Stability of Coastal Cutthroat Trout to Environmental Extremes

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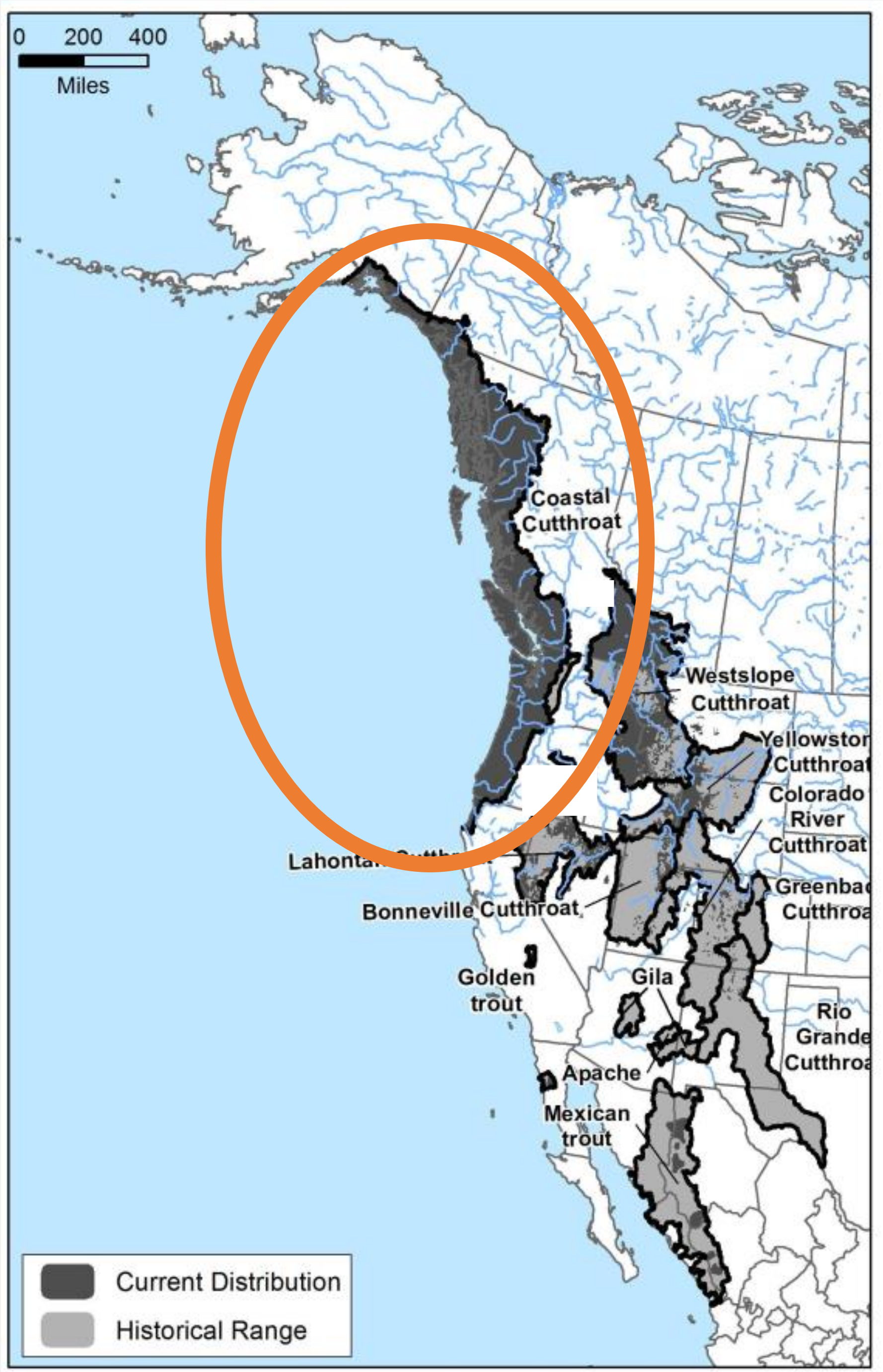
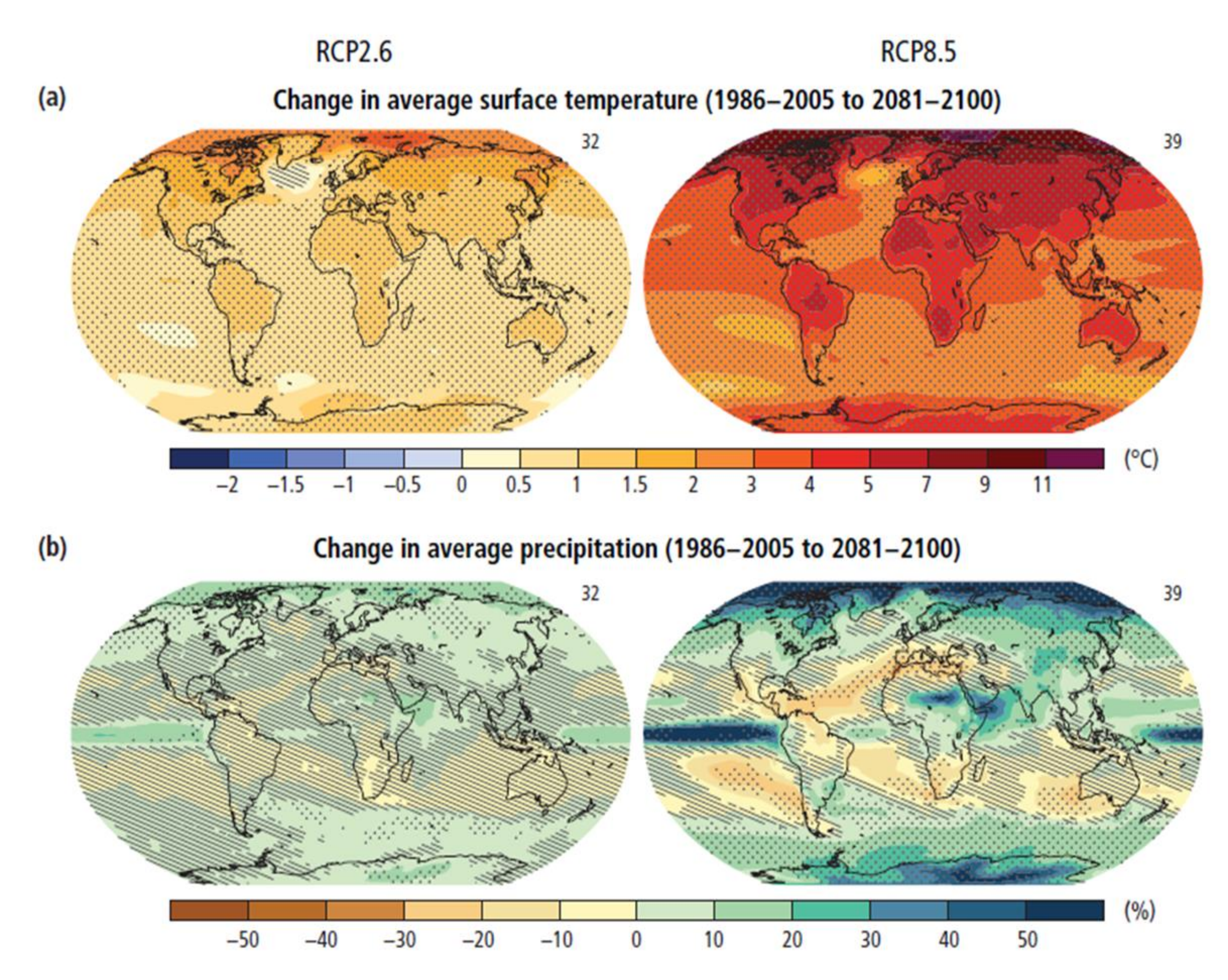


