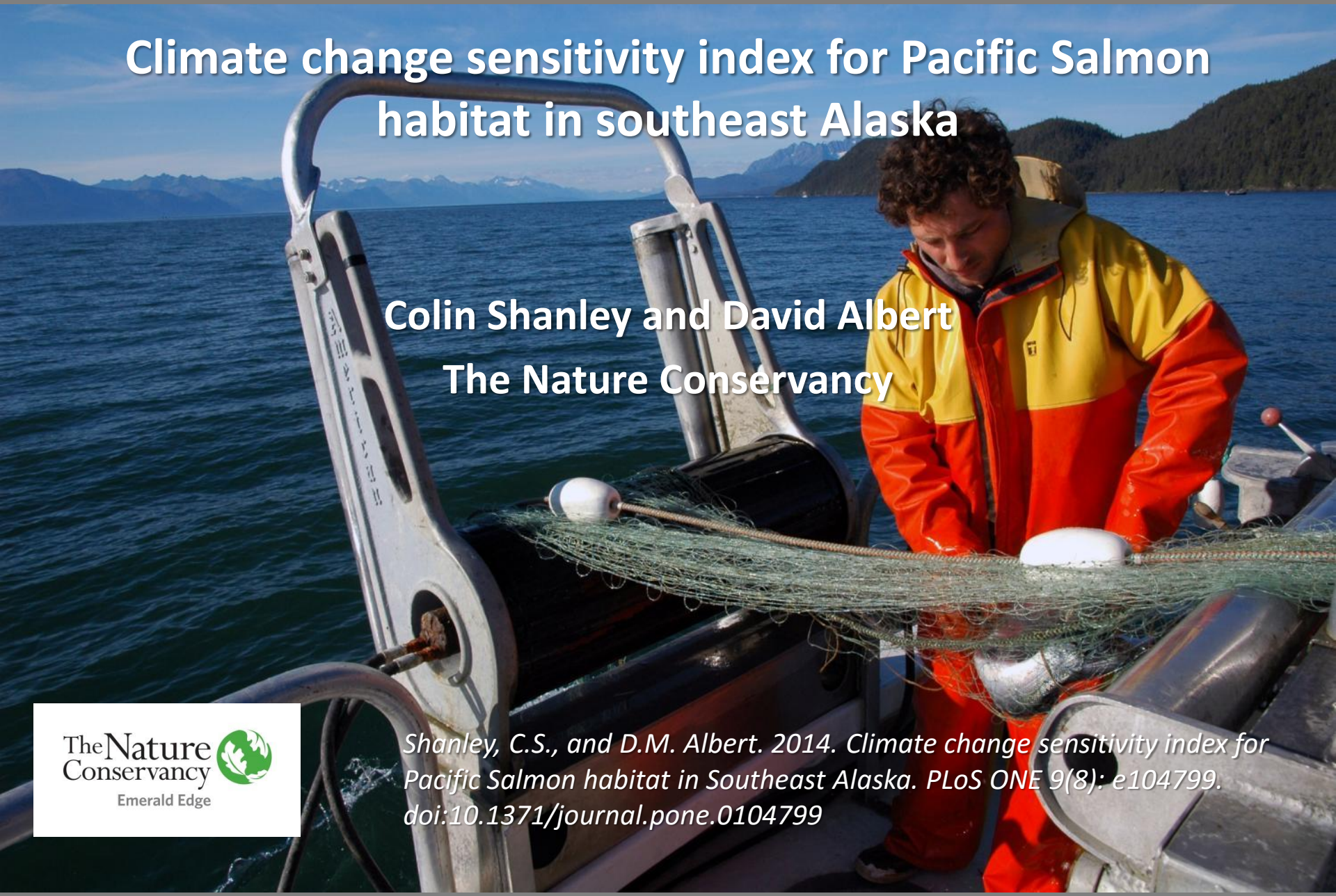
Climate change sensitivity index for Pacific Salmon habitat in southeast Alaska

