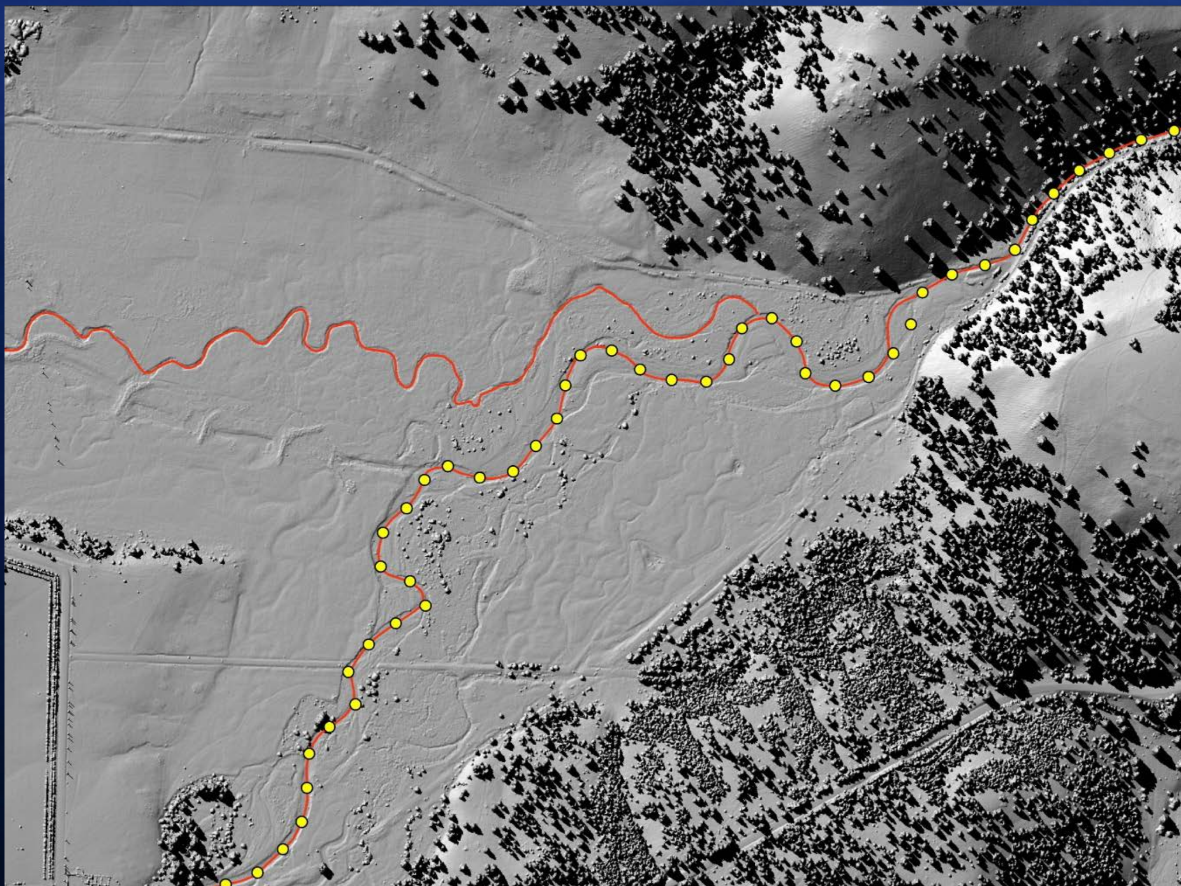
Stream Temperature in the Upper Grande Ronde and Meadow Creek

Available Data , Models, and Potential Applications for Restoration Planning



Meadow Creek Restoration and Research Planning Meeting

La Grande, OR

November 15, 2022

Presenter:
Casey Justice

Organization: Columbia River Inter-Tribal Fish Commission (CRITFC)

Collaborators:
Seth White (OSU), Dale McCullough (CRITFC – retired)

Funded By:

Background

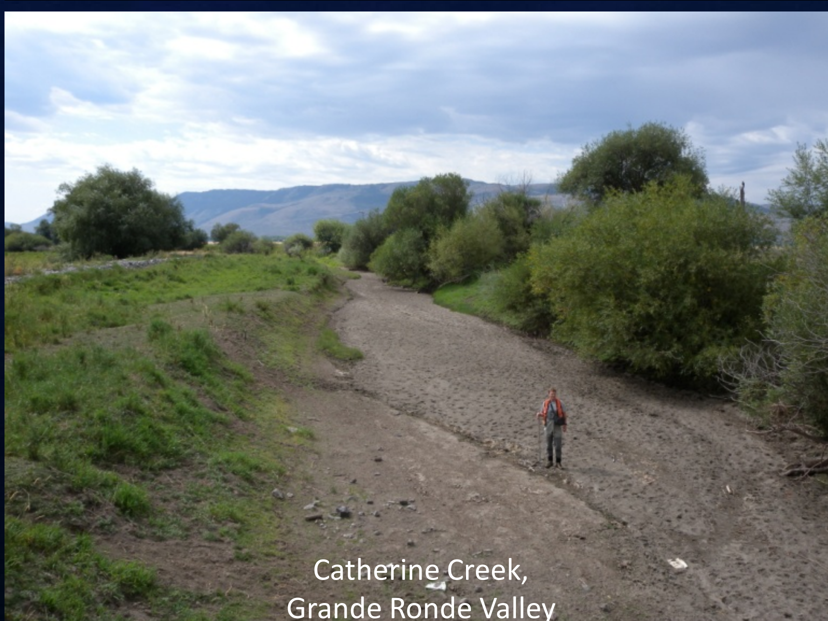
Fish habitat in the upper Grande Ronde basin has been heavily degraded by land use including timber harvest, agriculture, mining, over-grazing, and beaver trapping.

These impacts, combined with hydropower, over-harvest, and other factors led to the listing of local Spring Chinook Salmon and steelhead populations under the Endangered Species Act and subsequent efforts to restore habitat conditions and improve survival throughout the life cycle.

Habitat limiting factors for salmon recovery include:

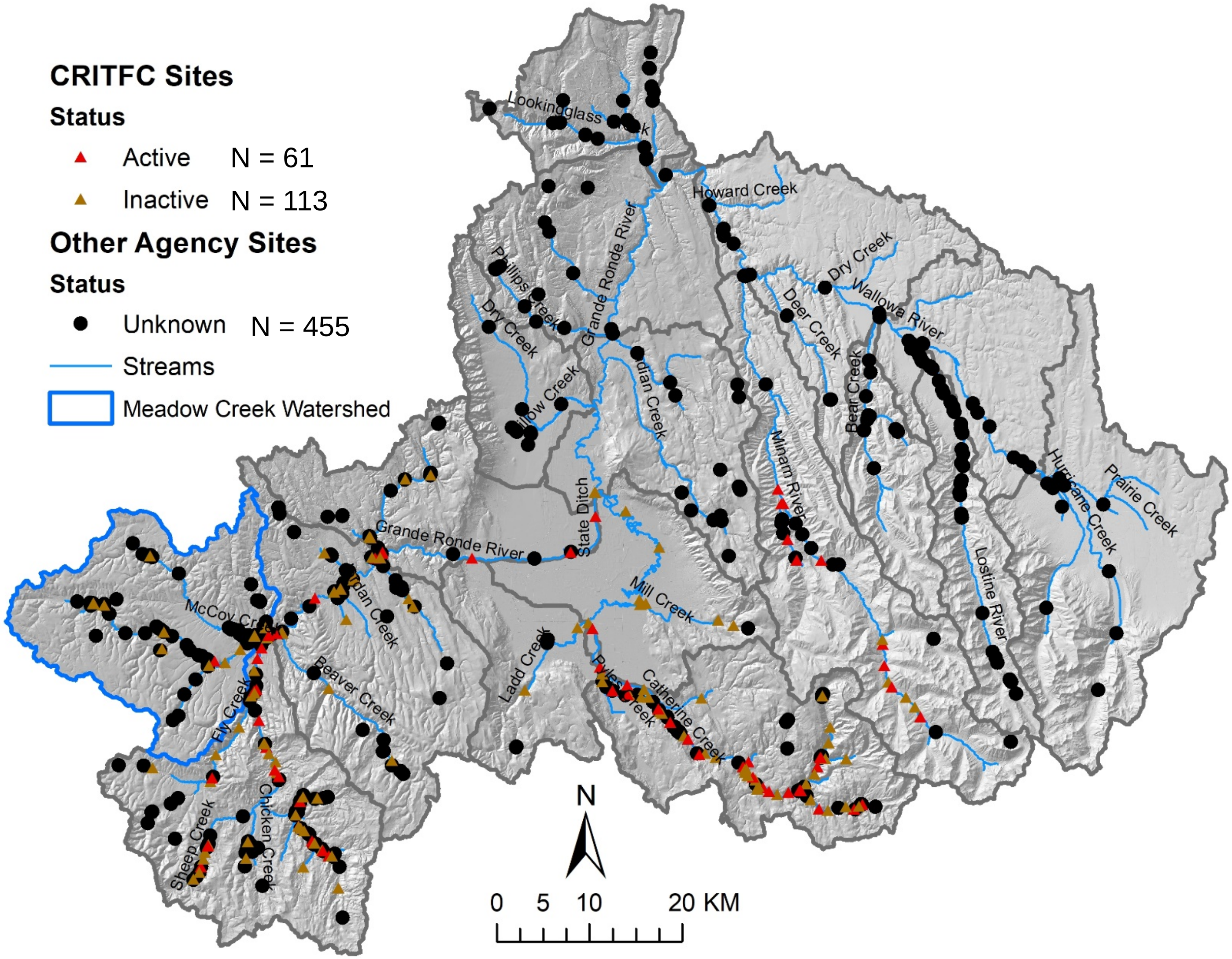
1) **Elevated summer water temperature,**
2) Diminished summer streamflow,
3) Reduced channel complexity and structure,
4) Reduced floodplain connectivity, and
5) Degraded riparian conditions

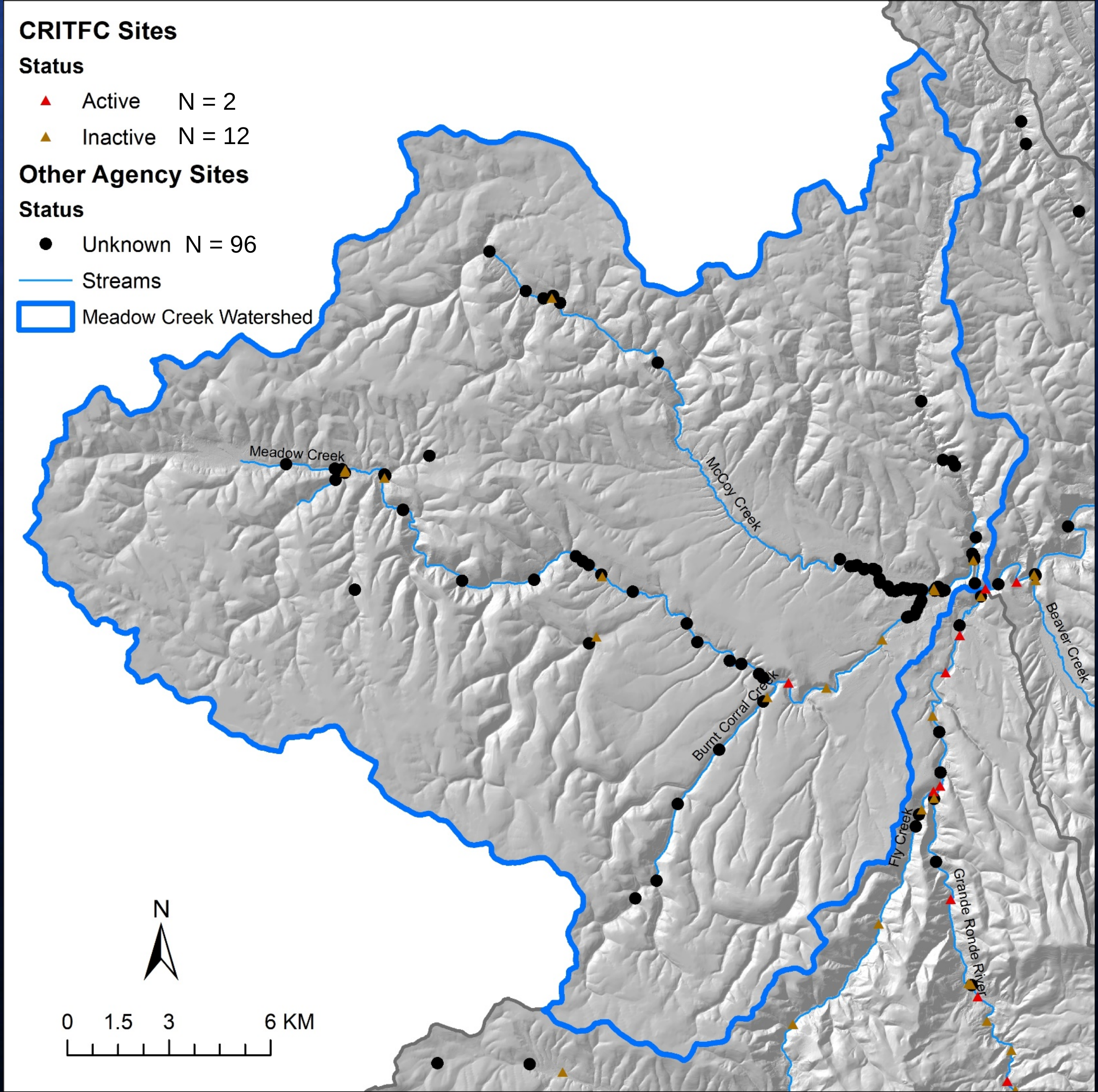
Tools are needed to evaluate past and future impacts of restoration actions on fish populations so that limited restoration dollars can be used most effectively to recover our salmon populations.