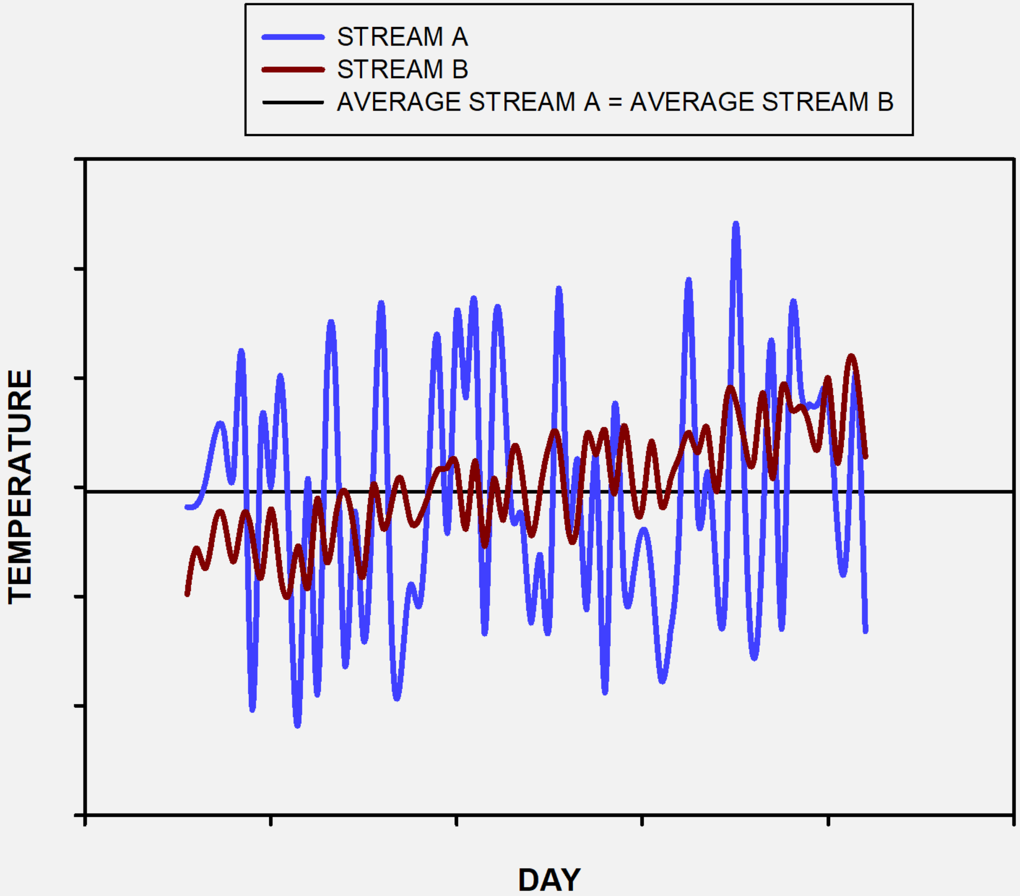
Climate change expected for western North America

- Increase in air temperature
- More severe hot weather events and less frost days
- Increase in wildfires
- Decrease in snowpack & early melting in spring
- Changes in precipitation: shift from snowmelt to flashy rain-dominated streamflow
- More extremes in regimes

Changes in extreme temperature and precipitation events are expected due to climate change (IPCC 2014)



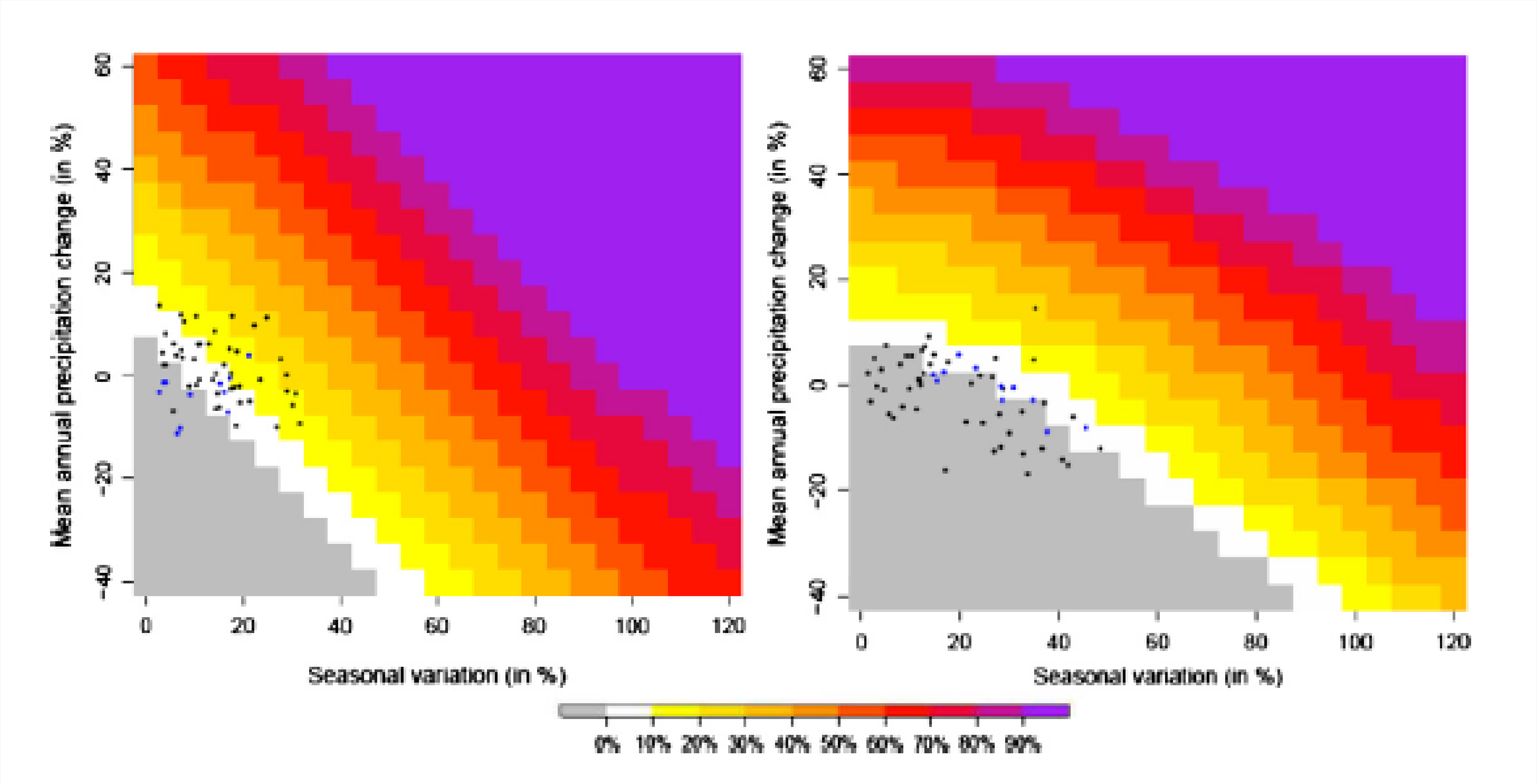
Are central tendency metrics sufficient to describe environmental regimes?



