Floodplains, Salmon, and Climate Change in the Skagit River Watershed

Ed Connor (SCL) and Jon Riedel (NPS)

SC^2 Workshop - October 2012

SC^2 SKAGIT CLIMATE SCIENCE CONSORTIUM

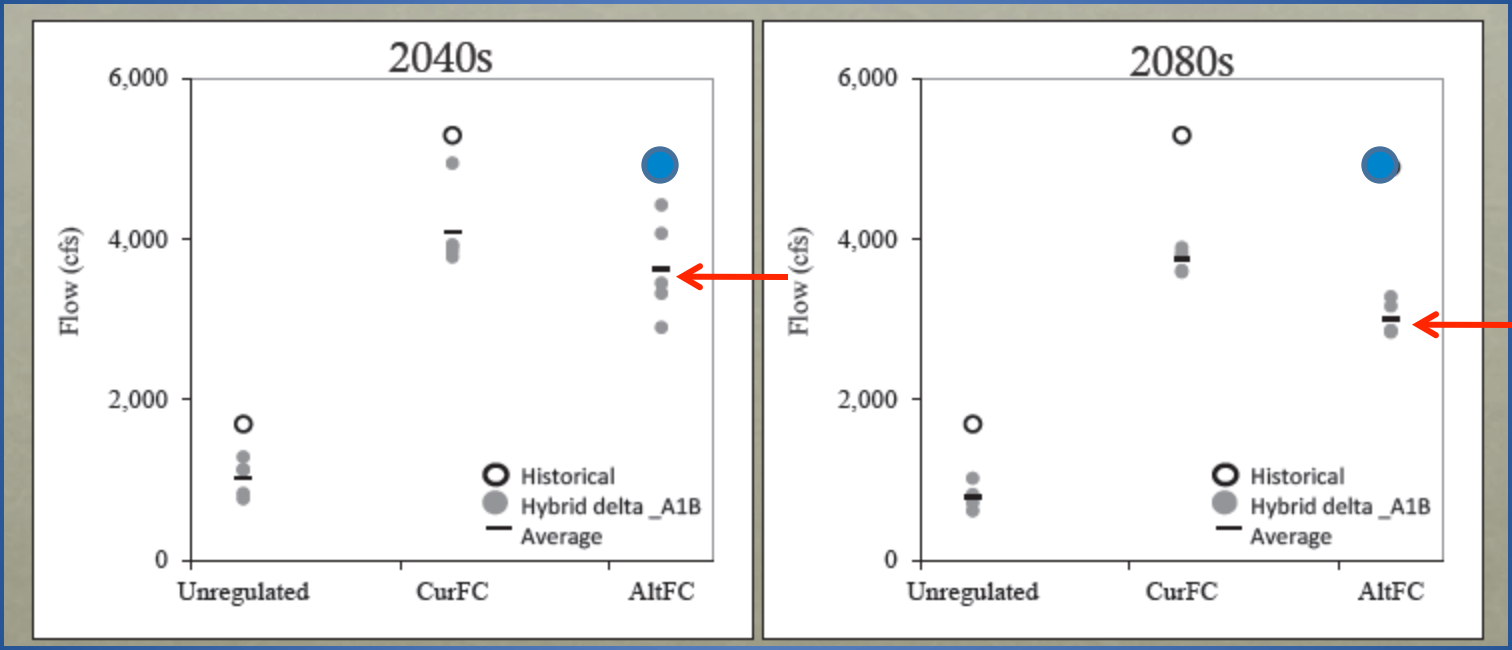
Outline for Floodplain Discussion

I – Revisit flow issues introduced by Alan (Jon)

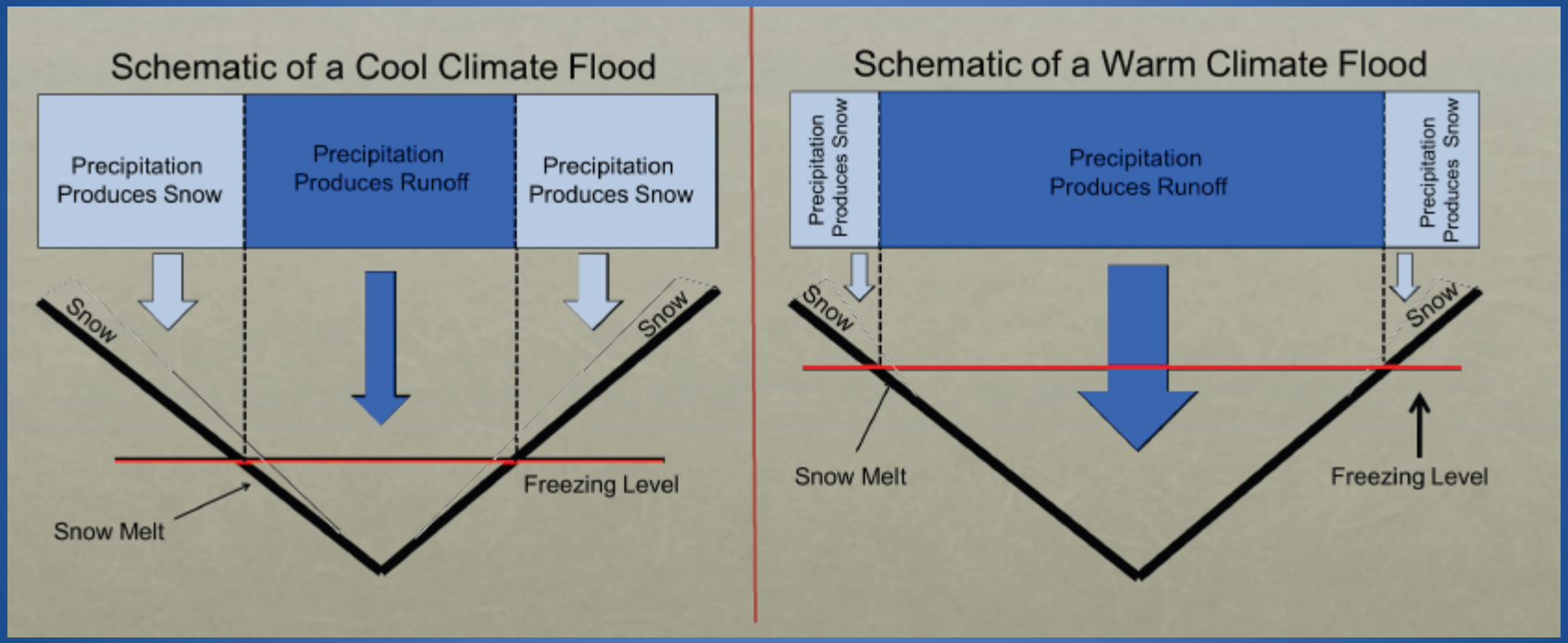
II- Geologic Considerations on Low Flow (Jon)
- A. Glaciers (watershed scale)
- B. Surficial Geology (main stem lower Skagit)

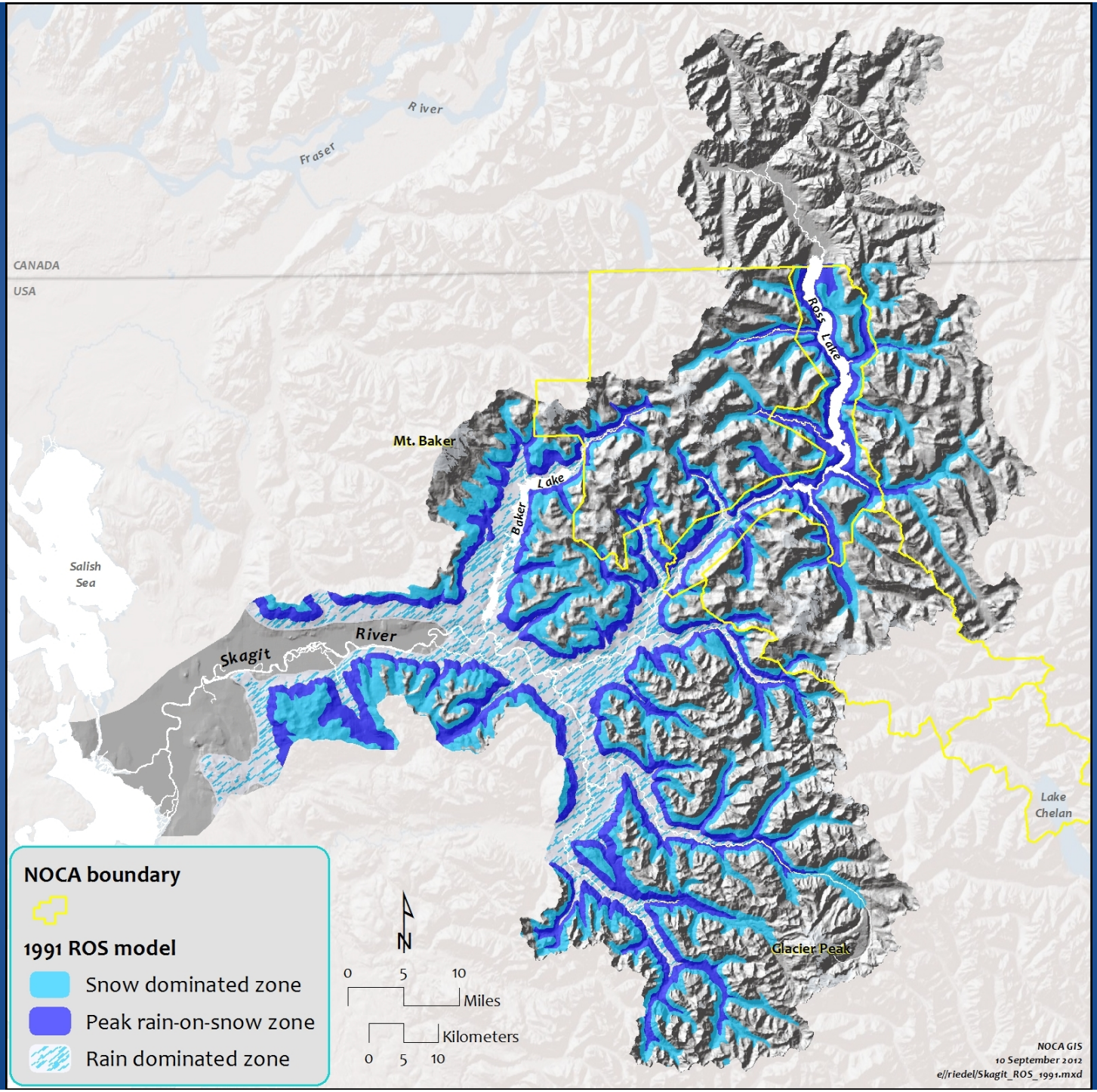
III- Climate Change Impacts to Salmonid Habitat (Ed)
- A. Peak Flow Conditions
- B. Low Flow Conditions

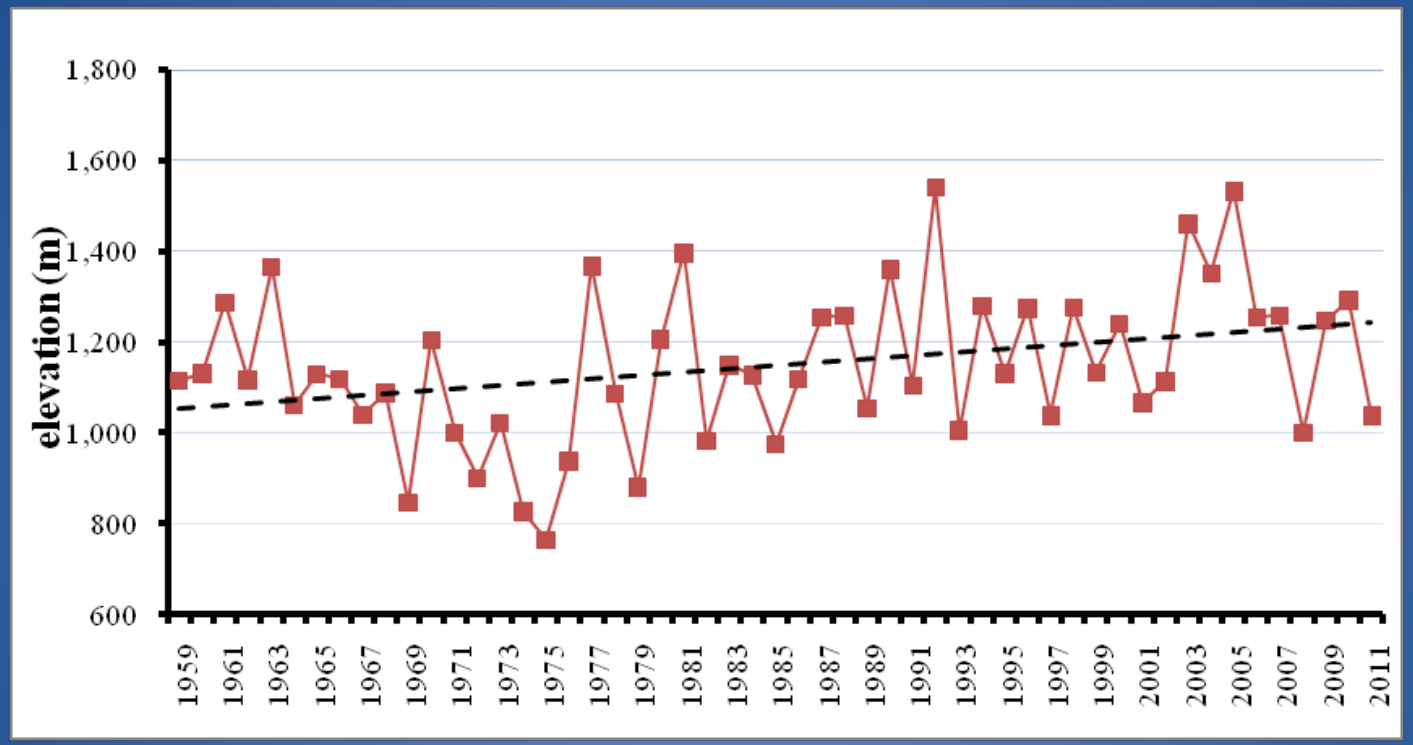
Climate warming reduces low flows under natural or regulated conditions.



