



Geomorphic Study of the Ohanapecosh River: Estimating Anadromous Fish Distribution up to 8,000 ya to aid Archaeological Investigations

2017 Annual GSA Meeting

April Kelly

Geoscientists-In-the-Parks

Mount Rainier NP

Paul Kennard

Region Geomorphologist

Mount Rainier NP

Ben Diaz

Park Archaeologist

Mount Rainier NP

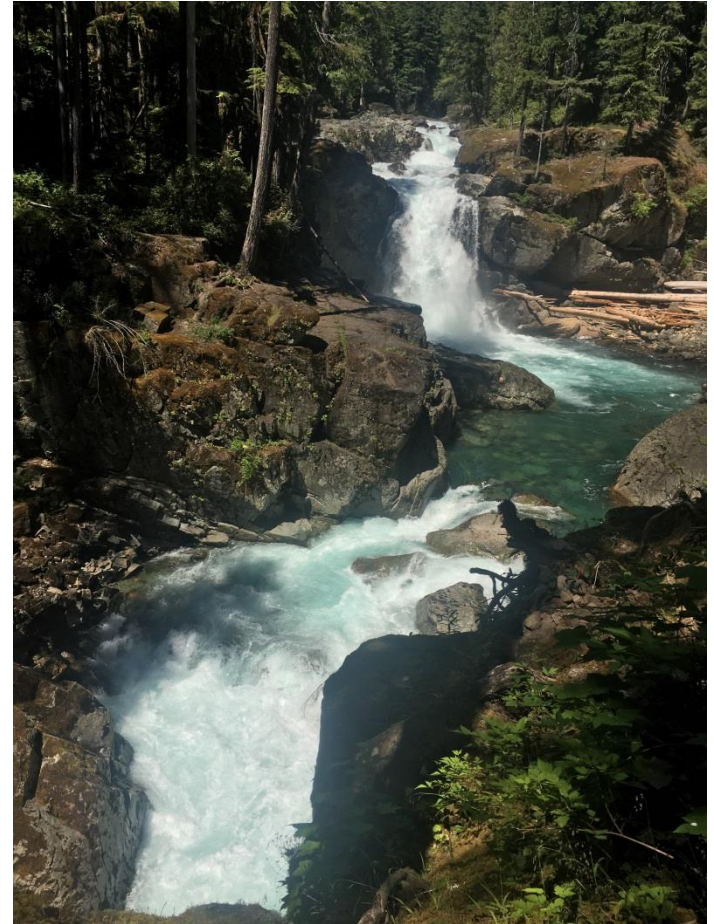


Objectives and Presentation Overview

- Presence vs. absence of anadromous fish
- Ohanapecosh River, Western WA
- 8,000 ya
 - Surrogate for human habitation

How?

- Archaeology
- Ethnography
- **Geomorphology**
 - Identify natural and anthropogenic fish barriers
 - Develop generic approach
 - Estimate fish passage using dated terraces

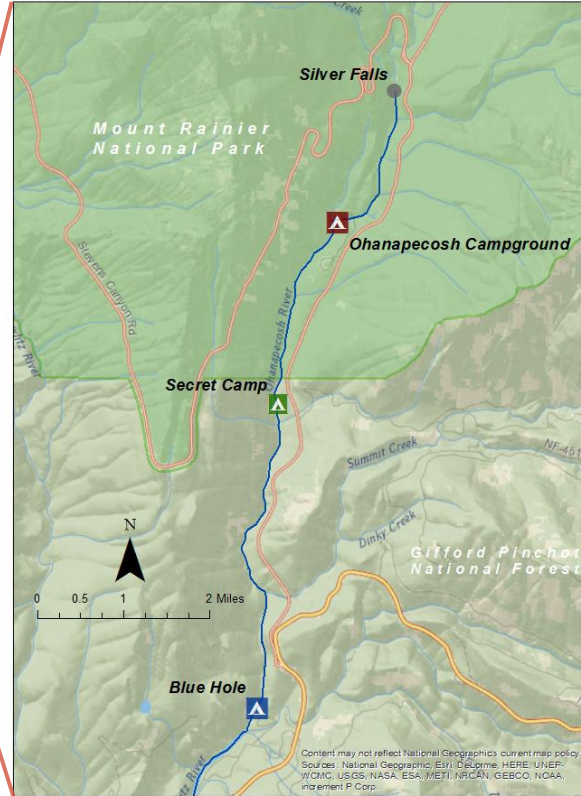


Silver Falls, Photo by April Kelly, 7-13-17

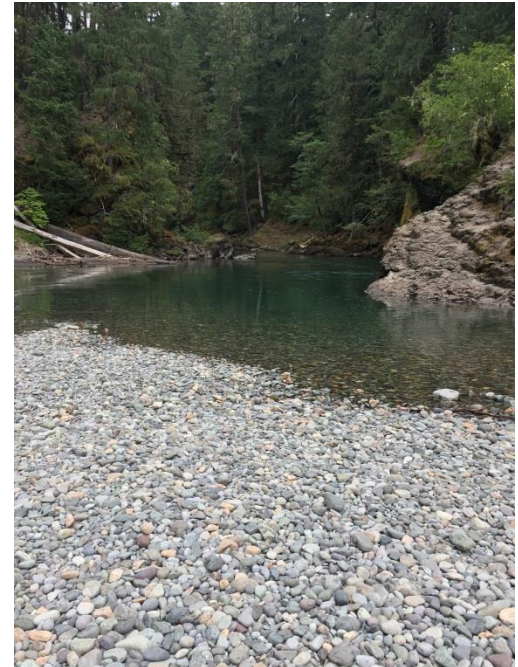
Upper Cowlitz Watershed Anthropogenic Barriers → 1963



