



Biological Responses to Seasonal Low Flow

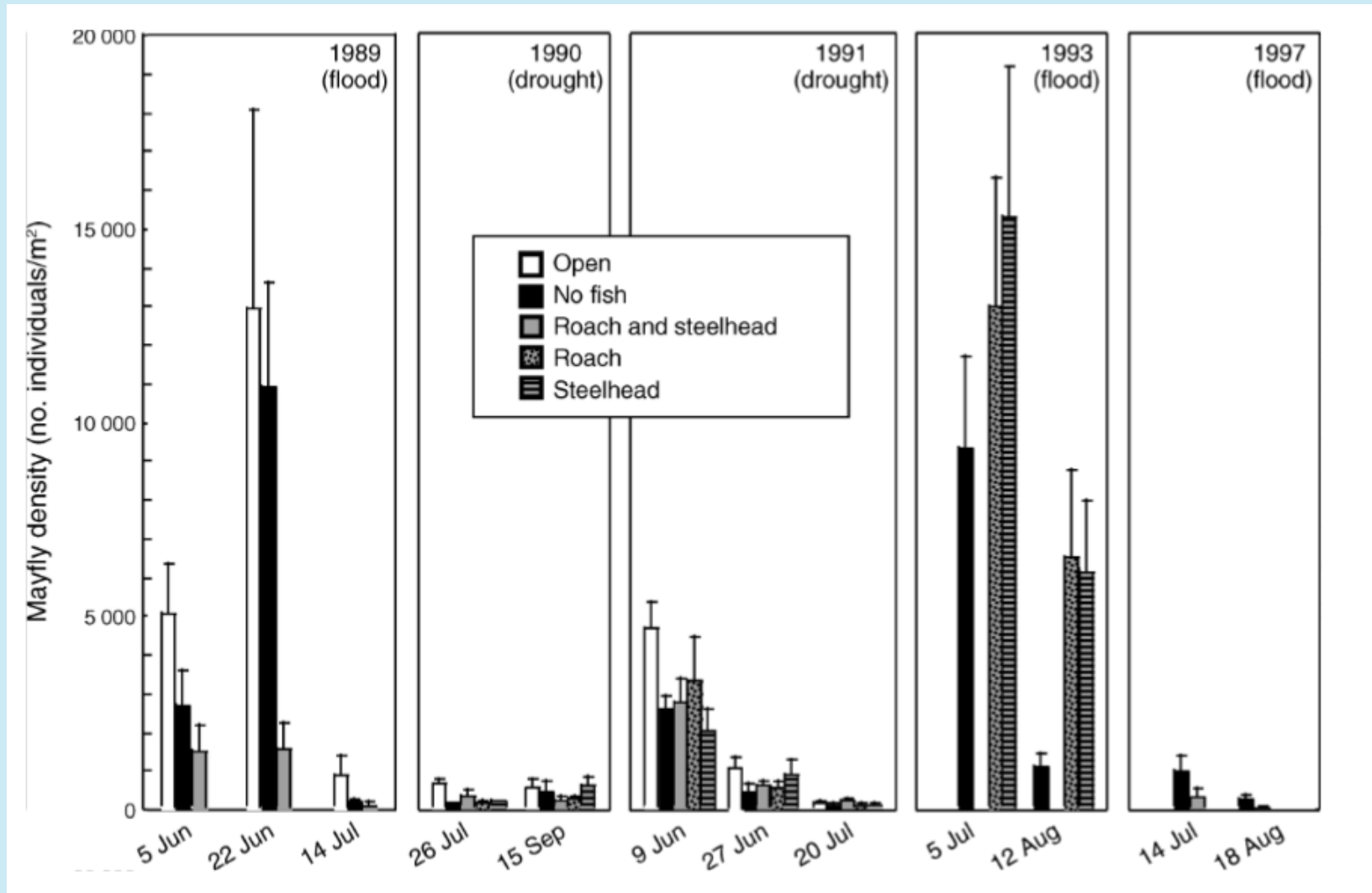
Brooke Penaluna
Research Fish Biologist
USFS Pacific Northwest Research Station

Seasonal low flow = ecosystem renewal

ecological crunch time/bottlenecks
concentration of resources



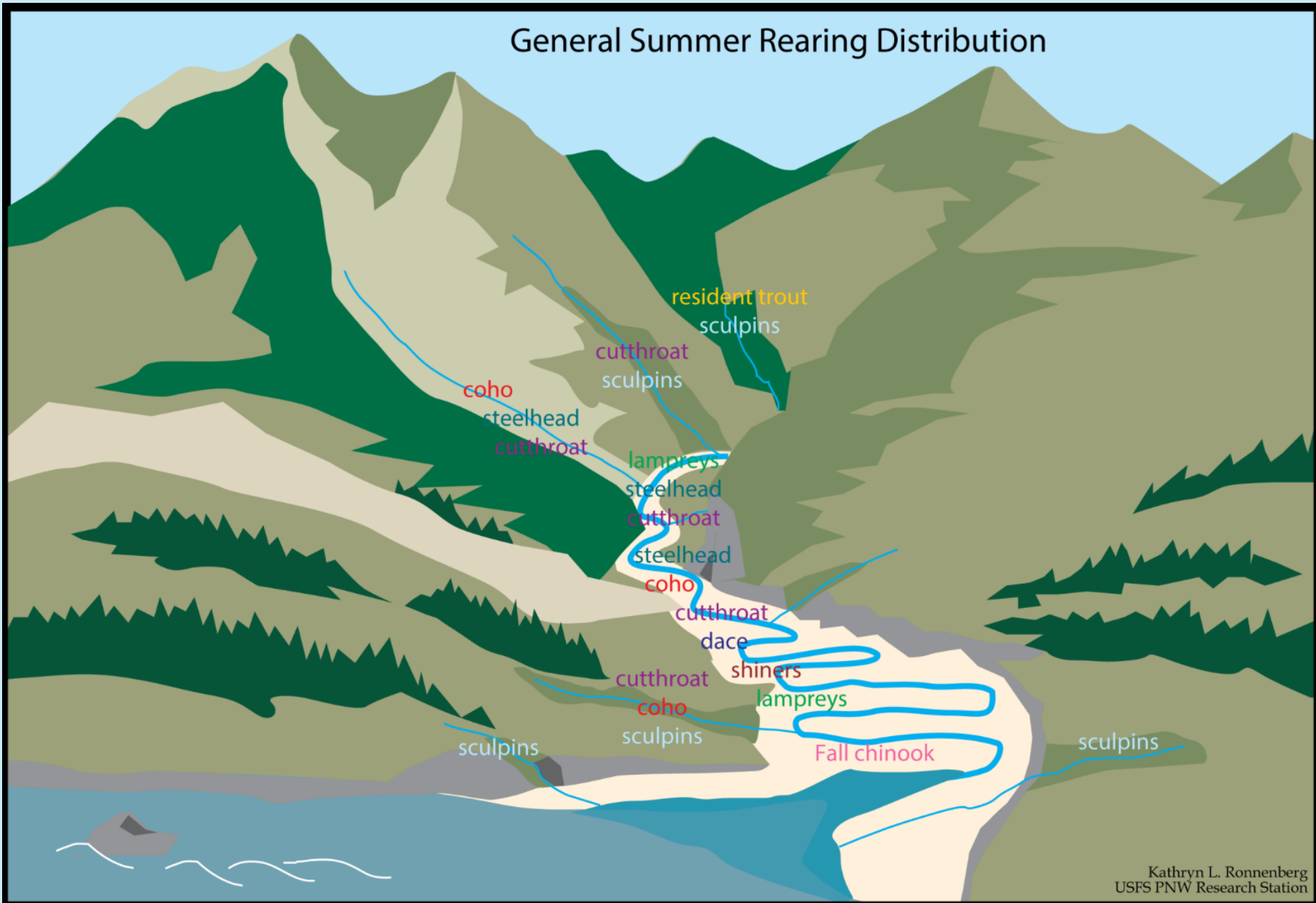
Dry years lead to less mayflies (and algae, chironomids, and caddisflies)