Changing Snowline and Effective Basin Area

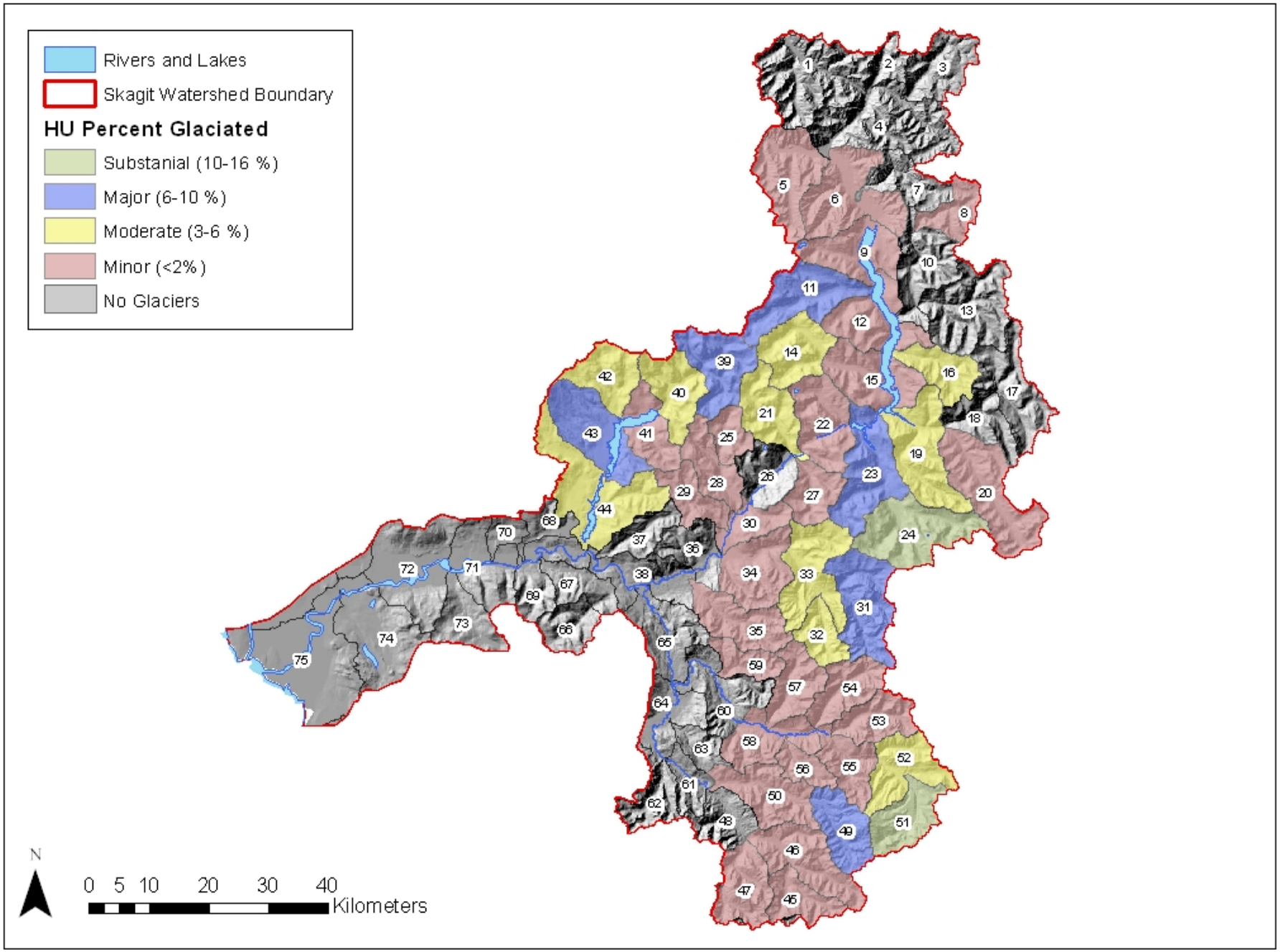


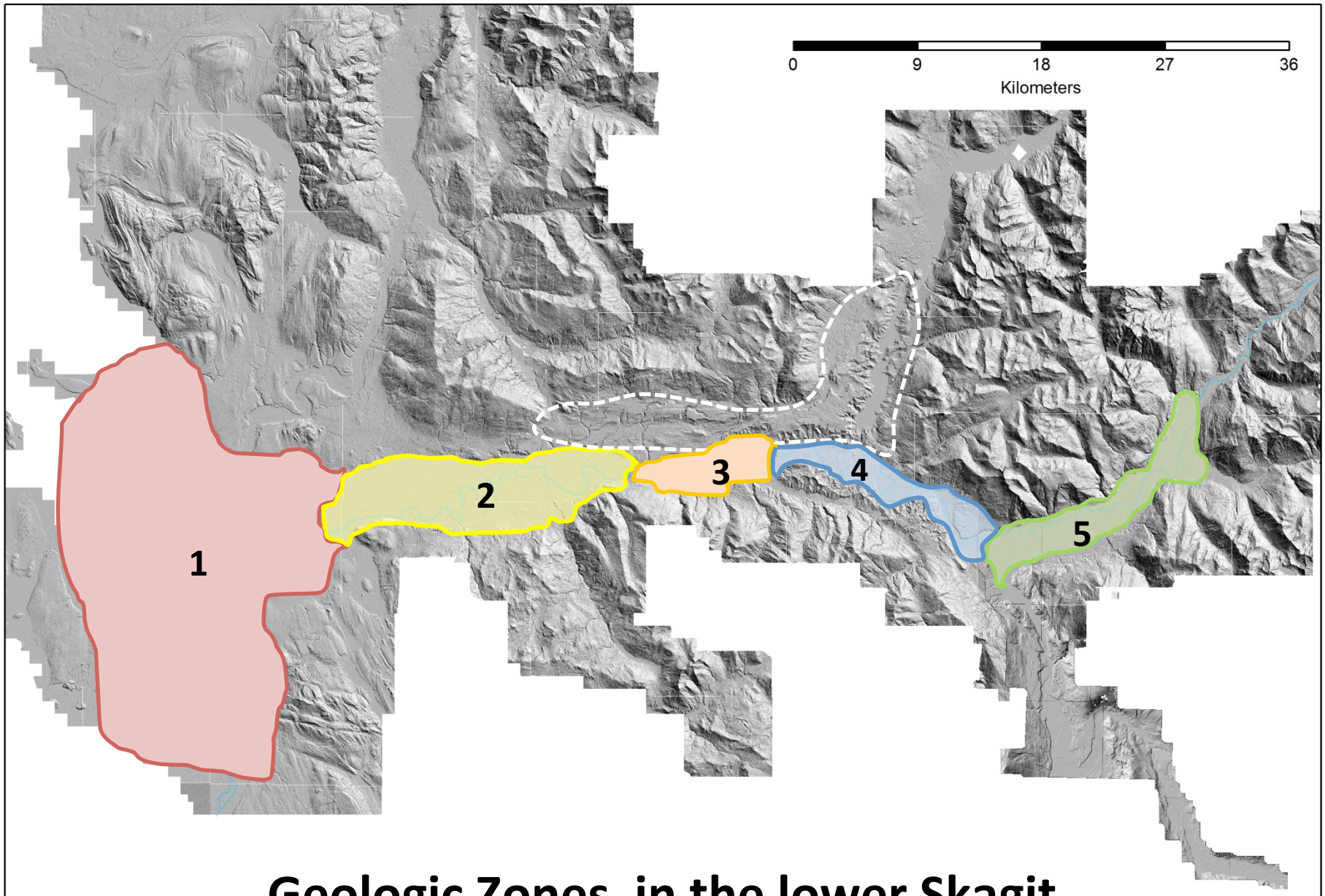

Fraser River
CANADA
USA
Ross Lake
Mt. Baker
Baker Lake
Salish Sea
Skagit River
Lake Chelan
Glacier Peak
NOCA boundary
1991 ROS model
Snow dominated zone
Peak rain-on-snow zone
Rain dominated zone
N
0 5 10
Miles
Kilometers
0 5 10
NOCA GIS
10 September 2012
e//riedel/Skagit_ROS_1991.mxd



Average winter (November-April) elevation of the freezing level in the North Cascades. Dashed line is trend, which has risen ~200m since 1959 (NOAA, 2012).