Gifford Pinchot NF and Mount Rainier NP



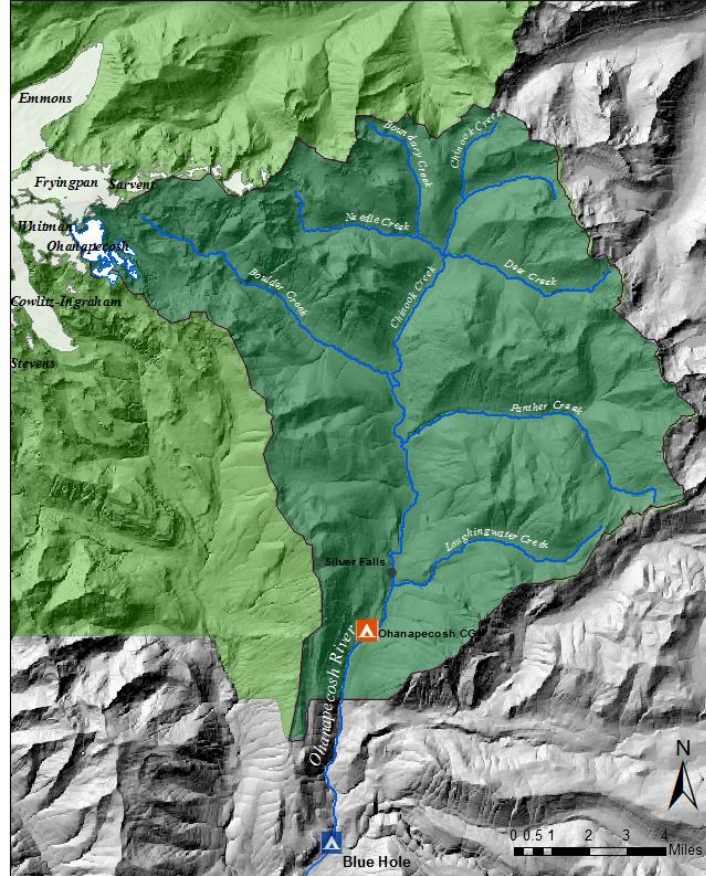
Ohanapecosh River Blue Hole



Ohanapecosh River - A Mount Rainier Anomaly



Largest river where the headwaters don't solely begin on Rainier's flanks



Watershed	% Valley Wall	% Floodplain
Ohanapecosh	71	0.7
White	53.6	2.42
Puyallup	52.4	1.56
Carbon	47.2	5.28
Muddy Fork Cowlitz	45.5	1.1
Nisqually	40	3.57
Mount Rainier NP	50.6	2.3



Nisqually River

Pre- and Post-Dam Fish Presence



Spring and Fall Chinook
10-15lbs, can be >100lbs

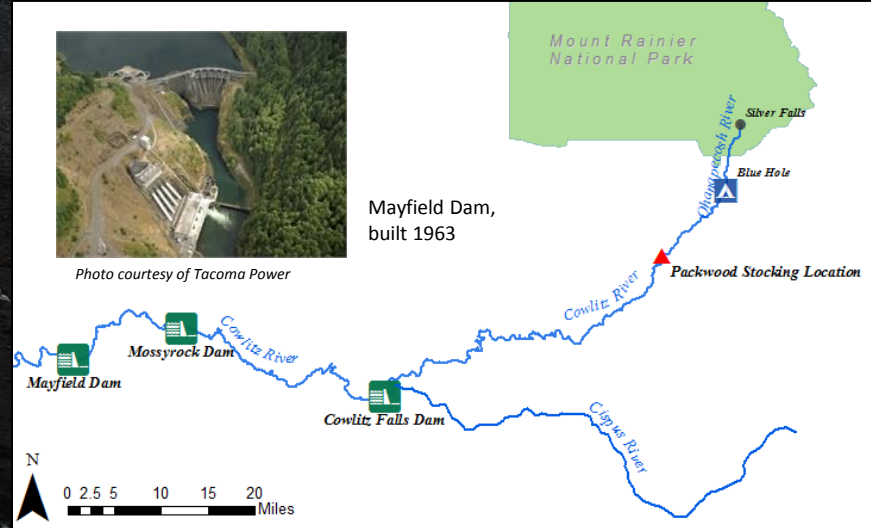
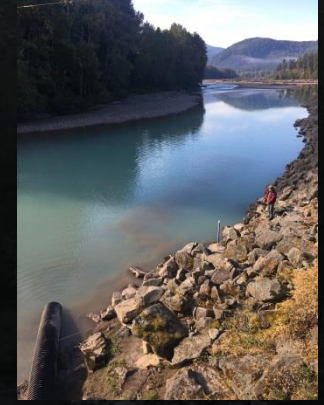
Winter Steelhead
8-11lbs, up to ~40lbs

Coho
6-10lbs, up to ~30lbs

Preferred Habitat:

- Gravel to cobble substrate – Laying redds
- Over hanging vegetation – Protection
- Riffles – Egg oxygenation
- Pools – Rest and recovery

Stocking Coho
in Packwood,
WA



Archaeologic Evidence

- Robust fish runs required → Sustainable community
 - Harvest and storage 5,000 – 4,000 ya
- Ohanapecosh CG → Temporary encampment
 - No fish evidence
- Blue Hole → Permanent village
 - Fish evidence



All evidence found at Blue Hole, photos courtesy of Rick McClure, USFS Archaeologist

Ethnographic Evidence

Taytnapam oral traditions by Louis Costima 1924-1926, “Northwest Sahaptin Text” (Jacobs 1934)

“He [Coyote] said, “**At this place [Blue Hole] will be salmon**, Chinook salmon, steelhead, silverside, grayling, Dolly Vardens, a great many large Dolly Vardens. **They will not go further upstream**, none will be above Ohanapecash, no people will ever dwell above there, there will be a great deal of snow in winter time. **The people will always be here**, at this place they will have salmon for food.”



