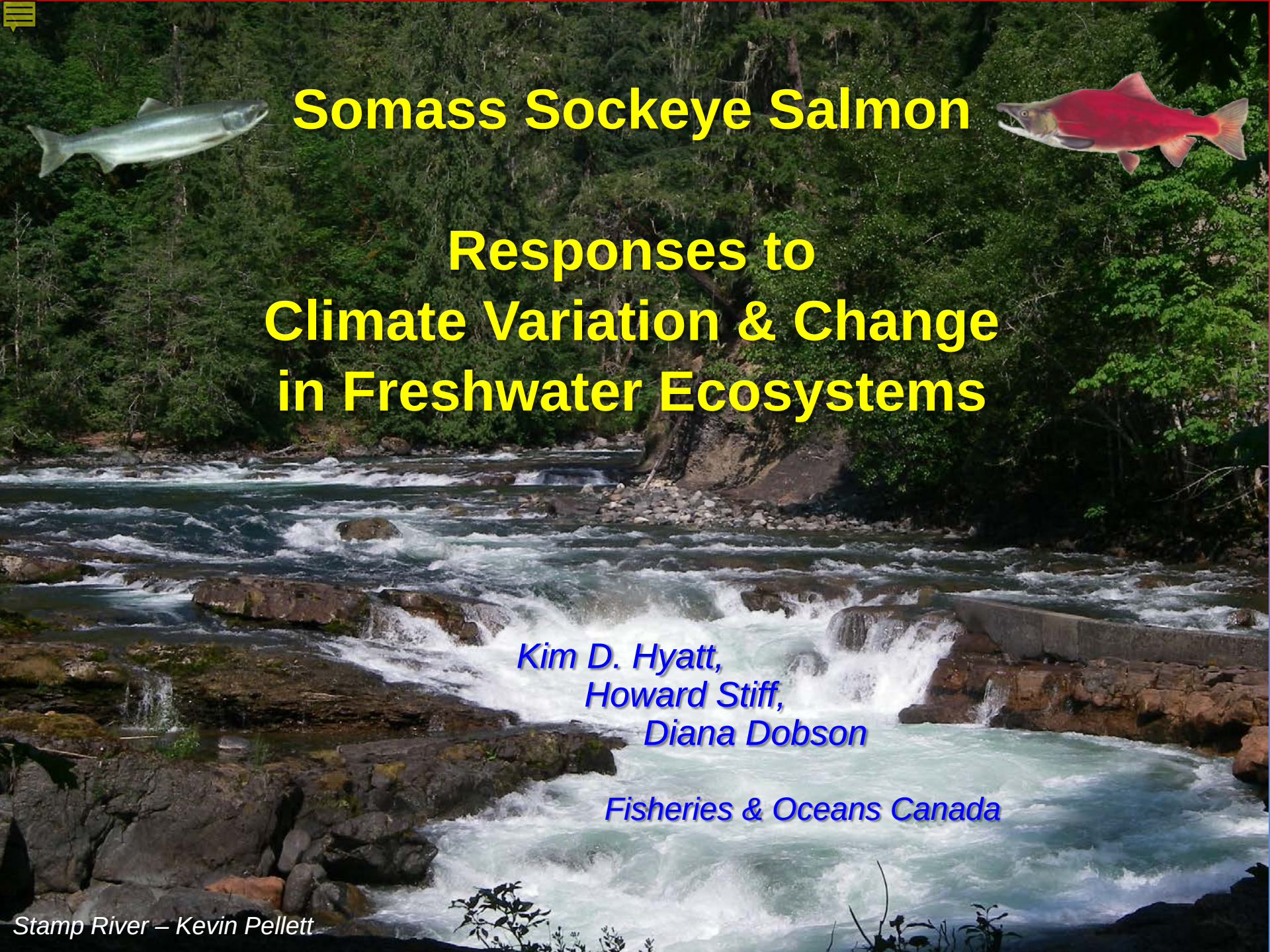


Somass Sockeye Salmon

Responses to Climate Variation & Change in Freshwater Ecosystems

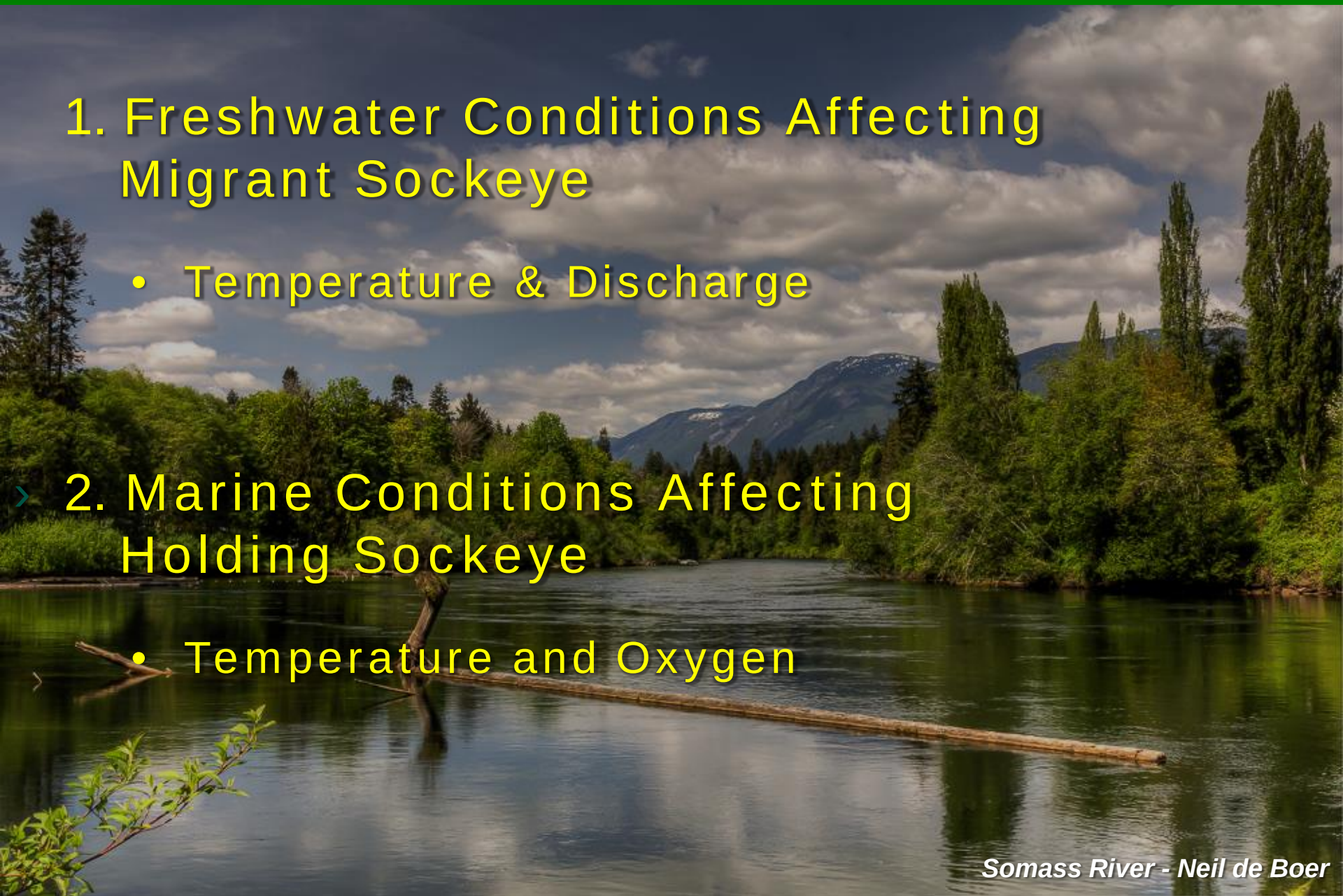
Kim D. Hyatt,
Howard Stiff,
Diana Dobson

Fisheries & Oceans Canada

Stamp River – Kevin Pellett

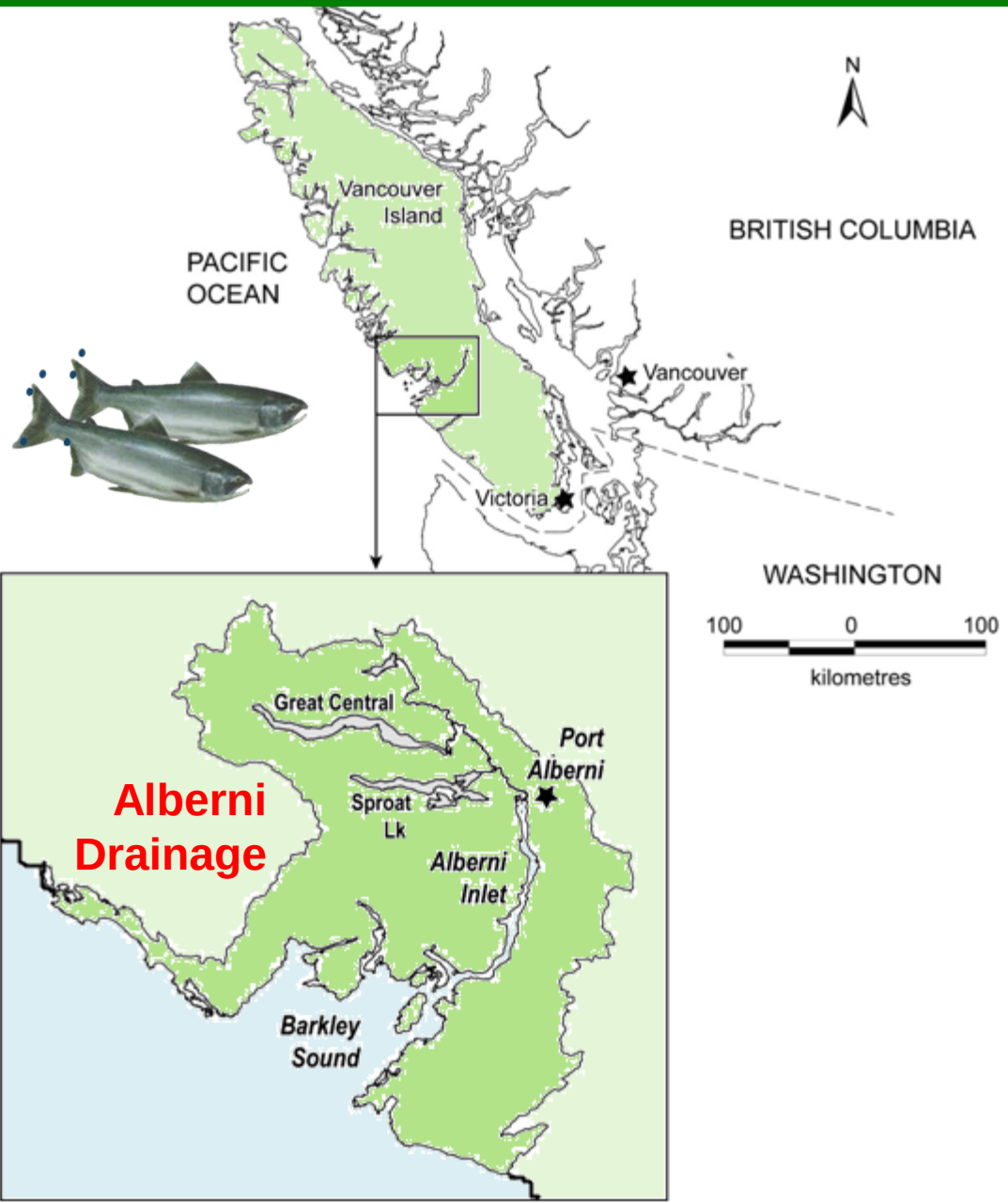
Outline

1. Freshwater Conditions Affecting Migrant Sockeye
   - Temperature & Discharge
2. Marine Conditions Affecting Holding Sockeye
   - Temperature and Oxygen

