Water Quality Program

Lower Willamette Cold Water Refuge Report: Stakeholder Presentation

January 31, 2020

Portland, Oregon

James McConaghie and Debra Sturdevant | Oregon Department of Environmental Quality

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Meeting Overview

Agenda

Time	Topic
2:00 pm	Welcome & Introductions
2:10 pm	Meeting Agenda and Objectives
2:15 pm	History and Background
2:30 pm	Overview of the CWR Study
3:20 pm	Implementation & Next Steps
3:35 pm	Q & A

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Background and Context

- Temperature standards for the lower Willamette
- Lower Willamette temperature listing & TMDL
- NOAA's 2015 Biological Opinion
- RPA – Implement the cold water refuge narrative

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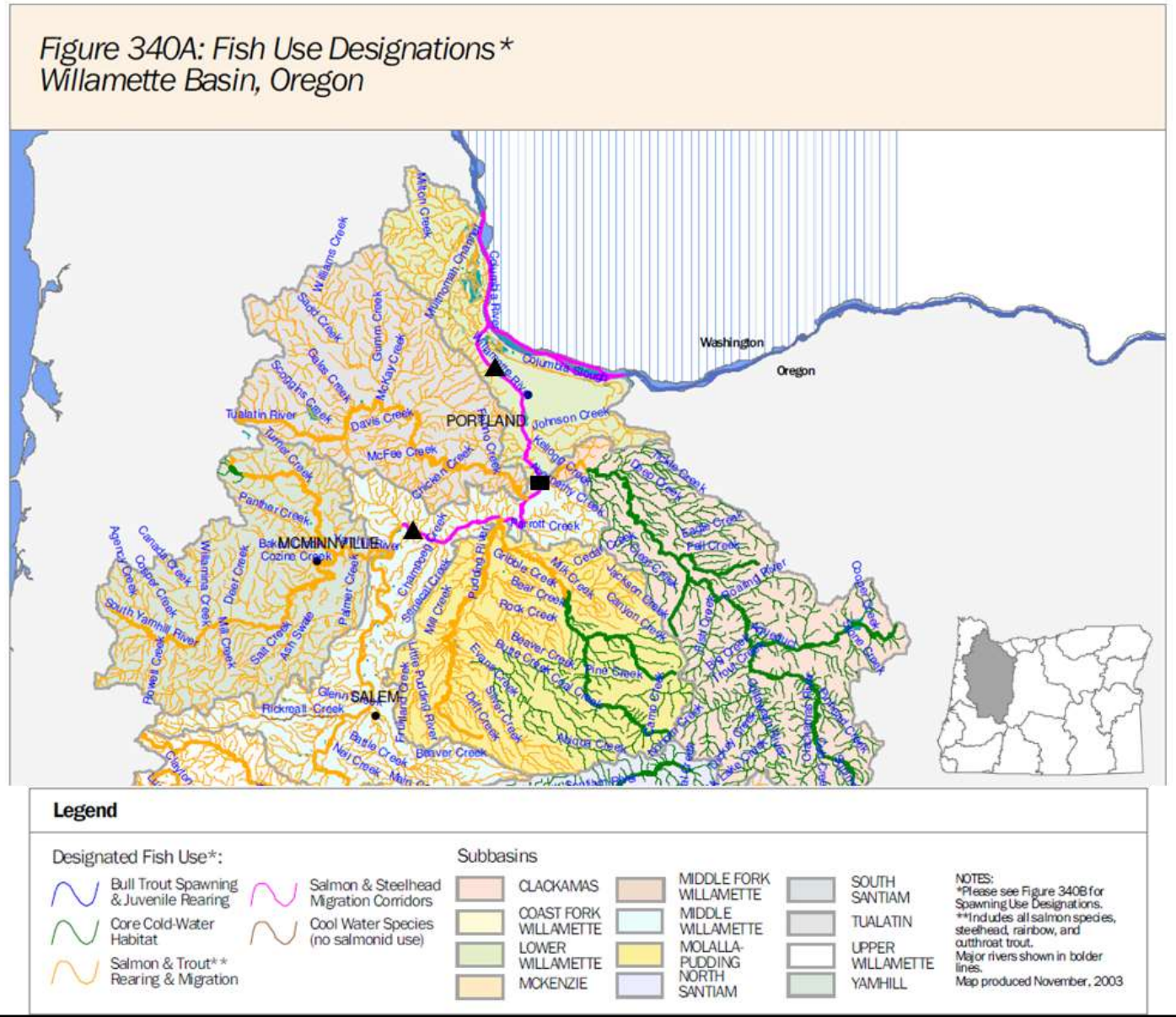
Temperature Standards for the Lower Willamette Migration Corridor

"Migration Corridor"

- Designated "Salmon and Steelhead Migration Corridor"
- River Mile 0 - 50.8 (km 88.2)
- Kelley Point -> Newberg Pool

Water Quality Standard

- 20°C as a 7-day average daily max



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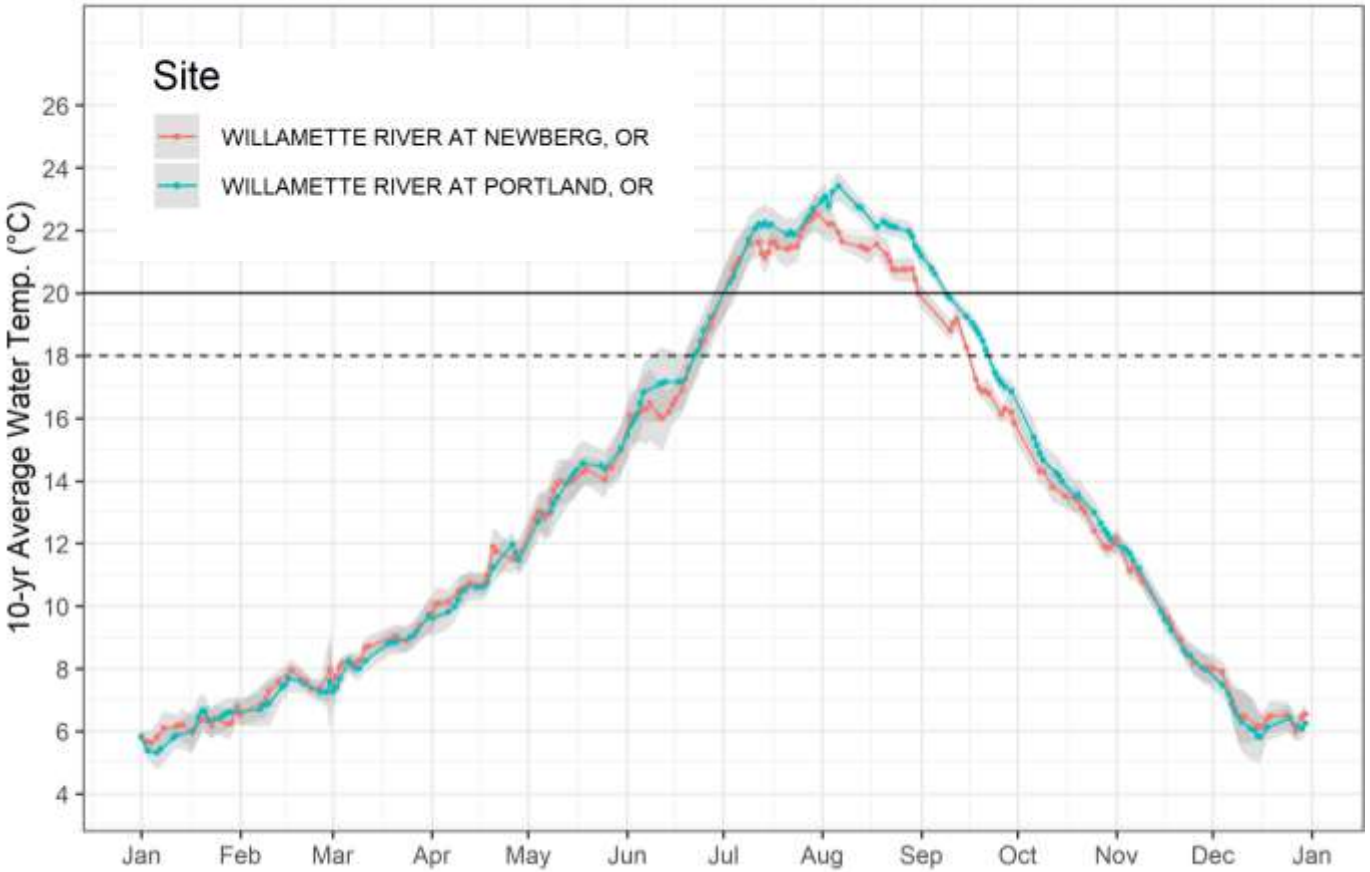
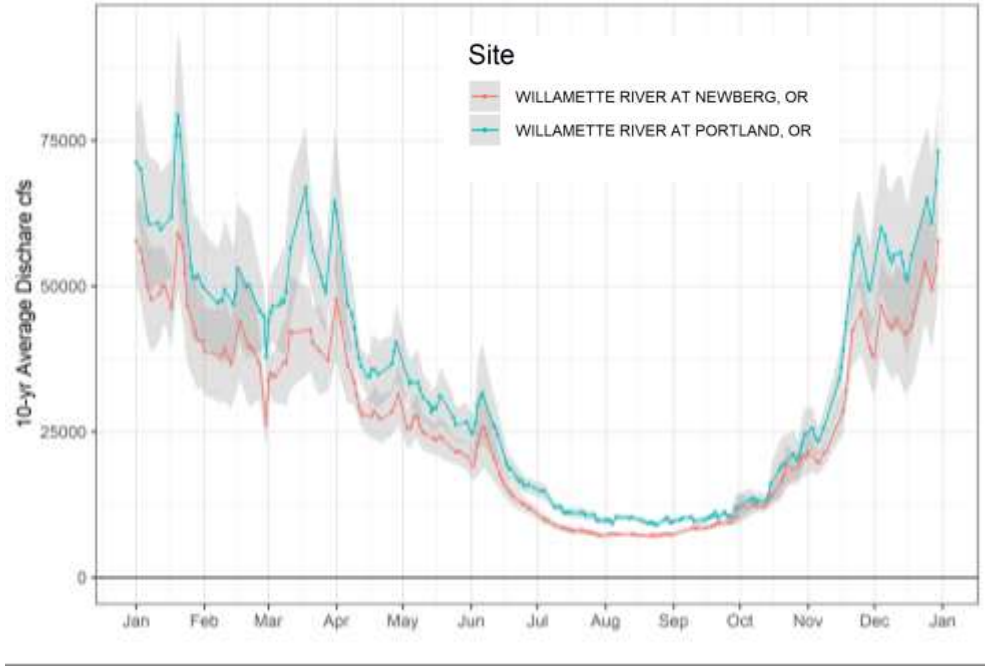
Current Conditions in the Migration Corridor



7-day average of the daily maximum criterion of 20°C exceeded *on average* from July 5 to September 11.



Corresponds to time period when flows are low.

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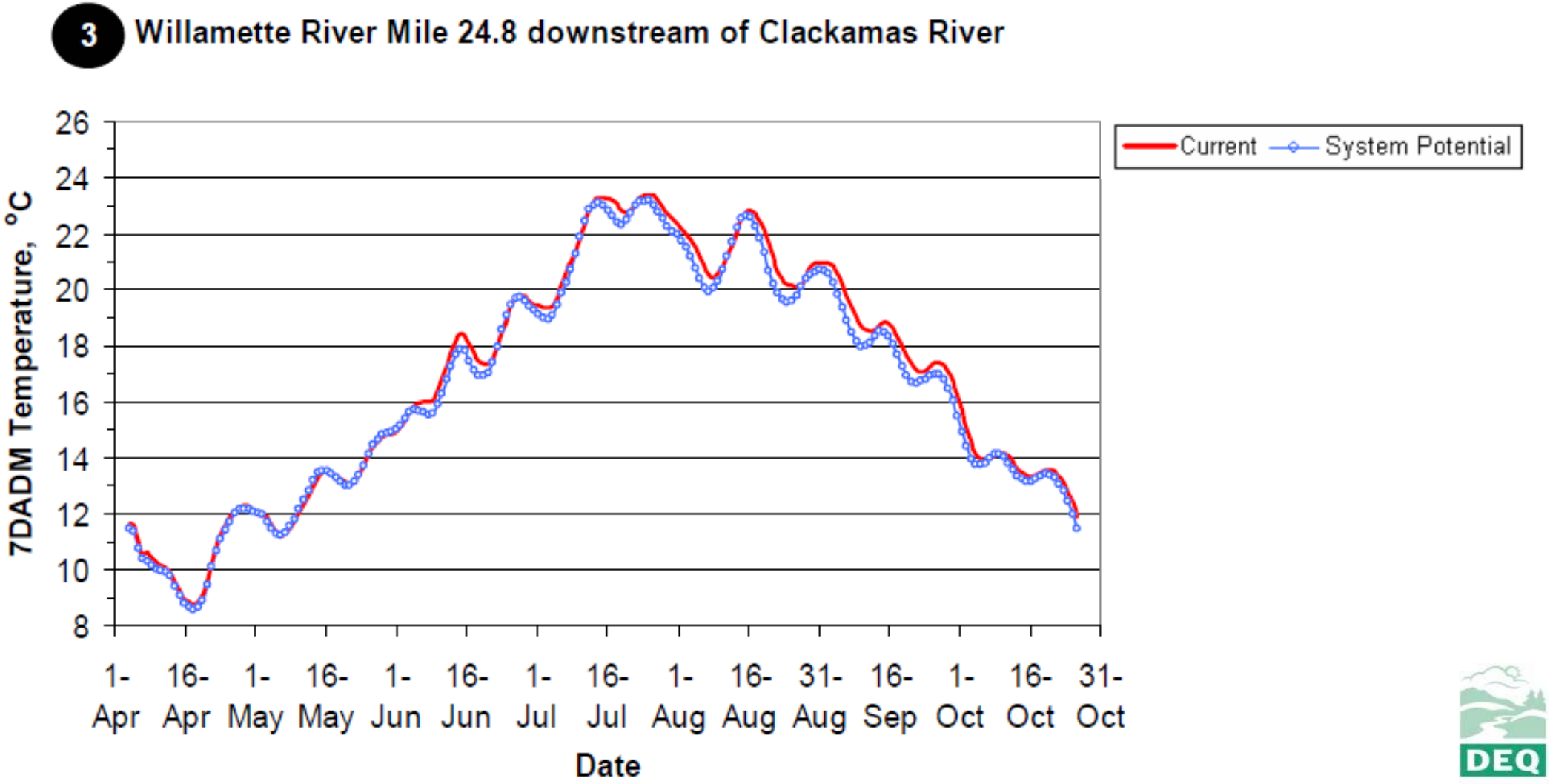
2006 Willamette Basin TMDL



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A two-part criteria for migration corridors

1. Numeric criterion 20°C as a 7-day average daily max (7-dadm)
2. Cold Water Refuge narrative criterion

OAR 340-041-0028

(4)(d) ***…….****In addition,* ***these water bodies must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body.***

OAR 340-041-0002

(10) "Cold Water Refugia" means those portions of a water body where, or times during the day when, ***the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed low of the water body.***

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NOAA's 2015 Biological Opinion

- Jeopardy conclusion for Migration Corridor criteria
  - Concerns that CWR narrative has not been implemented
- Willamette ESUs
  - Upper Willamette River Spring Chinook
  - Upper Willamette River Winter Steelhead
  - Lower Columbia River Spring Chinook
  - Lower Columbia Winter Steelhead

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RPA: Cold Water Refuge Study

The purpose of the CWR plan is to adequately interpret Oregon's "cold water refugia" narrative criterion to allow for implementation of the criterion through DEQ's Clean Water Act authorities.

1. Characterize the current spatial and temporal distribution of CWR
2. Characterize the current use of CWR by salmon and steelhead (4 ESUs) migrating through the corridor reach of the Willamette River
3. Assess whether the current spatial and temporal extent of CWR present is sufficient to meet the CWR narrative criterion
4. If DEQ concludes that the CWR criterion is not being met, characterize, to the maximum extent possible, the extent of additional CWR needed to attain the criterion
5. Identify and prioritize actions to protect, enhance, or restore CWR.
6. Identify scientific uncertainties and any additional research needed to fully implement the cold-water narrative.

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Goals for the Panel

Through a series of document reviews and guided discussions, provide scientific peer review and input to CWR study.

1. Identify additional data sets and analyses
2. Identify / fill information gaps
3. Identify/review assumptions and limitations
4. Address question of refuge sufficiency
5. Review conclusions and conservation priorities

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Expert Scientific Review Panel

Name	Affiliation
Matthew Keefer	Department of Fish and Wildlife Sciences, University of Idaho
Thomas Friesen	Oregon Department of Fish and Wildlife
Stanley Gregory	Department of Fisheries and Wildlife, Oregon State University
Krista Jones	U.S. Geological Survey
Anne Mullan	NOAA- National Marine Fisheries Service
Brook Silver	U.S. Fish and Wildlife Service
Joseph Ebersol	U.S. Environmental Protection Agency
Marcía Snyder	U.S. Environmental Protection Agency
Julia Bond	City of Portland, Bureau of Environmental Services
Melissa Brown	City of Portland, Bureau of Environmental Services

Oregon State University

USGS science for a changing world

OREGON Fish & Wildlife

Environmental Services City of Portland working for clean rivers

The University of Idaho 1889

United States Environmental Protection Agency

U.S. Fish & Wildlife Service

NOAA

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Overview of the Draft Lower Willamette River Cold Water Refuge Narrative Criterion Implementation Study

James McConaghie, PhD | Oregon Department of Environmental Quality

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Cold Water Refuge Study Objectives

The purpose of the CWR plan is to adequately interpret Oregon's "cold water refugia" narrative criterion to allow for implementation of the criterion through DEQ's Clean Water Act authorities.

1. Gather and synthesize readily available data, information, and professional opinion.
2. Characterize current distribution of CWR.
3. Characterize current species use of CWR.
4. Assess whether the current spatial and temporal extent of CWR present is sufficient to meet the CWR narrative criterion
5. If the CWR criterion is not being met, characterize the extent of additional CWR needed.
6. Identify and prioritize actions to protect, enhance, or restore CWR.
7. Identify scientific uncertainties and additional research needs to implement the CWR narrative.

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Cold Water Refuge Study Area

Photo: USACE

Cold Water Refuge Study Objectives

1. Gather and synthesize readily available data, information, and professional opinion.

Photo: Oregon Historical Society

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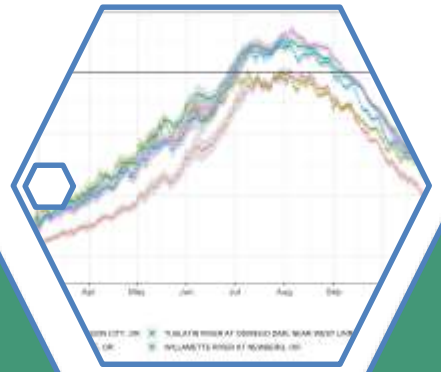
Temperature and Flow Data Sources

USGS

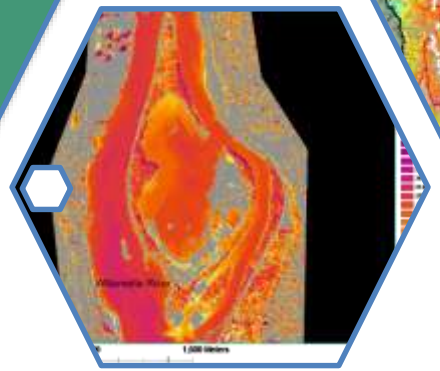


Oregon DEQ

Portland BES

EPA/ USFS:

