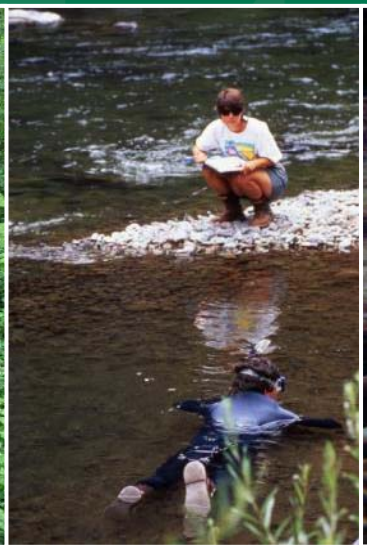
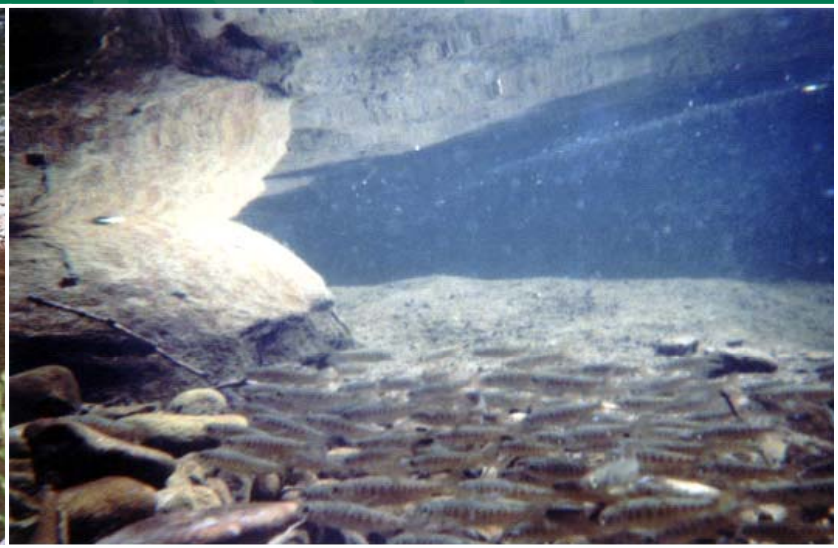
COLD-WATER REFUGES FOR CLIMATE RESILIENCE IN OREGON COASTAL STREAMS

Joe Ebersole1, Christian Torgersen2, and Dru Keenan3

U.S. Environmental Protection Agency, Western Ecology Division, Corvallis, Oregon, USA
U.S. Geological Survey FRESC, Cascadia Science Center, Seattle, WA, USA
U.S. Environmental Protection Agency, Region 10, Seattle, WA, USA

Mid-Coast Temperature Technical Working Group April 13, 2016

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Importance of Thermal Diversity in Riverine Landscapes

Habitats…that convey spatial and temporal resistance and/or resilience to biotic communities that have been impacted by biophysical disturbances may be called refugia.

(Sedell, Reeves, Hauer, Stanford, and Hawkins 1990)

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Overview

- Definitions
- Context and Policy Drivers
- Formative processes
- Biotic considerations
- “Restoration?”

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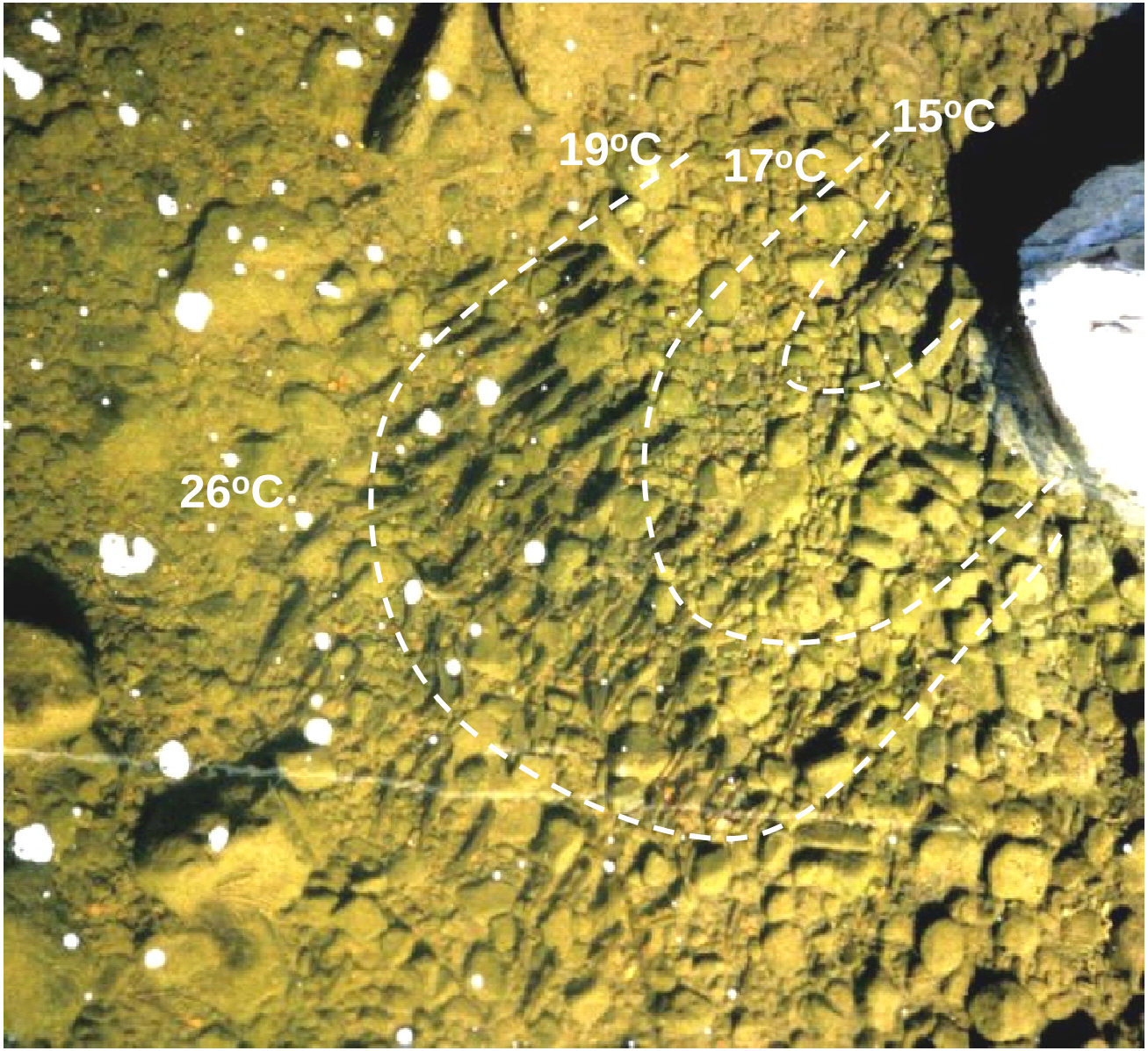
Cold-water refuges

- Are colder than surrounding areas
- Provide resources necessary for survival during periods of thermal stress



Watershed Sciences/DEQ/Aimee Fullerton

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Cold-water refuges

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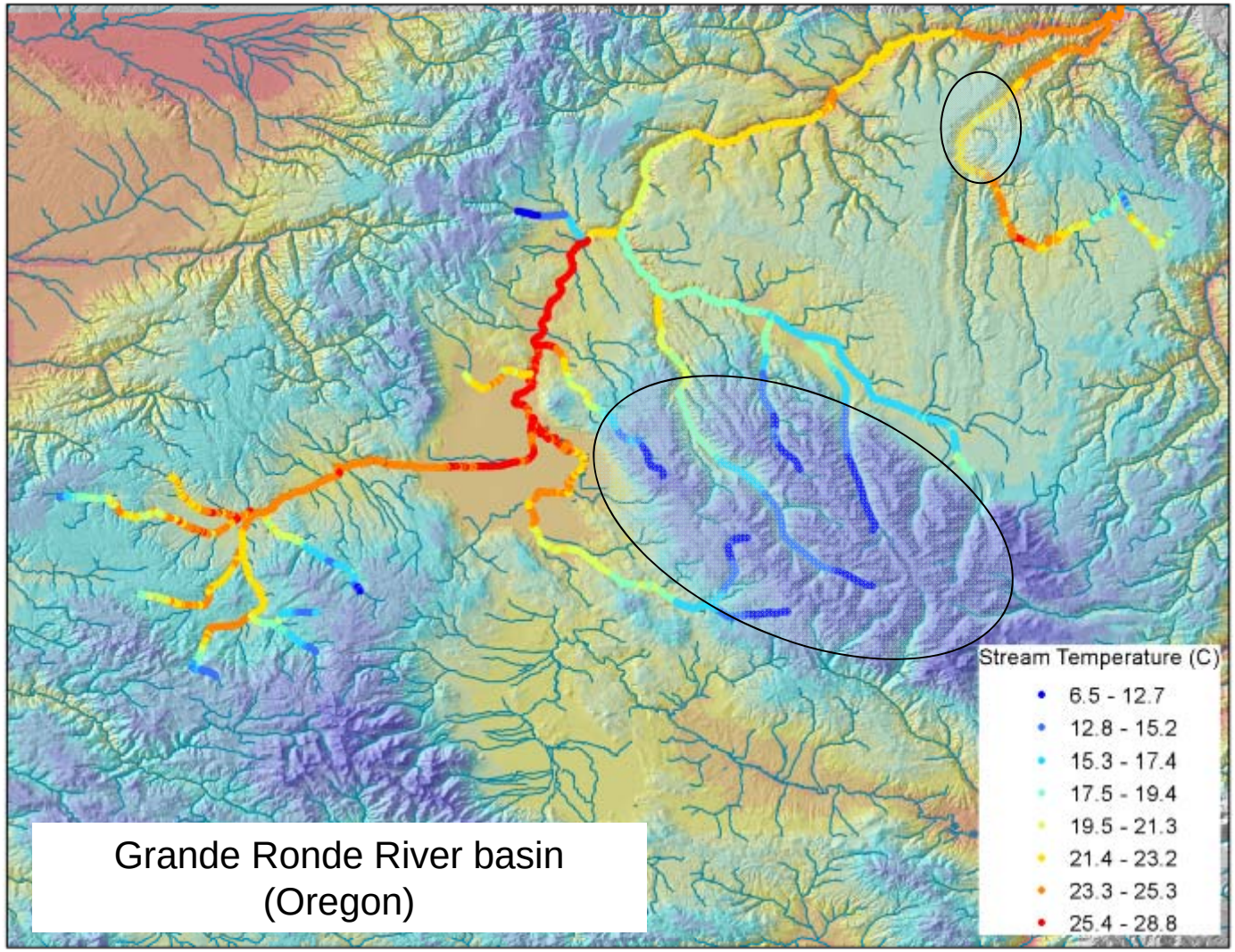

Grande Ronde River basin (Oregon)

