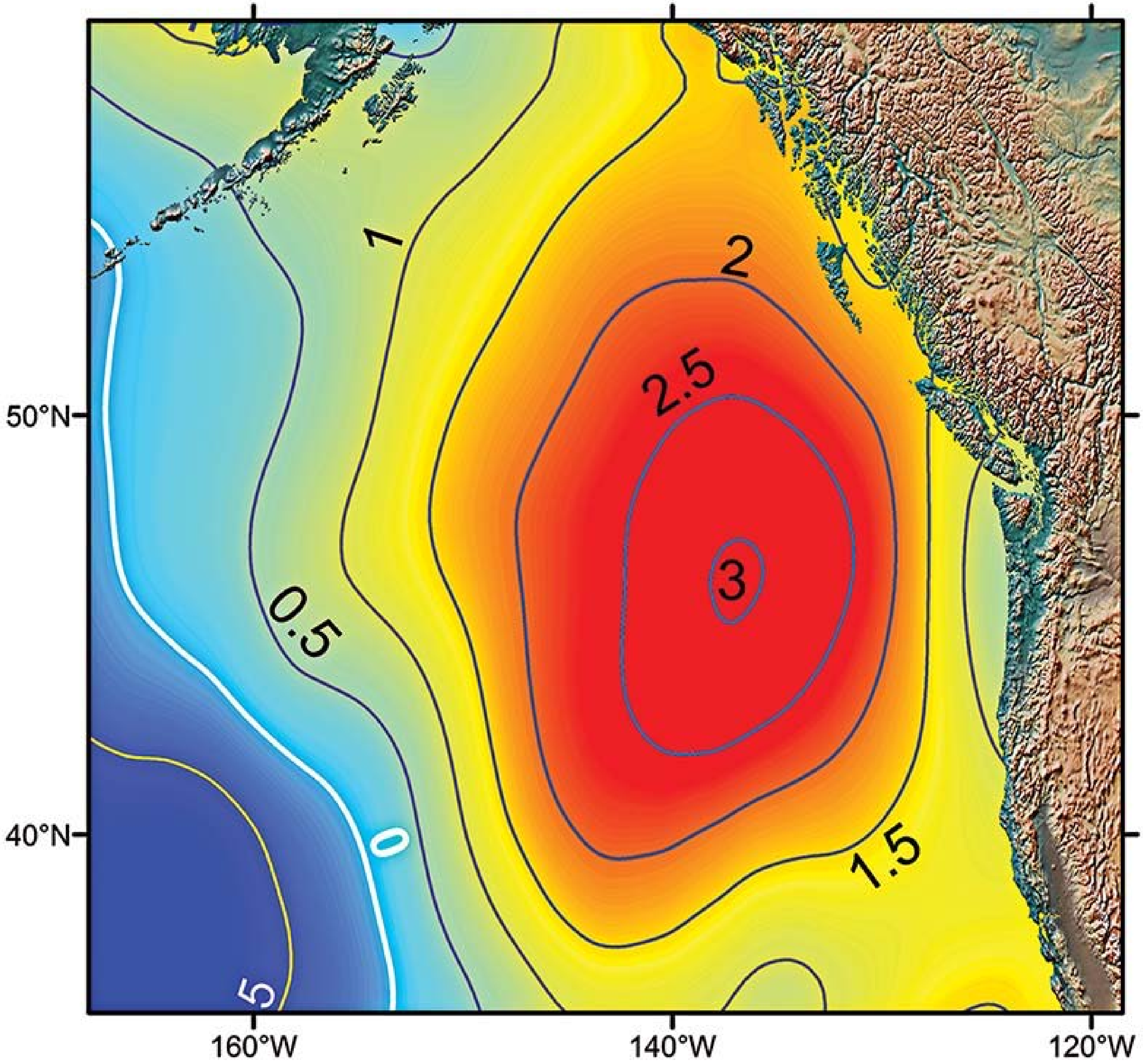


Source: Northwest Fisheries Science Center, 2017

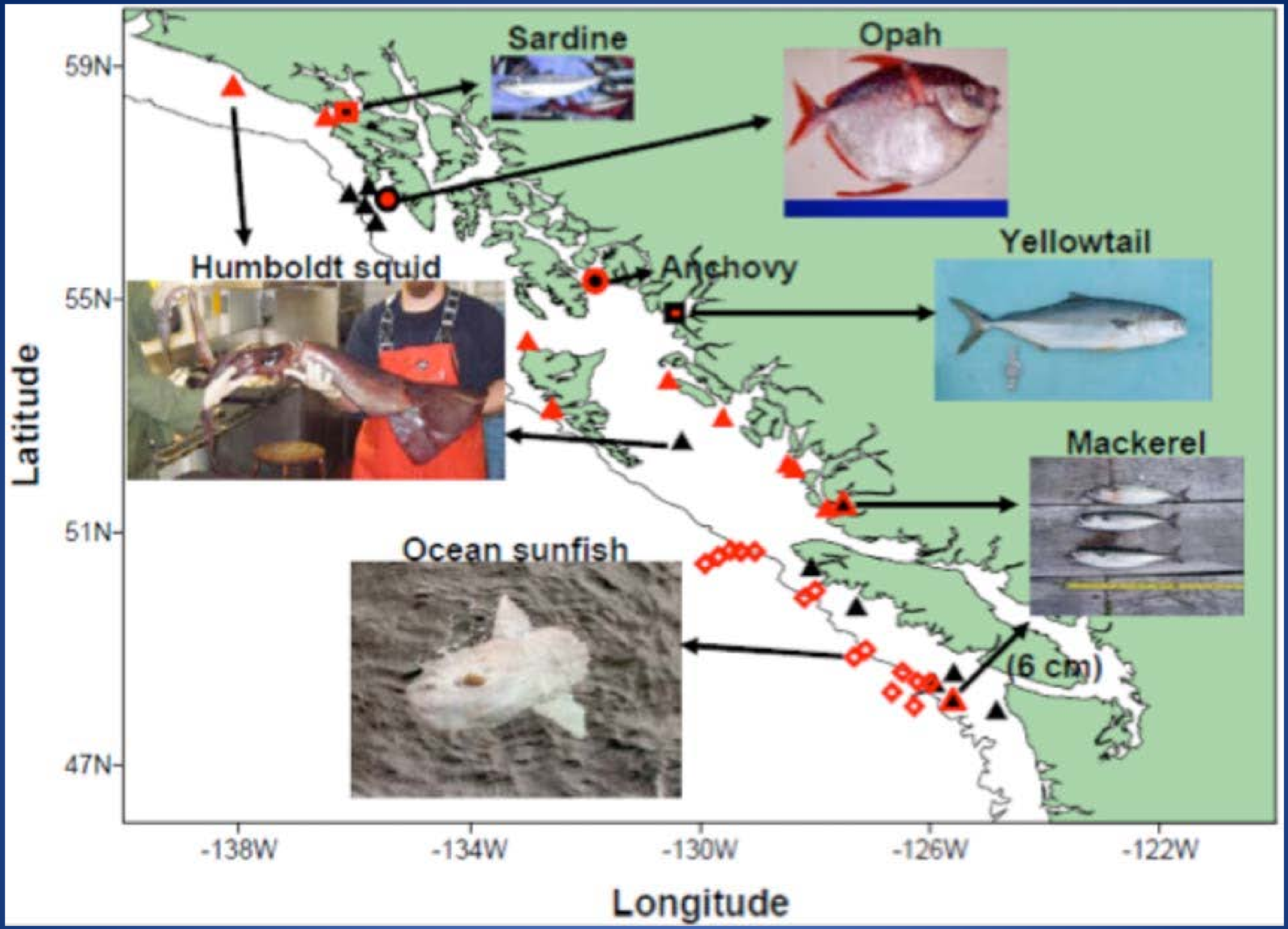
The "Blob"
2013 - 2016

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.

