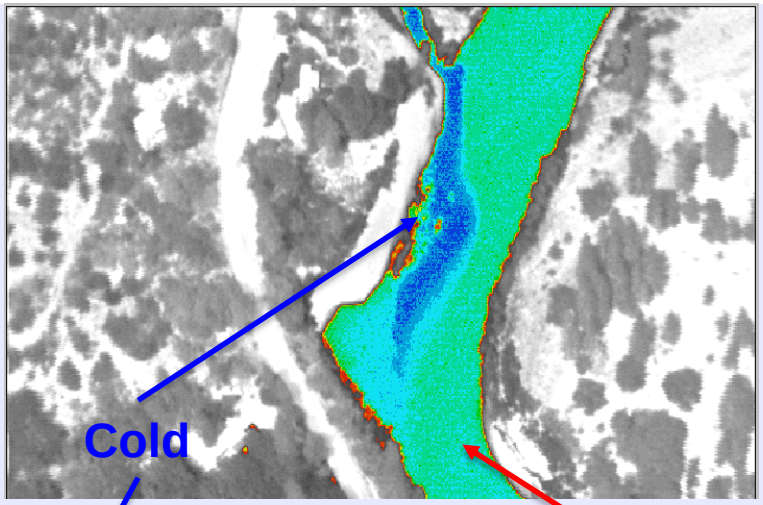
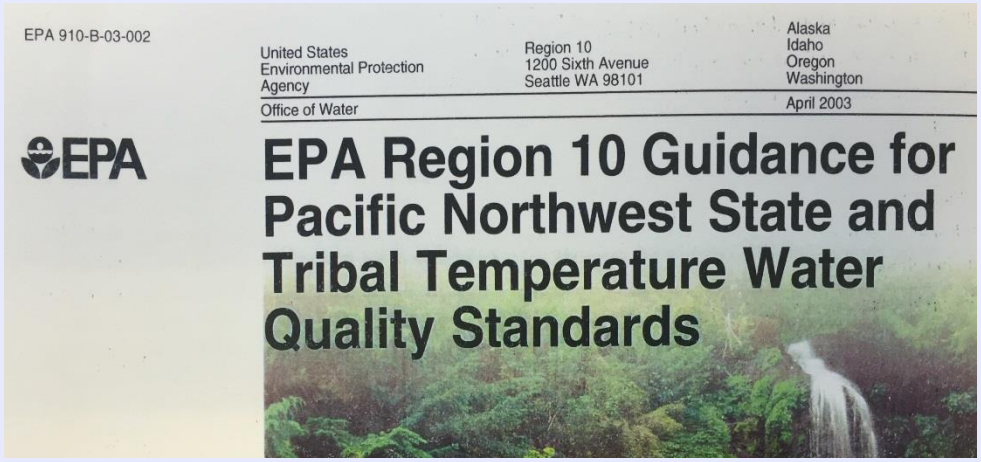
Columbia River
Cold Water Refugia Plan
(NMFS 2015 Oregon WQS BiOp RPA)

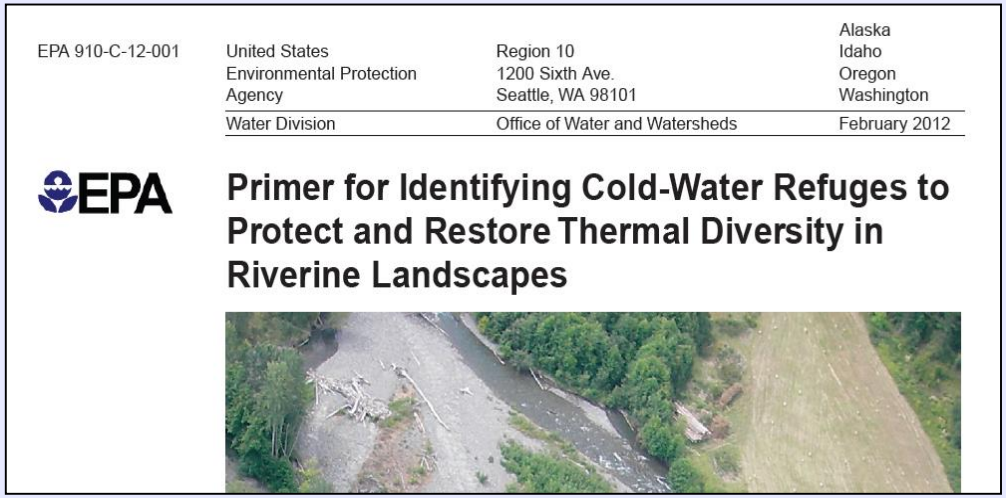
September 2016

John Palmer
EPA Region 10

What are cold water refuges?







