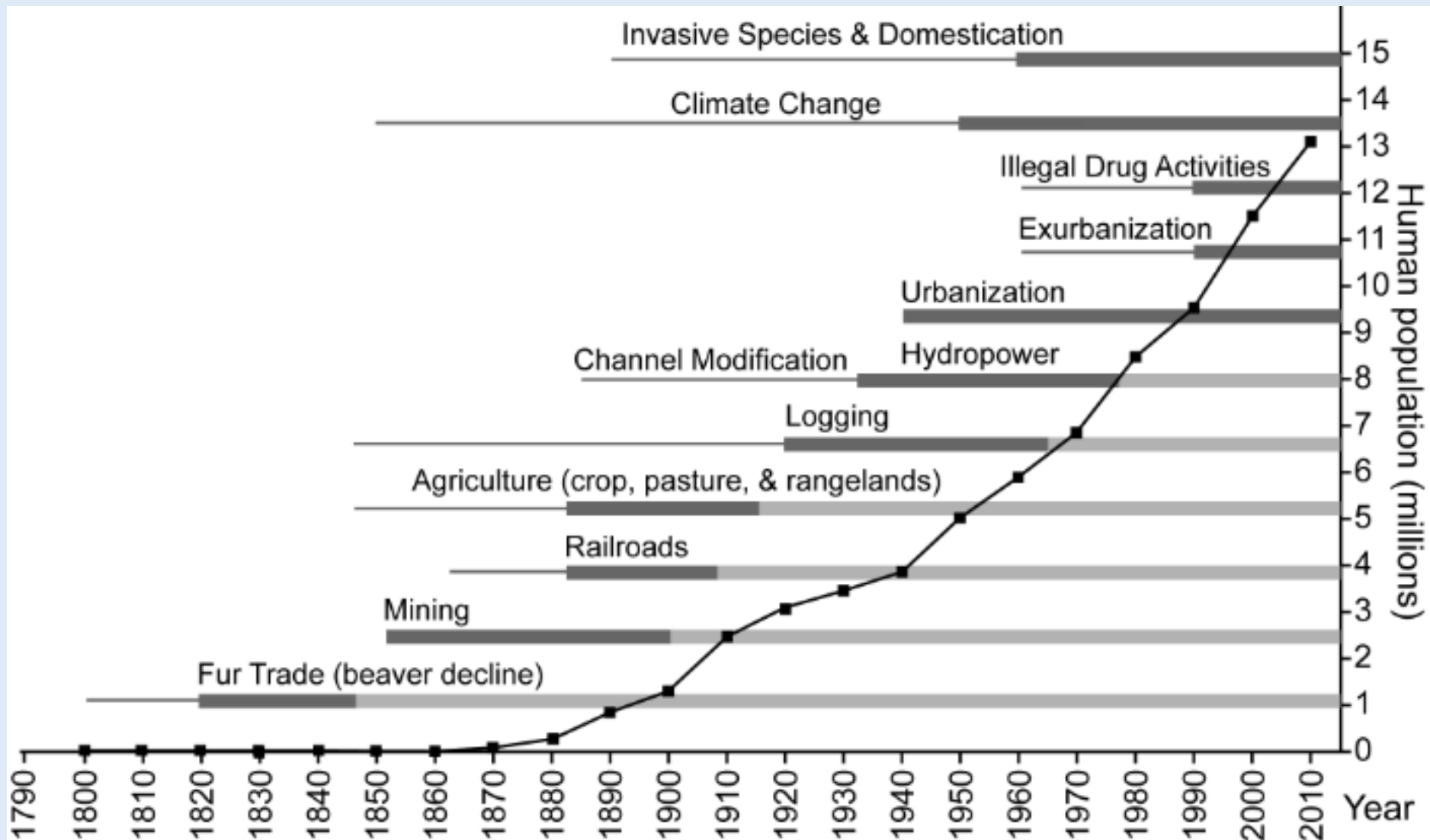


# Effects of Climate Change on Salmonids in the Columbia River Watershed



Brooke Penaluna  
PNW Research Station  
USDA Forest Service

# Climate change occurs simultaneously with other stressors



# Expected effects of Climate change 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

