Hatchery Adaptation in the Face of Climate Change

PSC Seminar Series

November 29th, 2023

David Willis, DFO Salmonid Enhancement Program

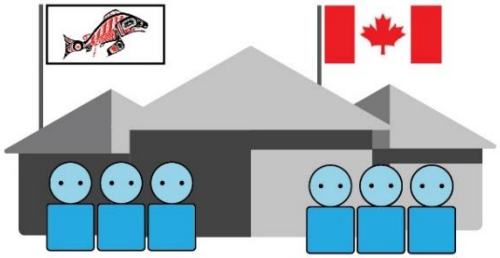
Overview

1. The Canadian enhancement context
2. Climate Challenges
3. Hatcheries and climate resiliency
   - What is being done, and what more needs to be done?

Different types of Enhancement hatcheries

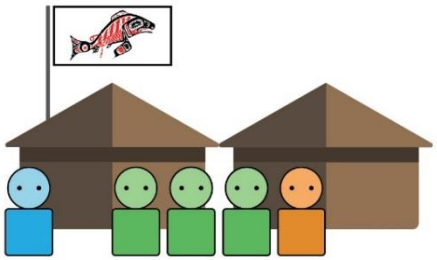
Enhancement hatcheries in Pacific Canada come in different sizes and models. Hatcheries support enhancement objectives, and provide information and education on salmon.

Major Operational Hatcheries



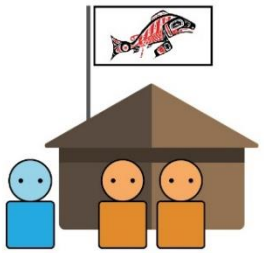
Enhancement operations run and staffed by DFO - These operations and hatcheries tend to be on a large scale

Community Economic Development Program Hatcheries (CEDP)



CEDPs tend to be medium scale hatcheries run in partnership with Indigenous communities to help restore depleted salmon stocks, contribute to harvest opportunity, and support indicator programs

Public Involvement Program Hatcheries (PIP)



Stewardship groups, volunteers, and Indigenous groups undertake small scale community based projects that restore salmon habitat, enhance salmon, and educate the public