If you enter the kitchen and put your head in the oven and your feet in the refrigerator, your body will be at the ideal average temperature

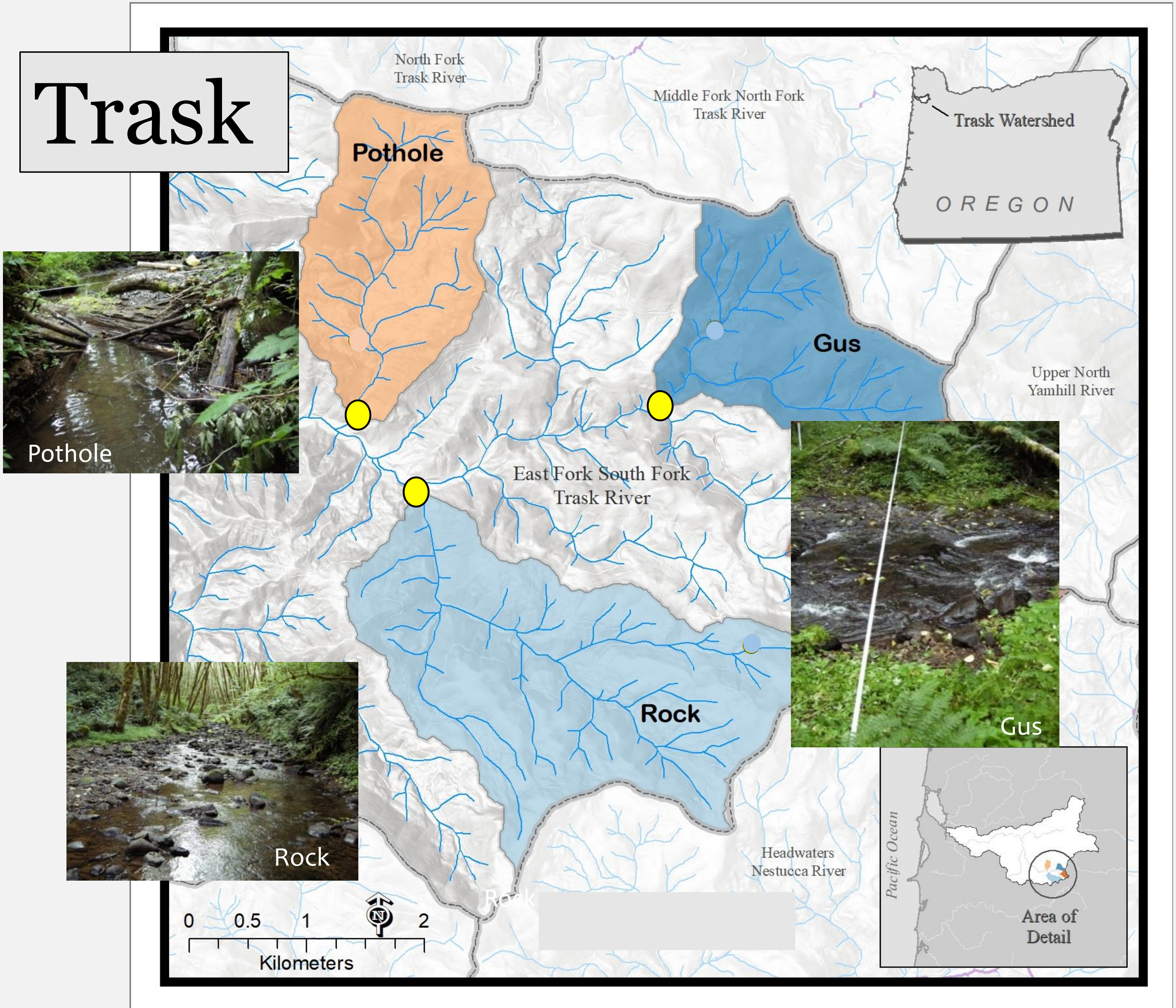
Behar et al. (2013) – The American Statistician

Scenario neutral approach



Prudhomme et al. 2010

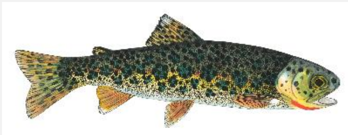
Trask



Map by K. Christiansen

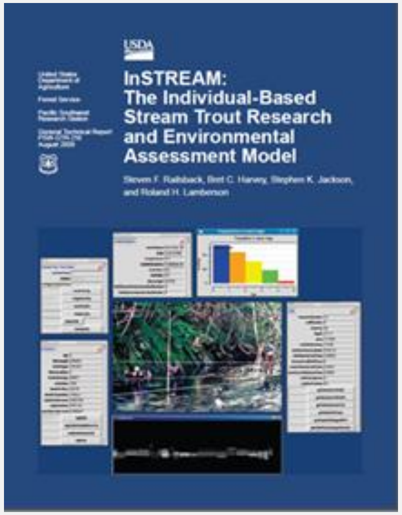
inSTREAM model

Individual trout behavior



Trout population responses

stability



InSTREAM trout model

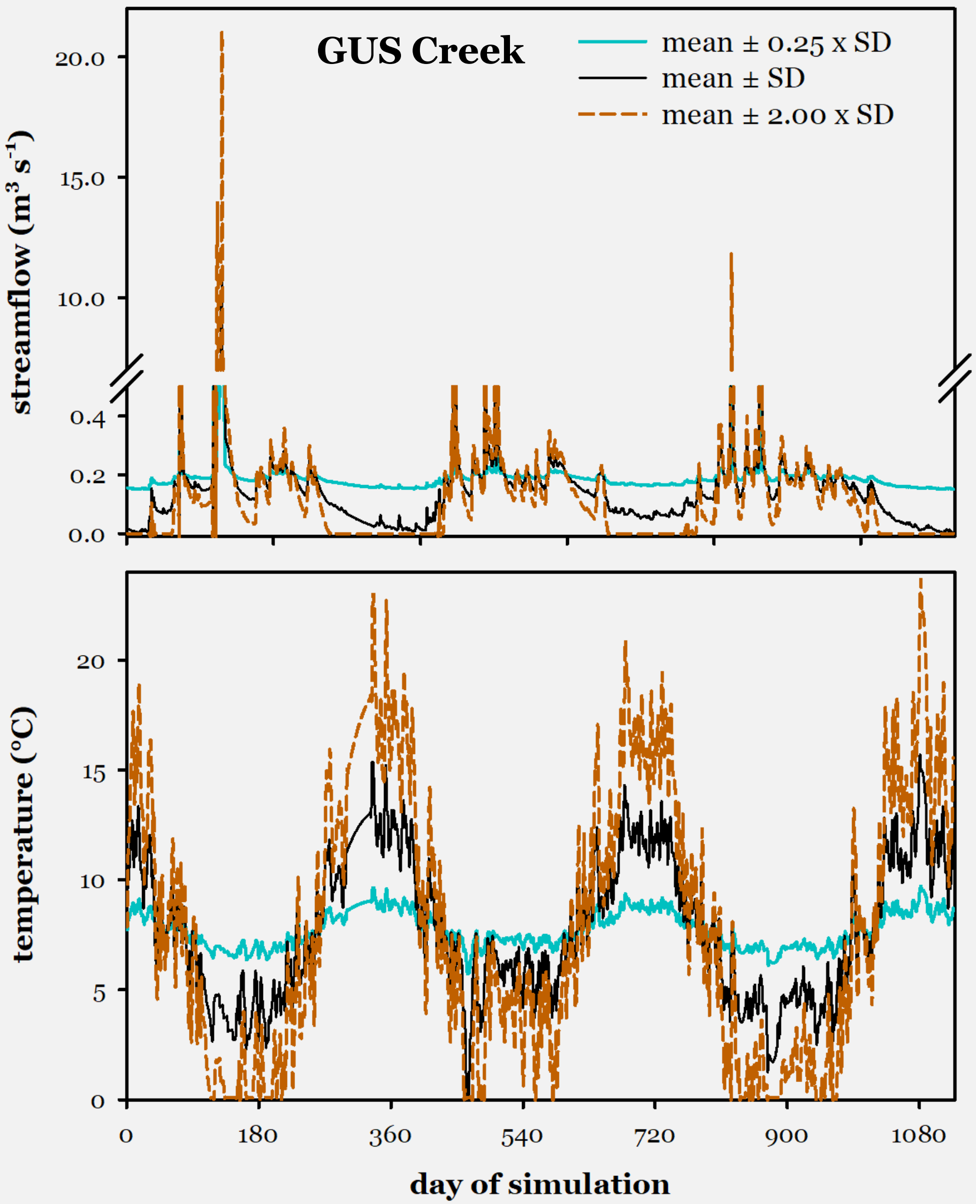
This individual-based model has shown realistic trout responses for individuals and populations