# General hypotheses related to climate change impacts on species

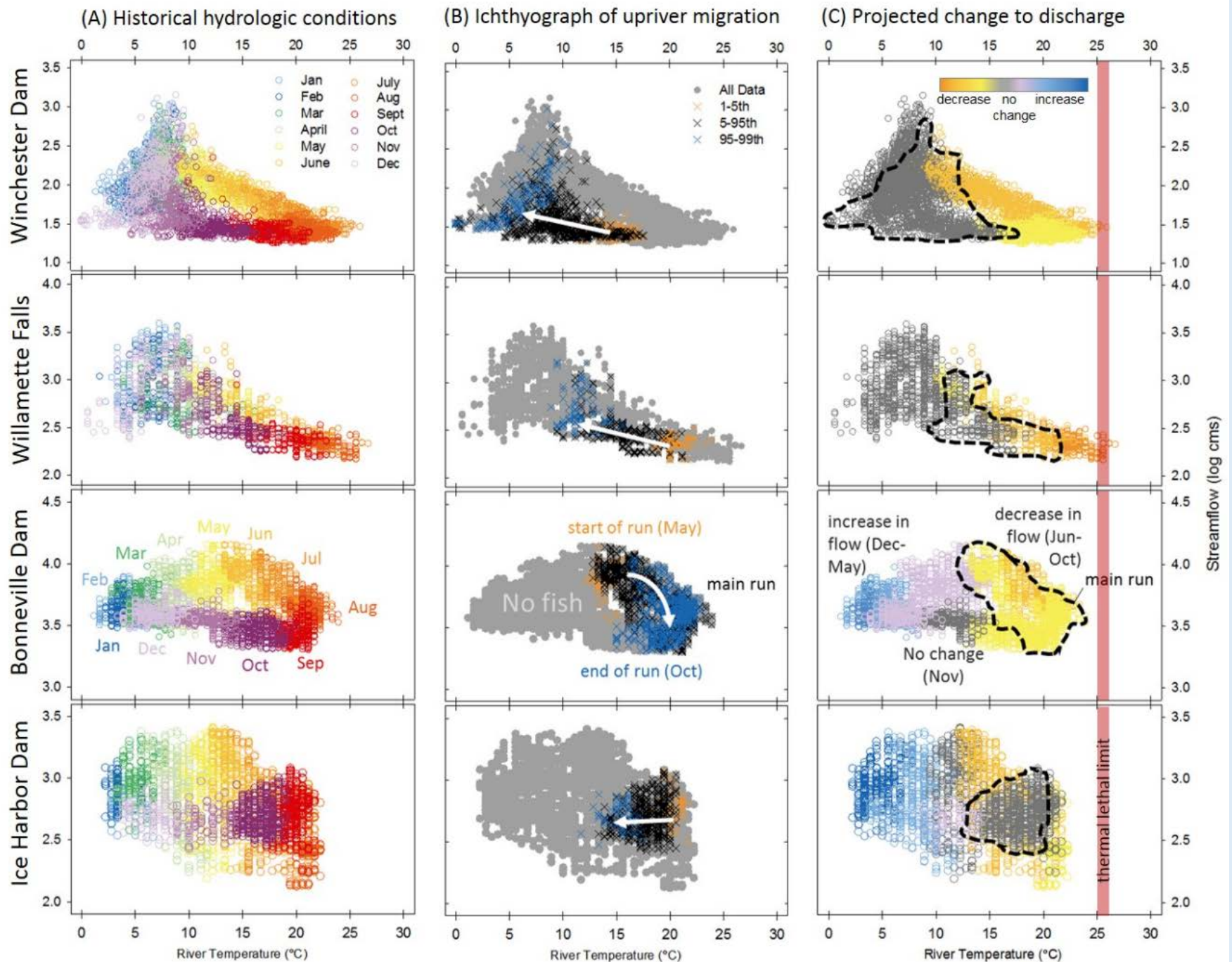
Shifts in species range towards poles (Parmesan and Yohe 2003)

Changes in timing of key life events (Walther et al. 2002, Parmesan and Yohe 2003, Thackeray et al. 2016, Cohen et al. 2018)