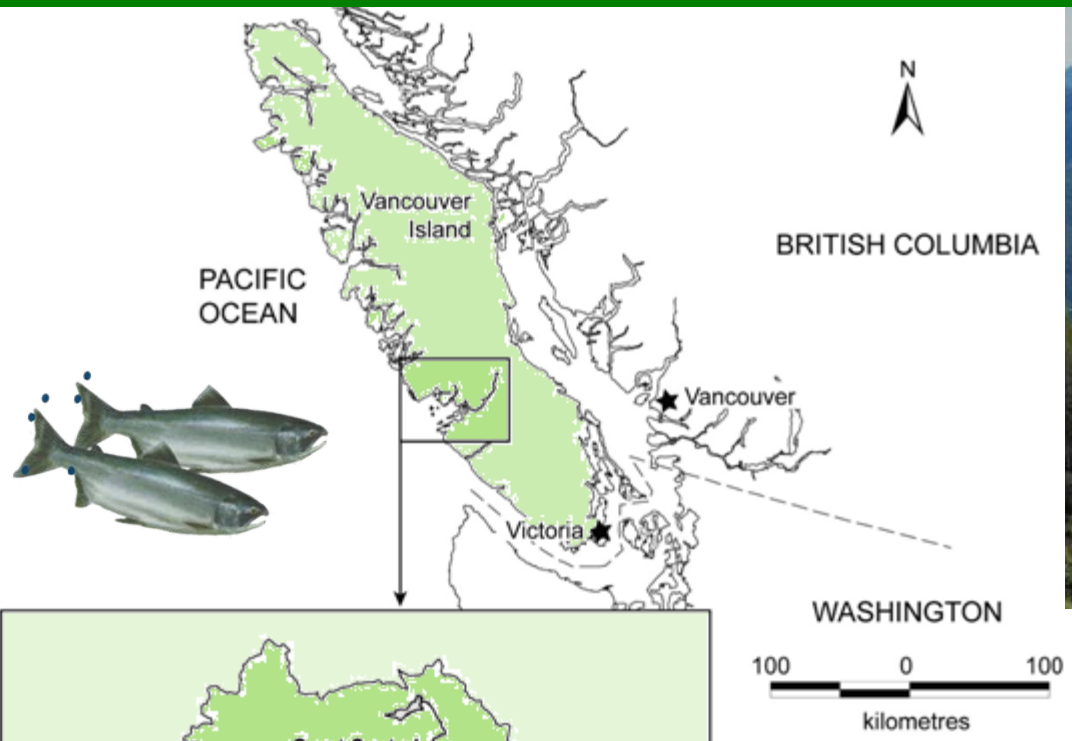


Somass River - Neil de Boer

Study Area


N
Vancouver Island
PACIFIC OCEAN
BRITISH COLUMBIA
Vancouver
Victoria
WASHINGTON
100 0 100
kilometres
Great Central
Port Alberni
Alberni Drainage
Sproat Lk
Alberni Inlet
Barkley Sound

Study Area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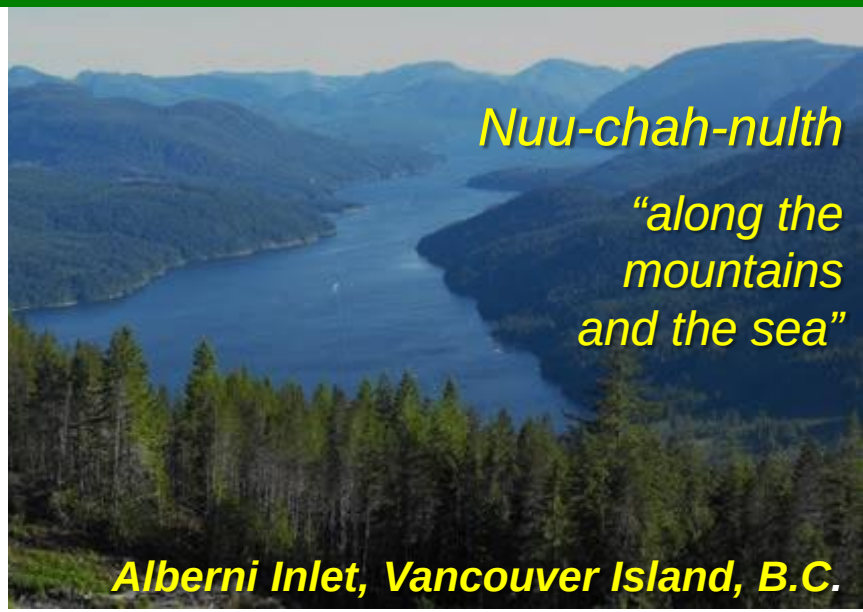
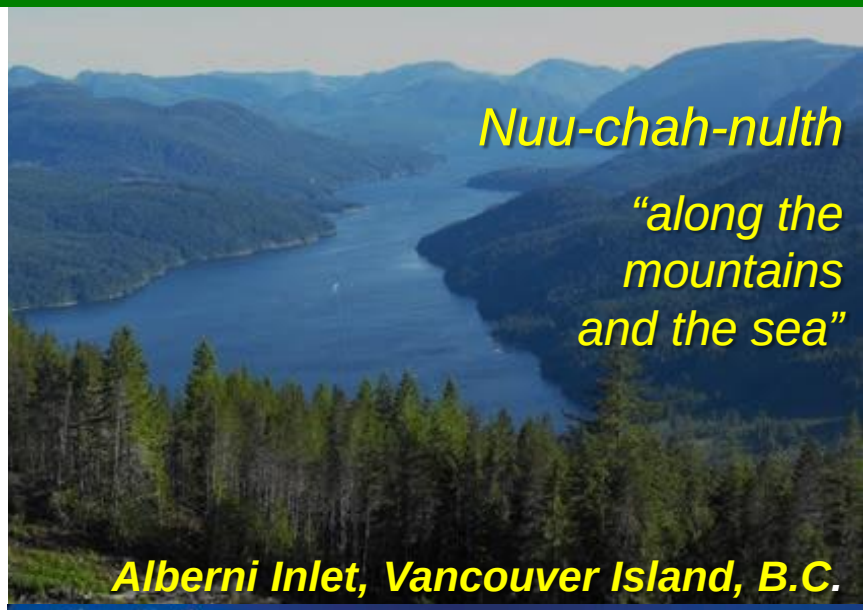
kilometres


Nuu-chah-nulth
"along the mountains and the sea"
Alberni Inlet, Vancouver Island, B.C.


Alberni Drainage
Great Central
Port Alberni
Sproat Lk
Alberni Inlet
Barkley Sound

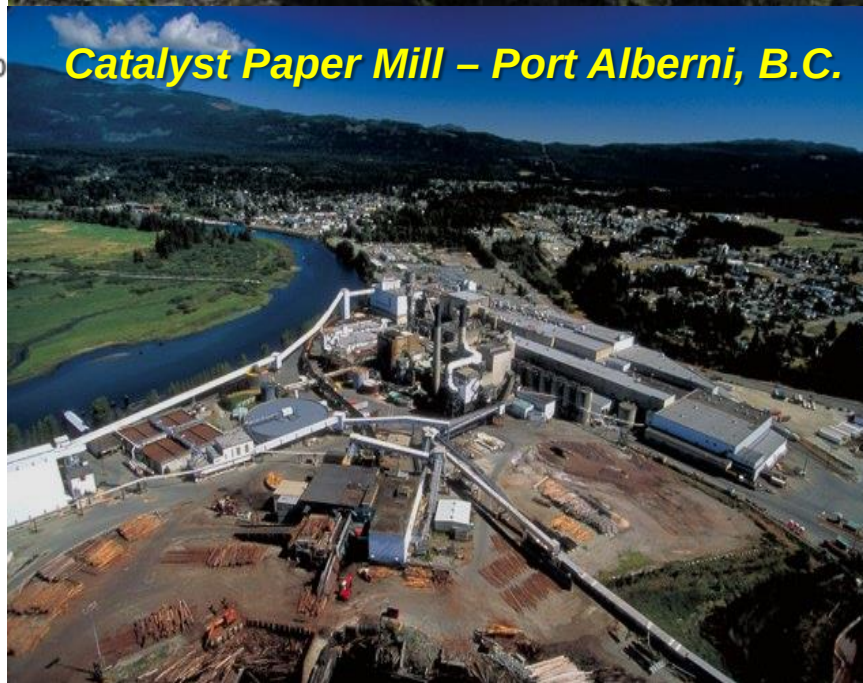
Study Area



Nuu-chah-nulth

"along the mountains and the sea"

Alberni Inlet, Vancouver Island, B.C.



Catalyst Paper Mill – Port Alberni, B.C.