Background - Oregon Temperture Water Quality Standards

Columbia & Lower Willamette River Temperature Criteria

- Salmon and Trout Migration Corridor Use
- 20C numeric criteria, plus
- Cold Water Refugia (CWR) narrative criteria
  - "must have CWR that's sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher temperatures elsewhere in the water body"
  - "CWR means those portions of a water body where, or times during the diel cycle when, the water temperature is at least 2C colder than the daily maximum temperature of the adjacent well mixed flow of the water body"
- EPA approved in 2004

NMFS Jeopardy Finding (2015 Biological Opinion)

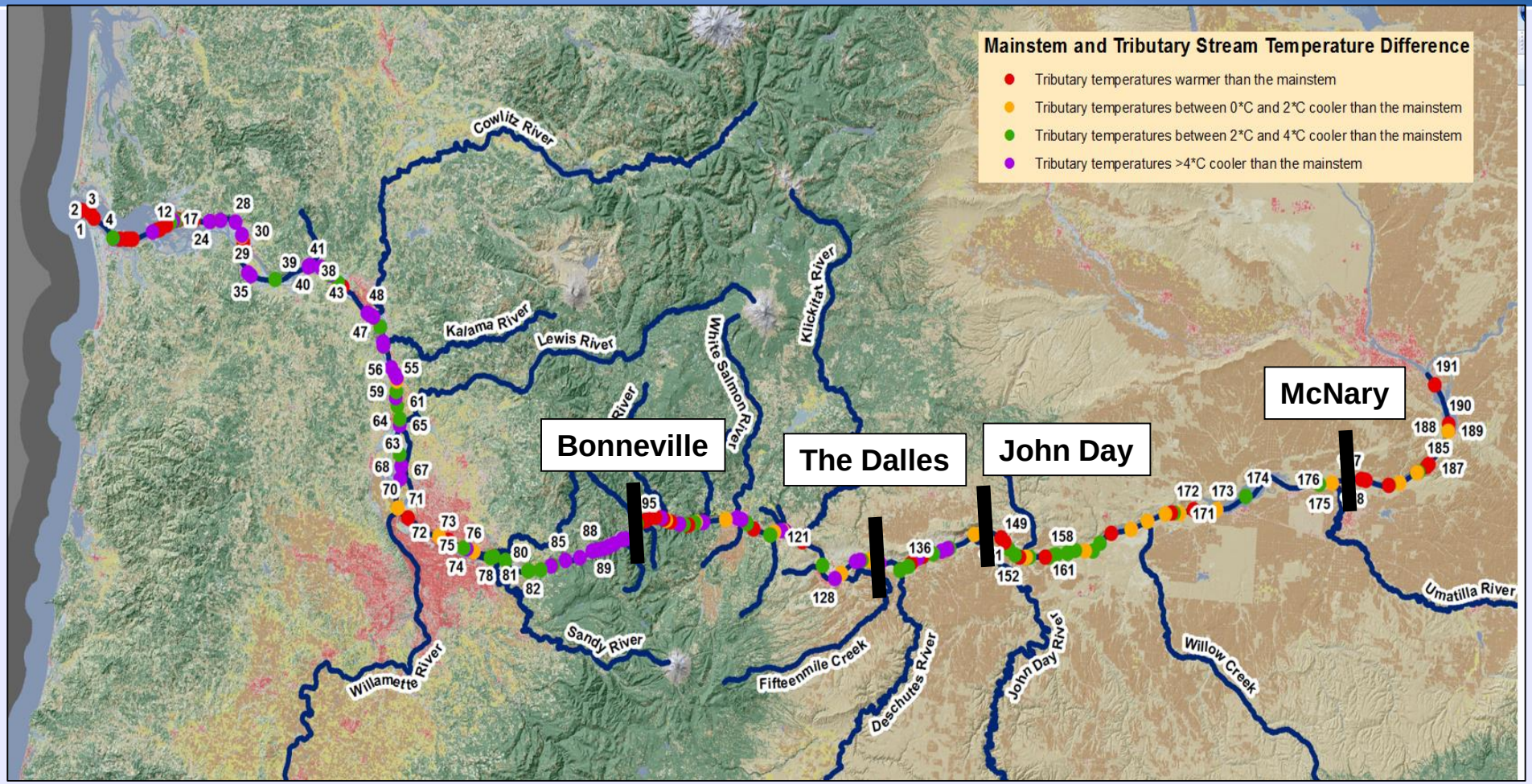
- NMFS concluded 20C criterion not protective without an effective CWR narrative & Oregon's CWR narrative criteria is not an effective criteria due to lack of implementation
- Jeopardy for Steelhead, Chinook, Sockeye, and Killer Whales
- Reasonable and Prudent Alternative (RPA)
  - ✓ EPA shall develop a Columbia River CWR Plan
  - ✓ Oregon DEQ shall develop a Willamette River CWR Plan
  - ✓ EPA shall work with NMFS, Columbia River Federal Caucus, and the NWPCC to align this work with FCRPS BiOp and Columbia River Fish and Wildlife Program
  - ✓ Columbia & Willamette River CWR plans due by November 2018