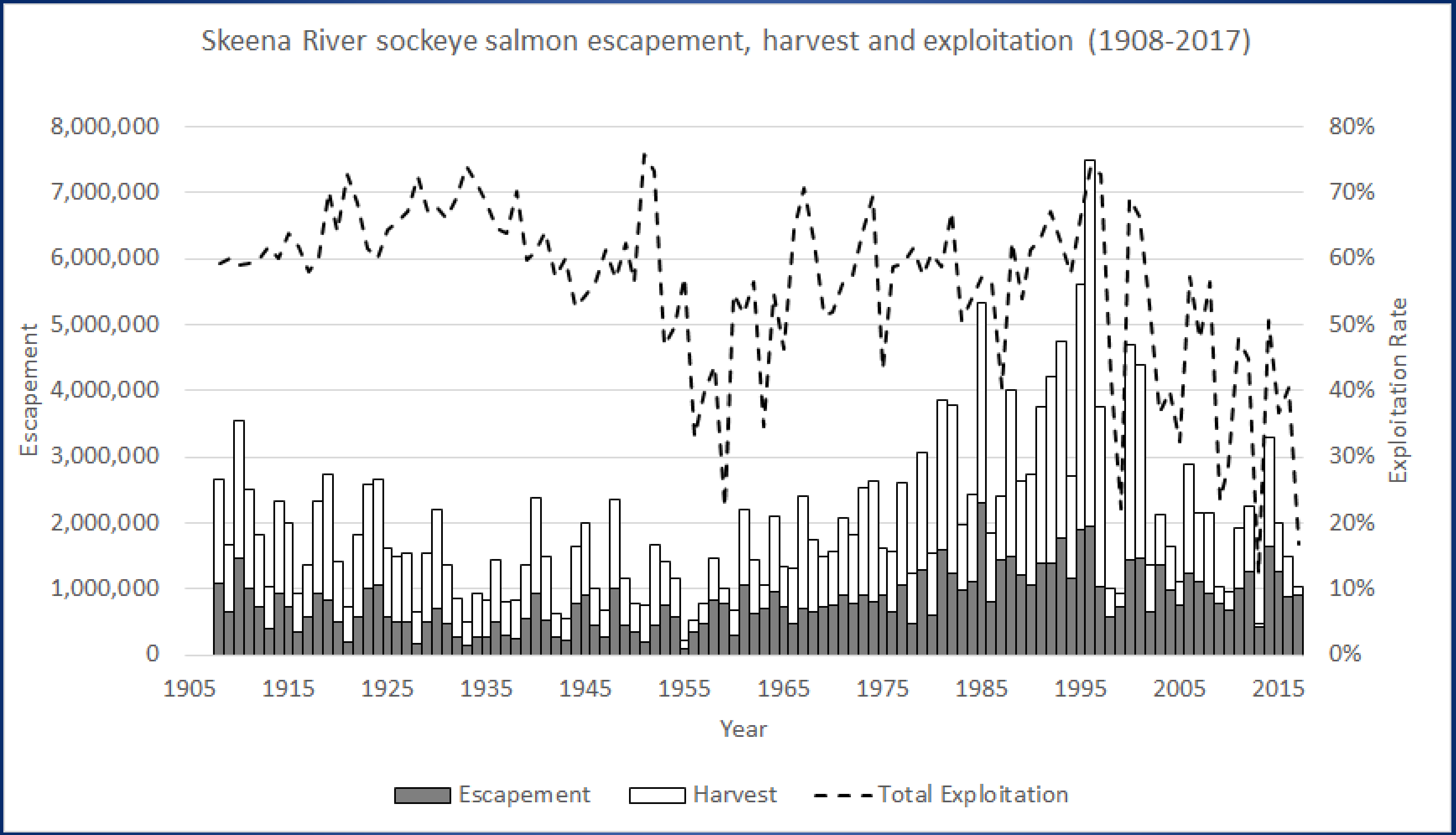
Source: WWF, 2012 (reproduced from Trudel et al. 2006)

How has all of this been impacting returns?