Civil servant

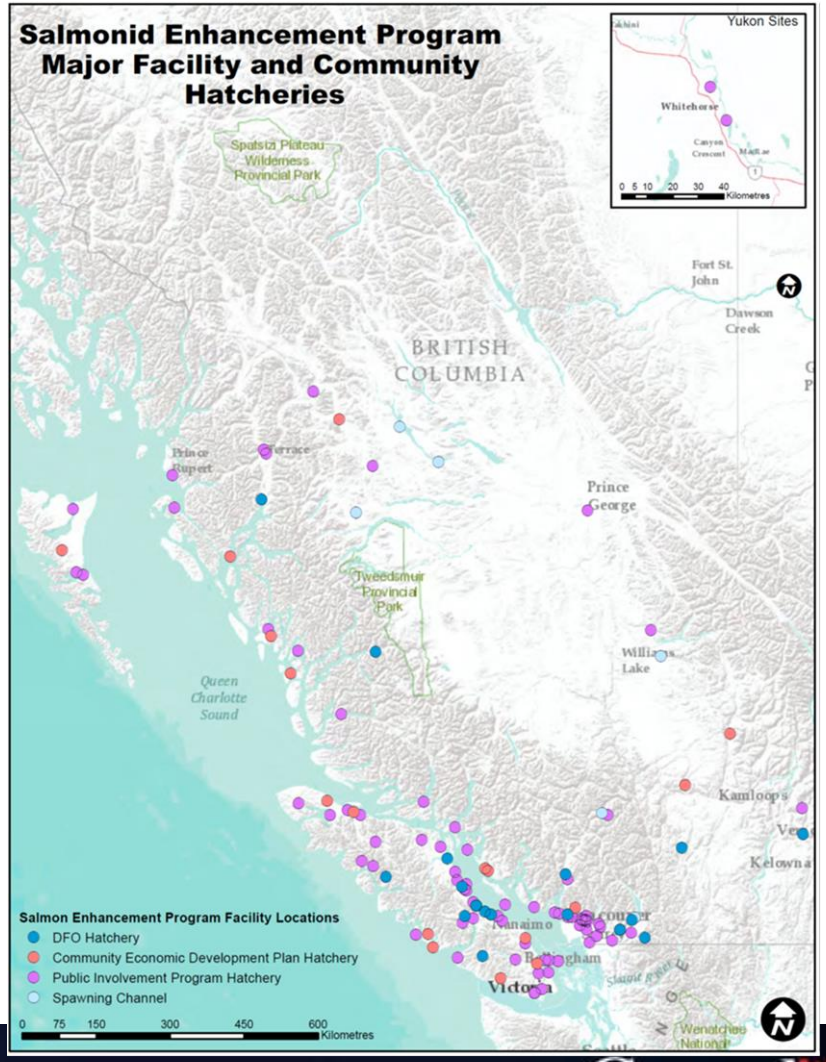
Non-government staff

Community volunteer

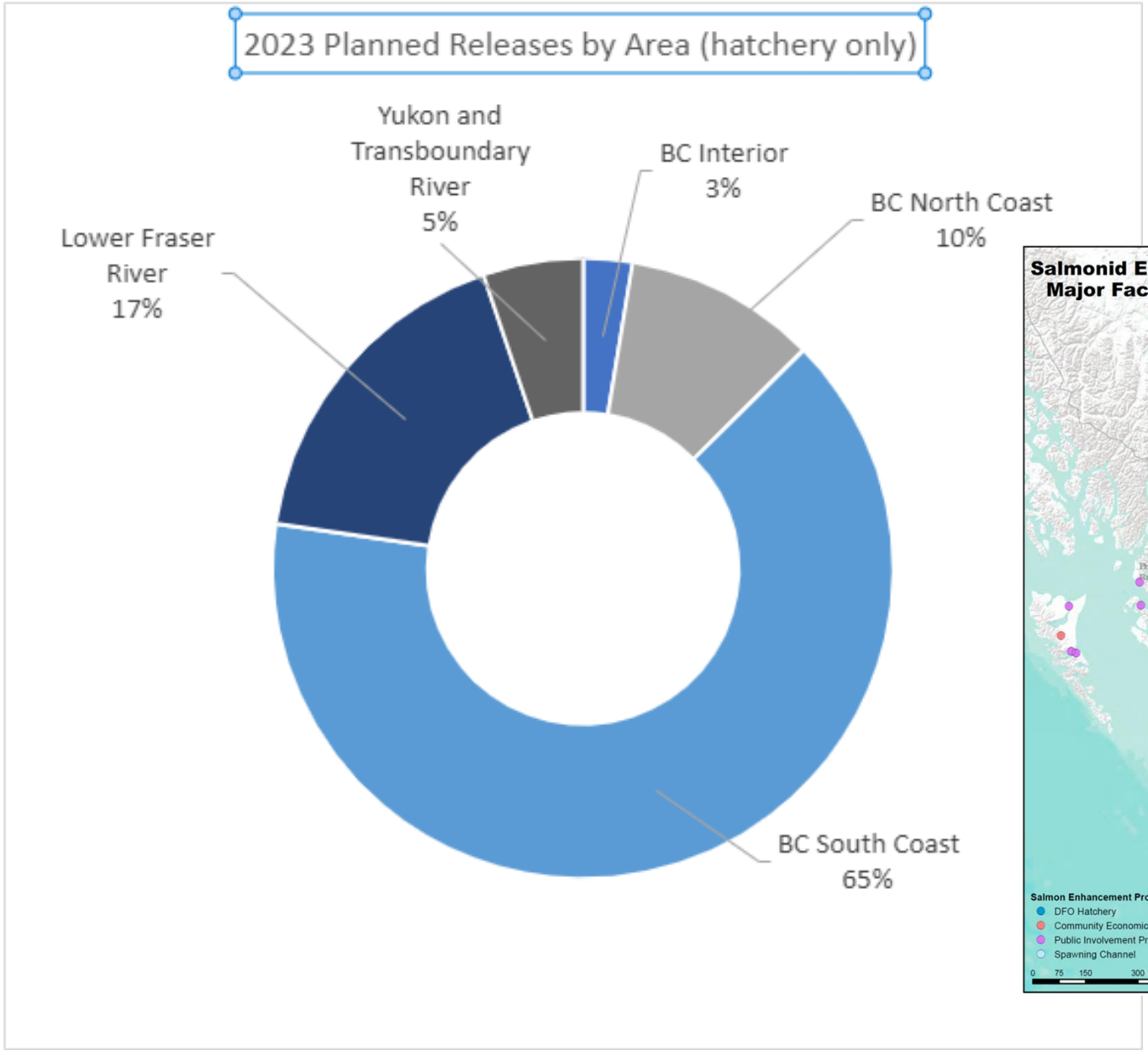
The Salmonid Enhancement Program

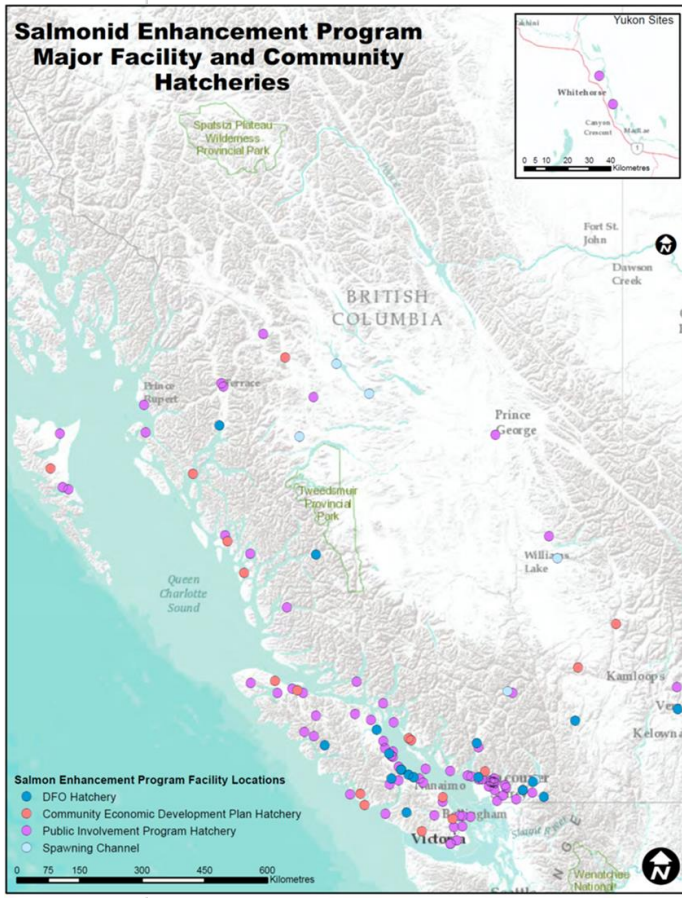
Program Basics:

- 23 DFO operated hatchery and spawning channel facilities
- 17 partner facilities funded through contribution agreements
- 66 volunteer run Public Involvement Program facilities; ~10,000 volunteers
- Diverse and highly geographically dispersed projects advancing objectives of conservation / rebuilding, sustainable harvest, stock assessment and / or stewardship
- Annual integrated production planning process linked to the IFMP, operational guidelines and risk management frameworks support optimized production and safeguards to wild stocks