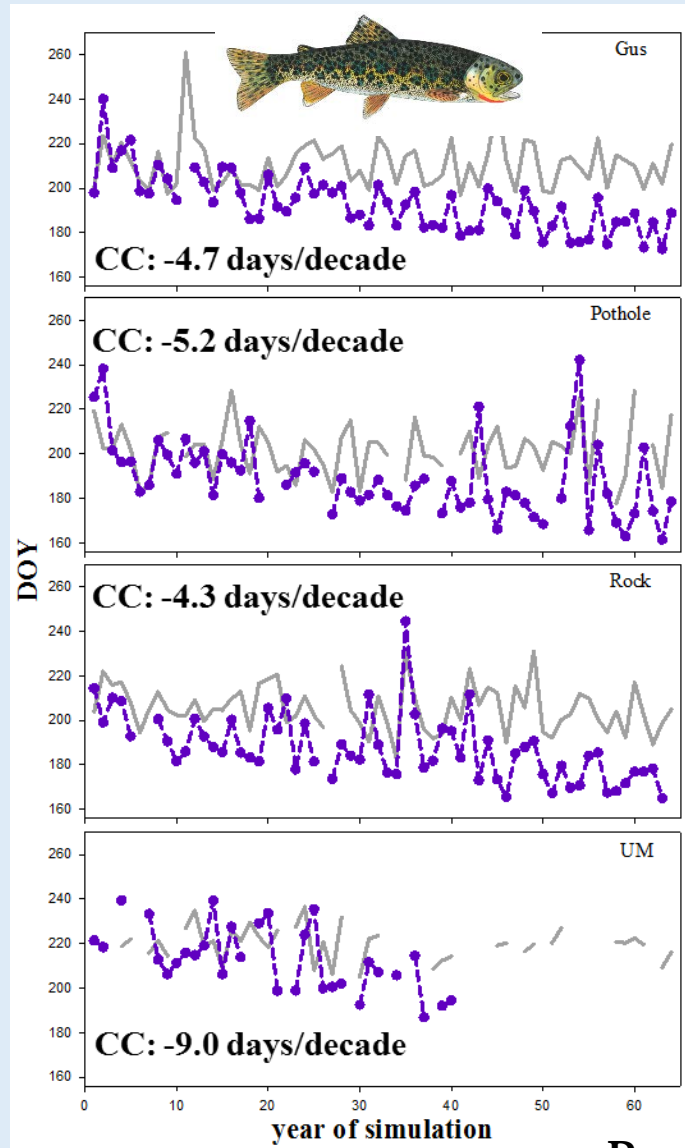
Shrinking body size (Daufresne et al. 2009)