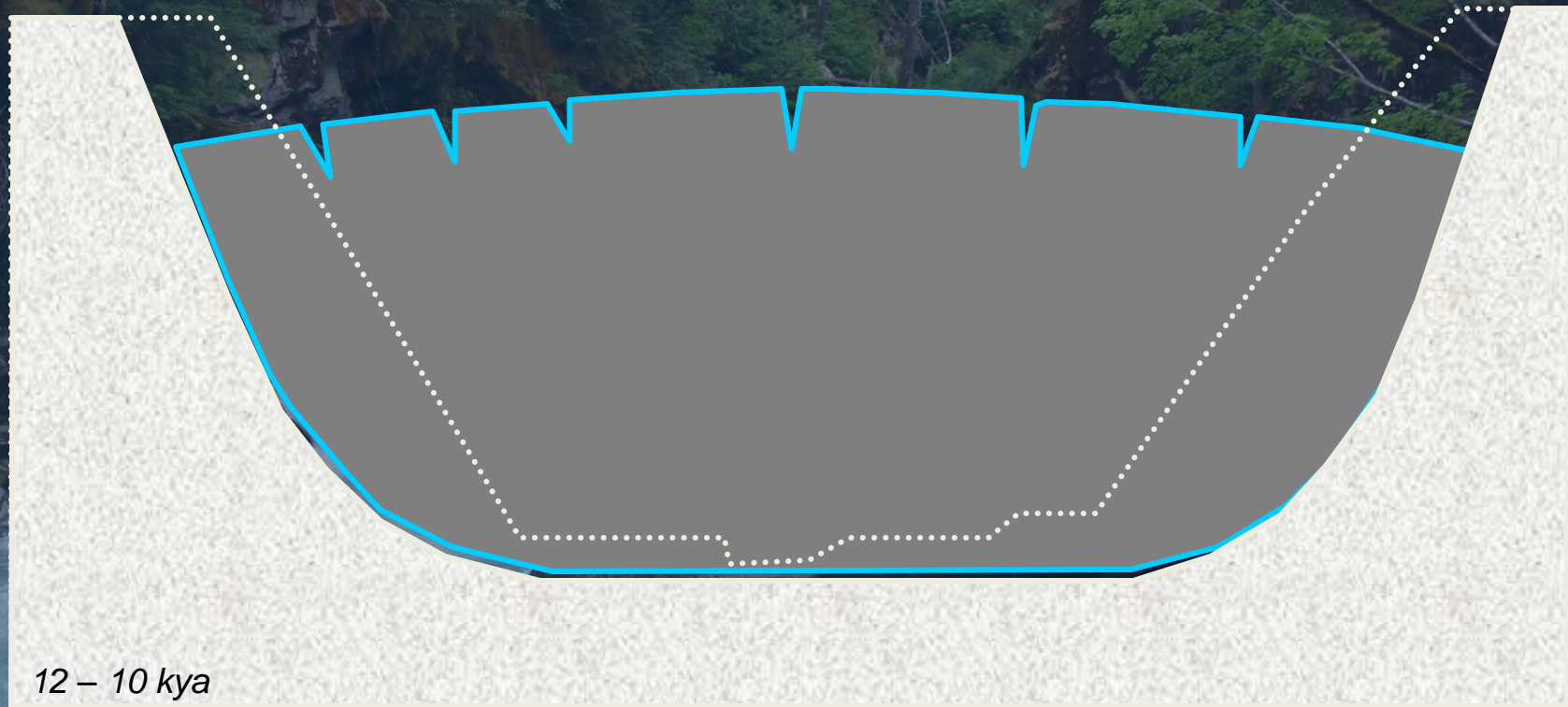
April 1939 photo courtesy of Rick McClure, USFS Archaeologist

General Geomorphic Approach

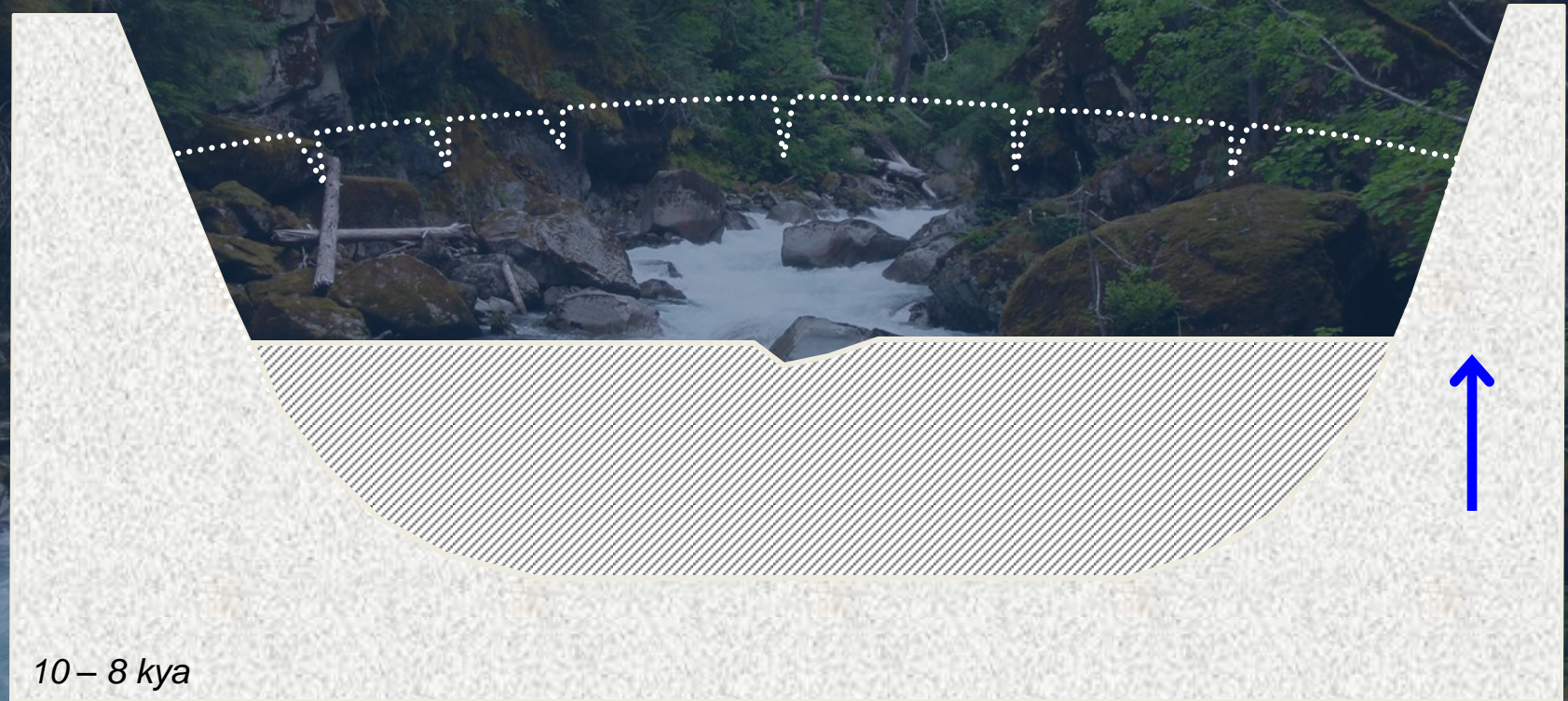
- Lack of previous work encouraged us to develop own method
- Identify current natural barriers, current fish distribution
- Physical and biological controls, *last 8 kya*