Study Area


N
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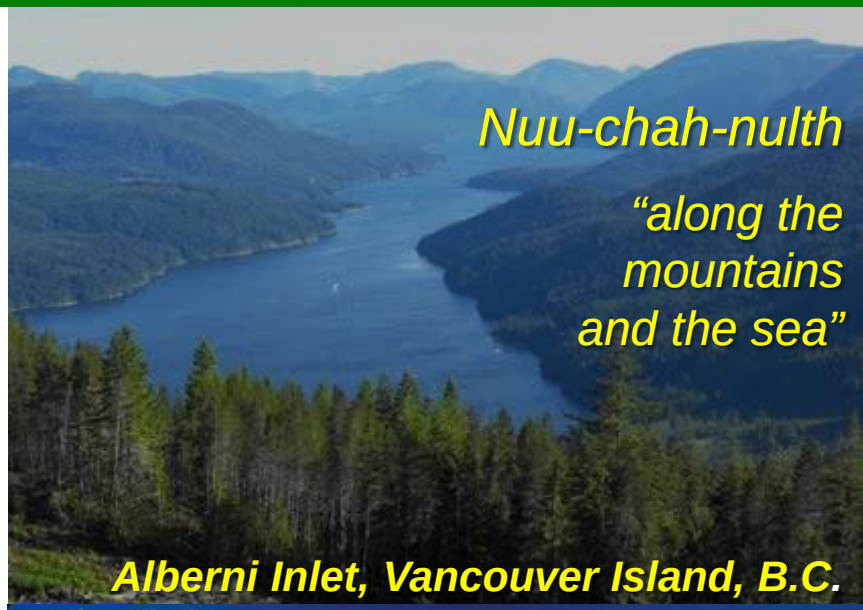
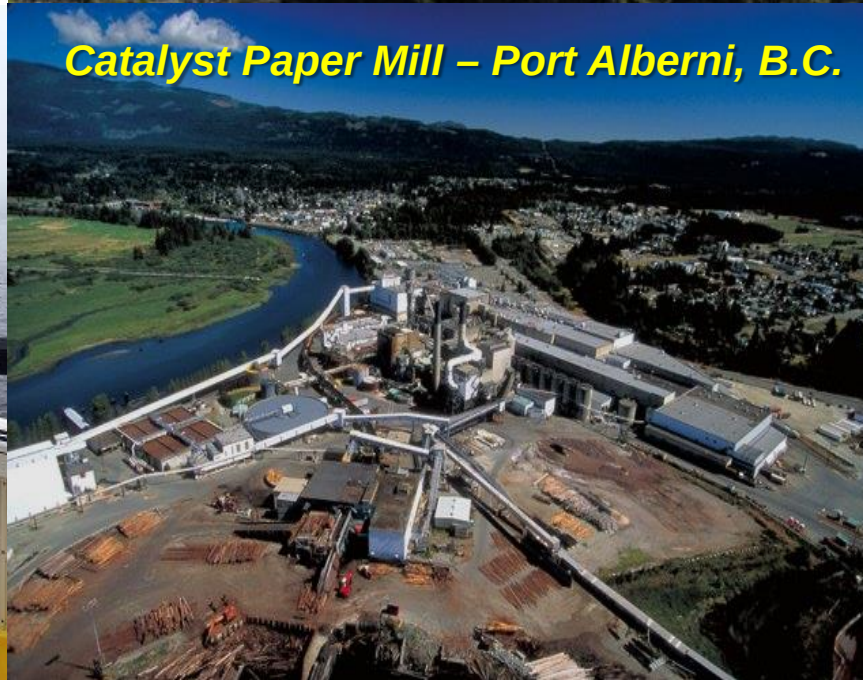
BRITISH COLUMBIA
PACIFIC OCEAN
Vancouver
Victoria
Aboriginal Multi-Media Society


Nuu-chah-nulth
"along the mountains and the sea"
Alberni Inlet, Vancouver Island, B.C.


Great Central
Port Alberni
Alberni Drainage
Sproat Lk
Alberni Inlet
Barkley Sound

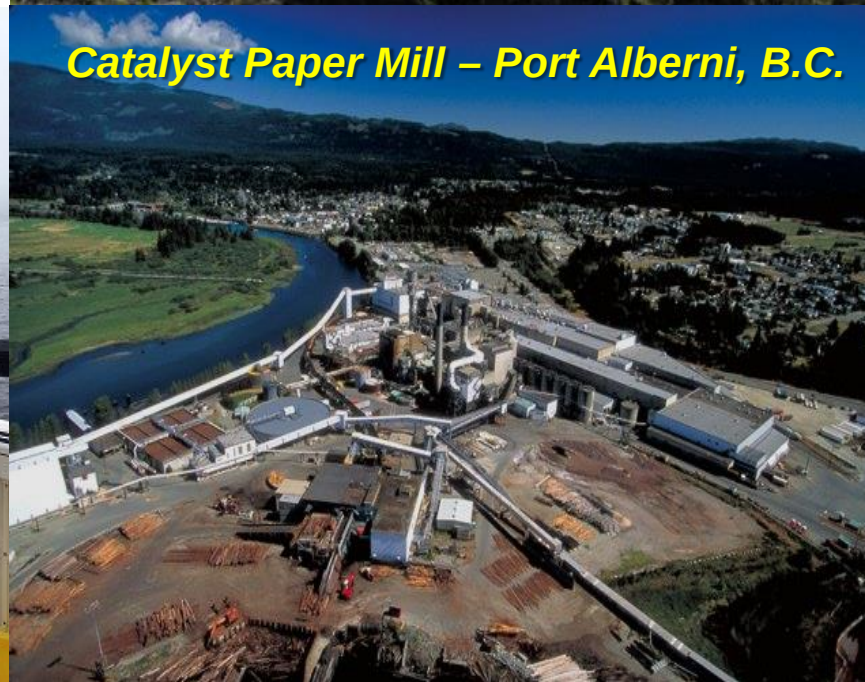

Catalyst Paper Mill – Port Alberni, B.C.

Study Area


N
Vancouver Island
BRITISH COLUMBIA
PACIFIC OCEAN
Vancouver
Victoria

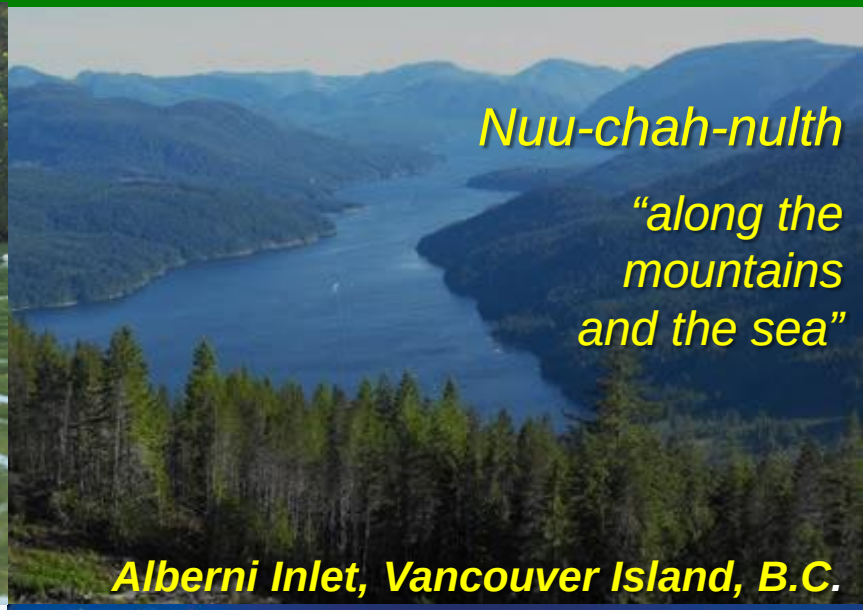

Nuu-chah-nulth
"along the mountains and the sea"
Alberni Inlet, Vancouver Island, B.C.


Economic value: Comm + Rec = $5 – $10M
Alan H Brown – "West Coast Fisherman"

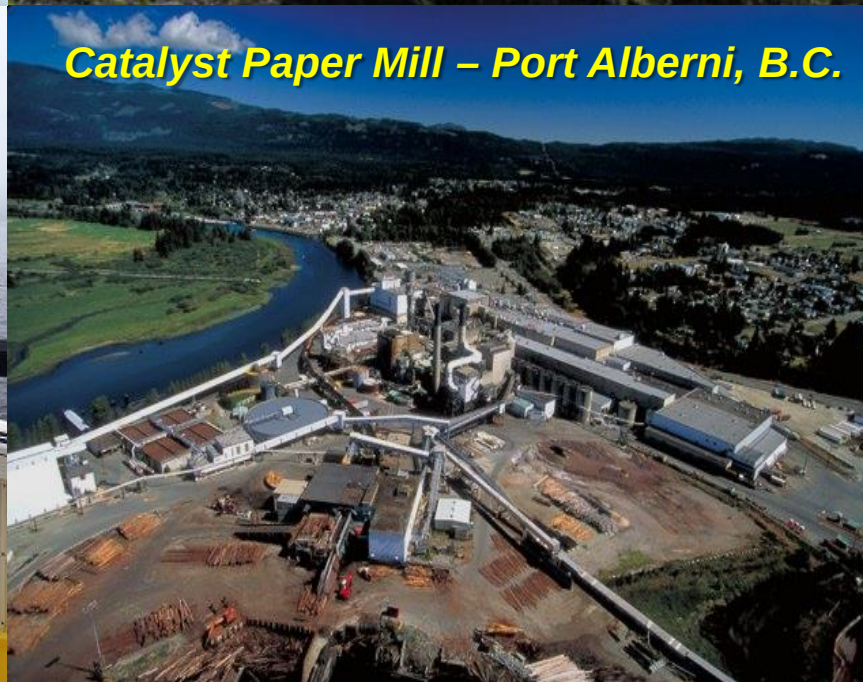

Catalyst Paper Mill – Port Alberni, B.C.