Exclosure experiments in south fork Eel River, CA

Power et al. 2008, EcoMonographs

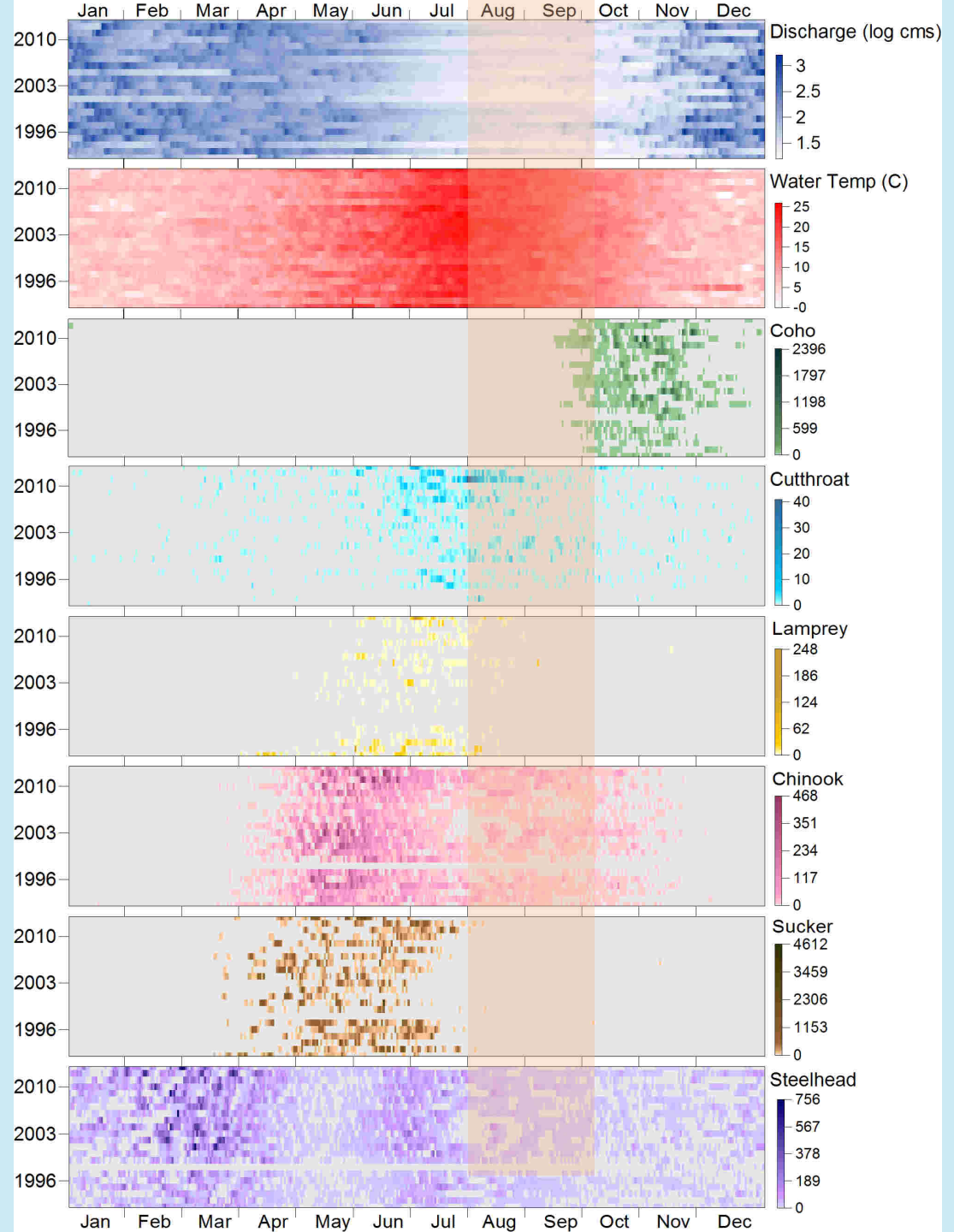
General Summer Rearing Distribution



Upriver Fish Migrations

Winchester Dam 1992-2013

Flitcroft et al. 2016



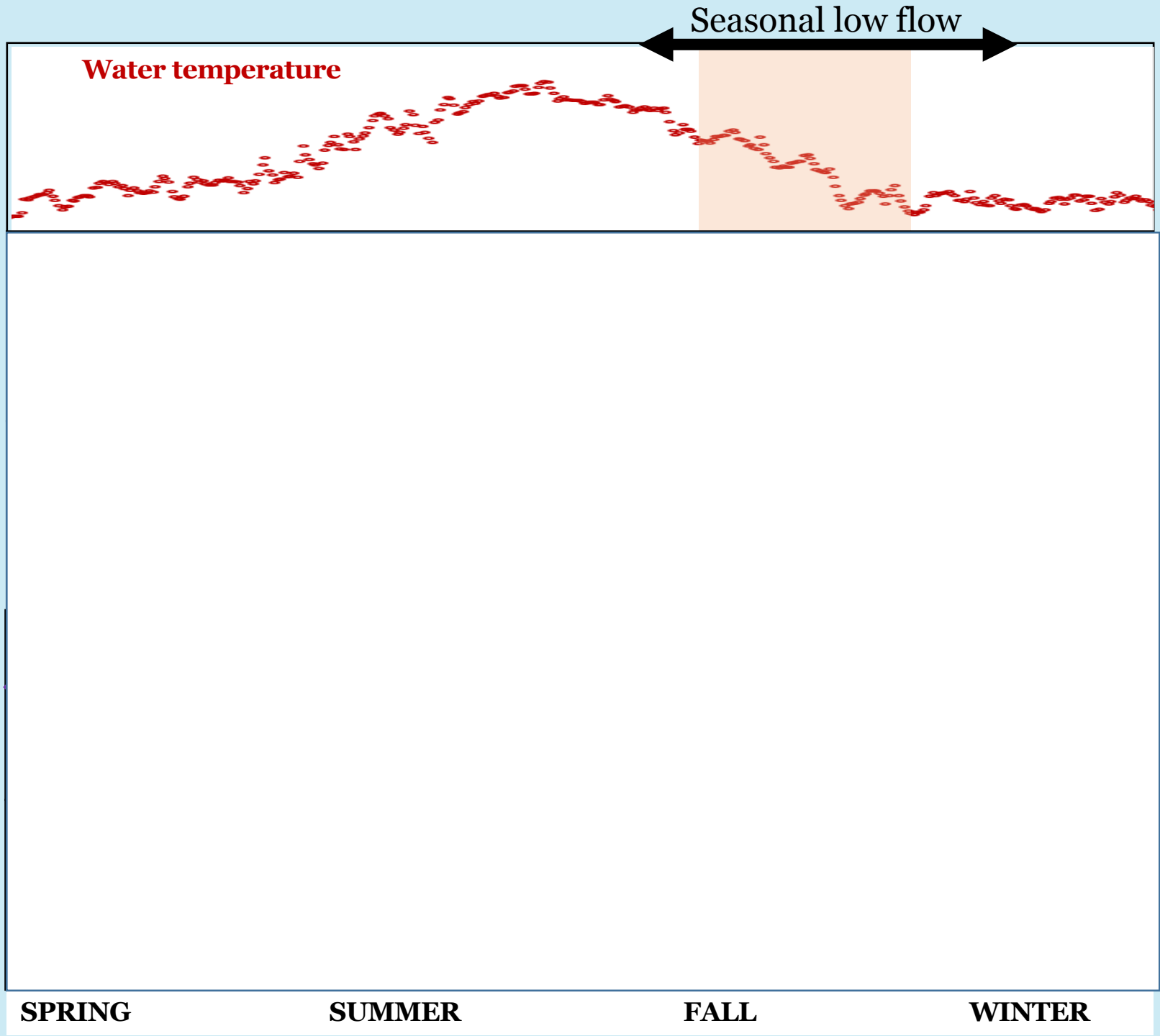
Habitat is less available during seasonal low flow