Difficult to measure

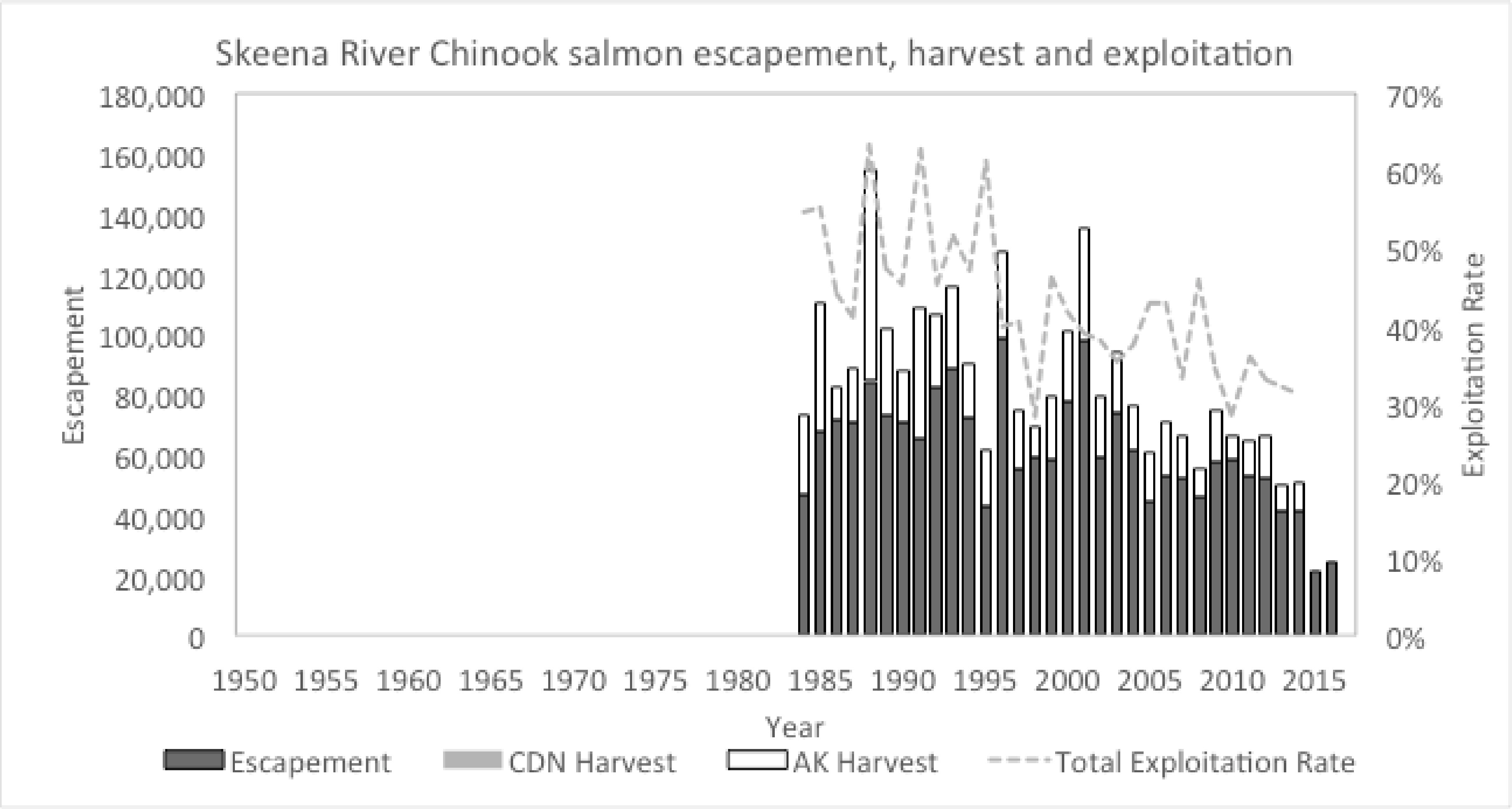
- Variation in conditions and returns is normal, but productivity of populations used to be more stable
- Increasing variability in returns of some species & populations
- Smaller size of returning adults = fewer eggs
- Sockeye and Chinook issues
- Ongoing Chum concerns