Watershed Sciences/DEQ/Aimee Fullerton

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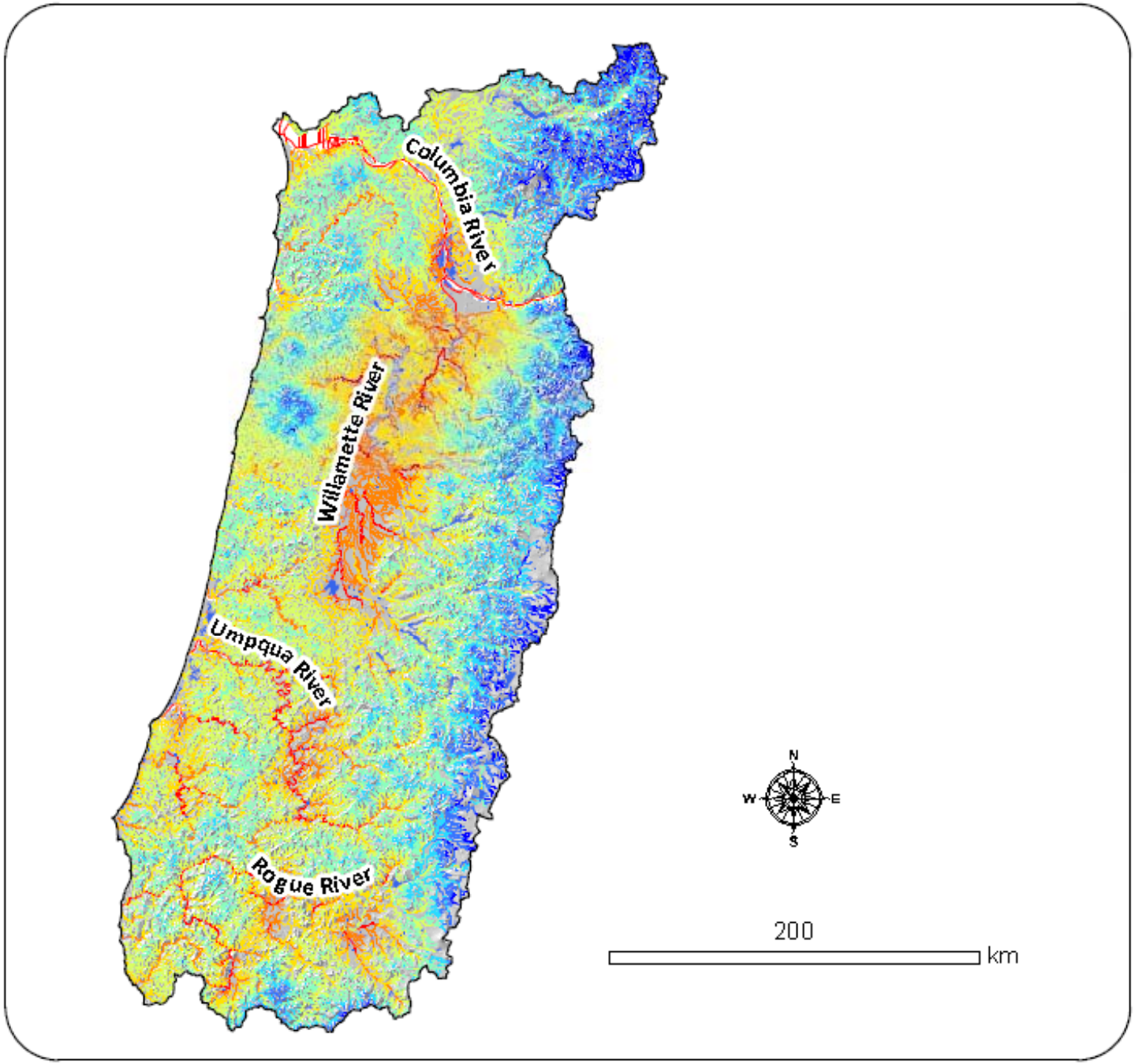

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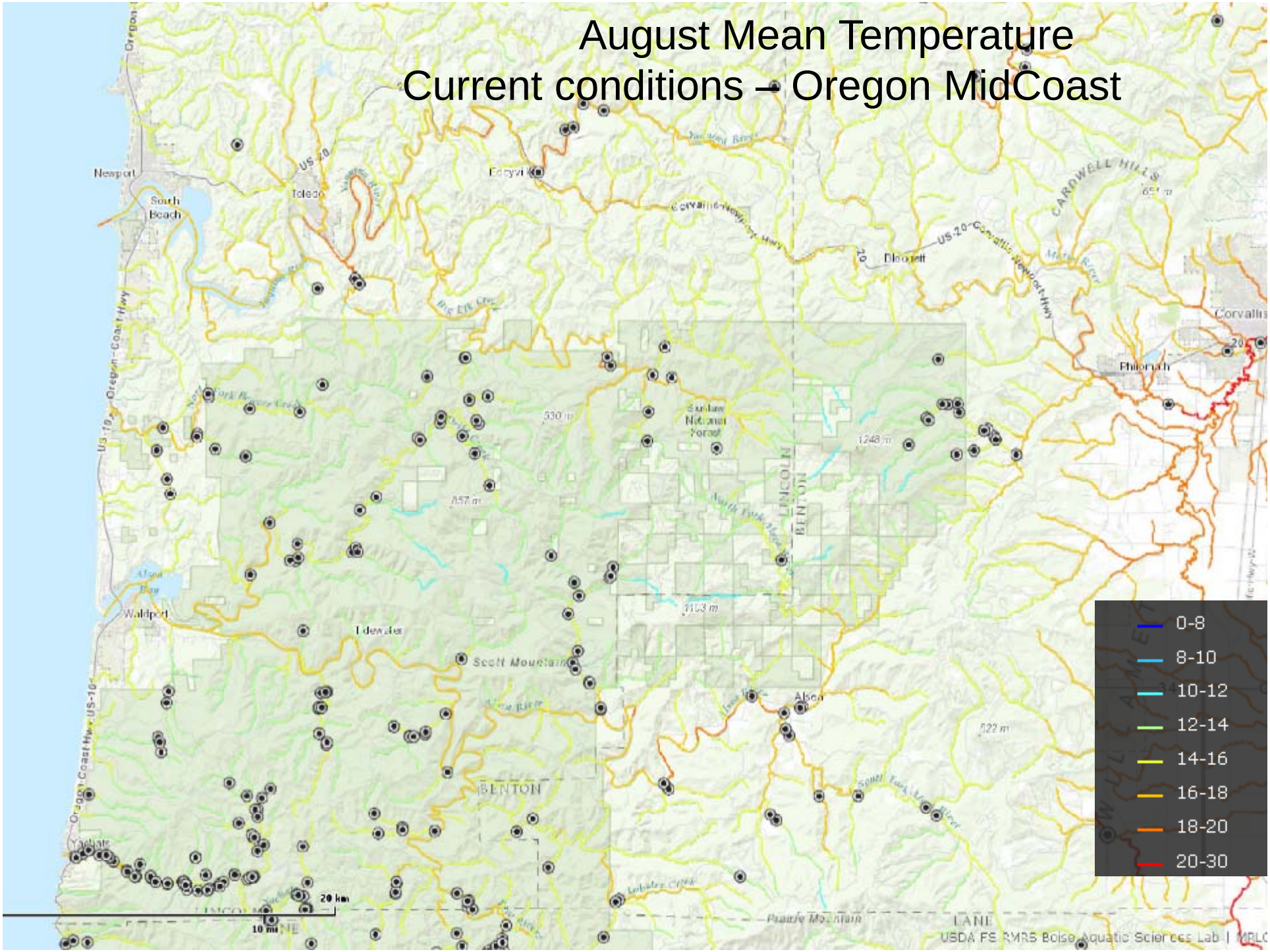
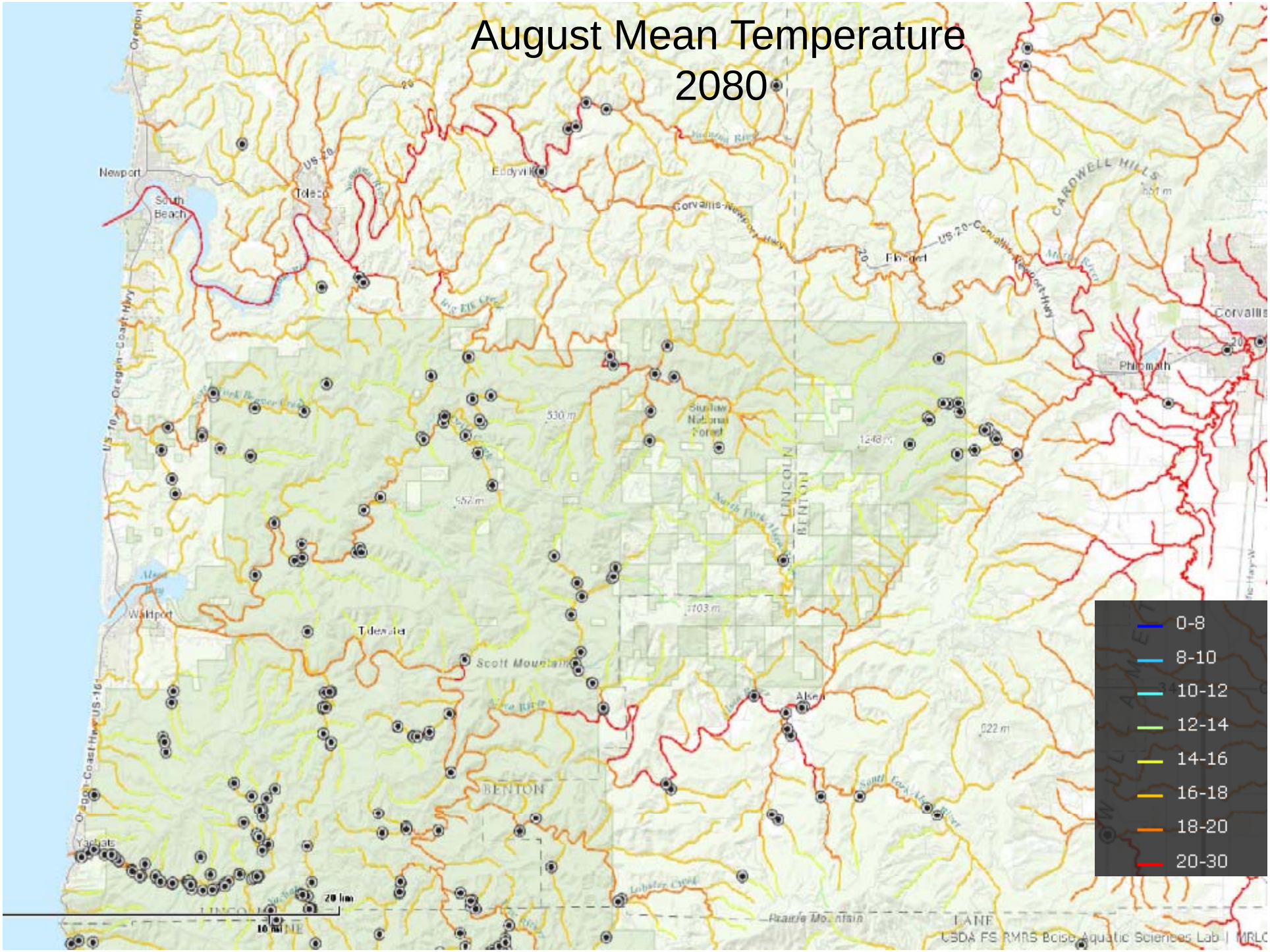
Western Ecology Division,

http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html

August Mean Temperature
Current conditions – Oregon MidCoast



August Mean Temperature 2080



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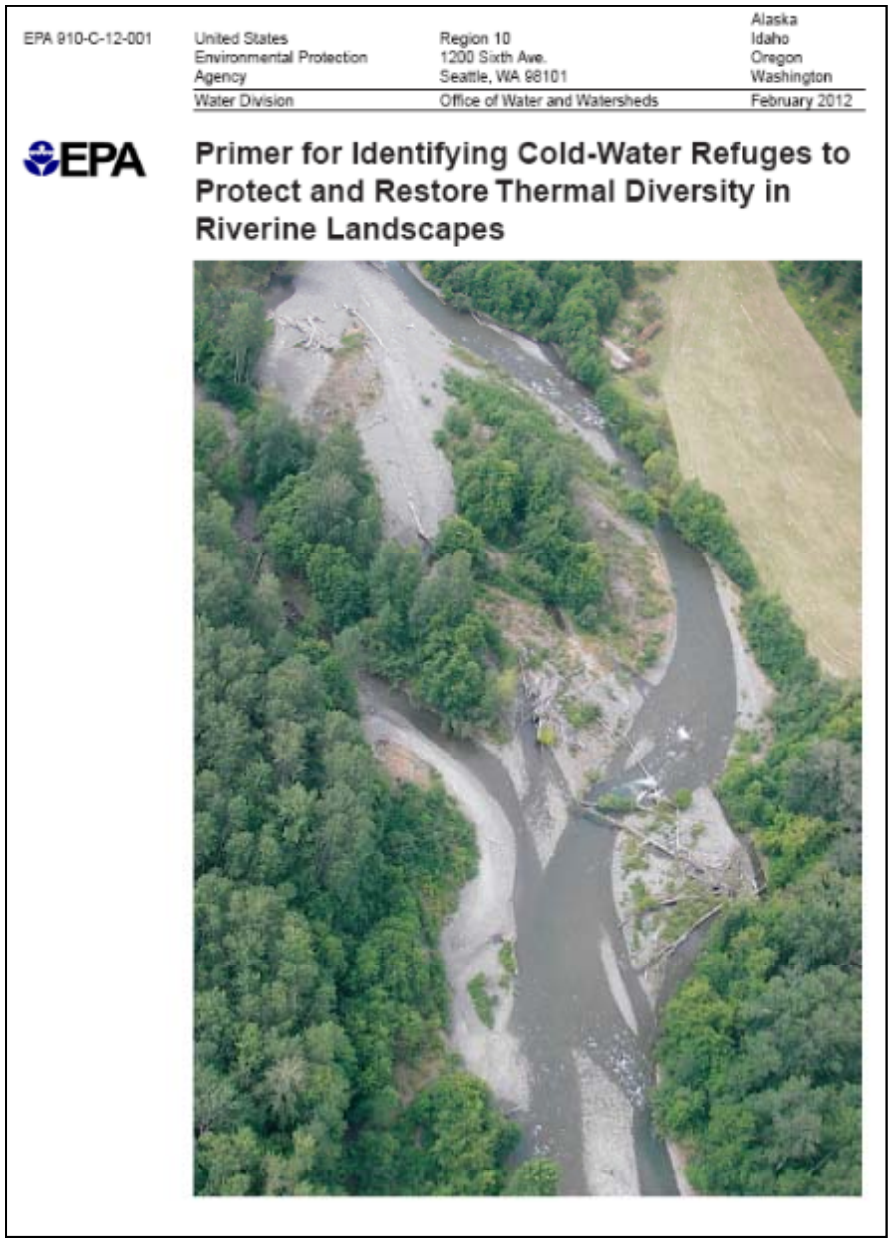
- **What are CWRs and why are they important?**