Low flow



High flow



Seasonal low flow

Water temperature



Discharge, habitat availability



SPRING

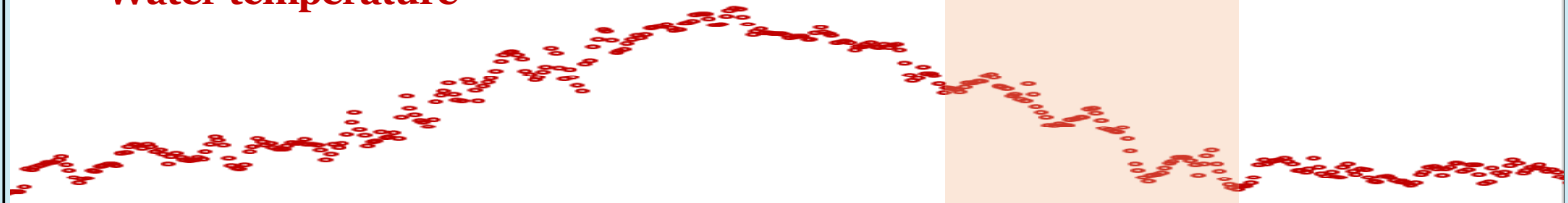
SUMMER

FALL

WINTER

Seasonal low flow

Water temperature



Discharge, habitat availability



Aquatic prey availability (per capita)