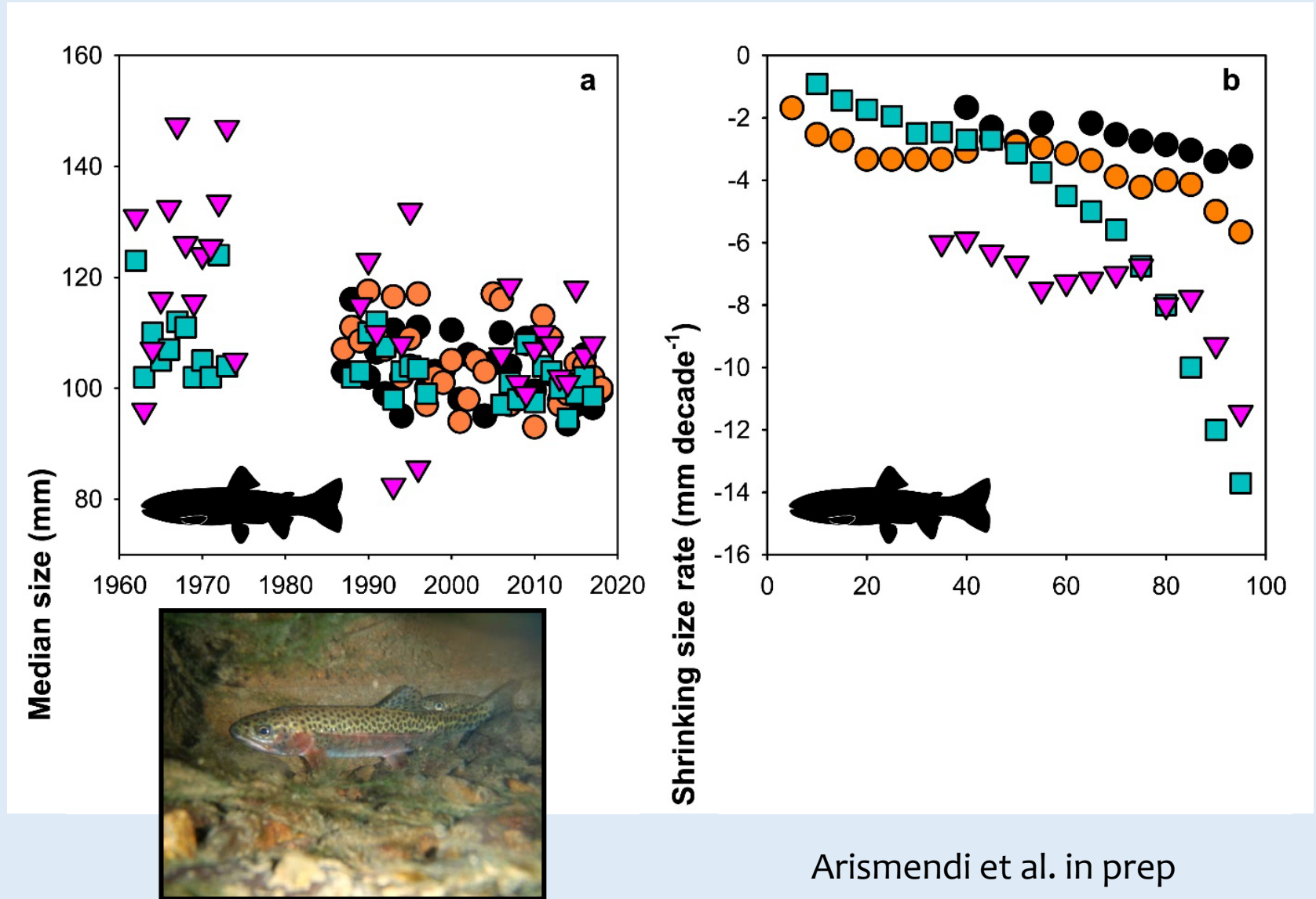




# Trends towards earlier fry emergence of trout under climate change



# Trout are shrinking under climate change





Very High

Central California Coast Coho\*\*\*  
 Sacramento River winter-run Chinook  
 Central Valley spring-run Chinook  
 Central Valley fall/late fall-run Chinook  
 Upper Willamette River Chinook  
 Snake River Sockeye

High

*Southern Oregon/Northern California Coast Coho\*\*\**  
*Mid-Columbia spring-run Chinook\*\*\**  
 Upper Columbia River spring-run Chinook  
 California Coastal Chinook  
 Puget Sound Chinook  
 Snake River Basin Steelhead  
 Southern California Coast Steelhead  
 Middle Columbia River Steelhead  
 Upper Columbia River Steelhead  
 Puget Sound Coho  
 Puget Sound Steelhead  
 Snake River fall-run Chinook  
 Hood Canal summer-run Chum  
 Upper Willamette River Steelhead  
 Lower Columbia River Coho  
 Oregon Coast Coho

Snake River  
 spring/summer-  
 run Chinook

Moderate

Puget Sound Chum  
 Columbia River Chum

Central California Coast Steelhead  
 South Central California Coast Steelhead  
 Northern California Steelhead  
 Central Valley Steelhead  
 Lower Columbia River Steelhead  
 Lower Columbia River Chinook  
 Lake Ozette Sockeye