Sockeye



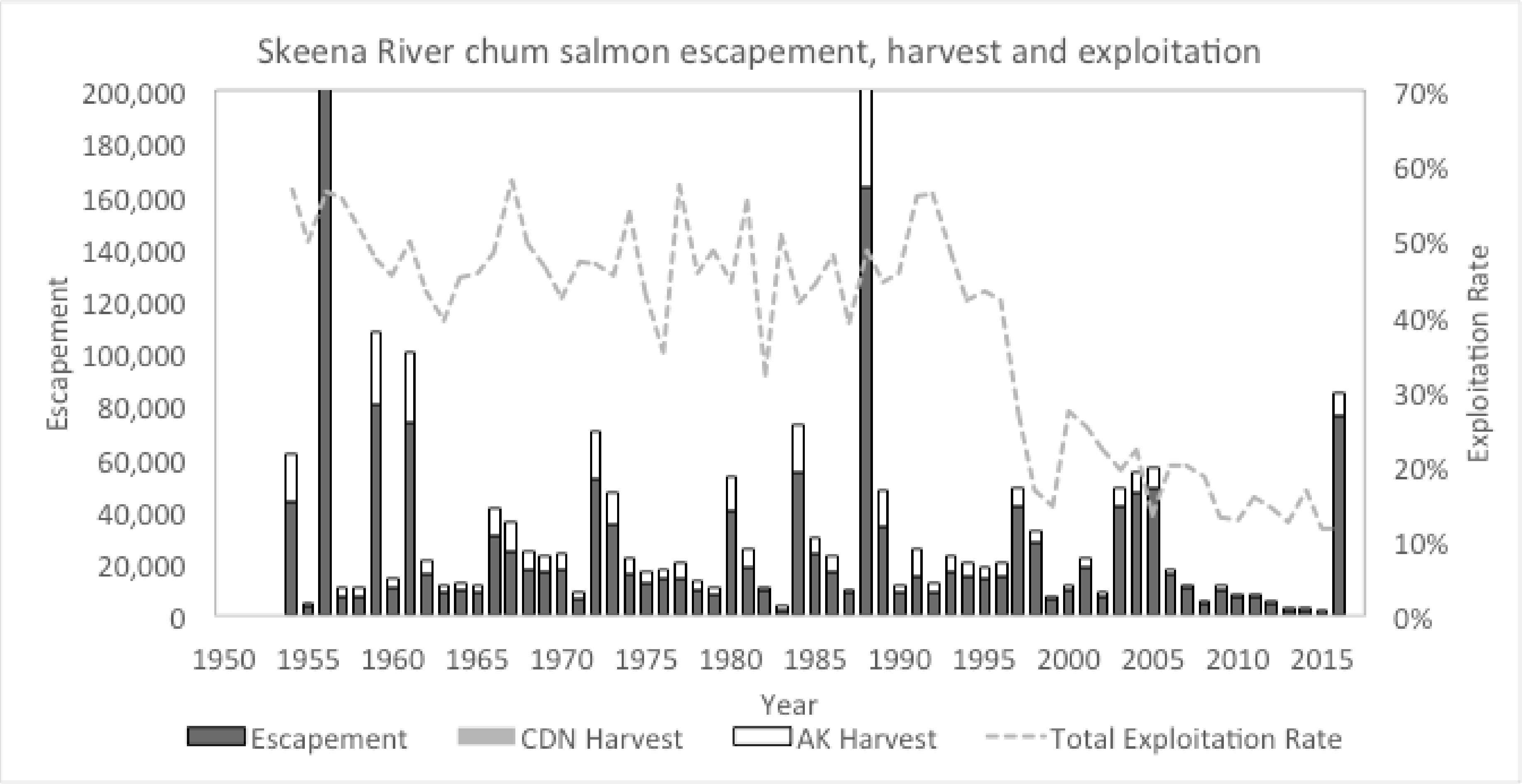
Source: SkeenaWild, 2017

Chinook



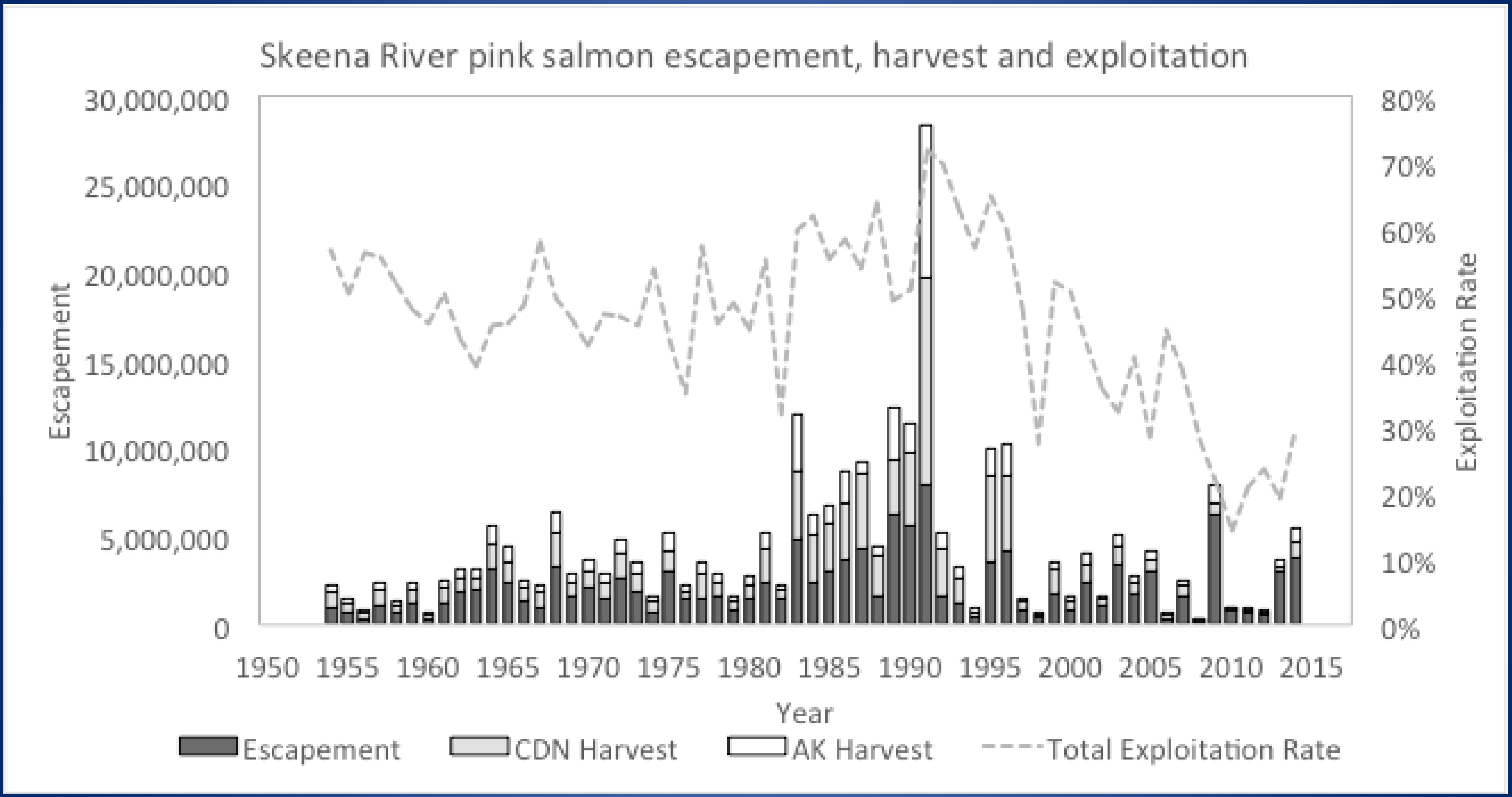
Source: SkeenaWild, 2017

Chum



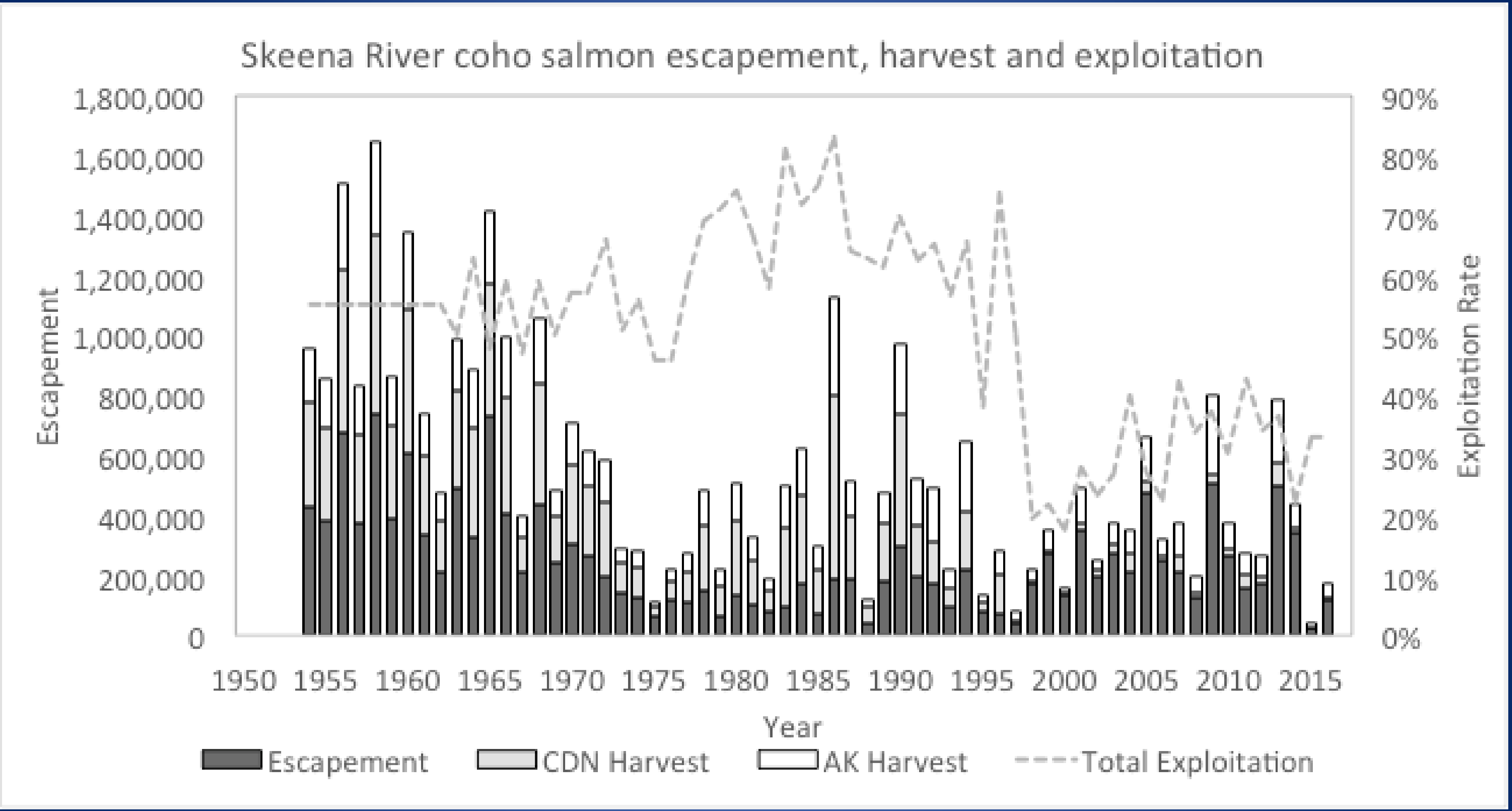
Source: SkeenaWild, 2017

Pink