<i>Drivers</i>	<i>Landscape Response</i>		
Lahars	Channel blockage	Aggradation	Spawning and rearing habitat
Volcanic Eruptions		Avulsion	
Mass Wasting	Δ Sediment Input	Loss or emergence of forests	Water temp, food sources
Glacial Recession	Sediment limited vs. Transport limited	Δ Base level	Incision or Aggradation

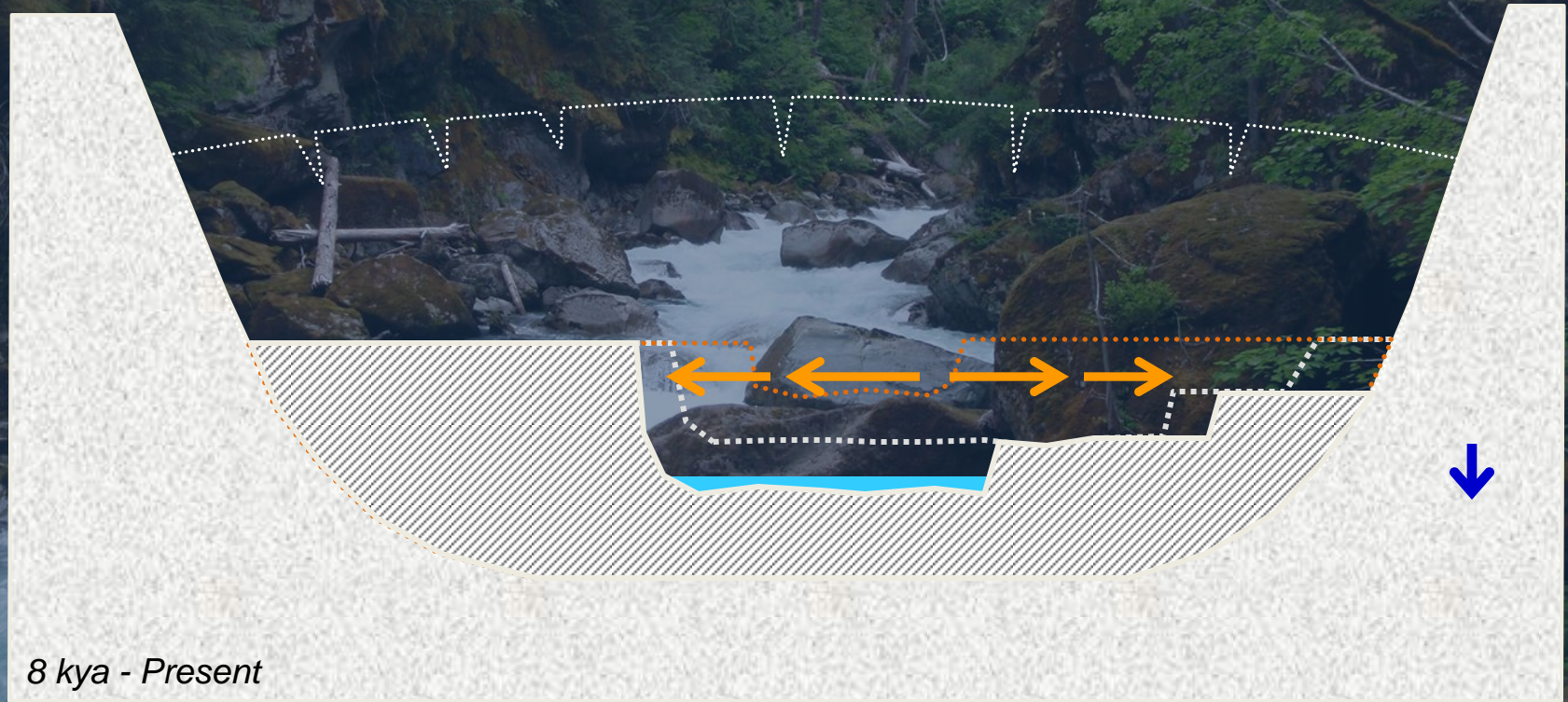
Alpine Glaciation



Glacier Retreat and Sedimentation



Incision and Terrace Formation Barrier Exposure



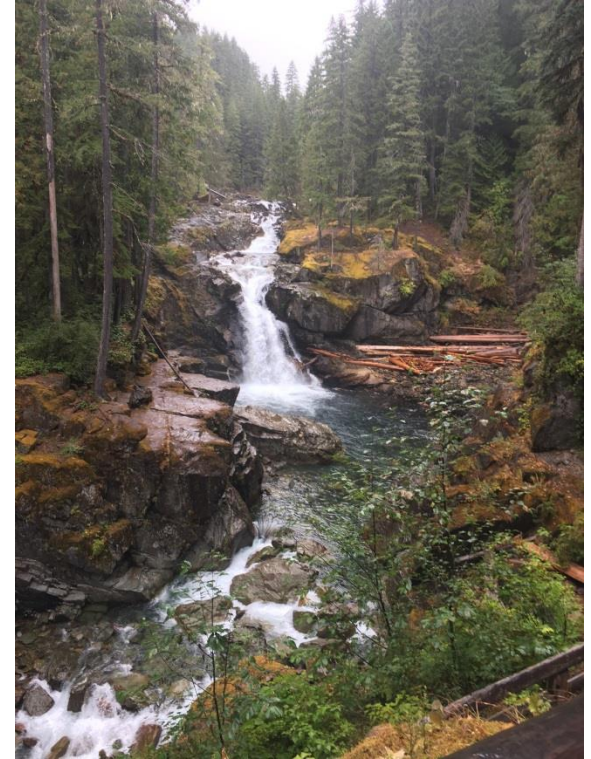
8 kya - Present

Natural Barrier Criteria (WDFW, 2009)

