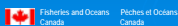


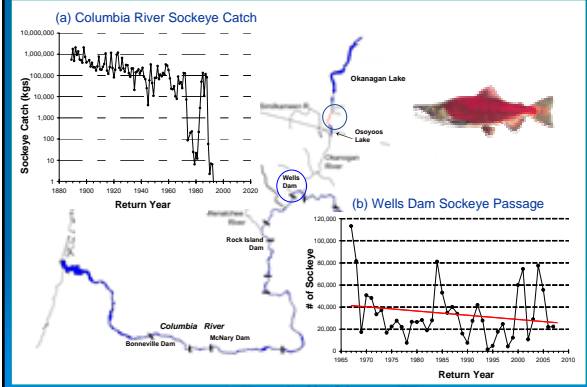
# The Influence of Water Temperature and Discharge on Okanagan Sockeye Salmon Migration, Spawning and Egg Incubation

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## Okanagan Sockeye Salmon Trends



## Water Temperature, Water Supply and Okanagan Sockeye Salmon

A general procedure developed for Okanagan sockeye studies:

- (1) Identify a biophysical model or set of "rules" for a given life history stage or event.
- (2) Use the "rules" to predict responses of salmon to natural or managed changes in environmental conditions.

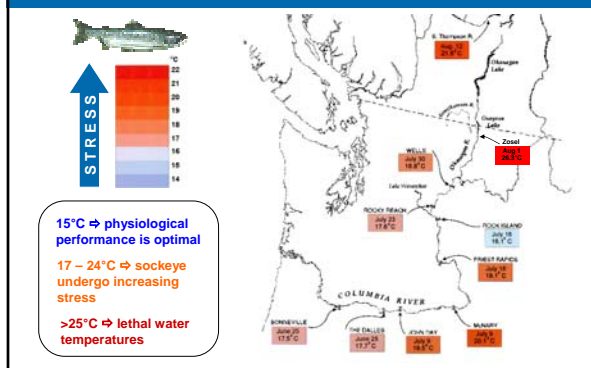


Okanagan Nation Alliance photo

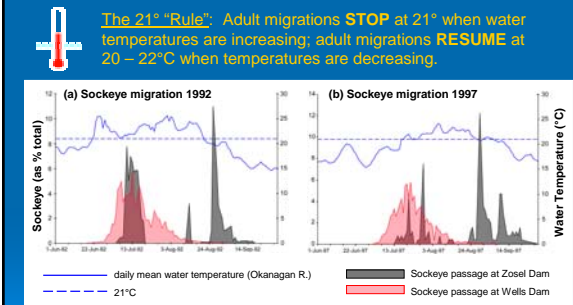
## Analysis of Sockeye Responses to Temperature and Flow Conditions for Impacts on Life History Events



## Returning Sockeye Commonly Encounter Stress Inducing Temperatures En Route to the Okanagan Spawning Grounds



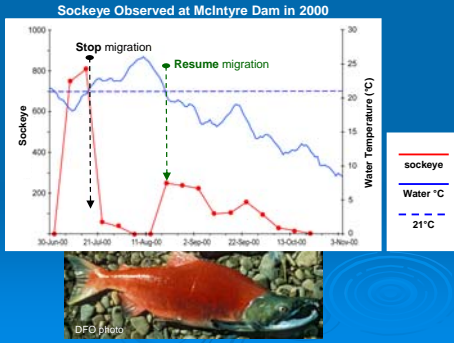
## Disruptions and Delays of Sockeye Entry Into the Okanagan Coincide with Seasonal Water Temperatures



(Source: Hyatt, Stockwell & Rankin 2003)

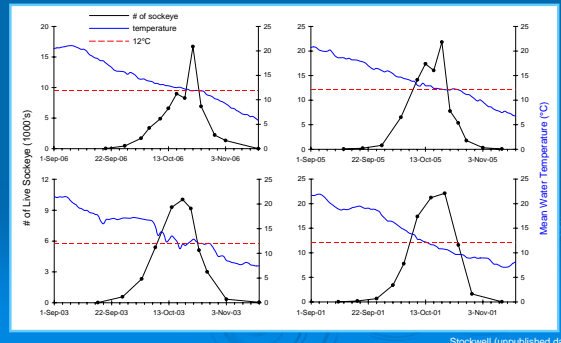
## Disruptions and Delays of Sockeye Entry Onto the Spawning Grounds Coincide with Seasonal Water Temperatures

The 21° "Rule" applies to adults "holding" on the spawning grounds.