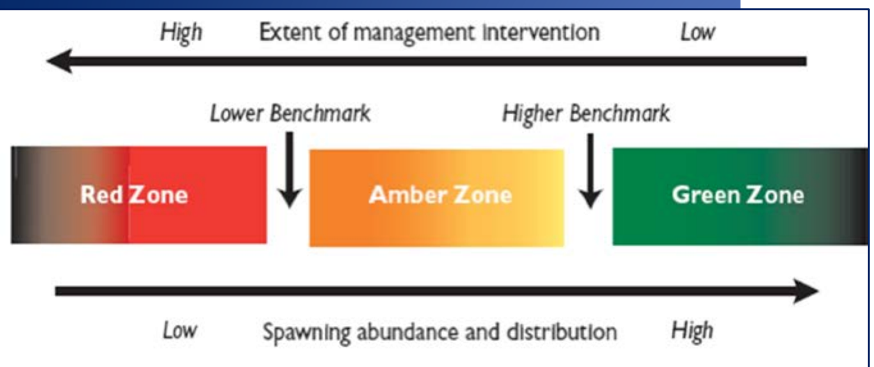
Source: SkeenaWild, 2017

Coho

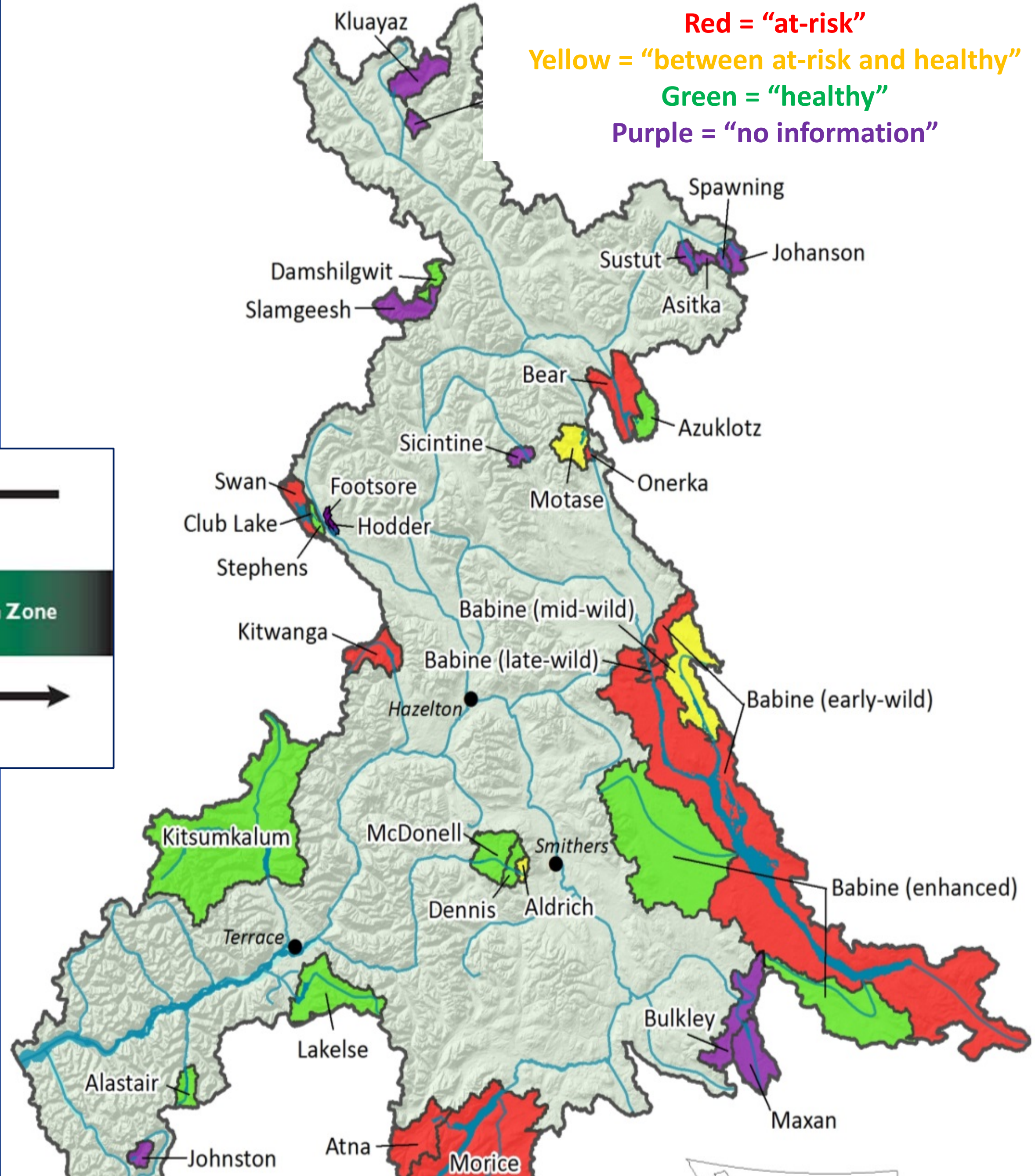


Source: SkeenaWild, 2017

Skeena salmon are already at risk



Source: DFO, 2005



Source: SkeenaWild, 2016
- adapted from PSF, 2012