- **Classification and characterization**
  - **Hierarchical organization**
- **Identification and prediction**
- **Protection and restoration**



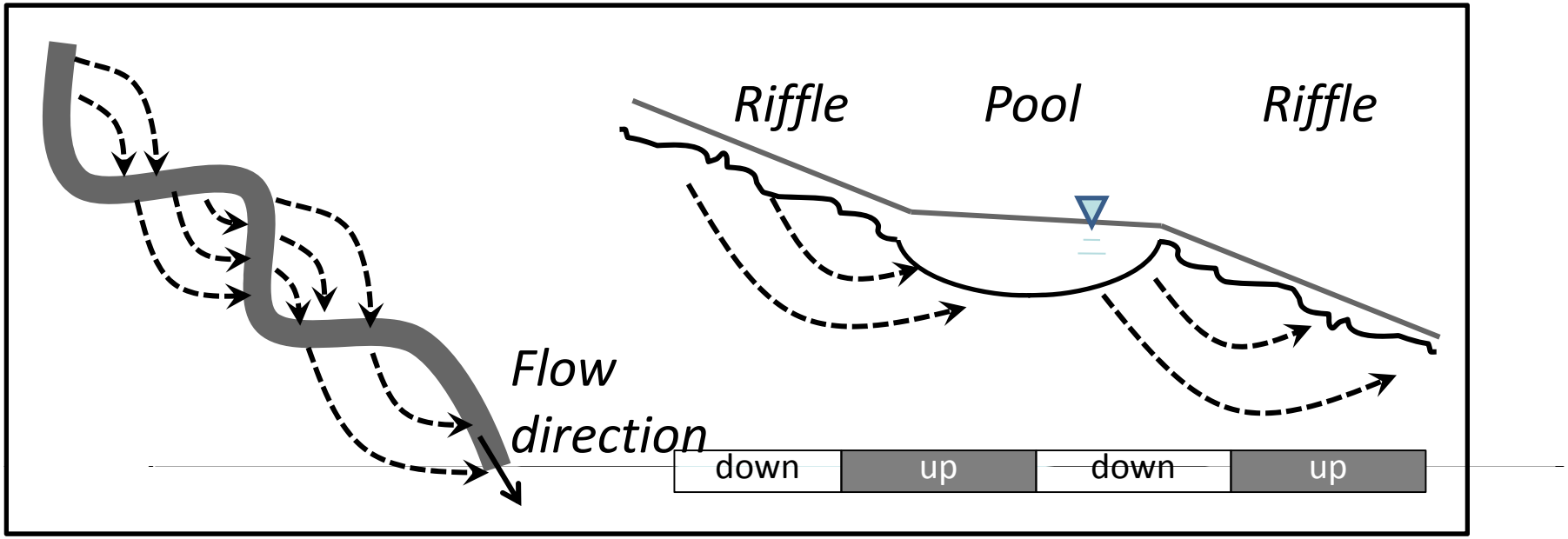
EPA 910-C-12-001

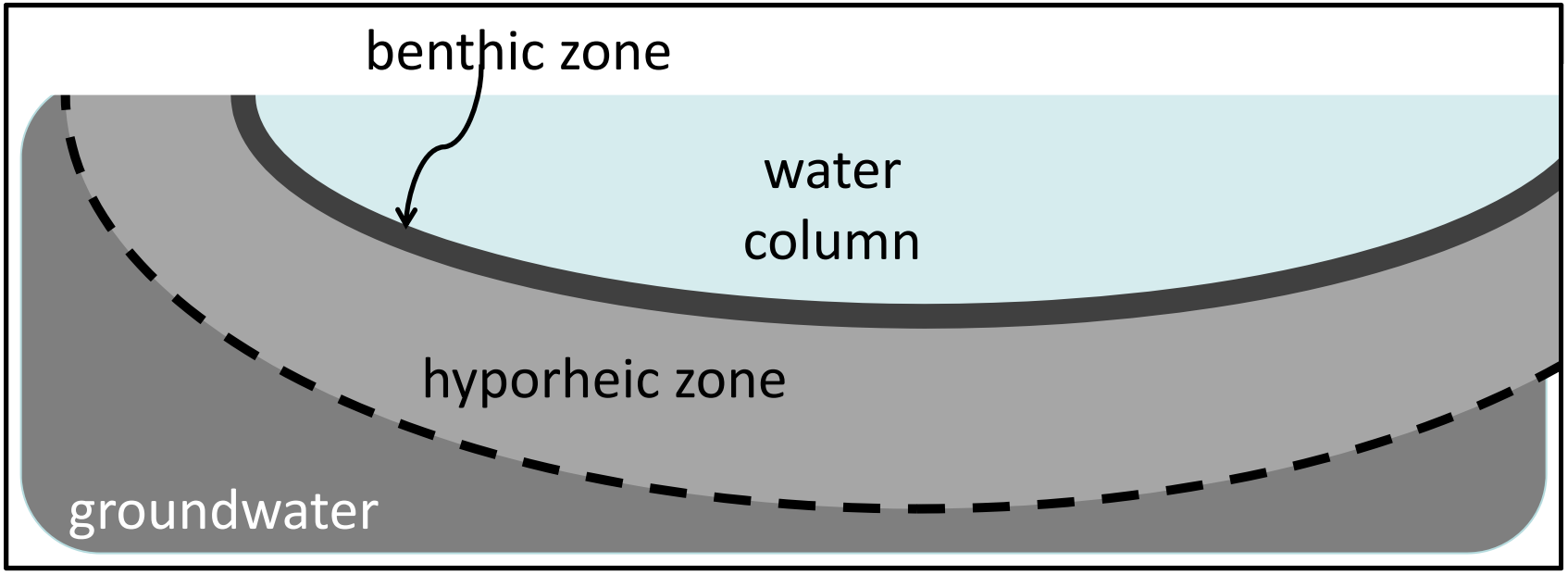
United States Environmental Protection Agency | Region 10, 1200 Sixth Ave., Seattle, WA 98101 | Alaska, Idaho, Oregon, Washington

Water Division | Office of Water and Watersheds | February 2012

EPA

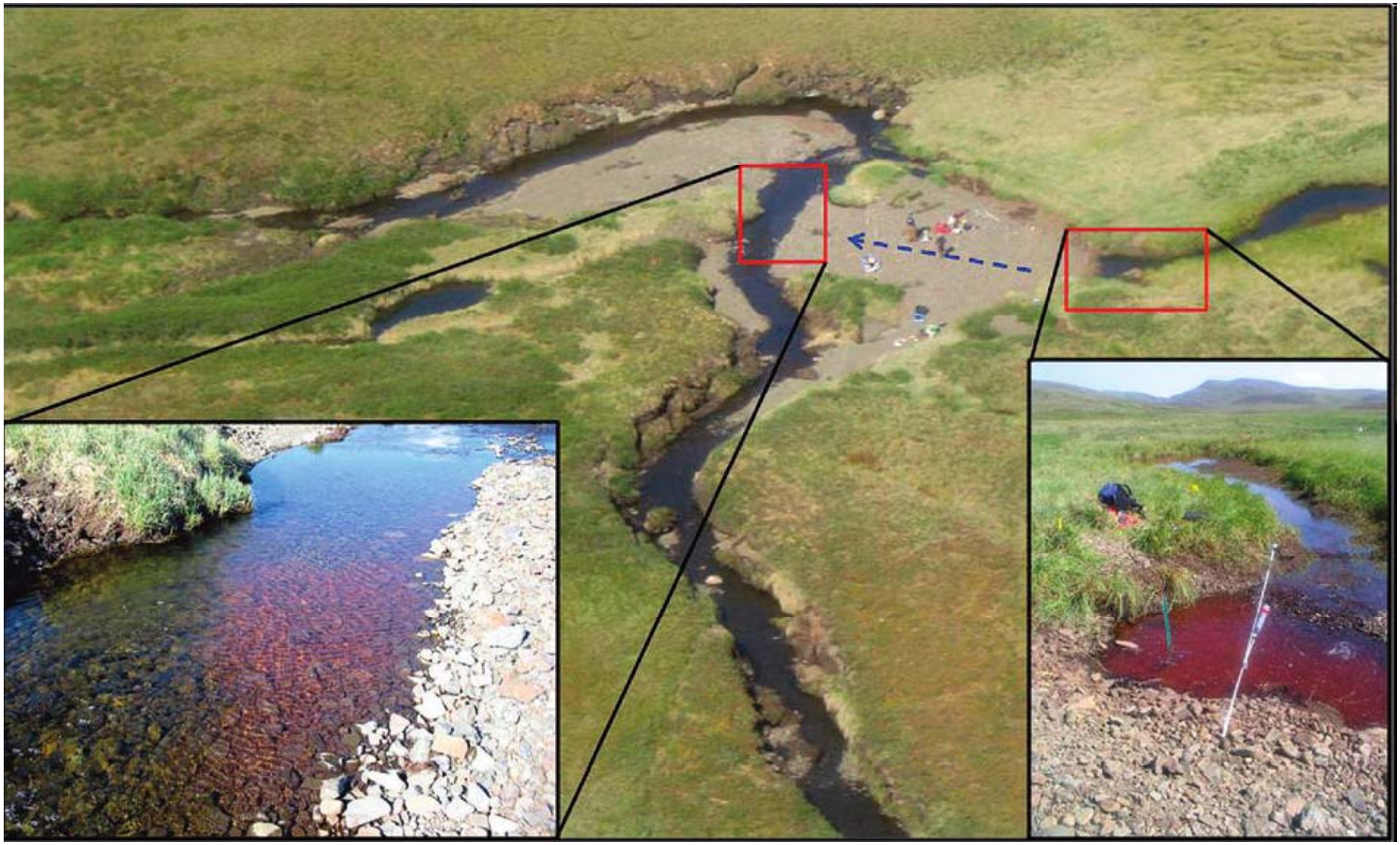
Primer for Identifying Cold-Water Refuges to Protect and Restore Thermal Diversity in Riverine Landscapes





