Optimizing Design for Stream Type Juvenile Chinook in Floodplains

Seattle City Light

SKAGIT RIVER SYSTEM COOPERATIVE

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PUGETSOUND PARTNERSHIP

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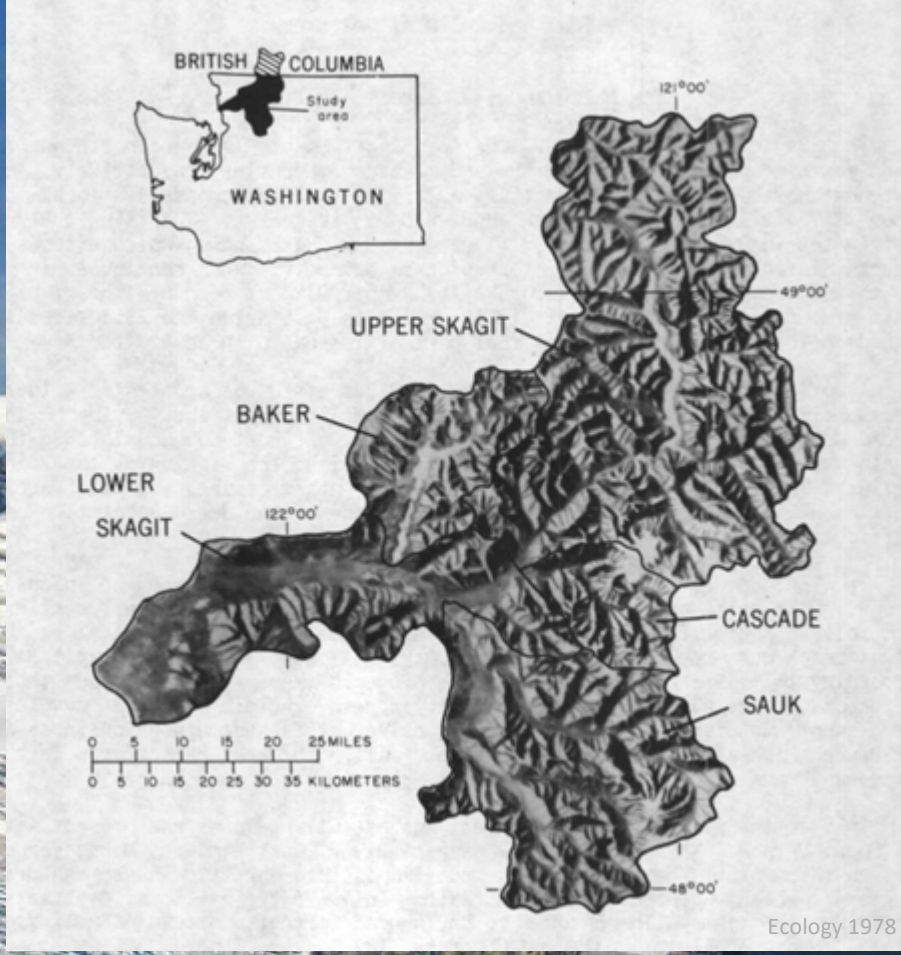
Why Study Stream Type Juvenile Chinook in the Skagit Basin?

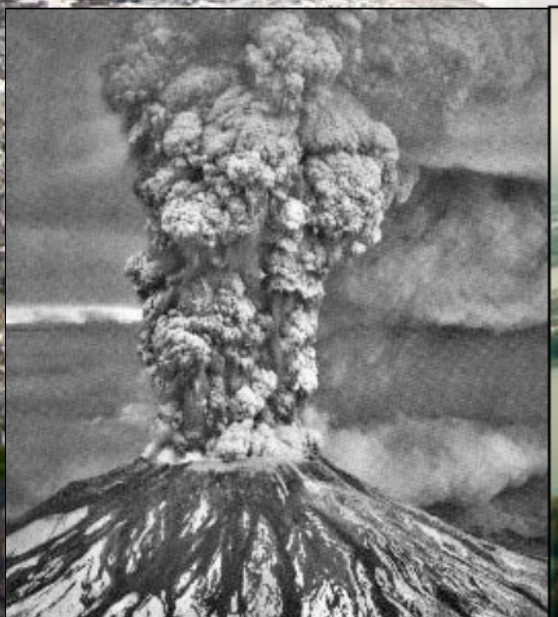
Chinook salmon, *Oncorhynchus tshawytscha,* has two common life-history patterns as juveniles:

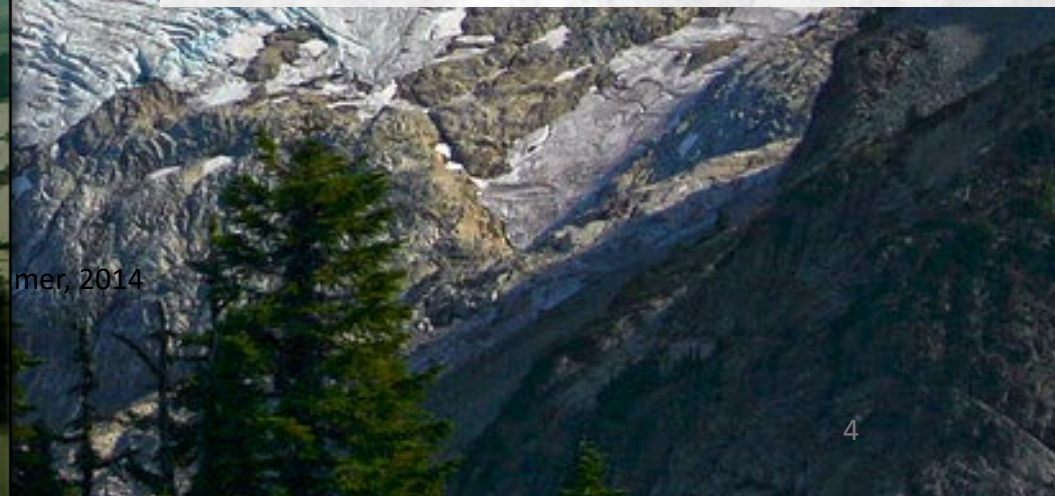
- **'Stream-type' juveniles** reside in streams for a year before abandoning territoriality and migrating to marine habitats.
- **‘Ocean-type' juveniles** migrate to sea soon after emergence.