Low

Puget Sound Pink

Low

Moderate

High

Very High

Exposure

# Columbia River is THE migratory corridor for salmonids





# Columbia River is THE migratory corridor for salmonids



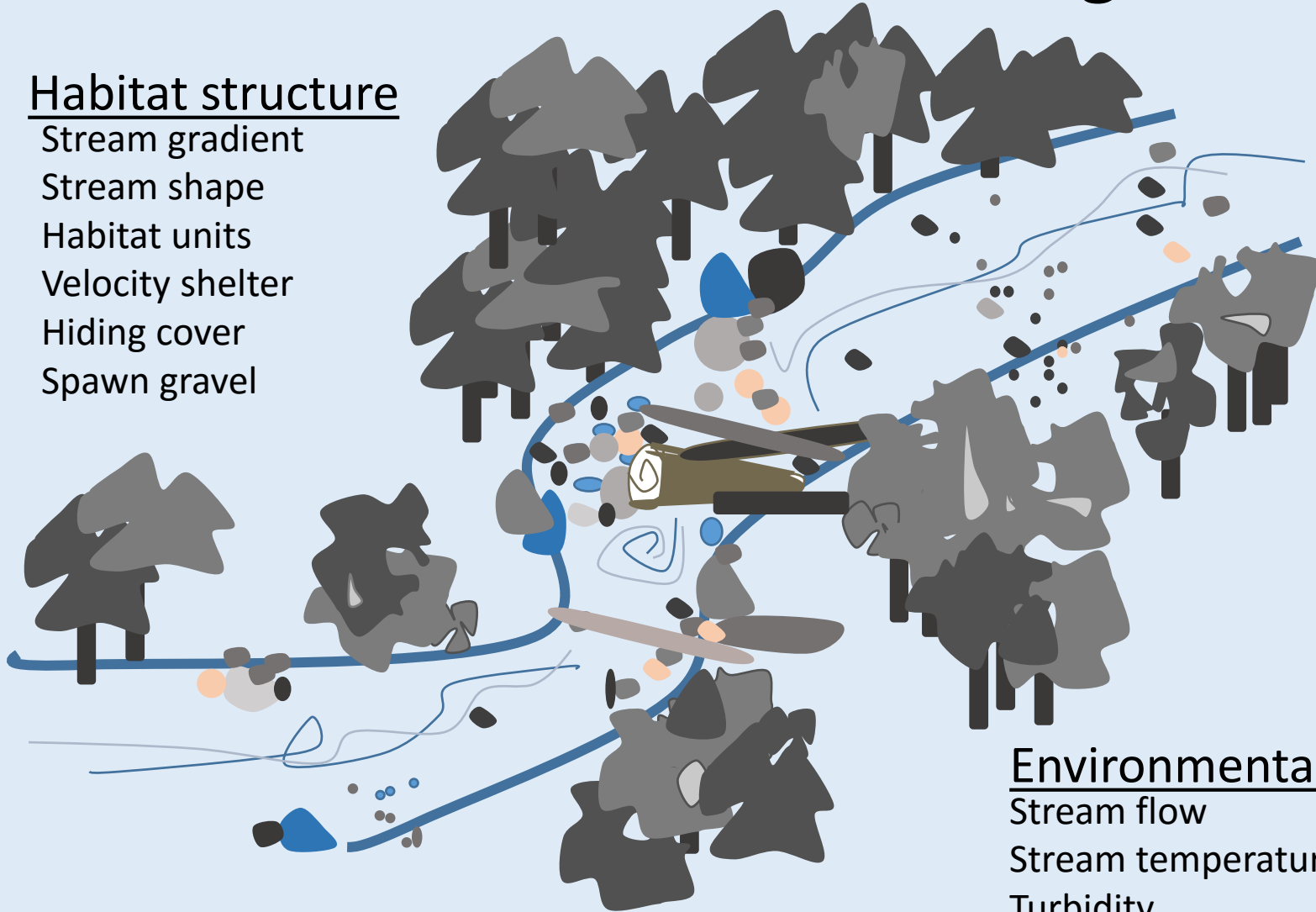
*Illustration of potential cold water refuges along the Columbia River Migration Corridor.*

Support conservation plans prioritizing cold water refugia on the Columbia River

# Local habitat conditions can mediate the effects of climate change

## Habitat structure

Stream gradient  
Stream shape  
Habitat units  
Velocity shelter  
Hiding cover  
Spawn gravel



## Environmental regimes

Stream flow  
Stream temperature  
Turbidity  
Nutrients

# SALMONSCAPE



Artwork by Ray Troll