Railsback et al. 2002 - Nat. Resour. Model.; Railsback and Harvey 2002 – Ecology; Harvey and Railsback 2014 - Environ. Biol. Fish.; Harvey et al. 2014 - N. Am. J. Fish. Manage.; Penaluna et al. 2015 – CJFAS; Penaluna et al. 2015 PLoS ONE

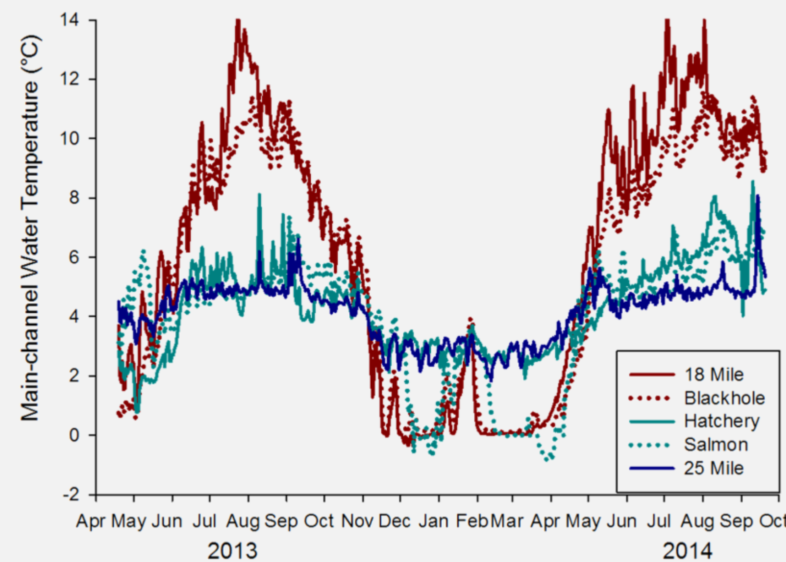
Scenarios and response variables

- Similar average conditions of Q and Tw, but <u>changed standard deviation</u> (x 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, and 2.00)
- 64 scenarios with 5 replicates (63 years) x 3 nearby streams located within the Trask Watershed Study, Coastal Oregon
- Stability of trout populations - coefficient of variation of abundance (Grossman et al. 1990)

Changing only variability of Q and Tw

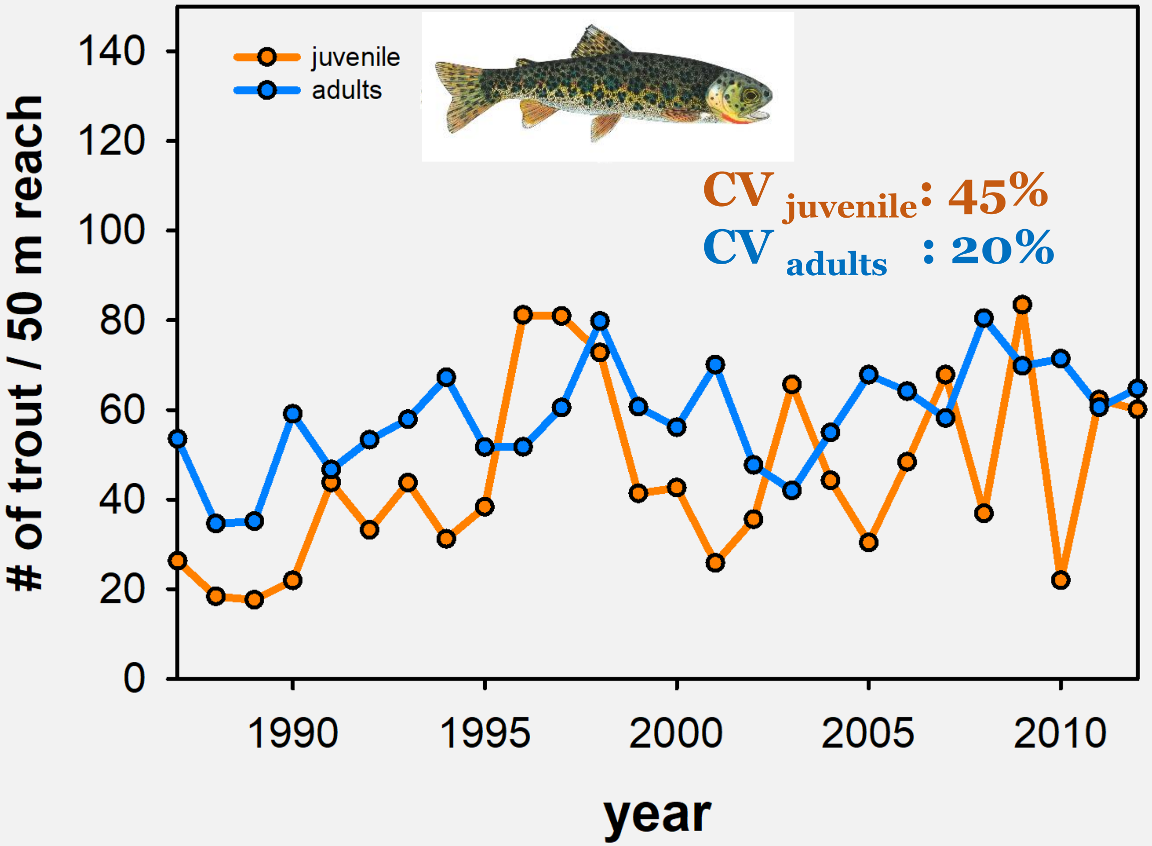


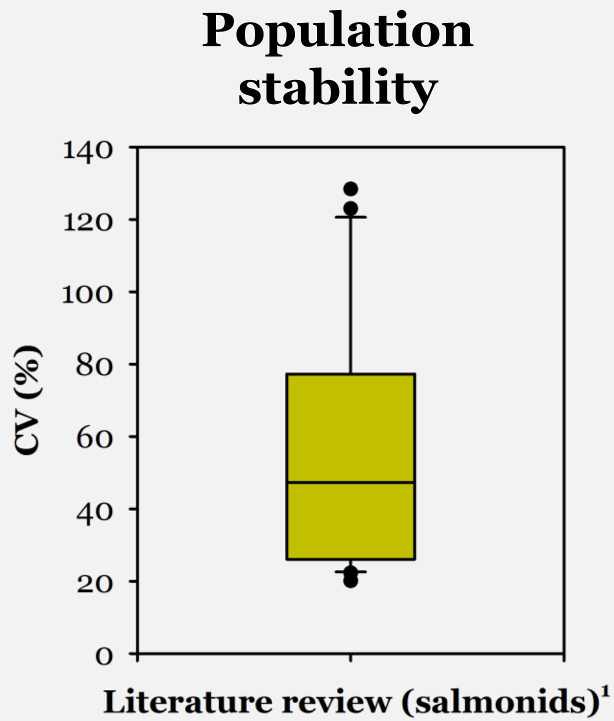
Copper River Tributaries, Alaska



Campbell et al. 2018 CJFAS

High fluctuation in population size may decrease their stability and increase their risk of extinction