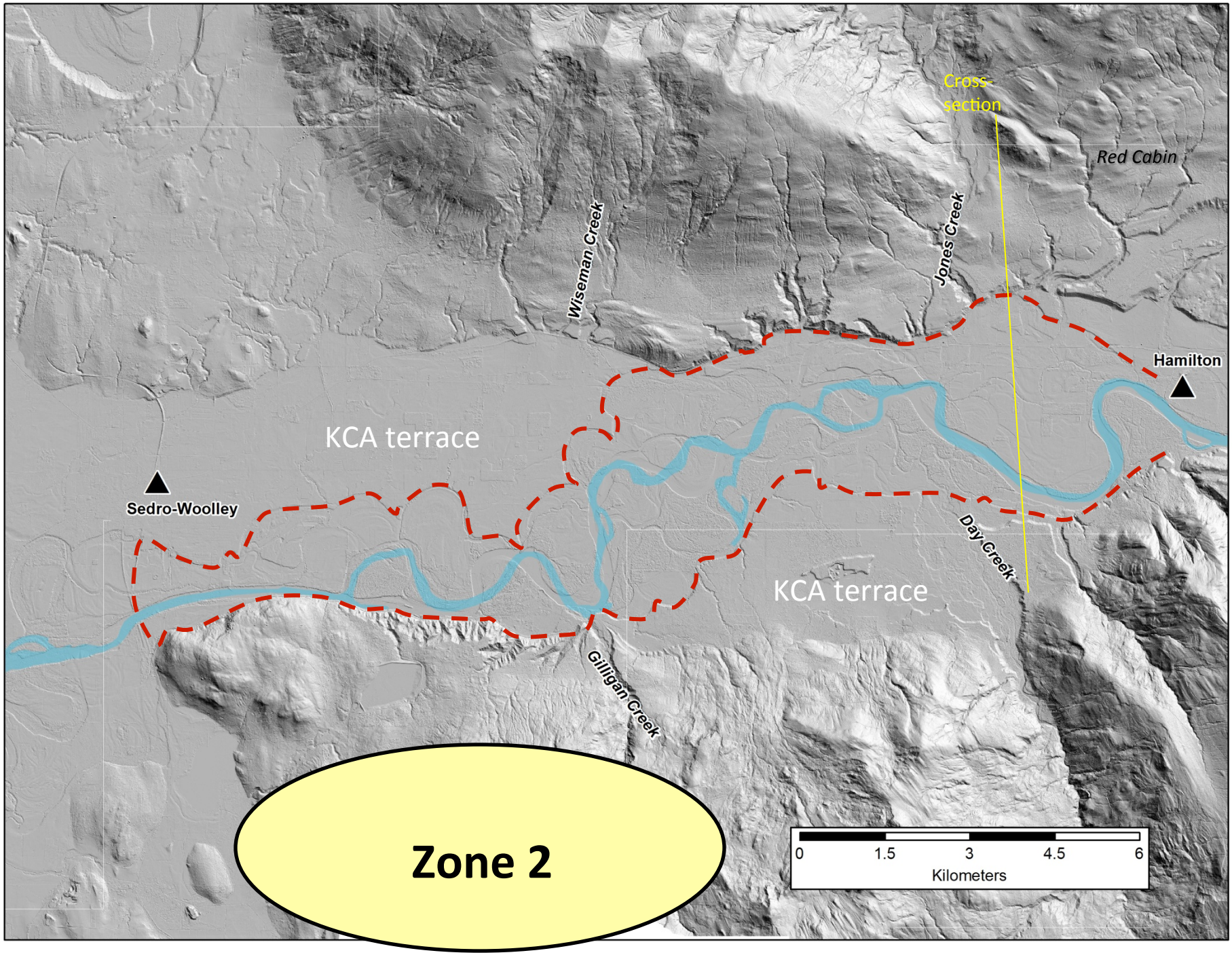
Part II – Geologic Factors

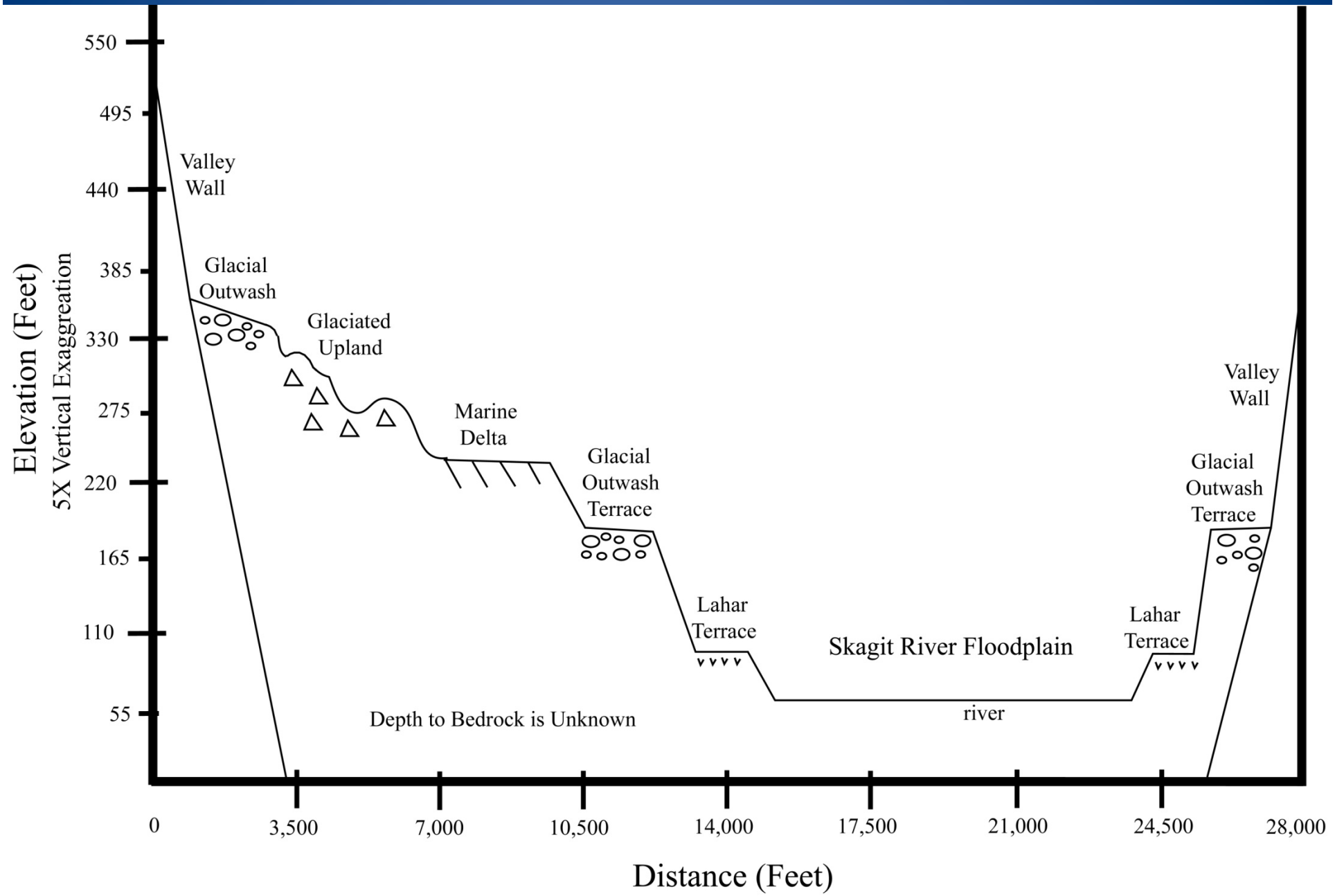

Rivers and Lakes
Skagit Watershed Boundary
HU Percent Glaciated
Substanial (10-16 %)
Major (6-10 %)
Moderate (3-6 %)
Minor (<2%)
No Glaciers
N
0 5 10 20 30 40
Kilometers



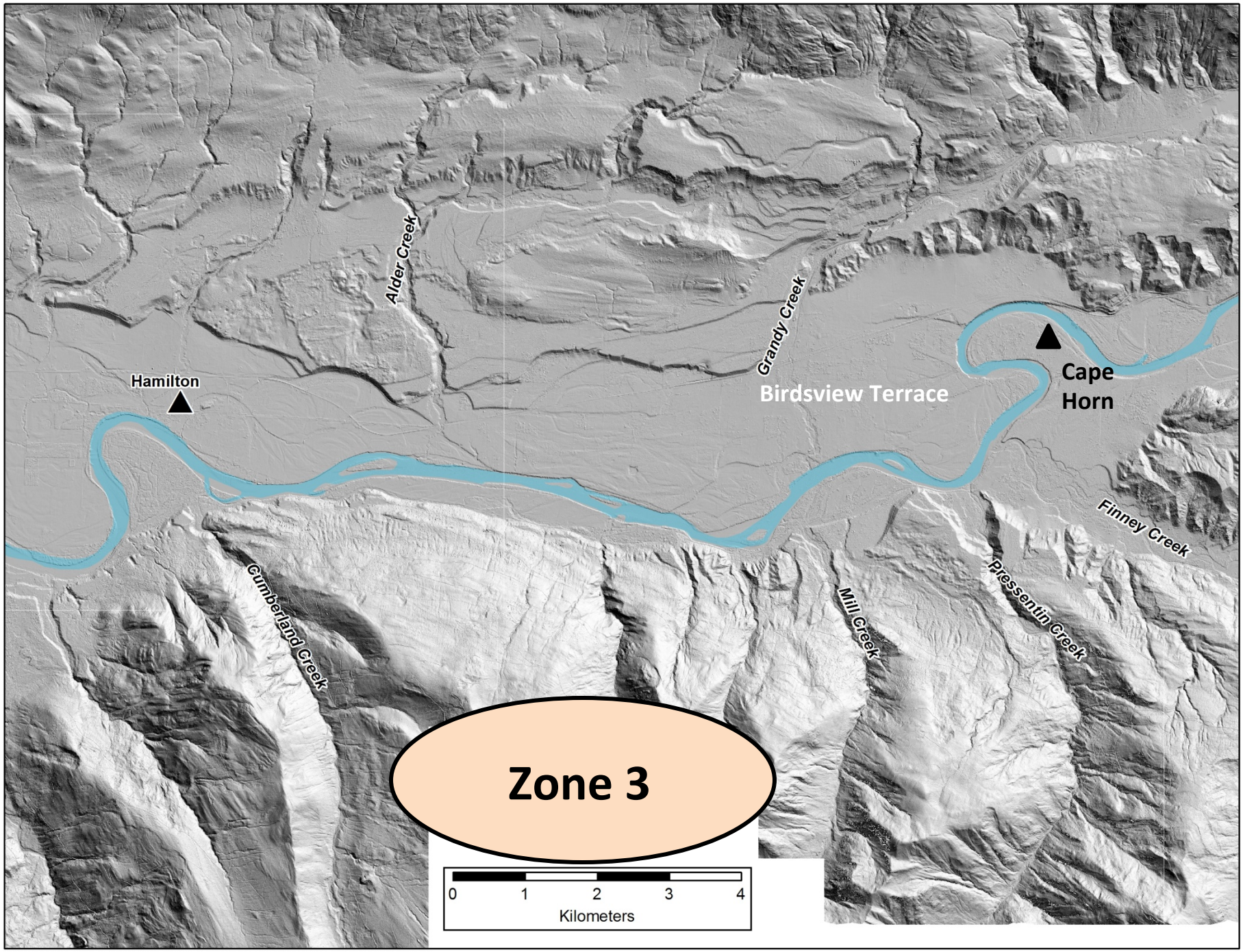
Geologic Zones in the lower Skagit
Zones 2-3-4 ‘ middle’ Skagit

	Zone 1 Delta	Zone 2 – Sedro Woolley-Hamilton	Zone 3 - Hamilton – Cape Horn	Zone 4 – Cape Horn – Rockport	Zone 5 - Rockport-Marblemount
Precipitation	25-30''	35-50''	50-60''	60-70''	70-85''
Evapotranspiration – Regional	~20%	~20%	~20%	~20%	~20%
Effective ppt.	20-25"	25-40"	40-50"	50-65"	65-75"
Maximum Floodplain Width	Wide (unconfined)	~4.5 miles	~3.5 miles	~ 1 mile	2 miles
Surficial Geology	Alluvium , lahar sand, marine silt and clay	Alluvium and lahar sands on low terraces , exstensive high glacial outwash terraces.	Wide Birdsview terrace and Extensive high glacial outwash terraces.	High glacial otuwash, lake, and ice-deposited terraces on both sides of the river	Coarse alluvium with broad, terraces
Main Soils	Skagit, Sumas, Field	Larush, Pilchuck, Minkler	Giles, Larush, Gilligan, Wickersham	Kline, Birdsview, Barneston	Barneston, Indianola
Hydrogeology	Low groundwater input – -Aquitards (Olympic non glacial beds?)	High groundwater input from glacial terraces to north	High groundwater input from north -Two silt clay units	Moderate groundwater Input -Glacial Lake Concrete silt-clay at surface	Moderate groundwater Input -Glacial Lake Concrete silt-clay at depth
Soil Permeability	Low	Moderate – high	Moderate – high	High	High
Porosity	High	High	High	Medium	Medium

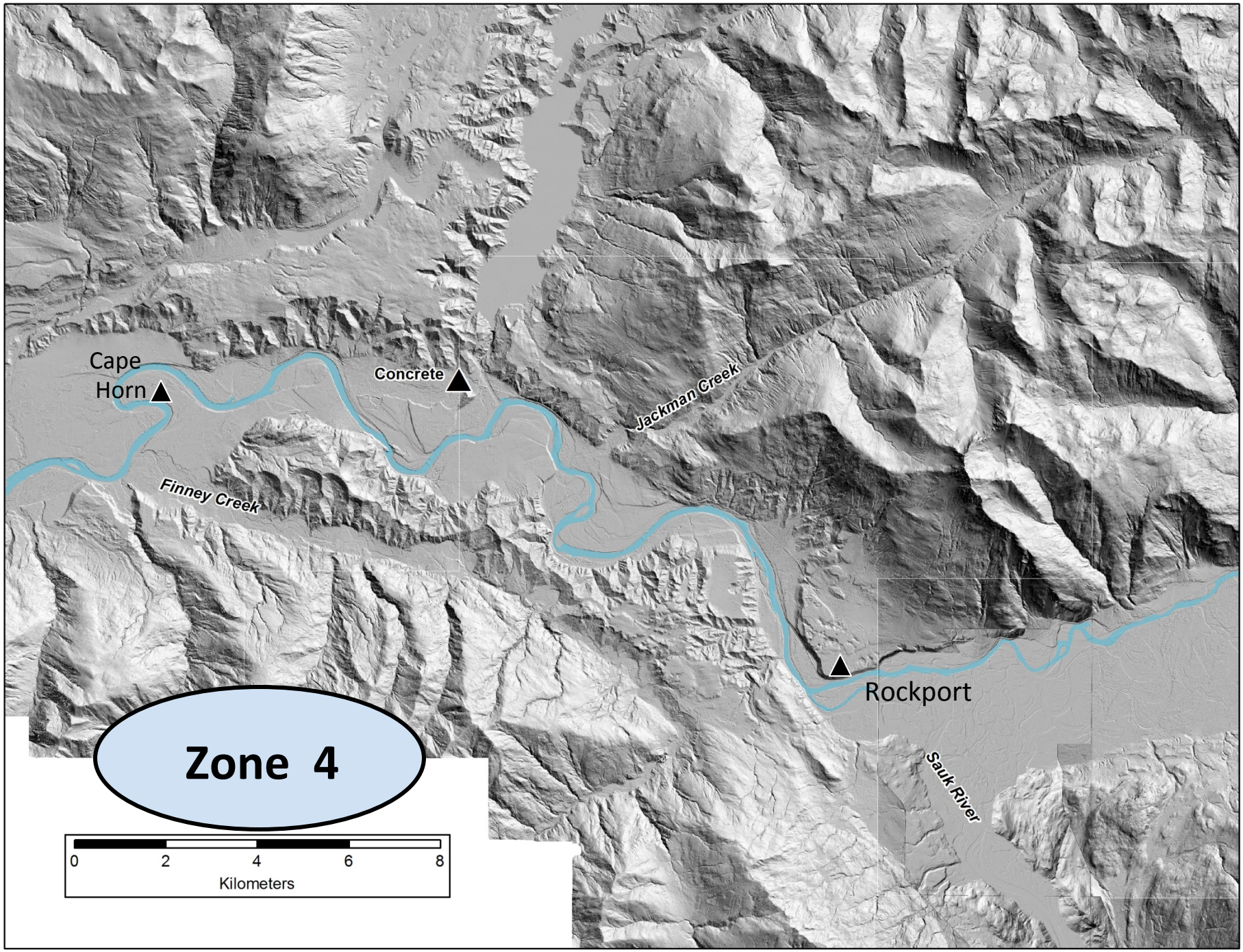

Cross-section
Red Cabin
Wiseman Creek
Jones Creek
Hamilton
KCA terrace
Sedro-Woolley
Day Creek
KCA terrace
Gilligan Creek
Zone 2
0
1.5
3
4.5
6
Kilometers