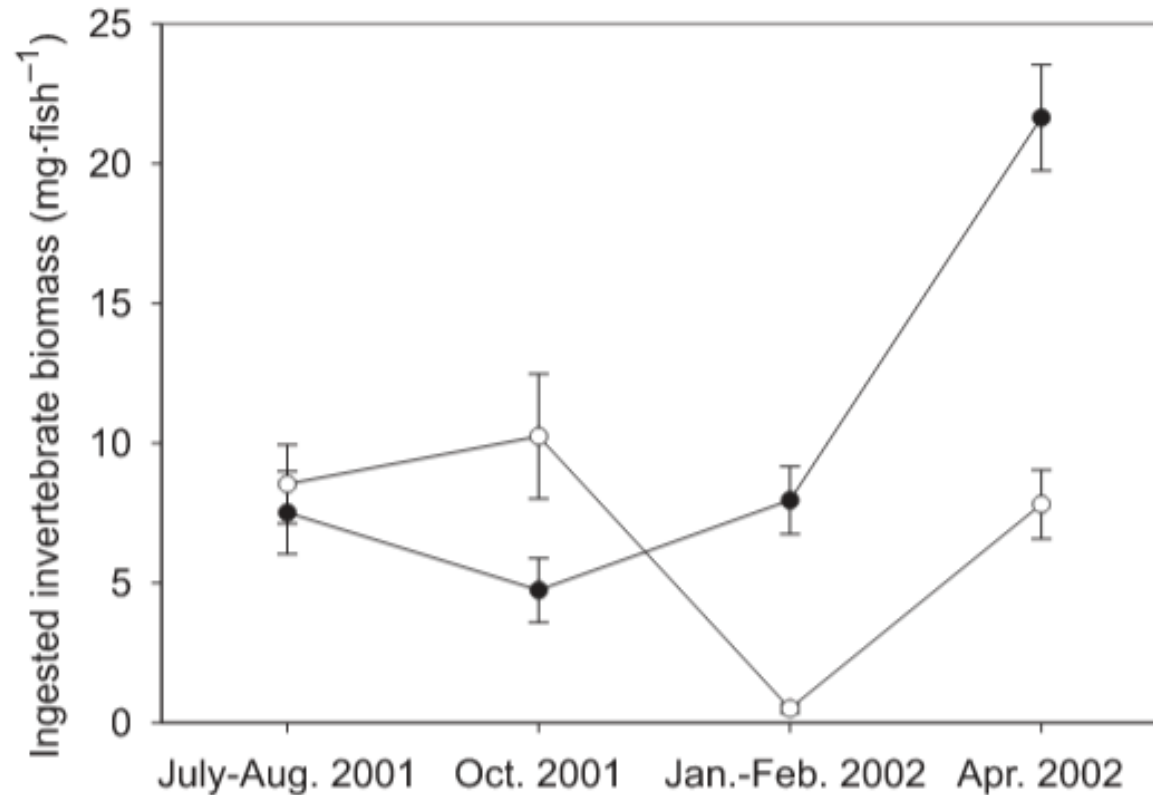
SPRING

SUMMER

FALL

WINTER

Cutthroat Trout consume more terrestrials during seasonal low flow



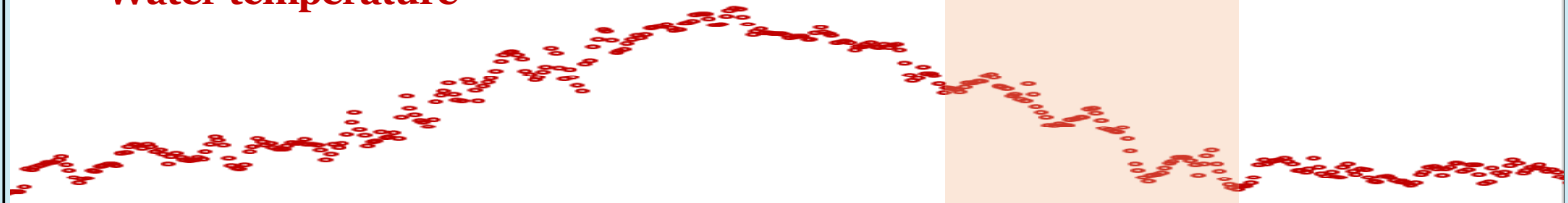
○ terrestrial

● aquatic

3 streams in Oregon Coast
Range
80-220 mm CCT

Seasonal low flow

Water temperature



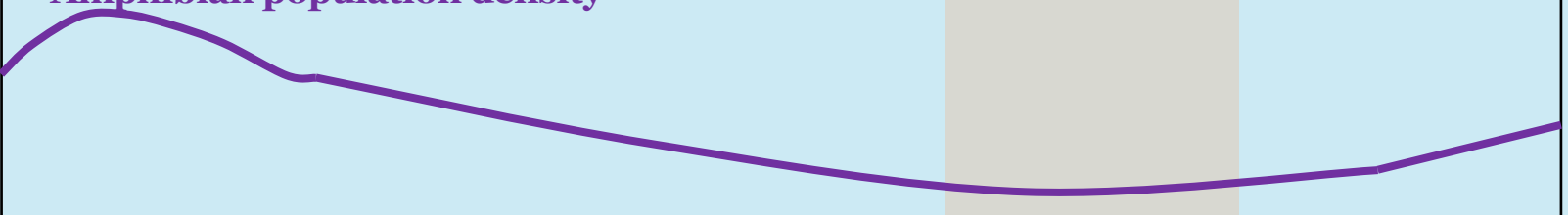
Discharge, habitat availability



Aquatic prey availability (per capita)



Amphibian population density



SPRING

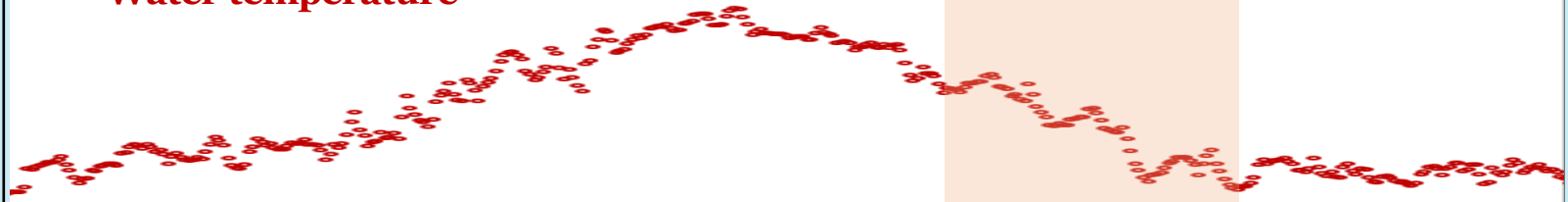
SUMMER

FALL

WINTER

Seasonal low flow

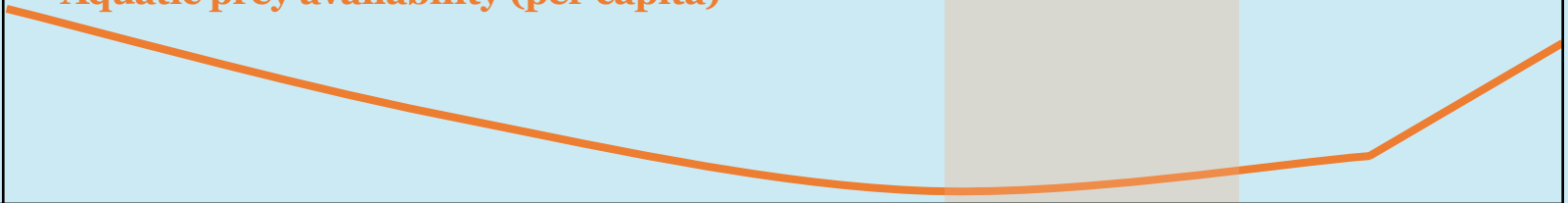
Water temperature



Discharge, habitat availability



Aquatic prey availability (per capita)