Catherine Creek, Grande Ronde Valley

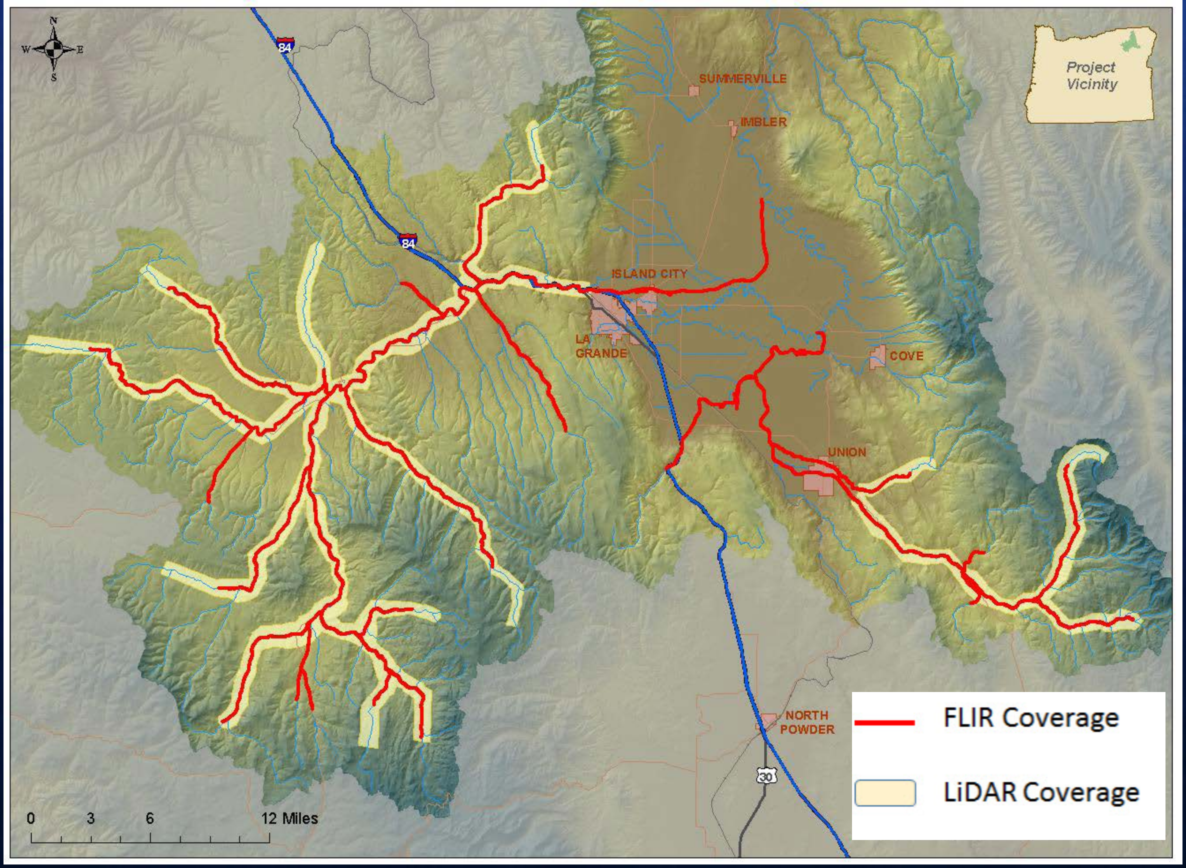
Upper Grande Ronde River, Vey Meadows


CRITFC Sites
Status
Active N = 61
Inactive N = 113
Other Agency Sites
Status
Unknown N = 455
Streams
Meadow Creek Watershed
Howard Creek
Dry Creek
Wallowa River
Deer Creek
Bear Creek
Grande Ronde River
Phillips Creek
Dry Creek
Minam River
Lostine River
Hurricane Creek
Prairie Creek
State Ditch
Grande Ronde River
Mill Creek
Ladd Creek
Catherine Creek
Fly Creek
Beaver Creek
Sheep Creek
Chicken Creek
N
0 5 10 20 KM



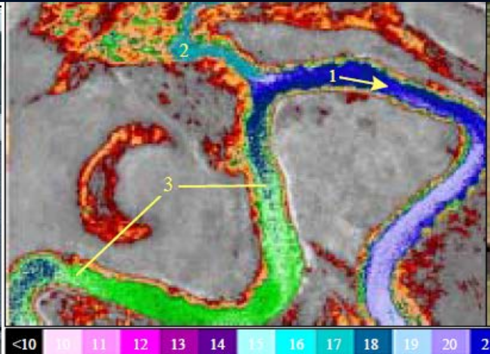
CRITFC Sites
Status
Active N = 2
Inactive N = 12
Other Agency Sites
Status
Unknown N = 96
Streams
Meadow Creek Watershed
Meadow Creek
McCoy Creek
Burnt Corral Creek
Beaver Creek
Fly Creek
Grande Ronde River
N
0 1.5 3 6 KM

Heat Source Water Temperature Model



LiDAR Data

FLIR Data



- LiDAR data for 500-m stream buffer in 2009.
- FLIR data for 364 river km in 2010.

Heat Source Model

Calibrated for July 10 – September 20, 2010

- Channel Geometry (LiDAR)
- Riparian Vegetation (LiDAR)
- Stream Temperature (FLIR and loggers)
- Discharge
- Climate

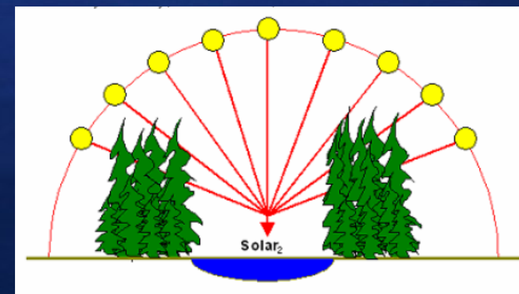
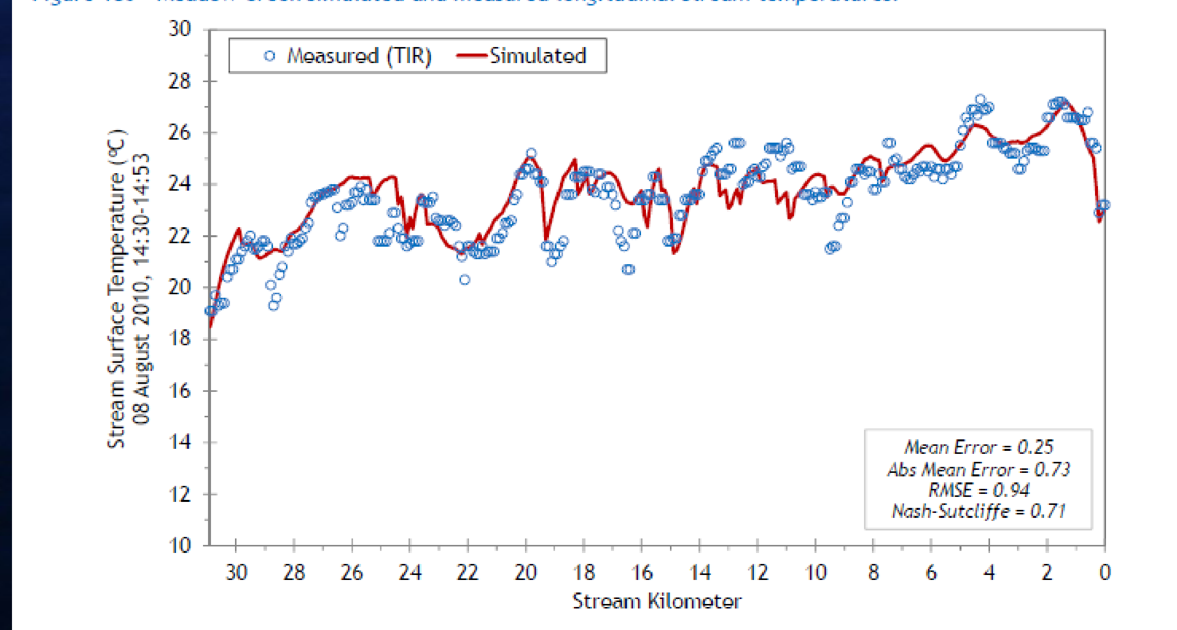