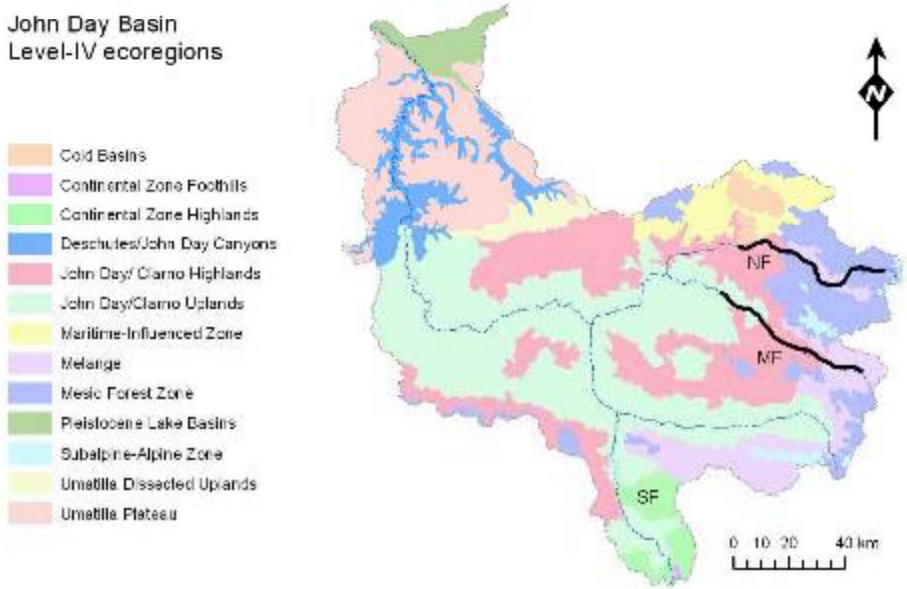
Source: Hester and Gooseff 2010

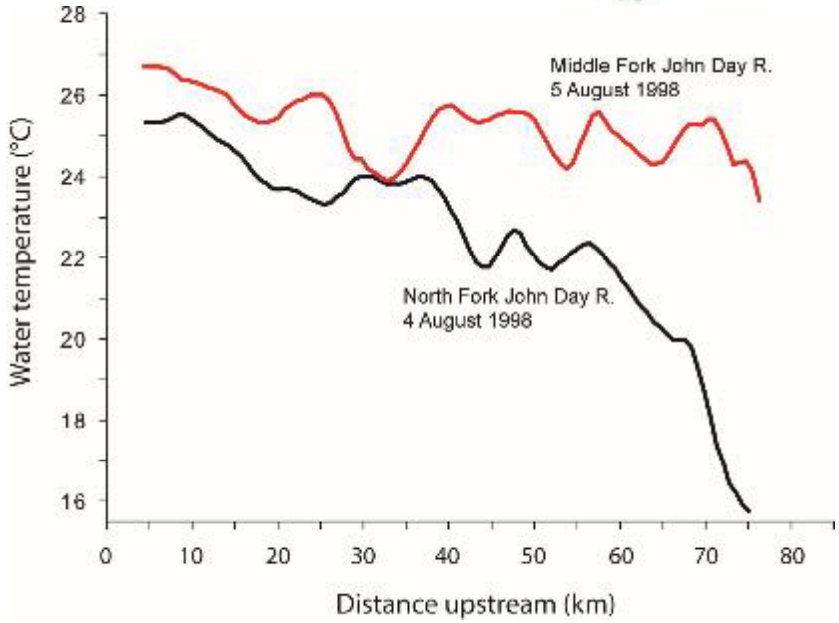
Hyporheic exchange within streams



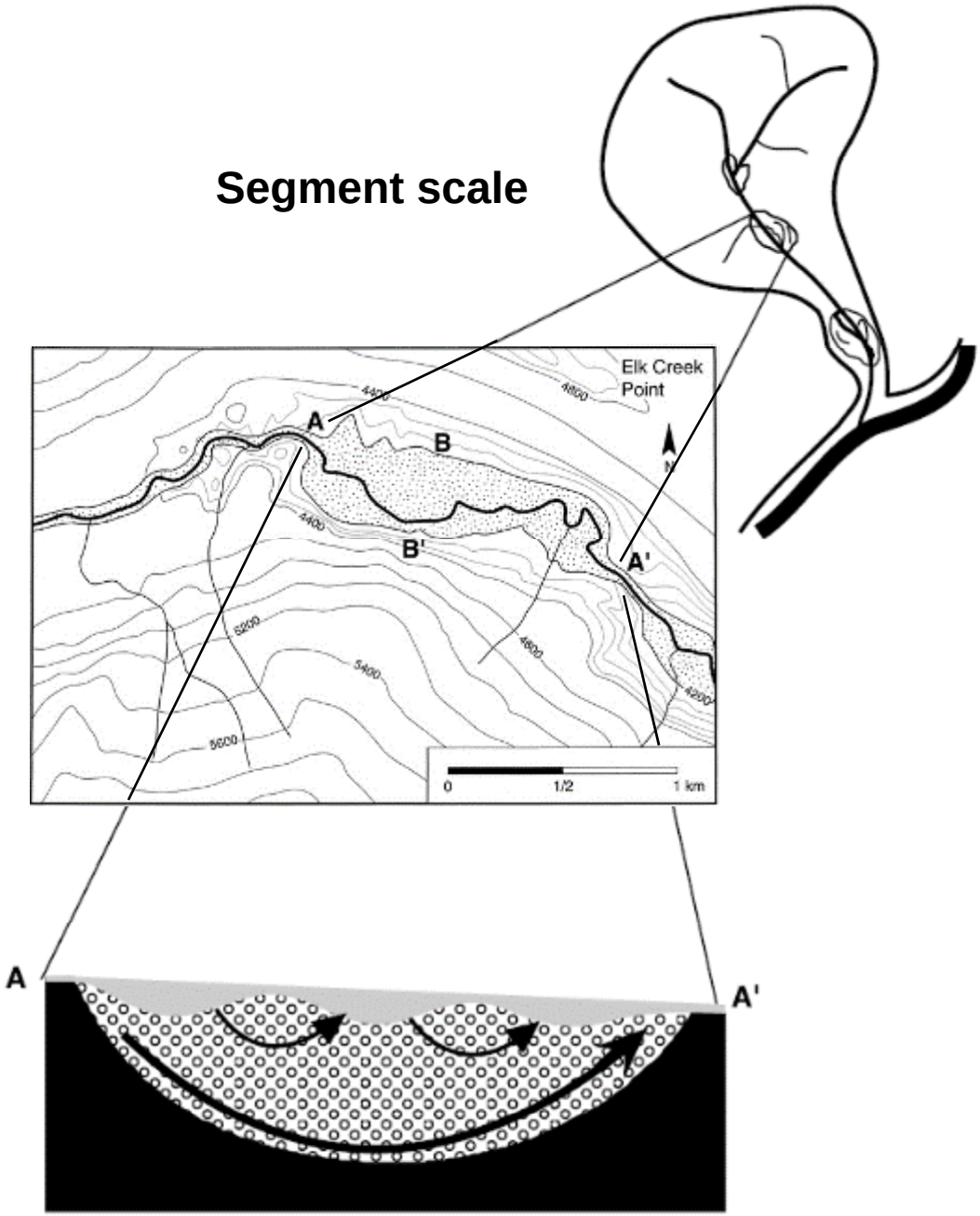
Source: Hester and Gooseff 2010

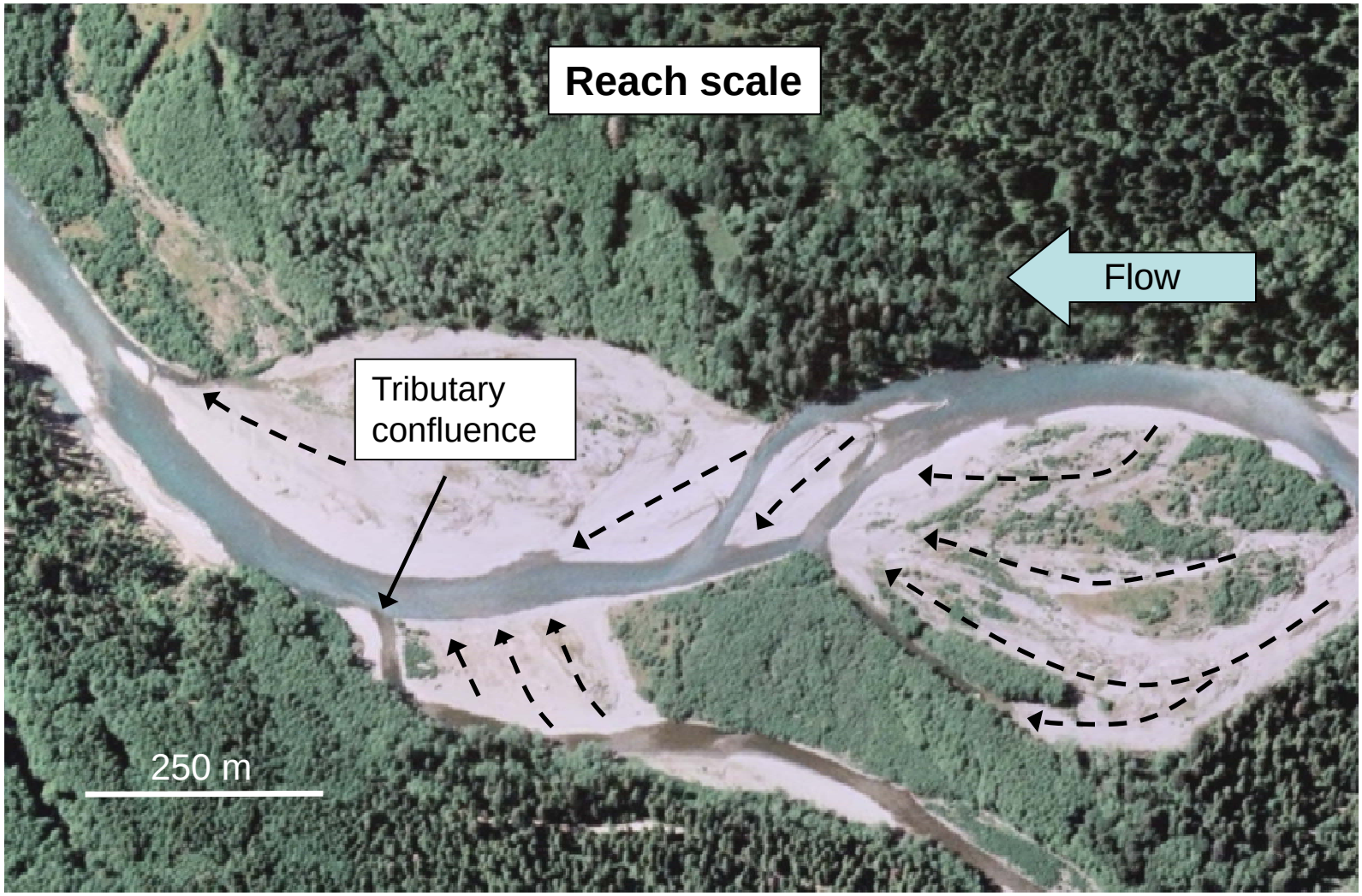
Basin and subbasin scale



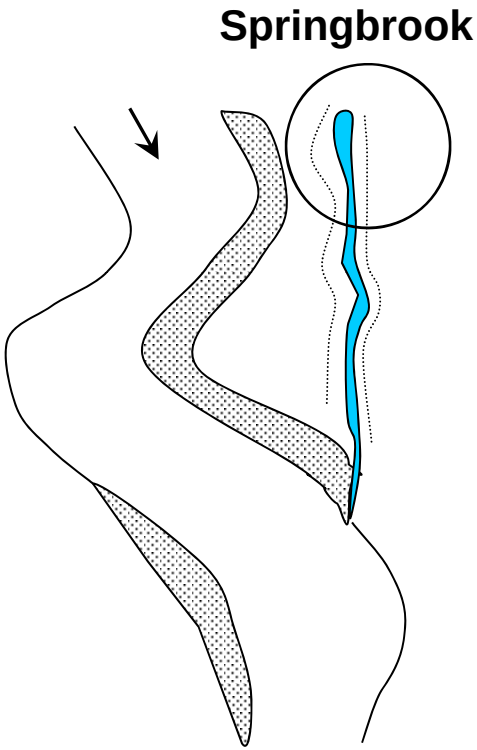