Study Area

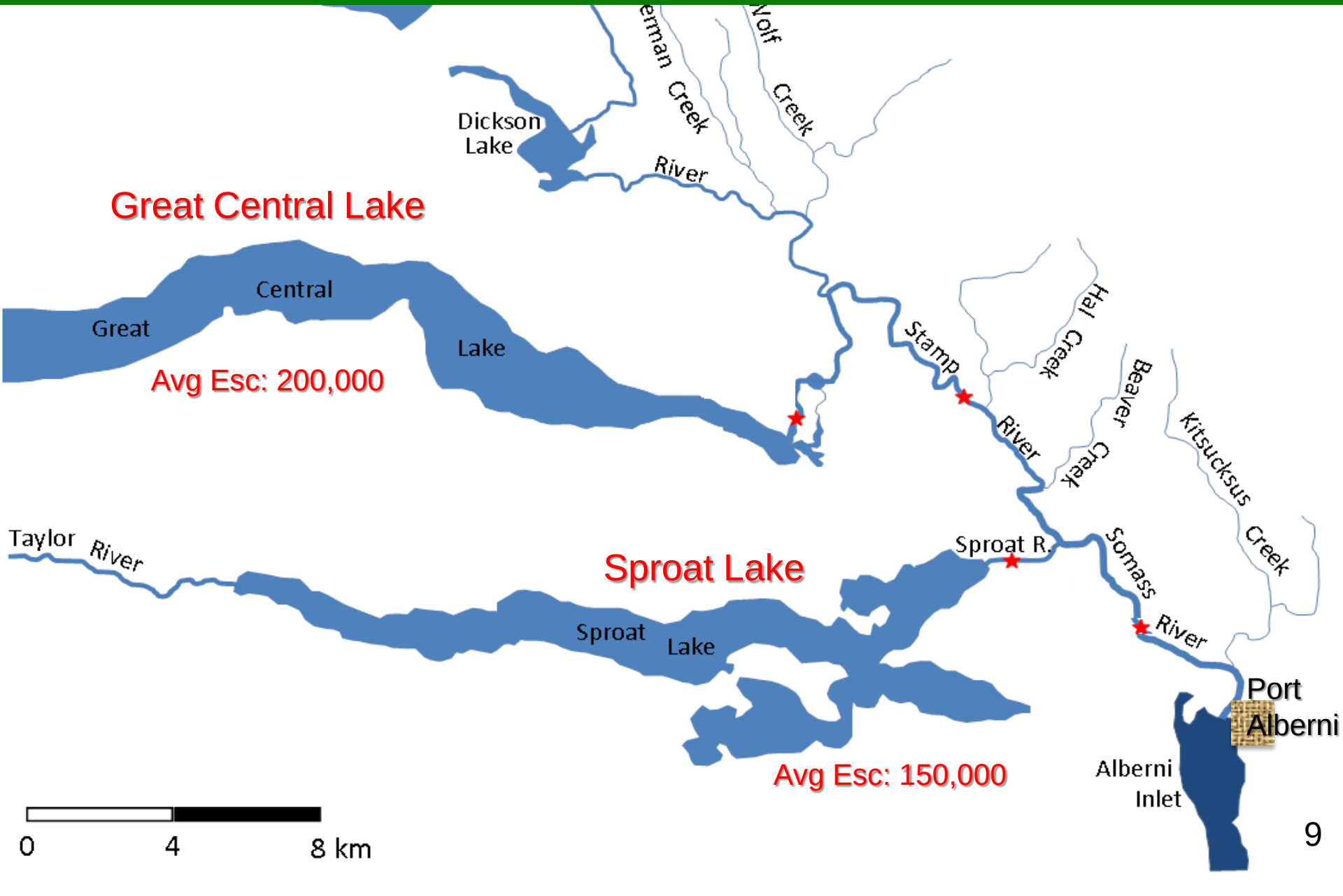

Tseshaht & Hupacaseth Community Fishing
Somass River


Nuu-chah-nulth
"along the mountains and the sea"
Alberni Inlet, Vancouver Island, B.C.

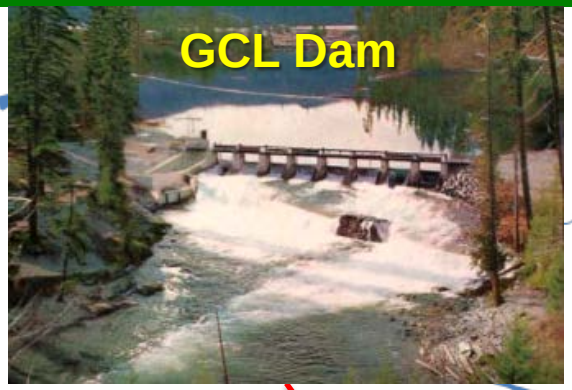

Annual economic value: Comm + Rec: $5 – $10M
Alan H Brown – "West Coast Fisherman"


Catalyst Paper Mill – Port Alberni, B.C.

Study Area


Dickson Lake
River
Great Central Lake
Great
Central
Lake
Avg Esc: 200,000
Stamp
River
Hal Creek
Beaver Creek
Kitsucksus Creek
Taylor River
Sproat Lake
Sproat Lake
Sproat R.
Somass River
Avg Esc: 150,000
Port Alberni
Alberni Inlet
0
4
8 km

Study Area



Great Central Lake

Great Central Lake

GCL Dam

Stamp River

Hal Creek

Beaver Creek

Kitsucksus Creek

Taylor River

Sproat Lake

Sproat Lake

Sproat R.

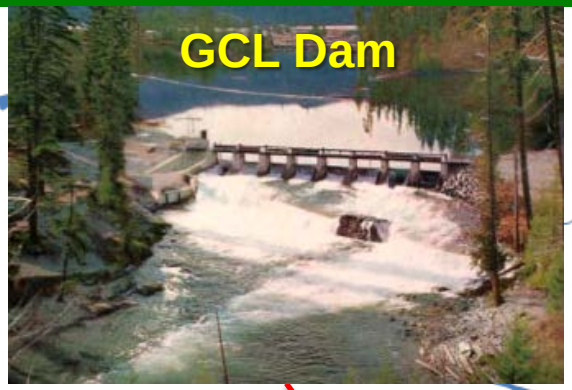
Somass River

Port Alberni

Alberni Inlet

0 4 8 km

Study Area



Great Central Lake

Great Central Lake

GCL Dam

Stamp Falls

Stamp River

Hal Creek

Beaver Creek

Kitsucksus Creek

Somass River

Sproat R.

Sproat Lake

Sproat Lake

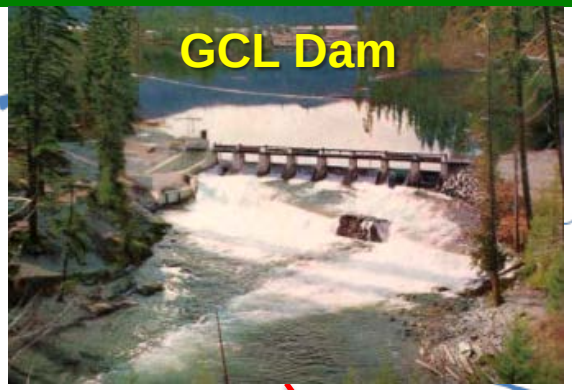
Taylor River

Port Alberni

Alberni Inlet

0 4 8 km

Study Area



Great Central Lake

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Sproat Lake

Sproat R.

Sproat Falls

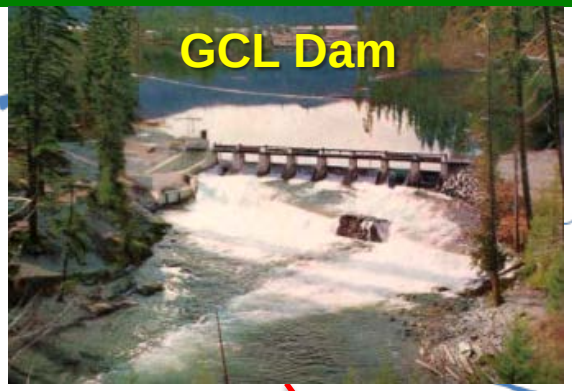
Somass River

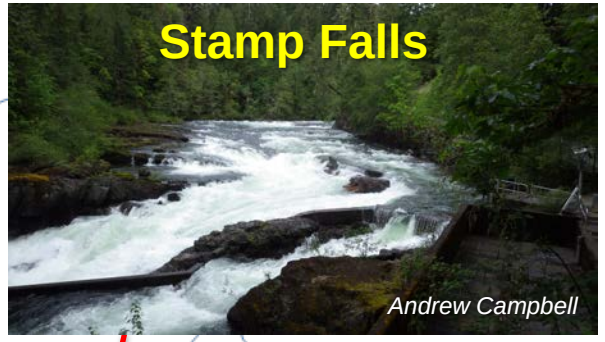
Port Alberni

Alberni Inlet

0 4 8 km

Study Area





Great Central Lake

Great Central Lake

GCL Dam

Stamp Falls

Stamp River

Hal Creek

Beaver Creek

Kitsucksus Creek

Taylor River

Sproat Lake

Sproat Lake

Sproat R.