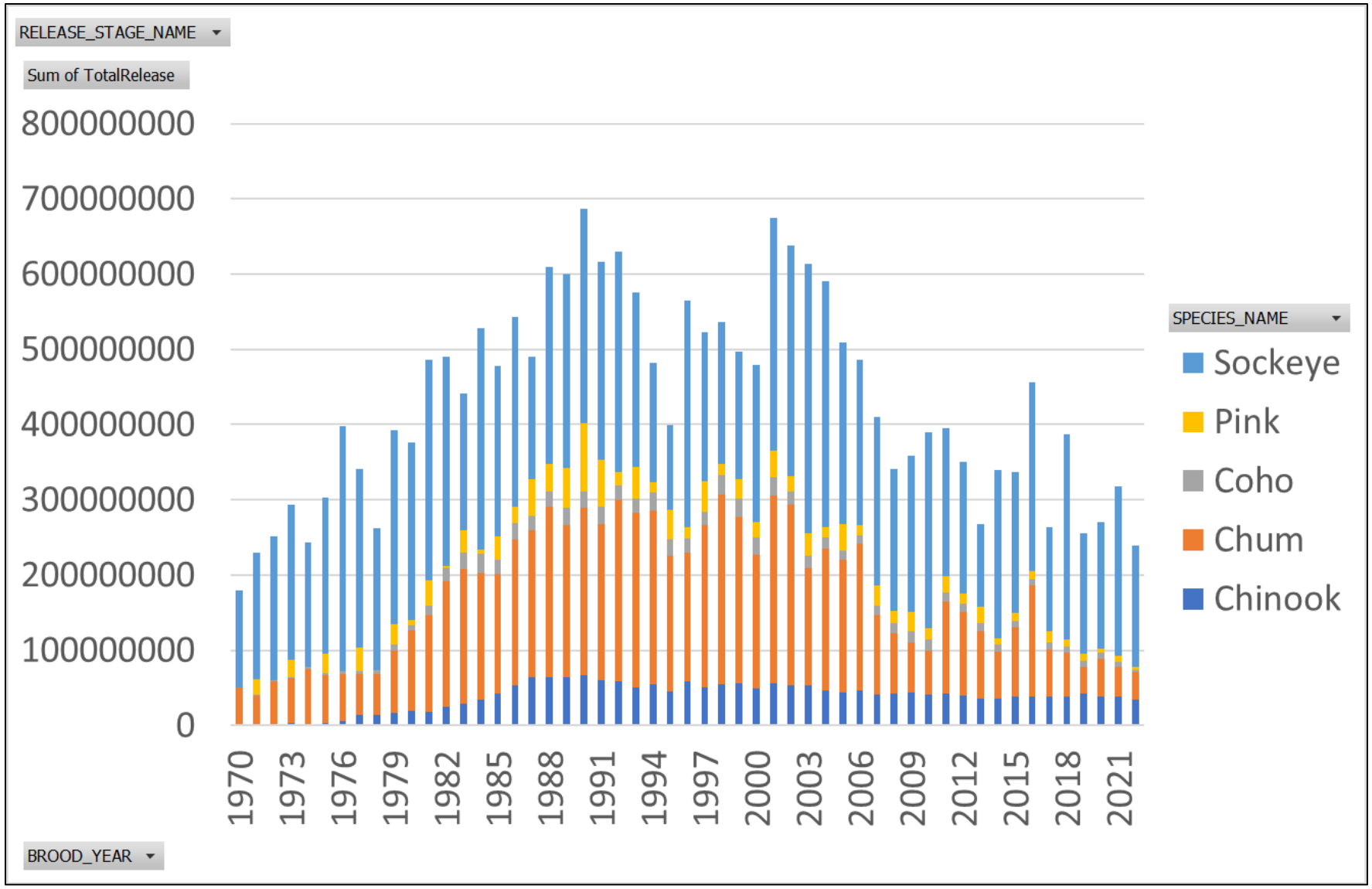


Overview of Canadian Enhanced Production





Overview of Canadian Enhanced Production



Climate Challenges

- For hatcheries
- For salmon

Wildfire - Snootli Creek Hatchery

Flooding - Spius Creek Hatchery 2021

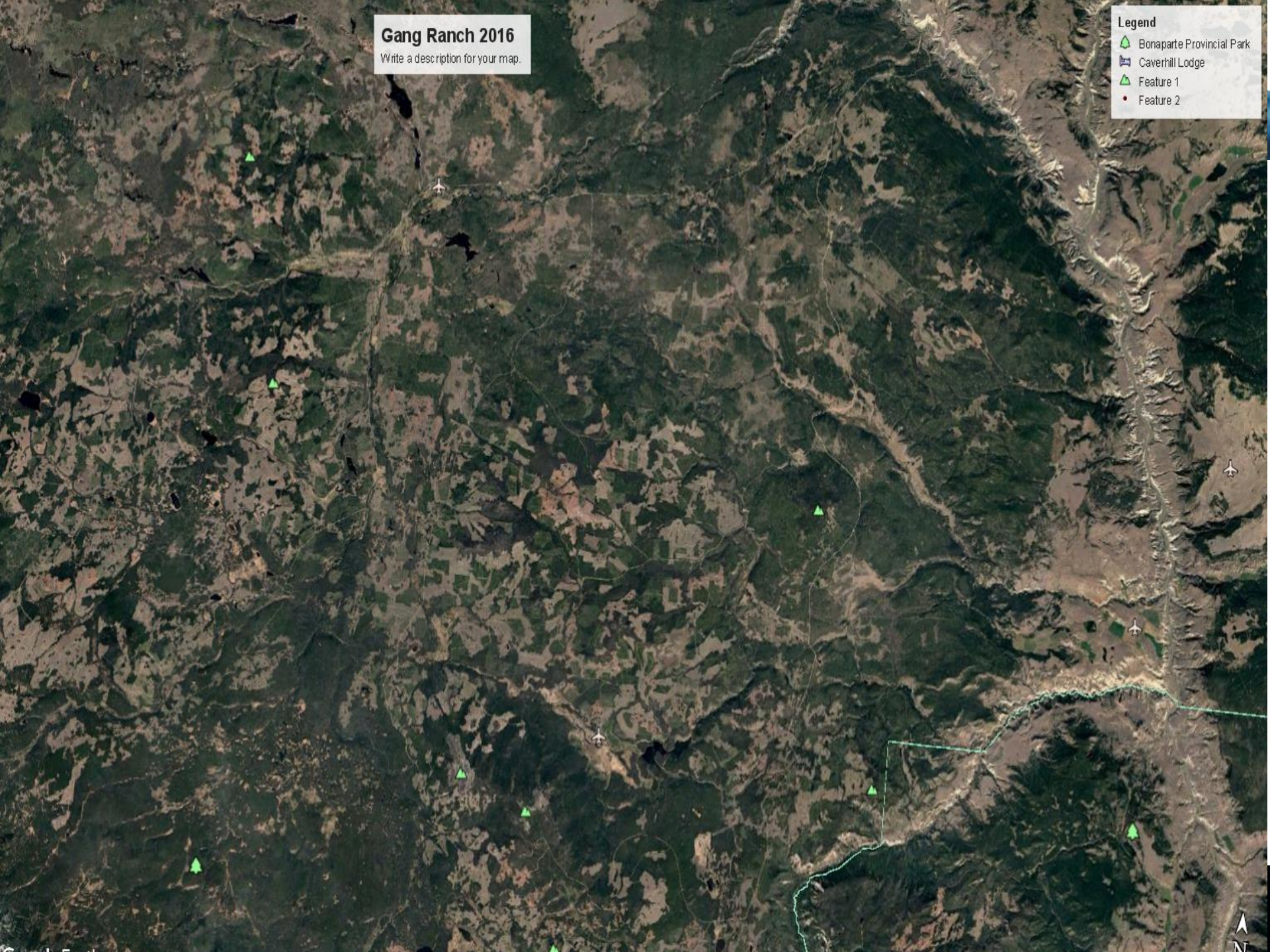
Flooding - Spius Creek Hatchery 2022

Oldfield Creek Hatchery water intake

Debris Slide - 2021

Fraser River Drought - 2023


Gang Ranch 1984
Write a description for your map.
Legend
Bonaparte Provincial Park
Caverhill Lodge
Feature 1
Feature 2
Big Creek
Gan
N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Horsefly 1984
Write a description for your map.
Horsefly
Legend
Bonaparte Provincial Park
Caverhill Lodge
Feature 1
Feature 2
150 Mile House
N