CWR Plan Elements

1. Characterize current spatial and temporal CWR
2. Characterize current salmon and steelhead use of CWR
3. Assess whether current CWR is sufficient to meet Oregon's narrative criteria
4. Identity additional CWR needed to meet criteria if current CWR is insufficient
5. Identify programs and actions to protect and enhance current CWR areas
6. Identify locations and actions to restore CWR

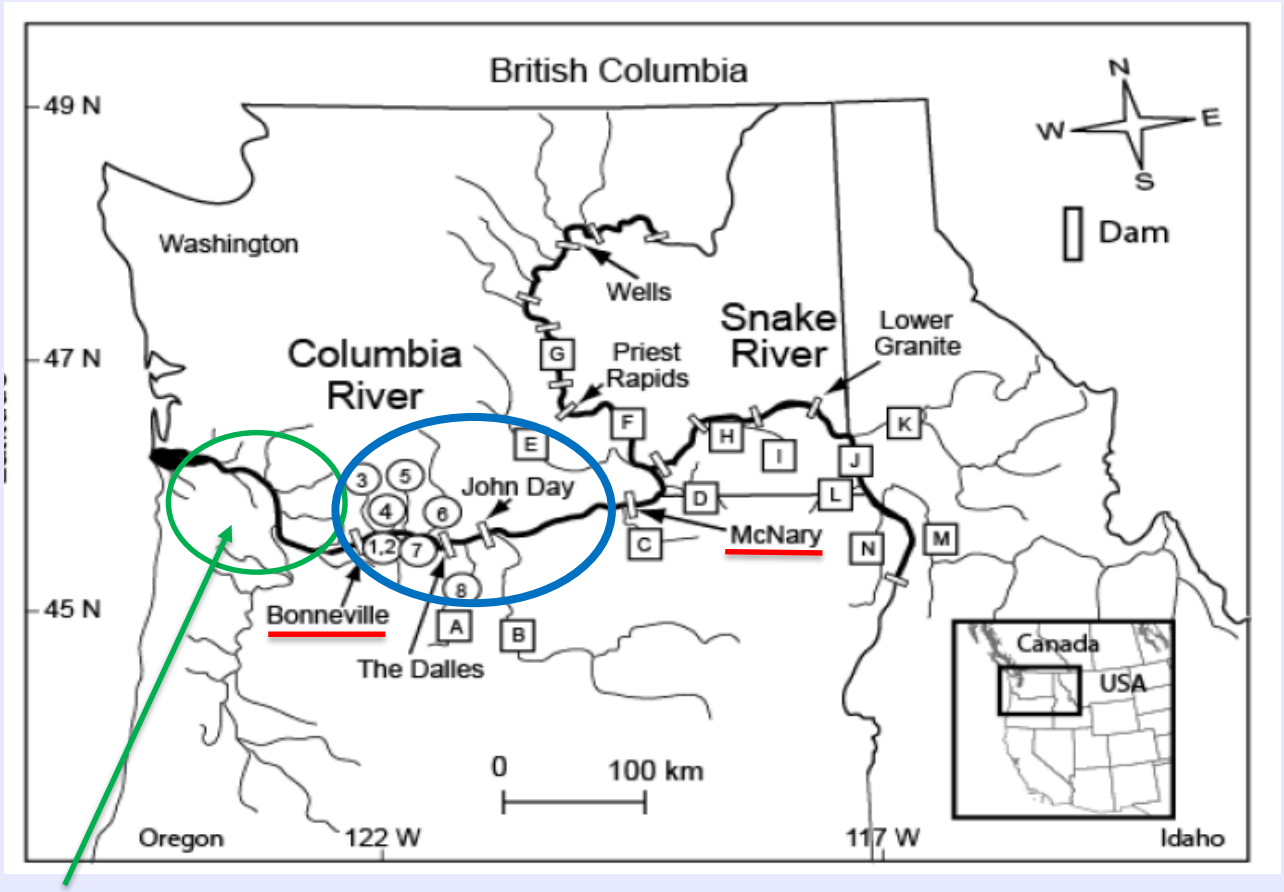