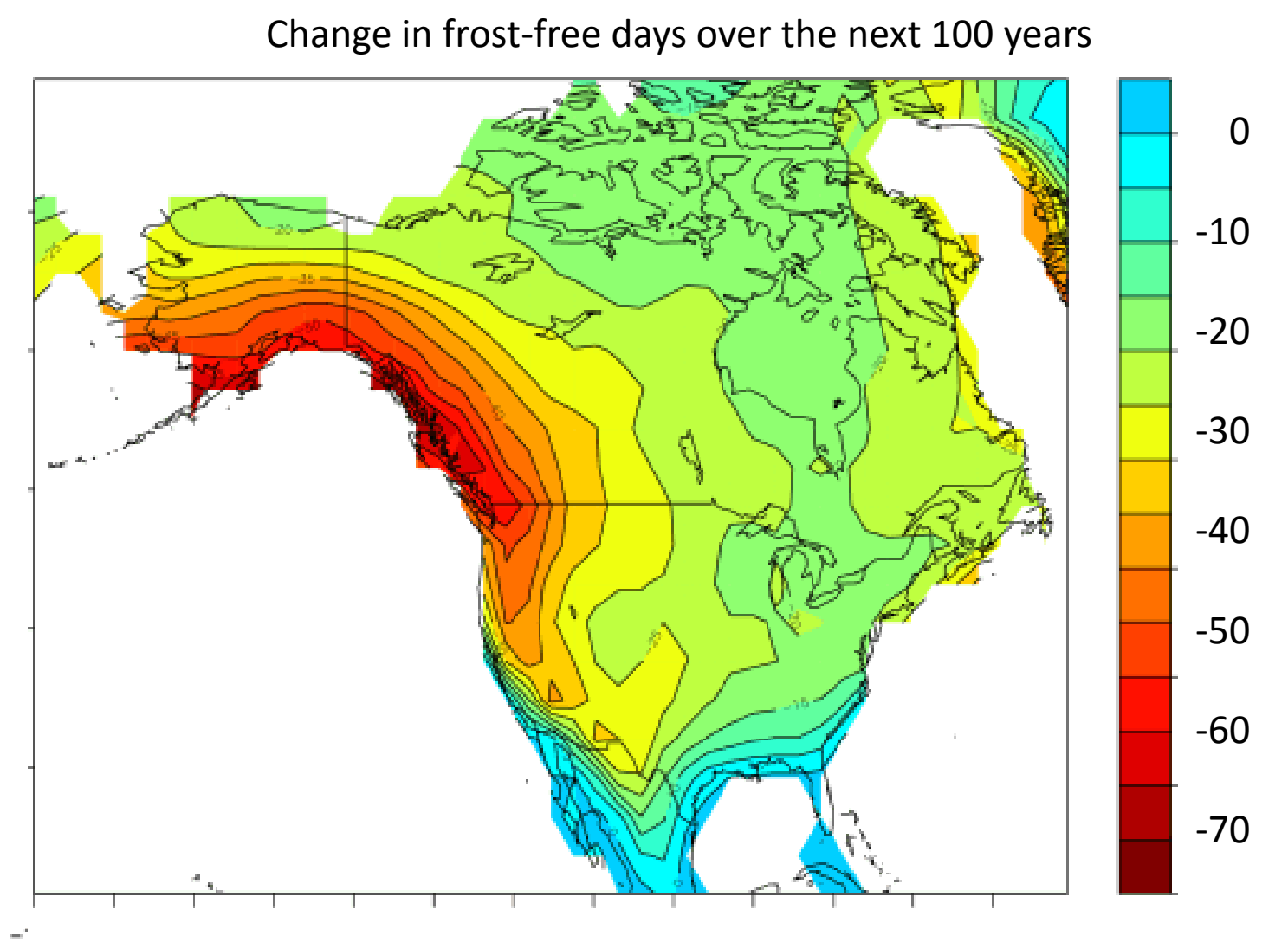
Colin Shanley and David Albert

The Nature Conservancy



Shanley, C.S., and D.M. Albert. 2014. Climate change sensitivity index for Pacific Salmon habitat in Southeast Alaska. PLoS ONE 9(8): e104799. doi:10.1371/journal.pone.0104799

Big picture (terrestrial) climate story



Meehl et al. 2004; Sillmann et al. 2013

Spring 2014

Photo: But not a drop to drink

Posted: May 14, 2014 - 12:03am

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JUNEAU EMPIRE

Low water at the Salmon Creek Reservoir exposes trees left standing, stumps and drying mud on Tuesday. The reservoir is at about one-third the normal level. The Salmon Creek Dam was built 100 years ago.

Summer 2014

Juneau water shortage; cruise ships cut off

Drinking water shortage means no filling up at cruise ship docks

Posted: May 13, 2014 - 12:04am

By KATIE MORITZ

JUNEAU EMPIRE

The city asked residents last week to hold off on washing cars and watering lawns due to low water reservoirs. But residents aren't the only ones who have to watch their water. Cruise ships are feeling it, too.

Until Juneau recovers from its temporary water shortage, ships are not allowed to fill up at the docks.

Winter 2014

Prince of Wales Island Recovering from Flooding, Landslides

Chris Klint, Senior Digital Producer, cklint@ktuu.com

POSTED: 01:19 PM AKST Jan 14, 2014 | UPDATED: 12:47 PM AKST Jan 15, 2014

Courtesy Alaska Department of Public Safety

Alaska State Troopers say this landslide during Southeast Alaska flooding, on the Klawock-Hollis Highway, closed the highway and knocked a nearby home off its foundations Tuesday. According to AST spokesperson Beth Ipsen, the slide and another one on Coffman Cove Road were cleared as of Wednesday, with no injuries reported.

Winter 2015

In search of snow, ski team flies south

Juneau Ski Club heads to Utah for needed training time

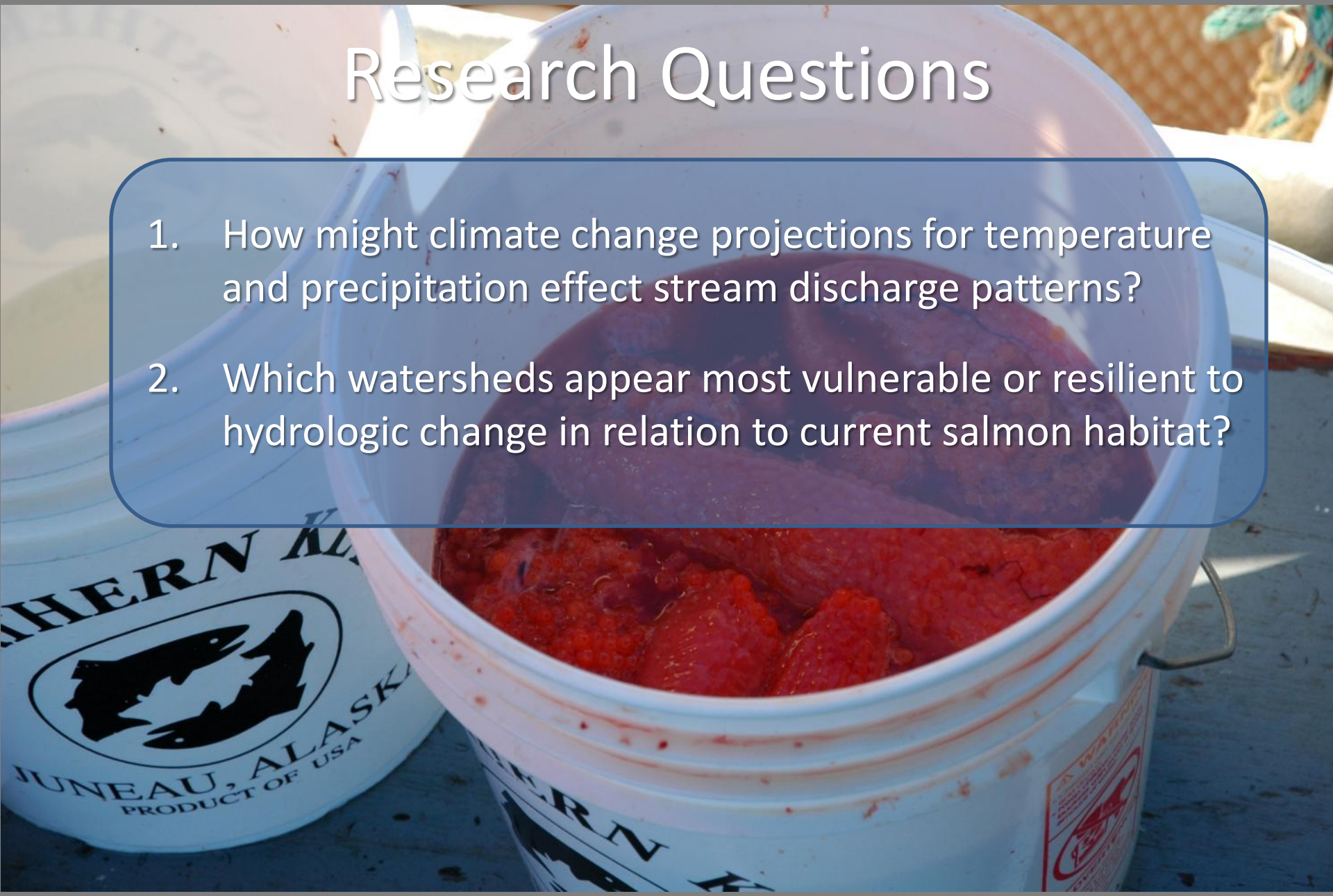
Posted: January 27, 2015 - 12:04am

KLAS STOLPE | JUNEAU EMPIRE

Members of the Juneau Ski Team prepare for a rainy ski down Eaglecrest's Sneaky alpine course during practice on Sunday.