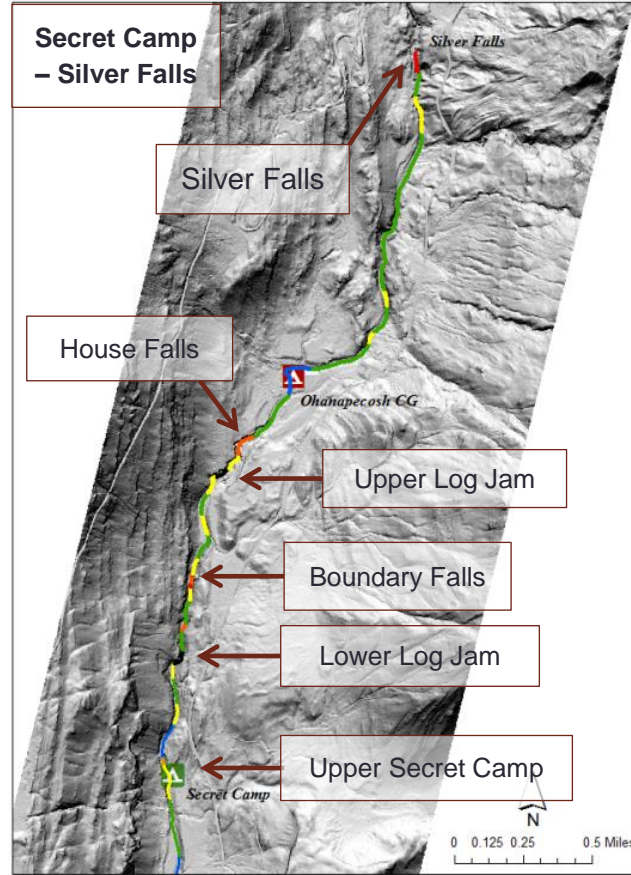
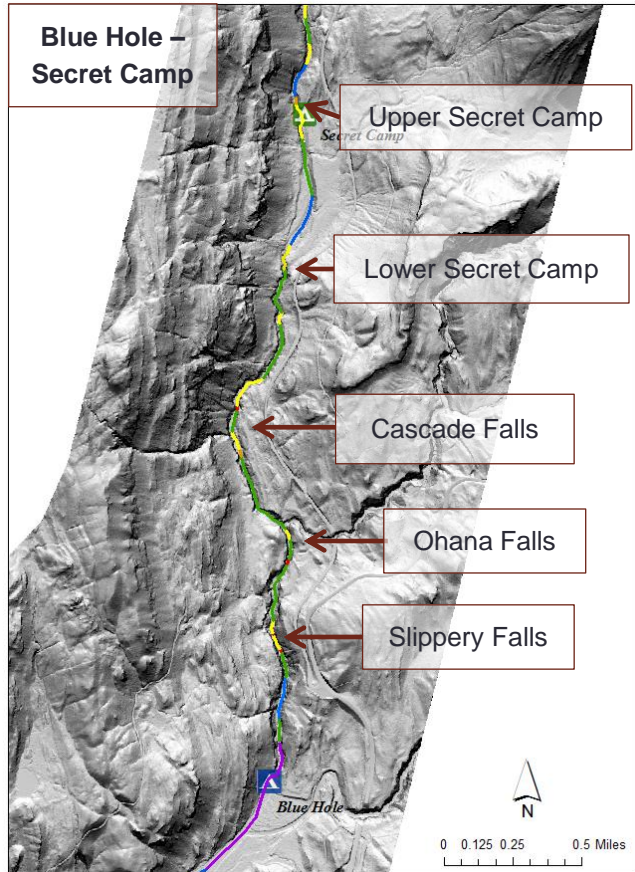