Columbia River CWR Plan Area RM0-RM310

191 Columbia River Tributaries below Snake River Confluence



Temperature data source: NorWest, USFS

Eight Primary CWR Areas studied in Columbia River from Bonneville Dam to McNary Dam



1. Eagle Creek
2. Herman Creek
3. Wind River
4. Little White Salmon River
5. White Salmon River
6. Klickitat River
7. Hood River
8. Deschutes River

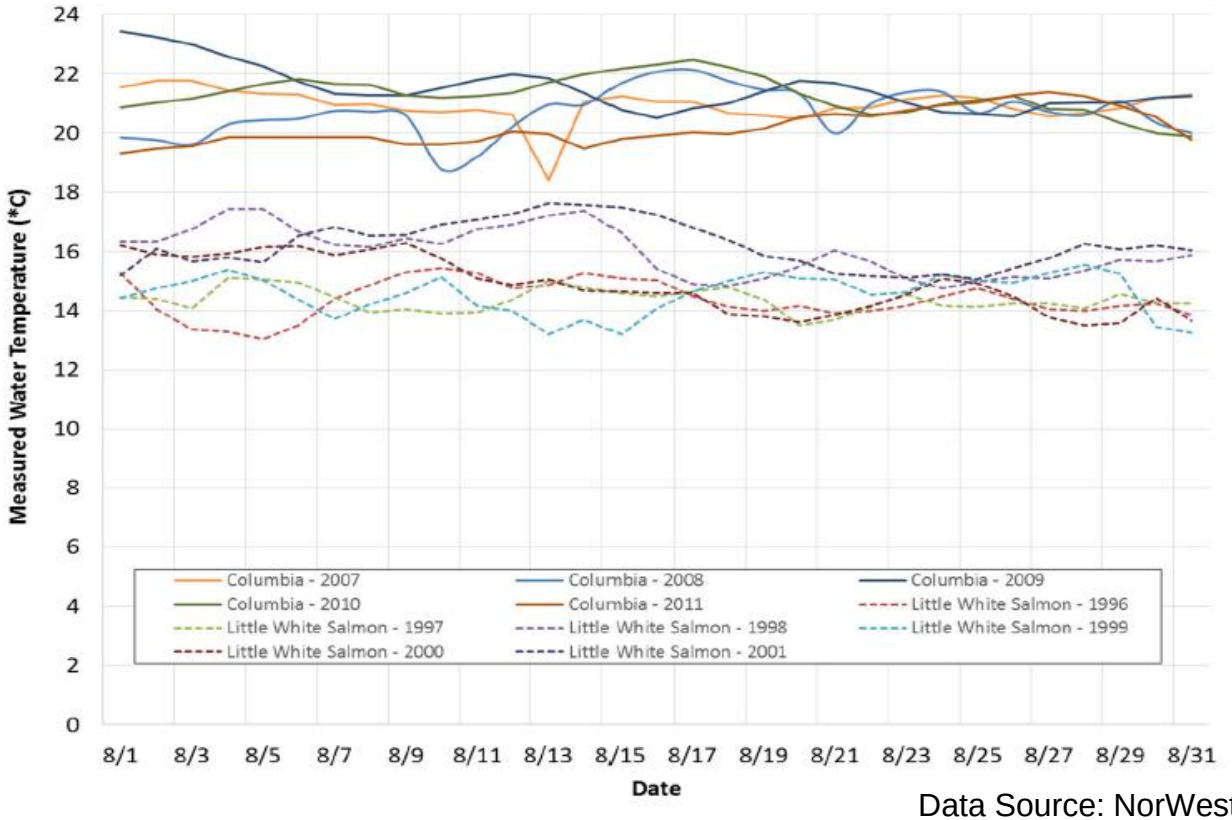
Little CWR research below Bonneville Dam