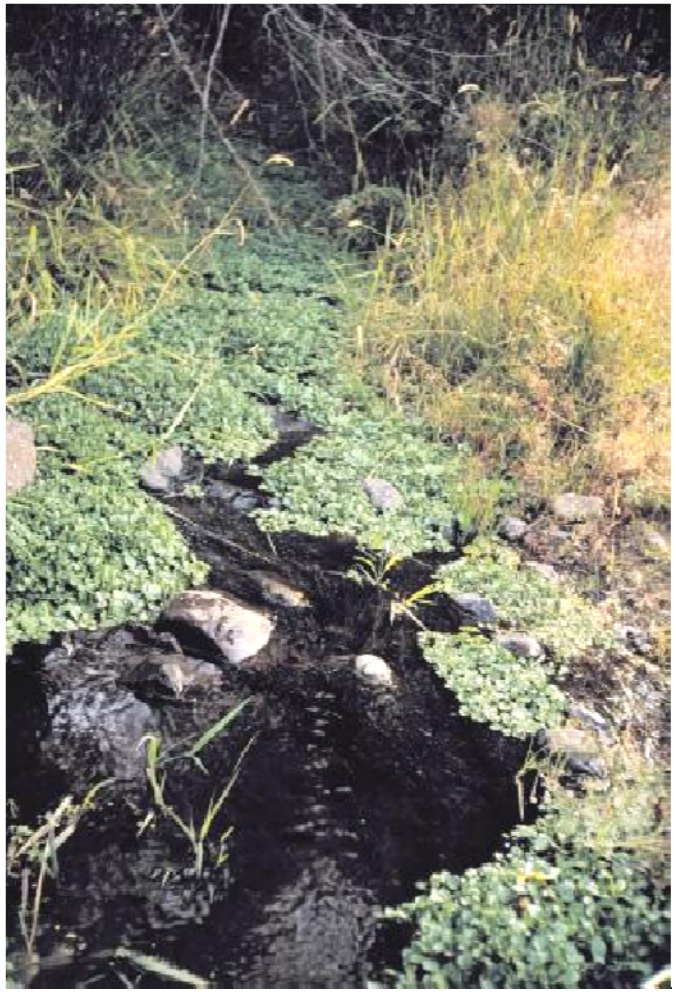
Segment scale



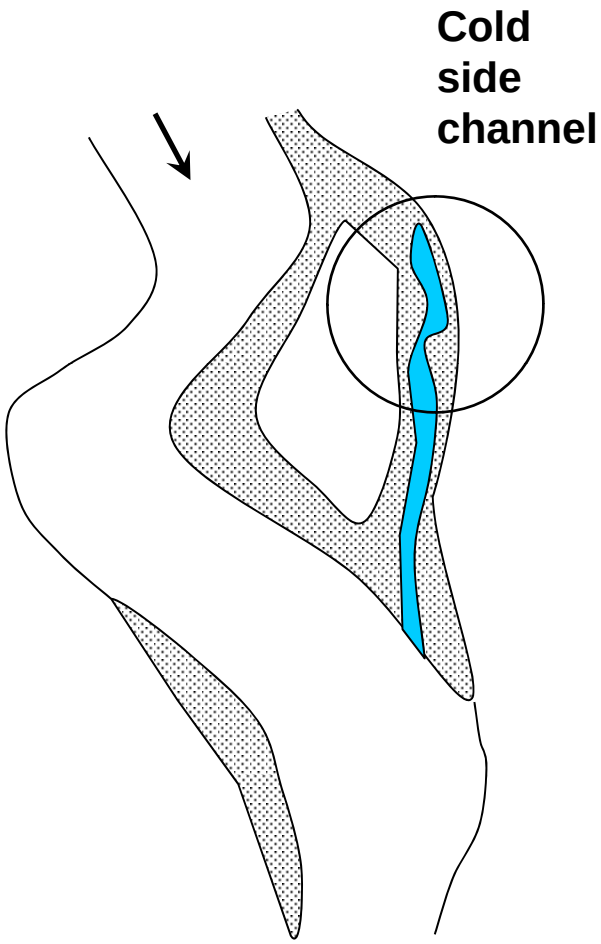

Reach scale
Flow
Tributary
confluence
250 m

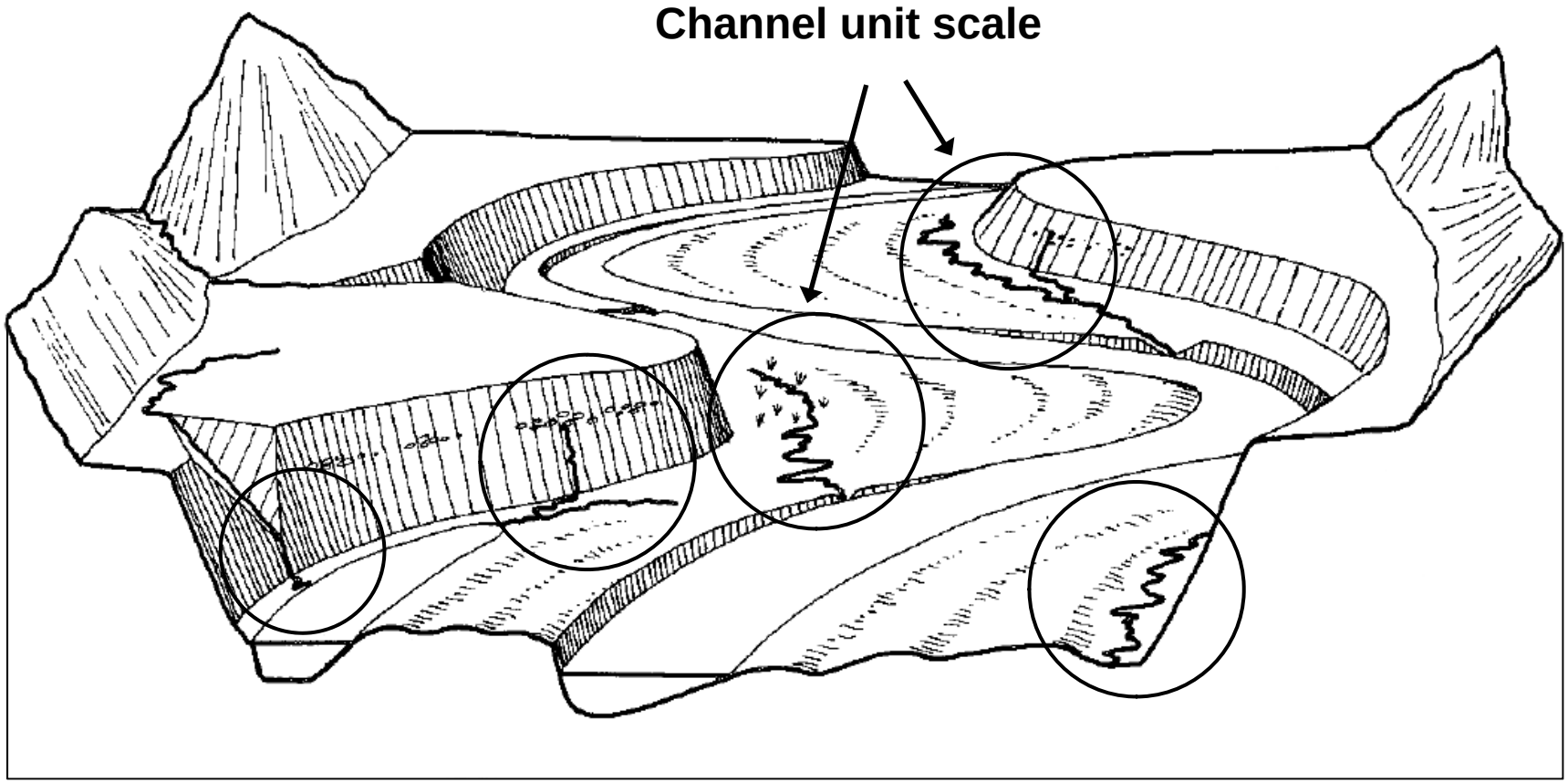
Channel unit scale





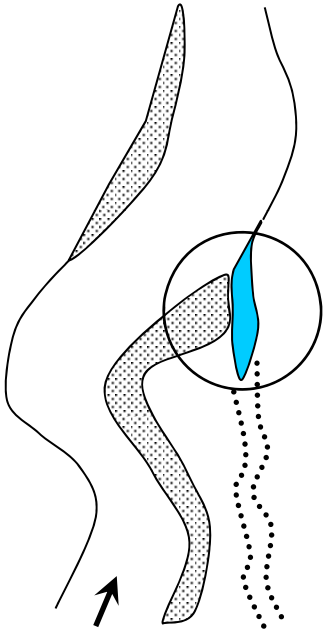
Channel unit scale

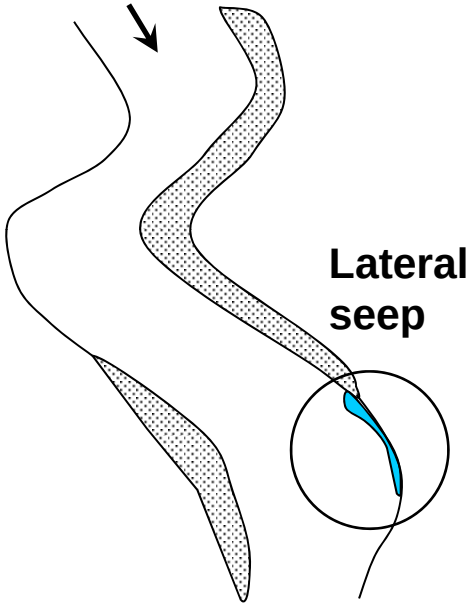