Image from Boyd and Kasper (2003)

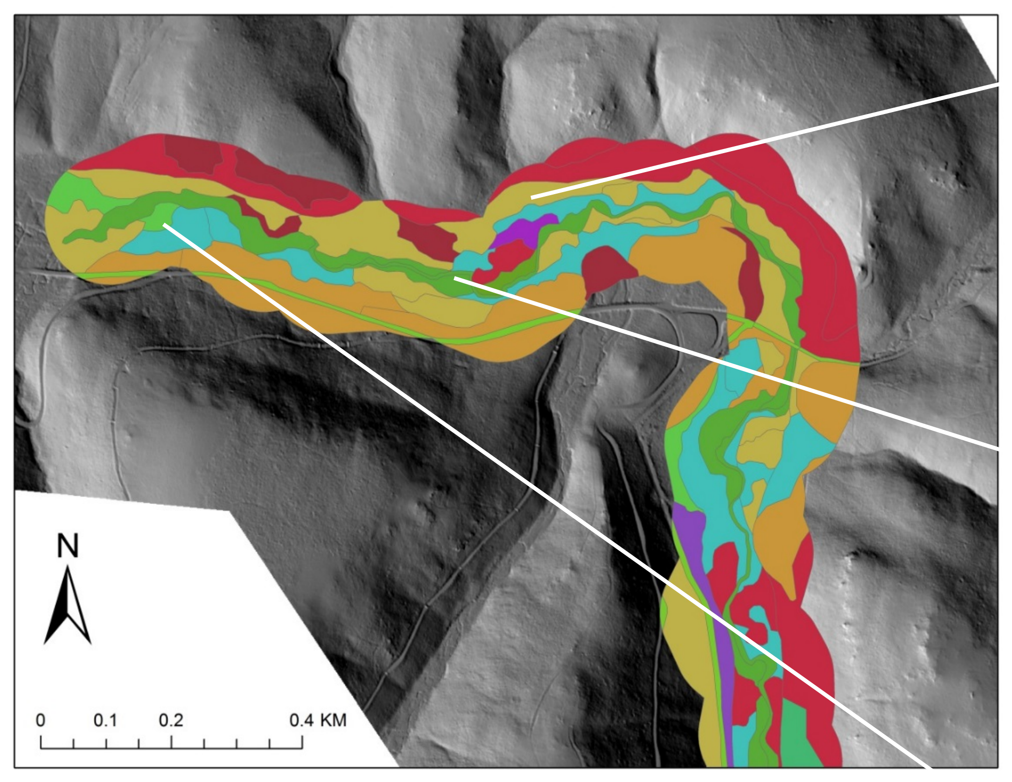
Figure 185 - Meadow Creek simulated and measured longitudinal stream temperatures.



From: Watershed Sciences (2012) Grande Ronde River Basin Stream Temperature Modeling

Riparian Mapping Methods

Plant Association Groups (PAGs)
Meadow Creek



Open Lodgepole Pine Forest

Open Tall Willow

Forb Meadow

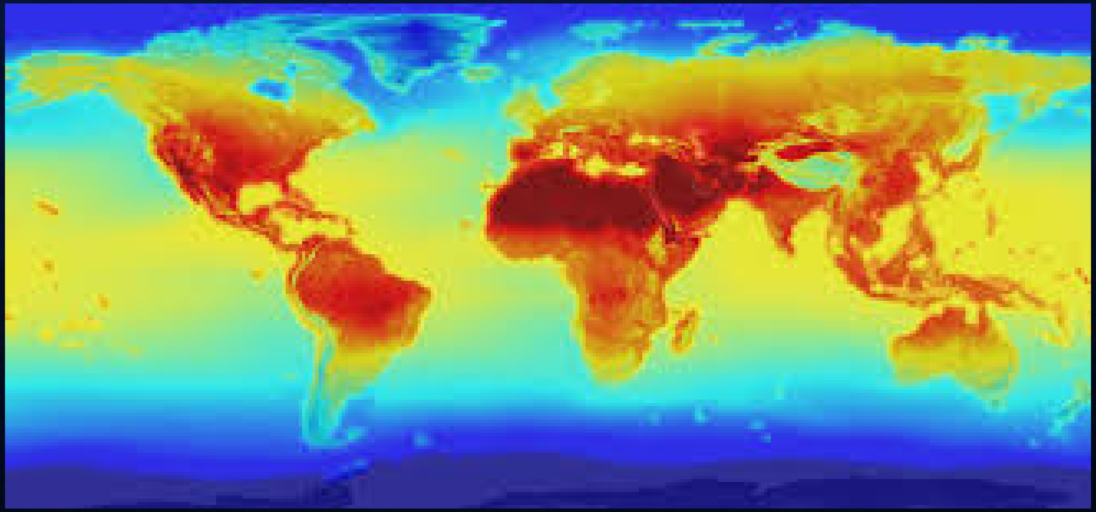
Riparian classification based on:

1) Physiography (lowland, upland, riverine),
2) Geomorphology (bedrock, alluvial fan, terrace, etc.)
3) Soils,
4) Vegetation, and
5) Disturbance

Wells et al. (2015)