Natural Disturbance



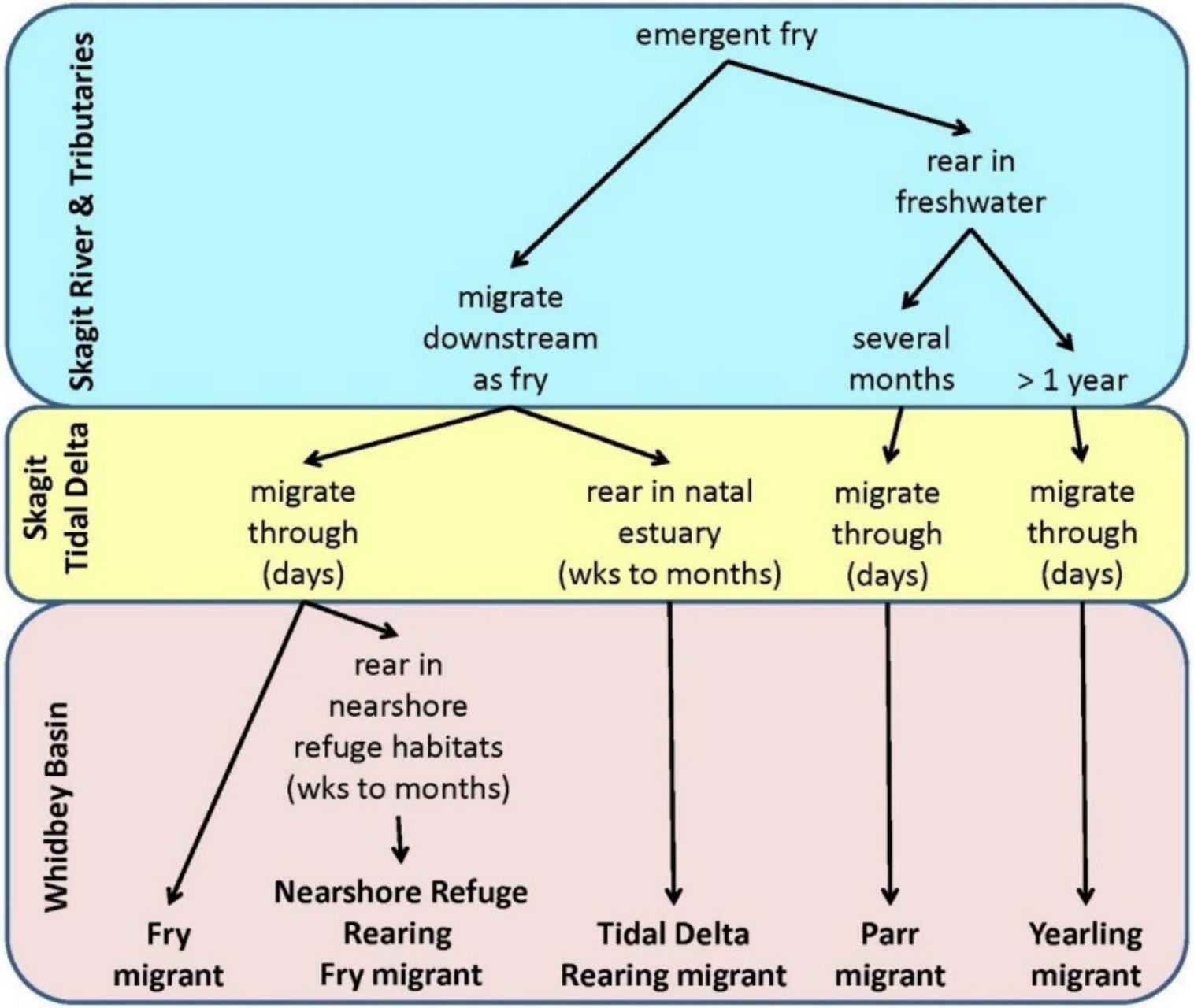
Ecology 1978





mer, 2014

Preservation of Life History Diversity



Source: Beamer, 2014

Climate Change Resilience

November 2021

Source: GoSkagit

Higher Smolt to Adult Returns

- Larger size at outmigration
- Increased chance of survival
- **Survival** for smolt to adult returns is **two times higher for stream type Chinook** as **compared to parr migrants** in the Skagit River (Beamer et al. 2005)

Jeffrey et al. 2010

Cultural Importance

Upper Skagit Tribe word for Chinook = Yúbəč = spring salmon

Source: Collins 1974

"Every spring, when the chinook began to run, two or three fish were caught and cooked in the longhouse of her grandfather. Like Communion, everyone would come there to eat a bit of these fish to give thanks for their return and to show that their remains would be well treated by everyone."

Vi Hilbert, Upper Skagit Elder

https://content.lib.washington.edu/aipnw/miller2.html#priest

Habitat Preferences Unclear

Current understanding of juvenile Chinook preferences does not match observations – larger river use, large range of depths vs. flood plain channels

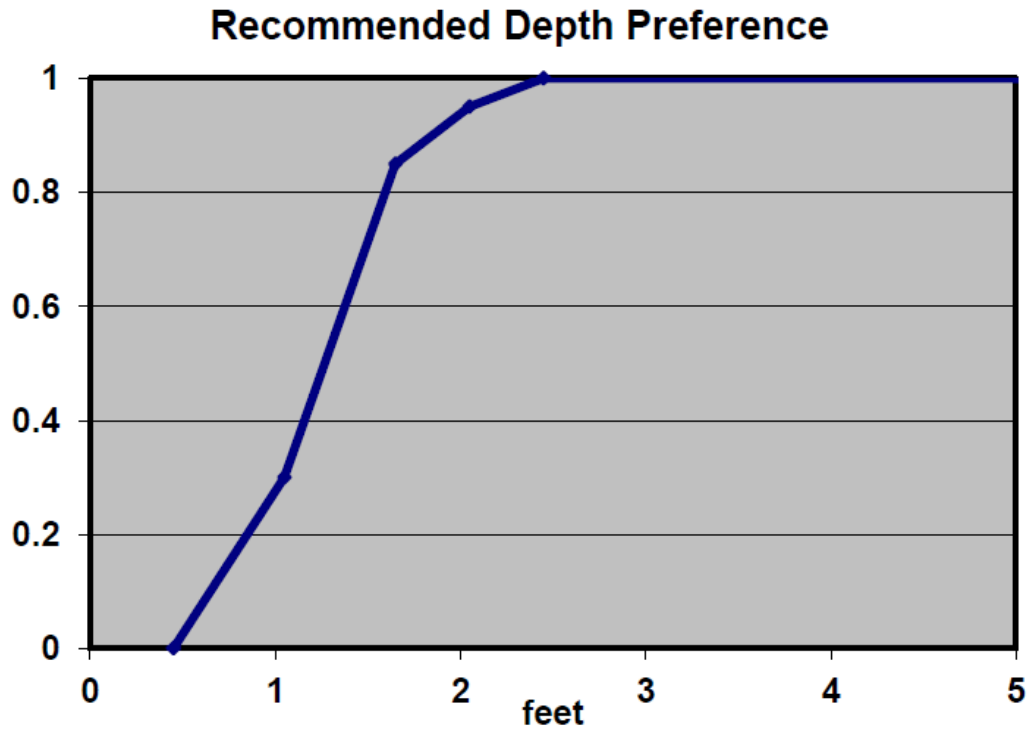
"Factors contributing to the yearling smolt life history [in the Skagit Basin] will benefit from additional study." (Zimmerman et al. 2015)