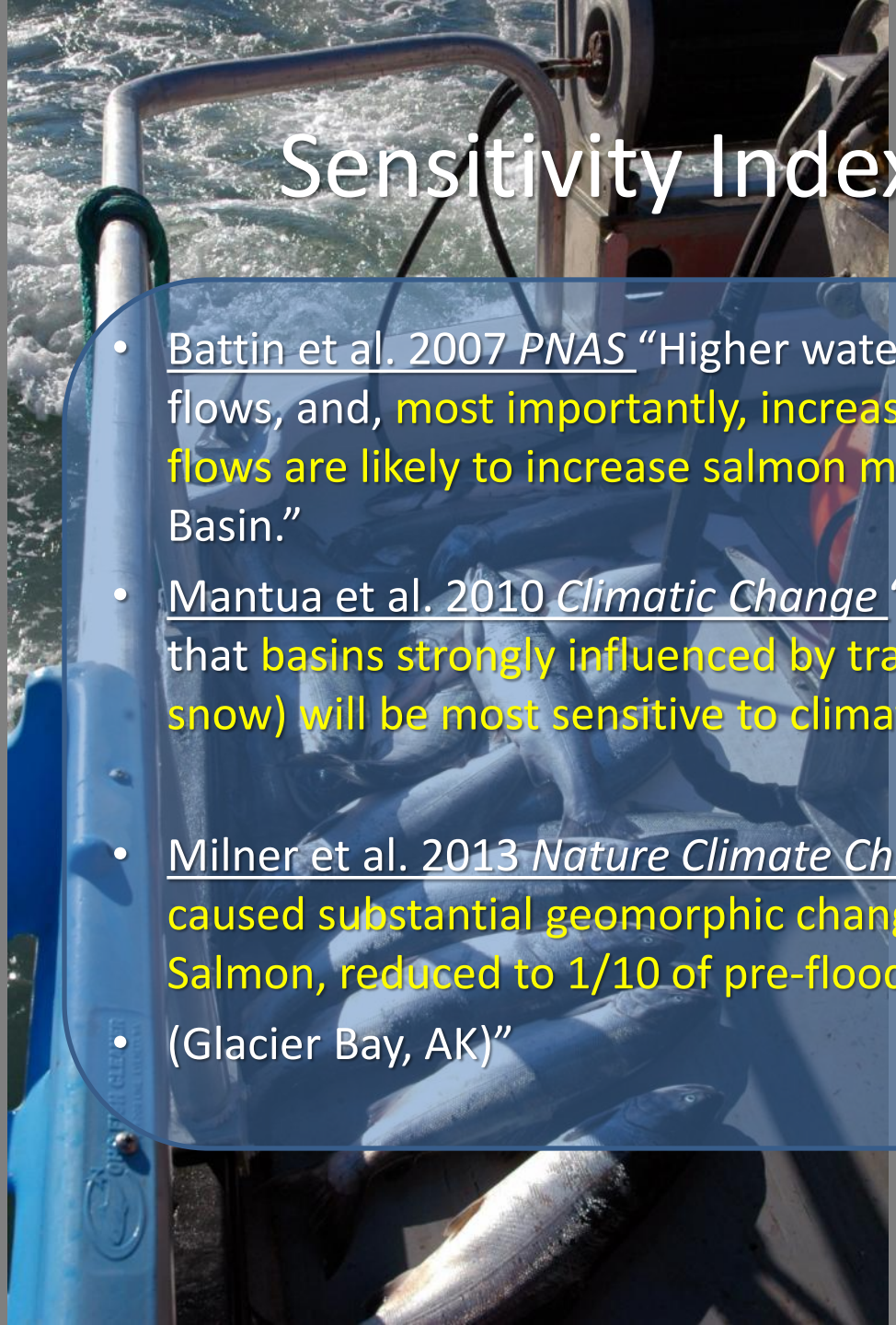
Research Questions

1. How might climate change projections for temperature and precipitation effect stream discharge patterns?
2. Which watersheds appear most vulnerable or resilient to hydrologic change in relation to current salmon habitat?



Project Phases

1. Literature review and consultation with regional experts
2. Built historical stream gauge station database with watershed physiography and climatology
3. Ran and tested monthly discharge models
4. Mapped discharge projections as a sensitivity index with current salmon habitat values



Sensitivity Index Rationale

- Battin et al. 2007 *PNAS* "Higher water temperatures, lower spawning flows, and, most importantly, increased magnitude of winter peak flows are likely to increase salmon mortality in the Snohomish River Basin."
- Mantua et al. 2010 *Climatic Change* "Streamflow simulations predict that basins strongly influenced by transient runoff (mix of rain and snow) will be most sensitive to climate change." (Washington State)
- Milner et al. 2013 *Nature Climate Change* "A major rainfall event caused substantial geomorphic change to the stream channel. Pink Salmon, reduced to 1/10 of pre-flood spawner densities
- (Glacier Bay, AK)"