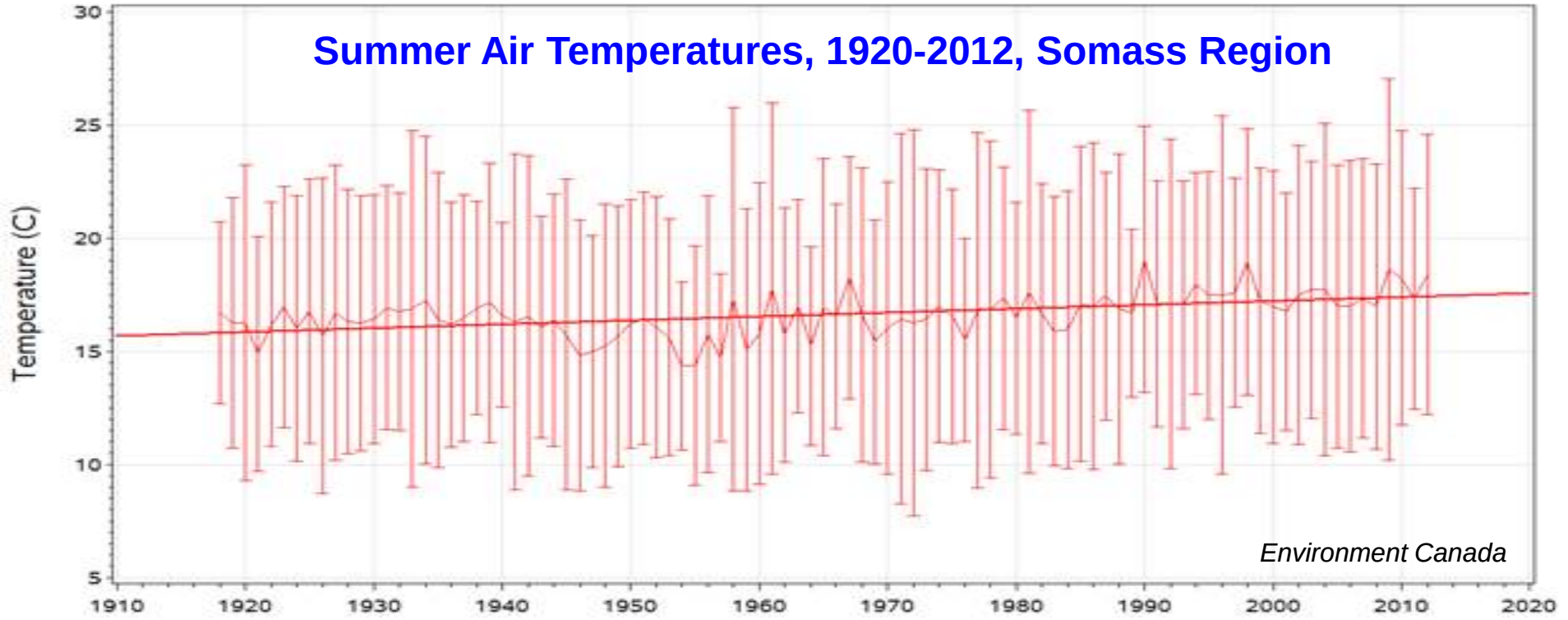
Sproat Falls

Somass River

Port Alberni

Alberni Inlet

Regional Climate Change



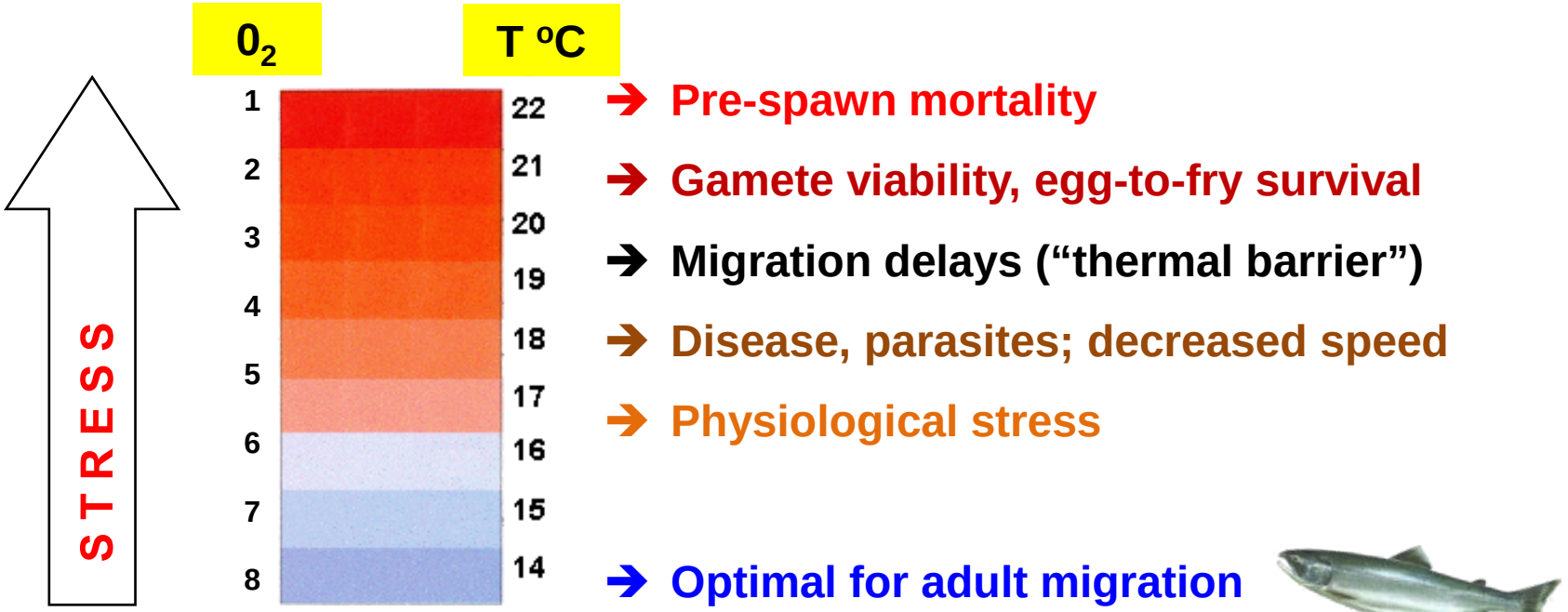
REGIONAL CHANGES		1900 - 2000	2000 - 2100
Mean Air Temperatures*	↑	0.8°C -1.1°C	↑ 1.4°C - 3.9°C
Summer Water Temperatures	↑	0.5°C -1.5°C	↑ 1.3°C - 2.5°C
Snowpack*	↓	0 - 10%	↓ 35% - 68%
Summer stream flows*	↓	0 - 10%	↓ 10% - 20%

** Pacific Climate Impacts Consortium*

Sockeye “Temp-Oxy Rules”

Temperature and **Oxygen** affect Sockeye physiology and behaviour

Sockeye mortalities - Sproat River - 2015



➔ **Pre-spawn mortality**

➔ **Gamete viability, egg-to-fry survival**

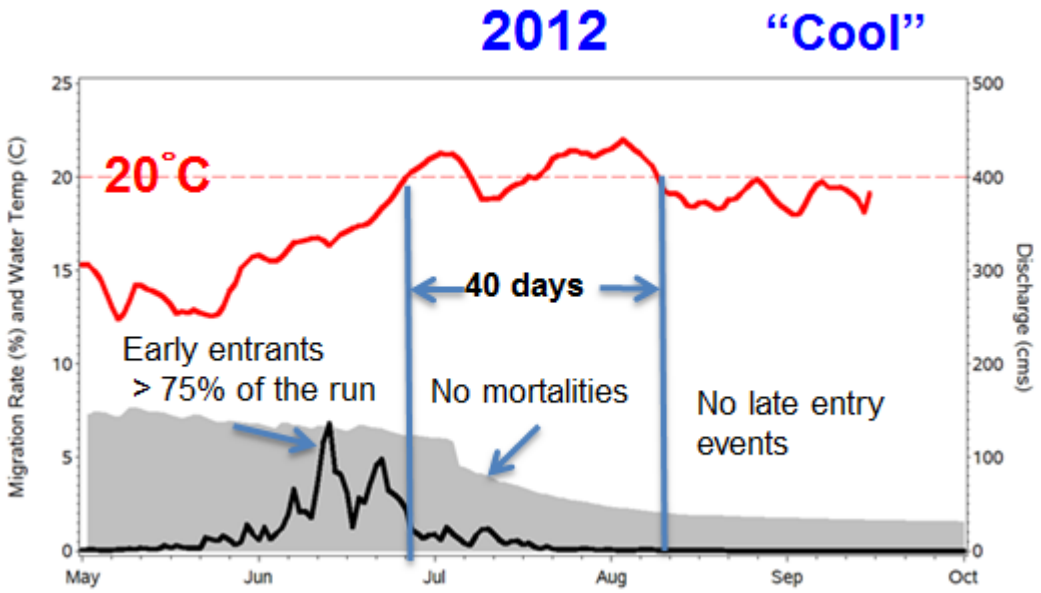
➔ **Migration delays (“thermal barrier”)**