INSTREAM FLOW STUDY GUIDELINES

Technical and Habitat Suitability Issues Including Fish Preference Curves

UPDATED, January 25, 2022

Depth Suitability Curve for Juvenile Chinook Salmon



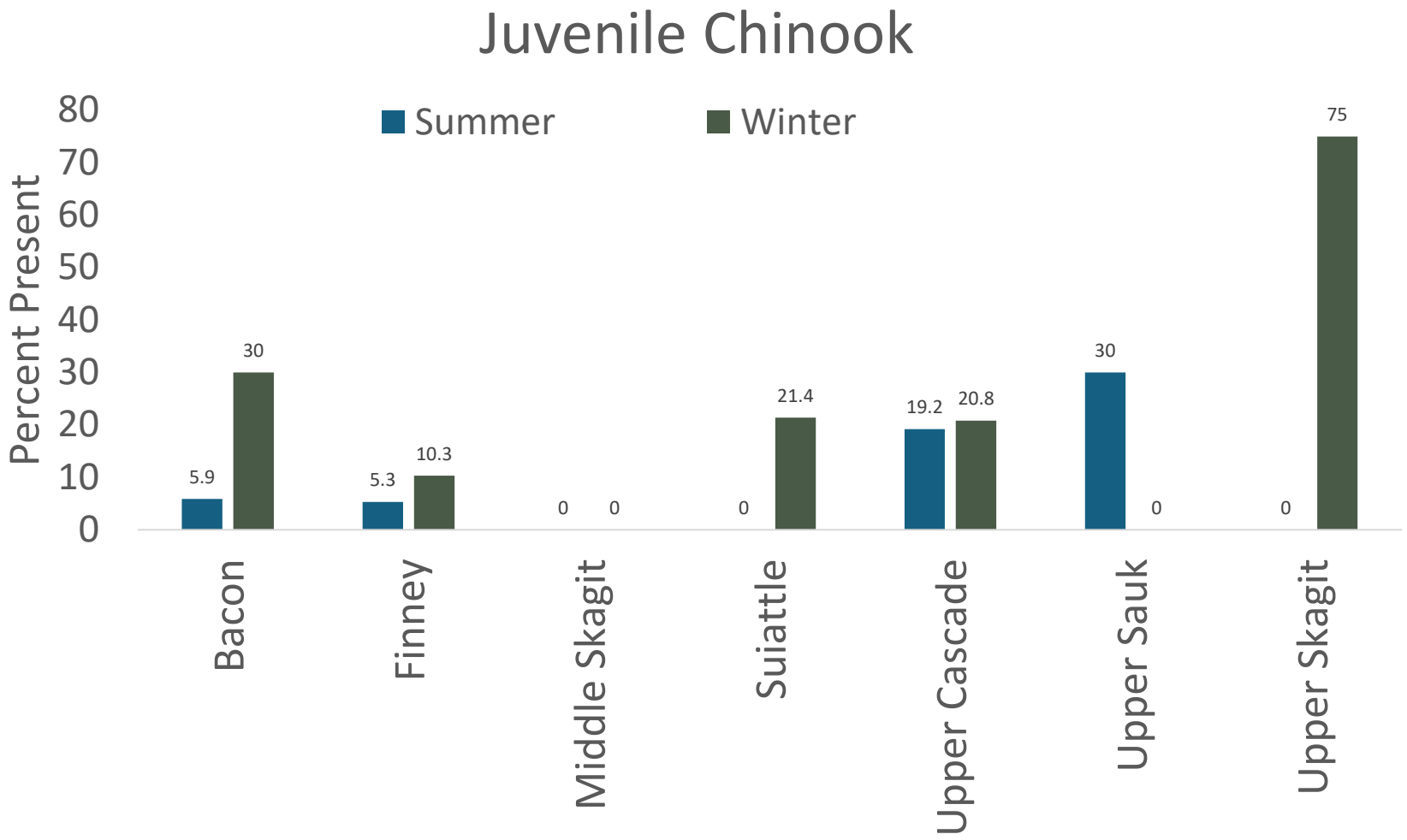
Phase 1: Watershed Scale

Freshwater Habitat Rearing Preferences for Stream Type Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*) in the Skagit River Basin: Phase 1 Study Report

Can we find them?

(Beamer et al. 2010)

Phase 1: Results - Occupancy



- Randomize site selection
- Snorkel at night across seasons
- Triple the effort for summer/double for winter
- Add a May sampling effort after fry and most parr have outmigrated (Zimmerman et al. 2010)

Phase 2: Habitat Types

Identify which habitat types are used by yearling Chinook salmon across seasons

Primary	Secondary