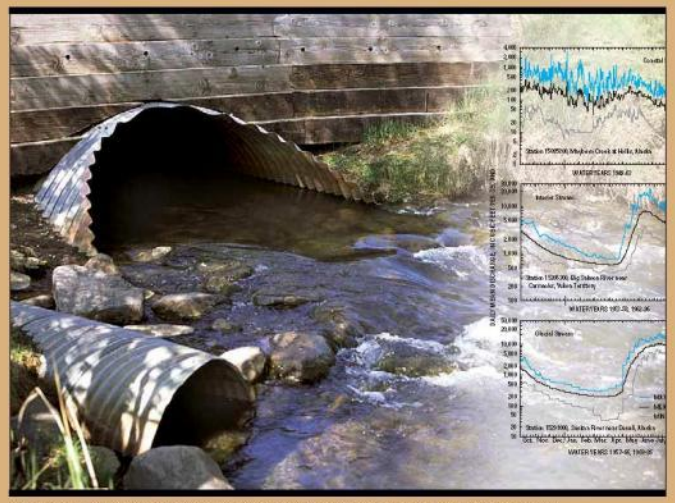
Model selection: multiple regression

USGS
science for a changing world

Estimating Annual High-Flow Statistics and Monthly and Seasonal Low-Flow Statistics for Ungaged Sites on Streams in Alaska and Conterminous Basins in Canada

Water-Resources Investigations Report 03-4114

Prepared in cooperation with the
ALASKA DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES



Photograph of culvert adjacent to U.S. Geological Survey stream-gaging station on Chester Creek at Arctic Boulevard in Anchorage, Alaska. Photograph taken by Janet Curran, USGS.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ANALYSIS OF SELECT STREAM DISCHARGE MODELS IN SOUTHEAST

ALASKA

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

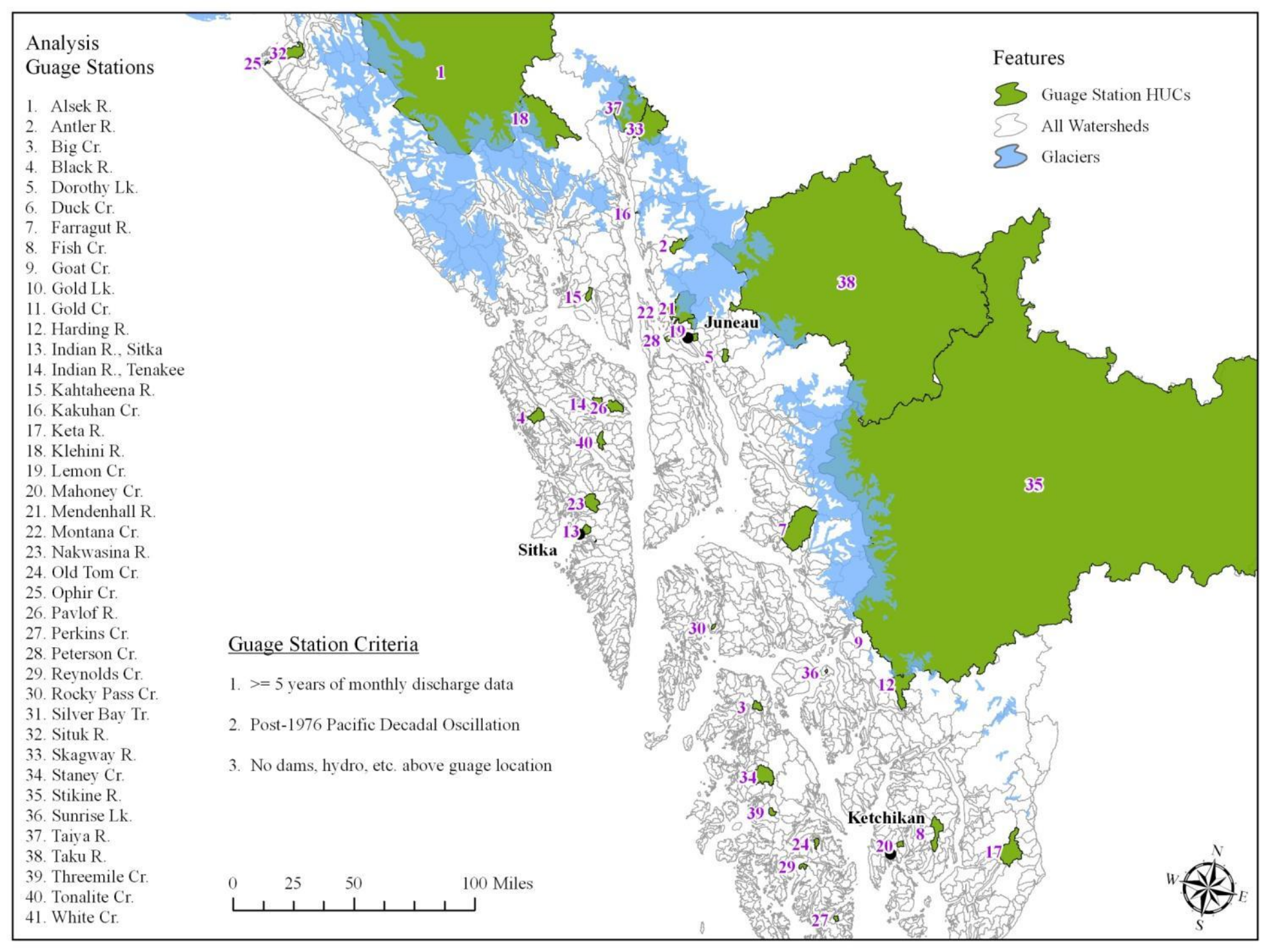
In Partial Fulfillment of the Requirements for the Degree of

Master of Professional Studies

by

Terence C Schwarz

February, 2010


Analysis
Guage Stations
1. Alsek R.
2. Antler R.
3. Big Cr.
4. Black R.
5. Dorothy Lk.
6. Duck Cr.
7. Farragut R.
8. Fish Cr.
9. Goat Cr.
10. Gold Lk.
11. Gold Cr.
12. Harding R.
13. Indian R., Sitka
14. Indian R., Tenakee
15. Kahtaheena R.
16. Kakuhan Cr.
17. Keta R.
18. Klehini R.
19. Lemon Cr.
20. Mahoney Cr.
21. Mendenhall R.
22. Montana Cr.
23. Nakwasina R.
24. Old Tom Cr.
25. Ophir Cr.
26. Pavlof R.
27. Perkins Cr.
28. Peterson Cr.
29. Reynolds Cr.
30. Rocky Pass Cr.
31. Silver Bay Tr.
32. Situk R.
33. Skagway R.
34. Staney Cr.
35. Stikine R.
36. Sunrise Lk.
37. Taiya R.
38. Taku R.
39. Threemile Cr.
40. Tonalite Cr.
41. White Cr.
Features
Guage Station HUCs
All Watersheds
Glaciers
Juneau
Sitka
Ketchikan
Guage Station Criteria
1. >= 5 years of monthly discharge data
2. Post-1976 Pacific Decadal Oscillation
3. No dams, hydro, etc. above guage location
0 25 50 100 Miles
N
W
E
S