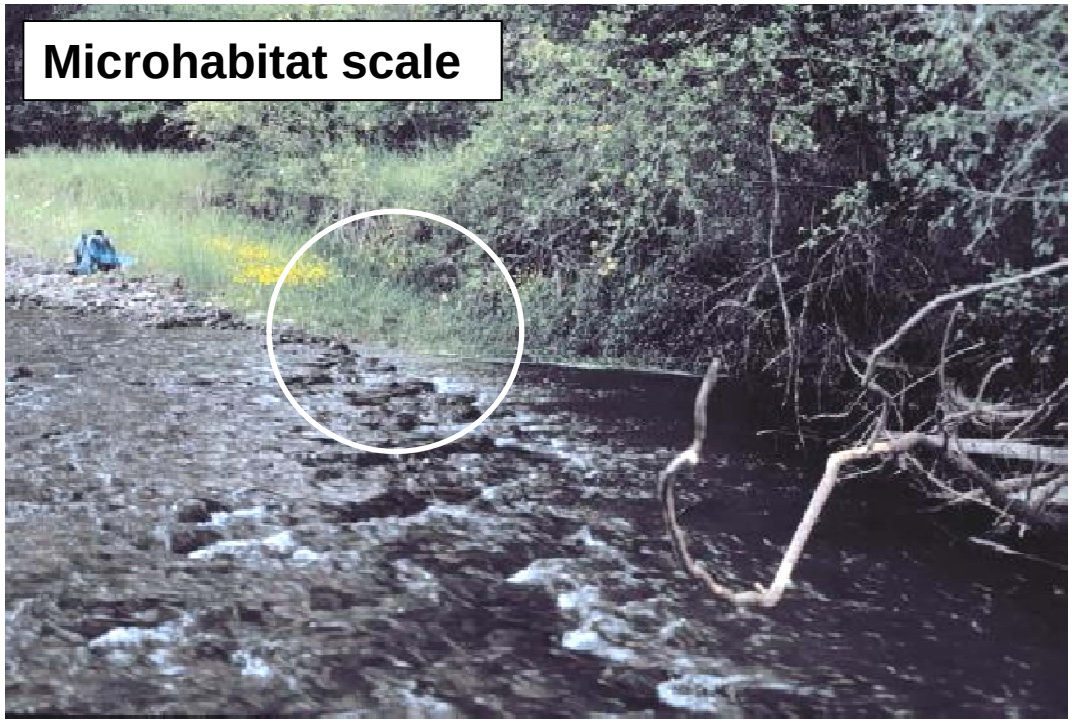


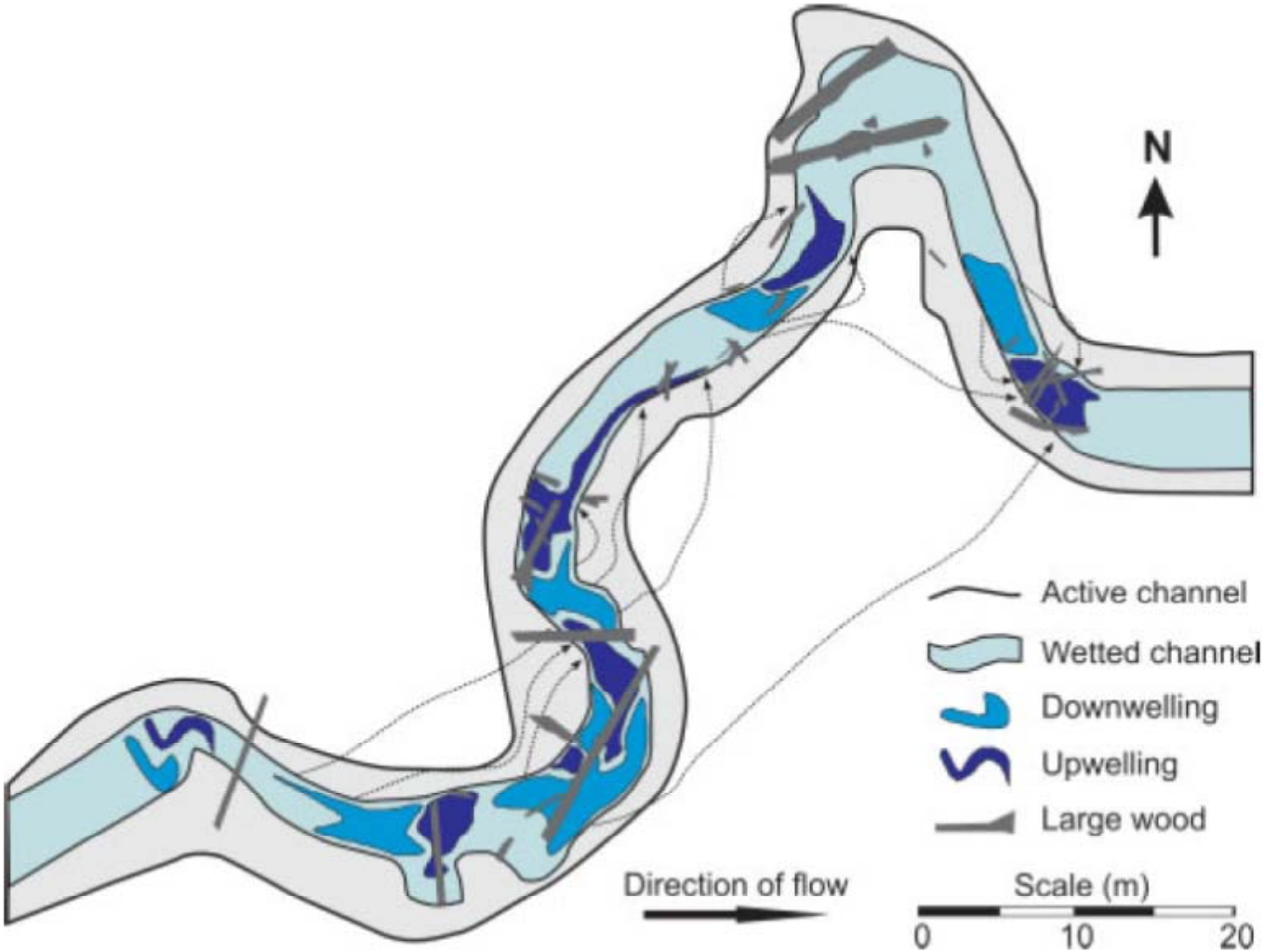
Wall-base channels

Cold alcove




Lateral
seep


Microhabitat scale



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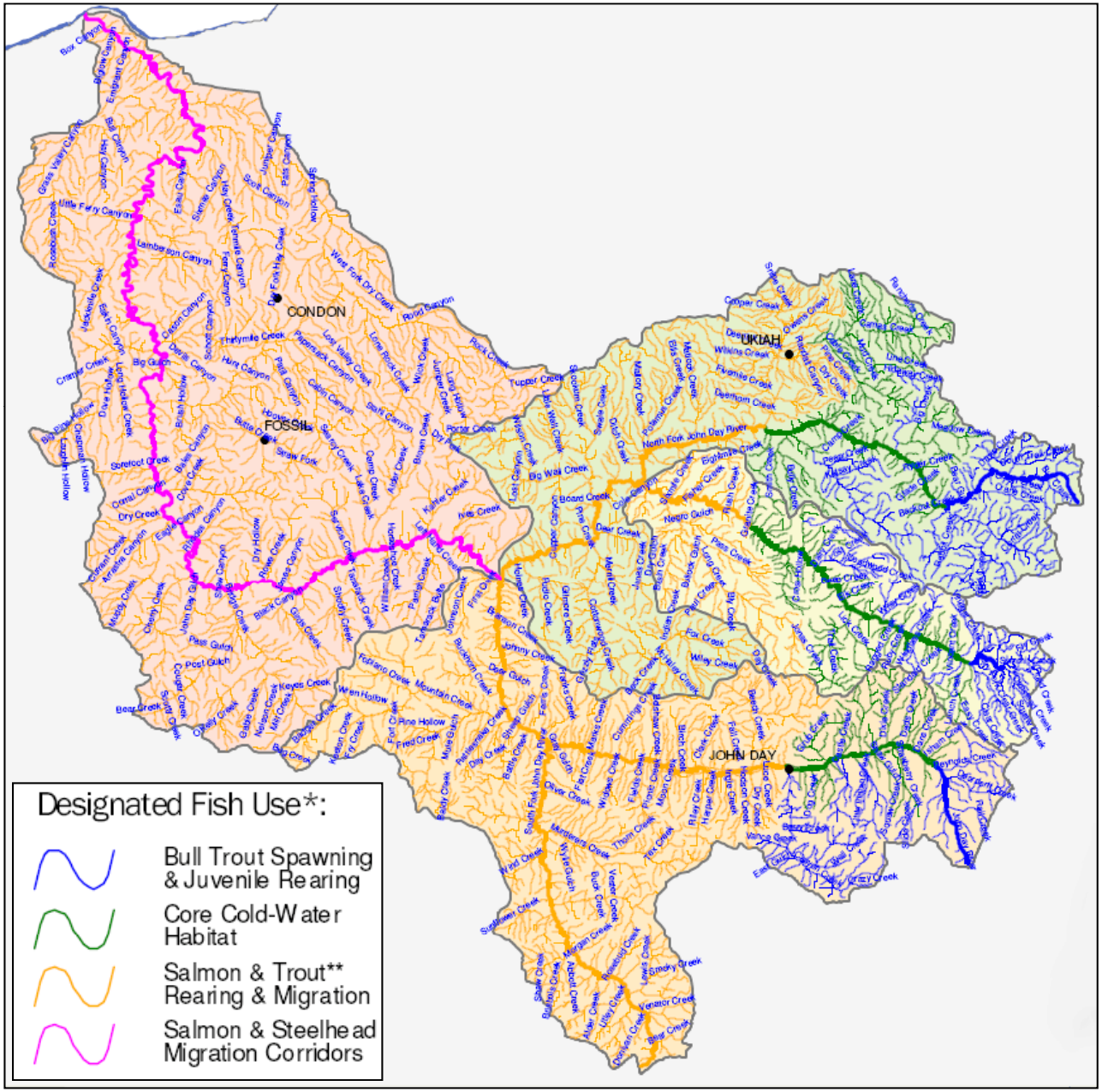
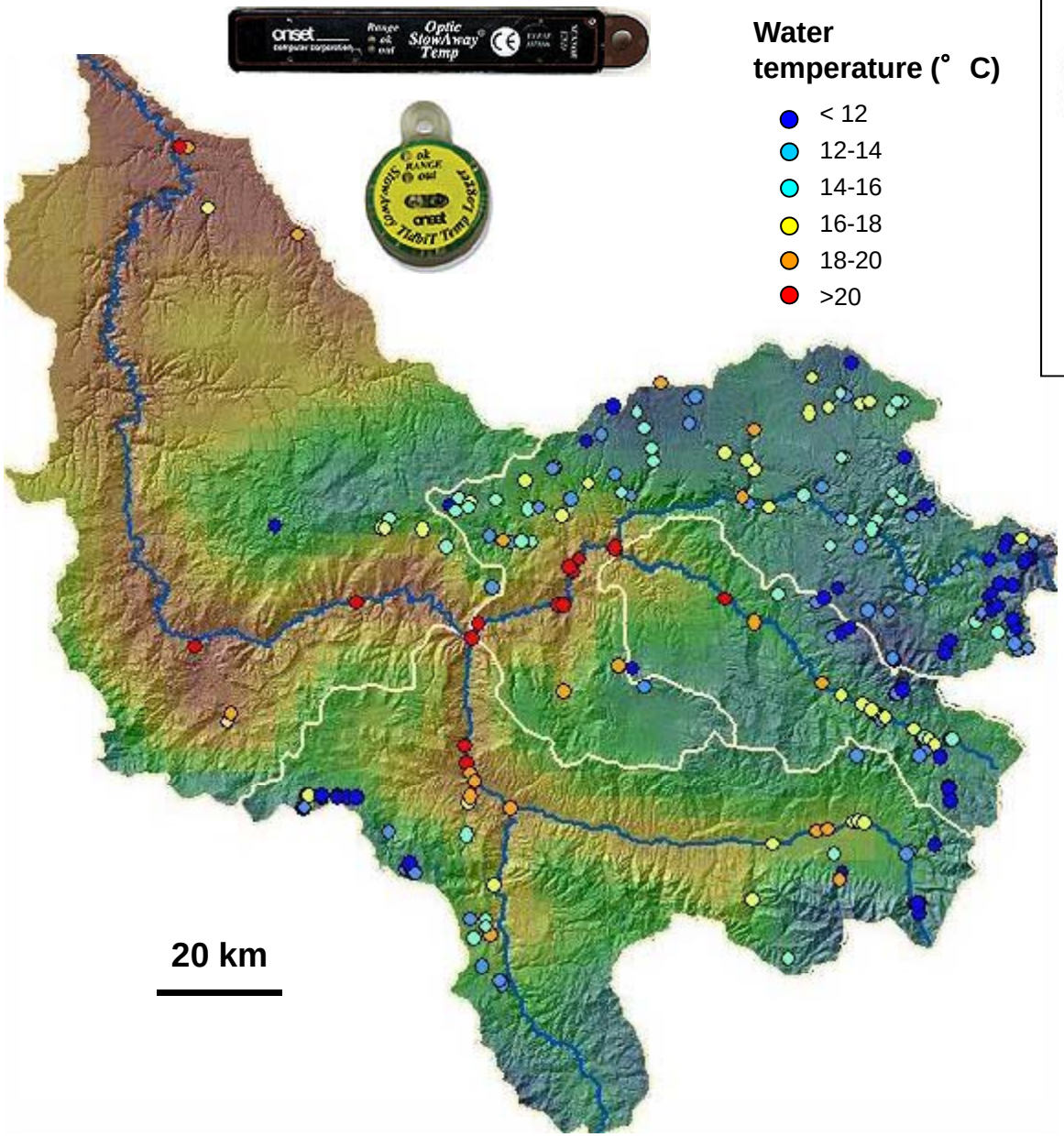
Wondzell, 2011. Hydrol. Proc.