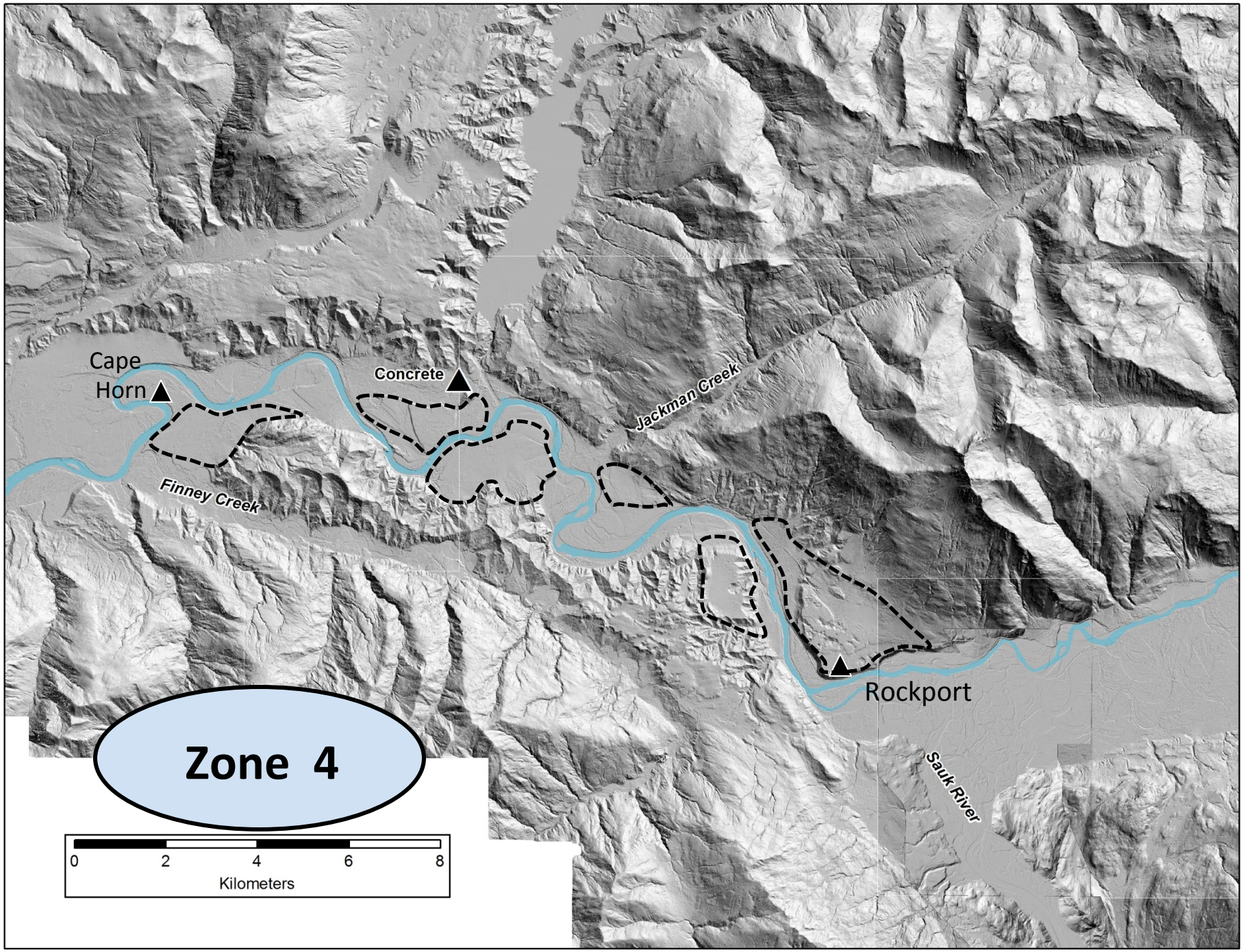

Elevation (Feet)
5X Vertical Exaggreation
550
495
440
385
330
275
220
165
110
55
Valley Wall
Glacial Outwash
Glaciated Upland
Marine Delta
Glacial Outwash Terrace
Lahar Terrace
Skagit River Floodplain
river
Lahar Terrace
Glacial Outwash Terrace
Valley Wall
Depth to Bedrock is Unknown
0
3,500
7,000
10,500
14,000
17,500
21,000
24,500
28,000
Distance (Feet)

Mount Josephine from Skagit valley – photo by Scurlock

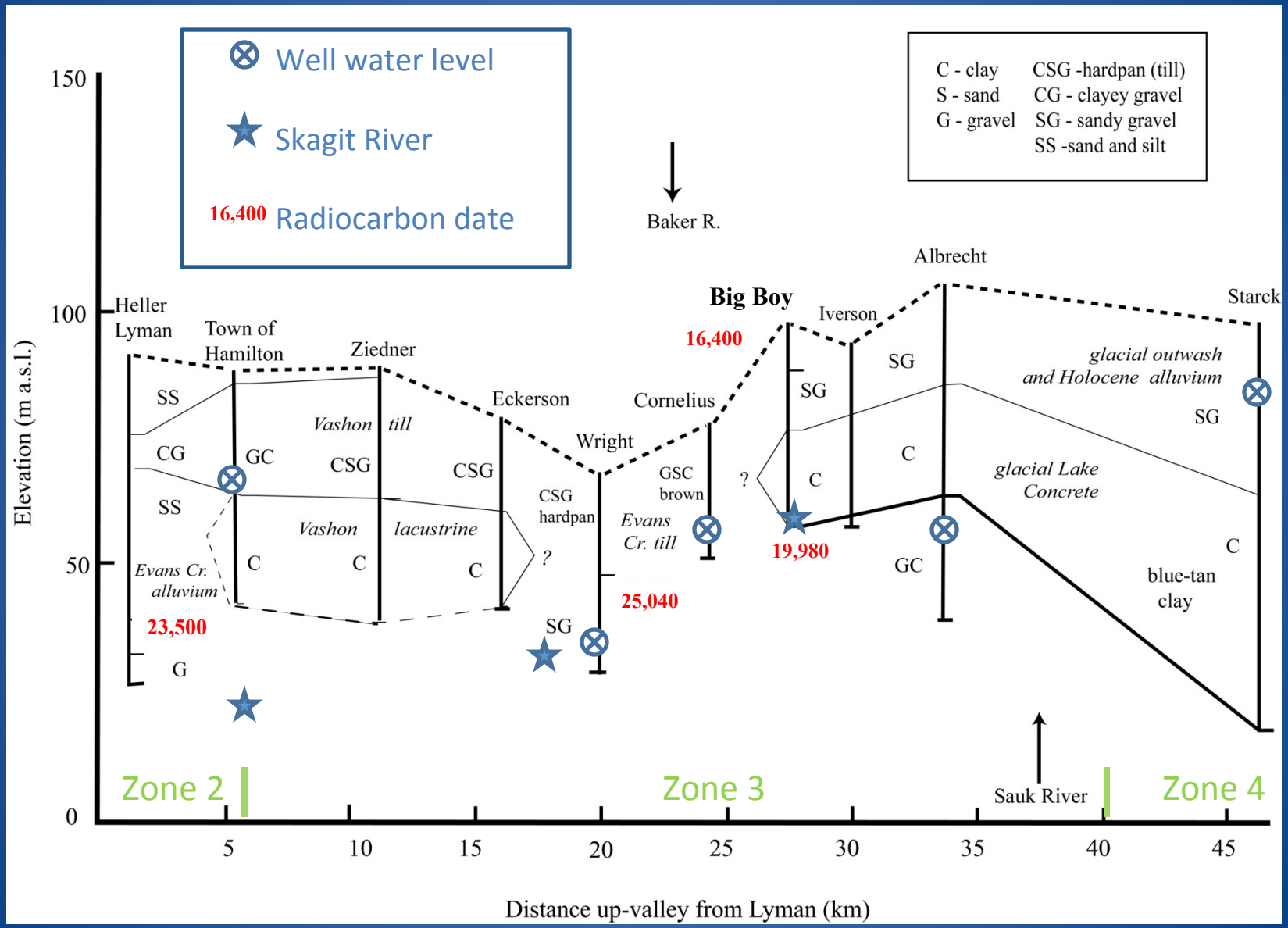

Hamilton
Alder Creek
Grandy Creek
Birdsview Terrace
Cape
Horn
Finney Creek
Pressentin Creek
Mill Creek
Cumberland Creek
Zone 3
0
1
2
3
4
Kilometers


Skagit River


Cape
Horn
Concrete
Jackman Creek
Finney Creek
Rockport
Sauk River
Zone 4
0
2
4
6
8
Kilometers


Cape
Horn
Concrete
Jackman Creek
Finney Creek
Rockport
Sauk River
Zone 4
0
2
4
6
8
Kilometers

Subsurface Geology of Lower Skagit Valley from Well Logs



Part III- Climate Change Impacts to Salmonid Habitat

Juvenile Salmonid Freshwater Habitat Requirements

- Low velocities, which are found along edges of mainstem river, side channels, off-channel habitats, and tributaries
- Abundant habitat cover including cobbles, boulders, wood, and vegetation
- Cool water temperatures
- Abundant invertebrate food supply

Skagit Watershed Council's Middle Skagit Initiative

SRFB 08-2132

John Scurlock

Skagit Watershed Council

Plan for Habitat Protection and Restoration in the Middle Reach of the Skagit River