Stream reach $>20\%$
sustained gradient for
160m or more

Waterfall $> 3.7\text{m}$ vertical
height



Slope Classification

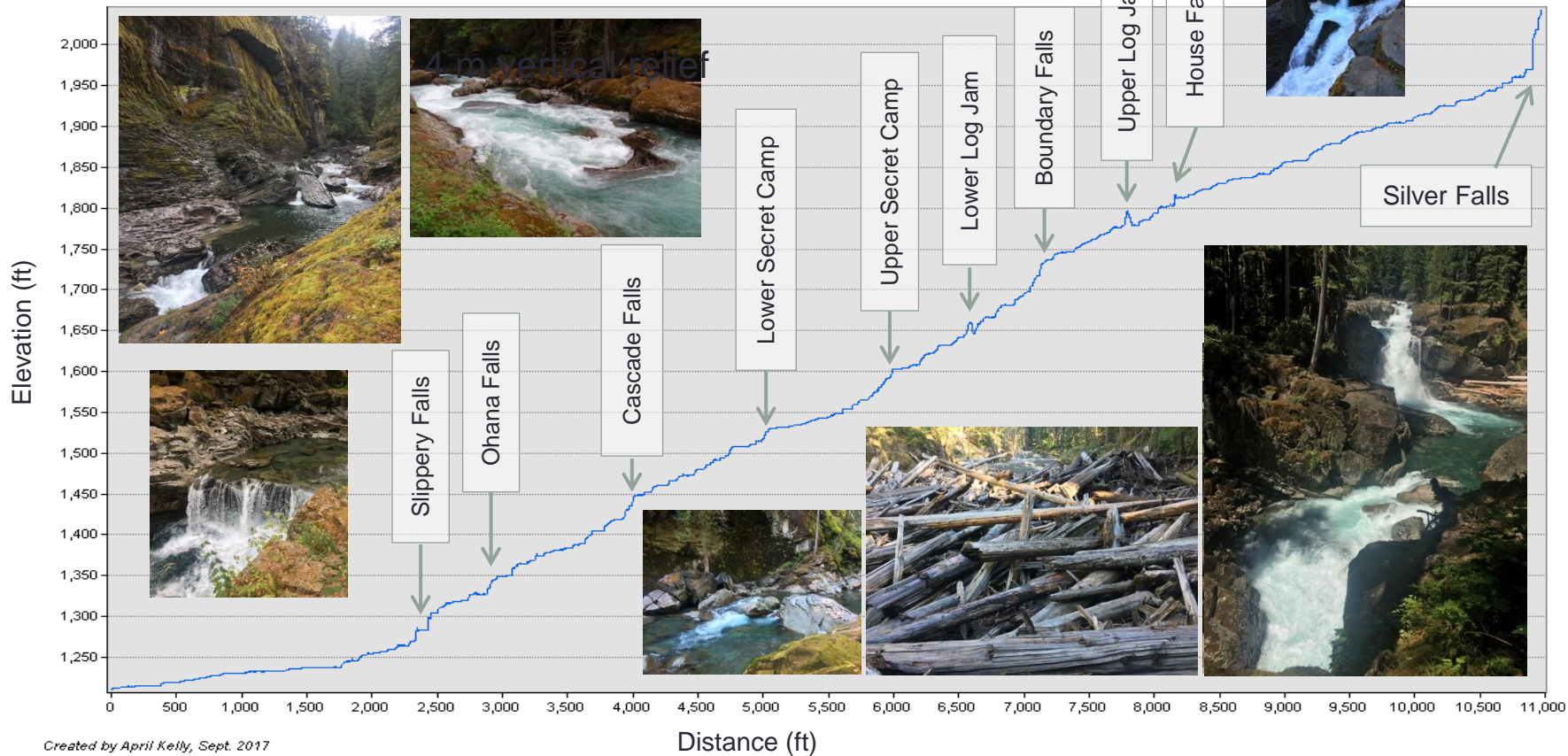


Stream reach with sustained gradient > 20% for 160m or more

Slope Classes	
>30%	Red
20-30%	Orange
8-20%	Yellow
4-8%	Green
2-4%	Blue
0.1-2%	Purple
Log Jam	Black

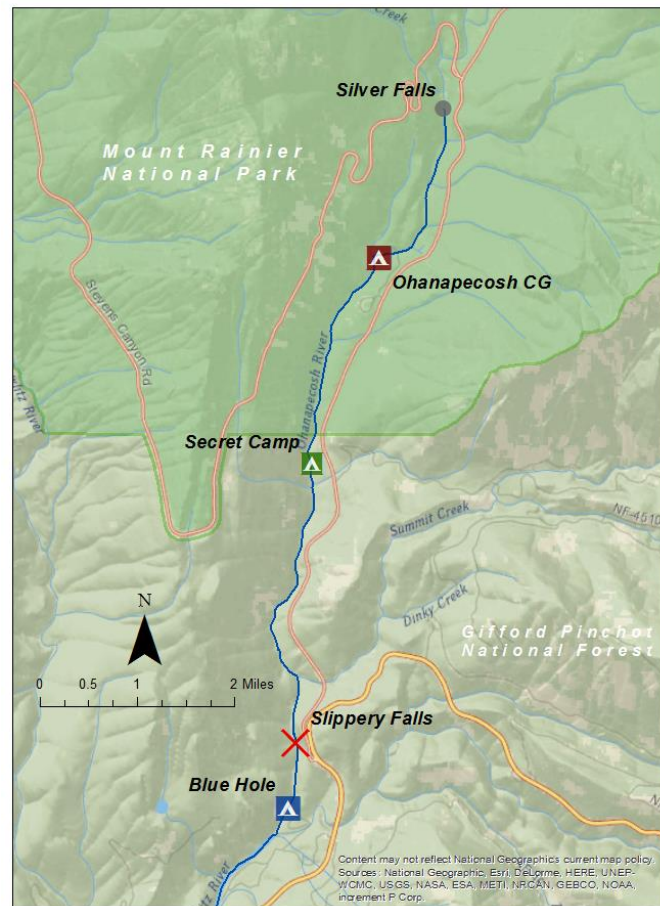
House Falls, > 20% gradient for 166m

Longitudinal Profile – Blue Hole to Silver Falls



Current Salmonid Distribution

- Spawning surveys and radio-tagging in Upper Cowlitz since 2005
 - Confirmed fish distribution to Slippery Falls (4m vertical relief)
 - No further fish migration



General Geomorphic Approach



- Glacial retreat → Glacial outwash deposits
- River incision → Erosion of glacial deposits → Barrier exposure
- Past river height (8,000 years) → **Dated Terraces**

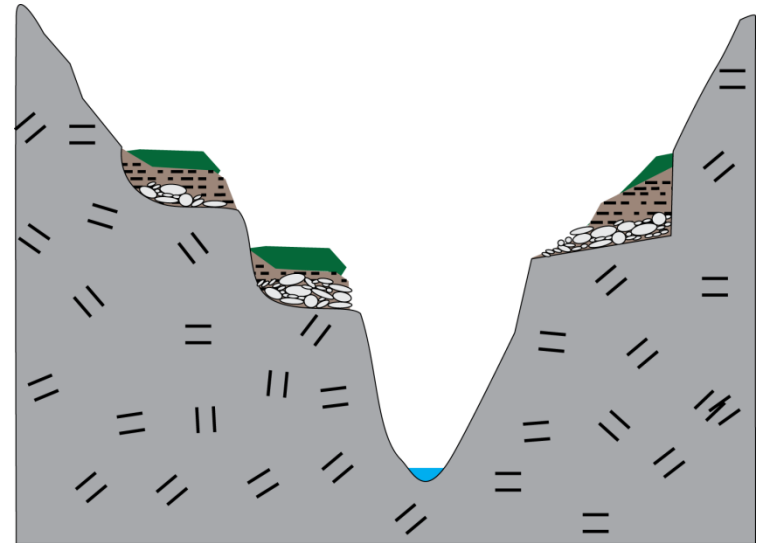


Figure Created by Robby Jost, Oct. 2017

A Search for Dated Terraces

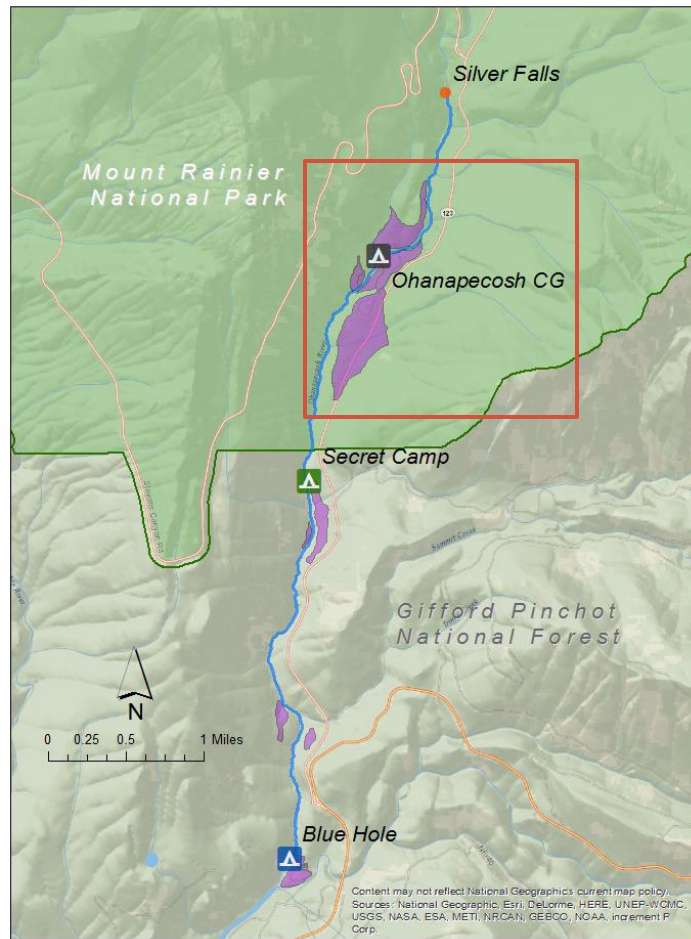
Terrace Classification	Height (m)
Low	0 – 5
High	>5 – 15
Very High	> 15