Horsefly 2016
Write a description for your map.
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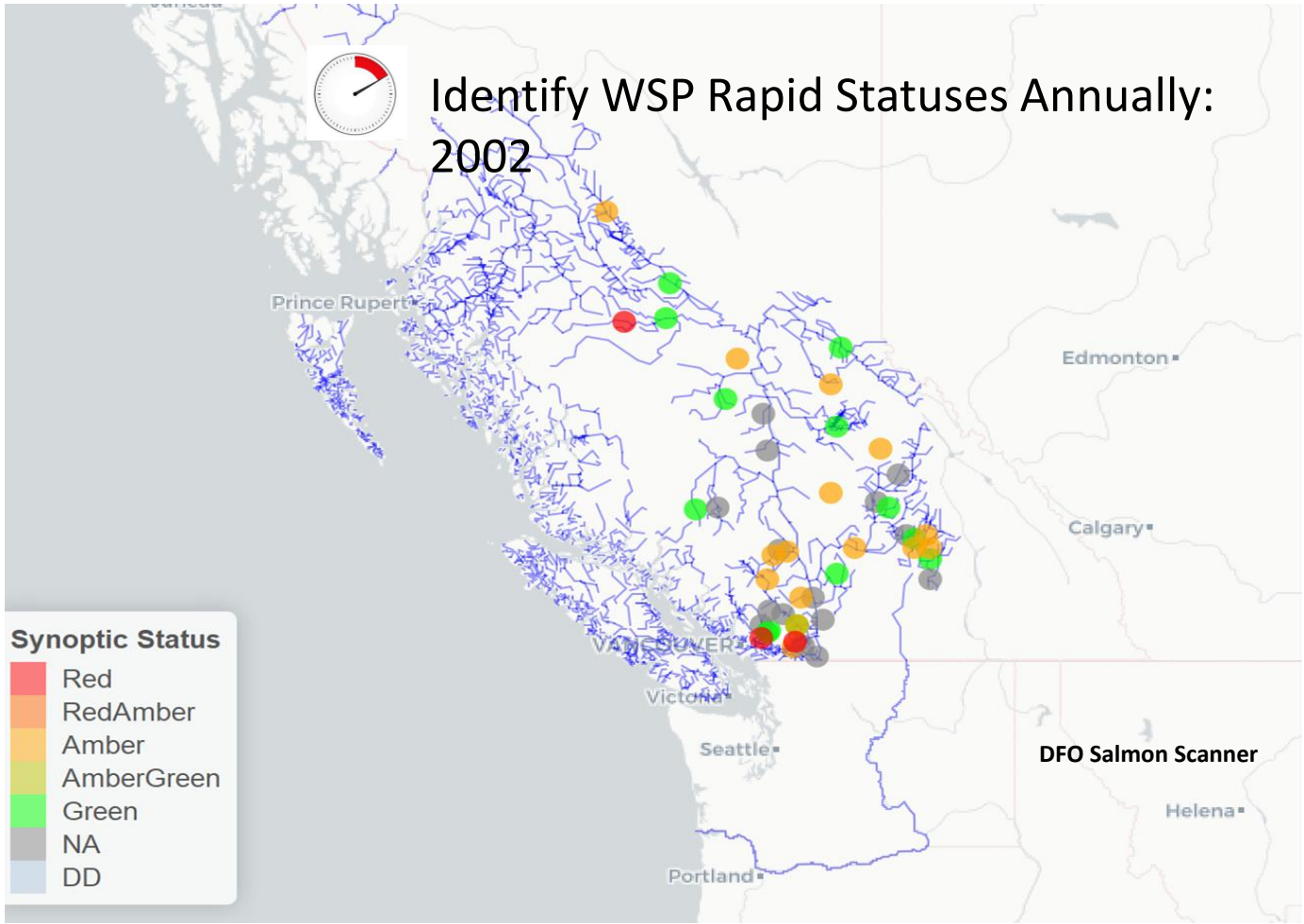
Identify WSP Rapid Statuses Annually: 2002