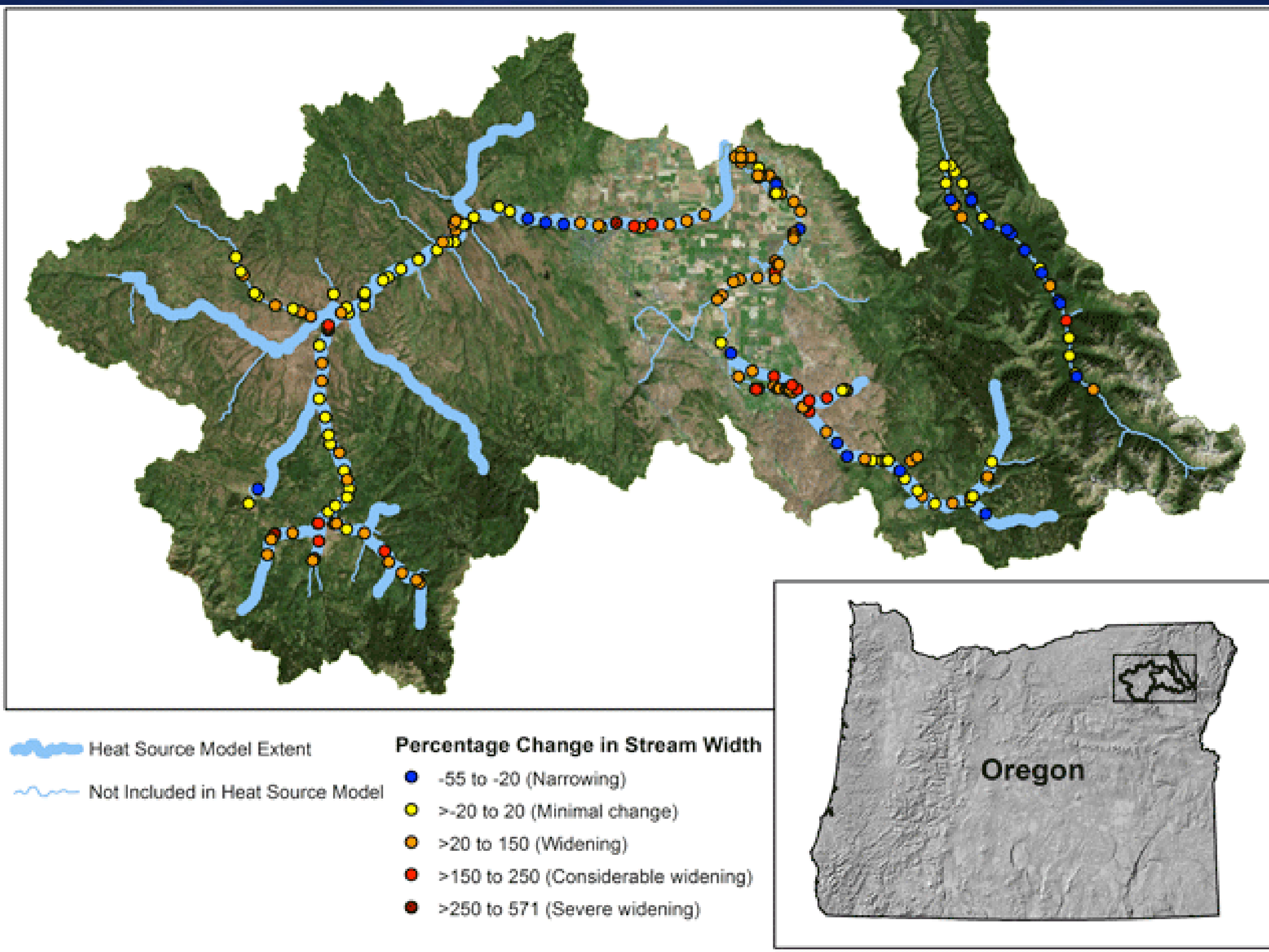
Climate Change Scenarios

- Climate change projections from University of Washington's Climate Impacts Group for 2080s (2070-2099).
- Summer air temperature increase: + 4.7 °C
- Summer streamflow decrease: - 20 %