Amphibian population density



Fish population density



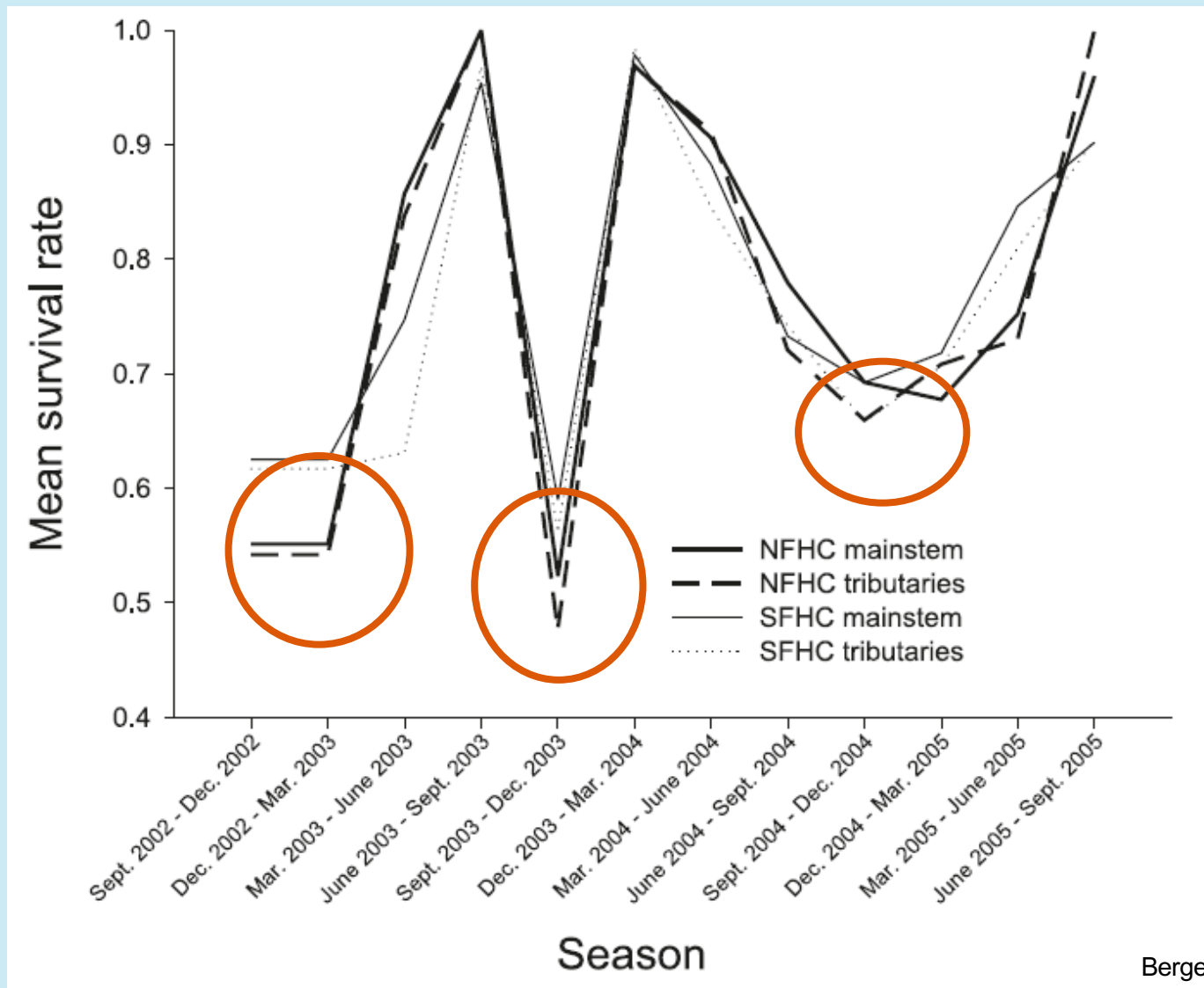
SPRING

SUMMER

FALL

WINTER

Cutthroat trout survival is depressed during seasonal low flow



Habitat is less available during seasonal low flow

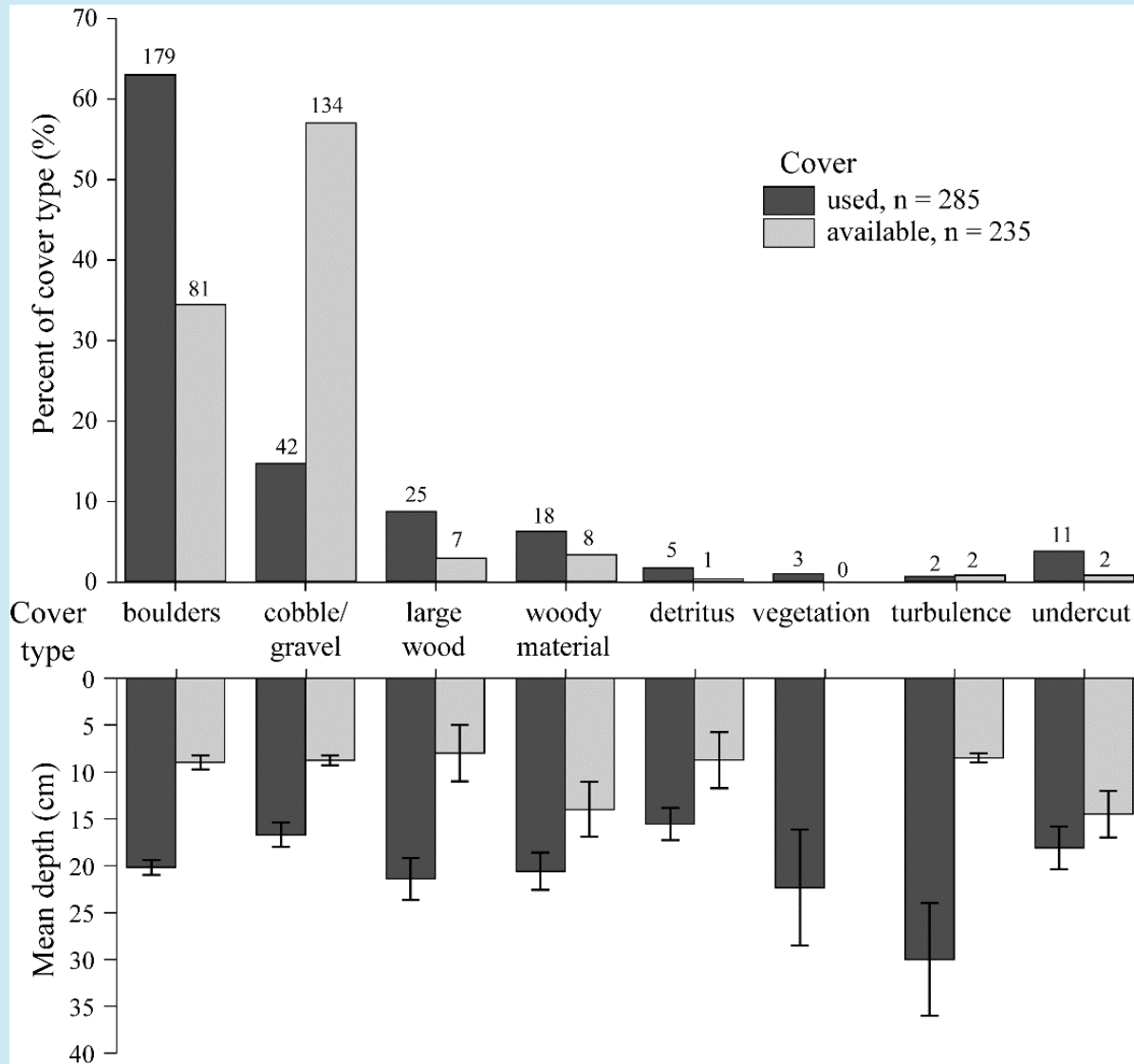


Low flow

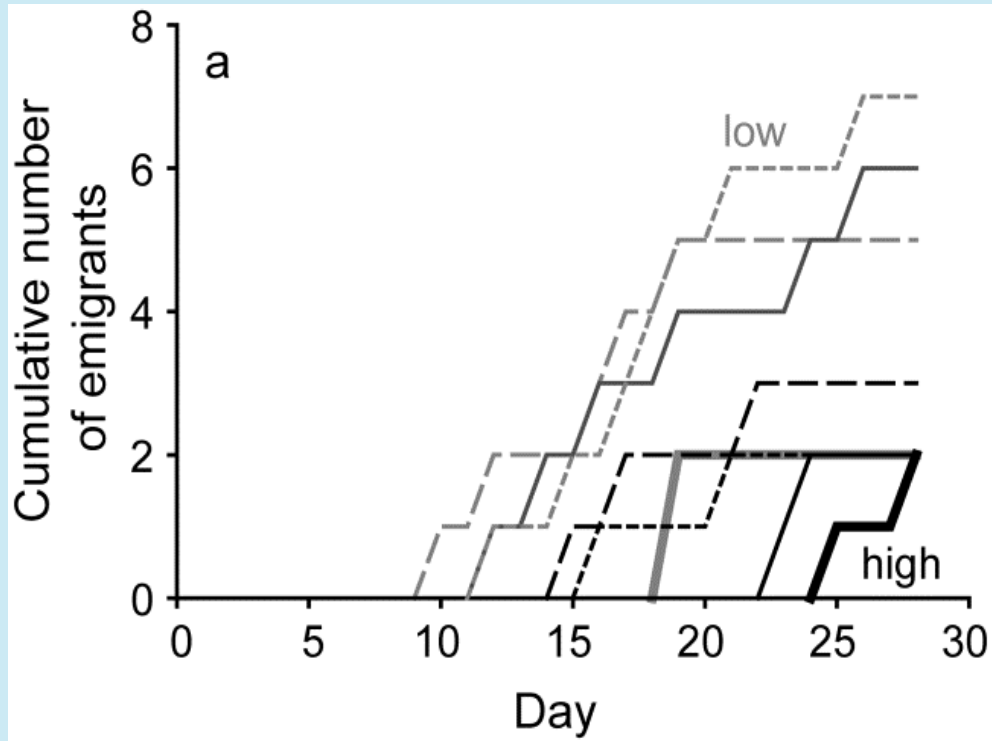