DFO Salmon Scanner

PINK
Oncorhynchus gorbuscha

CHUM
Oncorhynchus keta

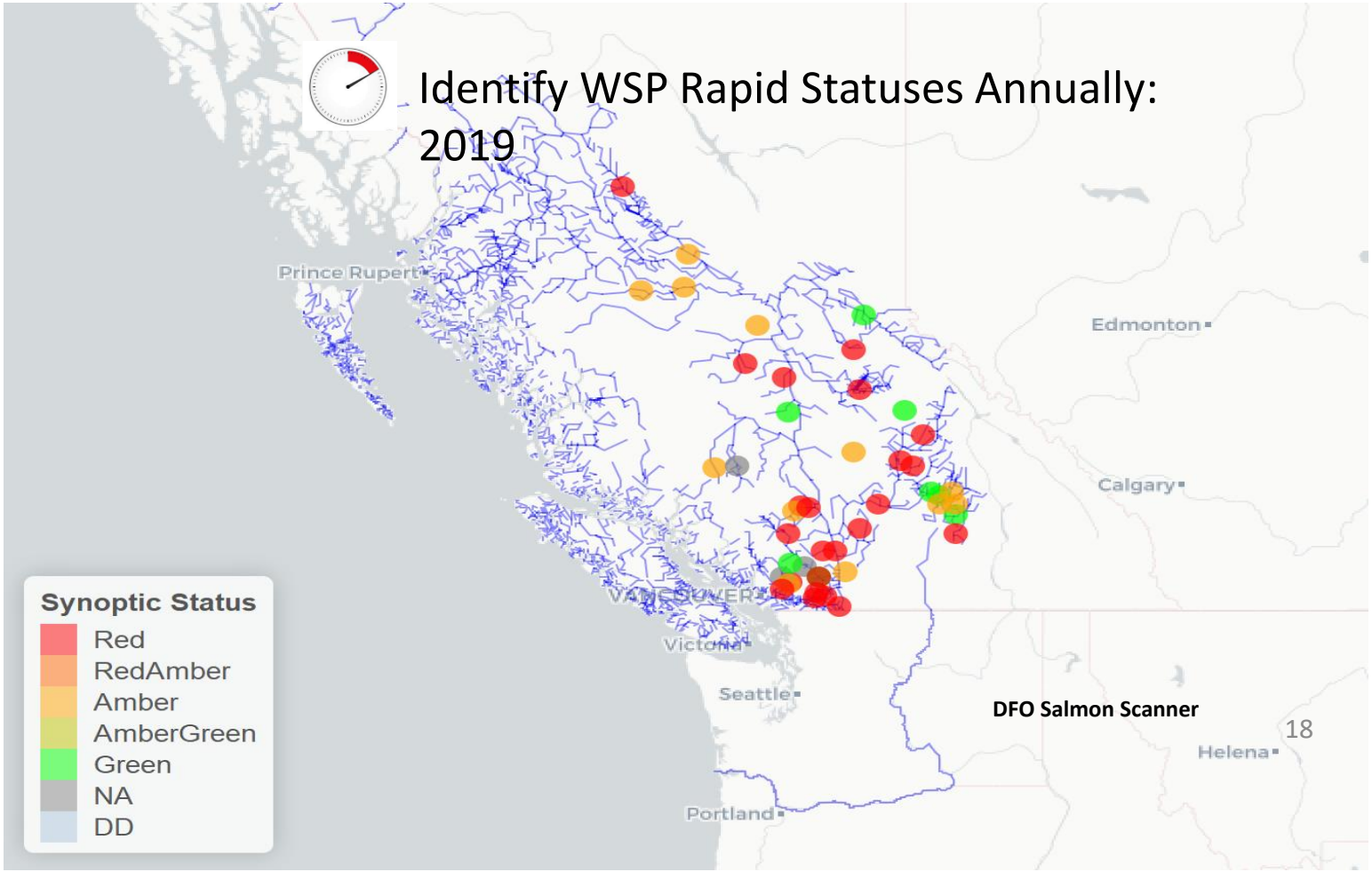
SOCKEYE
Oncorhynchus nerka

COHO
Oncorhynchus kisutch

CHINOOK
Oncorhynchus tshawytscha

Grant, S.C.H & MacDonald (Oct 2023)

Identify WSP Rapid Statuses Annually: 2019



PINK *Oncorhynchus gorbuscha*

CHUM *Oncorhynchus keta*

SOCKEYE *Oncorhynchus nerka*

COHO *Oncorhynchus kisutch*

CHINOOK *Oncorhynchus tshawytscha*

DFO Salmon Scanner

Grant, S.C.H & MacDonald (Oct 2023)

How can hatcheries help foster climate resiliency?

The ability to prepare for, recover from, and adapt to these impacts is called “climate resilience.”

How are we responding to climate change?

Business as usual/Coping

Maintaining current system structure;
Working within rigid/complex management systems, policies, practices;
Short-term planning;
Single-sector responses;
Narrow knowledge inputs;
Relying solely on past methods and responses

Adapting/Transforming

Creating flexible/nimble systems;
Planning for the long-term, at large scales across sectors and systems;
Knowledge diversity: Indigenous and other systems;
Innovative: thinking outside the box;
Facilitating systemic change

What conditions are we planning for?

Past

Assuming that conditions will be consistent with historical records, or, reactively coping with change;
Relying on historically-based benchmarks or baselines for management.

Future

Assuming non-stationarity (directional change), non-linearity & presence of tipping points;
Using climate change projections, vulnerability assessments & plausible future scenarios to guide planning;
Accounting for uncertainty; creating flexibility

When are we addressing climate impacts?

Reactive

Responding to issues as they arise

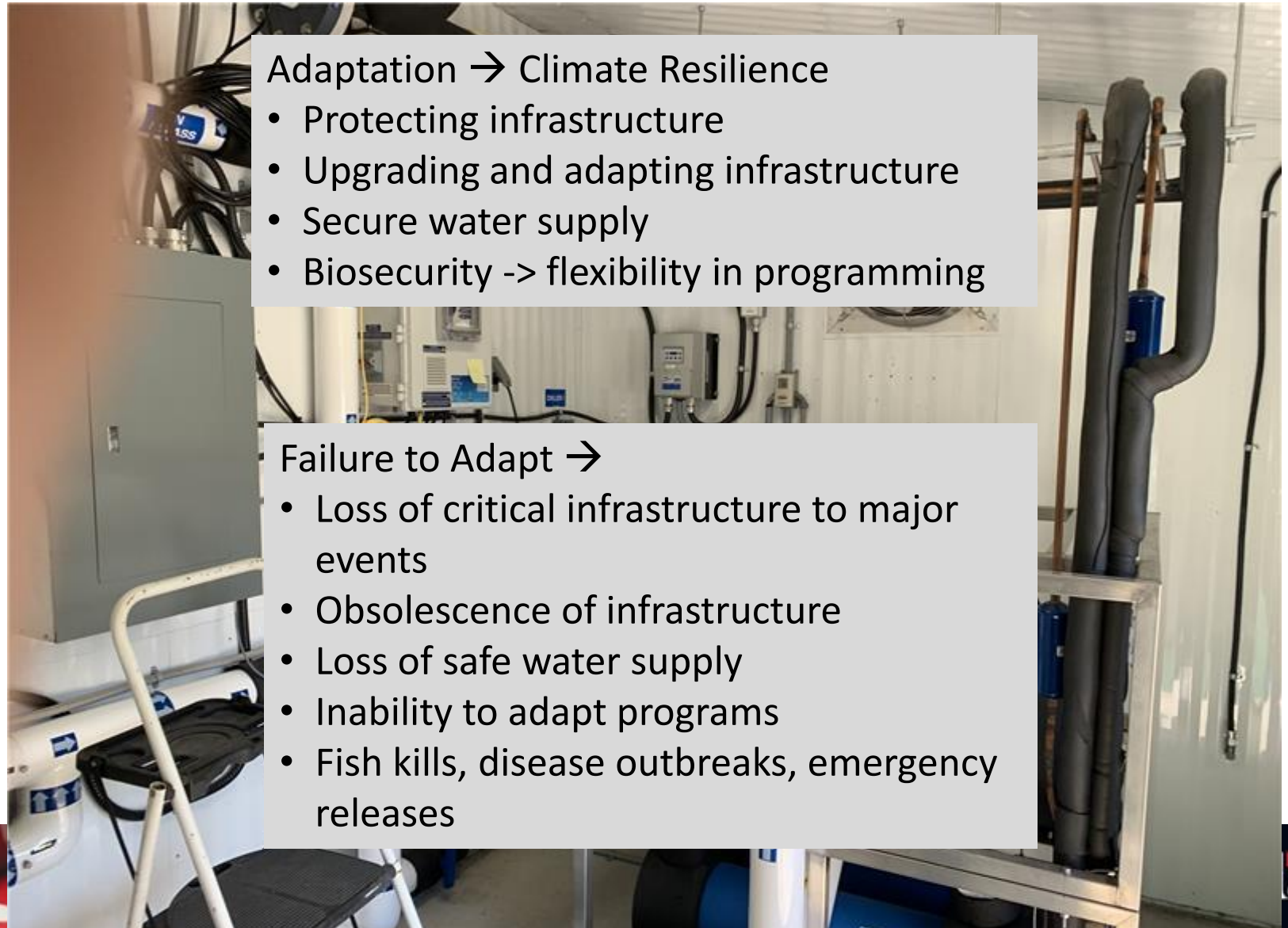
Proactive

Design comprehensive plans for possible future scenarios & surprises in advance

What can be done?