Hydrological Unit	Reach Type
Rain	Large Mainstem
	Small Mainstem:
Mix	Tributary
Snow	Floodplain Channel
	Tributary Junction
	Large Wood Jam

Lowery et al. 2020

Where do we find them?

Phase 2: Habitat Types

Winter

Higher STJ Chinook densities at sites > 21 km from the river mouth

Spring and Summer

Higher STJ Chinook densities in:
Channels < 7.3 m wide, with wood cover > 17%
Channels > 7.3 m wide, vegetation cover <58%

Lowery et al. 2020

Stream Type Juvenile Chinook Distribution

- Varies by precipitation regime
- Varies across seasons

Snow
- Spring-flood plain channels
- Summer-mainstems

Mixed
- Spring /Summer-all channel types
- Winter-flood plain channels

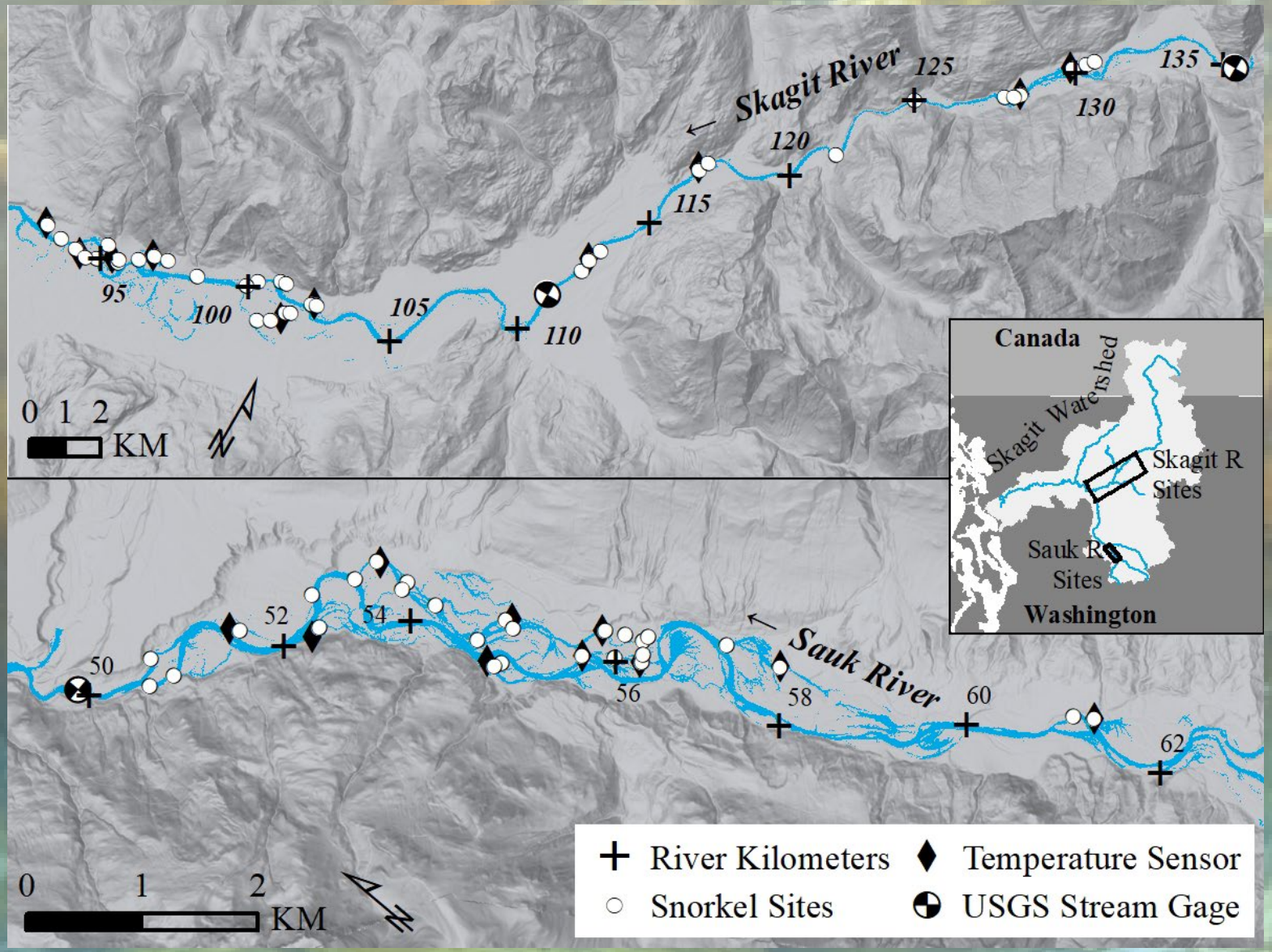
Rain
- Spring-larger mainstems and LWD
- Summer-LWD and flood plain channels
- Winter-flood plain channels