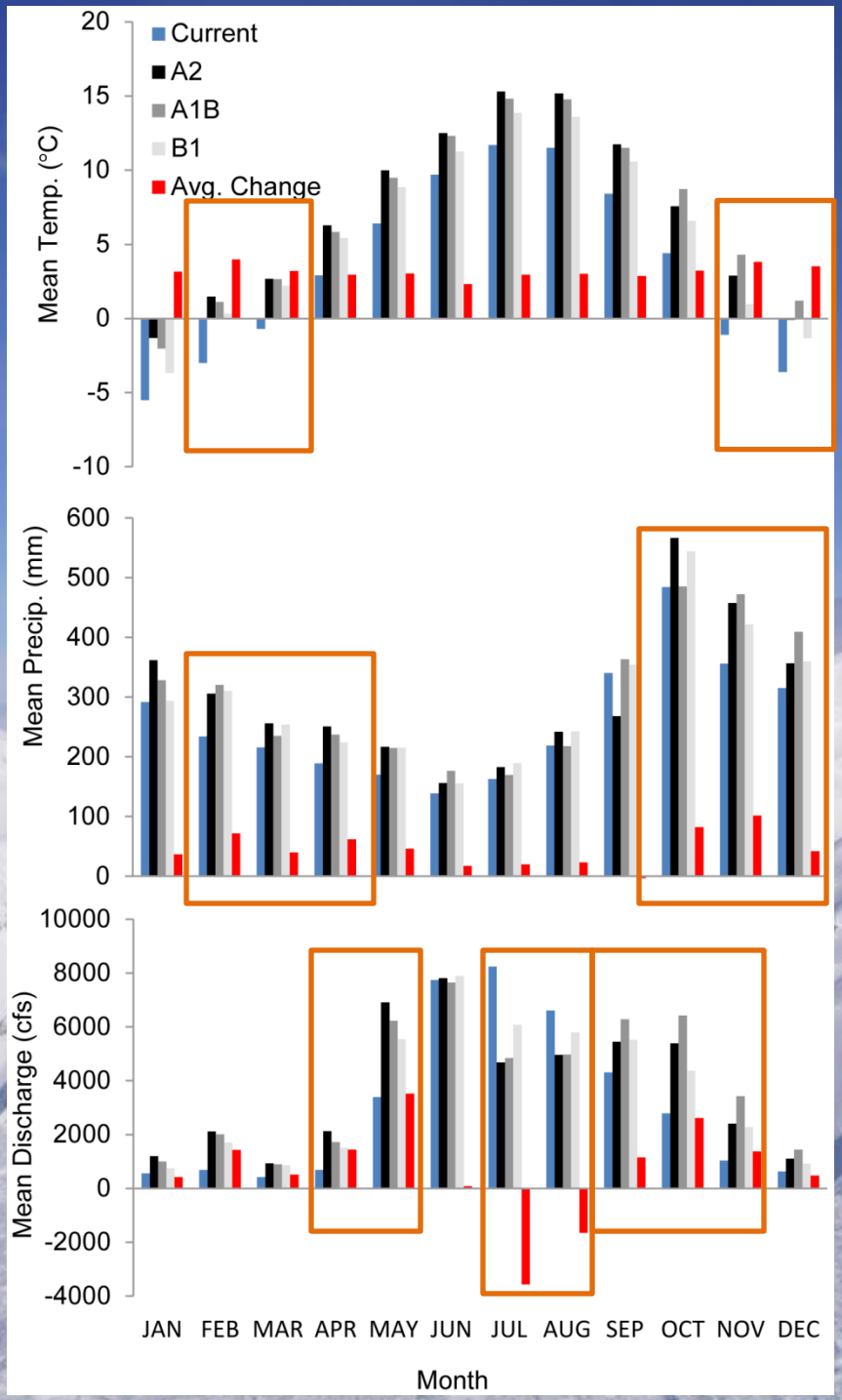
Monthly discharge model predictors

1. Watershed Area
2. Monthly Precipitation (mean)
3. Monthly Temperature (mean)
4. Elevation (mean)
5. Glaciers (%)
6. Lakes (%)

Model result coefficients (AIC)