- Infrastructure
- Fish Culture
- Production planning
- Research & experimentation
- Leadership & co-operation

Infrastructure



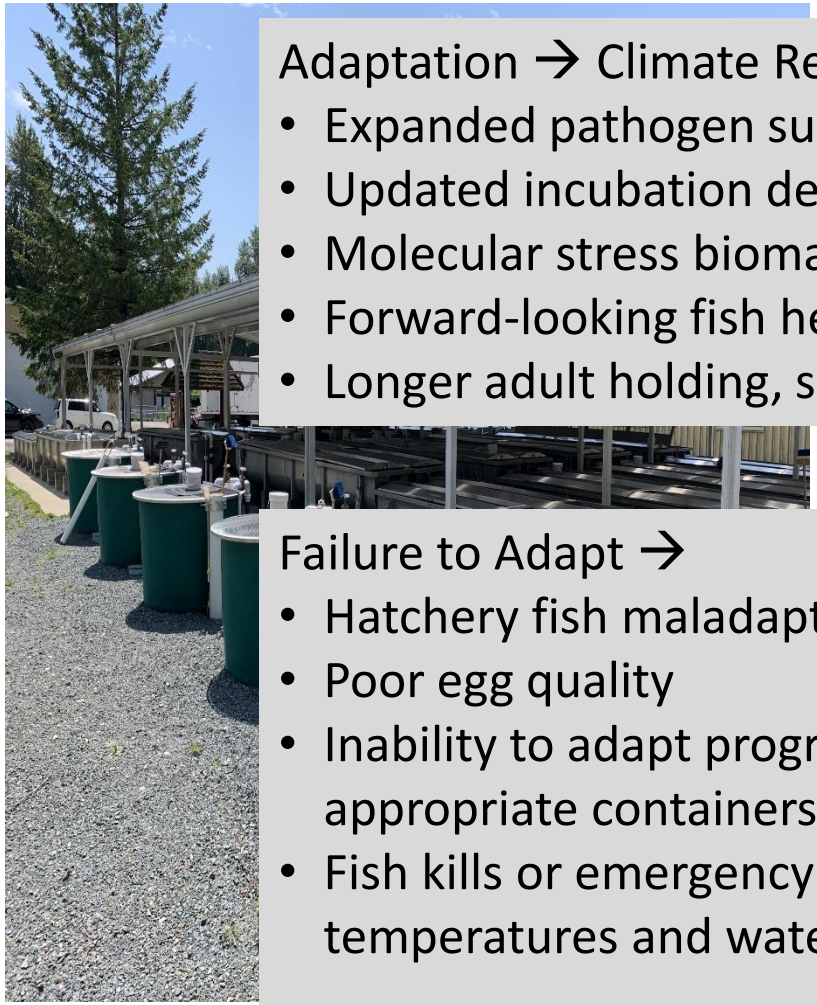
Adaptation → Climate Resilience

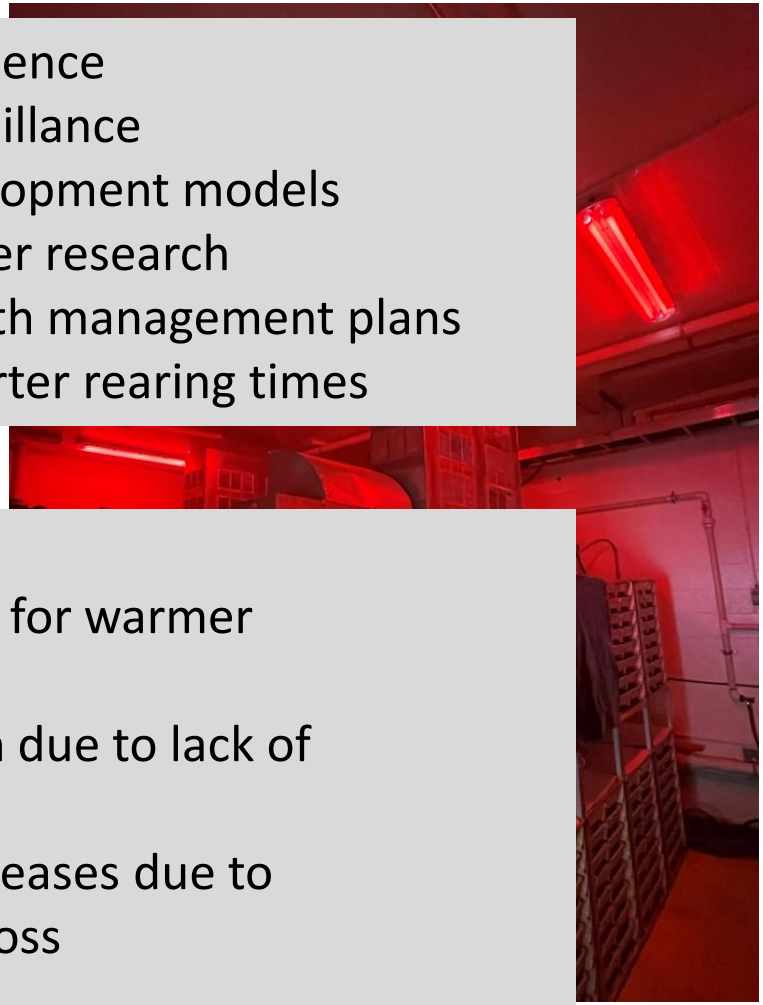
- Protecting infrastructure
- Upgrading and adapting infrastructure
- Secure water supply
- Biosecurity -> flexibility in programming

Failure to Adapt →

- Loss of critical infrastructure to major events
- Obsolescence of infrastructure
- Loss of safe water supply
- Inability to adapt programs
- Fish kills, disease outbreaks, emergency releases