High flow

Cutthroat trout strongly select deeper water; boulders



Earlier and faster emigration when cover is limiting



◆ Low
◆ High

KS=0.040; D=0.080



Avian predation on fish can be significant



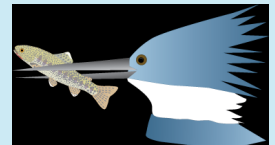
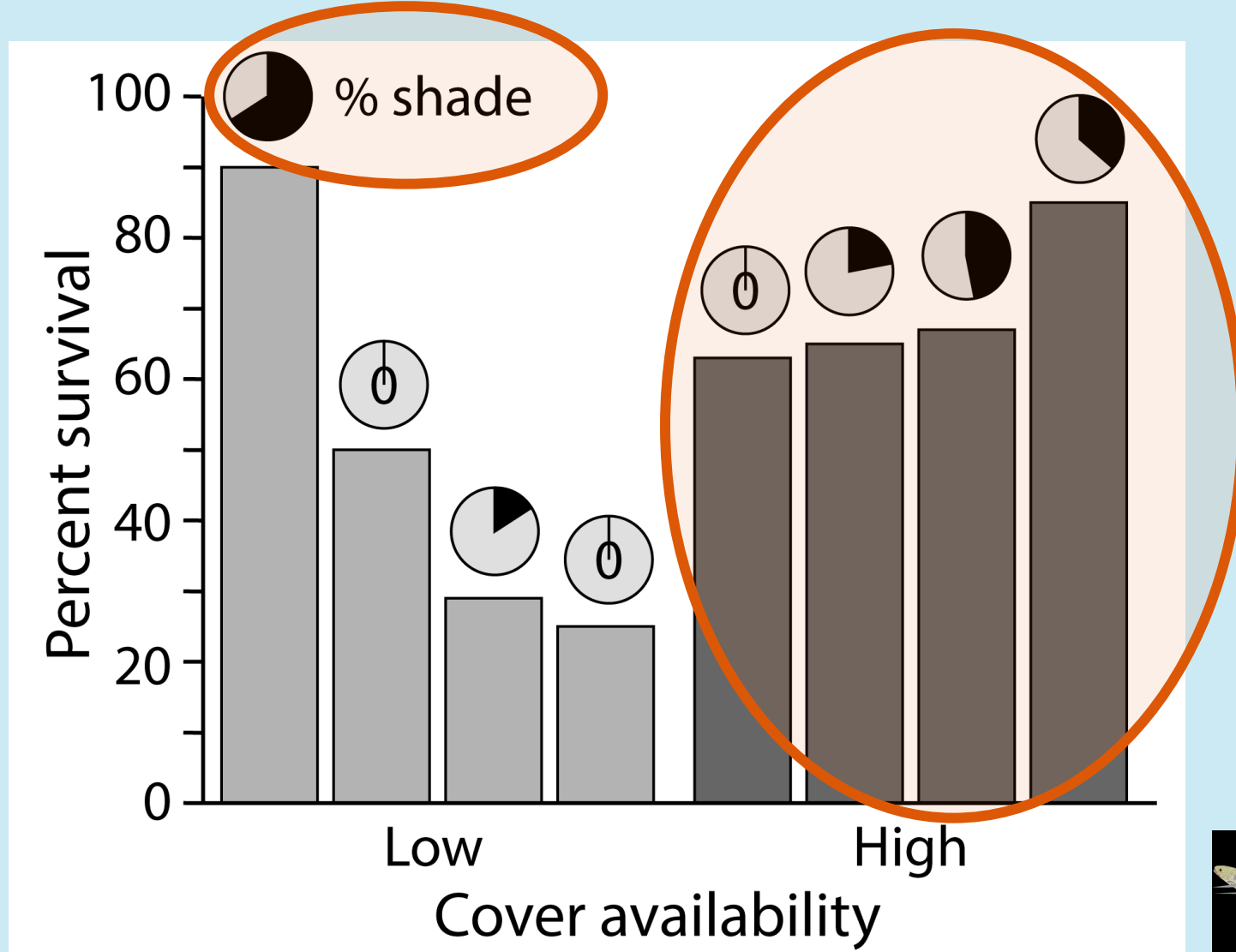
Belted Kingfisher