→ 14 terraces

→ 5 dated using tephra
chronology (Archaeologic sites)

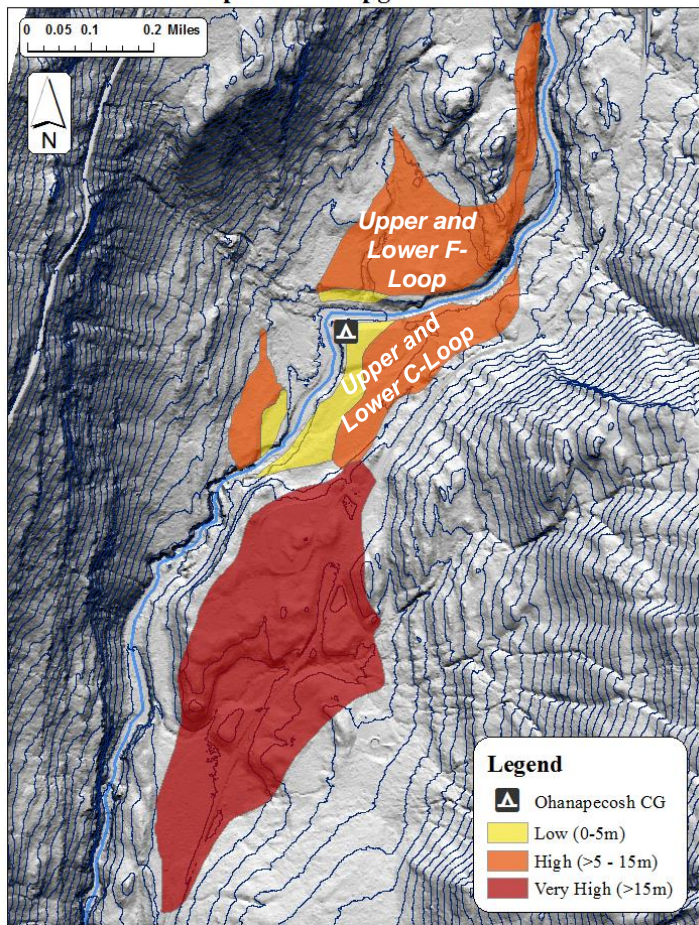
→ 2 with bounding dates

Terrace Name		Terrace Height Relative to River (m)	Height Classification
Ohanapecosh Campground	Upper F-Loop	14	High
	Lower F-Loop	4.5	Low
	Upper C-Loop	11.5	High
	Lower C-Loop	3.5	Low
	Housing	~40	Very High
	Lower West Ohana	~3.5	Low
	Upper West Ohana	~15	High
Secret Camp Region	Upper East SC	~15	High
	Lower West SC	~3.5	Low
	Gifford Pinchot East	~24	Very High
	Gifford Pinchot West	~24	Very High
Blue Hole	Lower BH	5	Low
	Intermediate Hummocky	9	High
	Upper BH	15	High

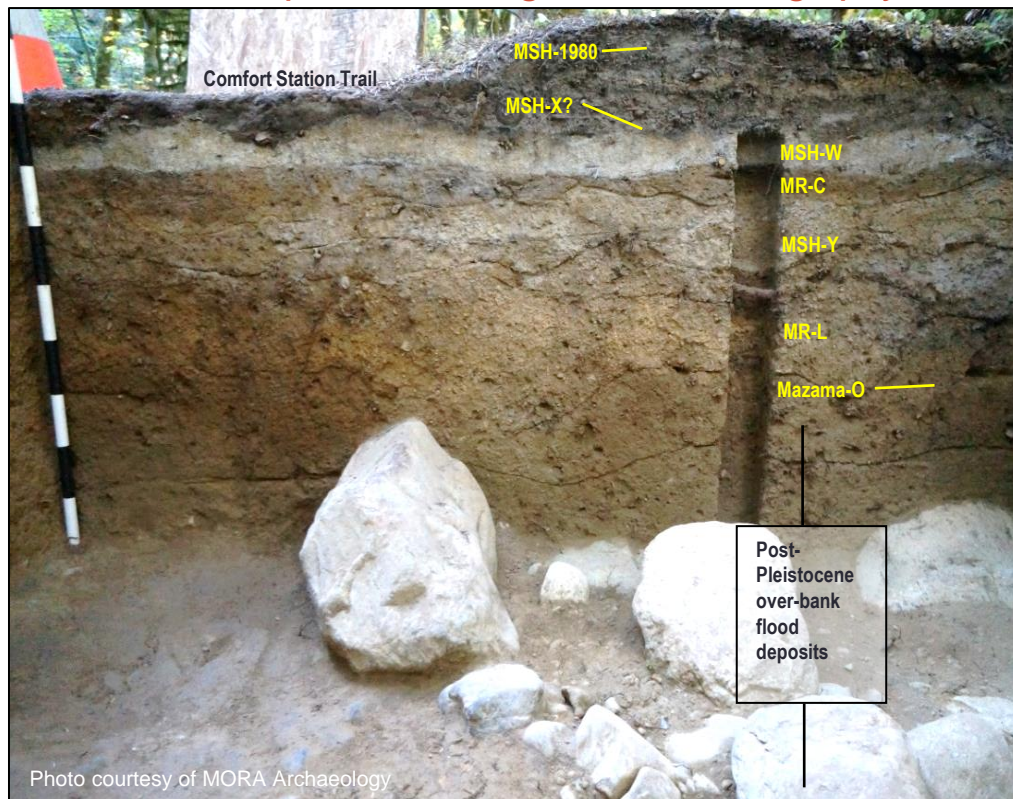


Content may not reflect National Geographic's current map policy.
Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC,
USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P
Corp.