Fish Health and Culture





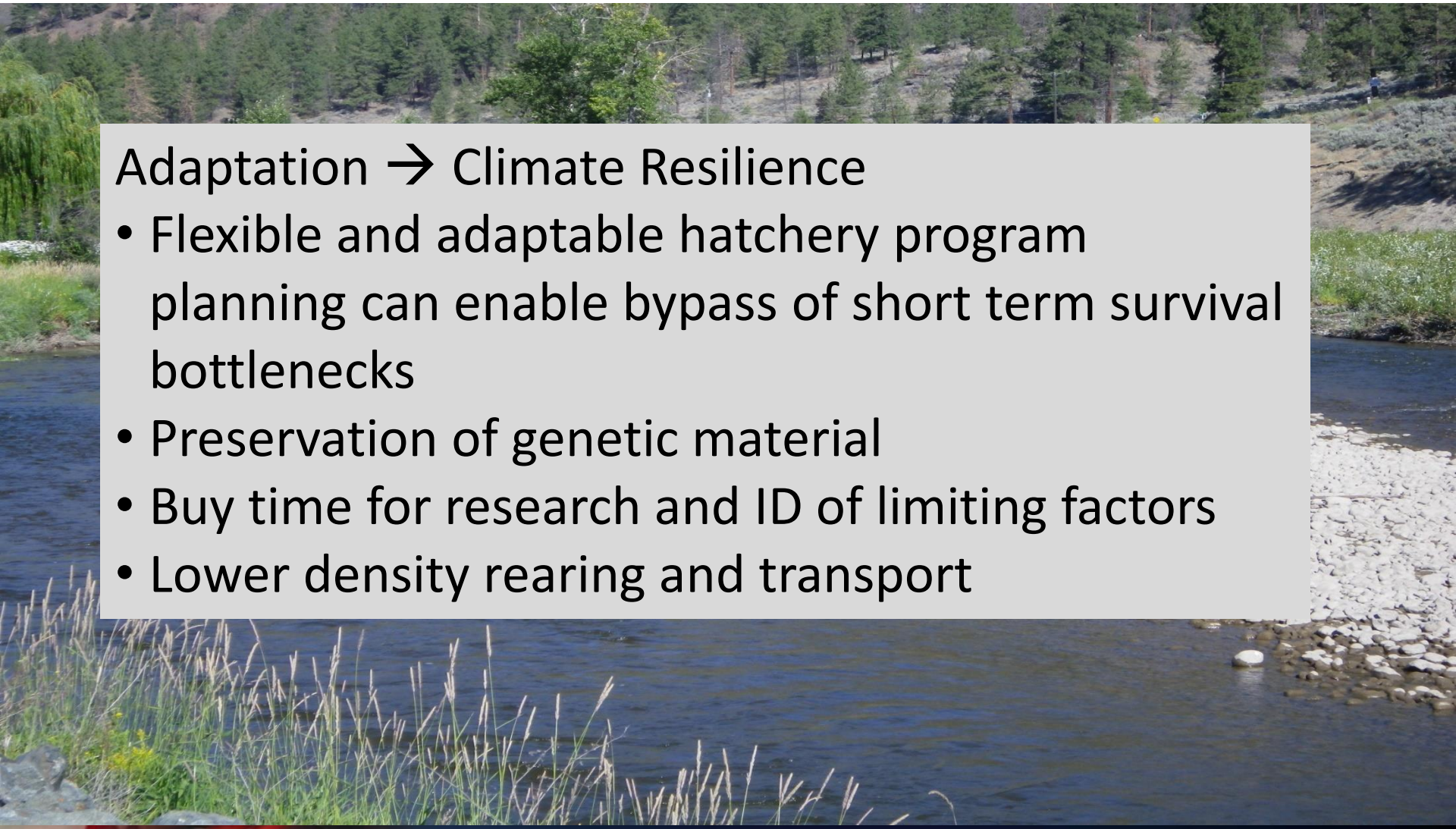
Adaptation → Climate Resilience

- Expanded pathogen surveillance
- Updated incubation development models
- Molecular stress biomarker research
- Forward-looking fish health management plans
- Longer adult holding, shorter rearing times

Failure to Adapt →

- Hatchery fish maladapted for warmer
- Poor egg quality
- Inability to adapt program due to lack of appropriate containers
- Fish kills or emergency releases due to temperatures and water loss

Hatchery Production Planning



Adaptation → Climate Resilience

- Flexible and adaptable hatchery program planning can enable bypass of short term survival bottlenecks
- Preservation of genetic material
- Buy time for research and ID of limiting factors
- Lower density rearing and transport

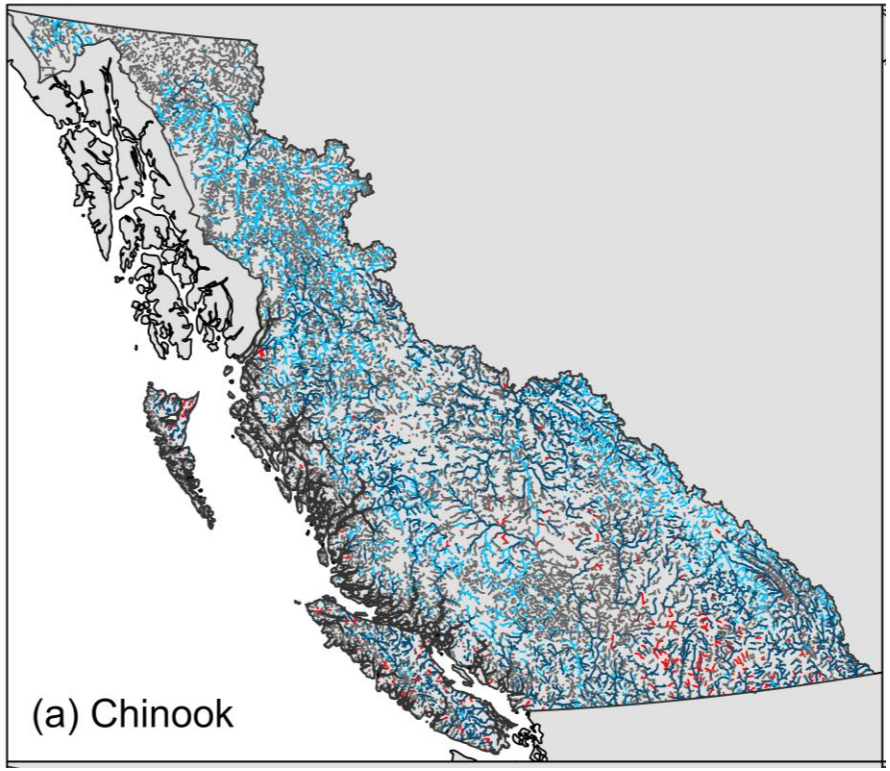
Hatchery Production Planning

What still needs to happen?