Strategies, Treatments, and Priorities

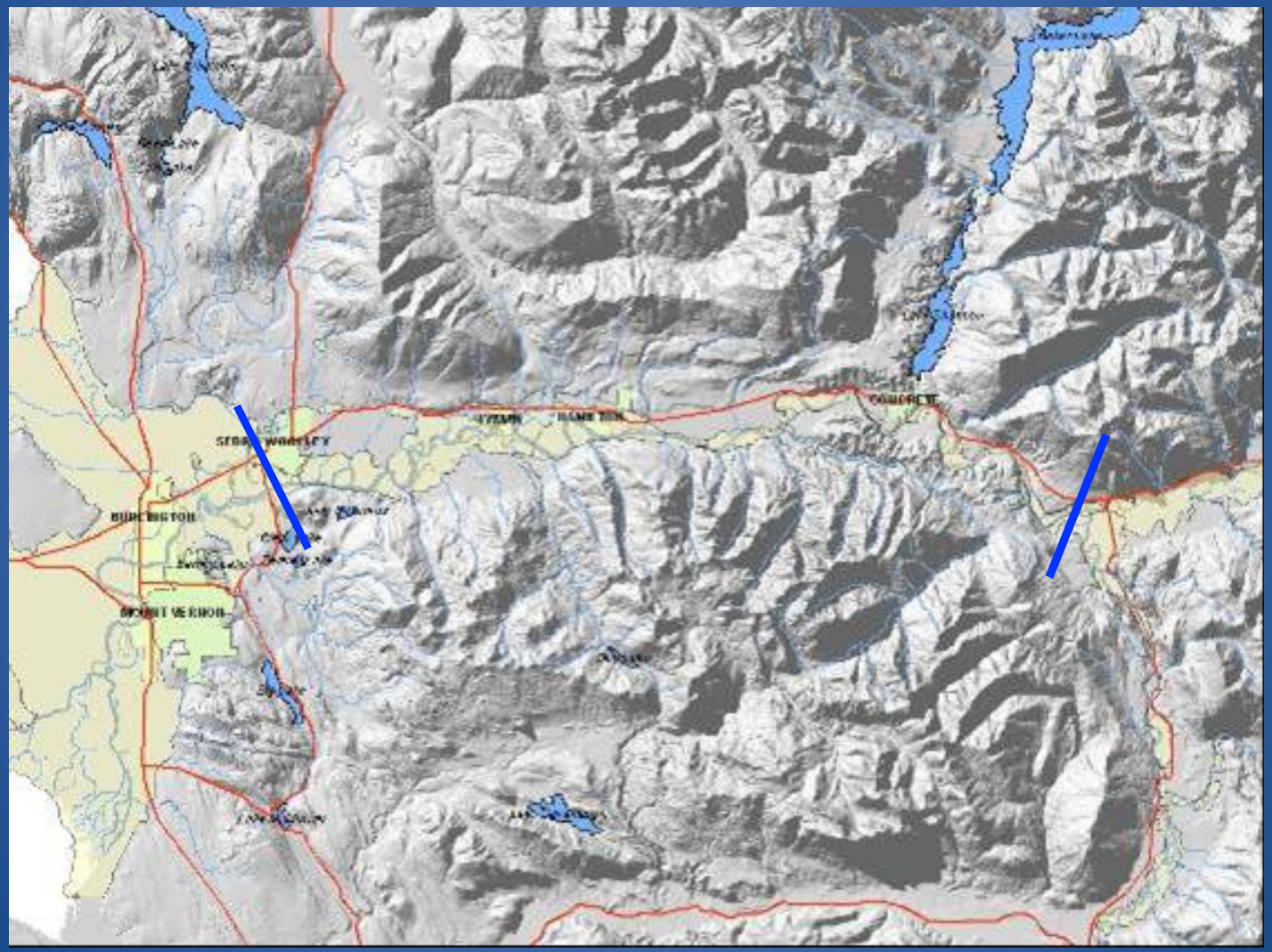
July 13, 2011

http://www.skagitwatershed.org/Our-Work/Middle-Skagit-Initiative.aspx

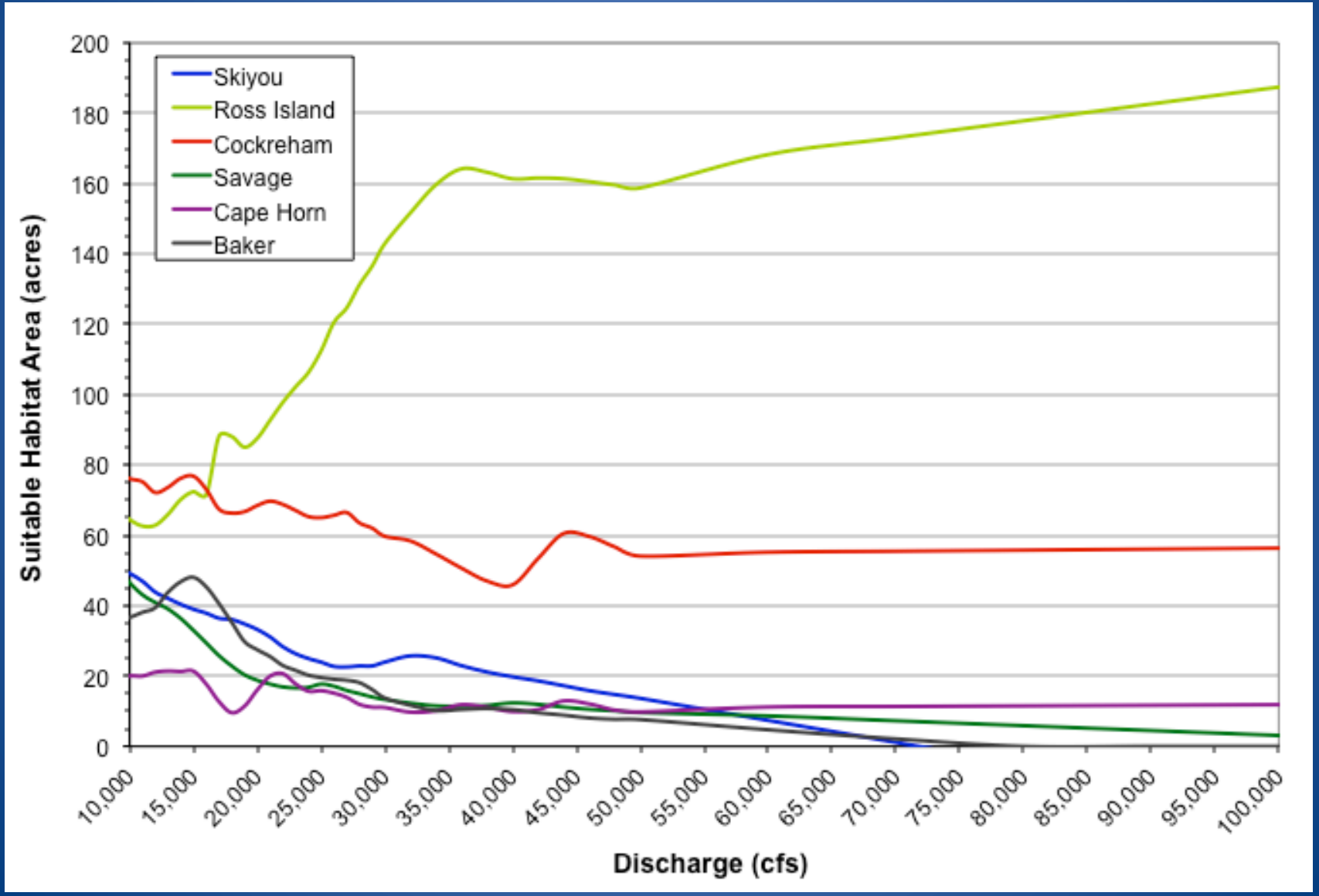
Habitat Restoration and Protection Issues in the Middle Skagit Habitat (zones 2-4)

- Juvenile rearing habitat is intrinsically scarce due to the large size of the Skagit River
- High flows compress low velocity areas in mainstem river to narrow “habitat bands”
- Habitat compression is increased by hydromodifications, including levees and roads, that narrow river channel and floodplain
- Fish typically move into off channel habitats areas or seek cover under wood, cobbles, and boulders during peak flows
- Many of the off-channel areas have become disconnected from the mainstem river

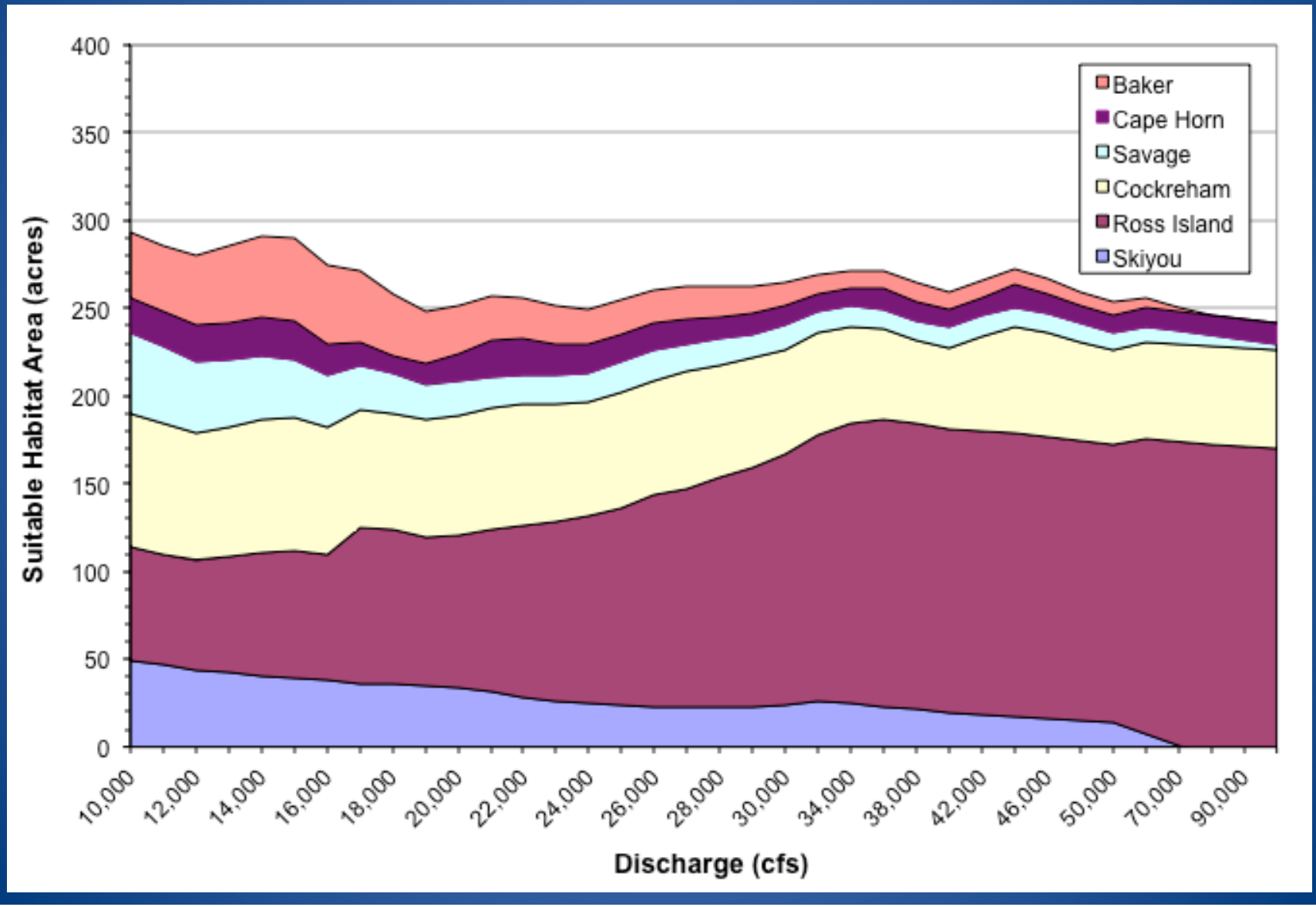
Middle Skagit Initiative Study Area



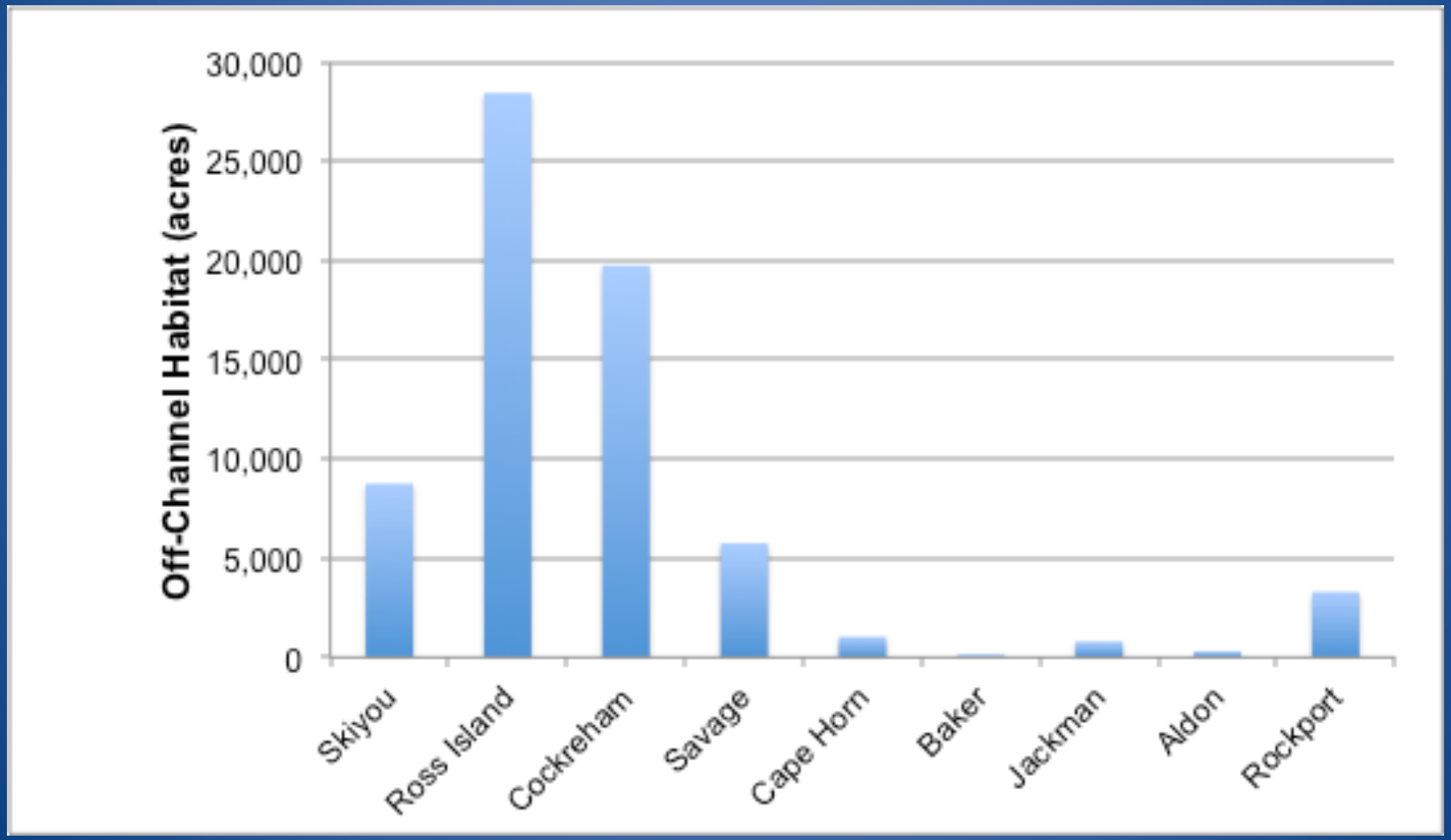
Juvenile Chinook Habitat versus Flow: Middle Skagit River Reaches