Ohanapecosh Campground Terraces

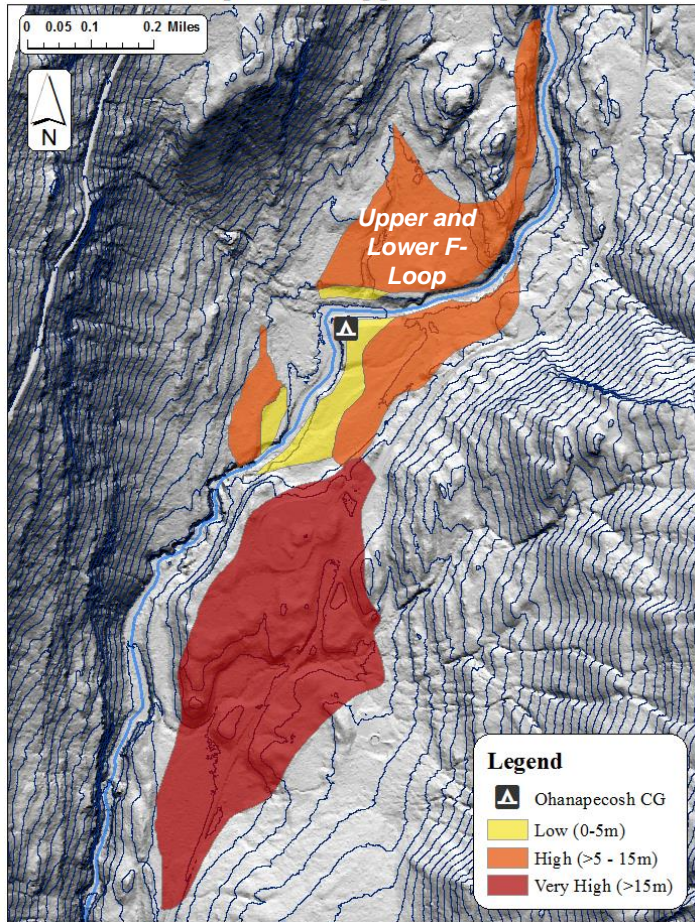


Ohanapecosh CG High Terrace Stratigraphy



- Preserved, dateable tephra layers from known past eruptions
- Terraces with dates 8,000 ya or younger
- Oldest tephra above fluvial deposits → youngest river bed height

Ohanapecosh Campground Terraces



Preliminary Results

Terrace	Height (m)	Oldest Tephra Layer above Fluvial Deposits	Depth to Fluvial Deposits (m)	Paleo River Bed Height (m)
Upper F-Loop	14	Mazama-O 7950 cal. BP	1.4	12.6
Lower F-Loop	4.5	MR-L 7320 cal. BP	0.5	4.0

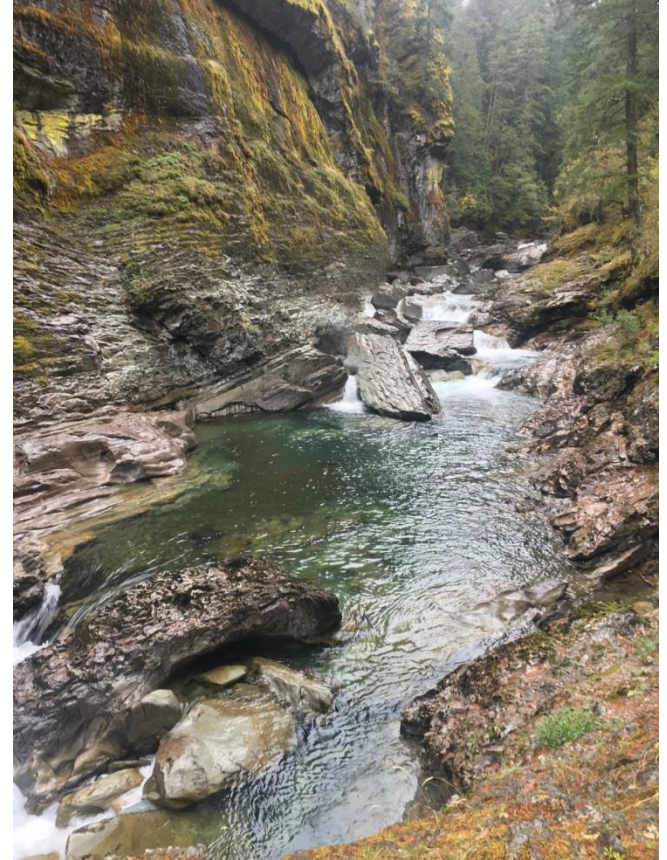
- River incised 8.6m over 630 years
- Since ~7320 ya, incised 4 m
 - Decadal to centennial time scale
 - Current base level established in ~300 years
- Slippery Falls Height: 4 m
 - Exposure began ~7320 ya
 - Impassable after exposed 3.7m, ~7000 ya



Lower F-Loop Terrace

Barrier Exposure → Fish Blockage

- Slippery Falls covered 10,000 to ~7,000 ya → Anadromous fish presence
 - Low spawning habitat quality
 - High proportion of cobble and boulder substrate
 - Turbidity
 - Less likely to imprint on natal stream
 - Little to no harvestable source
- Slippery Falls exposure ~7,000 ya
- Likely no fish 7,000 ya – Present above Slippery Falls
 - Barrier Impassable
- Archaeologic and Ethnographic data supports Geomorphic data



Future Work and Implications

- Established conceptual approach
 - Drivers → Landscape Response
- Need for more data
 - Date additional terraces
 - Bounded dates at Blue Hole
 - Further investigating other drivers
 - Lahars, mass wasting



South Puyallup River, Photo by April Kelly

Acknowledgements



*Paul Kennard &
MORA Geomorf crew*

*MORA and USFS
Archaeologists (Ben
Diaz, Greg Burtchard
and Rick McClure)*



Thank you! Questions?

FISHTRUCK
ACCESS
ONLY

NO TRESPASSING
VIOLATORS
PROSECUTED FOR
CRIMINAL TRESPASS