River Width Scenarios

White et al. 2017 *Elem Anth Sci*

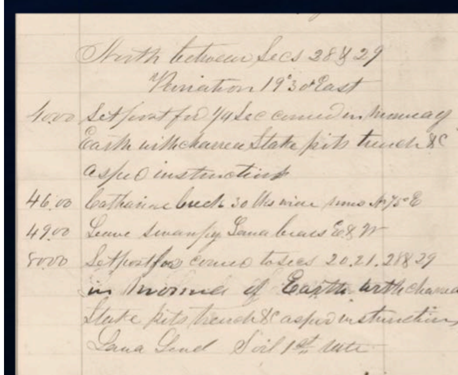


Evaluating change in river width

1800s: General Land Office survey

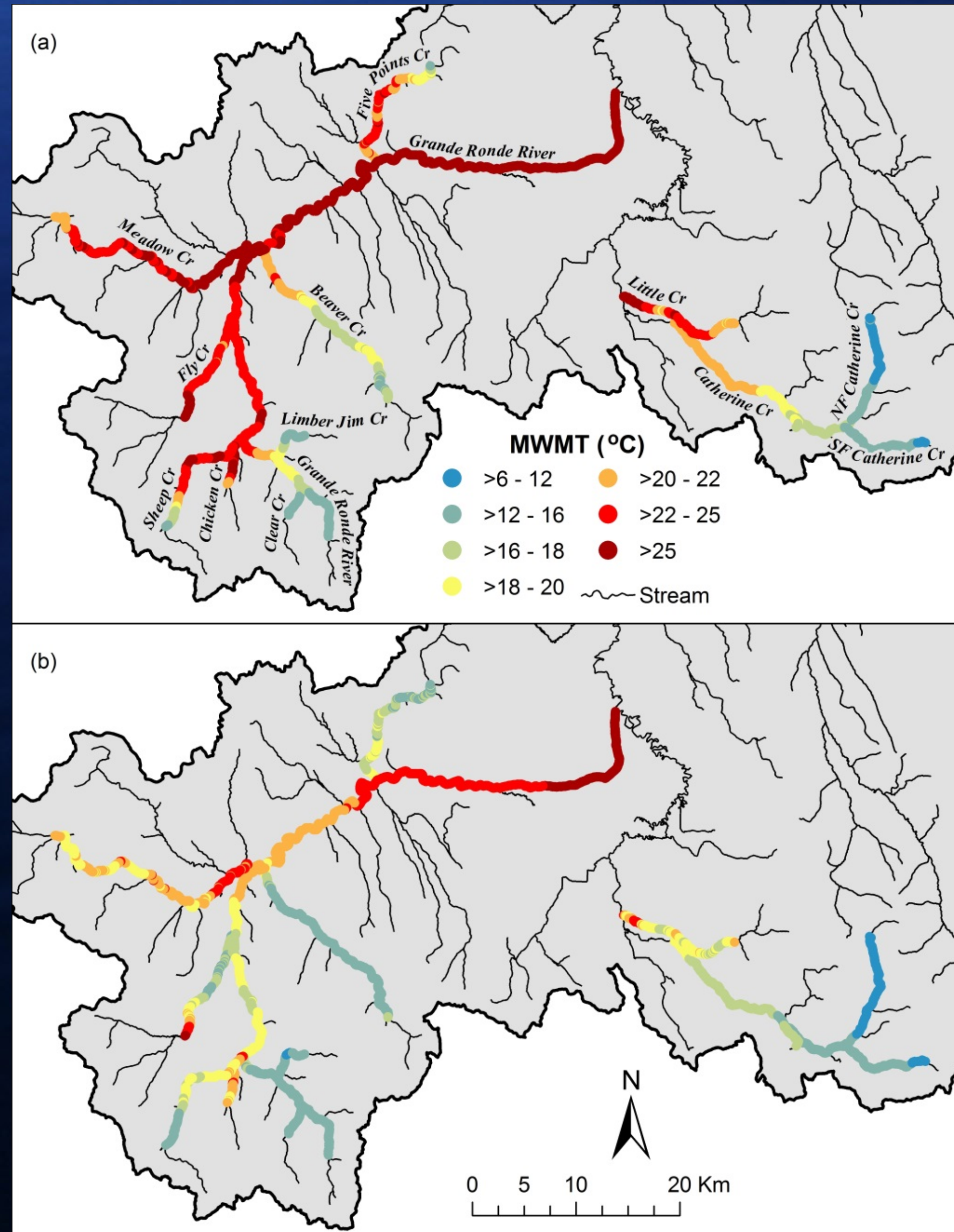
Current: Aquatic Inventories Program

$$\Delta W = \frac{W_P - W_H}{W_H} \times 100$$


North between Secs 28 & 29
Variation 19°30' East
40.00 Set post for 1/4 Sec corner in mound of
Earth with charred Stake pits trench &c
as per instructions
46.00 Catharine creek 30 lks wide runs N 75° E
49.00 Leave swampy Land bears E & W
80.00 Set post for corner to Secs 20.21.28 & 29
in mound of Earth with charred
Stake pits trench &c as per instructions
Land Level Soil 1st rate

Results: Water Temperature Predictions

Current Conditions (2010)



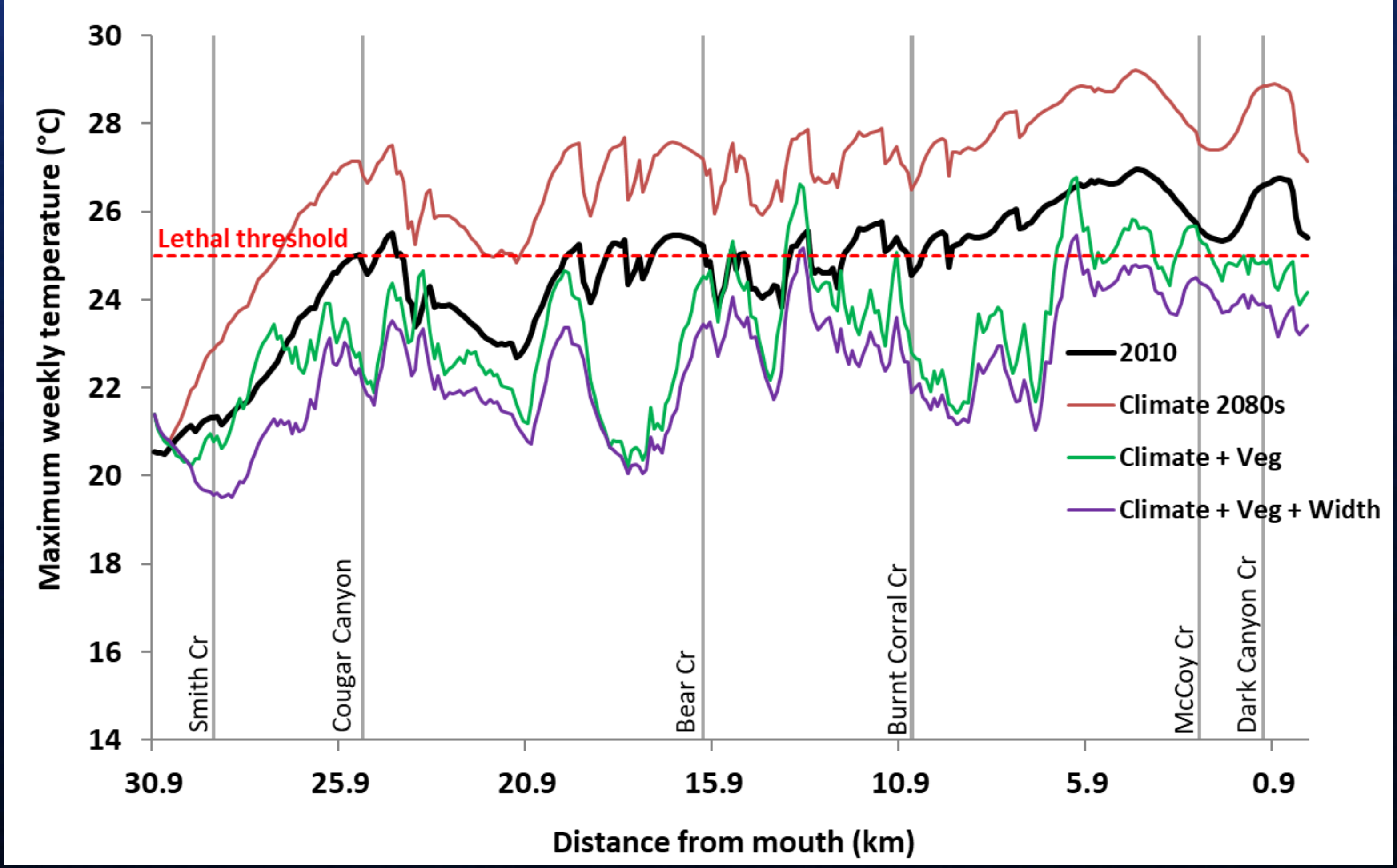
Restored Vegetation (PNV)

Median Temperature Reduction:
Upper Grande Ronde: -5.5 °C
Catherine Creek: -2.4 °C

Justice et al. (2017) Journal of Environmental Management

Water Temperature Predictions

Meadow Creek



Median temperature change:
(Climate + Veg + Width) = -2.5 °C

Mapping Cold Water Refuges in the Upper Grande Ronde

Background:

- High water temperature is a **key limiting factor** affecting abundance, productivity and spatial distribution of ESA-listed Upper Grande Ronde and Catherine Creek Spring Chinook populations (NOAA Recovery Plan 2014).

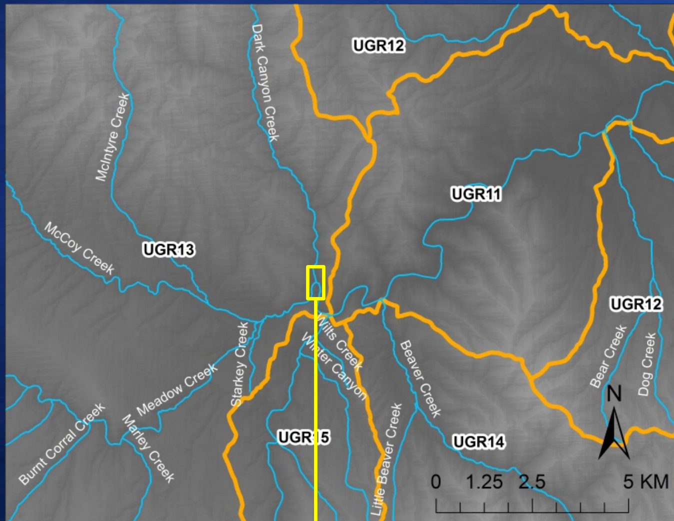
- Cold water refuges can provide important rearing or holding habitat for salmonids that can help mediate the effects of warm ambient water temperatures.