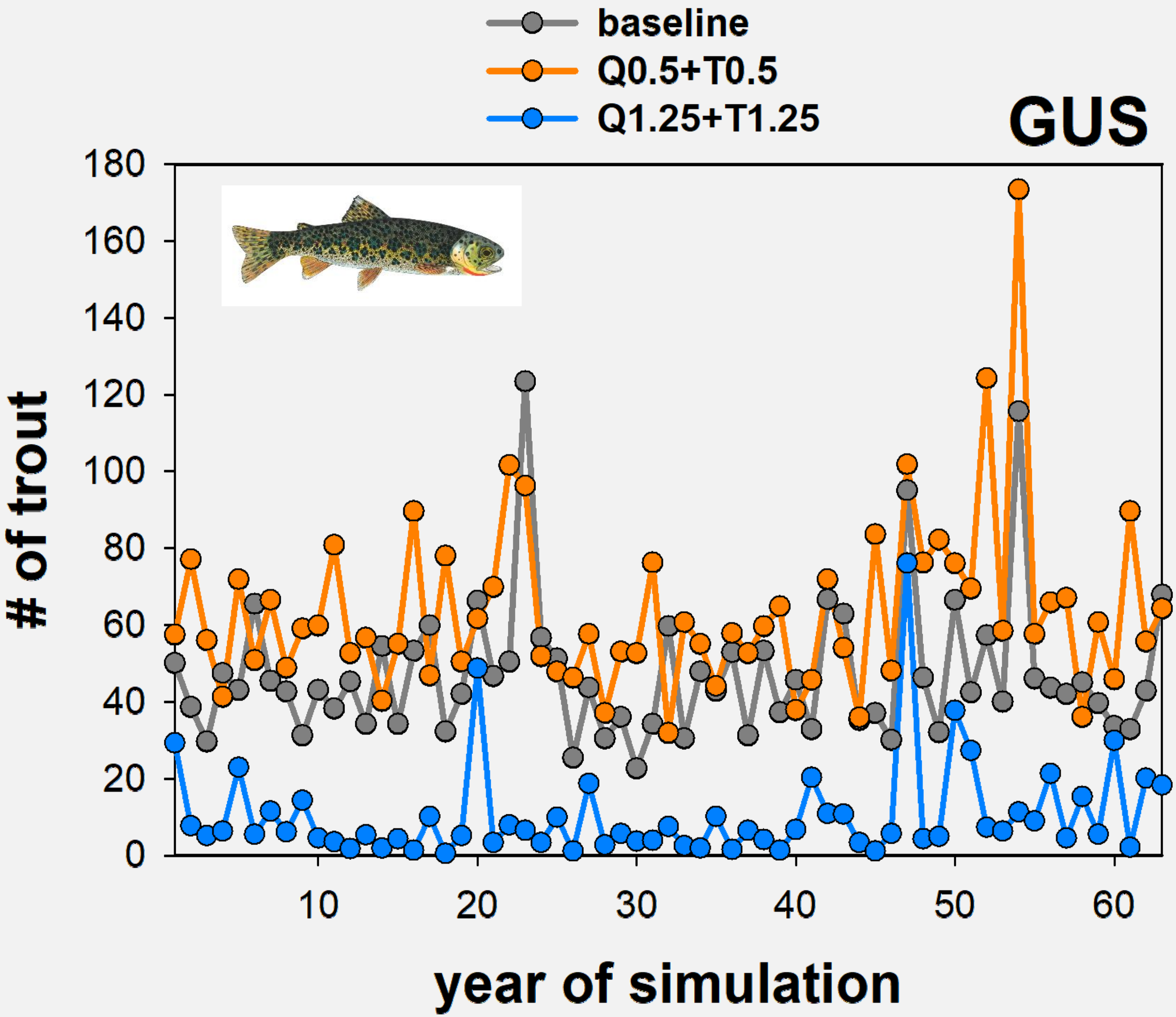




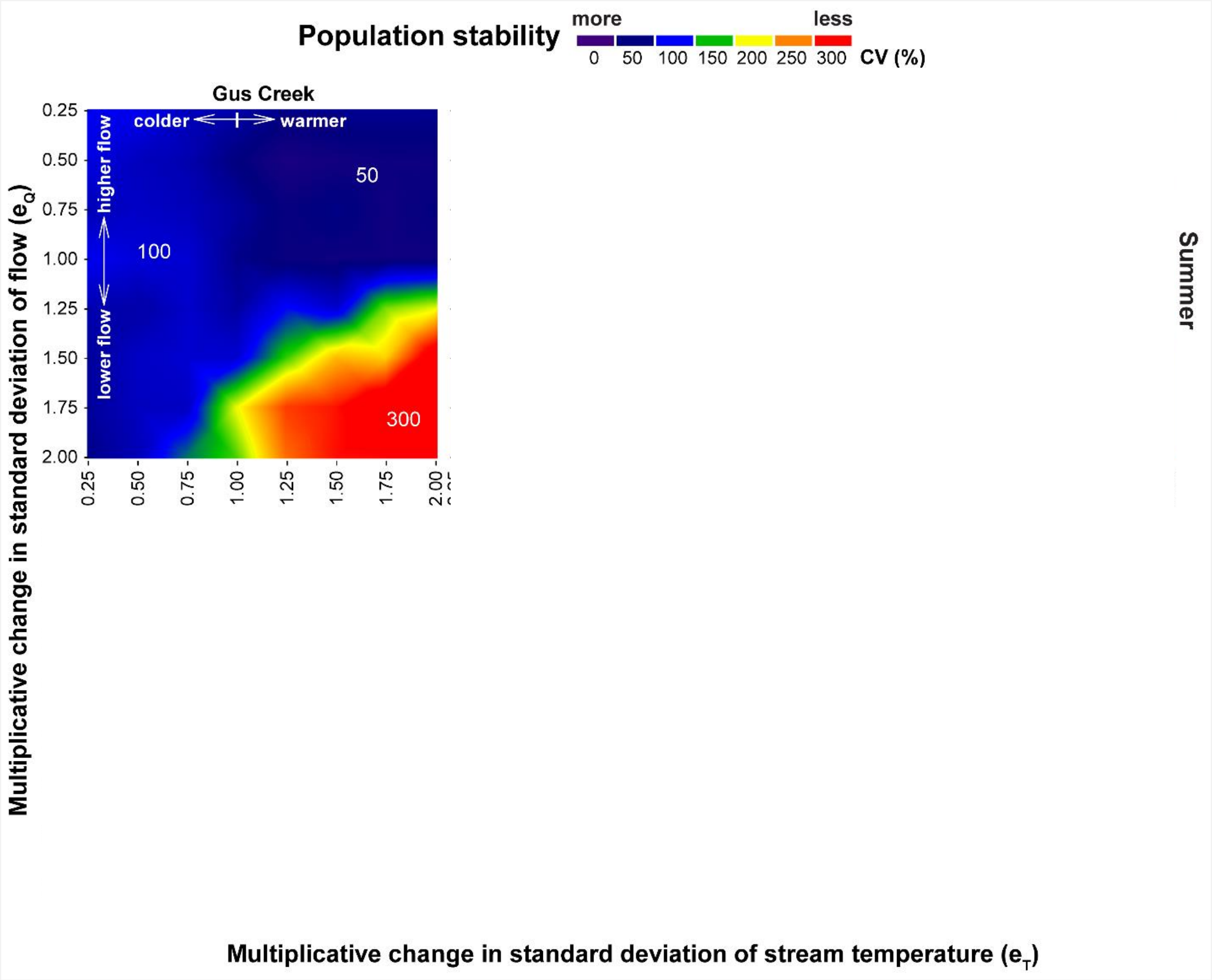
[1] Gregory et al. (various); Grossman et al. (1990); Dochtermann and Peacock (2010)

Mack Creek Old Growth Forest, HJ Andrews Experimental Forest, Data courtesy of Stan Gregory and Ivan Arismendi