- Enable change
- Difficult choices need to be made
- Planning, consultation, regulatory steps all take time.
- Triage. Long term viability of populations
- Enable local adaptation

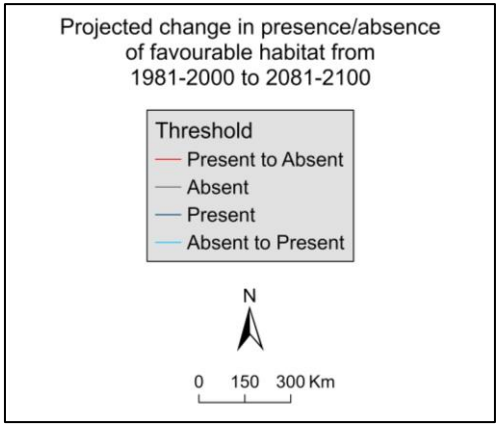
Shifts in favourable spawning and rearing habitats

This provides an indication of direction of projected salmon distribution change under climate change: north & higher elevations



Caveats:

- Only includes spawning & rearing habitats; not migration routes
- Does not include climate extremes
- This does not consider all factors that affect salmon distributions



Iacarella, J.C., and Weller, J.D. (in press). Can. J. Fish. Aquat. Sci. Predicting favourable streams for anadromous salmon spawning and natal rearing under climate change: 1–44. doi:https://doi.org/10.1139/cjfas-2023-0096.

Science & Research

Opportunities to support climate resiliency

- Hatcheries as a platform for new research & experimentation
- Citizen science via community hatcheries
- Climate vulnerability assessments

Risks of Failing to Adapt

- Lack of dedicated Canadian research capacity
- Lose the signal to the noise
- Past research no longer applicable in changing environment

Leadership & Cooperation

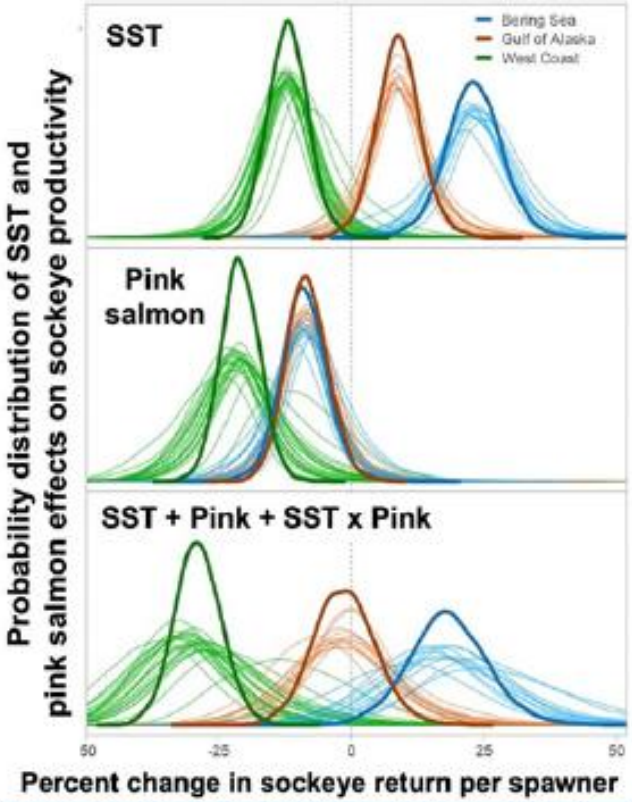


Figure 3. *Effects of a 1 standard deviation increase in both SST (1.5°C) and pink salmon abundance (119 million fish) and the combined effect of both variables on the percentage change in sockeye salmon return per spawner. Empirical model based on 47 sockeye salmon populations (1976 to 2009 brood years) spanning the Bering Sea, Gulf of Alaska, and West Coast (Southeast Alaska through British Columbia) of North America. Thin lines represent each stock; thick lines represent mean of 47 stocks. Source: Connors et al. 2020.*

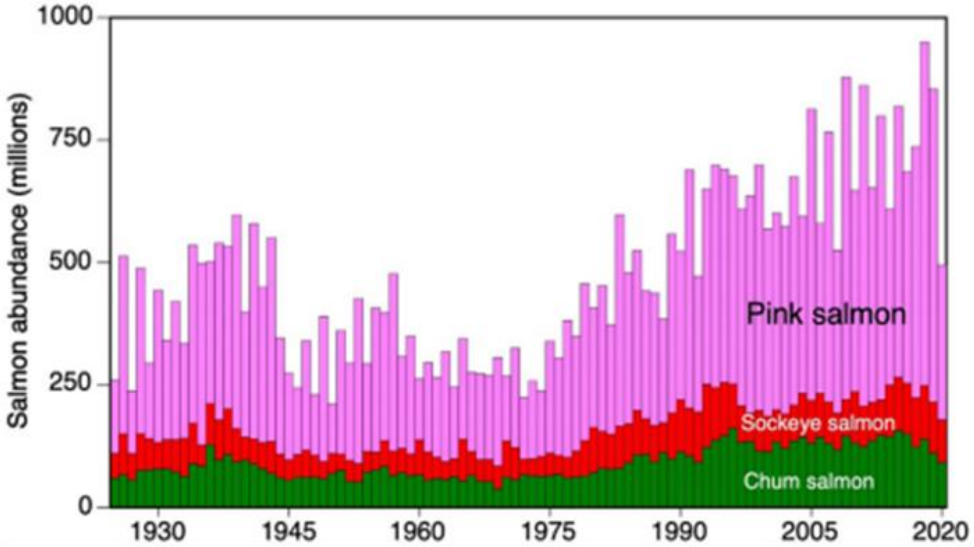


Figure 1. *Total abundance of adult pink, chum, and sockeye salmon (catch plus spawning escapement) returning from the North Pacific Ocean to streams in North America and Asia, 1925–2020. Ruggerone et al. 2021 (updated from Ruggerone and Irvine 2018).*

Leadership & Cooperation

Conclusions

Salmon enhancement can play an important role for conservation and fisheries in a changing climate.

Different thinking is required. Adaptive programs, adequate investment, renewed vision, and difficult choices.

Leadership and cooperation is critical.

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