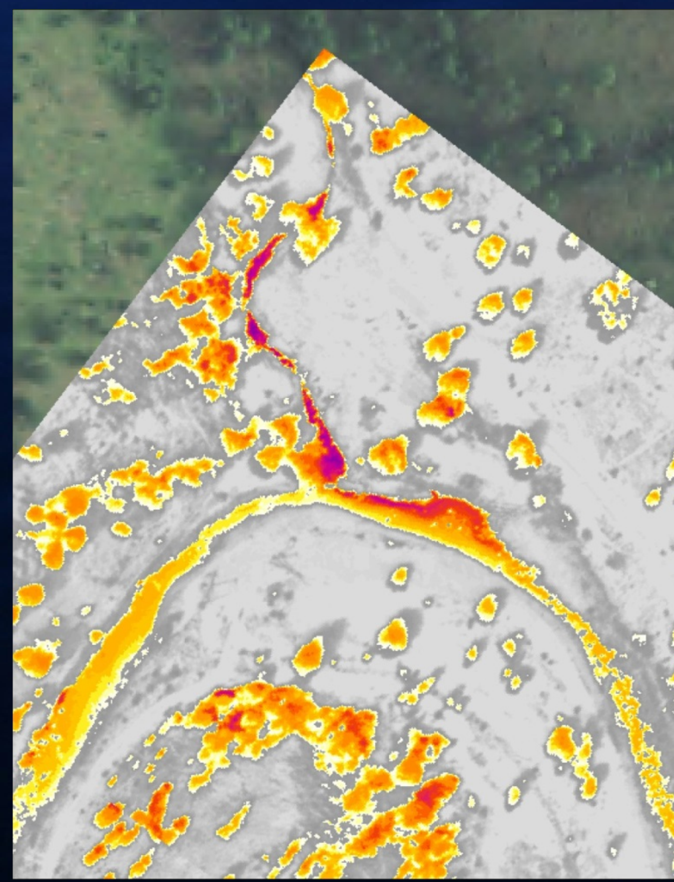
- Preferential fish use of cold water refuges has been documented in the Grande Ronde (Ebersole et al. 2001 & 2003) and John Day basins (Torgersen et al. 1999).