Numbers decrease with increased variability



Increasing the variability of regimes decreases the stability of populations



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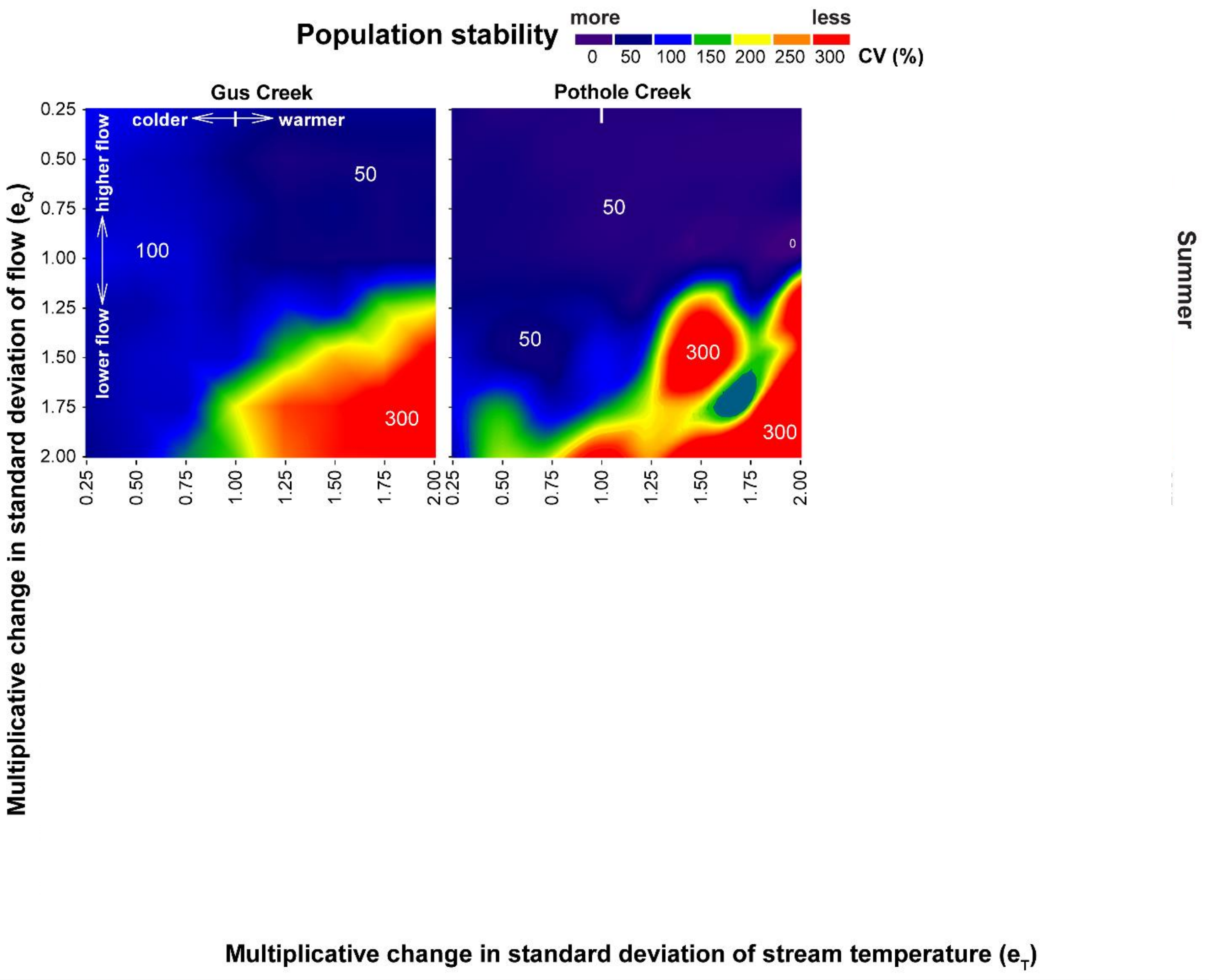

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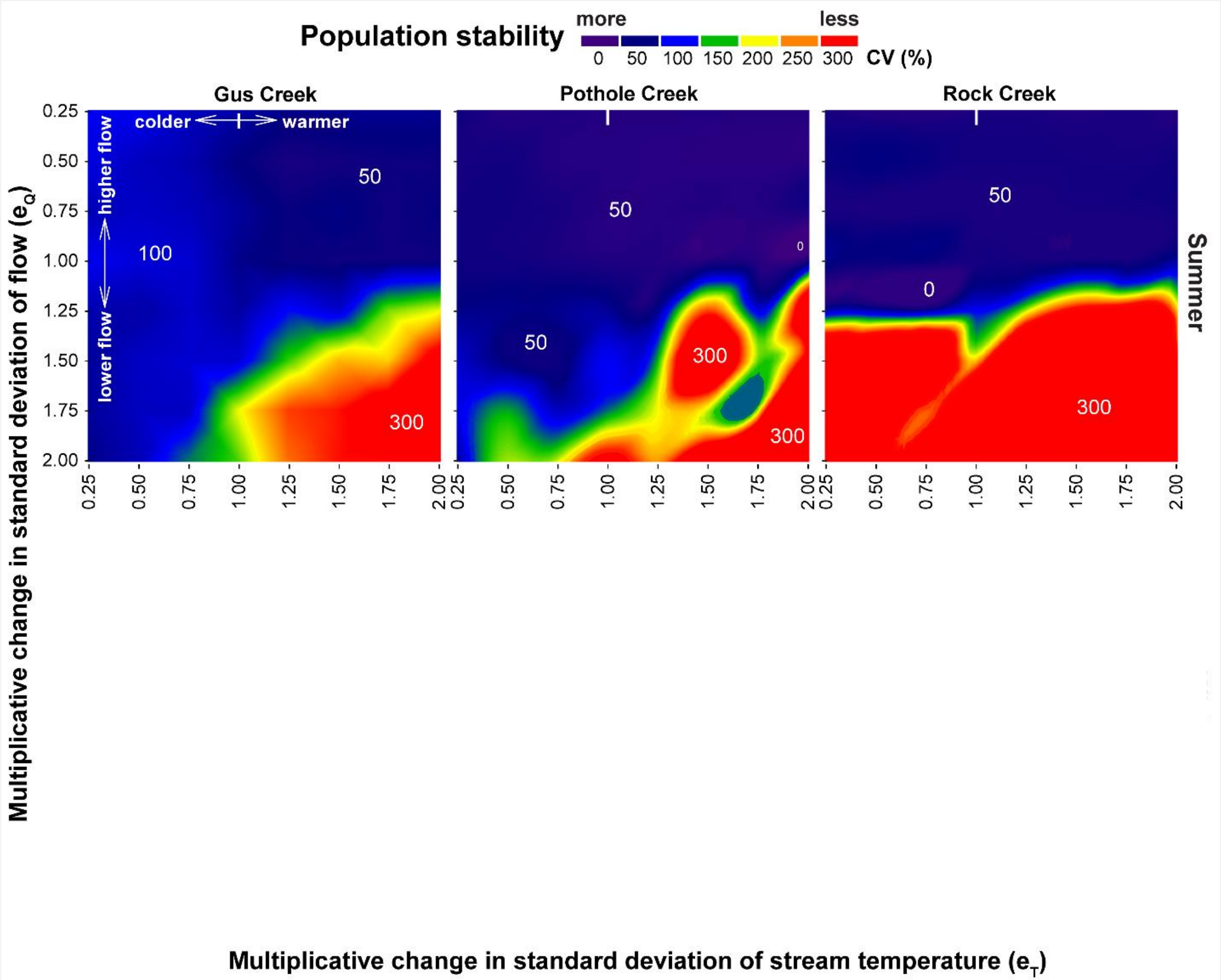