Total Juvenile Chinook Rearing Habitat versus Flow: Middle Skagit

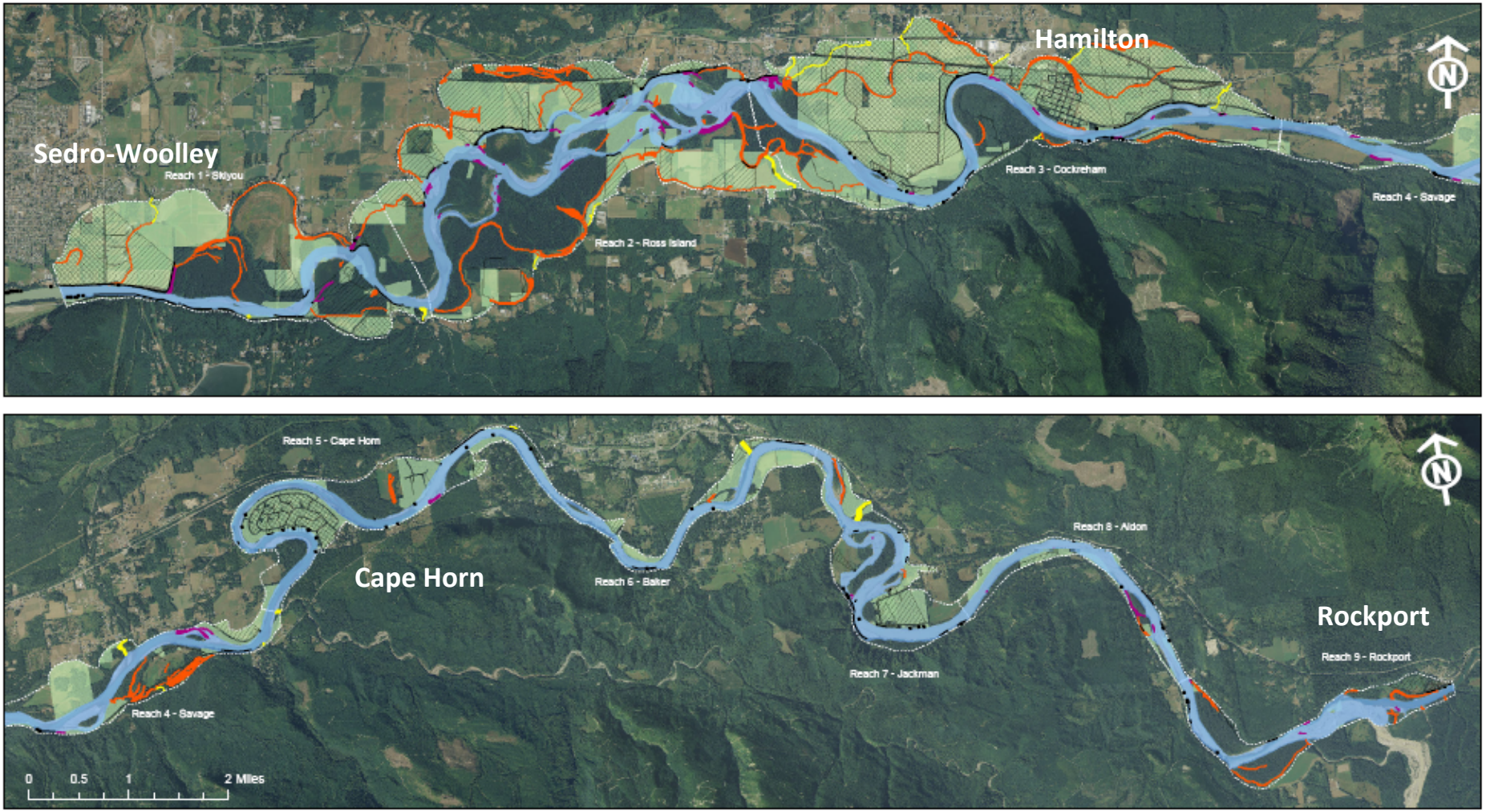


Off-Channel Habitat Area among Middle Skagit Reaches



Data source: SRSC 2011

Habitat in Zones 2 (top) and 4 in the Middle Skagit

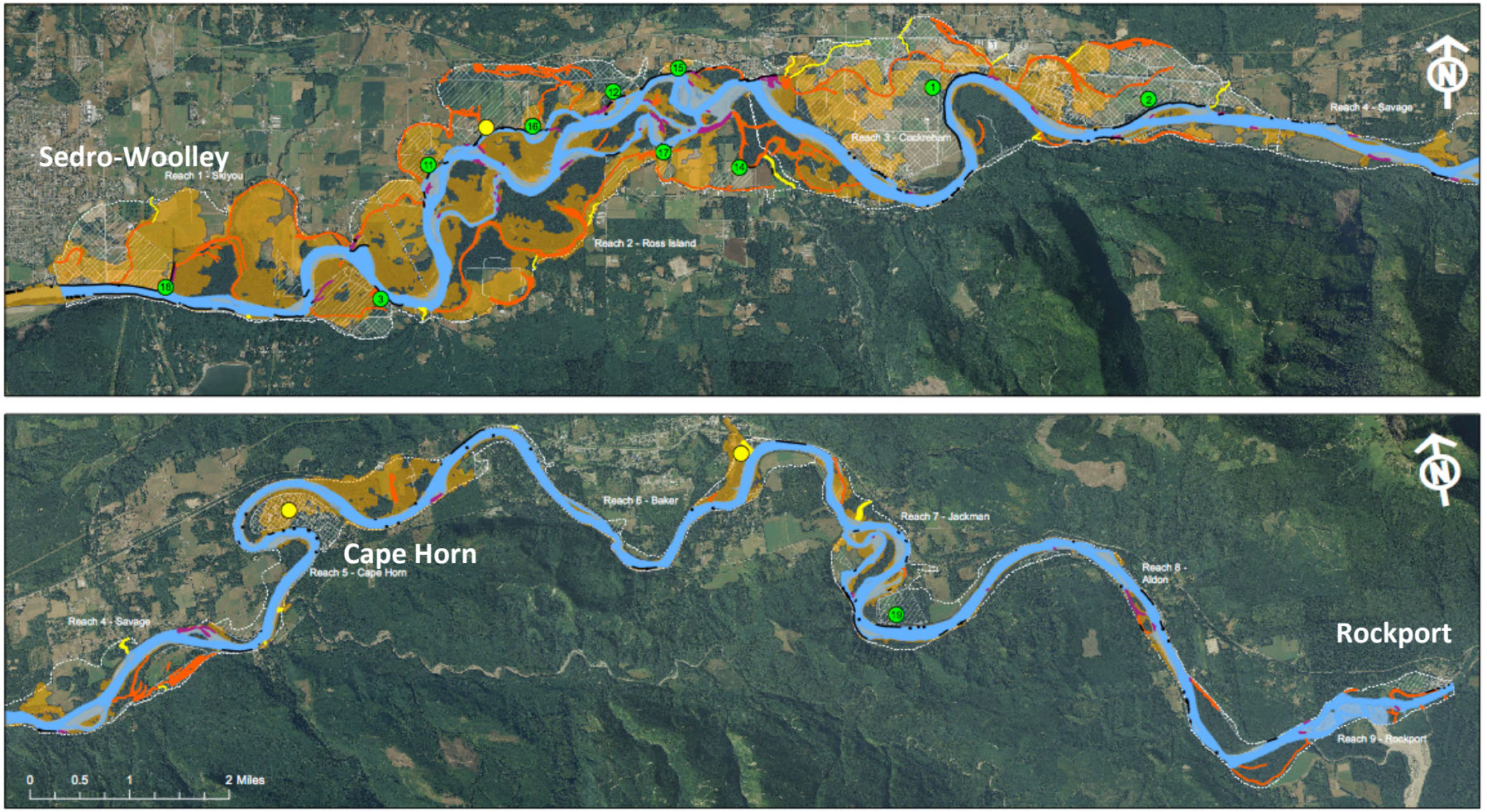


Map 1: Priority areas for protection of high quality habitats

- Backwater habitat
- Off-channel habitat
- Tributary habitat
- Unprotected areas
- River channel
- Hydromodifications (i.e. riprap, levees)
- Isolated habitat
- Shadowed habitat
- Project area

SKAGIT WATERSHED COUNCIL
A Community Partnership for Salmon

Floodplain Restoration in Zones 2 (top) and 4 in the Middle Skagit

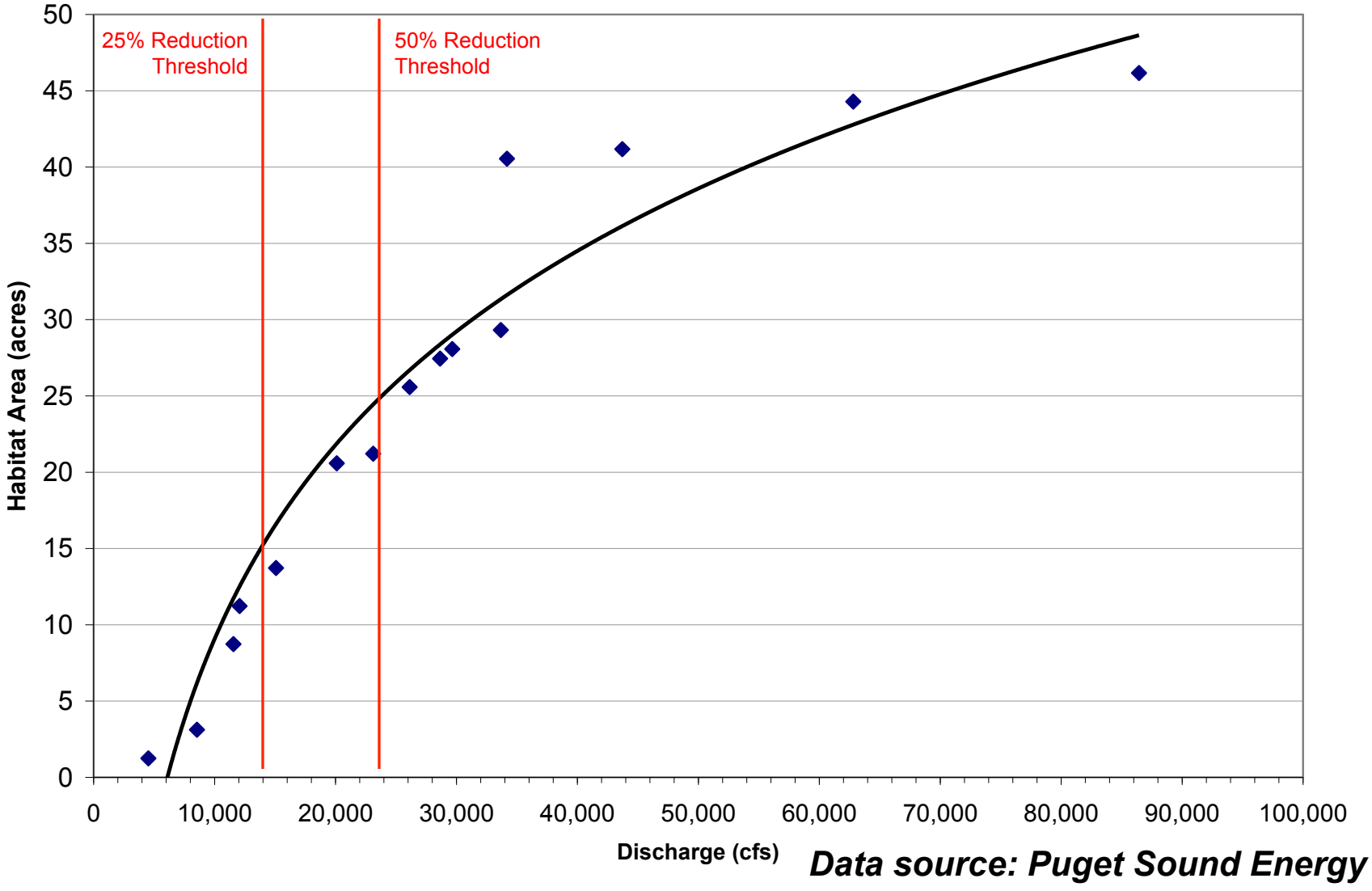


Map 4: Priority restoration sites for restoring floodplain habitat-forming processes