NorWeST



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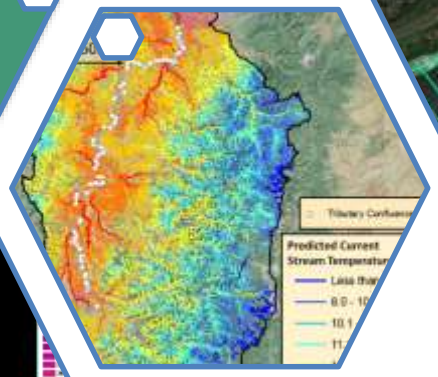
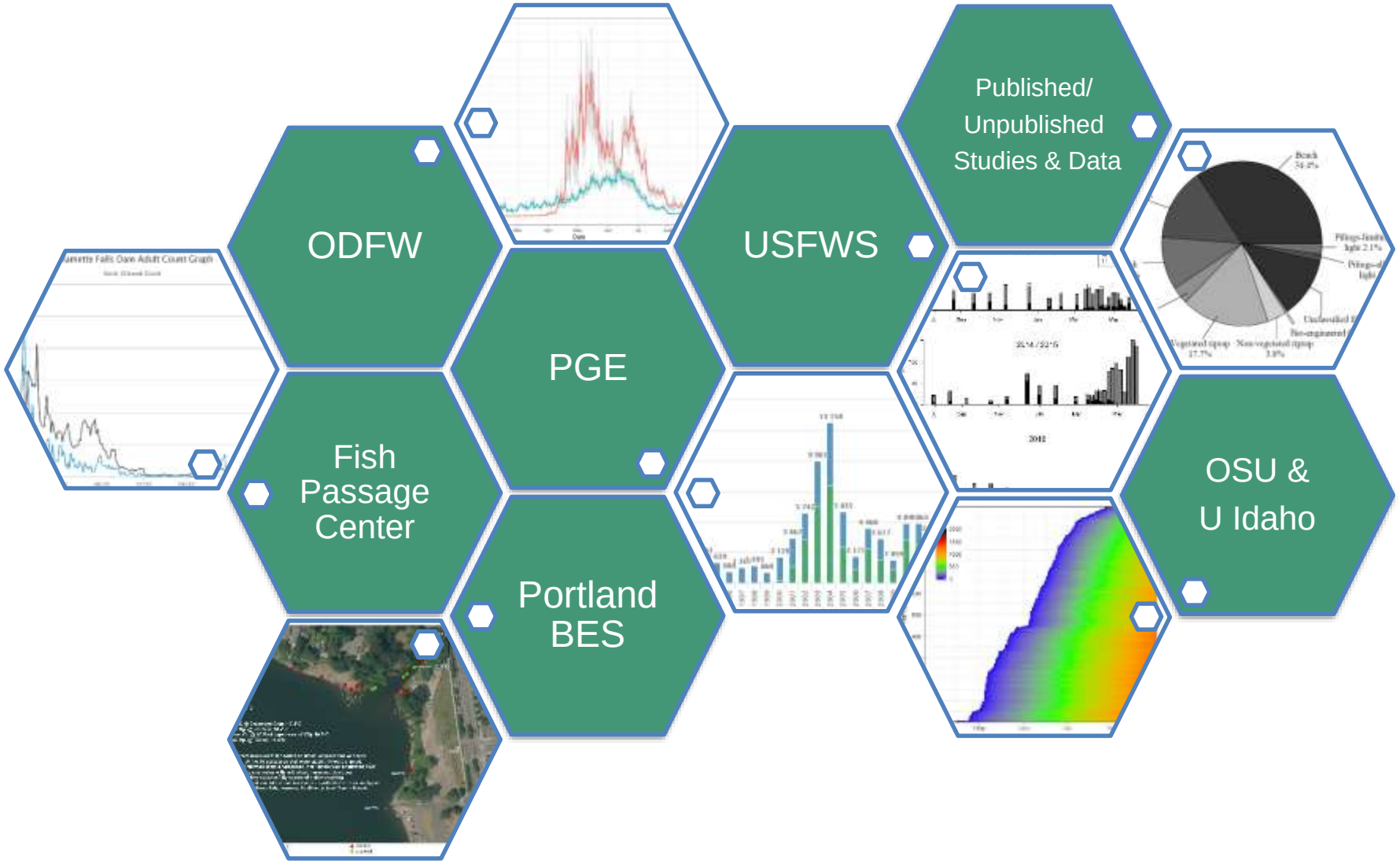
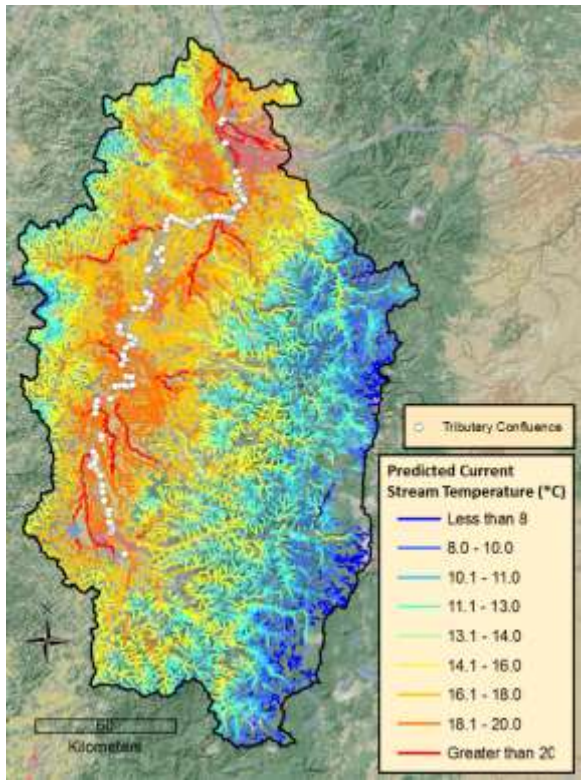


Fish Passage and Occurrence Data Sources



CWR Identification Framework

Tributary



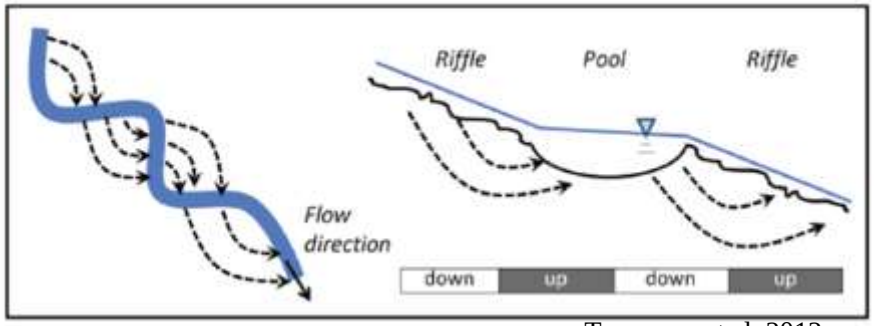
Leinenbach et al. 2017

Torgersen et al. 2012

Channel

Hulse et al. 2007

Reach



Torgersen et al. 2012

Coarse (Basin)

Scale

Fine (Feature)

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CWR Identification Framework

Operative Cold Water Refuge Definition:

Thermal	• ≥ 2°C reduction from mainstem • *High Quality:* absolute ≤ 18°C
Spatial	• Features within the floodplain at multi-scale: 1. Tributaries, 1cfs 2. channel units 3. microhabitat patches
Temporal	• Current conditions (2007-2017) • Available during June - September

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Cold Water Refuge Study Objectives

2. Characterize current distribution of CWR.

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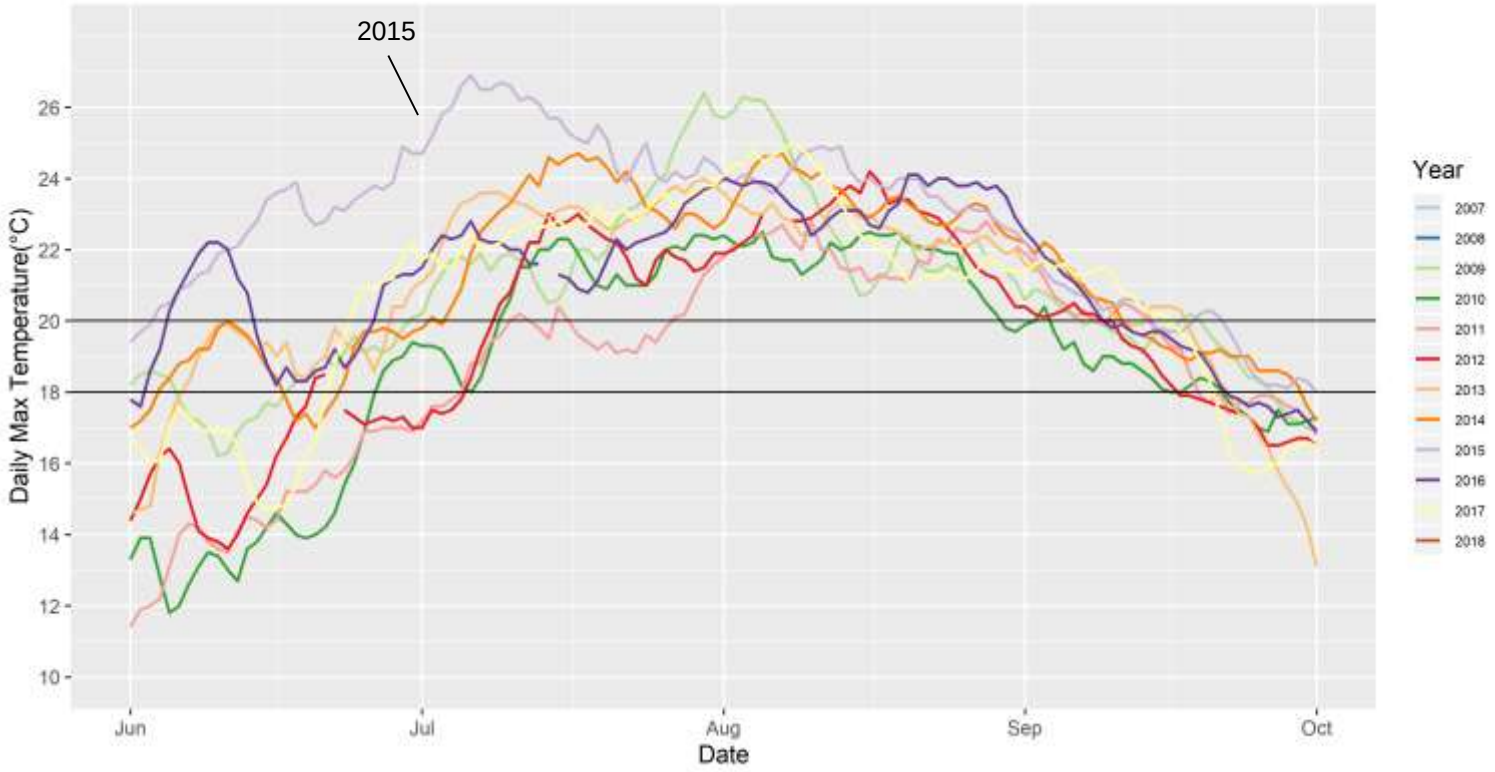
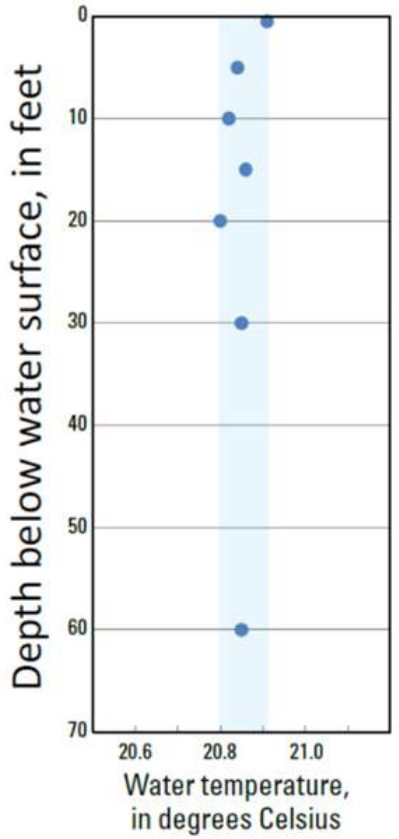
Willamette R. main stem temperature variability

Temporal



Spatial



Mangano et al, 2018

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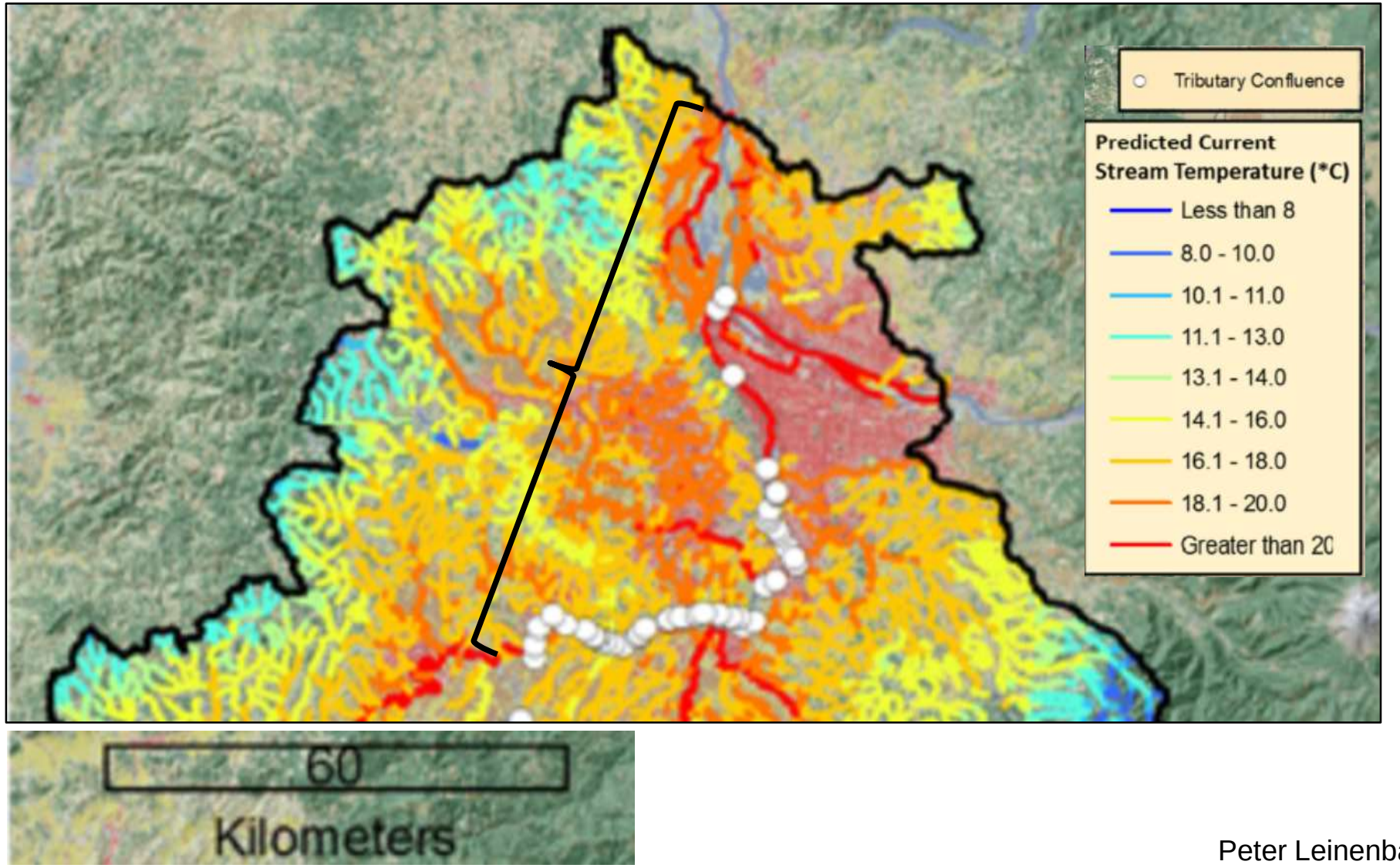
Tributary Screening : NorWeST Model



SSN temperature model:

- Average August
  - water temperature
  - stream flow

Peter Leinenbach, U.S. EPA

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

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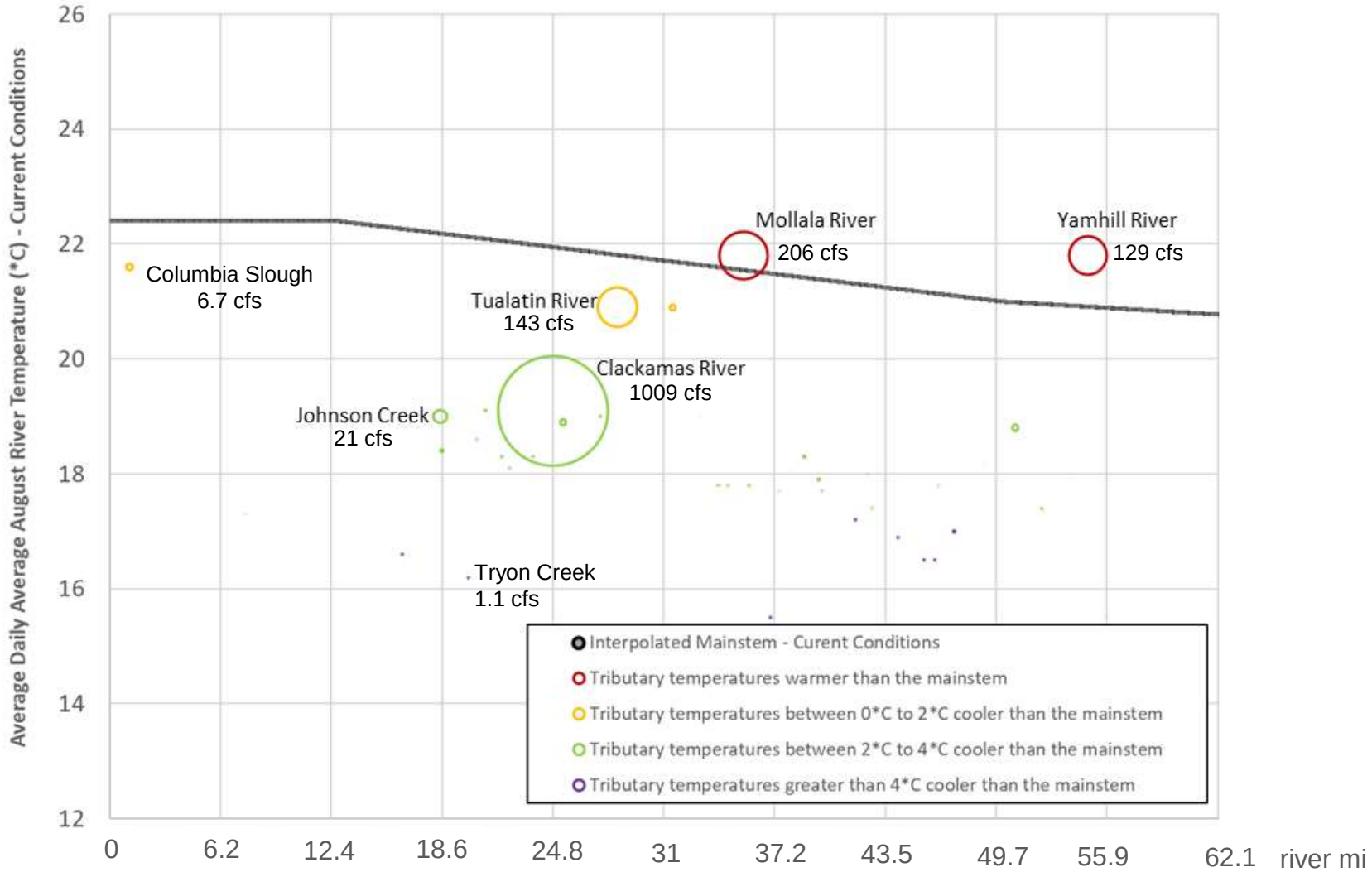
NorWeST: Cold Tributary Candidates



Peter Leinenbach, U.S. EPA

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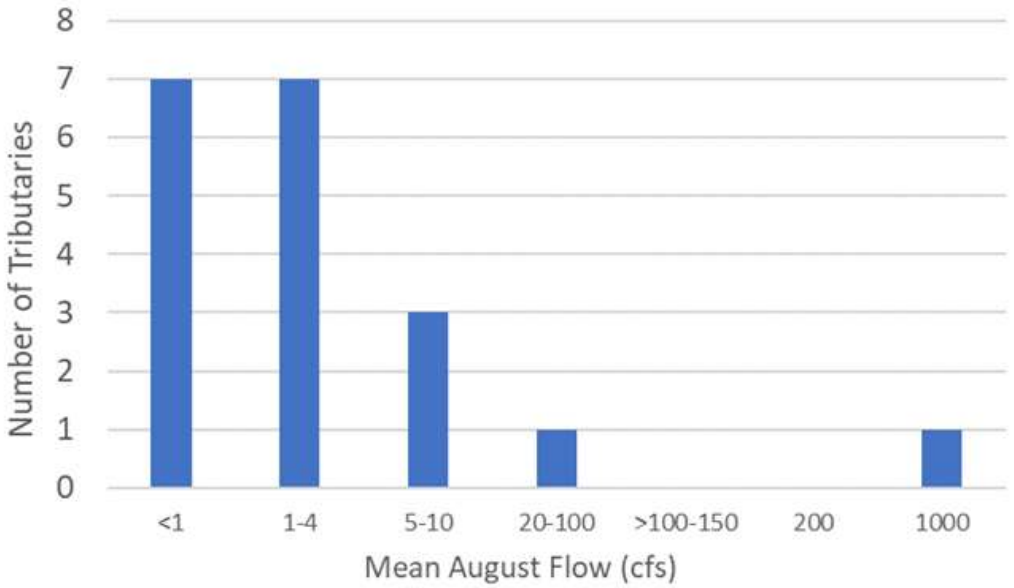
Flow distribution of candidate CWR tributaries



Adult Refuge Screening Criteria:

ΔT > 2°C cooler

Flow > 1 cfs

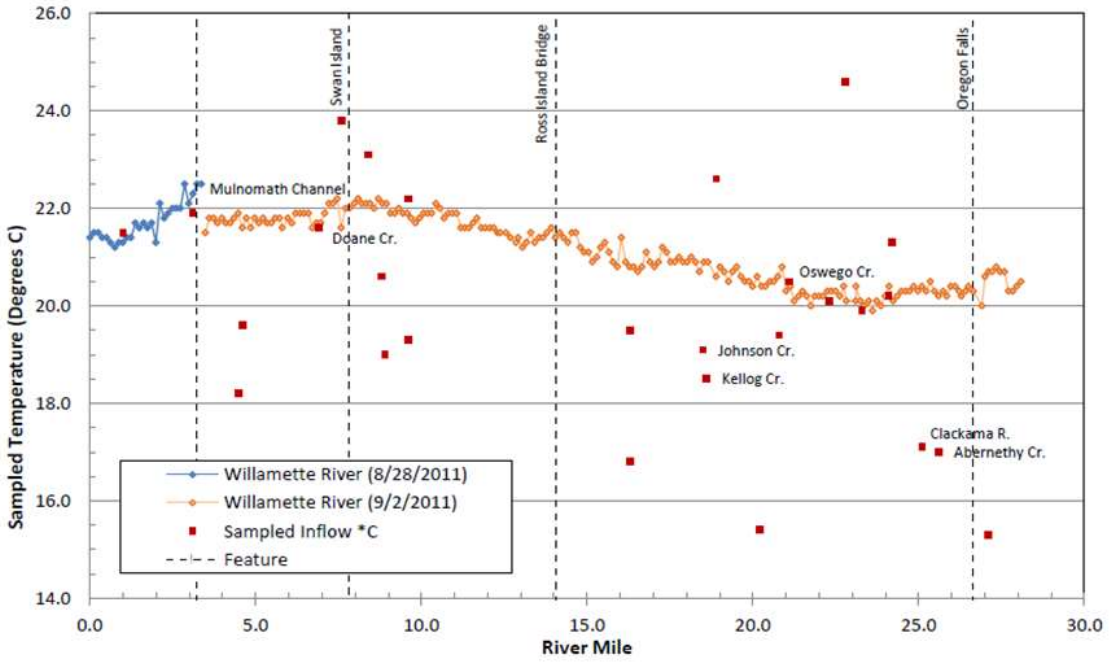
Photo: USGS

Photo: USGS

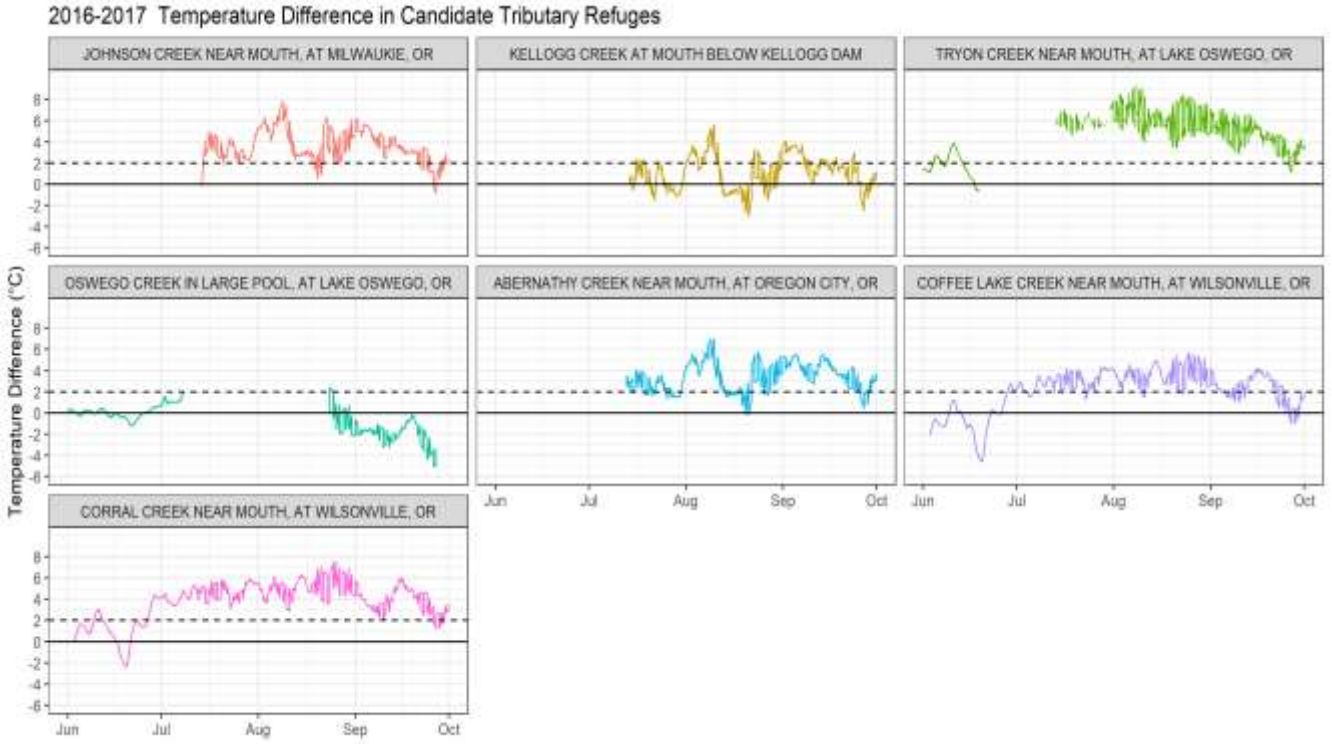
Photo: Google Inc.

Confirmation - Tributary & Inflow Field Surveys

Portland BES – continuous & synoptic



USGS – Continuous monitoring



*Data usually collected June - September

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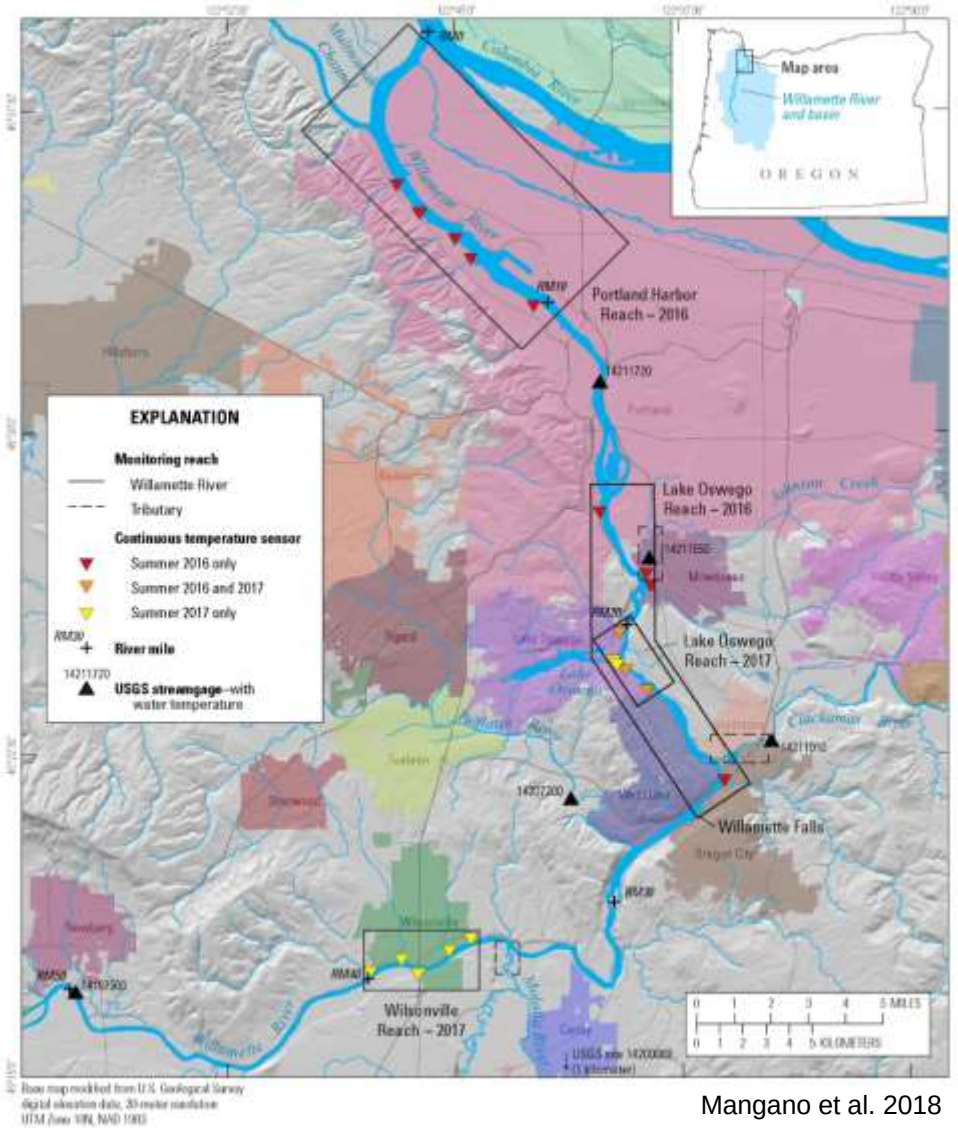
Off-Channel and Reach CWR Surveys

Oregon State University, 2011 – 2016

Hulse et al. 2010

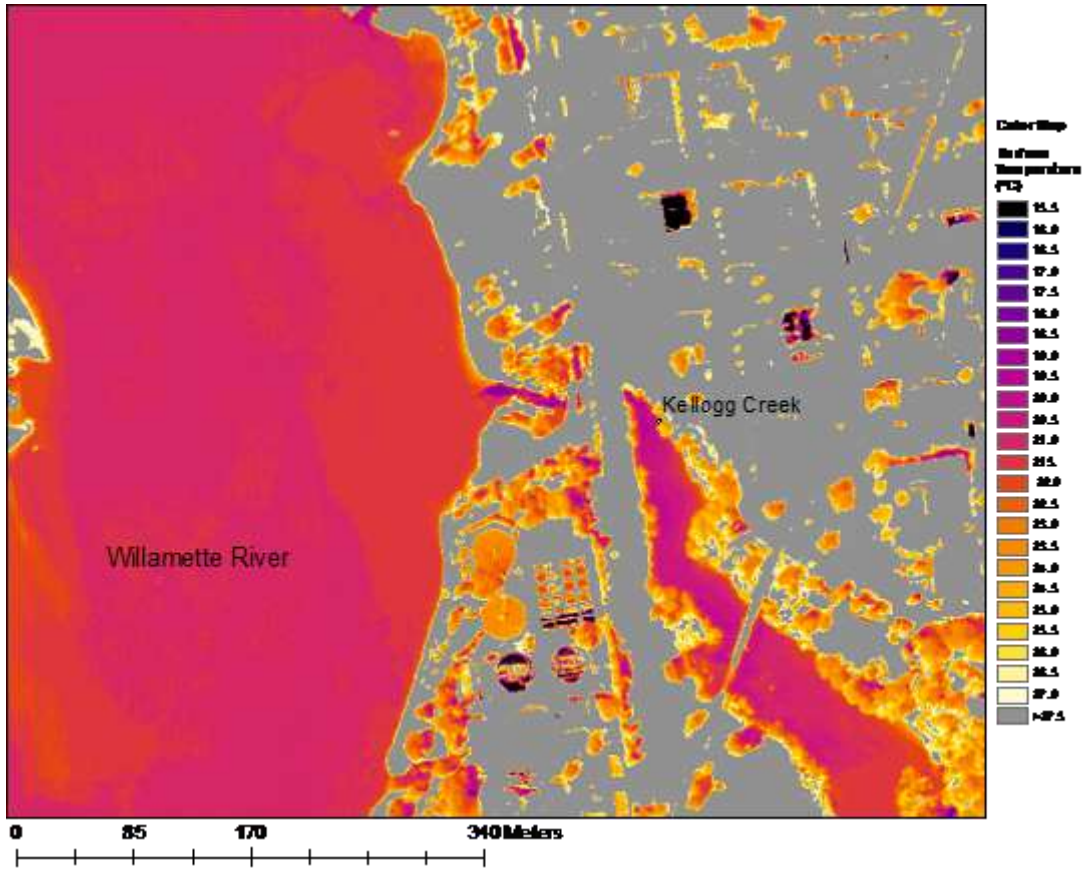
USGS, 2016 & 2017



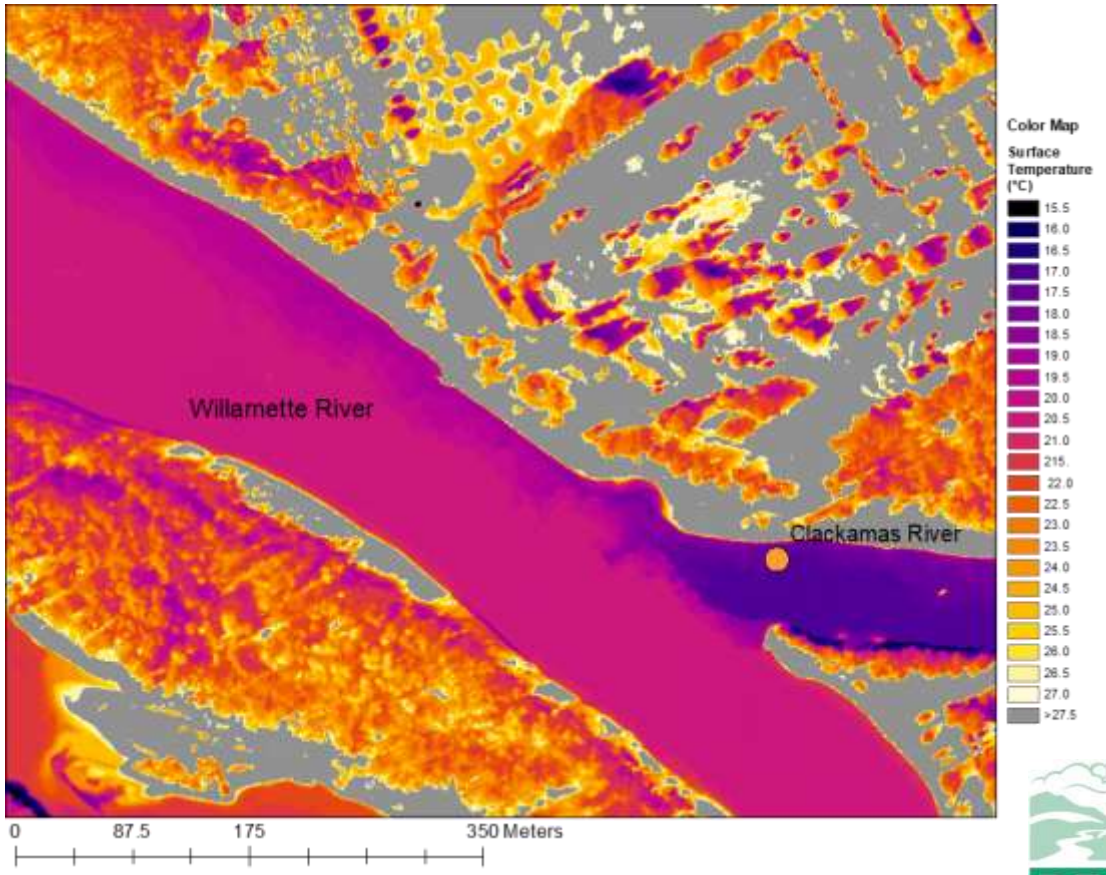
Mangano et al. 2018

FLIR Tributary Surface Plume Visualization

Kellogg Creek
2.7 cfs (NorWeST)



Clackamas River
1009 cfs (NorWeST)



* Data limited to areas downstream of Willamette Falls

Source: City of Portland BES, 2011

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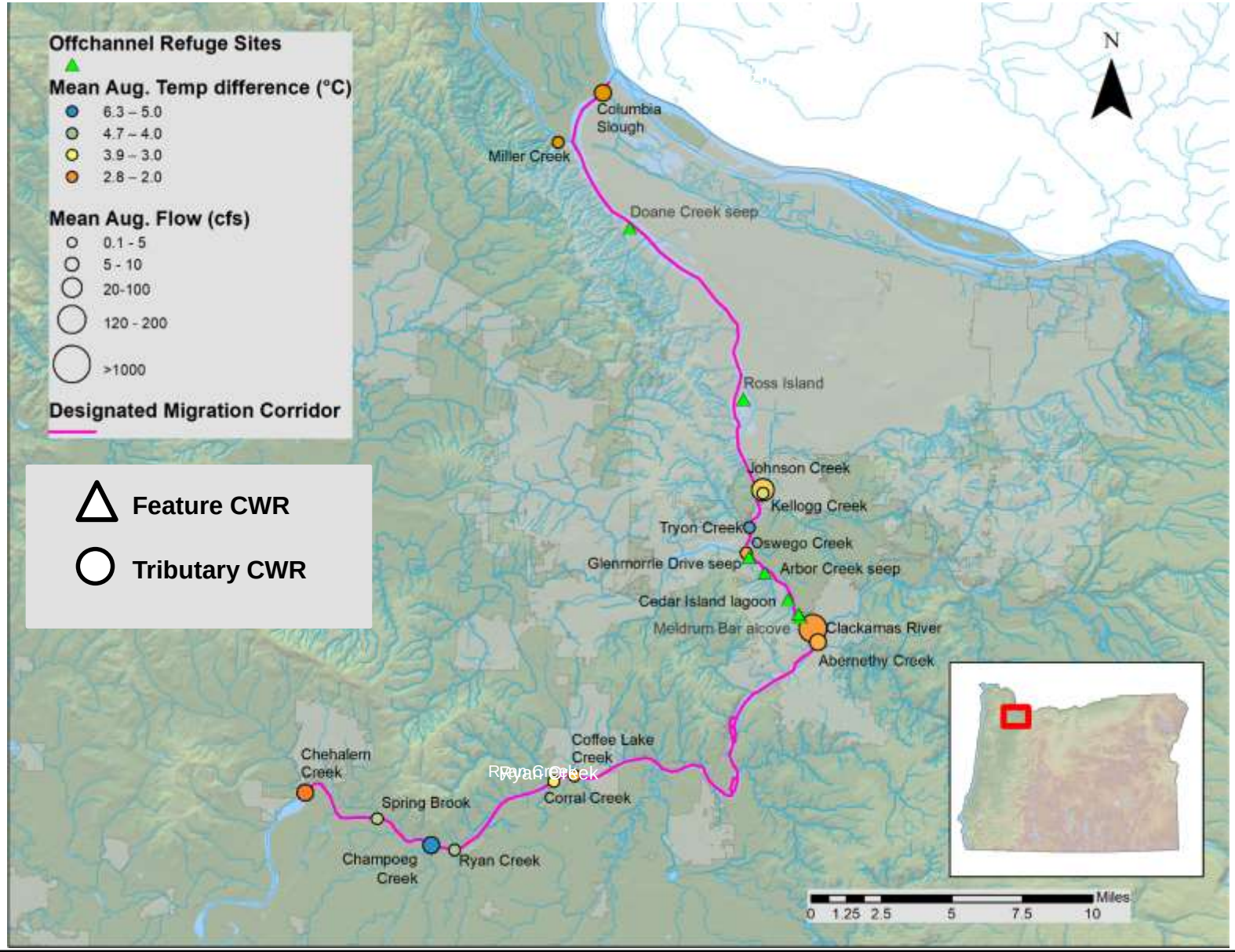
Existing CWR for adult migration



14 tributaries >1 cfs
6 seeps, alcoves, bars

Average density : 0.39 mi^{-1}
Max. distance : 13.5 mi

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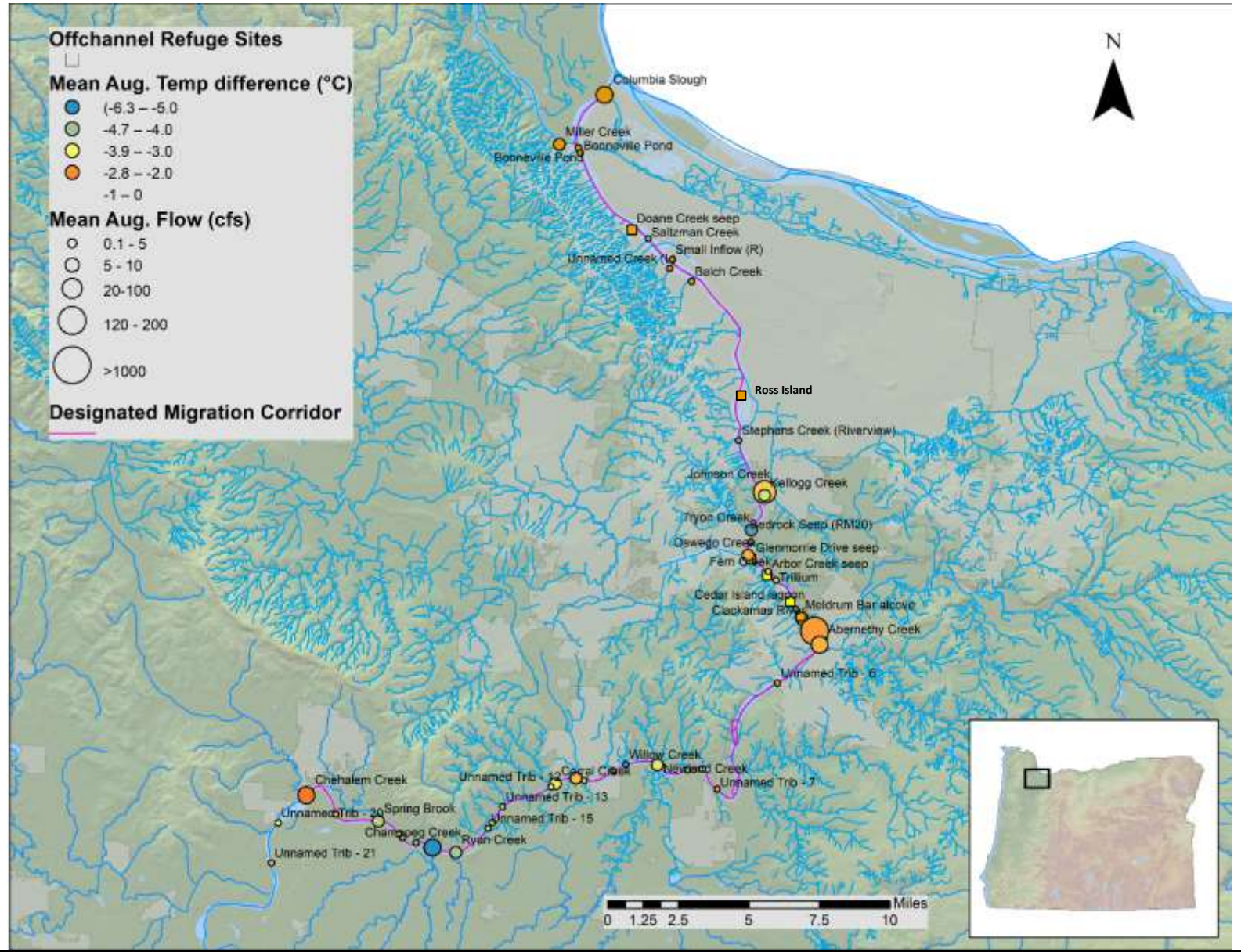
All CWR sites for juveniles and adults