➔ **Disease, parasites; decreased speed**

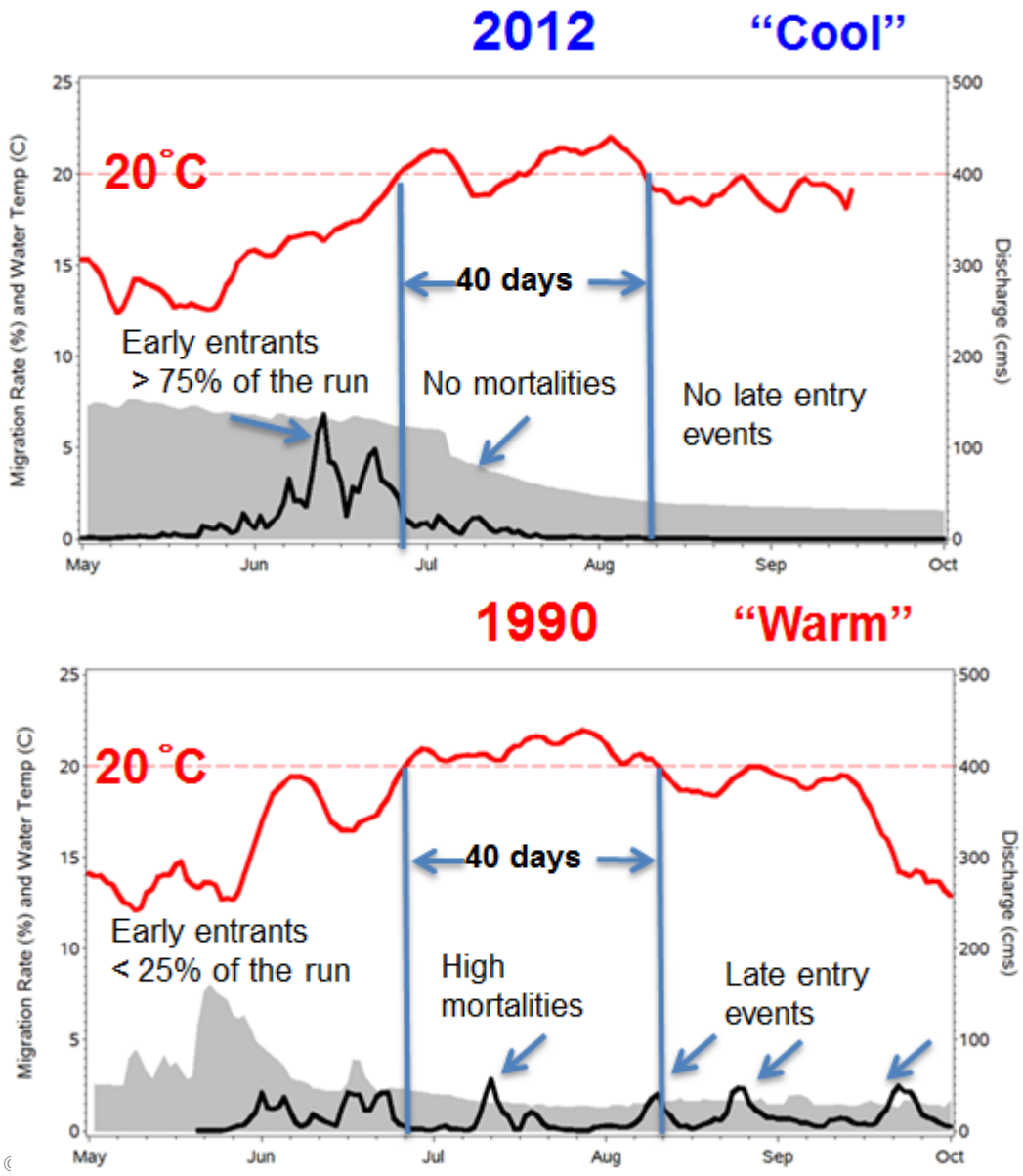
➔ **Physiological stress**

➔ **Optimal for adult migration**

River Conditions & Migration



River Conditions & Migration

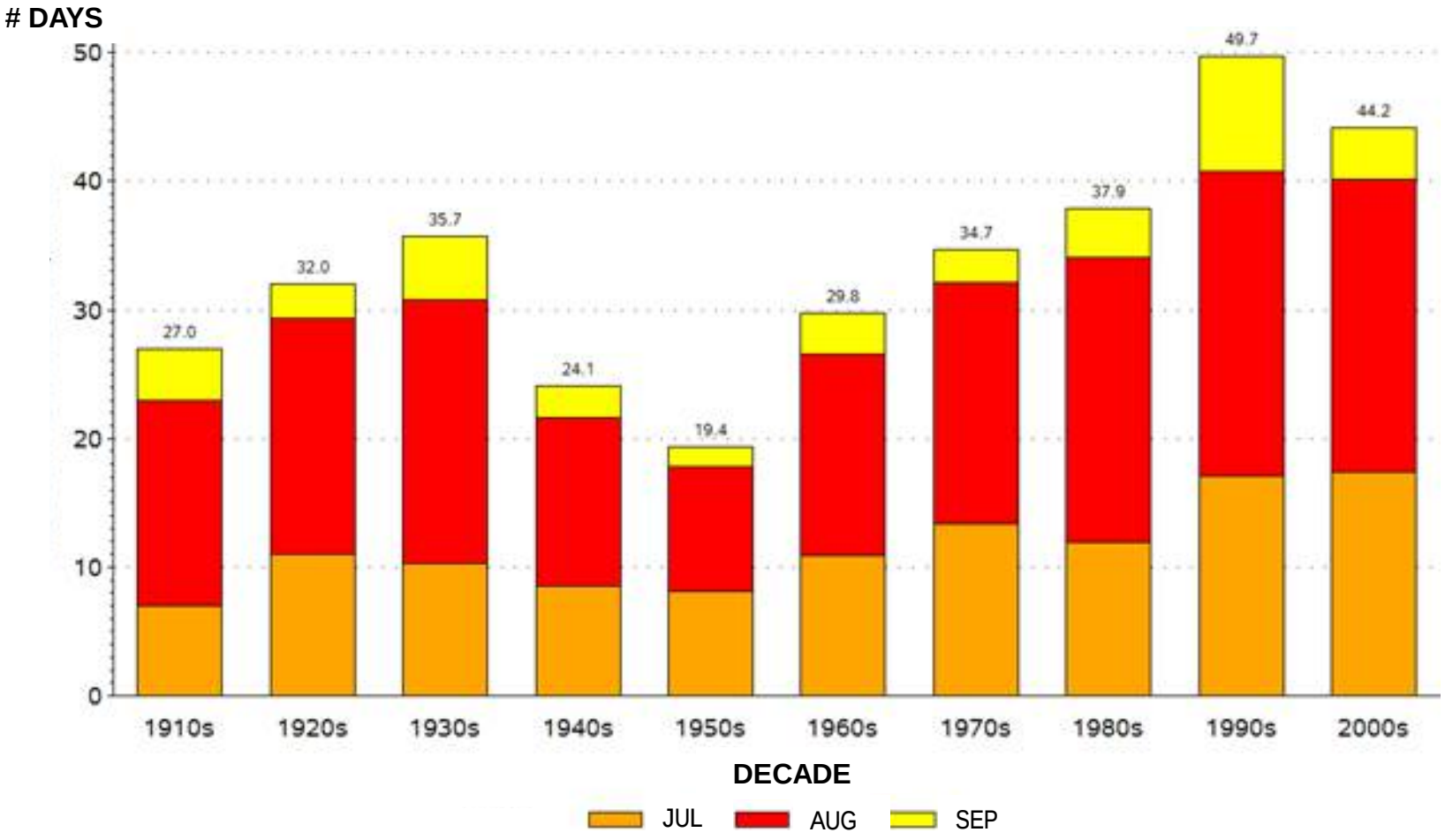


1990 Mortalities:
~100,000 fish
~$5 million
(Stucchi et al. 1990).

River Conditions - Temperature

Somass - Thermal Barrier Frequency – 20th Century

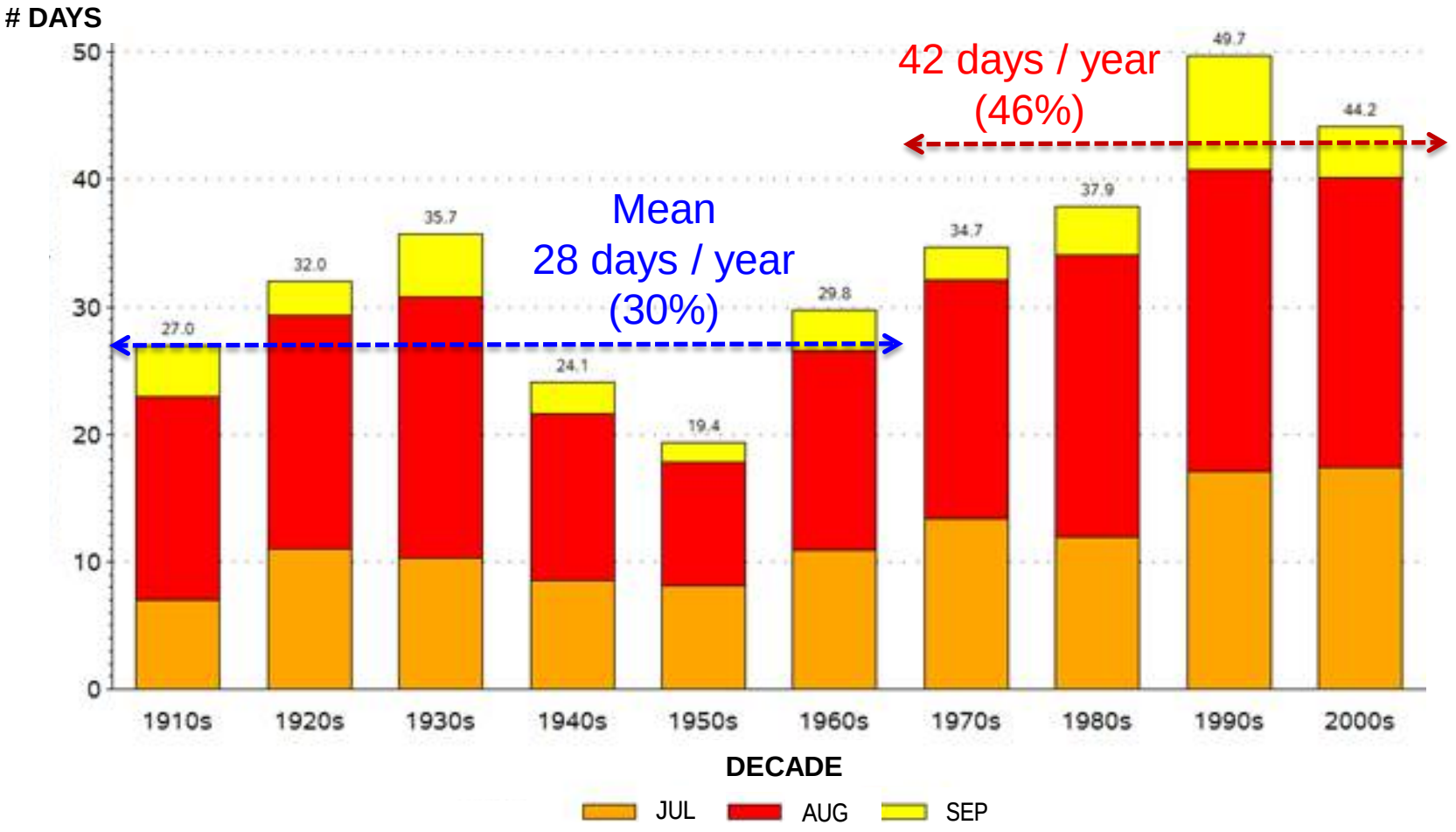
(Days where Water Temp > 19□C)



River Conditions - Temperature

Somass - Thermal Barrier Frequency – 20th Century

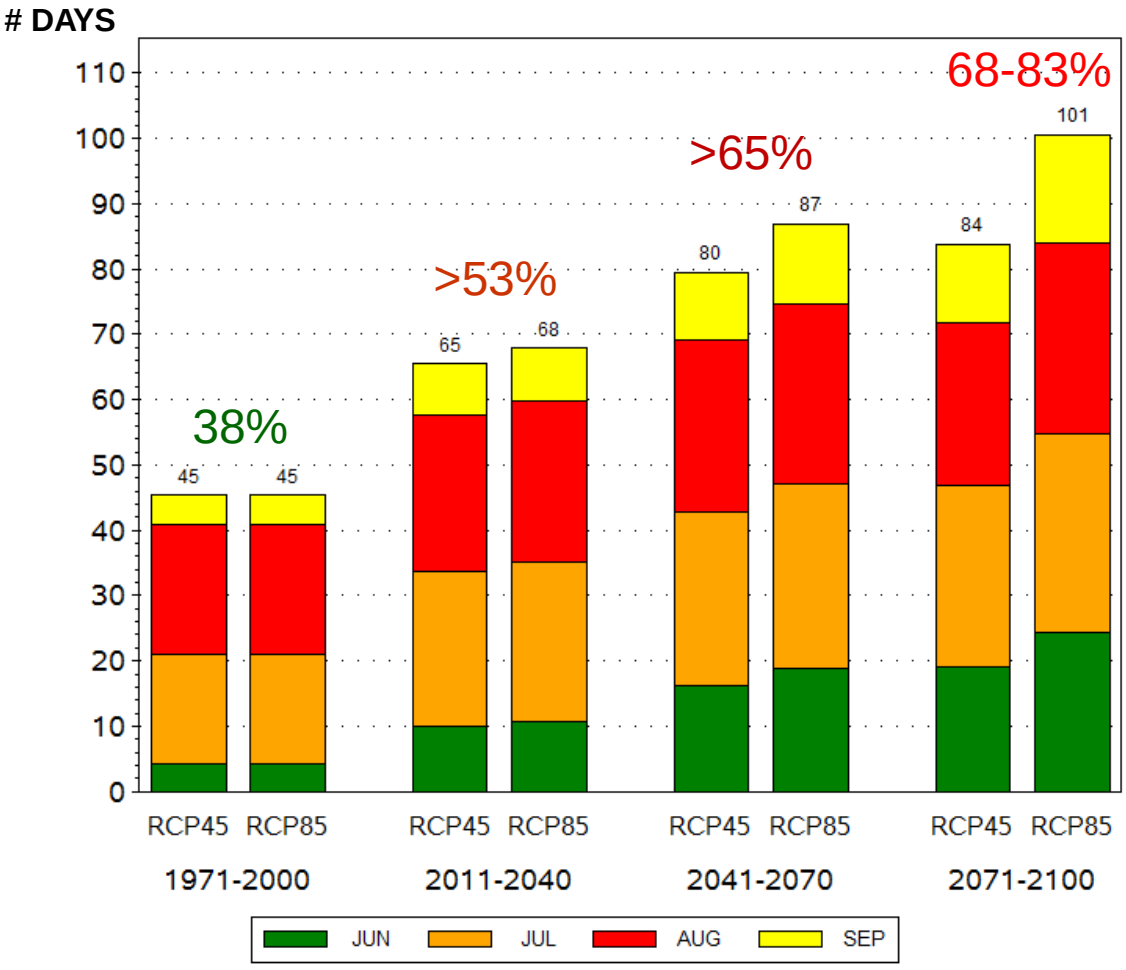
(Days where Water Temp > 19□C)