Phase 3: What Habitat Elements are Associated with Higher Densities?

1. What elements of habitat, including depth, velocity, cover, large wood, temperature, and substrate, are most responsible for differences in densities of stream-type juvenile Chinook?

2. Do preferred ranges of these habitats vary by season?

Why do we find them there?



Field Methods

- 70 sample locations
- 3 Seasons – Summer, Winter, Spring
- Night Snorkel
- Daytime Habitat Measurements
  - Depth
  - Velocity
  - Substrate
  - Cover
  - Temperature

Generalized Linear Mixed Model Results

Variable	Summer	Winter 2021	Spring
Fixed Effect Coefficients			
Mean Velocity	0.57	NA	NA
Range Depth: Range Velocity	NA	NA	-0.67
Range Velocity	NA	NA	-0.06 [a]
Range Depth	-0.74	-0.60	-1.08
D50	NA	0.80	0.97
Max Water Temperature	0.55	NA	NA
Wood Cover	0.49	0.43	NA
Distance to Mainstem	-0.46[a]	-0.68	-0.56
Easting	NA	-1.13	-1.14
Intercept	-5.96	-4.82	-7.67
Zero-inflation Intercept	-2.29	NA	-1.08
Random Effects Variance			
Year	1.53	NA	6.98E-08
Date Block	1.91E-09	NA	NA
Site ID	3.26	NA	0.51
Snorkel Staff	0.74	5.77E-11	1.48
Model Characteristics			
Marginal R-Squared	0.24	0.56	0.54
Conditional R-Squared	0.99	0.56	0.96
Number of Sites Sampled	63	48	54
Number of Years of Sample Data	2	1	2
Total STJ Chinook Salmon Count	1,246	662	516

Summer

Mean Velocity, Range Depth, Max Water Temperature, Wood Cover, Distance to Mainstem