37 tributaries
10 seeps, alcoves, bars

Average density : 0.94 mi^{-1}
Max. distance : 5.7 mi

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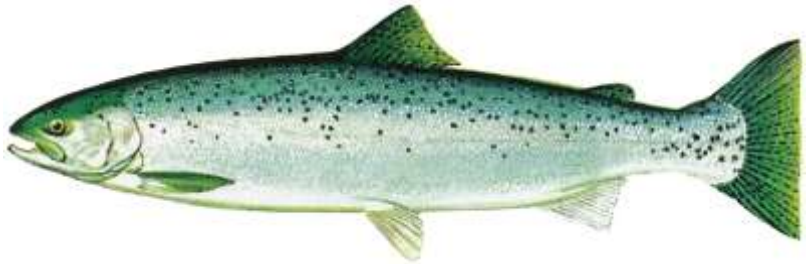
Cold Water Refuge Study Objectives

3. Characterize the current species use of CWR.

- *UWR spring Chinook*
- *LCR spring/fall Chinook*

- *UWR winter steelhead*
- *LCR winter steelhead*



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Biological Scope - Jeopardy Populations (ESUs):

Biological Assumptions:

- Analysis limited to ESUs identified in RPA
- Focus on up-migrating adults
- Defined by migration-date ranges
- CWR for these cold water fish also benefits non-listed native species

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Evaluating Cold Water Refuge Need and Use

1. Migration timing and abundance
2. Thermal exposure
3. Observation or evidence of CWR habitat use

Thermoregulation in anadromous fish

1. Salmon and steelhead are cold-blooded
2. “Thermoregulate” to find temperatures in environment to match metabolic needs
3. Not enough “power” if too cold
4. Respiratory stress if too hot
5. Timing and movement across the landscape to adapt to temperatures

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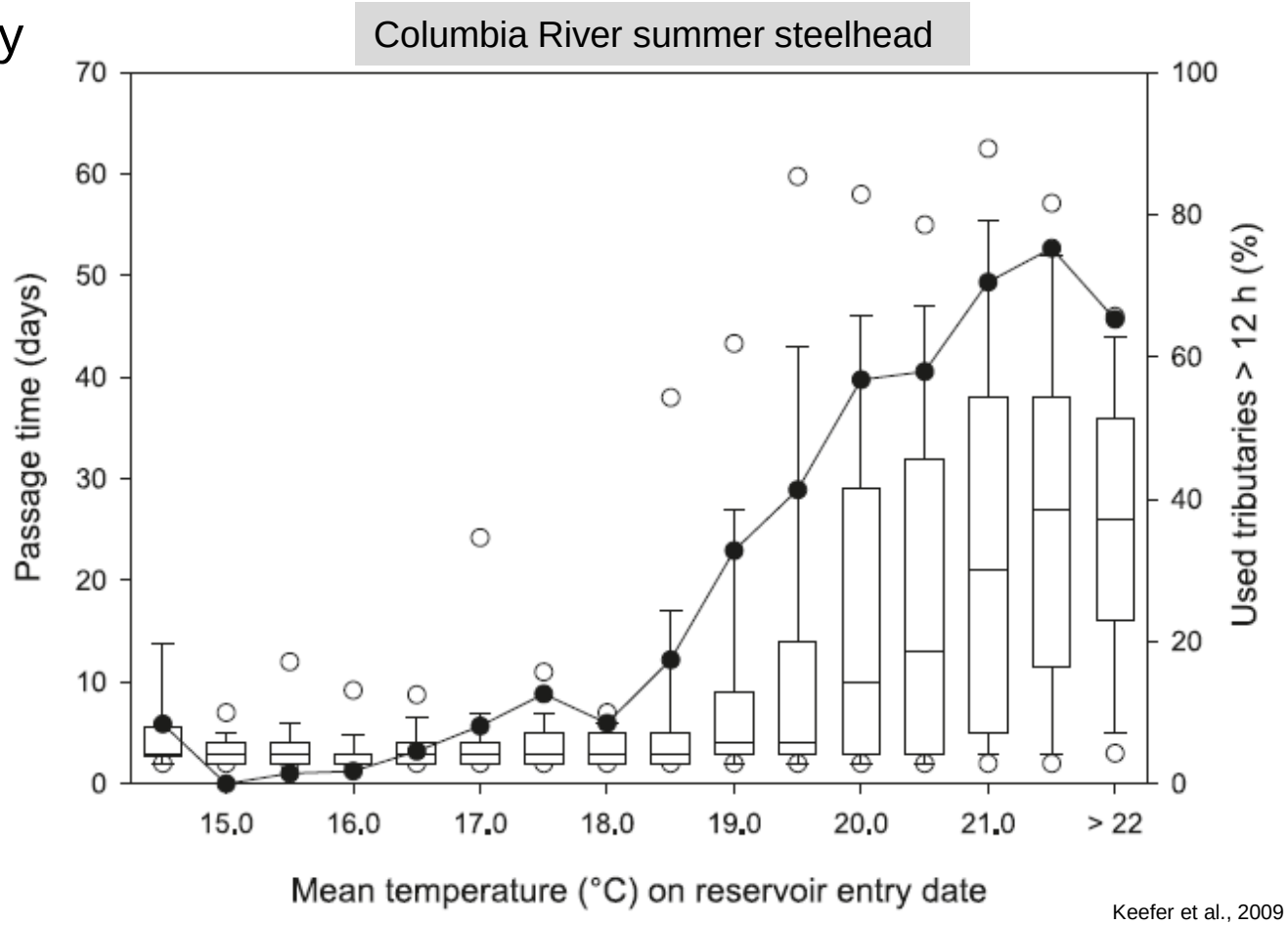
Looking for evidence of CWR use

What does CWR use look like?

1) Migration delay



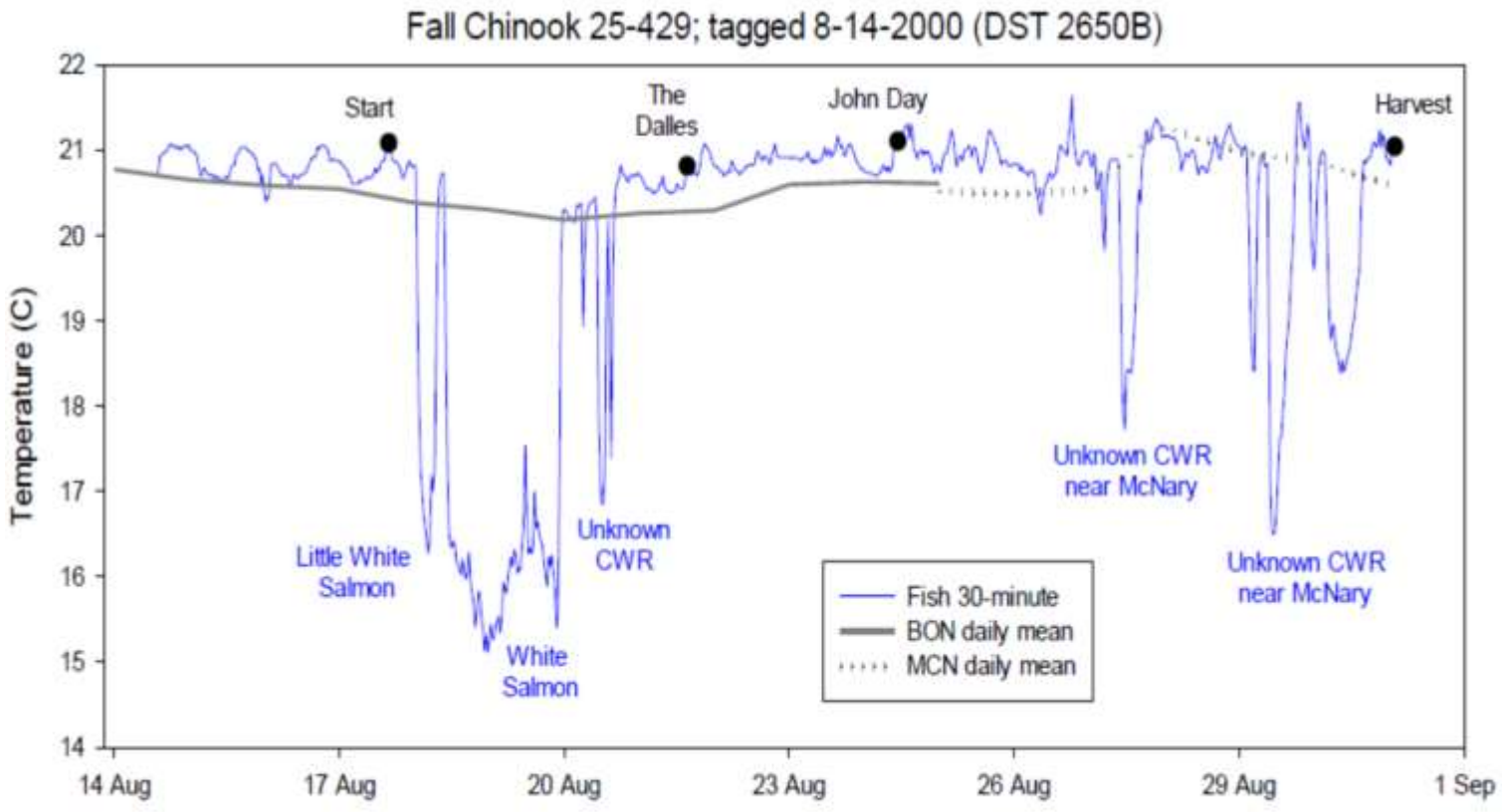
Keefer et al., 2009

Looking for evidence of CWR use

What does CWR use look like?

2) Holding in cooler water

Columbia River fall Chinook



Keefer and Caudill, 2017

Looking for evidence of CWR use

What does CWR use look like?

3) Congregation in refuges

Columbia River – Drano Lake

Evaluating Cold Water Refuge Need and Use

1. Migration timing and abundance
2. Thermal exposure
3. Observation or evidence of CWR habitat use

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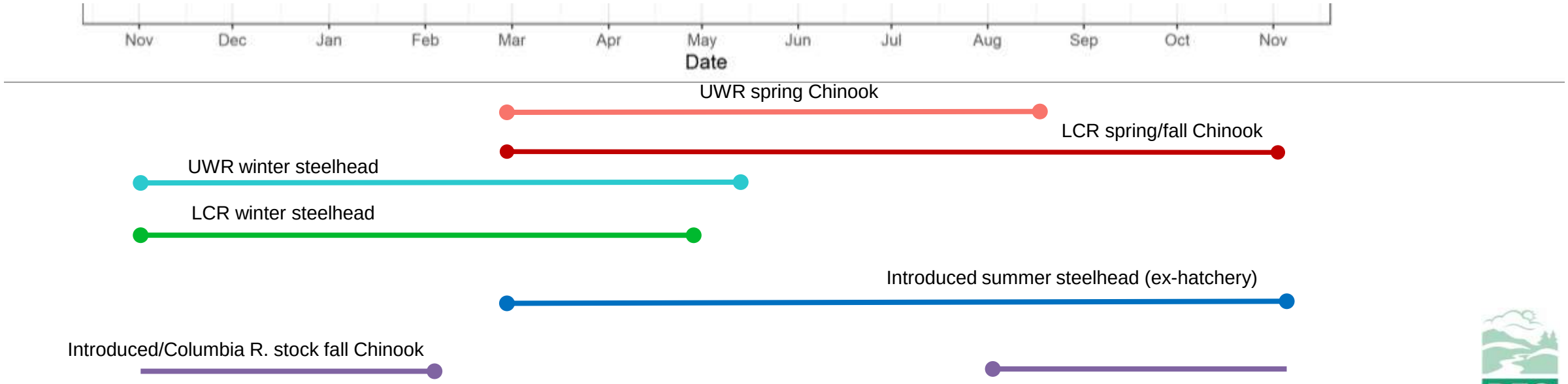
ESU Migration Timing at Willamette Falls

- Unique early migration timing
- Distinct native genetic population structure



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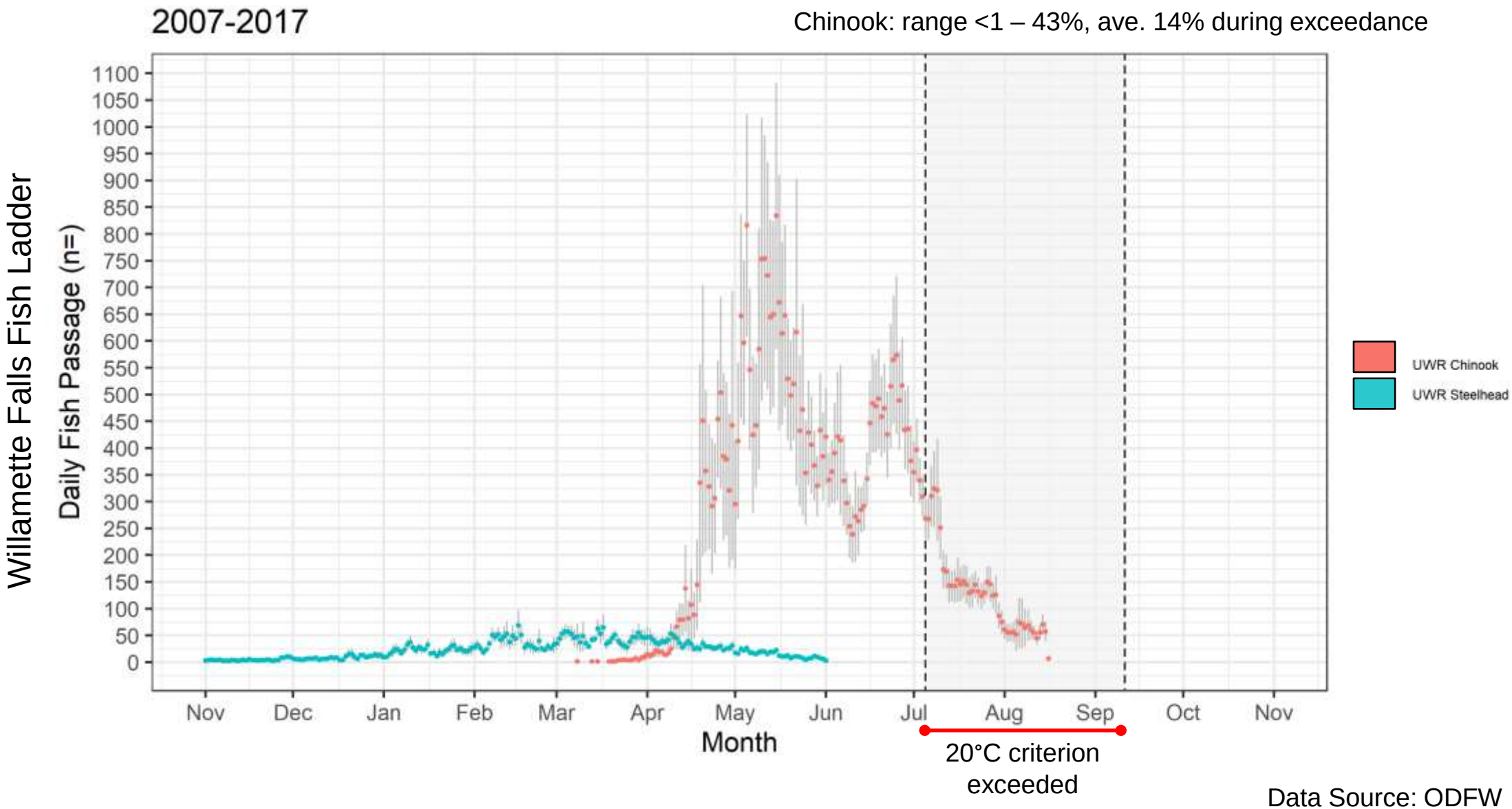
Historical Migration Barrier

Natural selection for a Willamette Falls without a fish ladder.

Long term UWR salmon & steelhead migration pattern



Data Source: ODFW

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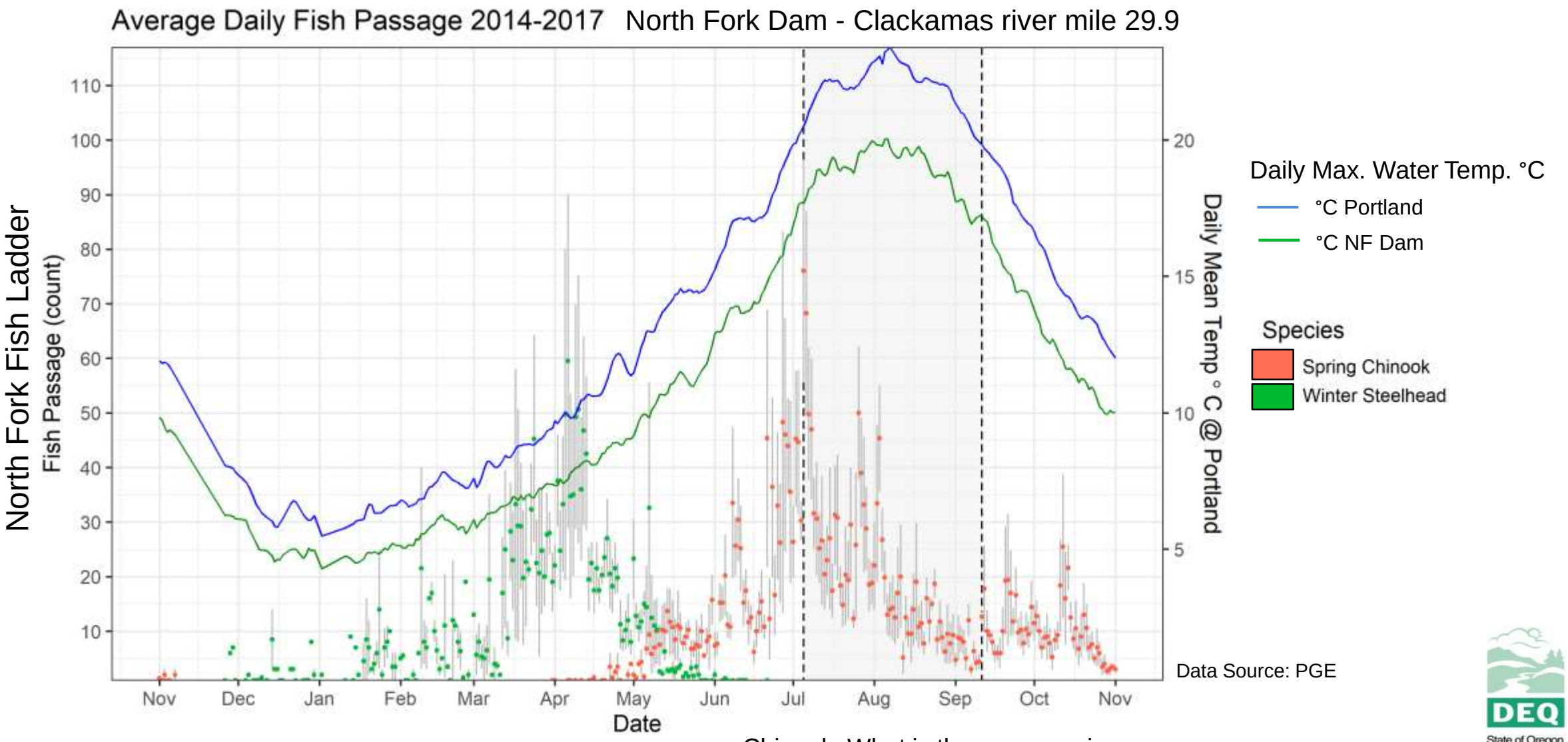
Long term LCR Chinook & steelhead pattern



Data Source: PGE

Chinook: What is the exposure in Willamette mainstem?