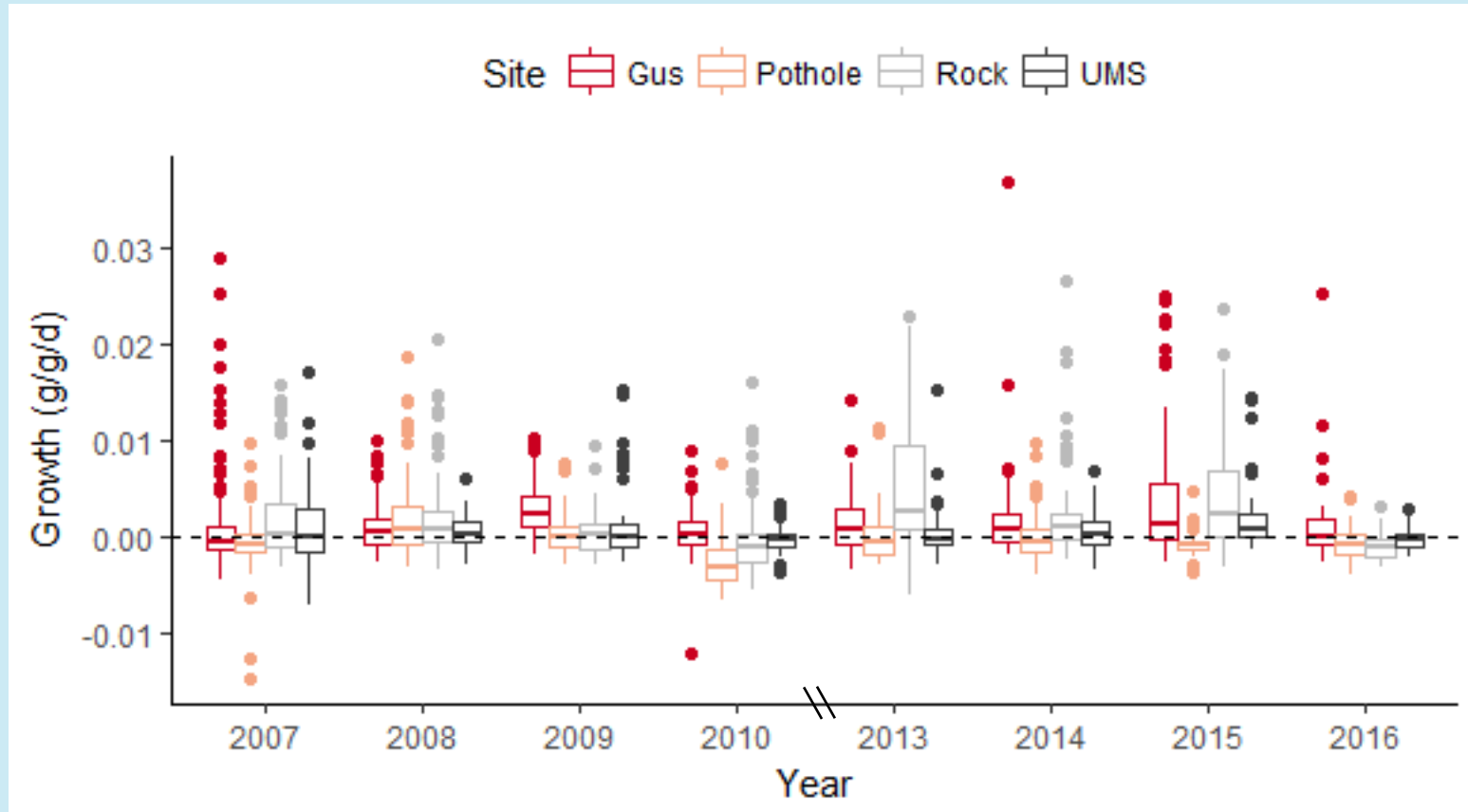
Screech Owl
Harvey and Nakamoto 2013



More cover and shade improve Cutthroat Trout survival



Cutthroat Trout have minimal growth during seasonal low flow



2,524 observations

Mean = 0.0012

46% lost mass

L. Jensen, 2017 MS Oregon St

Sculpins lose weight during seasonal low flow



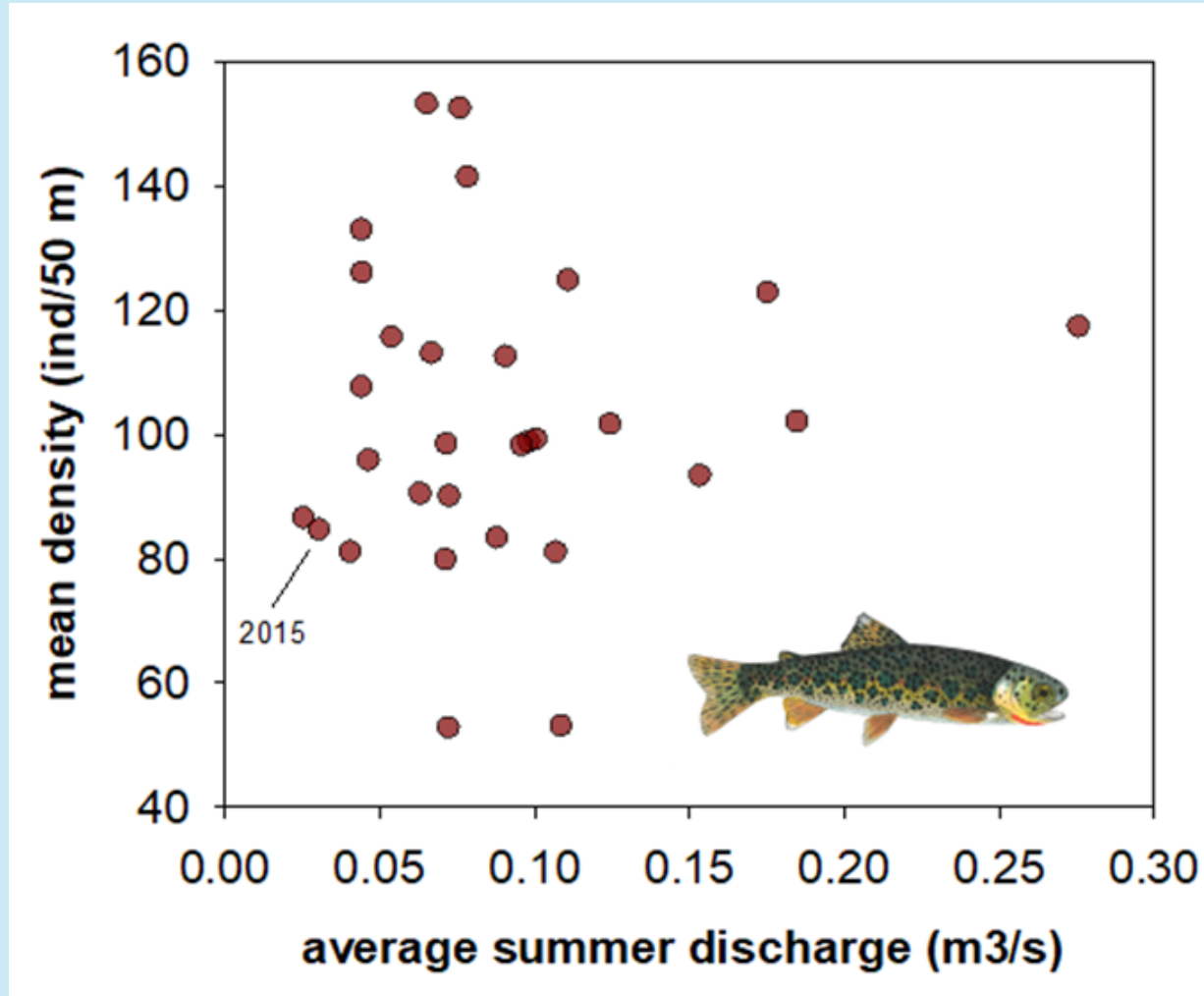
208 observations

Mean = -0.00033

66% lost mass

L. Jensen, 2017 MS Oregon St

Seasonal low flow has a less clear relationship with trout density

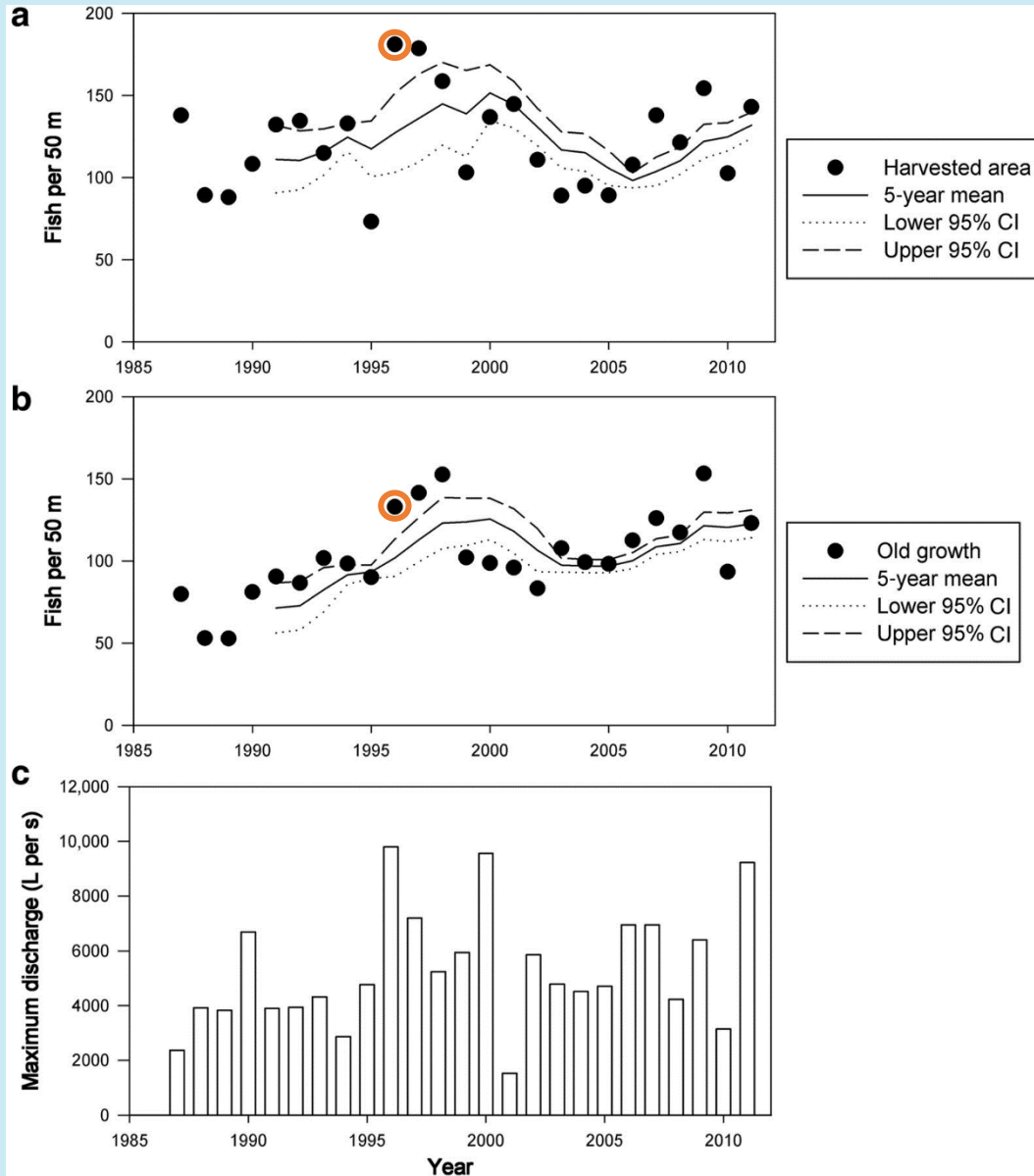


Mack Creek Old Growth Forest - Adults+YOY (1987-2016)

Gregory et al., in prep

Gregory/Arismendi long-term data

High winter flows yield higher trout densities



Dodd et al., 2012
Gregory/Arismendi long-term data

Take Home Messages

- Seasonal low flow concentrates resources
- Trout eat more terrestrial prey during seasonal low flow
- Instream cover and shade improve trout survival
- Shade, in addition to providing temperature refuge, provides a zone that deters predators
- When instream cover is limiting, there is more emigration of trout out of stream sections
- Management plans can enhance instream cover, shade, and pools, which are important to trout during seasonal low flow



Acknowledgements

Sherri Johnson, Jason Dunham, Ivan Arismendi, Dede Olson, Dave Roon, Bob Danehy

Contact information:

Brooke Penaluna, PhD

PNW Research Station

bepenaluna@fs.fed.us

#brookepenaluna



Tectah Creek, northern CA
Photo credit: David Roon



Rock Creek, northern OR