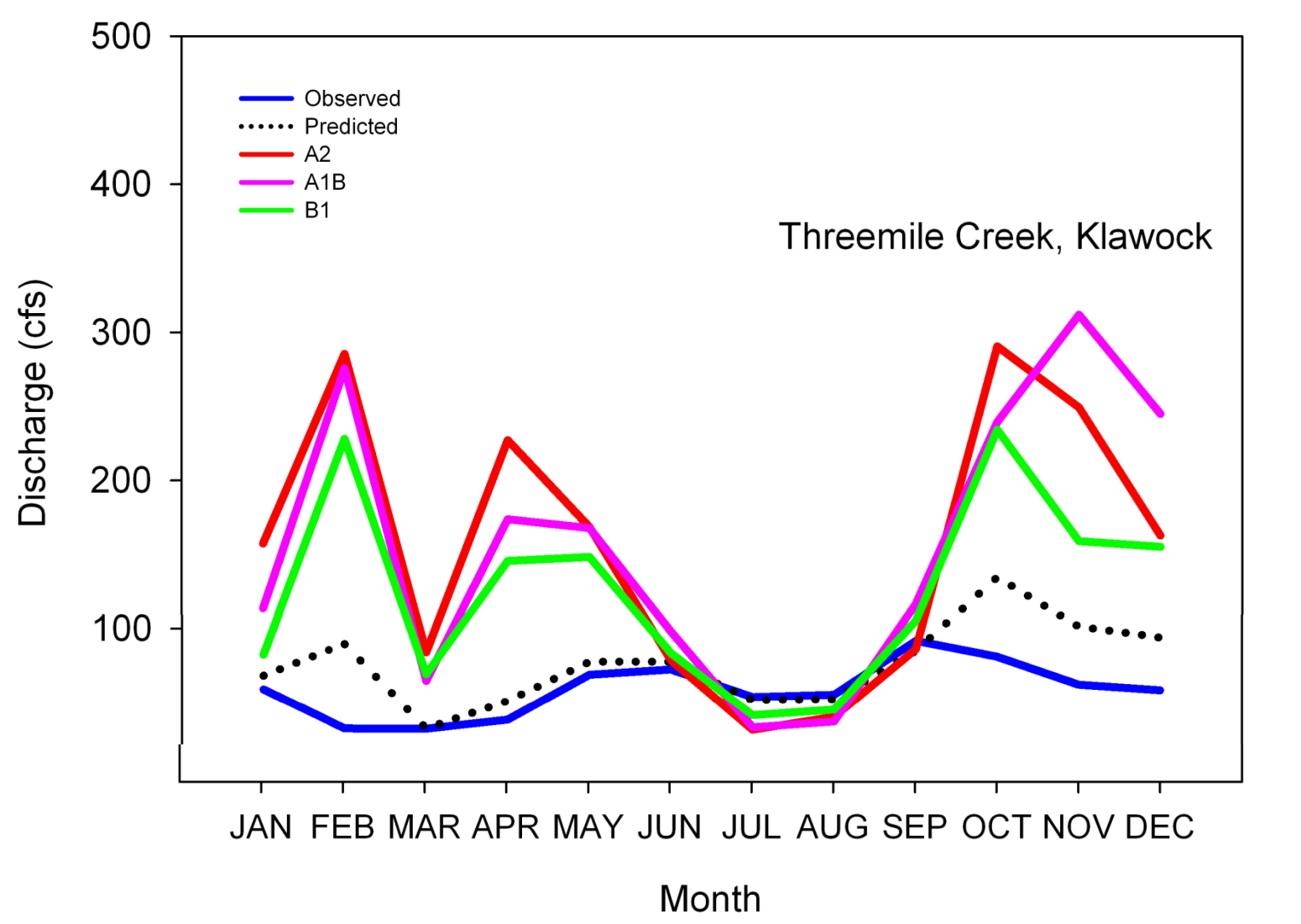
	Area	Precip	Temp	Elev	Glac	Lakes	Adj. R^2
January	+	+	+	-	-		0.96
February	+	+	+	-	-	+	0.97
March	+	+	+	-	-	+	0.96
April	+	+	+				0.97
May	+	+	+	+			0.98
June	+	+	-	+			0.98
July	+	+	-	+			0.97
August	+	+	-	+	+		0.97
September	+	+	+	+	+		0.97
October	+	+	+				0.97
November	+	+	+	-			0.97
December	+	+	+	-	-		0.96

Average Change

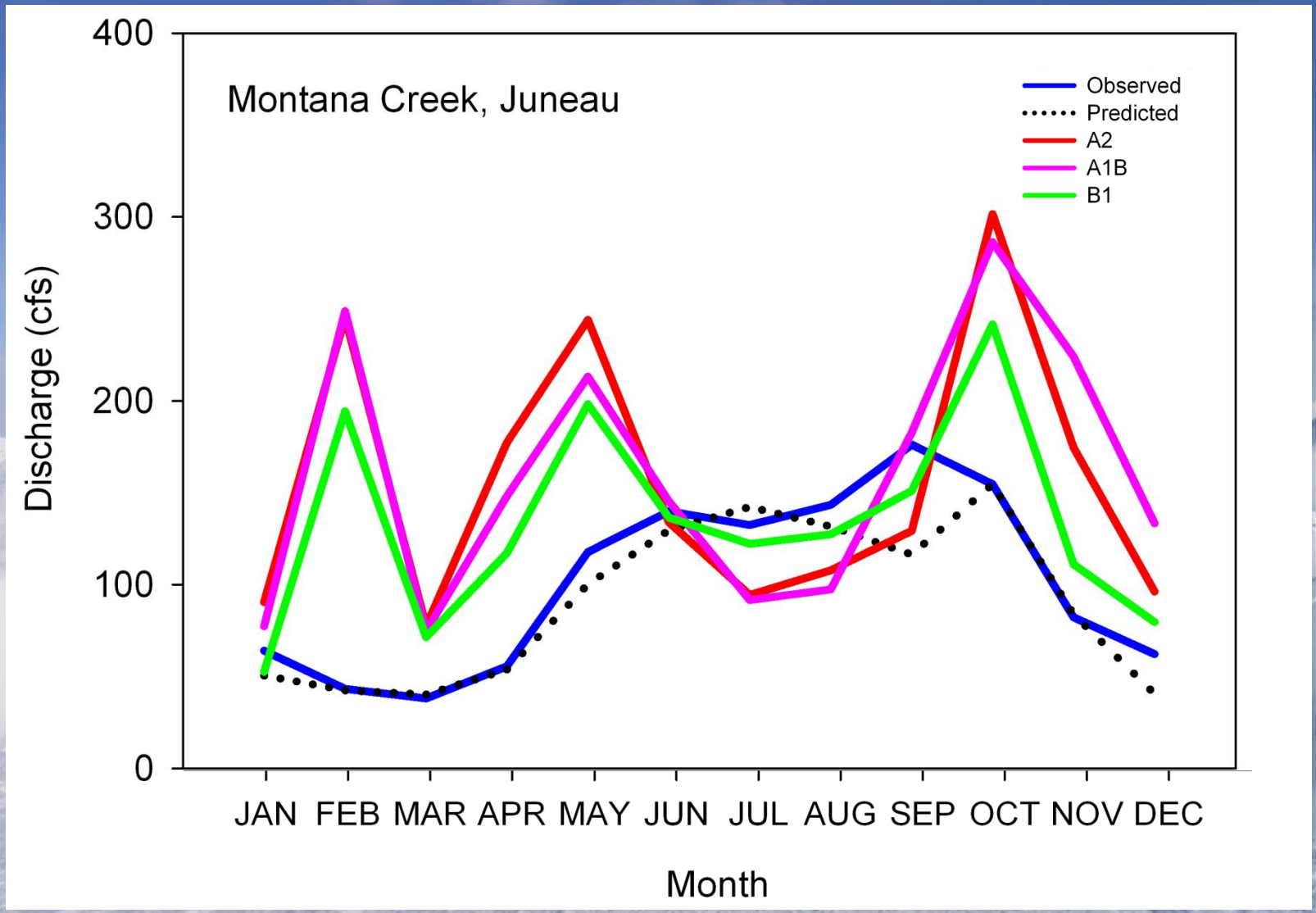


Analysis dataset (n=41)
3-GCM model average
IPCC 4th Assessment
Year 2080s forecast