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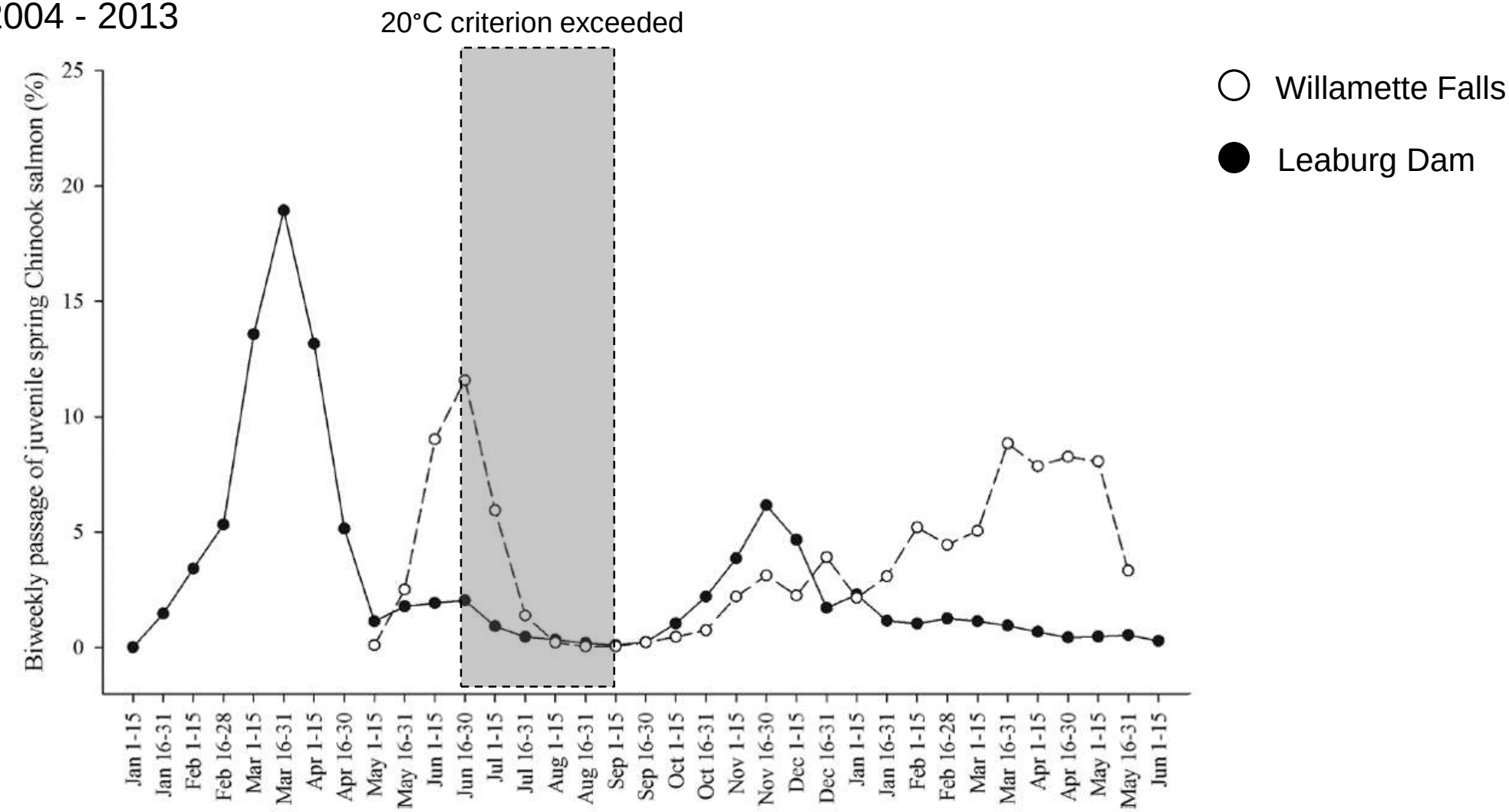
Juvenile Migration Timing- UWR Chinook

2004 - 2013



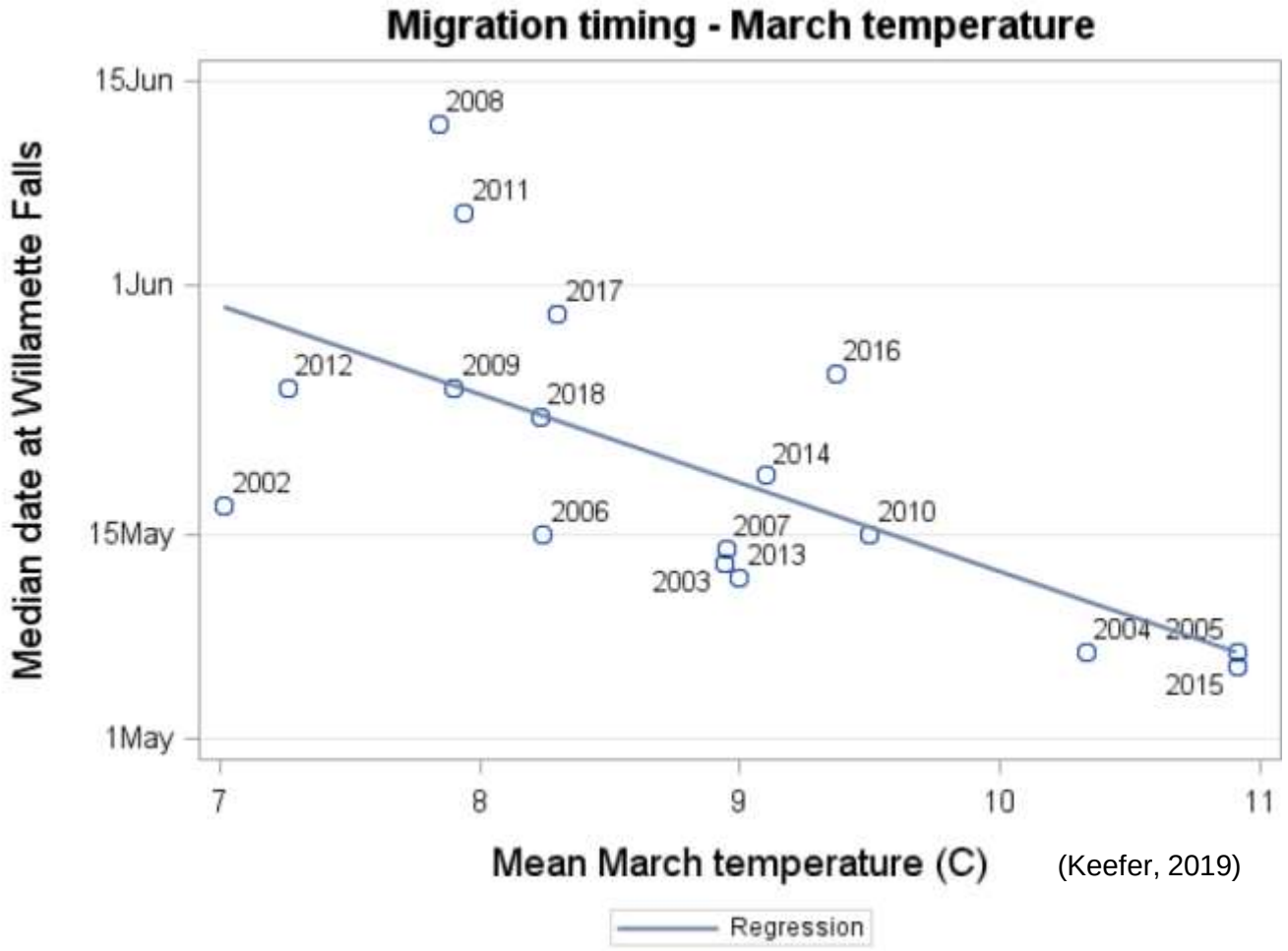
○ Willamette Falls

● Leaburg Dam

Schroeder et al, 2016

Migration Timing and Temperature

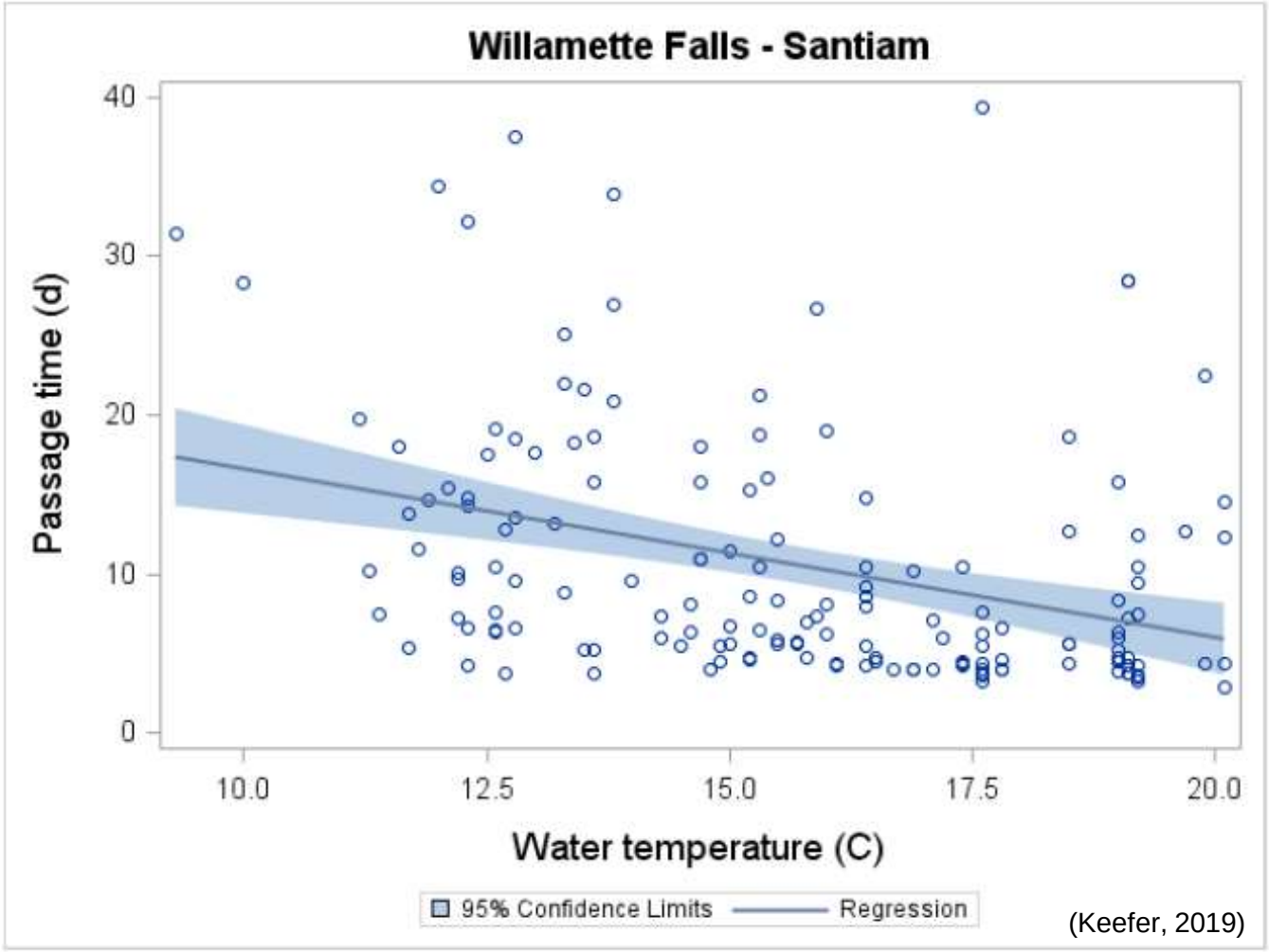
UWR Chinook migrate earlier with warmer temperatures.



(Keefer, 2019)

Corridor Residence Time and Temperature

UWR Chinook residence time decreases with warmer temperatures.



(Keefer, 2019)

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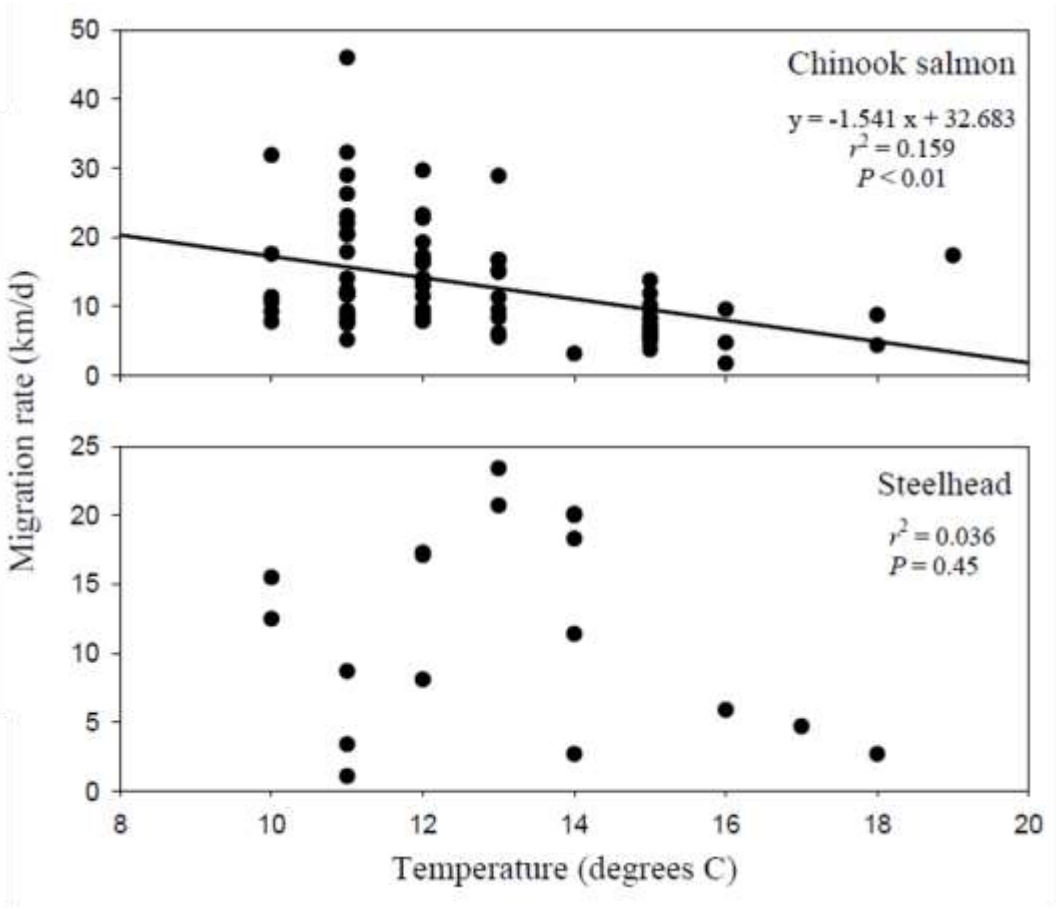
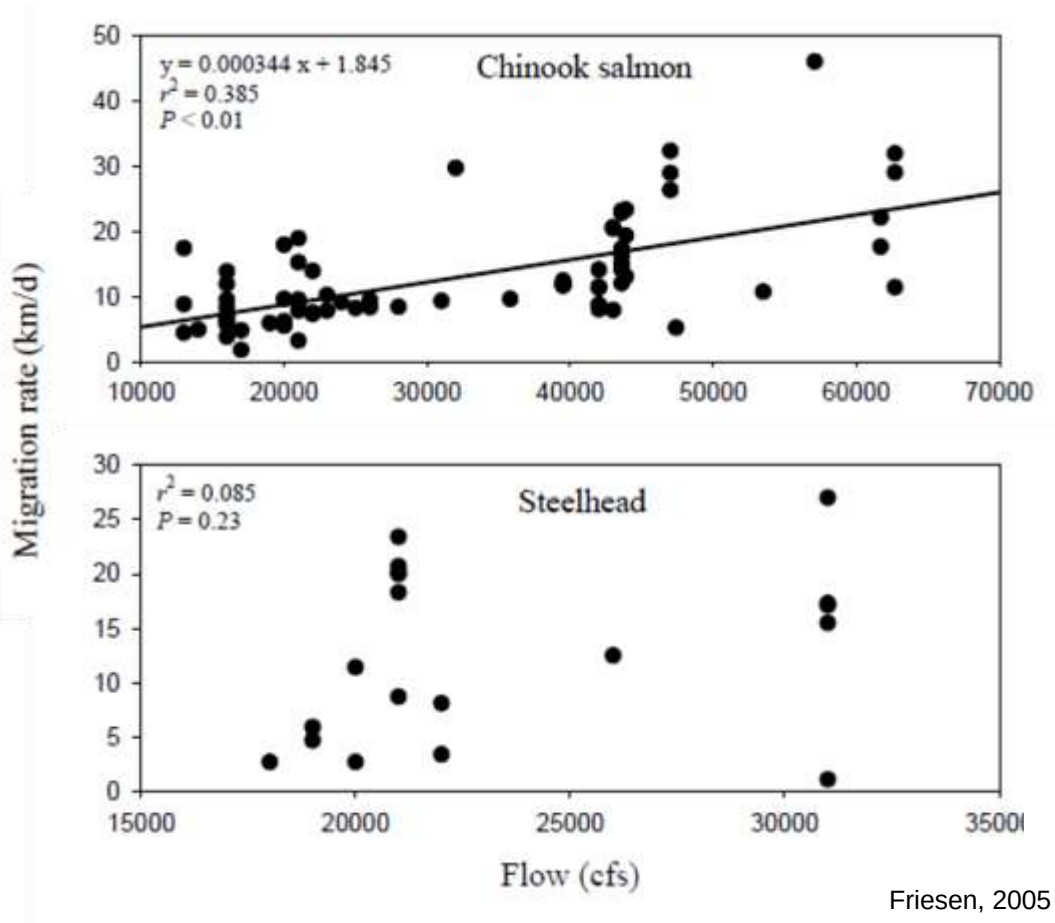
Juvenile Migration Rates and Temperature

Juvenile Chinook migration rates increase with flow and decrease with temperature.





Friesen, 2005

Evaluating Cold Water Refuge Need and Use

1. Migration timing and abundance
2. Thermal exposure
3. Observation or evidence of CWR habitat use

“For each species, quantify overall thermal exposure to temperatures above biological thresholds under different temperature conditions (e.g., hot, cold, median summers), if possible.” - NMFS

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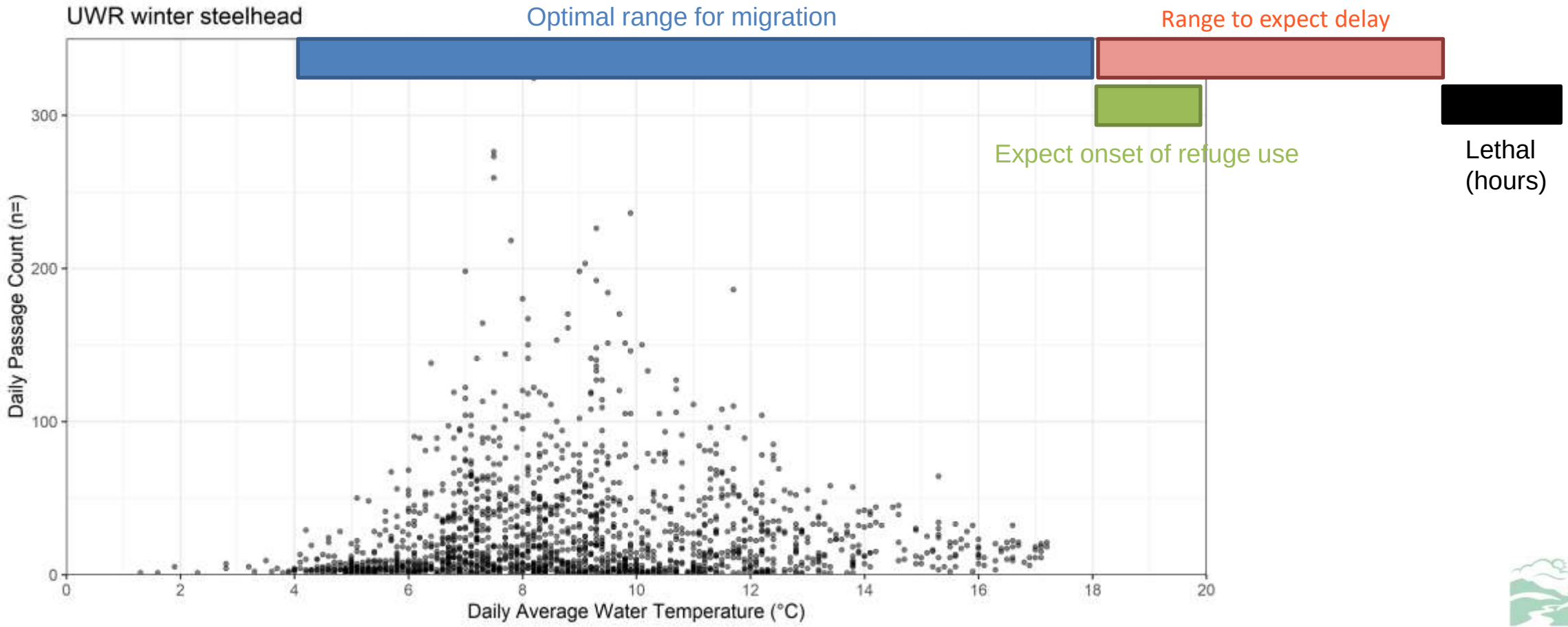
Steelhead temperature exposure and cues