- Identified priority restoration site
- Non-priority site
- Backwater habitat
- Off-channel habitat
- Tributary habitat
- River channel
- Hydromodifications (i.e. riprap, levees)
- Isolated habitat
- Shadowed habitat
- Existing 2 year flow
- Project area

SKAGIT WATERSHED COUNCIL
A Community Partnership for Salmon

Middle Skagit Side Floodplain Channel Area versus Discharge



Data source: Puget Sound Energy

Reach Level Habitat Quality: Highest to Lowest

- *Ross Island* – Complex multiple channel habitat located in broad intact floodplain
- *Cockreham* – Complex channel in broad floodplain with major hydromodifications
- *Skiyou Slough* – Complex channel in floodplain constrained by levees
- *Savage* – Single mainstem channel situated in transition area between unconstrained and constrained valley sections
- *Jackman* – Multi-channel habitat that is moderately confined by high glacial terraces
- *Rockport* – Moderately confined channel with wide gravel bars
- *Baker* – Single mainstem channel that is tightly confined by glacial terraces and bedrock
- *Cape Horn* – Single sinuous channel in moderately confined reach
- *Aldon* – Narrow channel with floodplain tightly confined by glacial terraces

Off-Channel Areas Provides Critical Refuge Habitat to Salmonids

- Refuge from high velocities
- Protection from moving bedload that can displace and crush fish
- Groundwater provides cool water temperatures during warm periods, and hydraulic barrier to high suspendedsediment loads
- Typically provides excellent growth habitat for juveniles fish during periods of poor growth in mainstem river

Stream and River Temperature Responses to Climate Change in Skagit

Seattle City Light Climate Change Analysis

Prepared for The City of Seattle, Seattle City Light

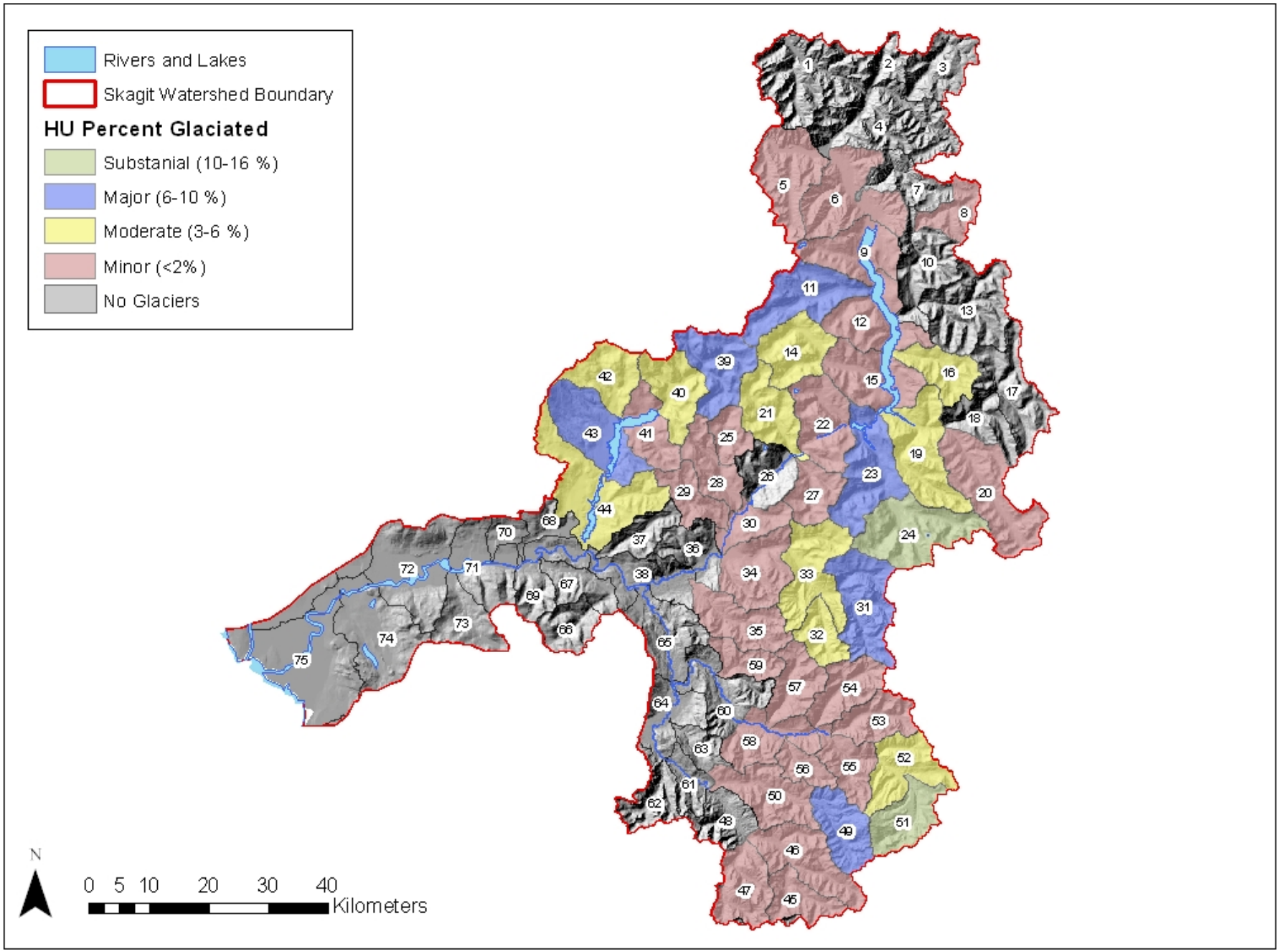
Prepared by The Climate Impacts Group,
Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Ocean, University of Washington

June 2010

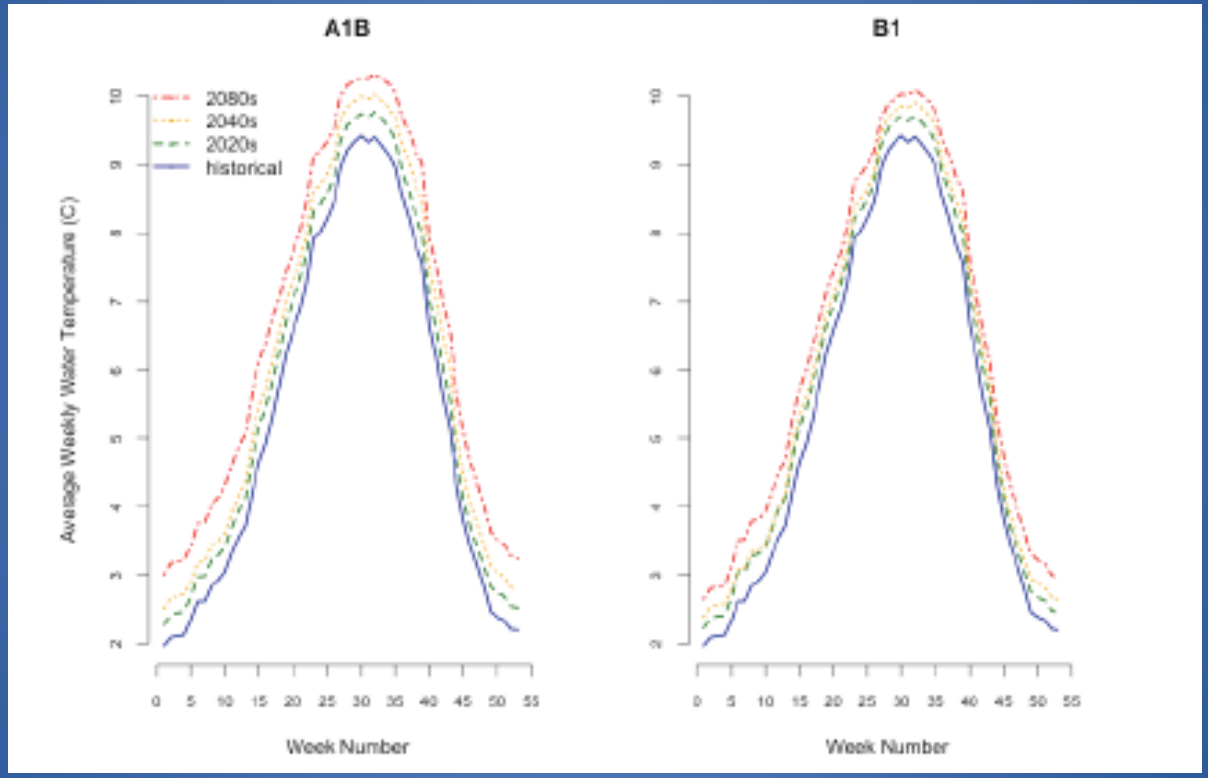
Contributing authors and researchers
(in alphabetical order):

Alan F. Hamlet[1,2]
Se-Yeun Lee[2]
Nathan J. Mantua[1,3]
Eric P Salathé, Jr[1,4]
Amy K. Snover[1]
Rick Steed[4]
Ingrid Tohver[1]

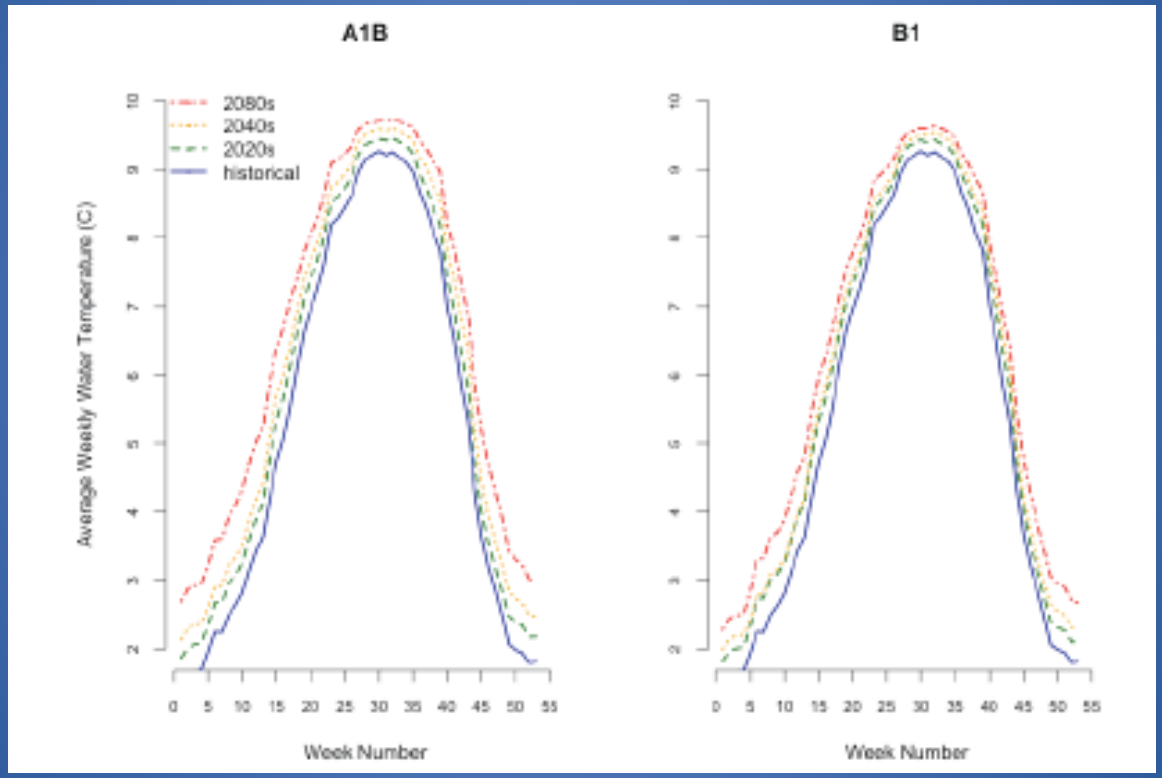
http://cses.washington.edu/db/pdf/snoveretalscl709.pdf