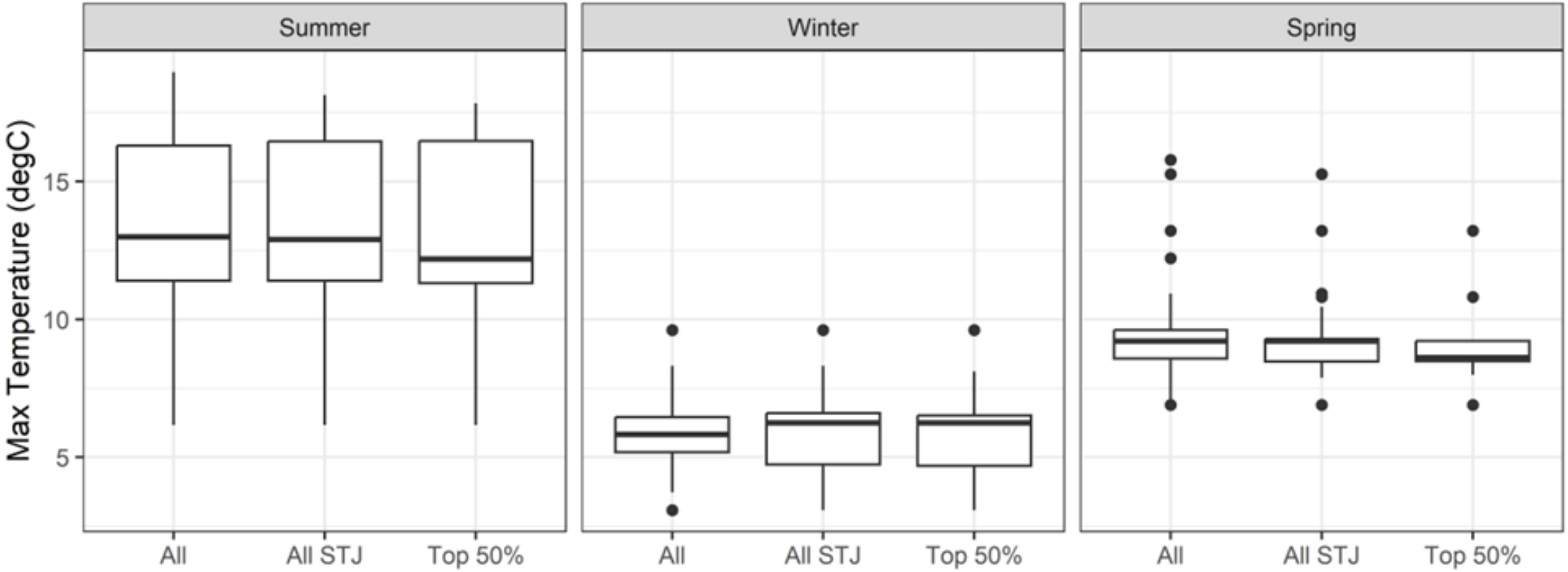
Winter

Range of Depth, D_{50}, Wood Cover, Distance to Mainstem

Spring

Range Depth X Range Velocity, Range of Velocity, Range of Depth, D_{50}, Distance to Mainstem

What Does it Mean?



Habitat Results Combined Across Seasons

Habitat Element	Observed Ranges of STJ Chinook
Mean Depth	40-68 cm
Mean Velocity	0.06 – 0.33 m/s
Mean D50	3- 36 mm
Distance to Mainstem Connection	33-119 m
Mean Temperature (summer only)	9-14°C
Max Temperature (summer only)	11-16°C
Wood Cover*	7-23% (at the mouth of side channels in particular)

*Observed rather than optimum

Floodplain Design Paradigm

Risk Based	Resiliency / Habitat Based
Q100, Q10, Q2	Summer Low Flow, Winter Base Flow, Spring High Flow : Q<1
Infrastructure, Flooding, Insurance and FEMA Requirements, People and $$	Species, Life Stage, Habitat Elements, Days of Use, Ecosystem Function
No Rise, Risk Averse (Hydrophobic)	Connectivity, Inundation (Hydrophylic)
PREVENT HARM	CREATE /EVALUATE BENEFIT

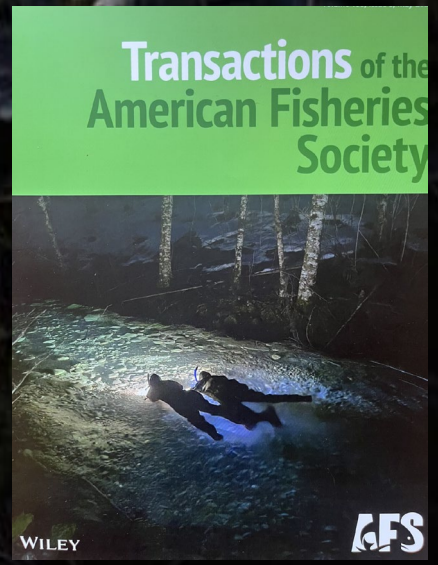
Parting Thoughts…

Survival for smolt to adult returns is **two times higher for stream type Chinook** as **compared to parr migrants** in the Skagit River
(Beamer et al. 2005)

Higher Survival Rates → Increased productivity and abundance of Chinook populations

Design approaches targeting fish preferences better optimize habitat outcomes

Questions?



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