WFA Passage Counts 2007-2017



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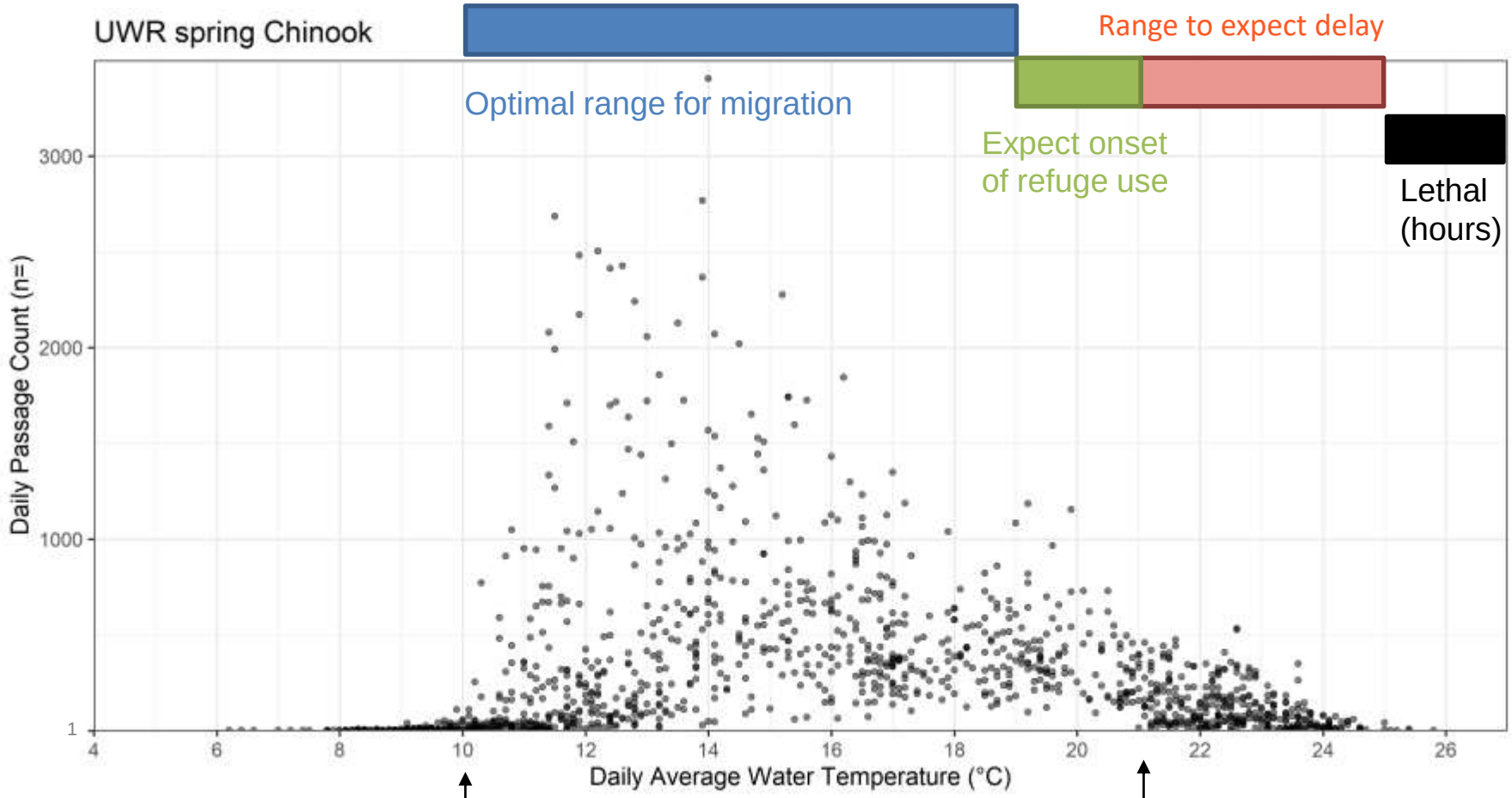
Chinook temperature exposure and cues

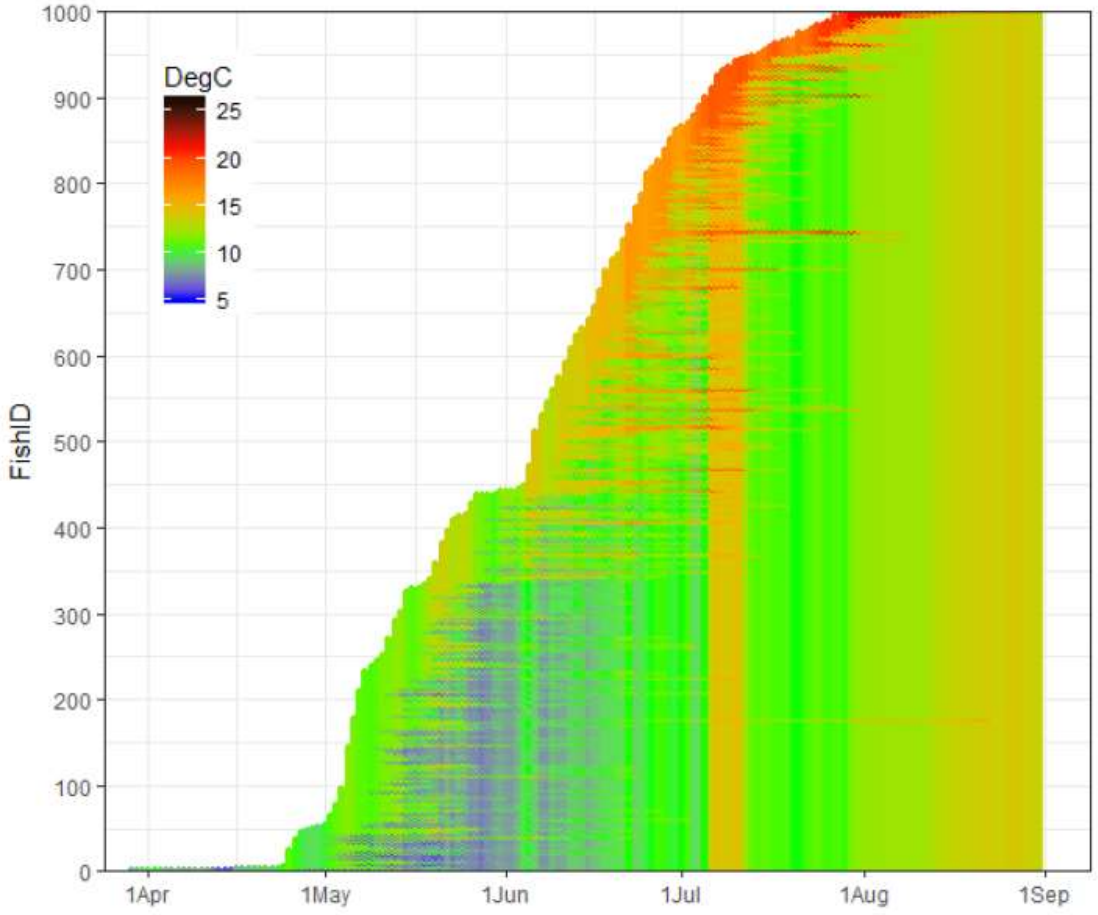
WFA Passage Counts 2007-2017



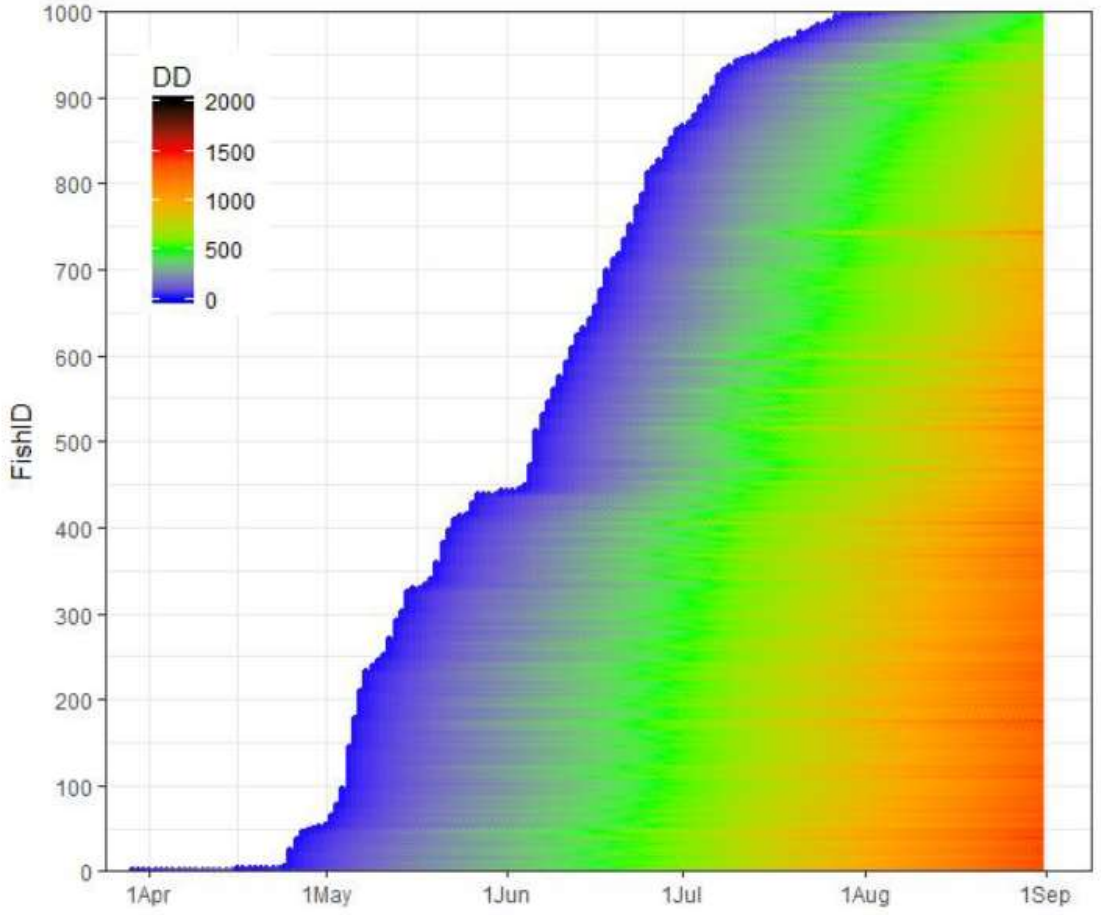
Modeled Run Timing & Thermal Exposure

UWR spring Chinook - Willamette Falls to N. Santiam River

Temperature experienced



Degree-days accumulated



(Keefer et al., 2019)

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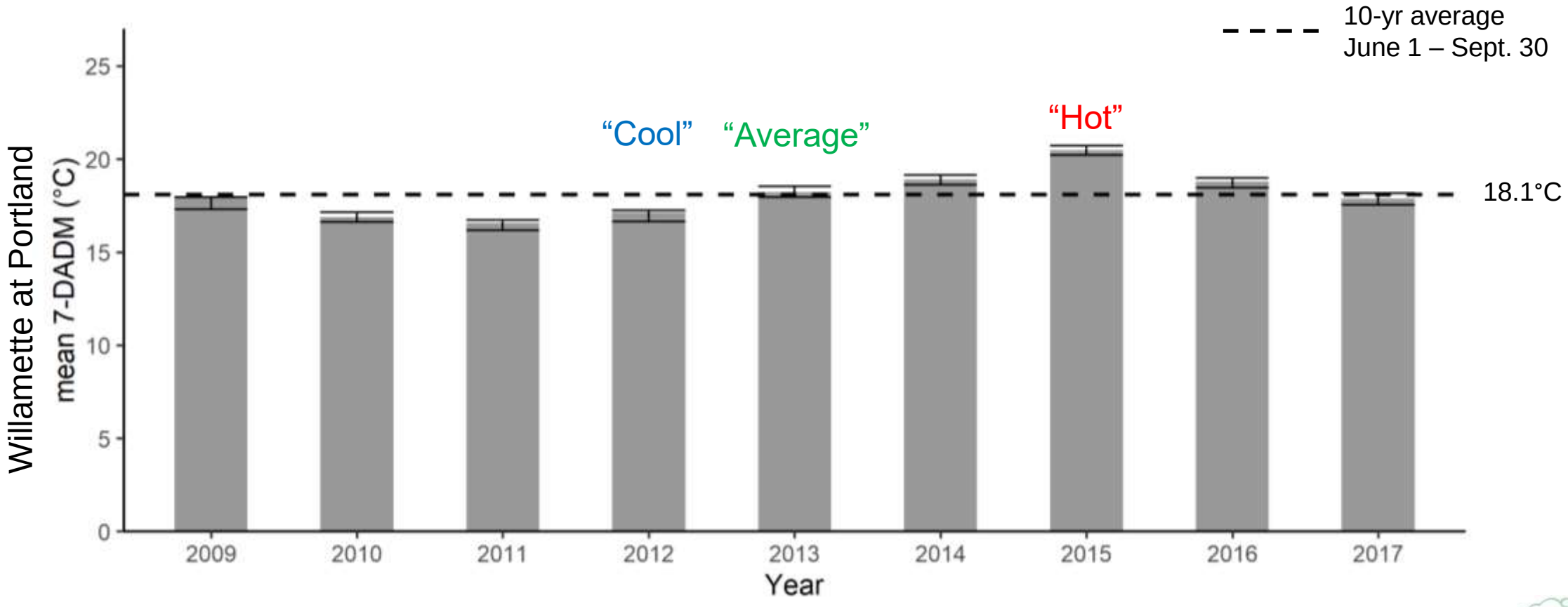
Reference Year Approach



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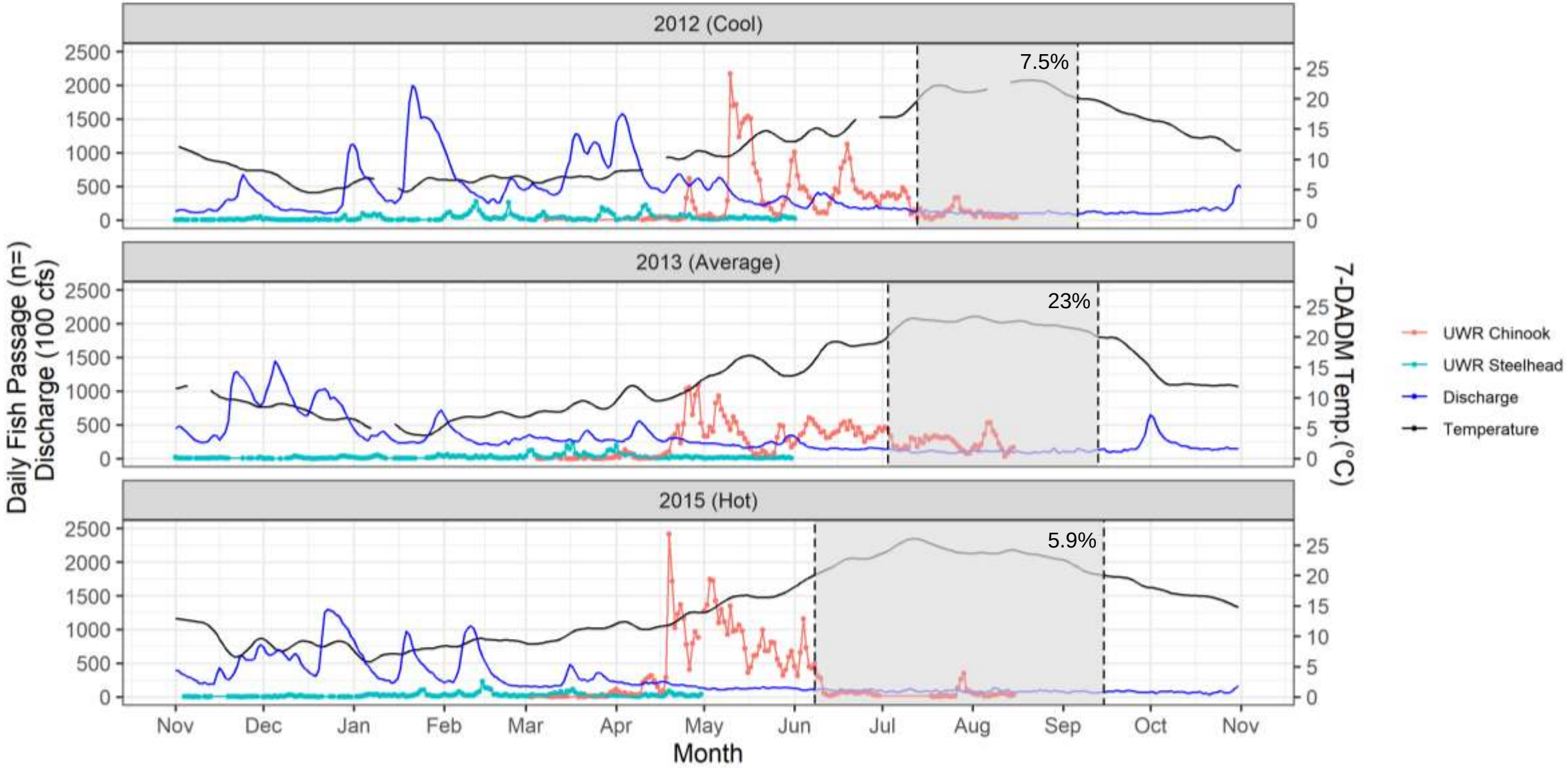
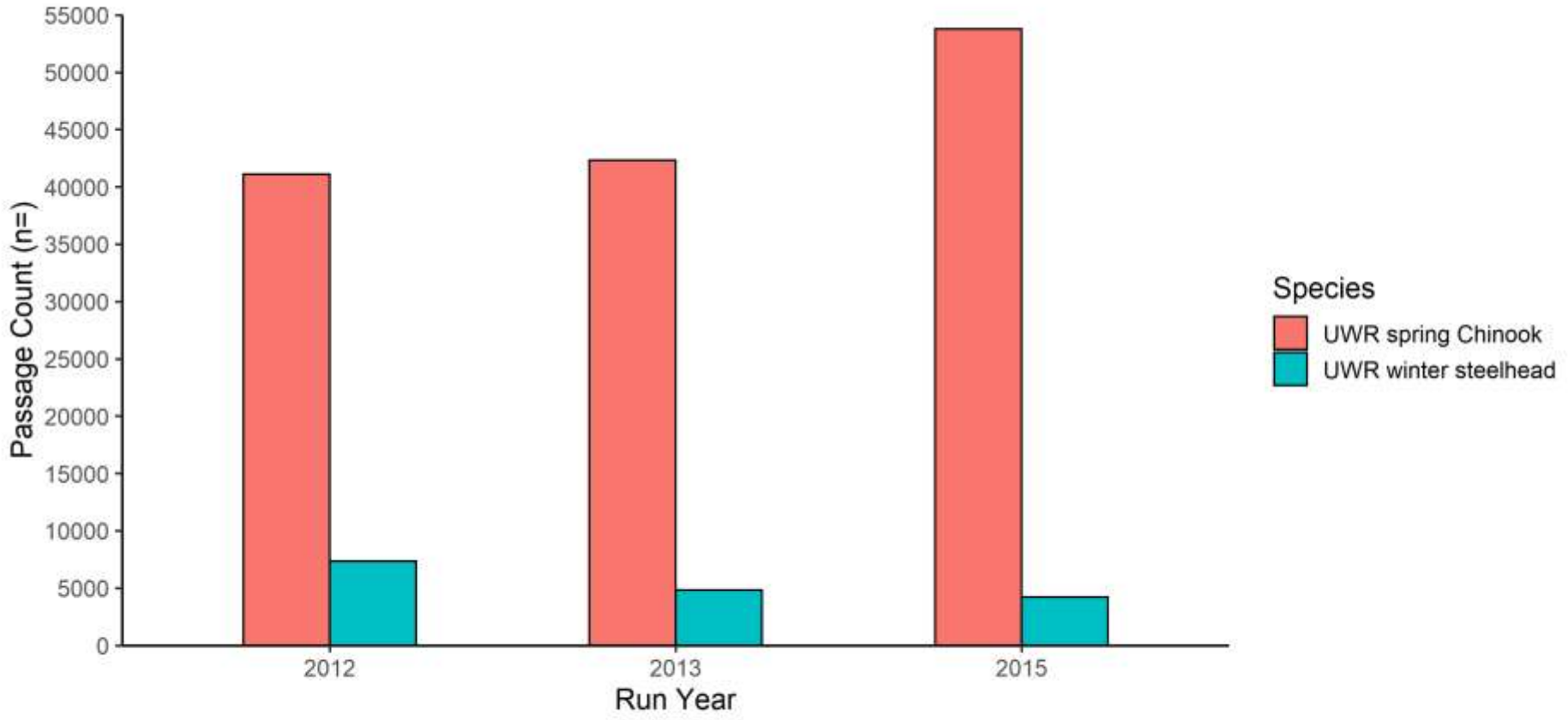
Reference Year Approach



Reference Year Run Sizes and Mortality

2.0% 2.4% 11.2%

Chinook natural mortality*
below Willamette Falls (ODFW, 2019)



"cool" "average" "hot"