River – Future Temperature

Somass – Thermal Barrier Frequency

(#Days where Water Temp > 19□C)



GCM EMISSIONS SCENARIOS

RCP 4.5 – '**moderate scenario**' – emissions decline after 2040

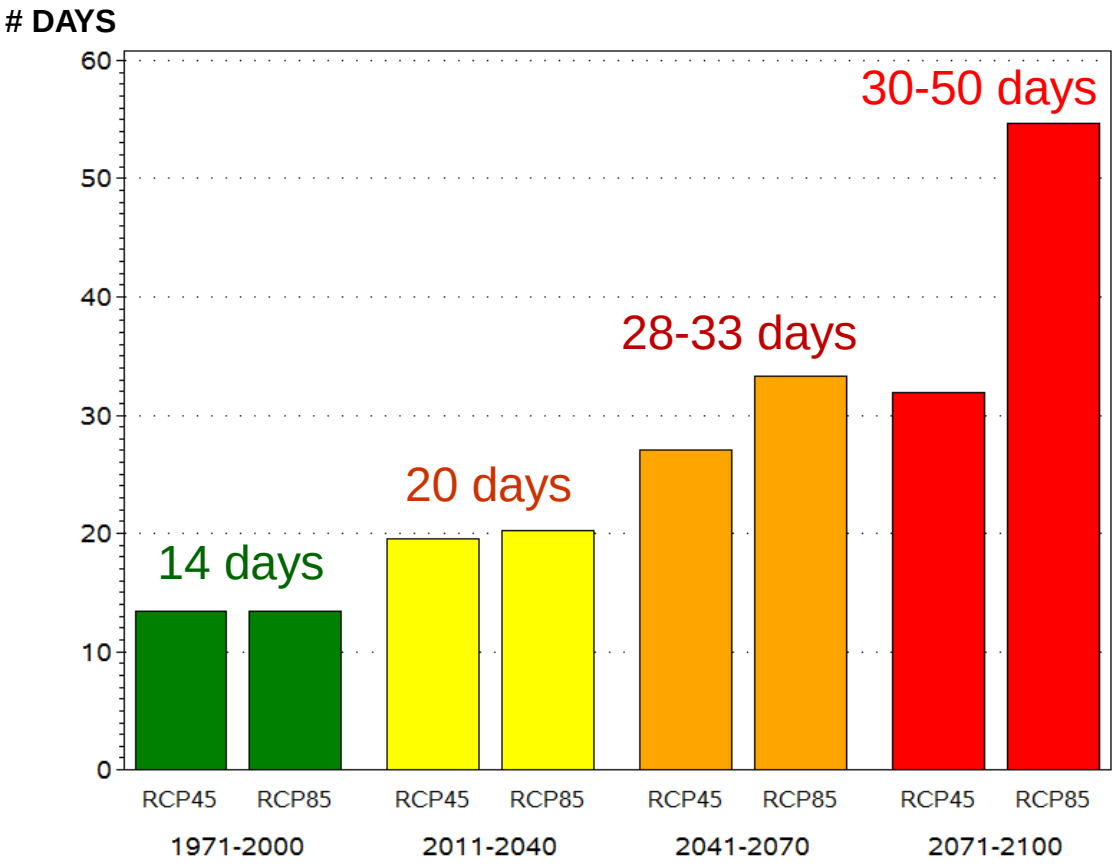
RCP 8.5 – '**business-as-usual'** scenario – emissions rise throughout 21st century

Ensemble means: 10 GCMs x 2 RCPs
(Stiff, Hyatt & Cannon 2018)

River – Future Temperature

Somass – Thermal Barrier Duration

(Avg Length of Thermal Barrier Events, in Days)



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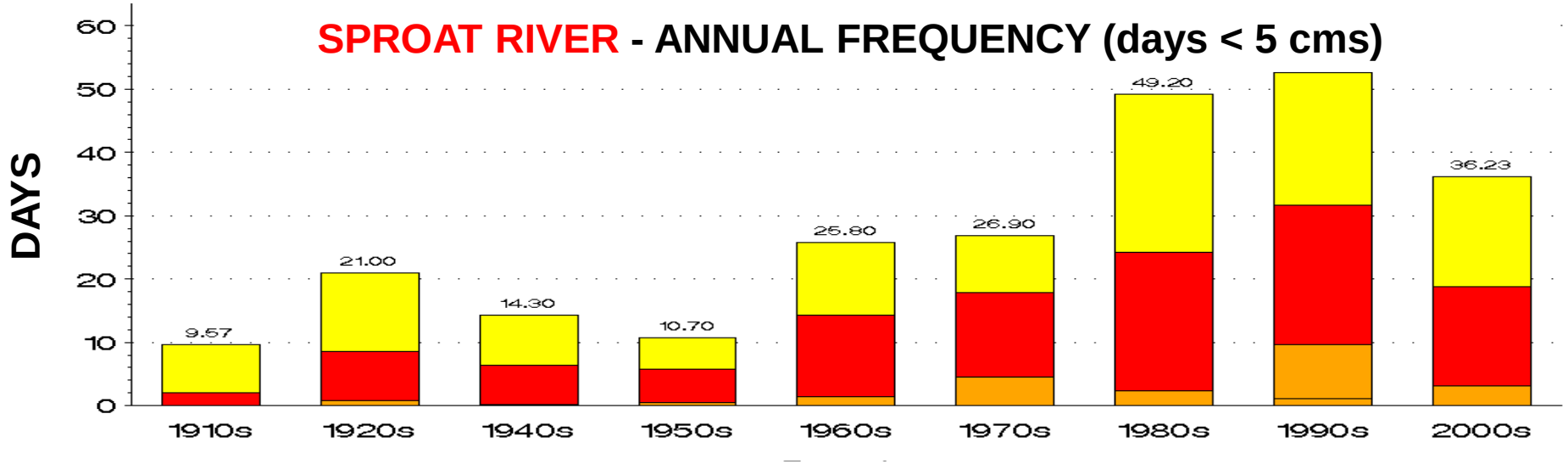
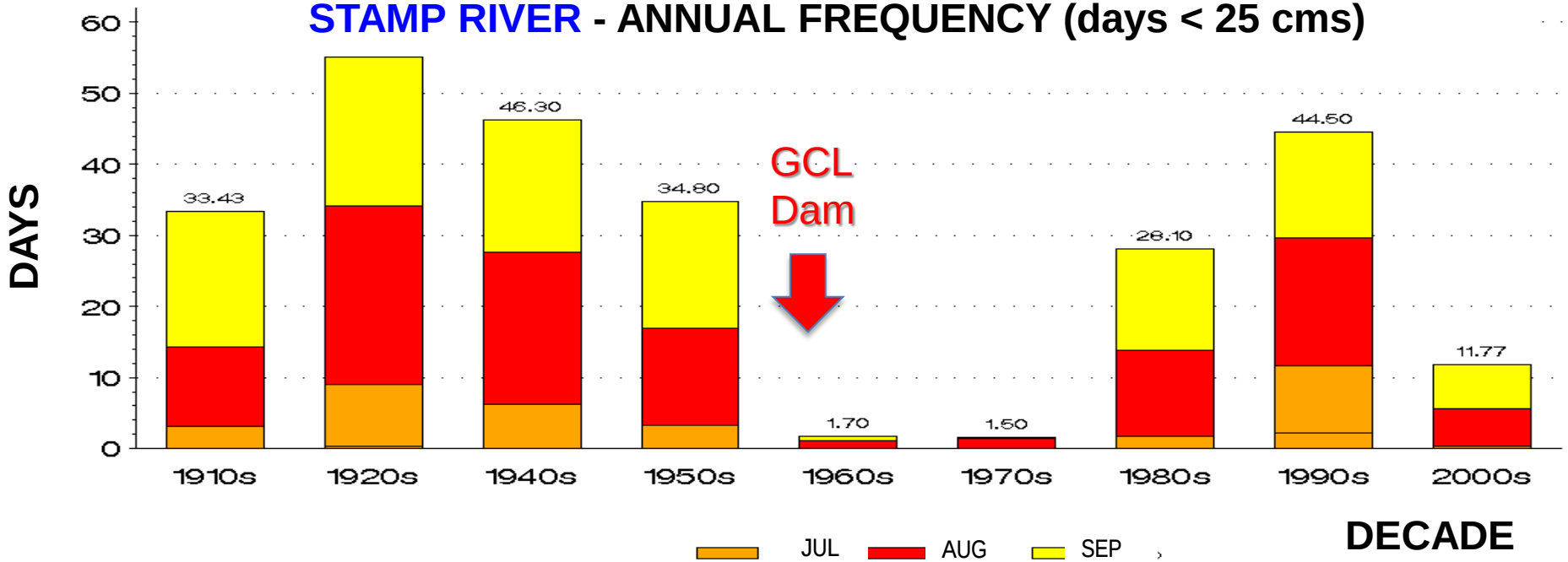
River Conditions - Discharge