Rivers and Lakes
Skagit Watershed Boundary
HU Percent Glaciated
Substanial (10-16 %)
Major (6-10 %)
Moderate (3-6 %)
Minor (<2%)
No Glaciers
N
0 5 10 20 30 40
Kilometers

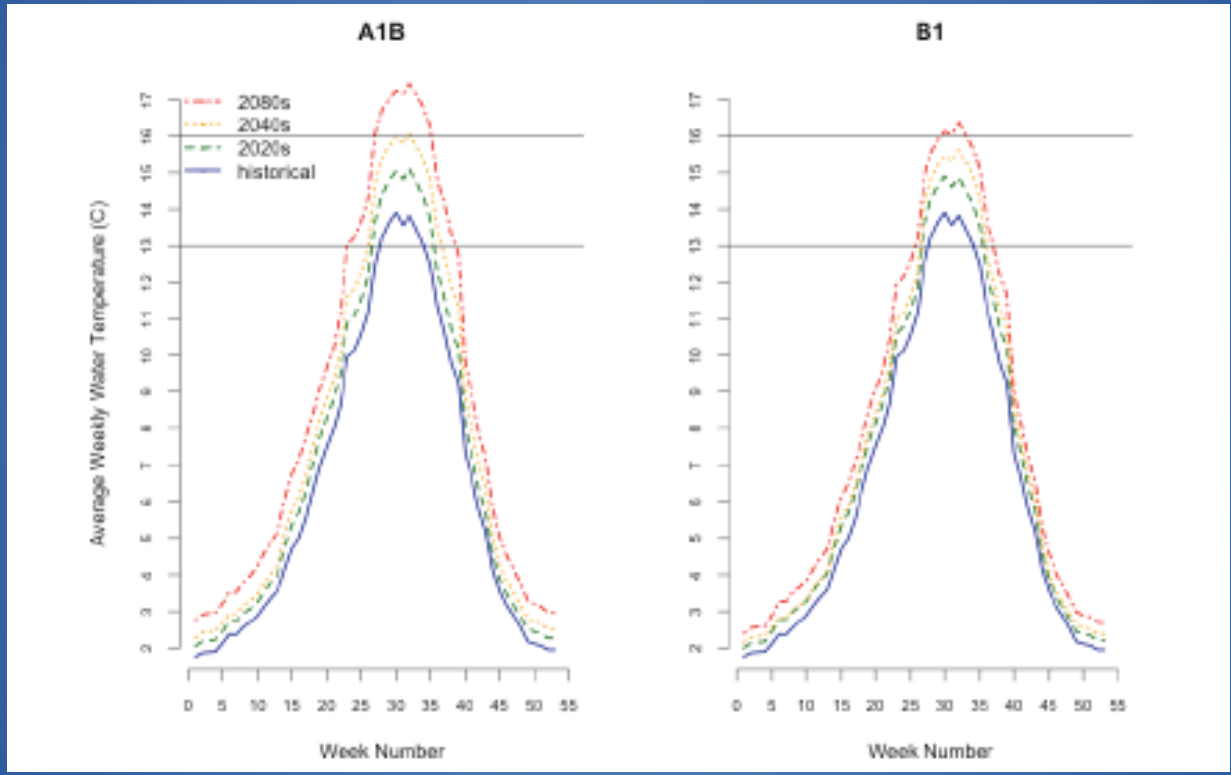
Big Beaver Creek: Glacial Watershed



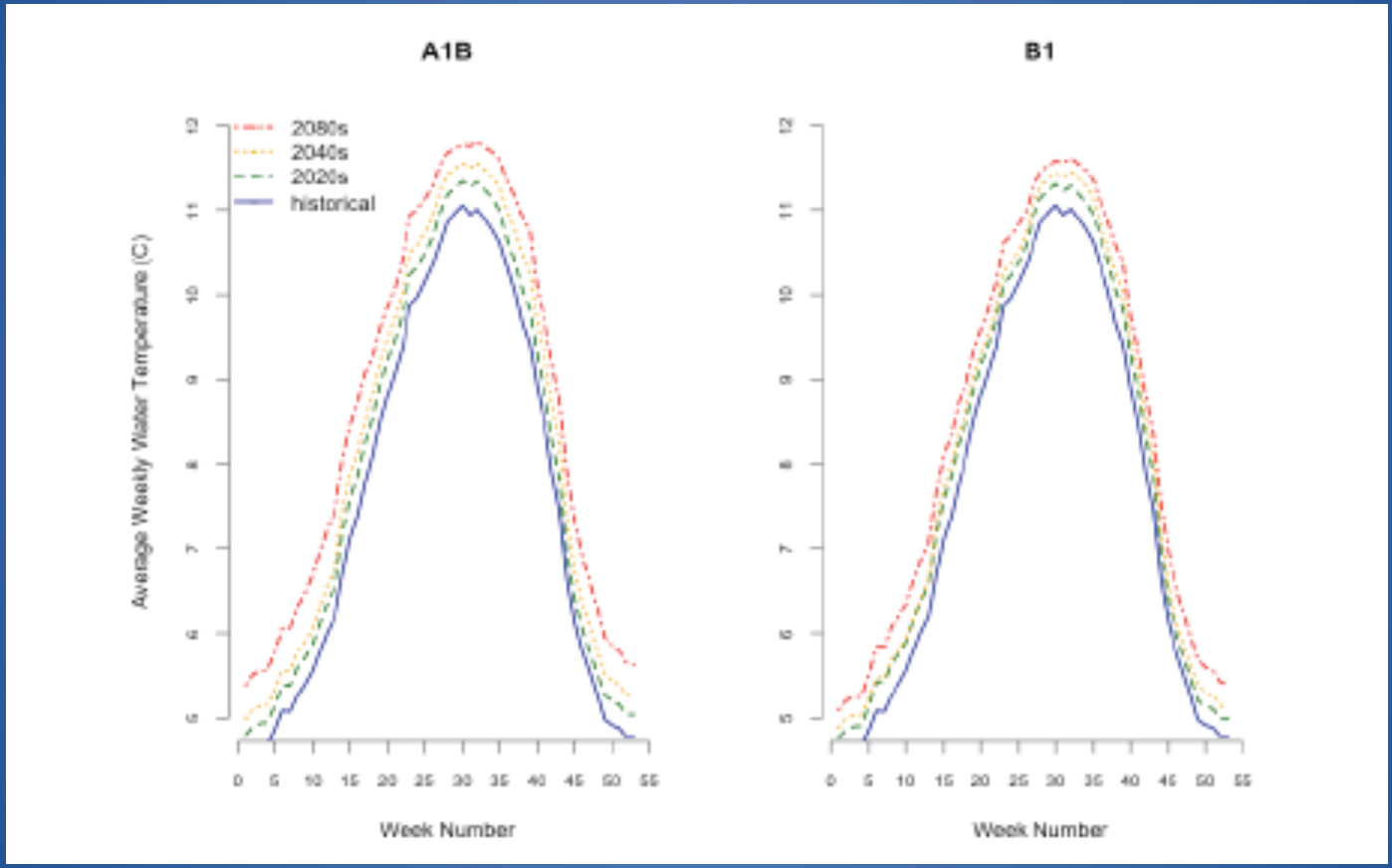
Stettatle Creek:
Snow Dominated Watershed



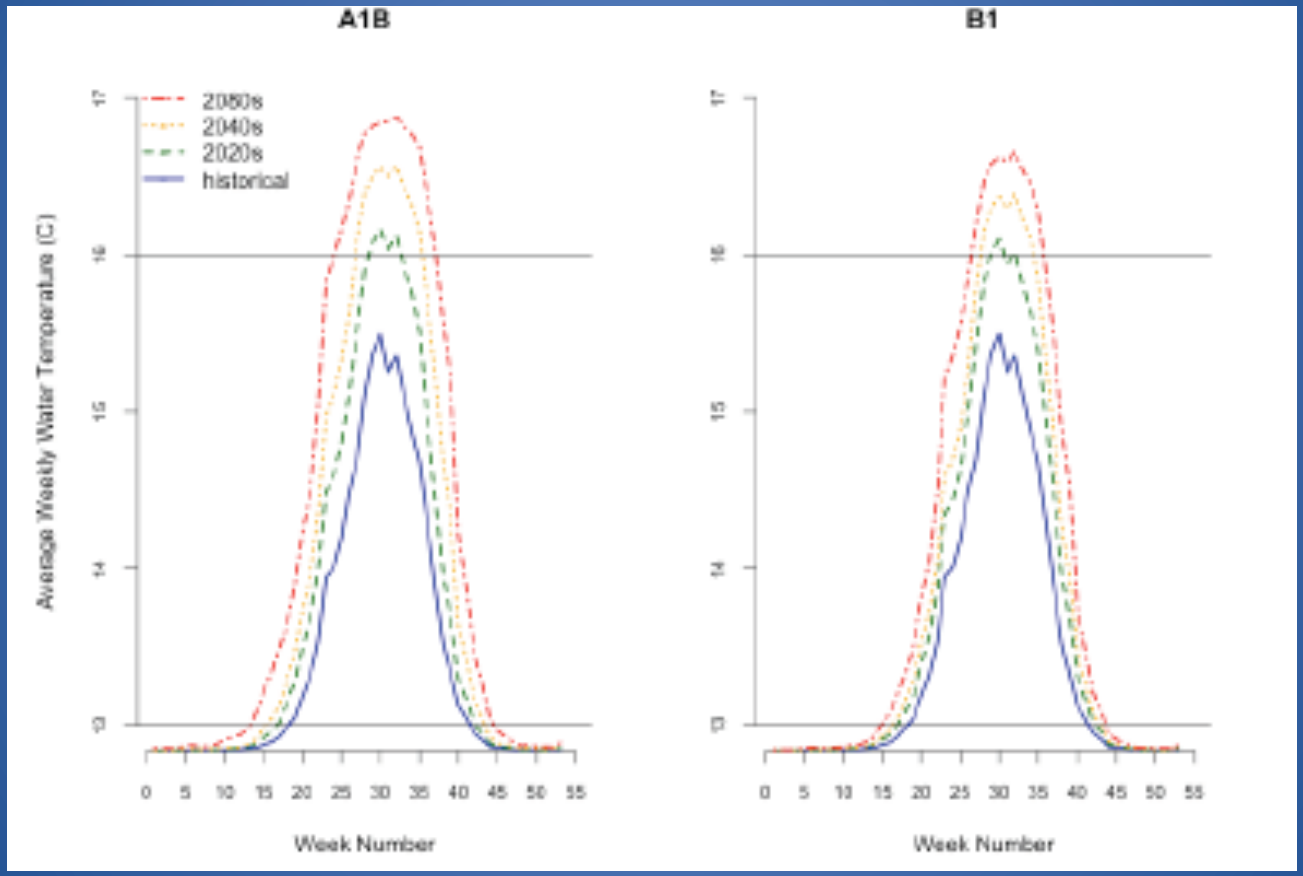
Ruby Creek:
Rain/Snow Watershed



Skagit at Marblemount: Mainstem River below Reservoir



Skagit at Sedro Woolley: Lower Mainstem River



Climate Change and Habitat Restoration: Identifying Zones of High Resilience

- Juvenile rearing habitat is limiting factor for Chinook and Steelhead in the middle Skagit
- Habitat quantity and quality is directly linked to geology, geomorphology, and hydrology
- Some reaches provide excellent habitat over wide range of flows, and these will be the "resilience zones" for salmon to climate change
- These areas also are have high groundwater input, which provide resilience to warming water temperatures
- Need to protect and restore these zones
- High priority reaches in the Middle Skagit Study are the zones of highest resiliency

Top Five List of Areas to Identify, Protect, and Restore for Climate Change

1. High elevation basins with glaciers or heavy snowpack accumulations
2. Groundwater inflow areas
3. Wide, ecologically intact, and well-connected floodplains
4. Major tributaries (cold and connected)
5. Areas that provide abundant habitat cover during winter peak flows (large wood, cobbles, and boulders)

Floodplains, Salmon, and Climate Change in the Skagit River Watershed

Ed Connor (SCL) and Jon Riedel (NPS)

SC^2 Workshop - October 2012

SC^2 SKAGIT CLIMATE SCIENCE CONSORTIUM