*Includes sea lion predation.
6.4% average since 2014

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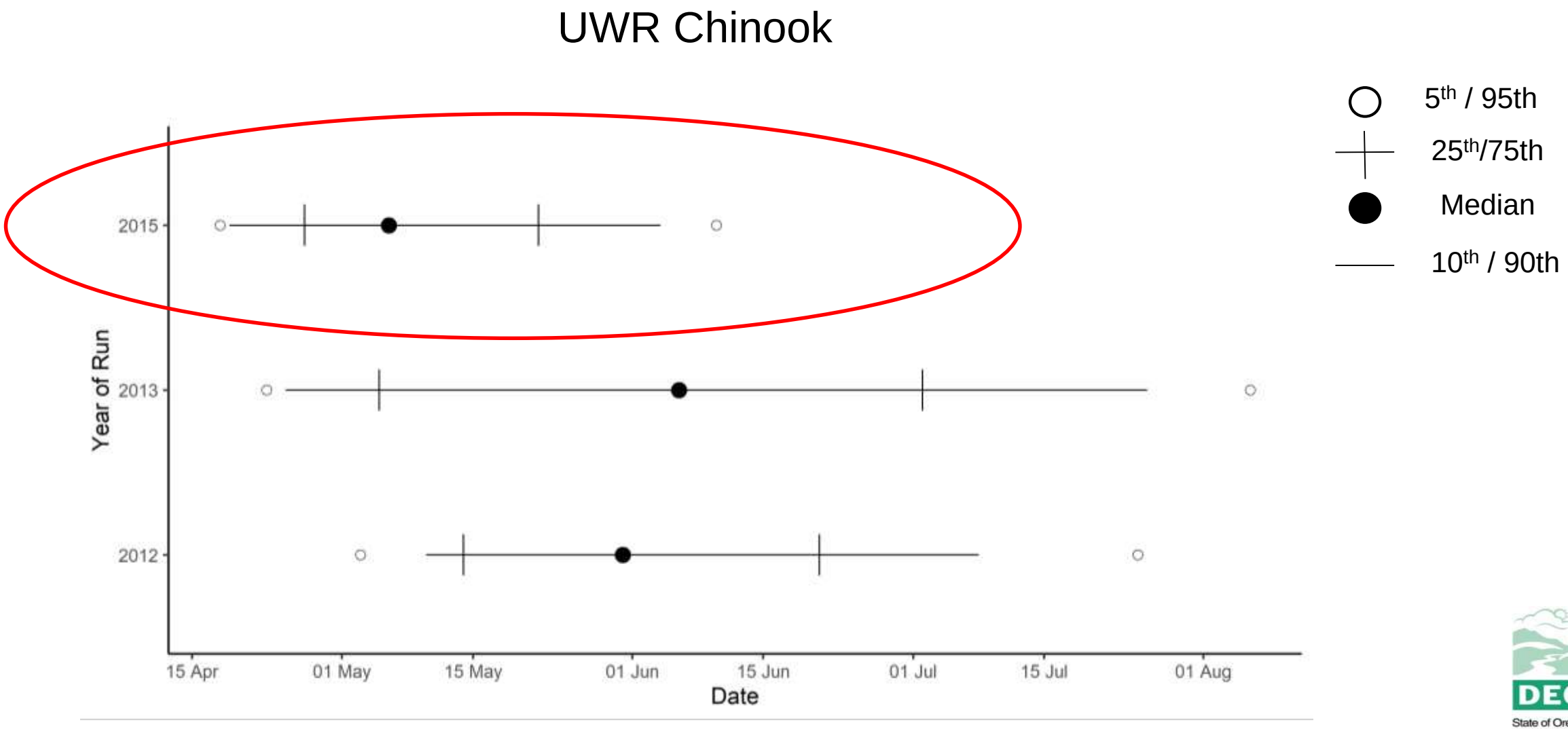
Interannual Migration Timing Variability



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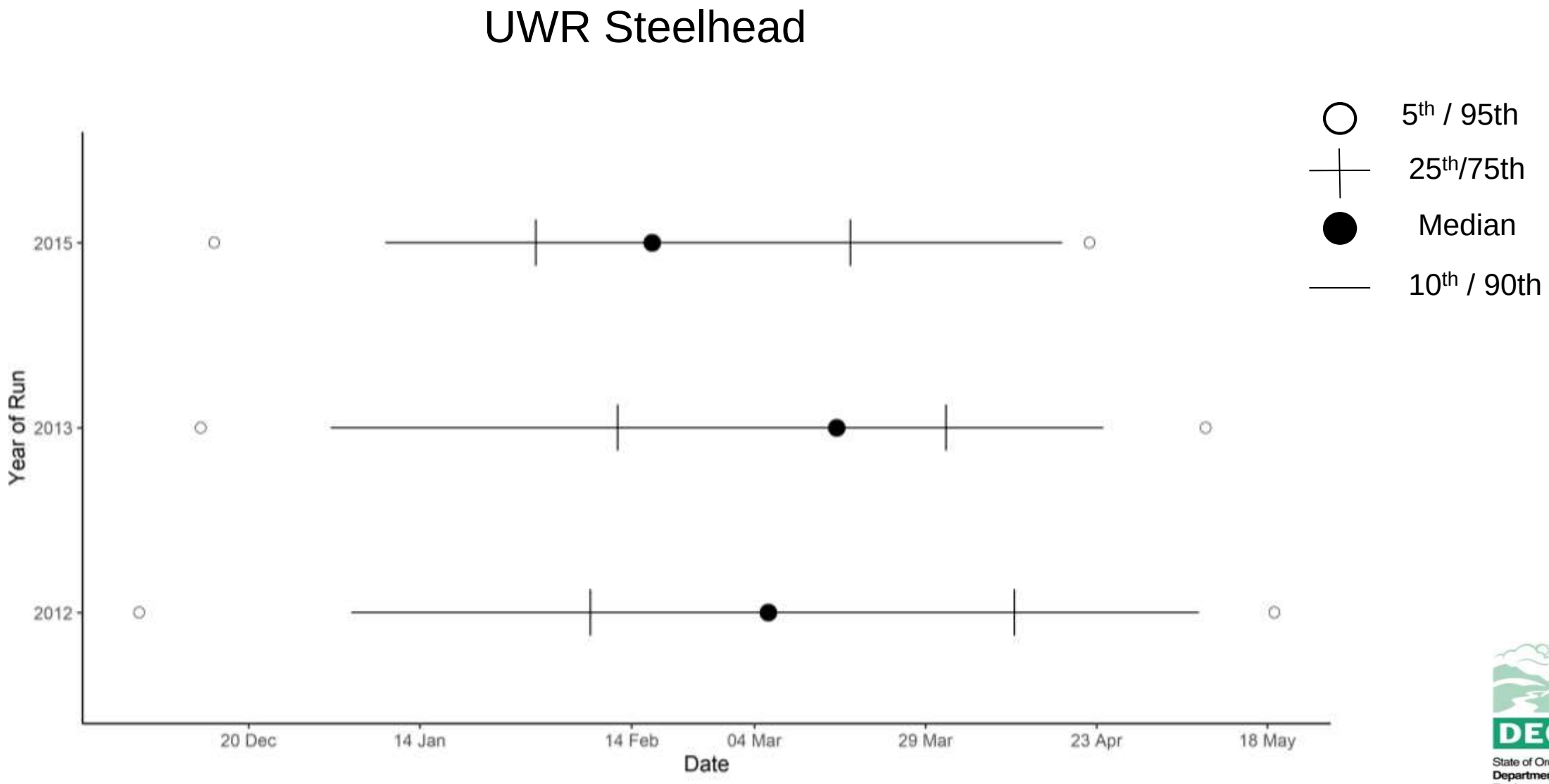
Interannual Migration Timing Variability



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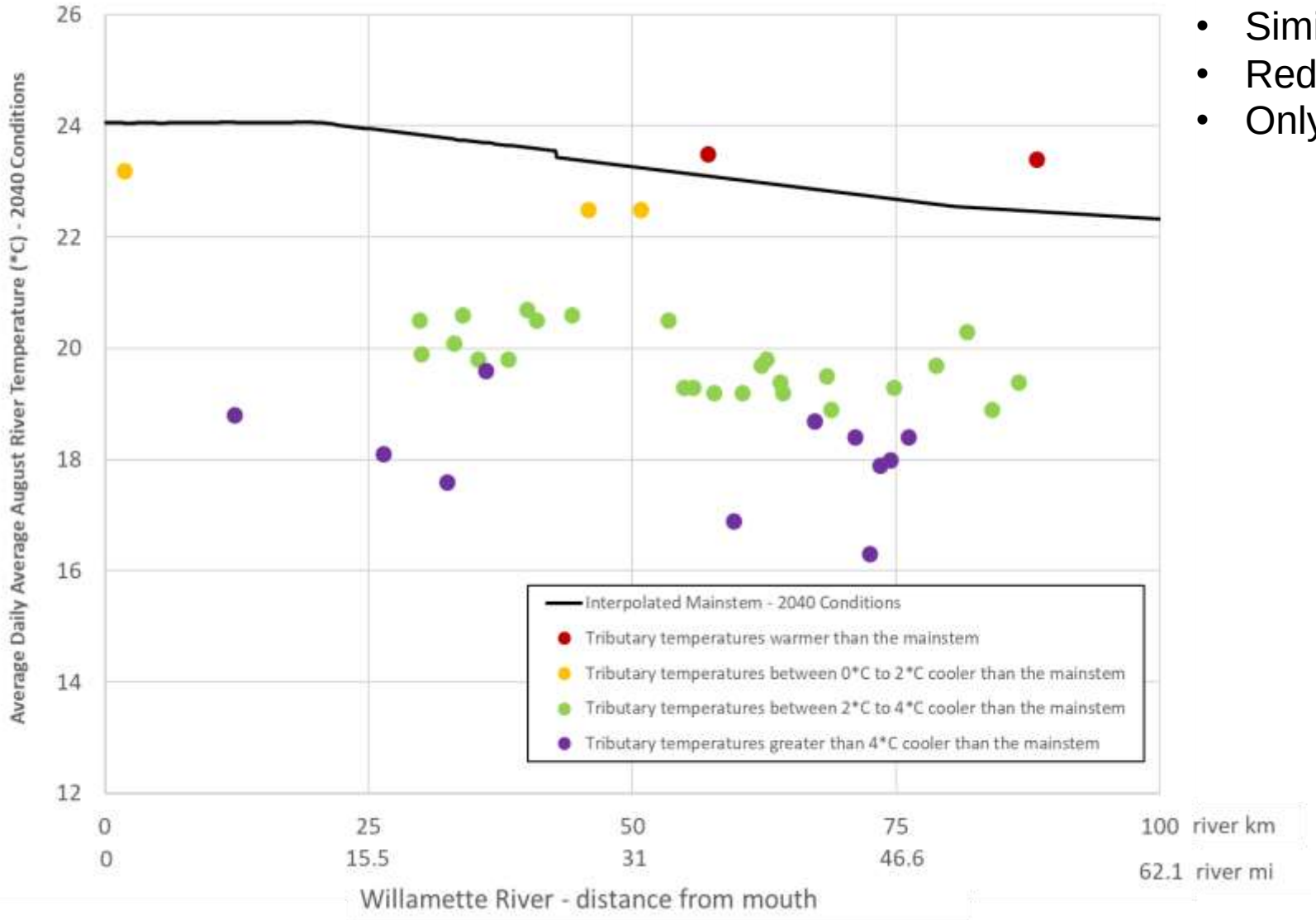
Temperature Exposure Under Climate Change

NorWeST mean Aug. temperatures - 2040



- Similar number of CWR
- Reduced Quality
- Only 5 CWR site for adults < 18°C

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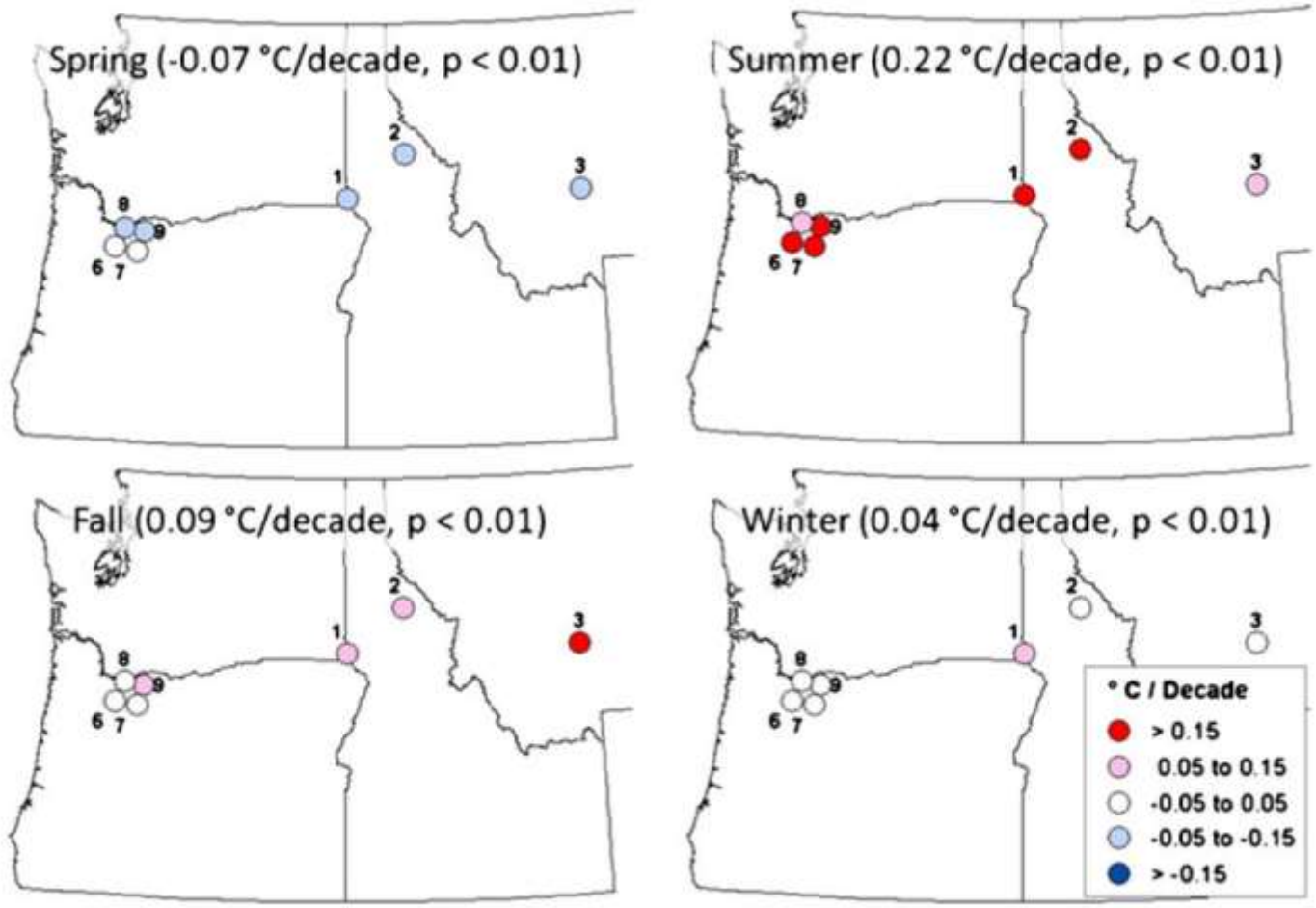
Temperature Exposure Under Climate Change

Temperature increases may be moderated outside of summer.

Realized warming since 1980.



Isaak et al., 2012

Evaluating Cold Water Refuge Need and Use

1. Migration timing and abundance
2. Thermal exposure
3. Observation or evidence of CWR habitat use

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Observation & Evidence of CWR Use

Tag and Observational Surveys

Data Limitations:

- Most tag studies begin collection at Willamette Falls
- Few studies and surveys downstream of Willamette Falls
- Sampling protocols limit collection from waters >18°C

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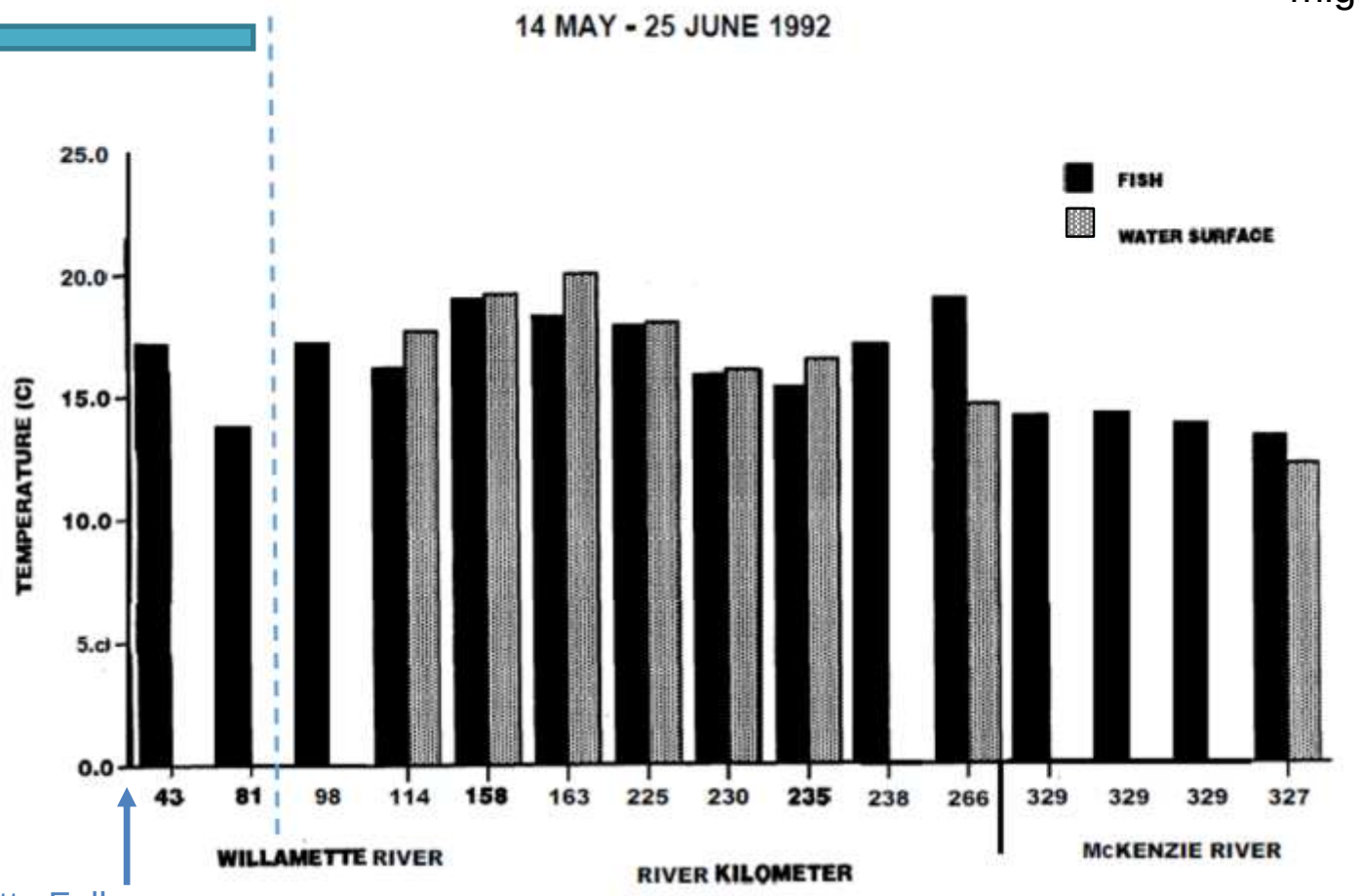
Thermistor Tag Studies

UWR Chinook salmon

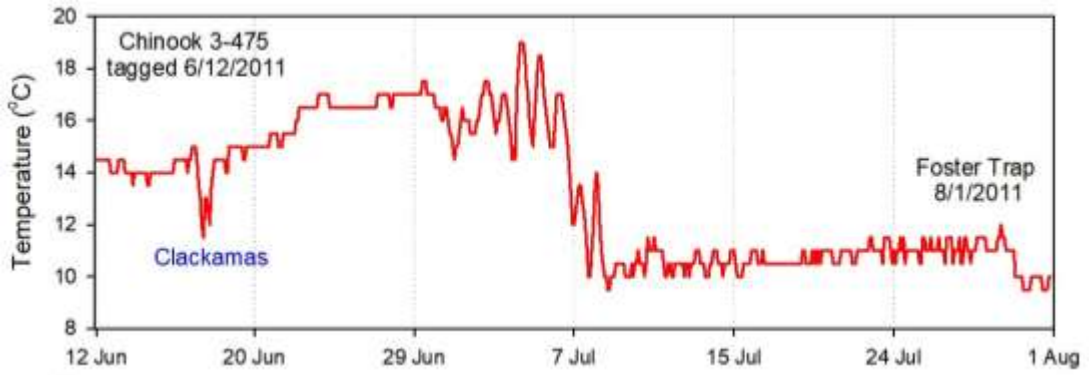
Lower Willamette Migration Corridor

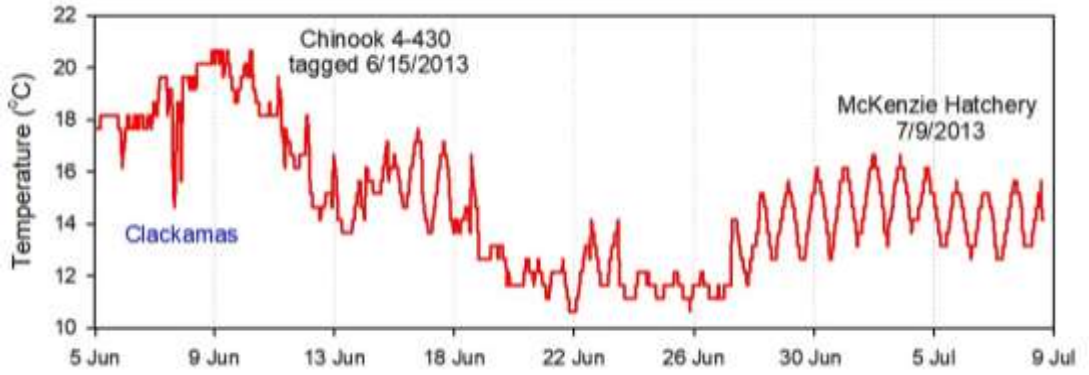
* “Mid Run” and “Late run” fish kept migrating in temps over 20°C.