Source - Keefer et. al. 2011

Little White Salmon vs Columbia River Temperatures

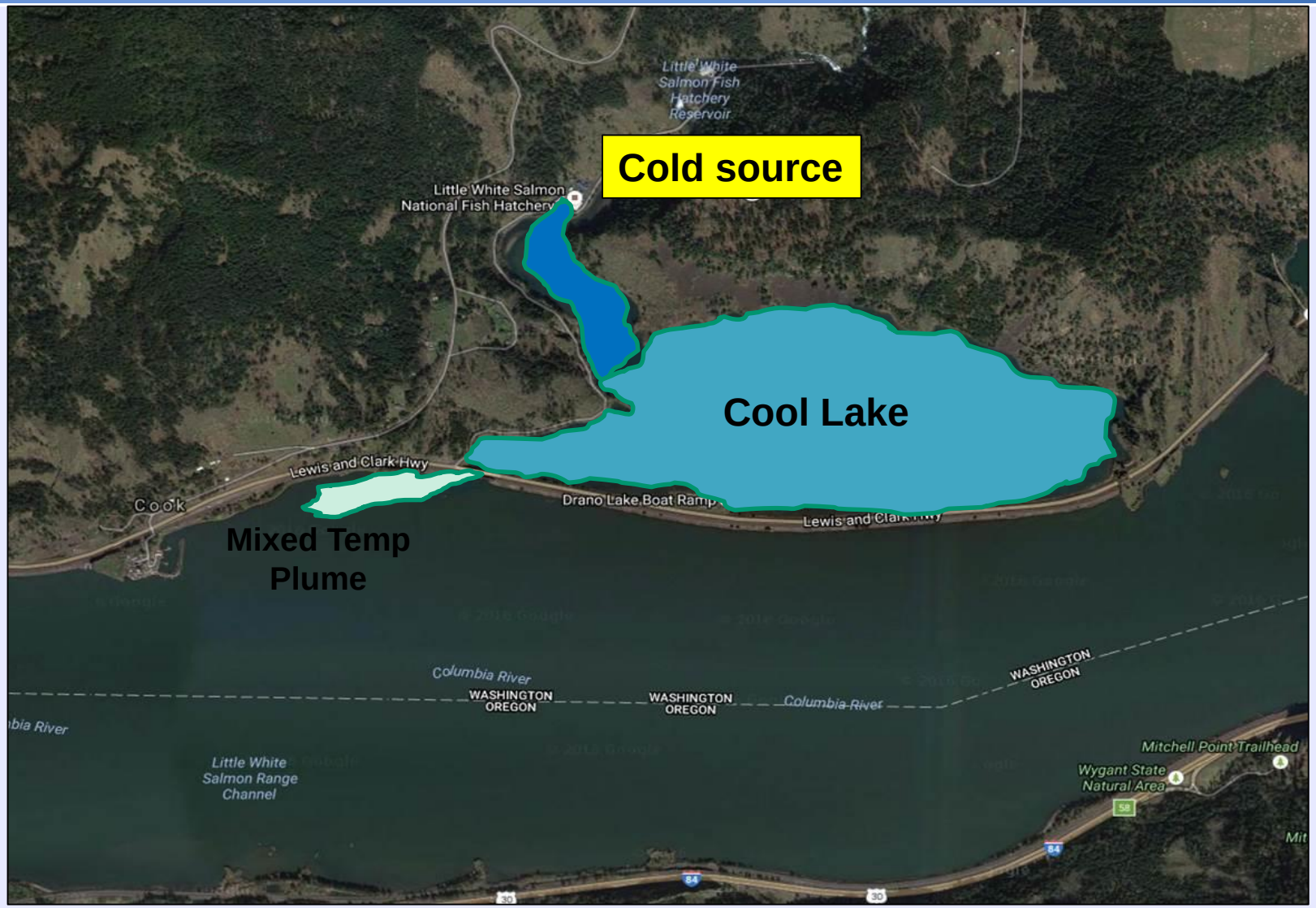
Tributary #112 – Little White Salmon River