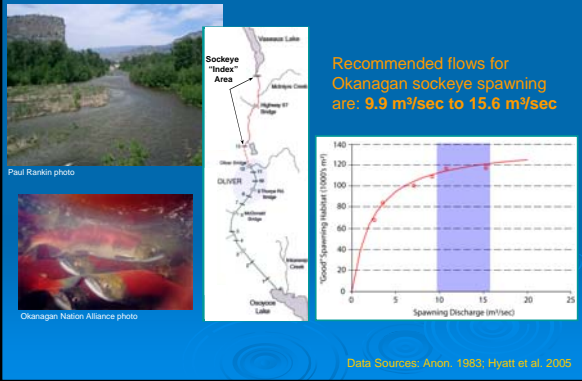


## Okanagan Sockeye Spawn Timing

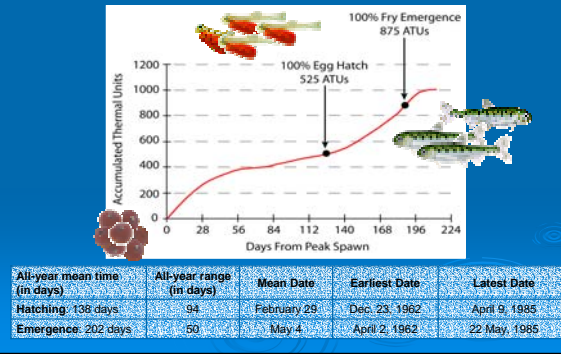
The 12° "Rule": Peak spawning occurs when declining water temperatures have reached approximately 12°C.



## Available Spawning Habitat is Controlled by Flow



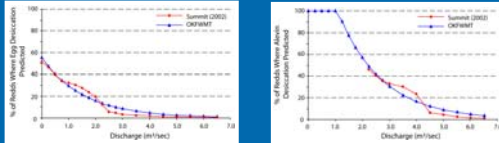
## Water Temperature Controls Developmental Rate and "Period of Vulnerability"



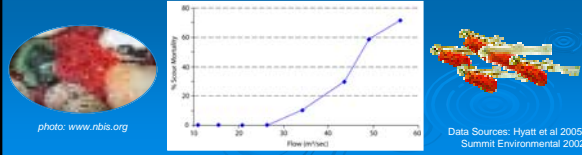
## Sockeye Incubation Success and Discharge

Dewatering/desiccation or flood-and-scour processes control incubation and emergence success of sockeye eggs and alevins.

(a) % Eggs Dewatered at flows < 5.0 m³/sec (b) % Alevins Stranded at flows < 7.0 m³/sec



(c) % Eggs / Alevins Scoured at flows > 28.3 m³/sec

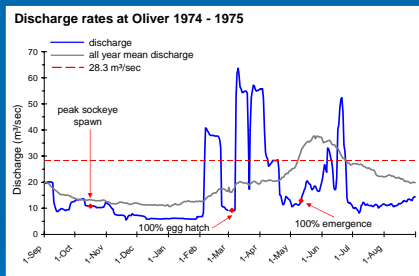


## Okanagan Sockeye Have Predictable Temperature Based "Rules"

- Migration stops at >21°C; restarts at <21°C
- Spawning "peaks" as declining temperatures reach 12°C
- Eggs Hatch when they have accumulated 525 thermal units
- Free swimming fry emerge from the gravel when they have accumulated 875 thermal units



## Use "Rules" to Develop Fish Friendly Flows



# Adults spawning in 1974 = 16,700

# Adults returning in 1978 = 7,644

## Use "Rules" and Knowledge of Life History Events to Manage Water in a "Fish Friendly Fashion"!

### RECOMMENDED DISCHARGES

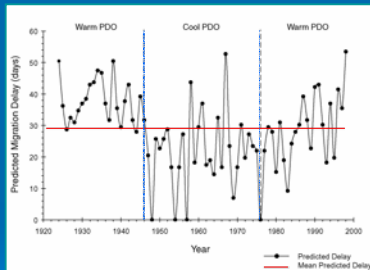
**Adult migration:** 8.5 – 12.7 m<sup>3</sup>/sec  
→ ease of passage to spawning grounds ensured.

**Spawning:** 9.9 – 15.6 m<sup>3</sup>/sec  
→ maximize area of good spawning habitat available

**Incubation:** 5.0 – 28.3 m<sup>3</sup>/sec  
→ minimize loss of eggs, alevins and pre-emergent fry from dewatering or scouring of redds



## Historic Adult Sockeye Migration Delay Based on Seasonal Changes in Okanagan River Water Temperature



Applying temperature-migration rules suggest delays may range from 0 - 54 days & an average of 30 days per annum. The magnitude of delays alternates with PDO cycles & have been increasing steadily in association with climate warming during 1985 - 2000 compared with lesser delays in the "cool" 1947-1985 interval.

## Apply Knowledge of Physical Influences on Life History Events to Assess Potential Impacts of Climate Change on Okanagan Sockeye Production and Survival

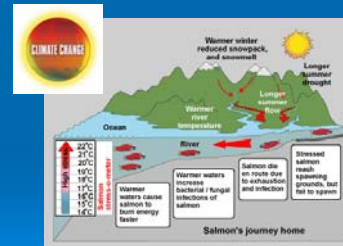
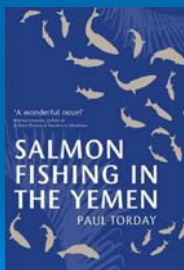


Image: adaptation.nrcan.gc.ca

Thank you!



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