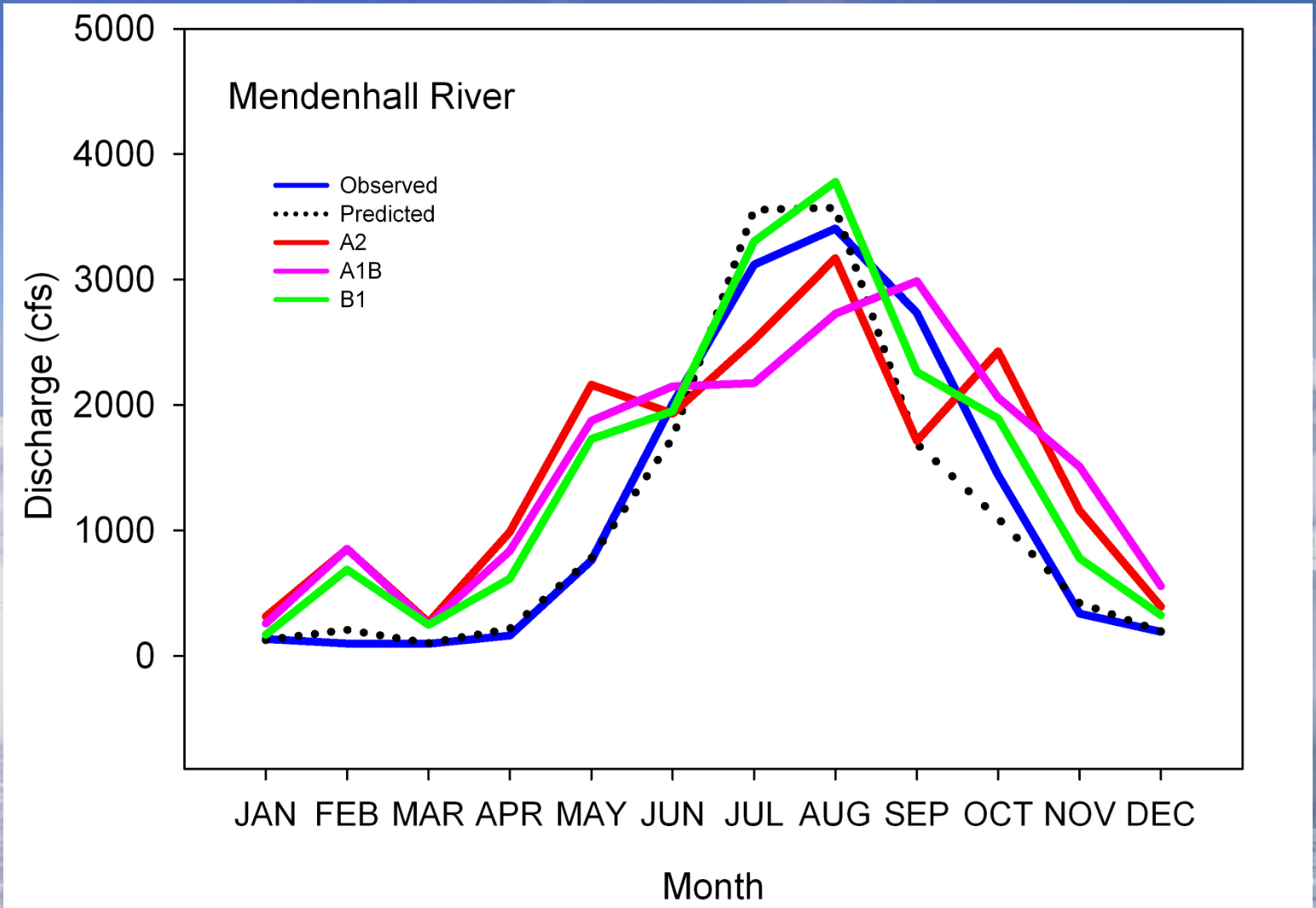
Rain-fed hydrograph

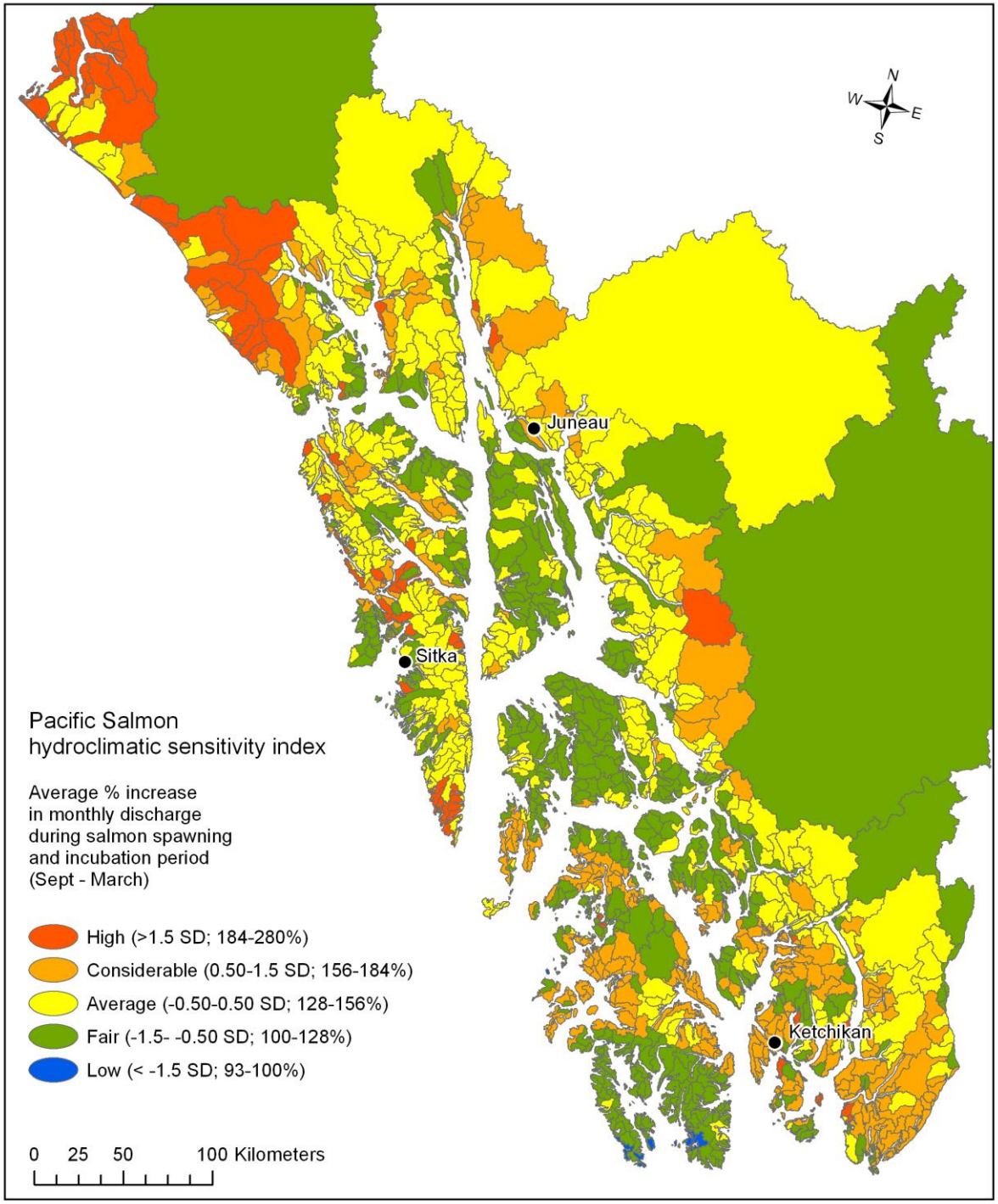


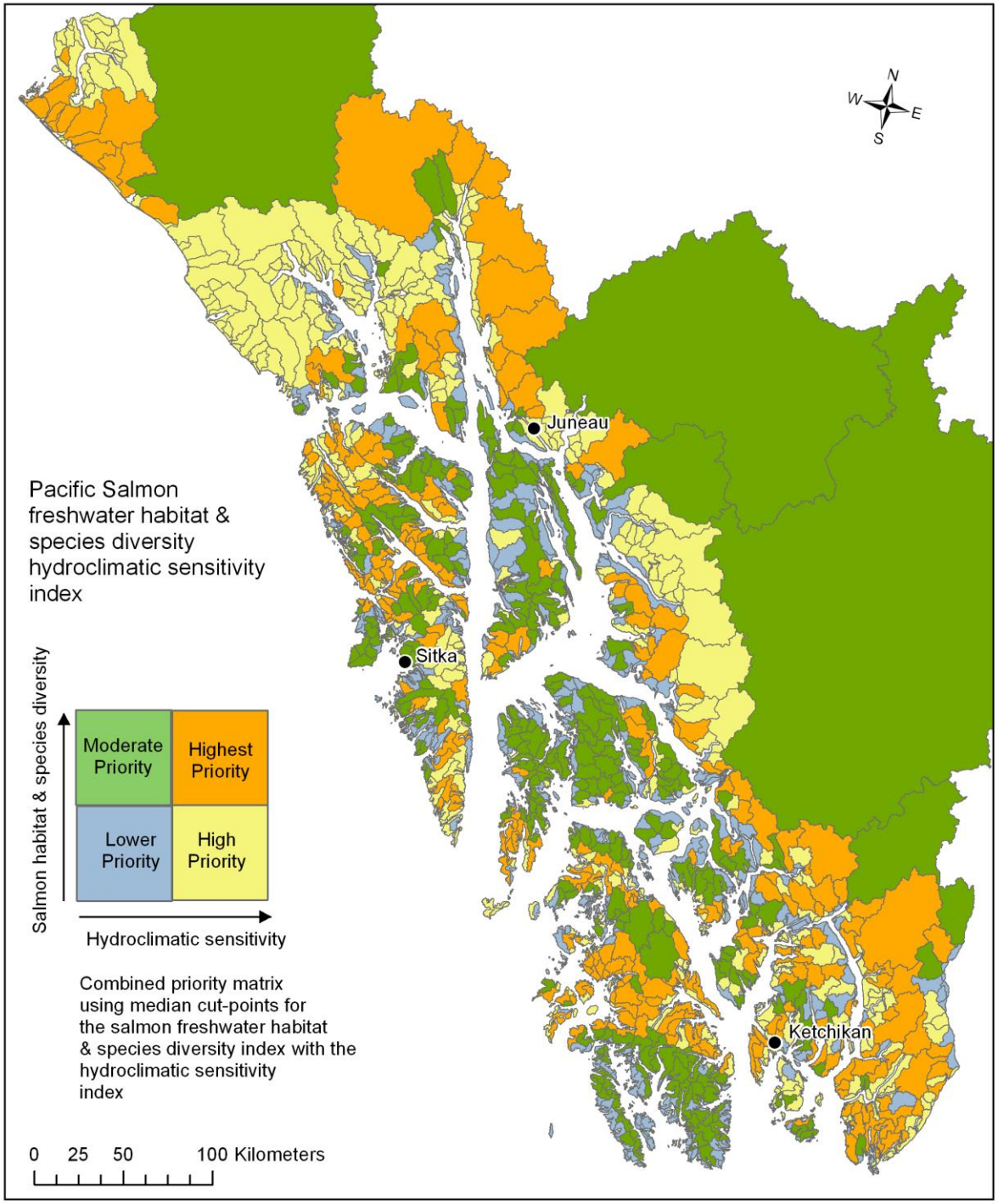
Snow-fed hydrograph



Glacial hydrograph




N
W
E
S
Juneau
Sitka
Ketchikan
Pacific Salmon
hydroclimatic sensitivity index
Average % increase
in monthly discharge
during salmon spawning
and incubation period
(Sept - March)
High (>1.5 SD; 184-280%)
Considerable (0.50-1.5 SD; 156-184%)
Average (-0.50-0.50 SD; 128-156%)
Fair (-1.5- -0.50 SD; 100-128%)
Low (< -1.5 SD; 93-100%)
0 25 50 100 Kilometers


N
W
E
S
Juneau
Sitka
Ketchikan
Pacific Salmon freshwater habitat & species diversity hydroclimatic sensitivity index
Salmon habitat & species diversity
Moderate Priority
Highest Priority
Lower Priority
High Priority
Hydroclimatic sensitivity
Combined priority matrix using median cut-points for the salmon freshwater habitat & species diversity index with the hydroclimatic sensitivity index
0 25 50 100 Kilometers

Conclusions

1. Watersheds may change in a relatively predictable pattern.
2. Experimental studies are needed to validate salmon vulnerability hypotheses (e.g., egg scouring).
3. A broader stream gauge station network is needed to better capture hydrologic patterns (e.g., flooding).
4. Lastly, are salmon adapting as we speak?

Thank you to the Alaska Sustainable Salmon Fund and the Gordon & Betty Moore Foundation for funding and support.