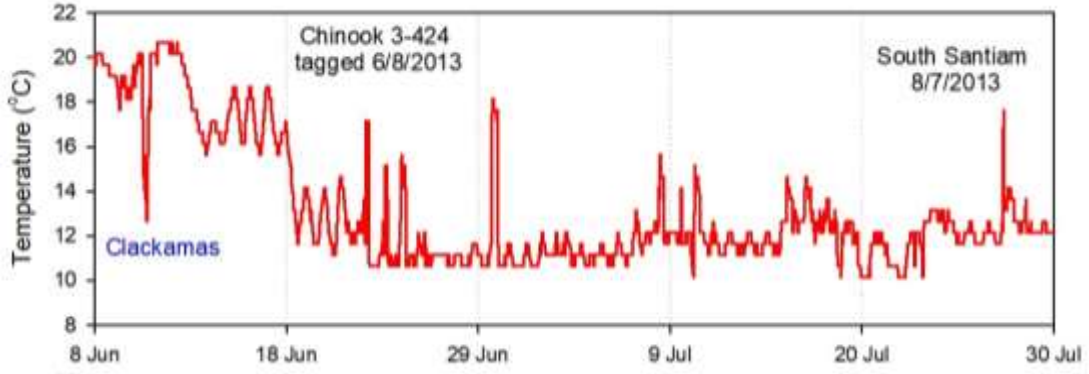


Schreck et al, 1994

Thermistor Tag Studies







- ~7% of recovered loggers showed use of Clackamas R.
- Most fish did not fall back.

Keefer et al, 2015 (unpublished data)

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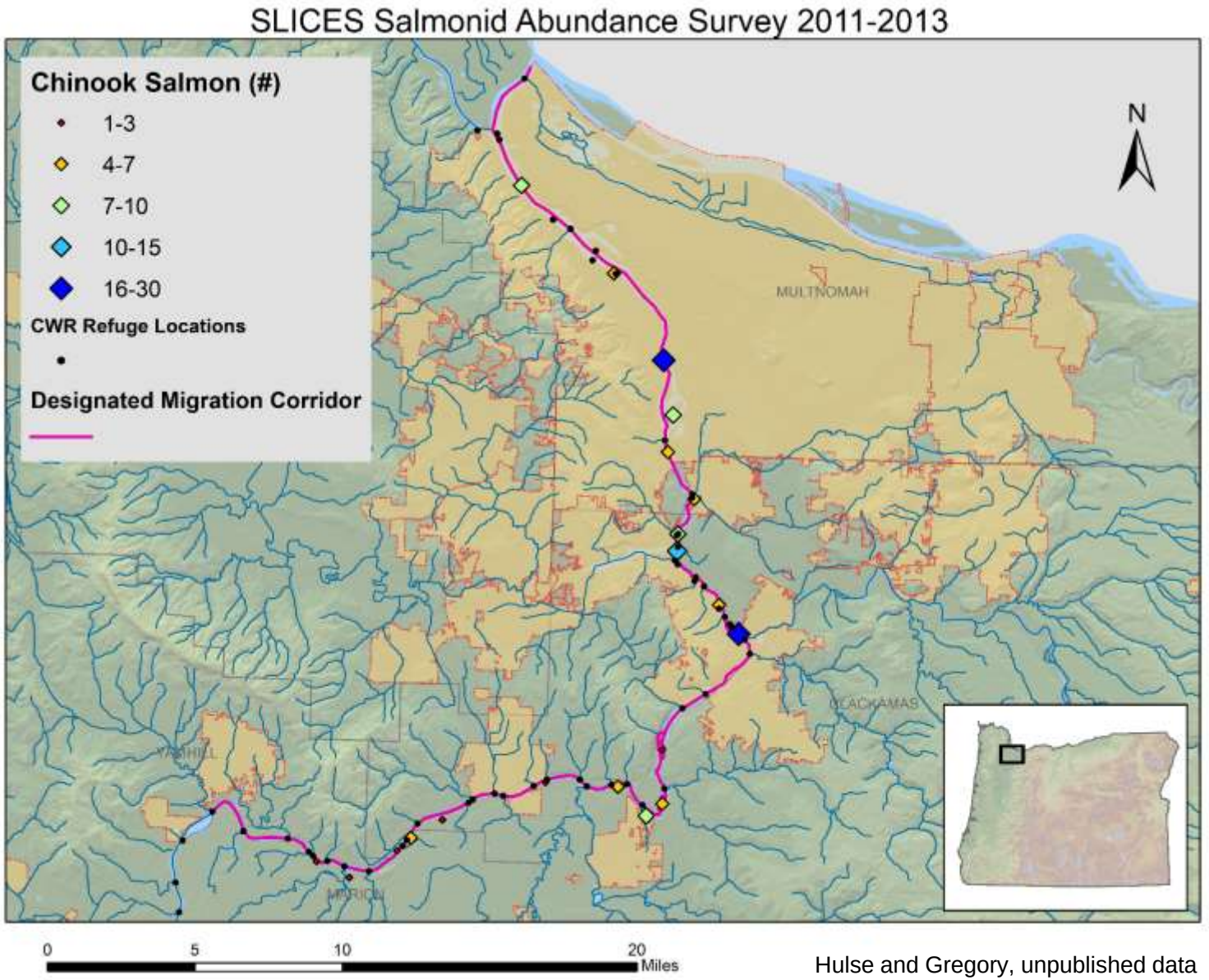
Fish Congregation in Main Stem Habitat

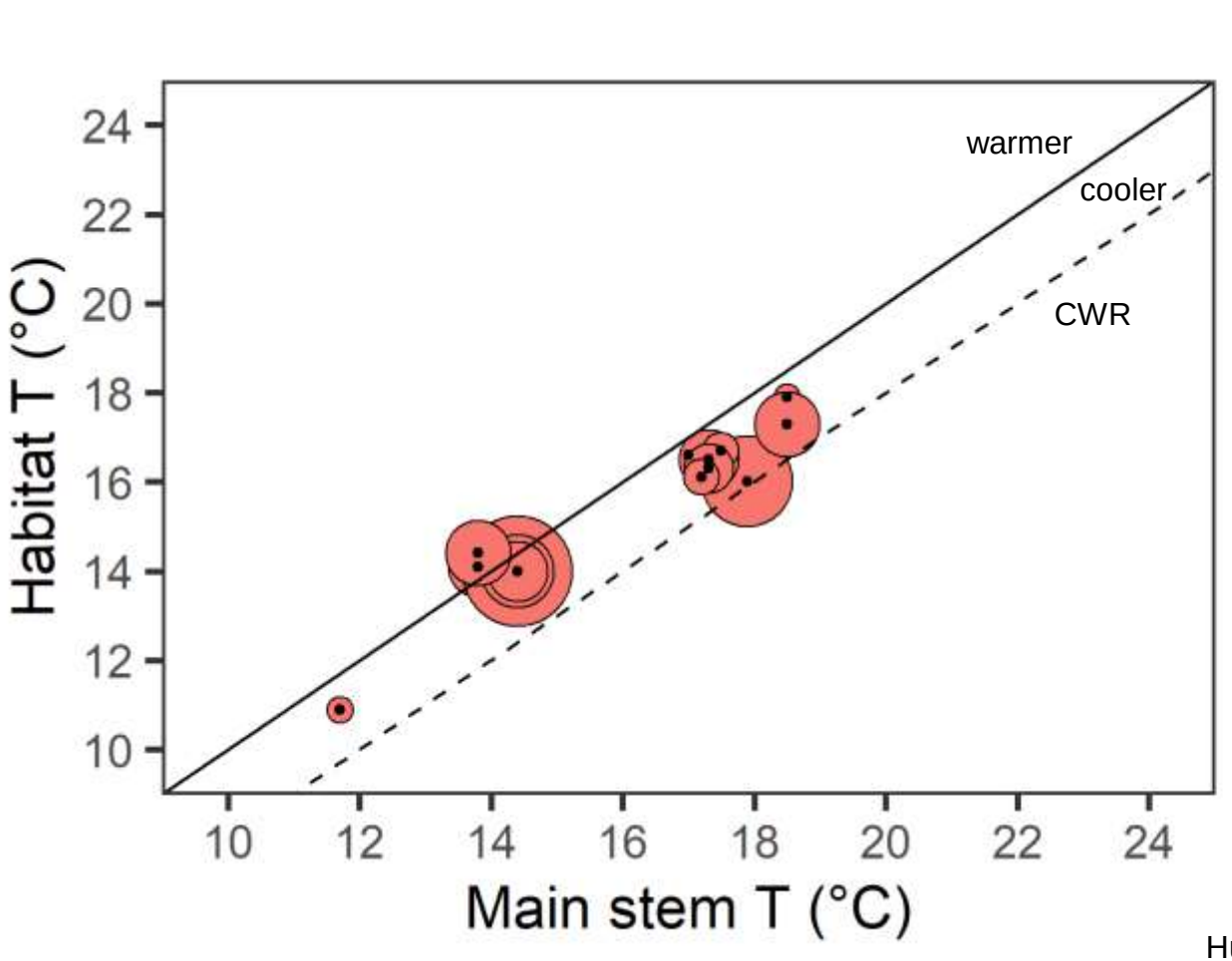


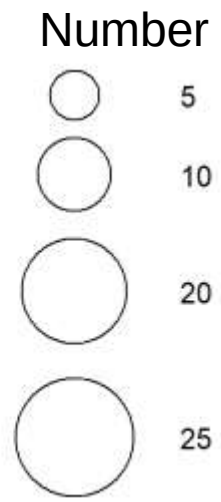
Adults & juveniles

Hulse and Gregory, unpublished data

Fish Habitat and CWR Use

SLICES surveys 2011-2013





*Juveniles and adults

Chinook salmon

Steelhead

Hulse and Gregory, unpublished data

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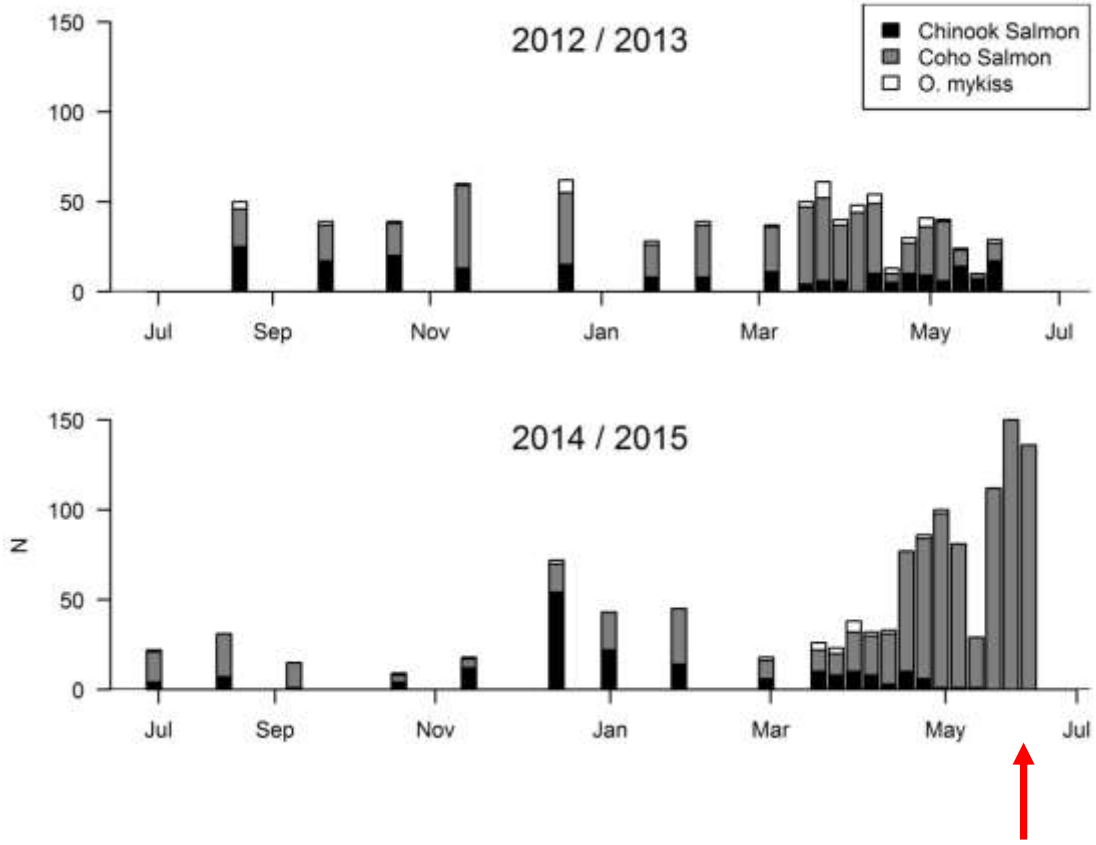
Mixed Evidence for Refuge Use in Warmer Conditions

BES synoptic survey June 23, 2015

Portland BES, 2015

Tryon Creek restoration monitoring, USFWS

Adults and juveniles



Silver et al, 2017

Cold Water Refuge Study Objectives

4. Assess whether the current spatial and temporal extent of CWR present is sufficient to meet the CWR narrative criterion

5. If DEQ concludes that the CWR criterion is not being met, characterize, to the maximum extent possible, the extent of additional CWR needed to attain the criterion

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Refuge Use Conclusions

Is there enough CWR for migration in temperatures up to 20C?

Qualified yes –

- Steelhead not exposed to warm temperatures
- Chinook don’t appear to use many CWR in temps ≤20°C.

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Refuge Use Conclusions

Is there enough CWR for migration in temps >20°C

due to naturally warmer conditions or from anthropogenic warming?

- Not enough information about use to conclude sufficiency or insufficiency.
- Therefore, protect what is currently available and evaluate level of use and benefits under warmer conditions.

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Cold Water Refuge Criterion Attainment

	Population	When mainstem <20°C	When main stem >20°C
Below Willamette Falls (RM 0 –26.7)	UWR Chinook	Attained	Insufficient data
	UWR steelhead	Attained	N/A
	LCR Chinook	Insufficient data	Insufficient data
	LCR steelhead	Attained	N/A
Above Willamette Falls (RM 26.7–50.8)	UWR Chinook	Attained	Insufficient data
	UWR steelhead	Attained	Insufficient data

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Cold Water Refuge Study Objectives

6. Identify and prioritize actions to protect, enhance, or restore CWR.

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Recommendations for the Migration Corridor Reach

Maintain existing cold water refuge habitat for adults and juveniles of all species.

- The existing CWR and thermal heterogeneity of all sizes should be maintained and protected in order to support potential use.
- Knowledge gaps about use and benefit should be addressed before recommending large investments to add new cold water refuge areas.

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Recommendations for the Migration Corridor Reach

Prioritize maintaining access and cool temperatures in the Clackamas River – Meldrum Bar area

- Largest CWR area by volume at a key junction within the lower Willamette migration corridor.
- Multiple habitat functions - fish staging to ascend Willamette Falls.
- Also important for LCR Chinook and LCR steelhead populations that spawn and rear in the Clackamas River basin.

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Cold Water Refuge Study Objectives

7. Identify scientific uncertainties and any additional research needed to fully implement the cold water narrative.

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Knowledge Gaps

- Uncertainty in level refuge use when temperatures are over the criterion.
- Few tag studies downstream of Willamette Falls
- Data limited for:
  - Juveniles of all species
  - Steelhead Kelts
  - LCR Chinook timing & abundance entering Clackamas R.

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CWR Study Process and Next Steps

Final expert panel review -Jan. 23

Final draft study available DEQ Website -by Feb. 3

Contact DEQ with Questions or concerns? -by Feb. 17

Submit final Report to NMFS -by Feb. 29

https://www.oregon.gov/deq/wq/Pages/WQ-Standards-Temperature.aspx

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What does this study mean for DMAs?

Andrea Matzke
Lower Willamette Basin Coordinator

2006 Willamette Basin Temperature TMDL

Directed Designated Management Agencies located along the lower 50 miles of the mainstem Willamette River to develop strategies to identify and protect CWR in their TMDL Implementation Plans.

NPDES Thermal Plume Requirements

OAR 340-041-0053(d)

Thermal plume limitations apply to discharges that will impact CWRs. This report can inform permits issued for thermal discharges within the migration corridor.

DMAs along mainstem

1. Clackamas Co./WES/River Grove/Happy Valley
2. Multnomah Co.
3. Marion Co.
4. OR Parks and Recreation Dept.
5. Port of Portland
6. Portland
7. Milwaukie
8. Lake Oswego
9. Oak Lodge Water Services District
10. West Linn
11. Gladstone
12. Oregon City
13. Canby
14. Wilsonville
15. Newberg
16. Metro
17. ODA

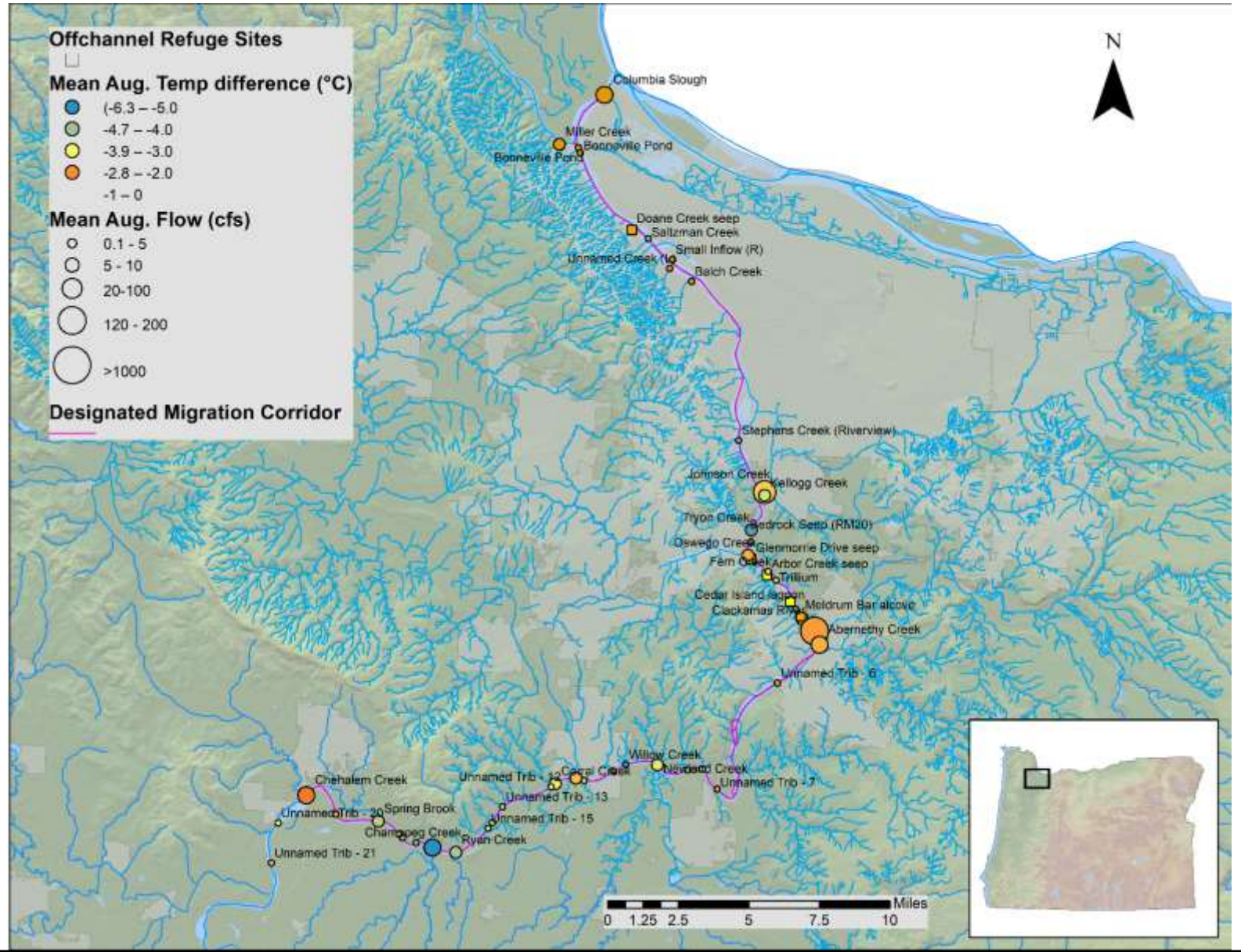
Draft TMDL five-year report

- DMAs have been identifying and protecting CWR since 2006 and will continue to implement protection strategies over time
- **Six** of the DMAs implemented approximately **twelve** projects in support of CWR (not all DMAs were required to report)
  - e.g. Oaks Bottom Project, contributing $ for USGS CWR study
- The CWR report will provide additional clarity to DMAs on where these CWR are located

What about other DMAs not along the mainstem?

DEQ encourages any DMA in the Willamette Basin to take steps to protect other CWRs identified in other waterbodies, as well as implement actions to bring cooler waters downstream to Lower Willamette mainstem CWRs.

Q&A


Offchannel Refuge Sites
Mean Aug. Temp difference (°C)
(-6.3 – -5.0
-4.7 – -4.0
-3.9 – -3.0
-2.8 – -2.0
-1 – 0
Mean Aug. Flow (cfs)
0.1 - 5
5 - 10
20-100
120 - 200
>1000
Designated Migration Corridor
N
Columbia Slough
Miller Creek
Bonneville Pond
Doane Creek seep
Saltzman Creek
Small Inflow (R)
Balch Creek
Stephens Creek (Riverview)
Johnson Creek
Kellogg Creek
Tryon Creek
Bedrock Seep (RM20)
Oswego Creek
Glenmorrie Drive seep
Fern Creek
Arbor Creek seep
Trillium
Cedar Island lagoon
Clackamas R.
Meldrum Bar alcove
Abernethy Creek
Unnamed Trib - 6
Willow Creek
Unnamed Trib - 7
Unnamed Trib - 12
Cedar Creek
Unnamed Trib - 13
Unnamed Trib - 15
Chehalem Creek
Unnamed Trib - 20
Spring Brook
Ryan Creek
Unnamed Trib - 21
0 1.25 2.5 5 7.5 10
Miles

ifish.net