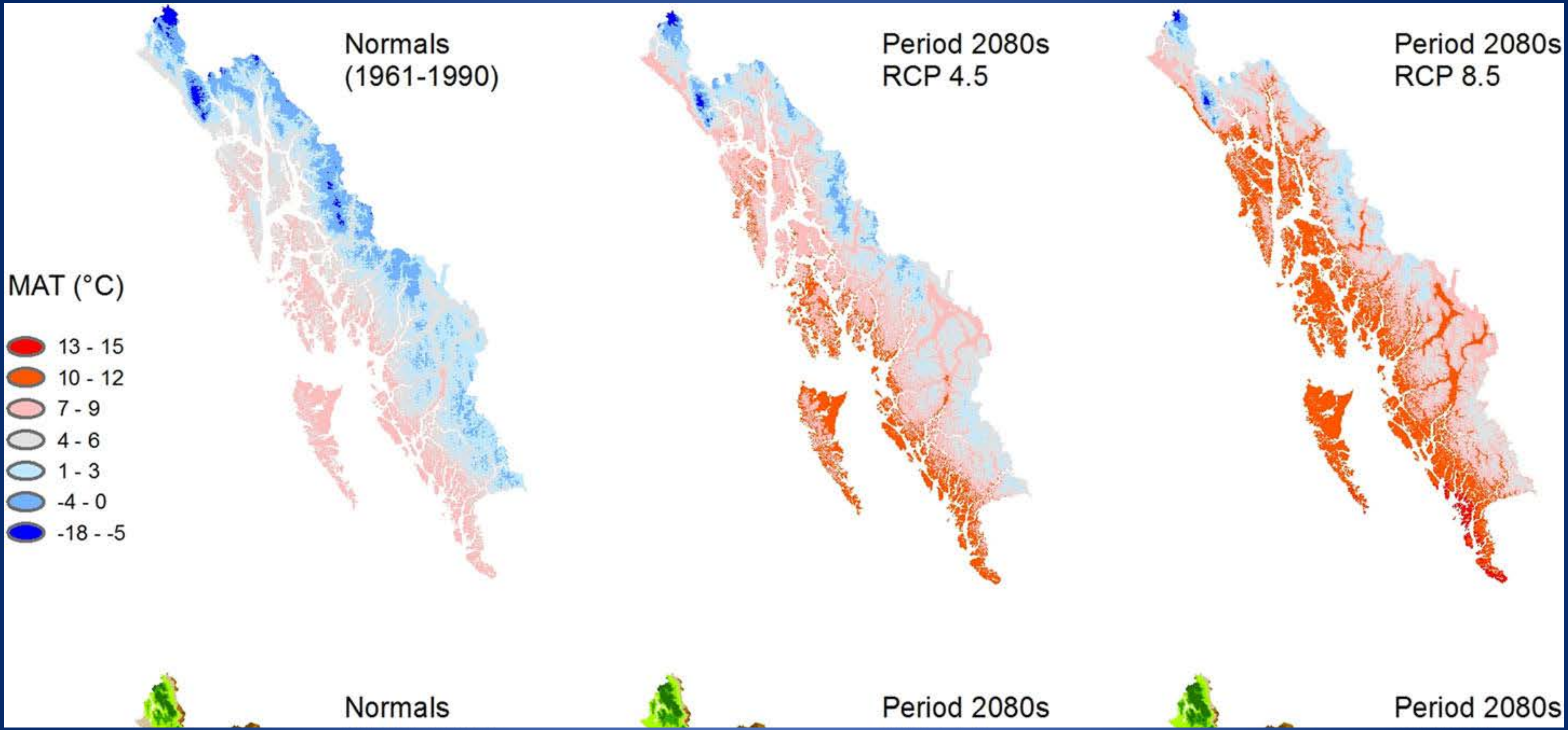
What Changes can we expect to see over the coming decades?

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

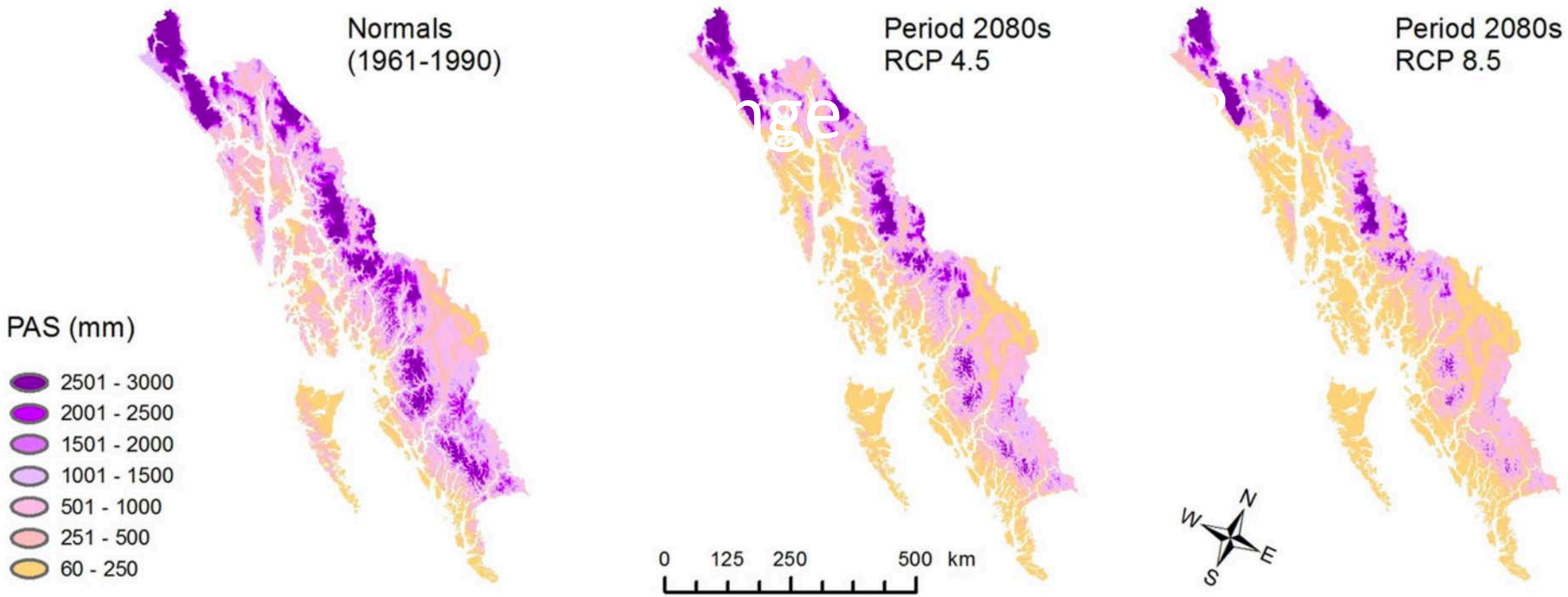


Precipitation increasing from 3130 mm to:

- 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

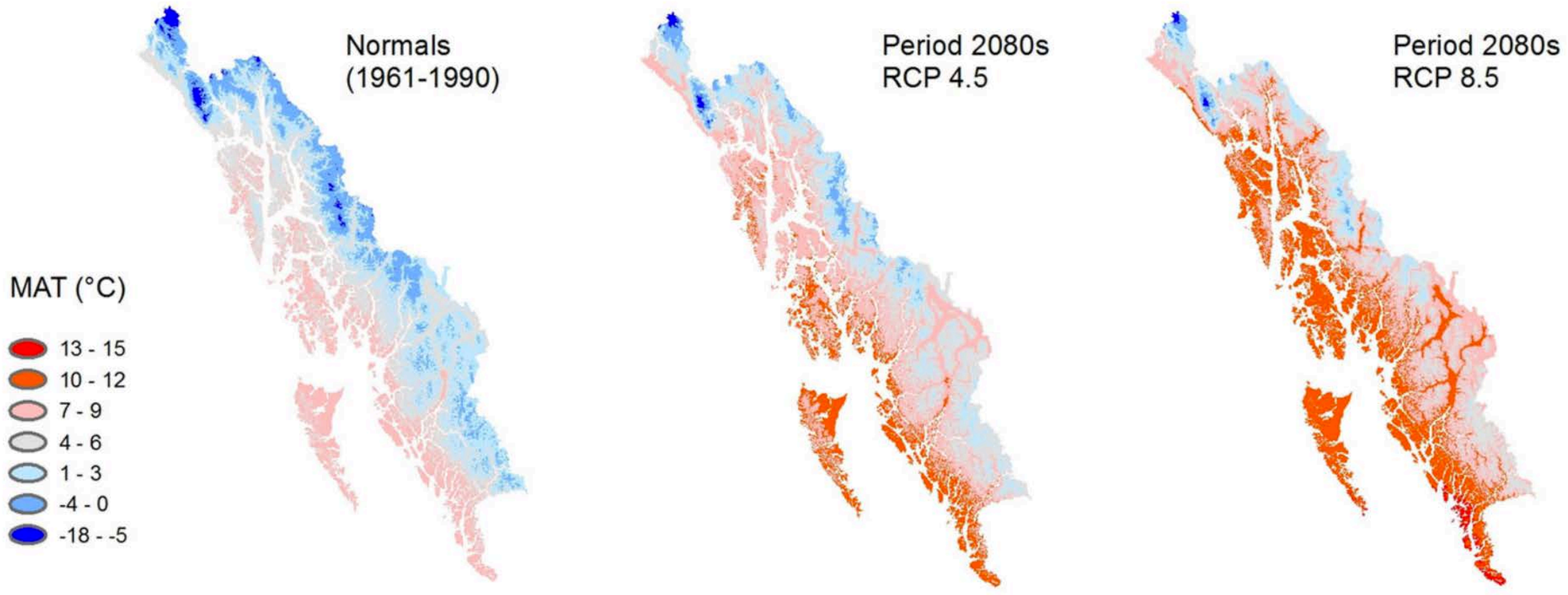


Snow decreasing from 1200 mm to;

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

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

Projected Increases in Mean Annual Temperature - 2080

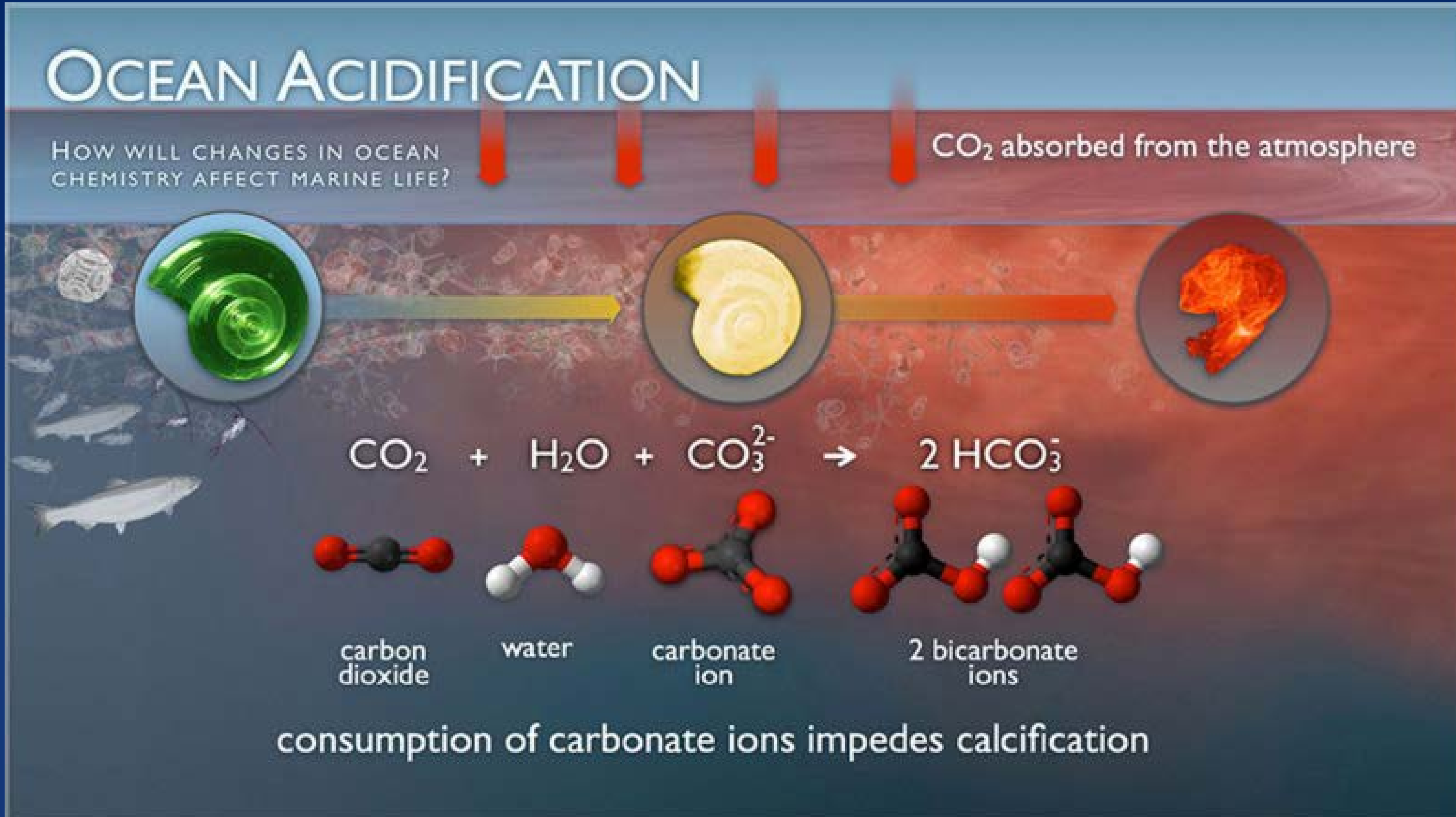


1961 – 1990 mean annual temp = 3.2 ° C

- to 4.9–6.9 ° C (RCP4.5 scenario, 2080)
- or 6.4–8.7 ° C (RCP8.5 scenario, 2080)

+1.7° C to 5.5° C by 2080s

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



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 CO2 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