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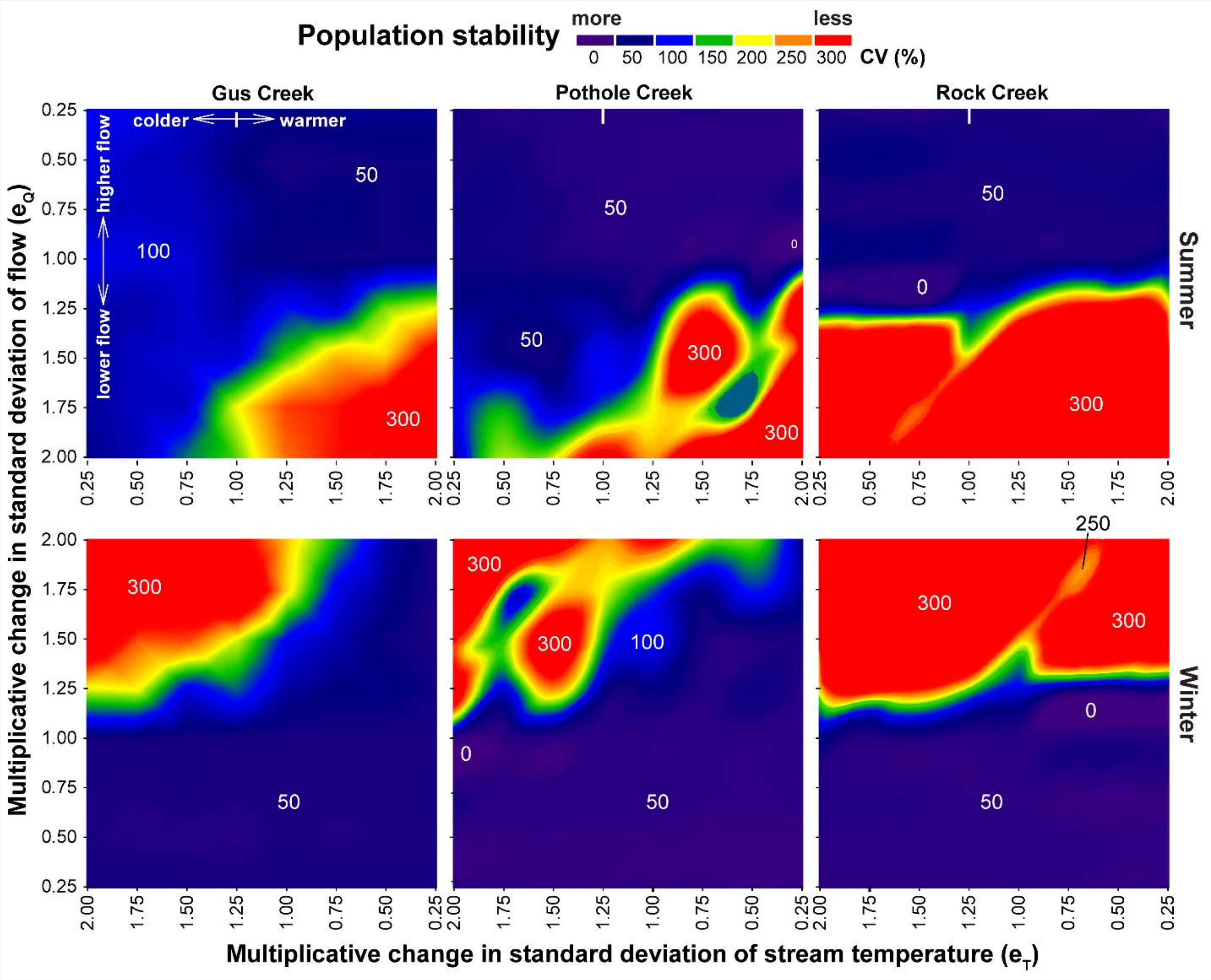
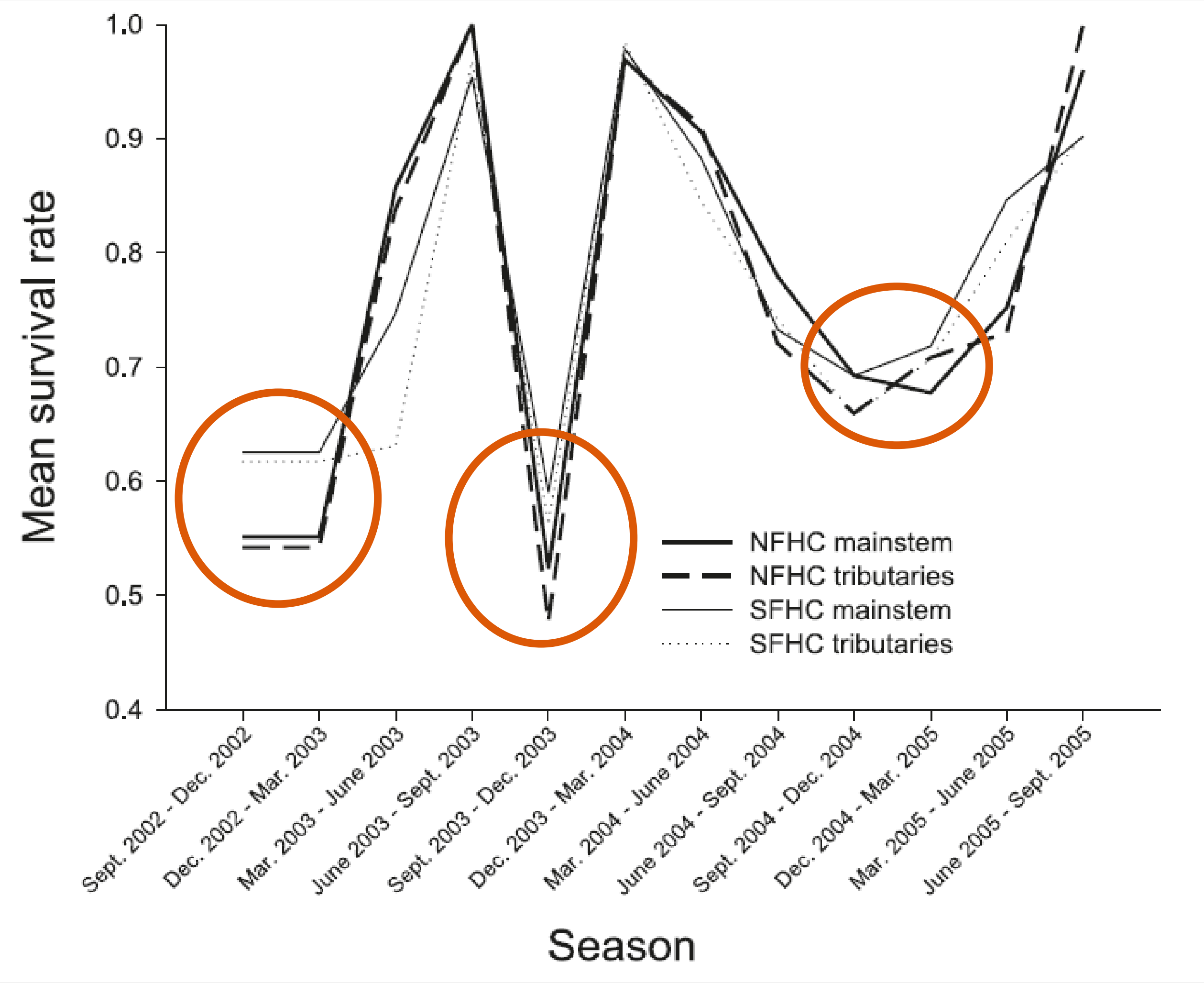


Deeper pools and more wetted area in summer support broader population structure in Gus Creek

Factor	Gus	Pothole	Rock
Watershed area (ha)	302.1	325.4	667.6
Wetted area in summer (ha)	**0.15**	**0.101**	**0.142**
Elevation (m)	469	324	337
Distance to hiding cover (m)	2.40	2.30	1.75
Velocity shelter	0.40	0.36	0.88
Spawning gravel	0.14	0.06	0.10
Winter velocity (m/s)	0.42	0.32	0.40
Winter depth (m)	0.54	0.29	0.63
summer velocity (m/s)	0.18	0.16	0.19
Summer depth (m)	**0.23**	**0.09**	**0.10**
Cells (no. per stream)	35	0.23	31