Tributary confluence plume Meadow Creek

RKM 1.1

BSR UGR13

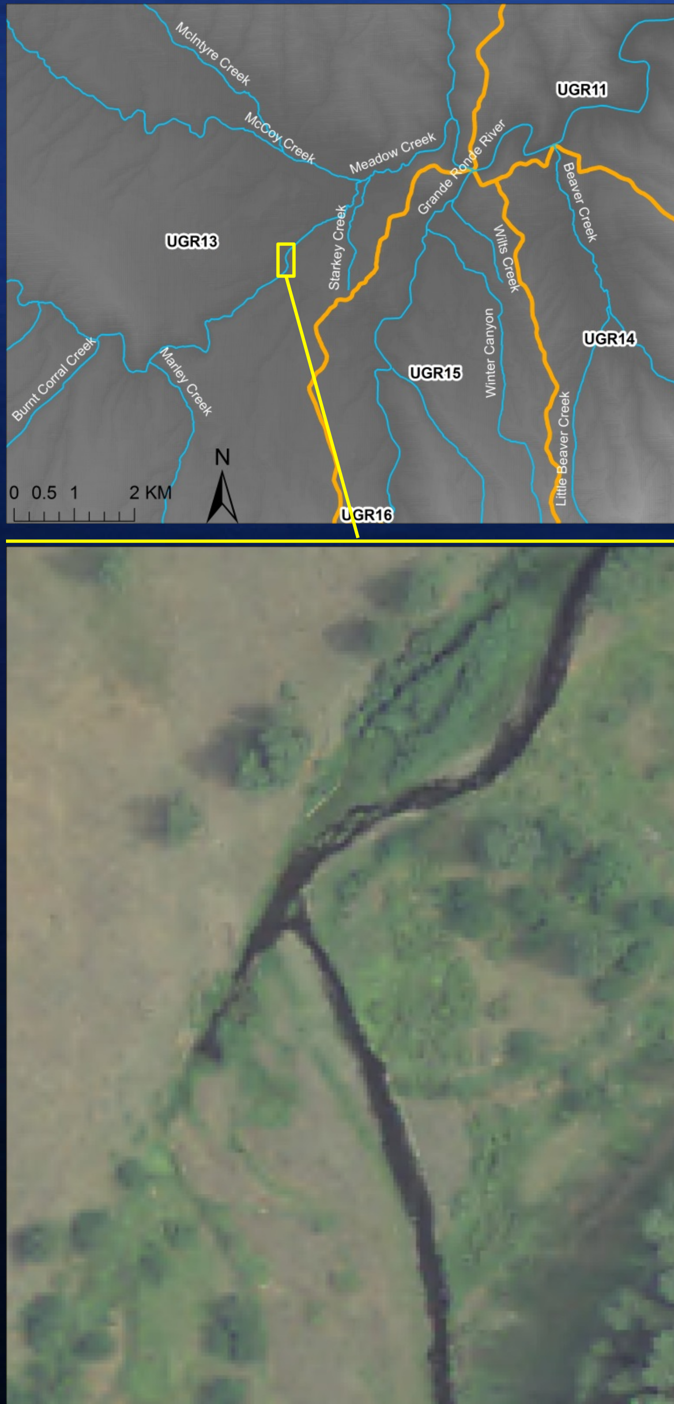


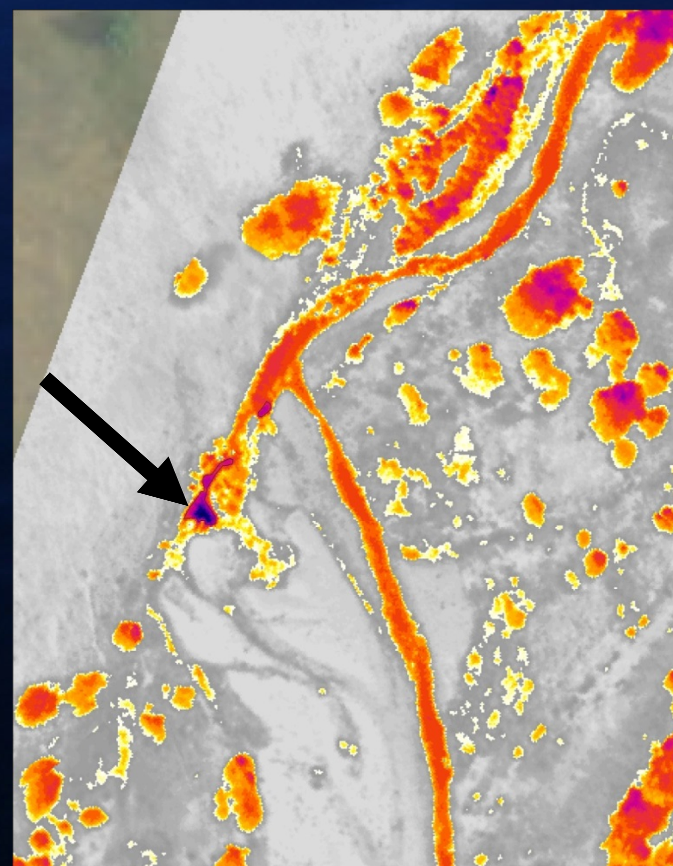


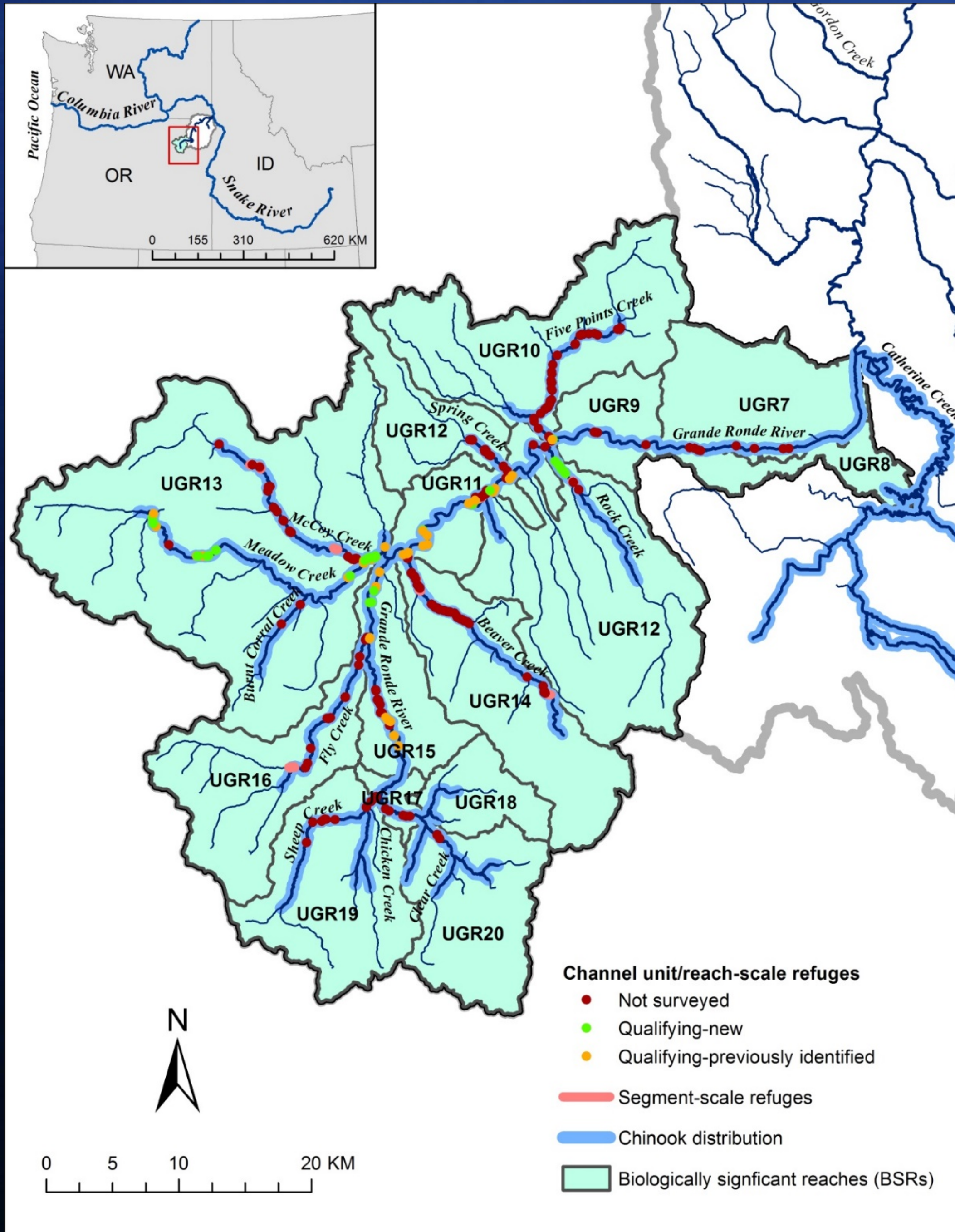
Cold water alcove Meadow Creek

RKM 5.5

BSR UGR13







Cold-water Refuge Summary

Refuge type	Count	Area (m²)
Cold side channel	92	2230
Lateral seep	74	2155
Hyporheic upwelling	48	883
Cold alcove	38	612
Tributary confluence plume	16	1627
Springbrook	10	1202
Unknown	10	344
Isolated floodplain pool	2	109
Total	290	9162

Details in: McCullough et al. (2017) Annual Report to BPA

https://www.cbfish.org/Document.mvc/Viewer/P155445

Take Home Messages

1. These data highlight that water temperature is a critical limiting factor for salmonids in the Meadow Creek watershed with 100% of the mainstem channel exceeding 18 °C and > 50% exceeding a lethal threshold of 25 °C.

2. Riparian restoration and channel narrowing/deepening will not be sufficient to offset impacts from historic stream degradation and climate change. Aggressive, watershed-scale restoration actions aimed at increasing floodplain connectivity and hyporheic exchange in addition to riparian shading will likely be needed.

3. Cold water refuges play an important role in providing suitable rearing/holding habitat for salmonids in this system and have been mapped from FLIR data in 2010, providing an opportunity to track changes in refugia habitat in response to future restoration.

Initial ideas on using these data/models to set watershed-scale objectives

1) **Objective # 1 - Water Temperature (Magnitude):** Reduce average peak summer surface water temperature (MWMT or Average August) within the Meadow Creek mainstem (mouth to Waucup Creek) by X °C within 5 years, and by Y °C within 20 years.
   - Data sources: Annual water temperature loggers distributed at key tributary junctions, upstream/downstream boundaries, and treatment/control reaches. Heat Source or similar temperature models may provide insights on where stream warming is occurring most rapidly and therefore, where restoration may be most effective.

2) **Objective # 2 – Water Temperature (Frequency):** Reduce the average number of days per year that surface water temperatures exceed 18 °C by X within 5 years and by Y within 20 years.
   - Data sources: Annual water temperature loggers

3) **Objective # 3 – Water Temperature (Spatial Variability):** Increase the coefficient of variation (SD/Mean) of surface water temperature during summer by X % within 5 years and by Y within 20 years.
   - Data sources: Thermal infrared imagery pre vs post project. 2010 FLIR imagery could serve as pre data, annual water temperature loggers. UAS imagery?

4) **Objective # 4 – Water Temperature (Cold-water Refugia):** Increase the frequency of cold-water refugia (number per km) by X % within 5 years and by Y within 20 years.
   - Data sources: Thermal infrared imagery pre vs post project. 2010 FLIR imagery could serve as pre data, annual water temperature loggers. UAS imagery?

Temporal variability?

Winter/Spring Temperatures?


dsgn4-000213, RKM 2.7 (2017)


ORW03446-139144, RKM 11.3 (2016)


Stky-P3-Ex1, RKM 20.5 (2017)


CBW05583-275866, RKM 28.1 (2017)