River Conditions - Discharge

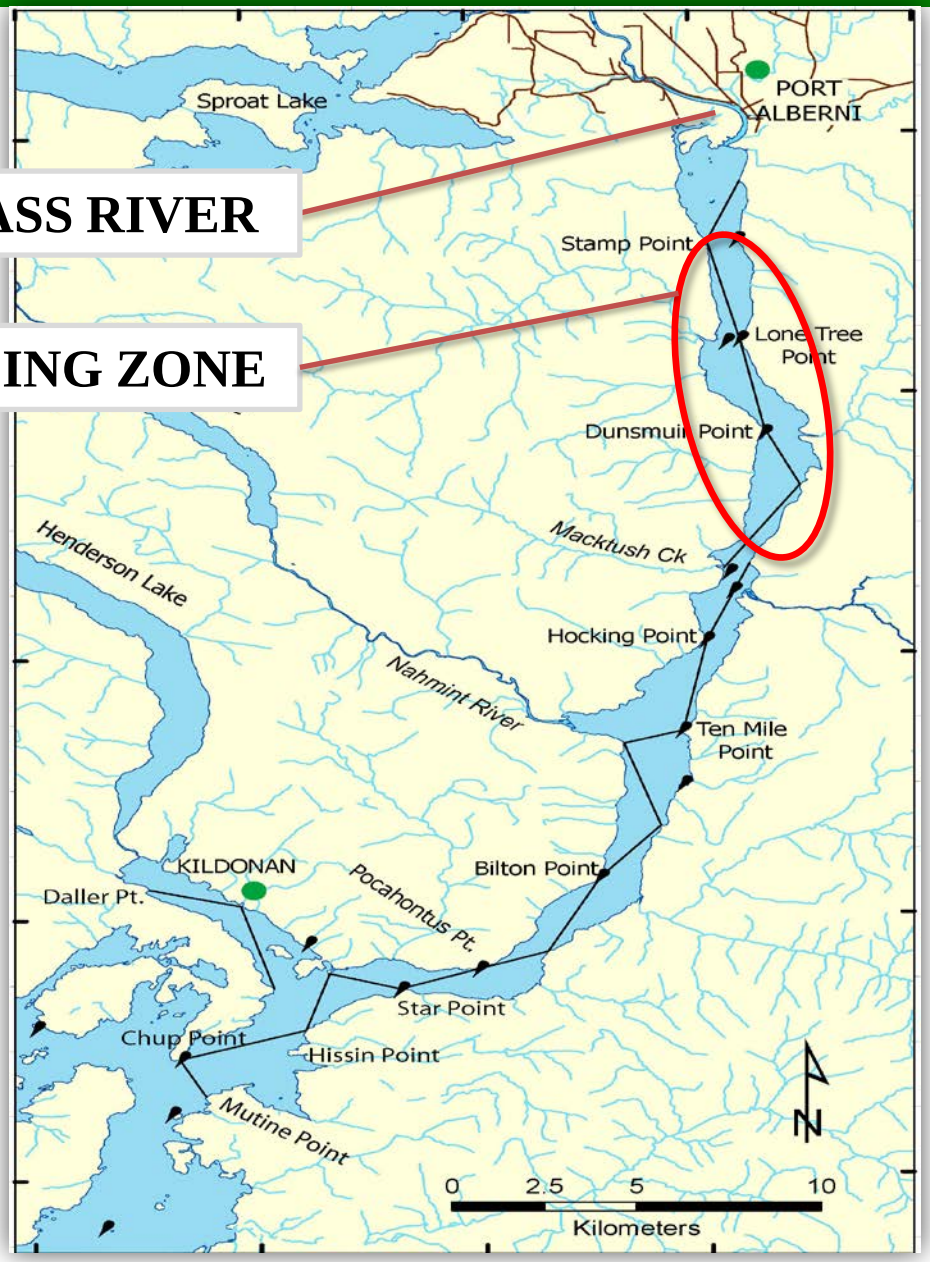
Photos: Kevin Pellett

Low Flow Events





Alberni Inlet



Somass River:

Water temperatures >19-20□C act as a "thermal barrier" to Sockeye migration.

(Hyatt et al., 2015)

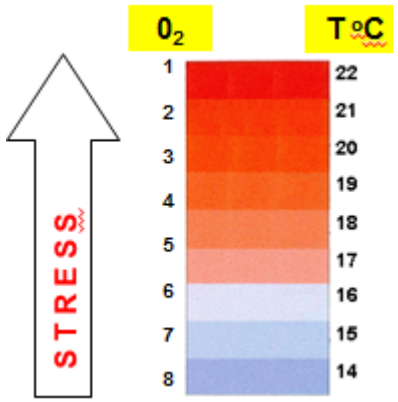
Holding Zone:

Low mixing rates

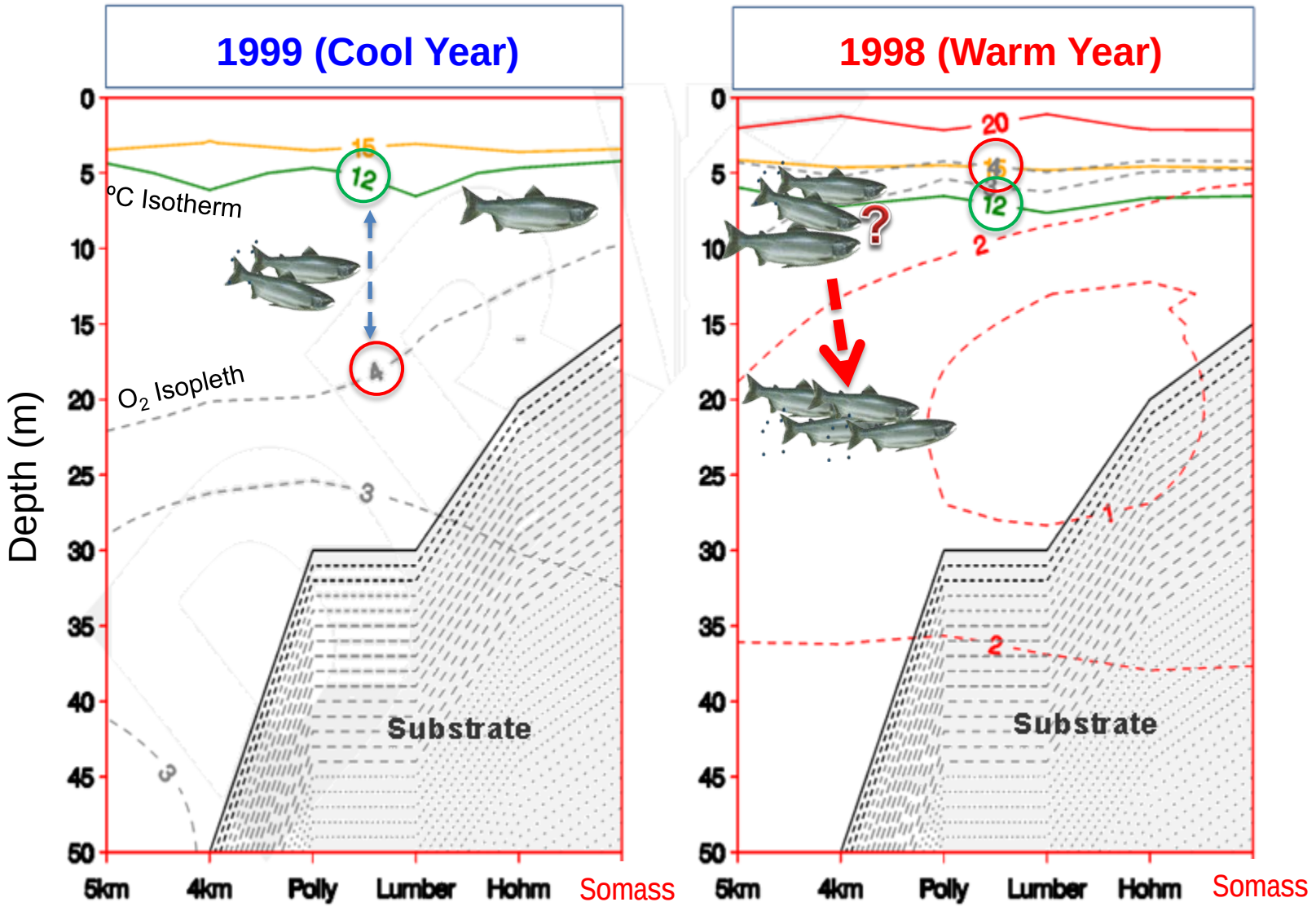
\+ Pulp-mill effluents

= Poor marine water quality

(high temps, low oxygen)



Alberni Inlet – “Temp-Oxy Squeeze”



Summary

1. Somass water temperature >19-20ºC present thermal barriers to Sockeye migration in freshwater.

2. Outlook: near-doubling of baseline (1971-2000) thermal barrier impacts by the 2050s due to climate change:

    - Average frequency up from 38% of migratory season to 70%.
    - Average duration of delays increase from 14 to 30 days.

3. Low flow events will likely occur more frequently during peak Sockeye migration periods (added stressor).

4. Temp/oxy conditions at the head of Alberni Inlet tend to provide poor holding conditions when upstream migration conditions are also poor.

5. Sockeye holding in the marine environment prefer temperatures of 9-10□C, even if oxygen concentrations are detrimental (< 4 ppm).

Thank You

Project funding provided by NR-CAN and the DFO ACCASP program.

Depth profile data for this analysis were largely sourced from ENVIRONMENT CANADA'S Environmental Effluent Monitoring Program c/o Catalyst Paper Corporation which collected weekly or bi-weekly CTD sampling of the head end of the inlet. EEMP (Catalyst Paper Corp) 1991-present (Janice Boyd (EC); Larry Cross (Catalyst;); Hatfield Consultants (maps).

Other depth profile data were retrieved from various cruise reports and the DFO-IOS CTD database, and SAFE & South Coast StAD also teamed up to obtain depth profiles at other seaward locations from Stamp Narrows to Uchucklesit Inlet (2015).

Alex Cannon (ECCC) and Trevor Murdock (PCIC) assisted in the **projection of future air temperature conditions** in the Somass watershed.

Photos: Kevin Pellett; Andrew Campbell; Philip Pereboom; Neil de Boer; Lorne Collicutt