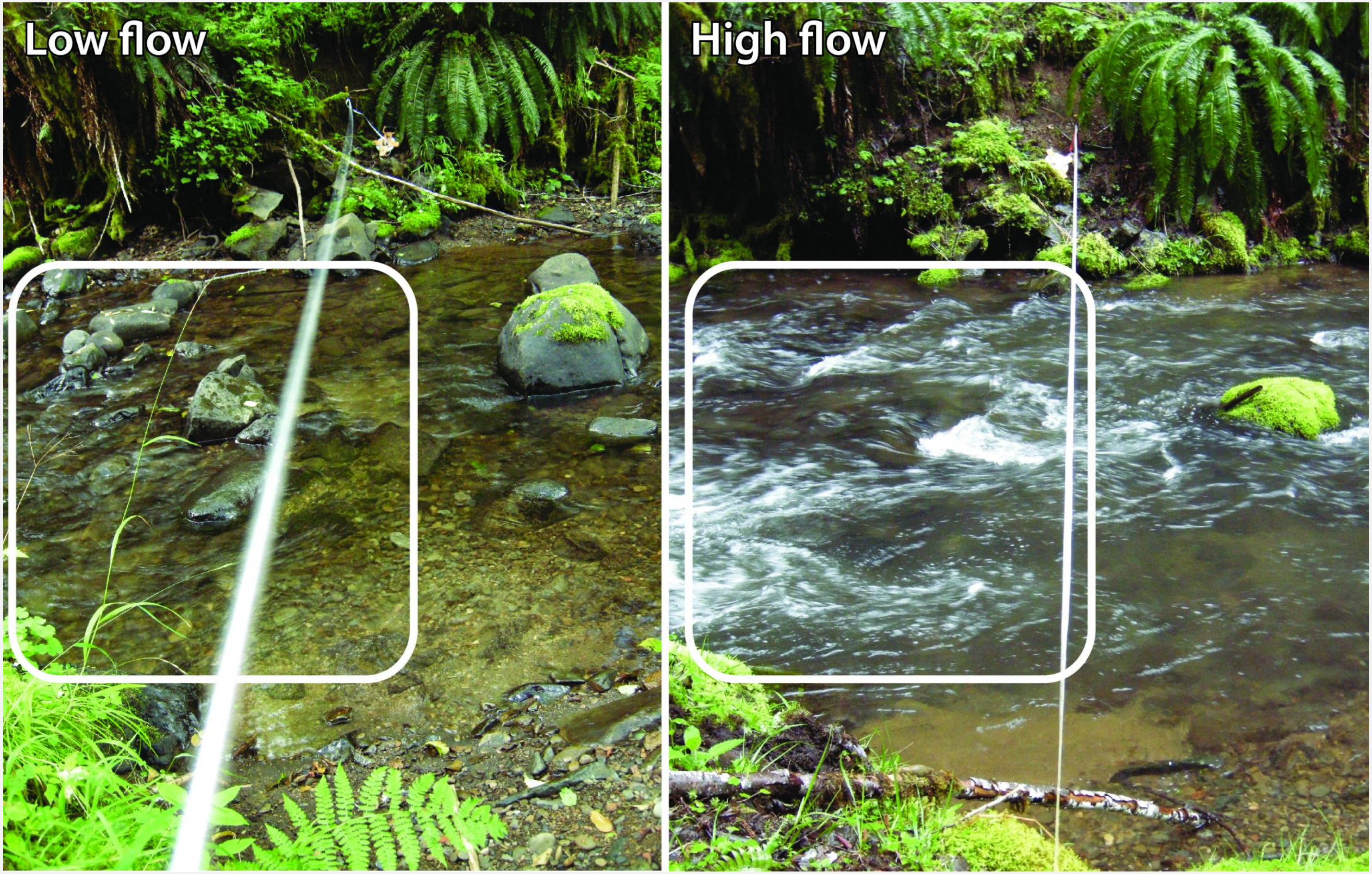
Penaluna et al.
2015 CJFAS

Cutthroat trout survival is depressed during low-flow

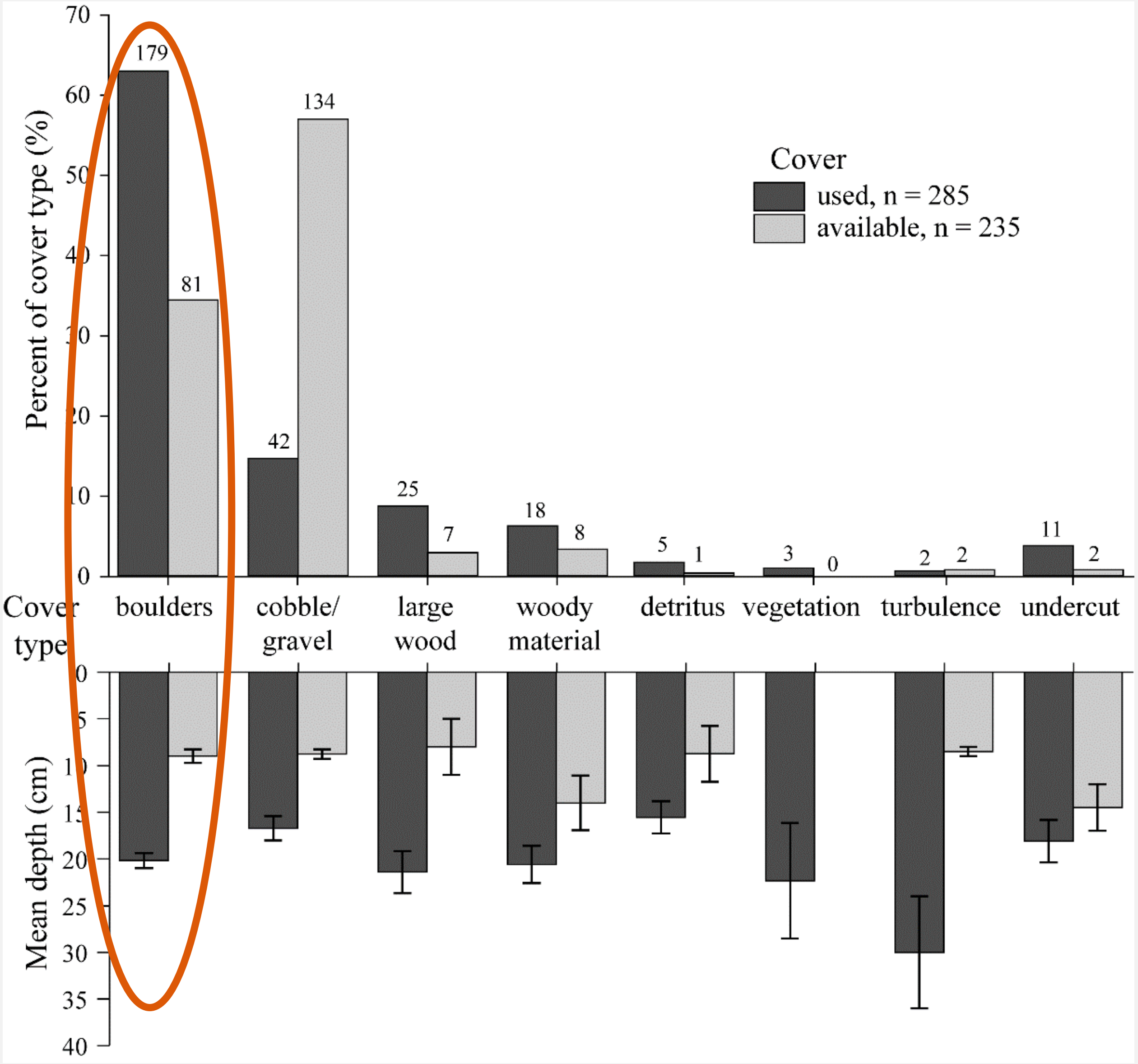


Berger and Gresswell 2009, CJFAS

In-stream cover is more limiting during seasonal low flow



Cutthroat trout strongly select boulders as instream cover



Penaluna, Andersen, and Dunham, in prep

Take Home Messages

- Increasing the variability of environmental regimes decreases the stability of trout populations, but effects are idiosyncratic due to stream conditions

- Trout responses to shifts in environmental regimes may not be apparent when examining only average conditions

- The risk of extirpation may increase under more extreme hydroclimatic events which are expected into the future

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Acknowledgements

Trask Watershed study

Trout drawing: Azita Roshani

Weyerhaeuser

Oregon Department of Forestry

Forest Service U.S. Department of Agriculture

OSU Oregon State University

USGS science for a changing world

U.S. Department of the Interior Bureau of Land Management