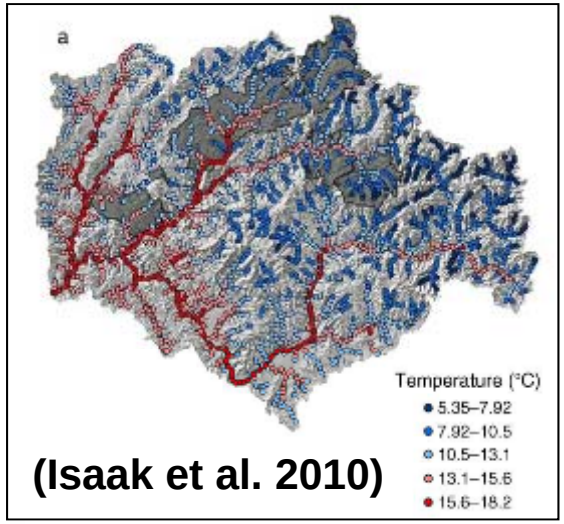
Identification and prediction

Maps

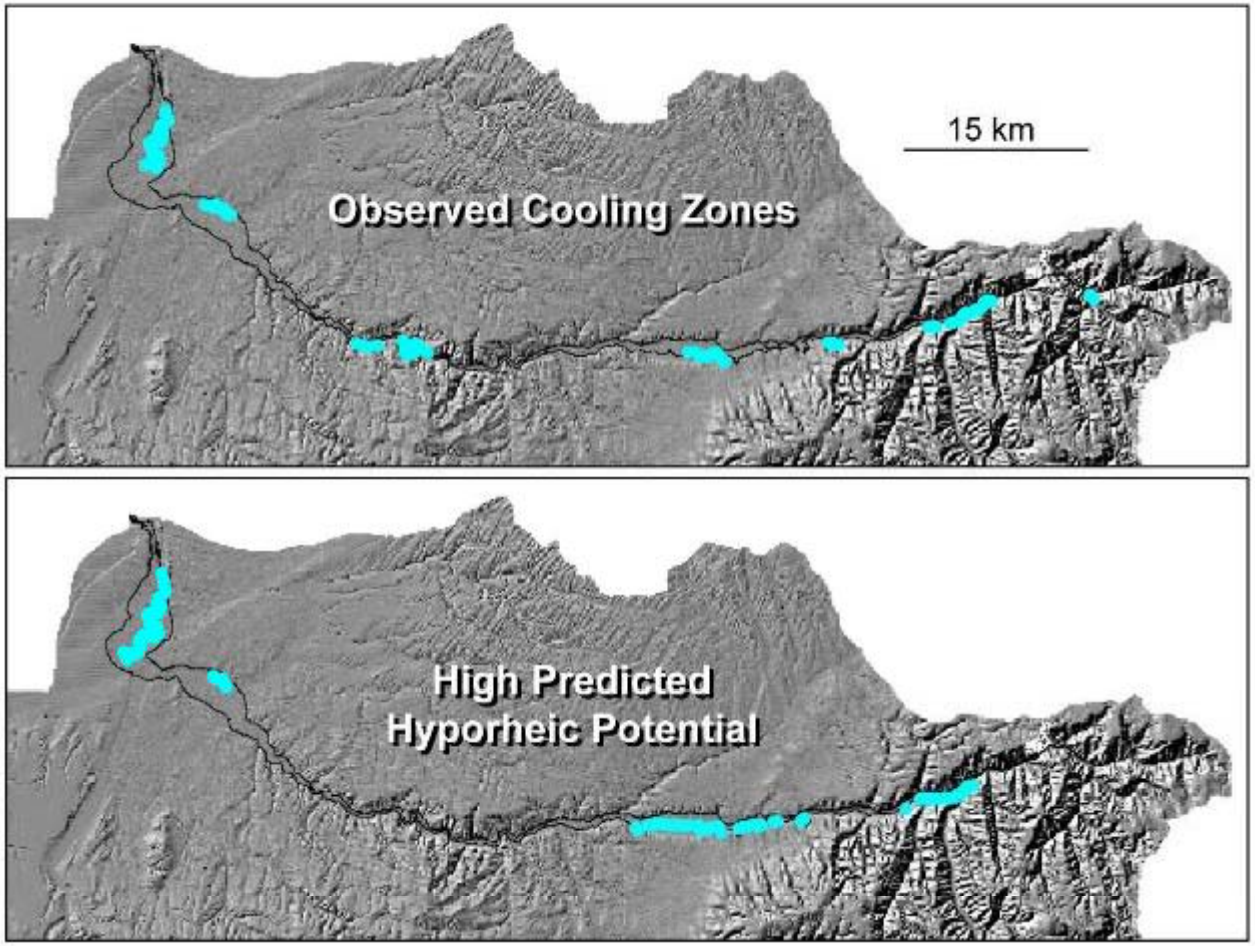


Data loggers and modeling





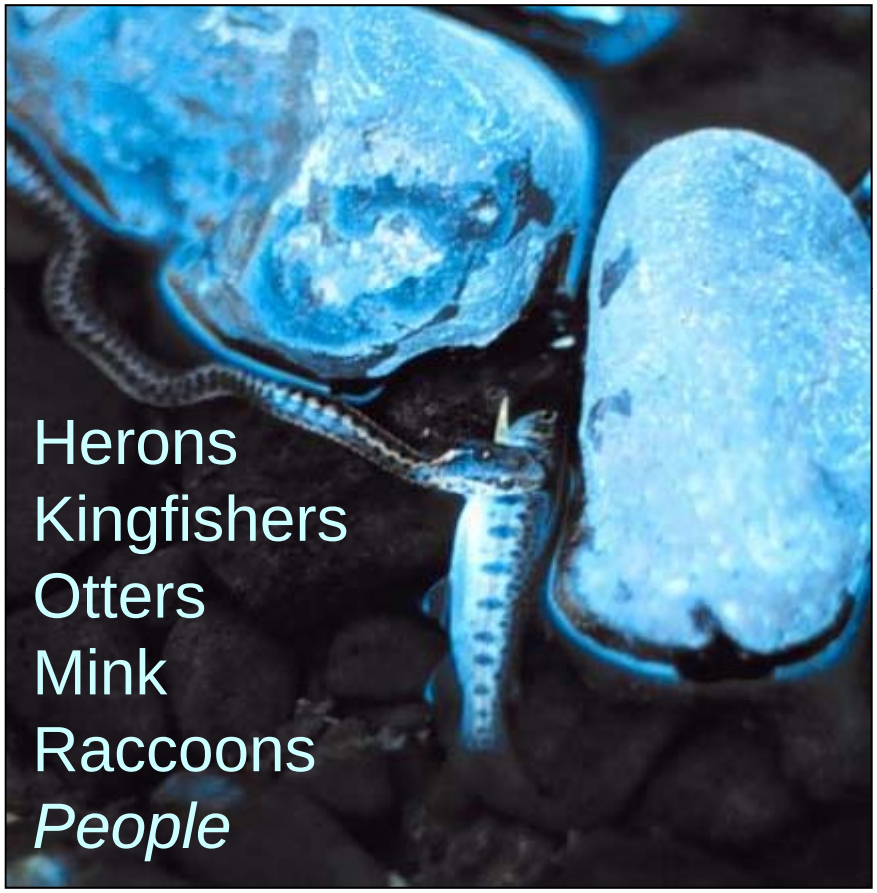
(Isaak et al. 2010)



Scott O'Daniel, CTUIR

Refuge effectiveness

Predation risk



Accessibility

Cold water refuge

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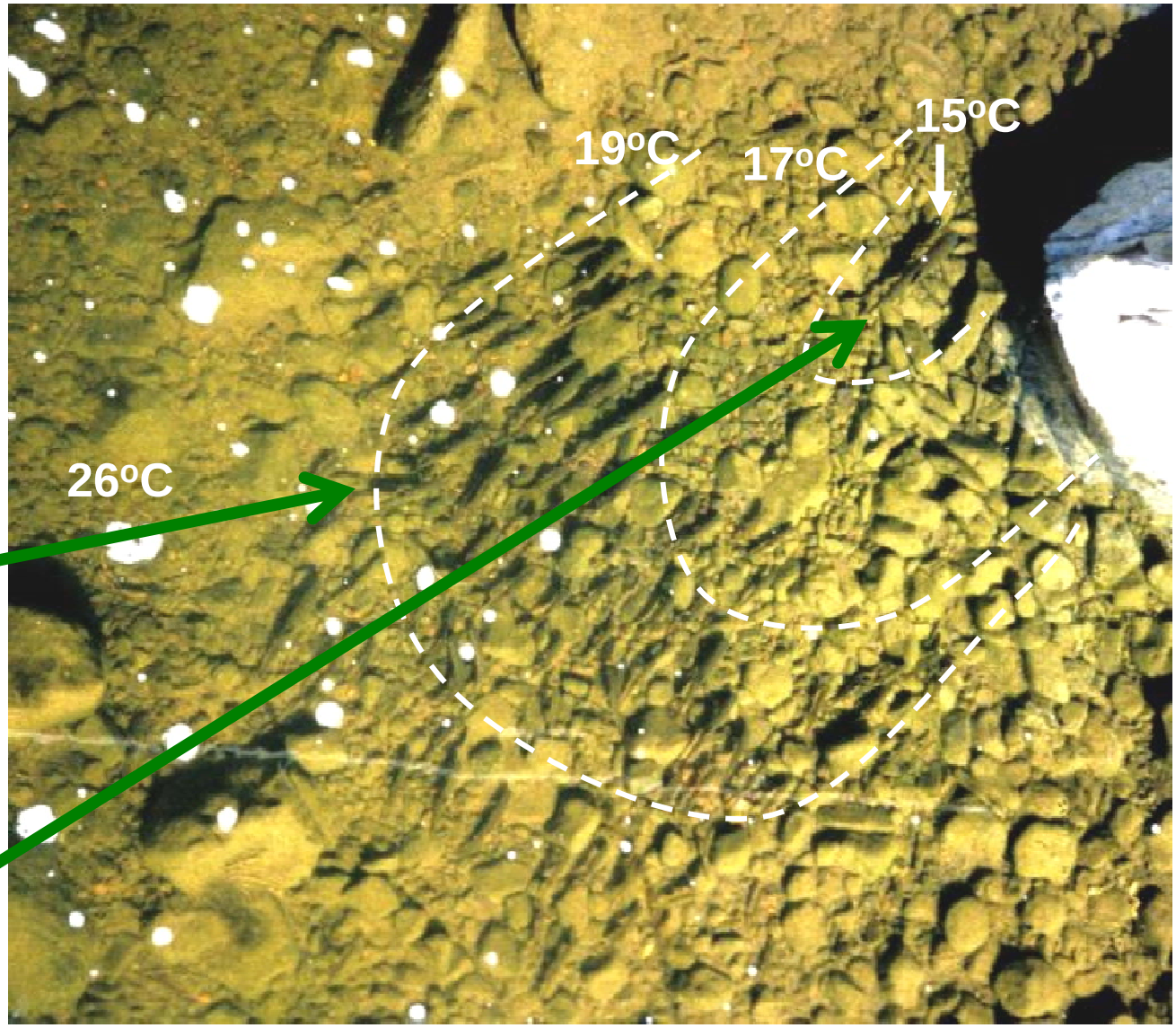
Micro-refuge – small patch within a stream

47 juvenile steelhead trout

bully



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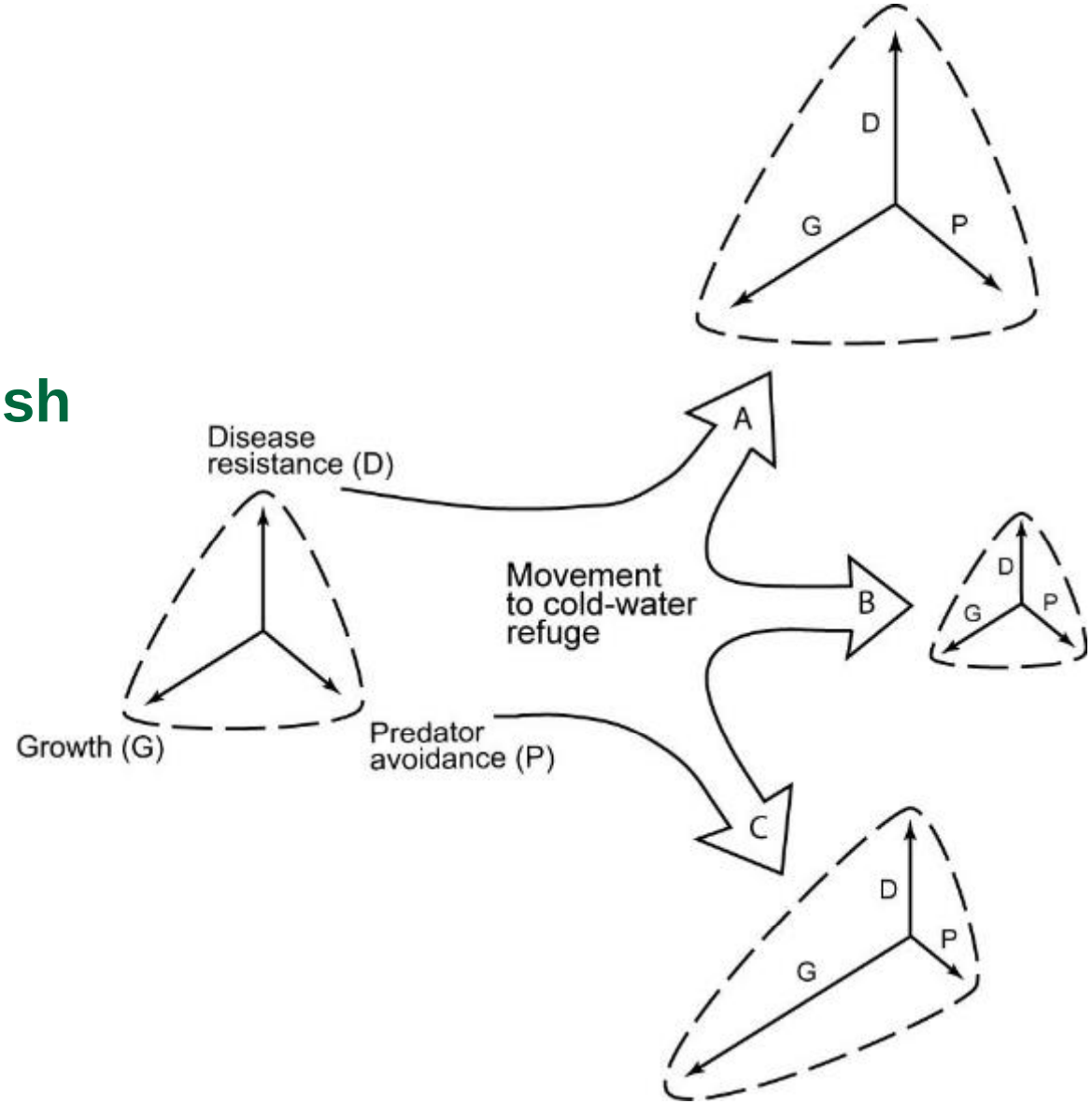
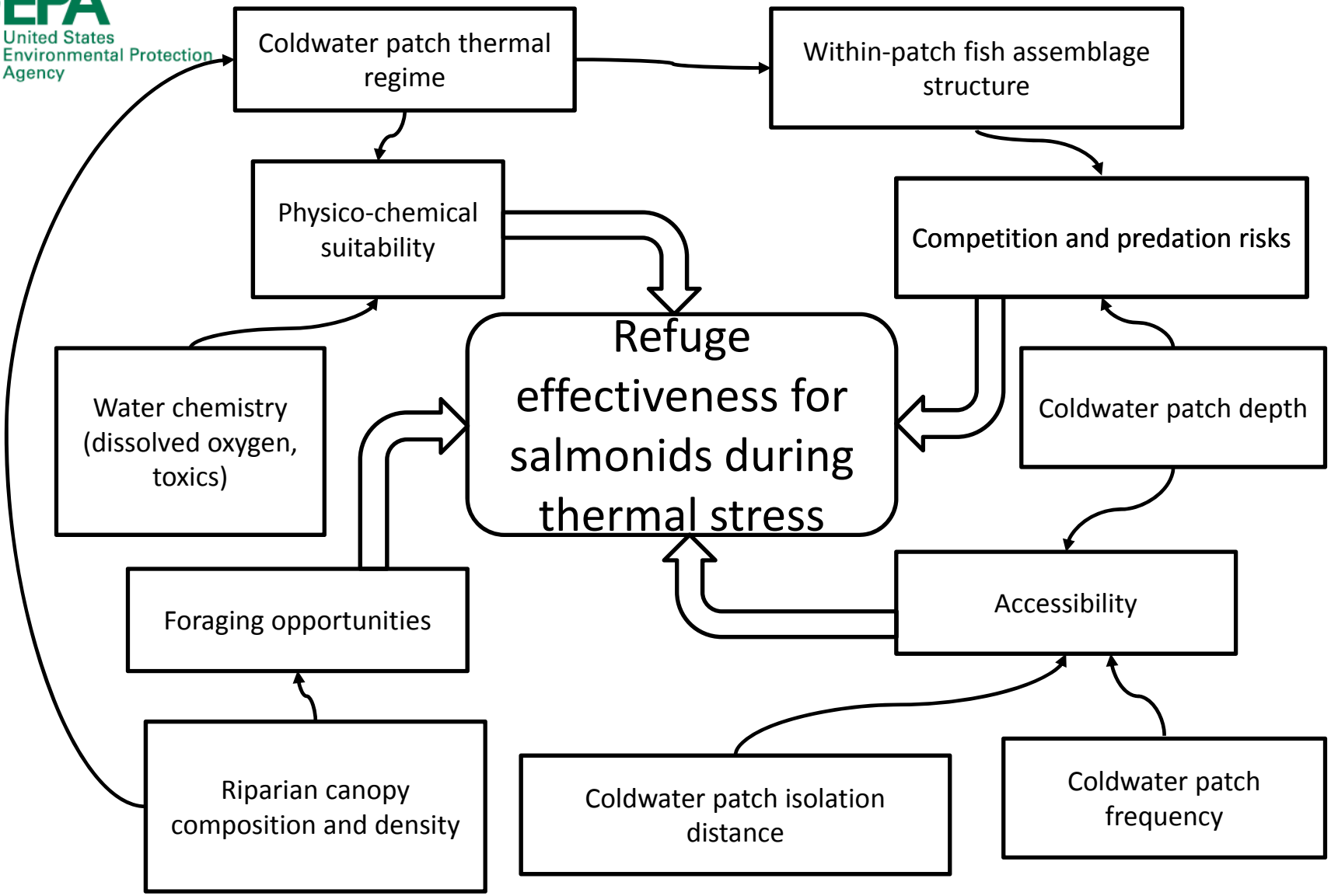
Performance capacity of fish in coldwater refuges