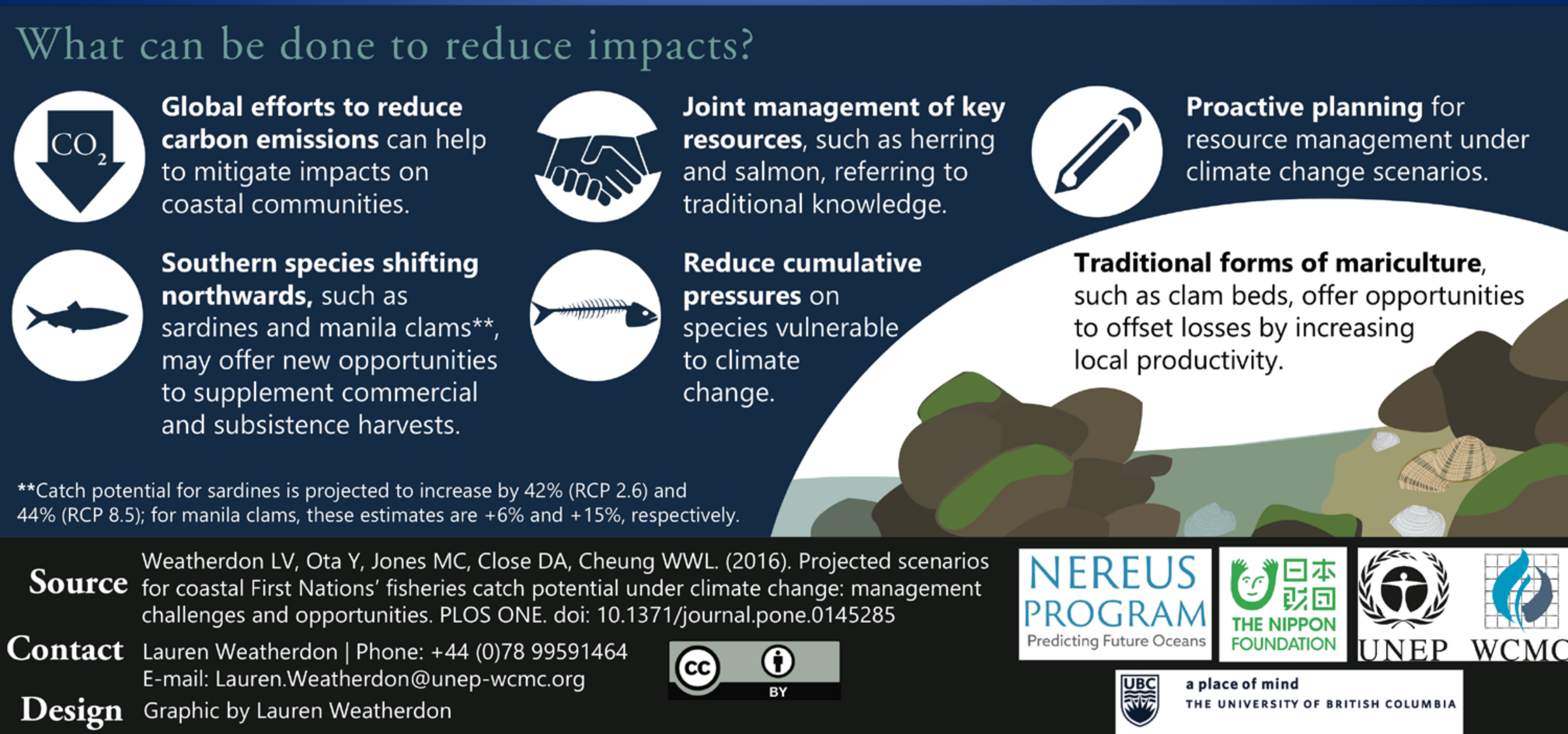
- Better in-season assessments
- Set clear management actions to deal with uncertainty and greater fluctuations – start with Chinook, but do ABMP's for all species.
- Develop & Implement Rebuilding Plans for populations in the red zone

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



Source: Weatherdon et al, 2016

Will Skeena Salmon Be Able to Adapt?

There's Hope!

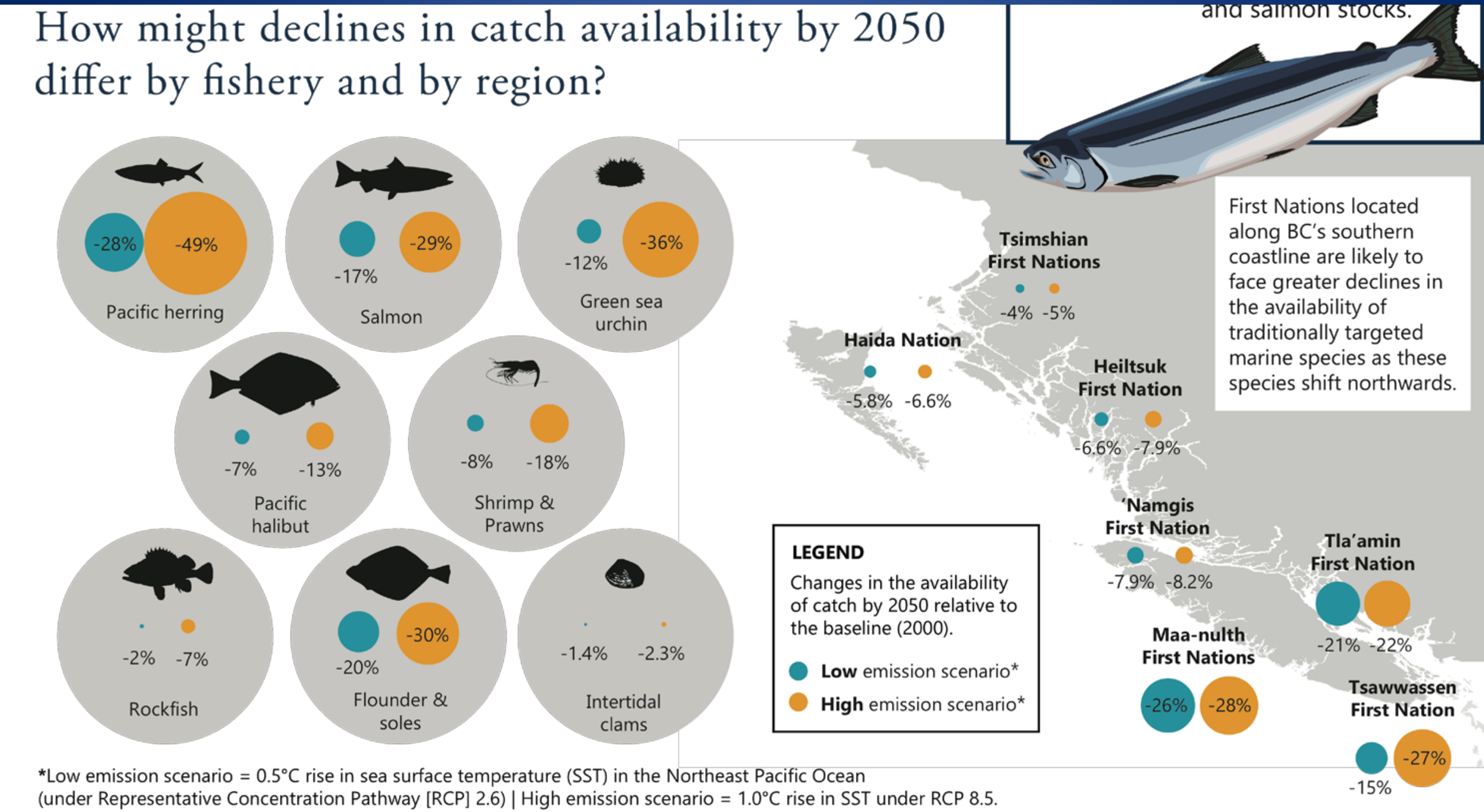
Salmon are resilient

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



Weatherdon et al, 2016