Adapted from Schreck, C. B., and H. W. Li. 1991. Performance capacity of fish: stress and water quality. Aquaculture and water quality. Advances in World Aquaculture 3:21-29.


Coldwater patch thermal regime
Within-patch fish assemblage structure
Physico-chemical suitability
Competition and predation risks
Refuge effectiveness for salmonids during thermal stress
Water chemistry (dissolved oxygen, toxics)
Coldwater patch depth
Foraging opportunities
Accessibility
Riparian canopy composition and density
Coldwater patch isolation distance
Coldwater patch frequency

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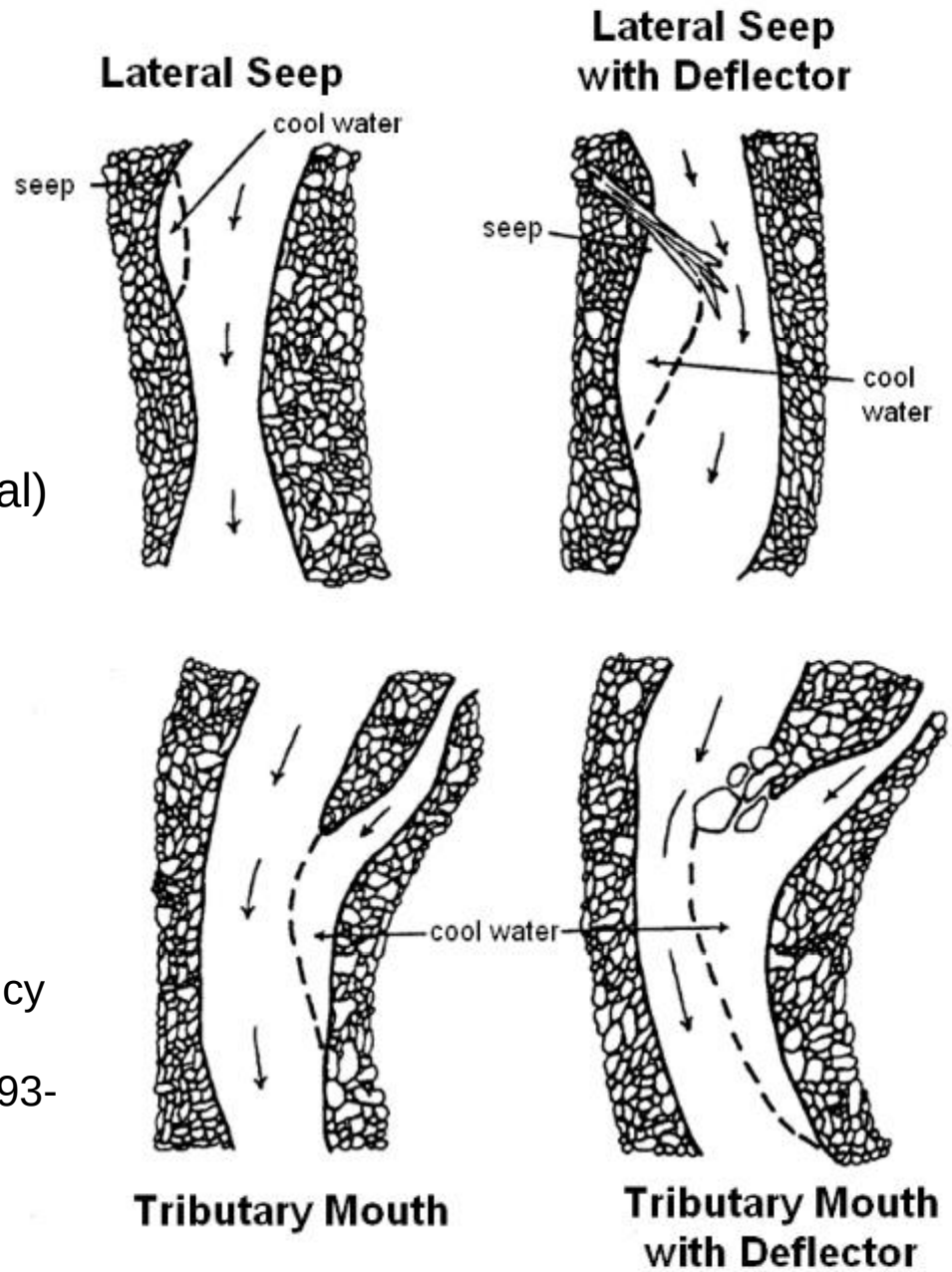
Creation and rehabilitation efforts

- Modifying channel structure
  - Deflectors (lateral and vertical)



Bilby, R. E. 1984. Characteristics and frequency of cool-water areas in a western Washington stream. Journal of Freshwater Ecology 2(6):593-602.

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Creation and rehabilitation efforts

- Modifying channel structure
  - Channel reconfiguration, excavation, fill
- Hydraulic engineering

Confederated Tribes of the Warms Springs Reservation Shitike Creek Project

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Creation and rehabilitation efforts

- Increasing connectivity
  - Access to off-channel ponds/thermal habitats
  - Removal of barriers (culverts)

River Design Group
Mid Klamath Watershed Council

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Creation and rehabilitation erforts

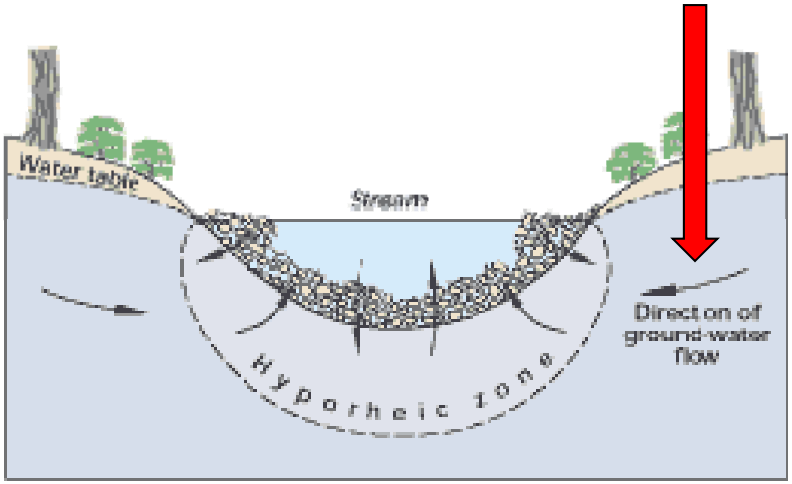
- Reducing risks
  - Provision of cover or predator-exclusion devices

Mid Klamath Watershed Council

Creation and rehabilitation efforts

- Altering groundwater connectivity
  - Injecting outflows into groundwater
  - Routing water through hyporheic pathways

injection



From Winter et al. 1998 USGS Circ. 1139

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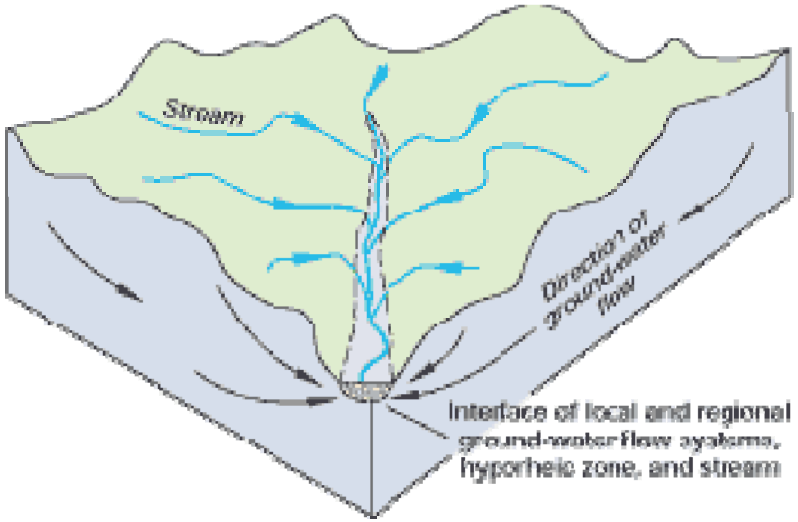
Creation and rehabilitation efforts

- Riparian and floodplain restoration
  - Hydraulic connectivity; vertically, laterally, longitudinally
  - Vegetation
  - Watershed management



From Winter et al. 1998 USGS Circ. 1139

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Guidance for “restoration” and creation of cold-water refuges

- Understanding formative processes
  - Maintenance is a process, not a state
  - Issues of scale
  - Awareness of potential for unintended consequences
- Understanding of biological and ecological constraints, trade-offs, and opportunities
  - Avoiding creation of ecological traps or dead-ends
- Climate adaptation and mitigation

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Contact: Joe Ebersole
(541) 754 4775
ebersole.joe@epa.gov

The views expressed in this talk are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

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