Daily Average Water Temperature



Data Source: NorWest, USFS

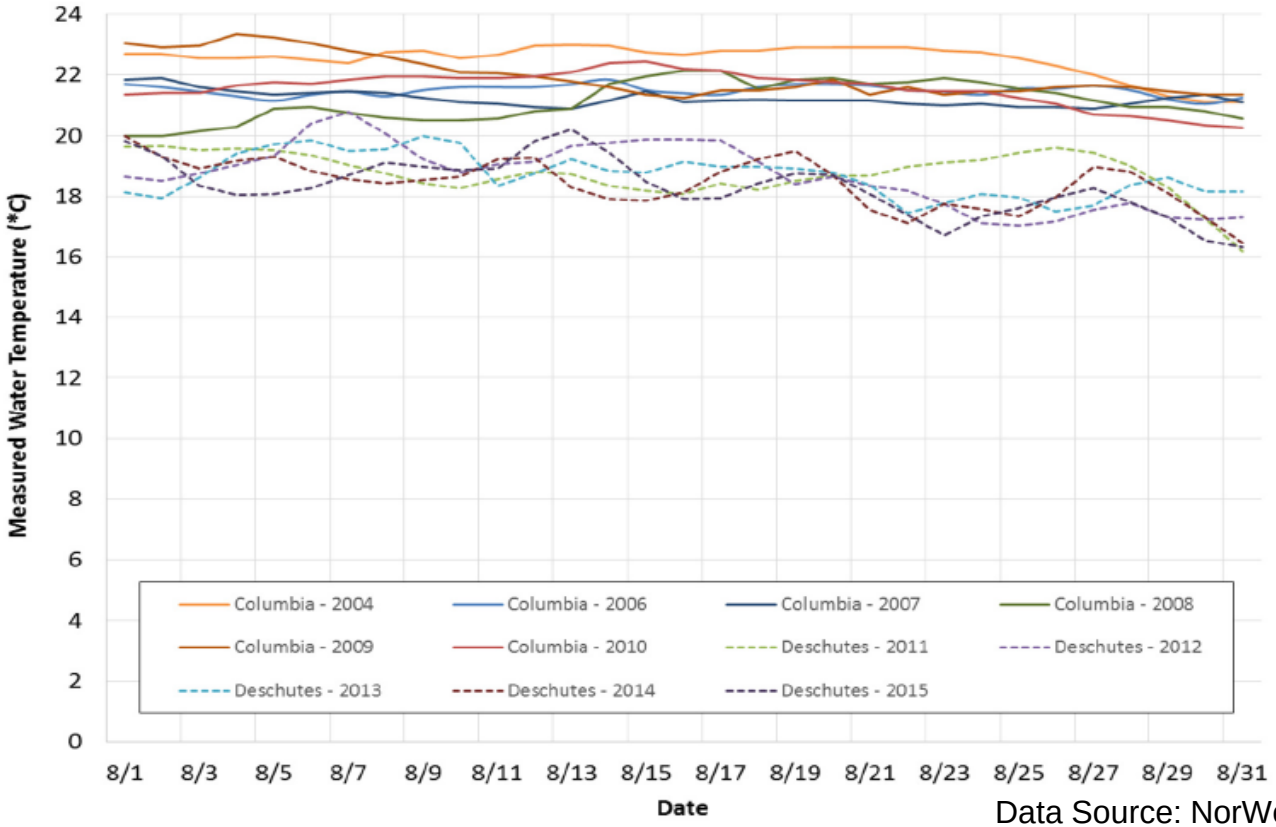
Little White Salmon / Drano Lake CWR



Deschutes vs Columbia River Temperatures

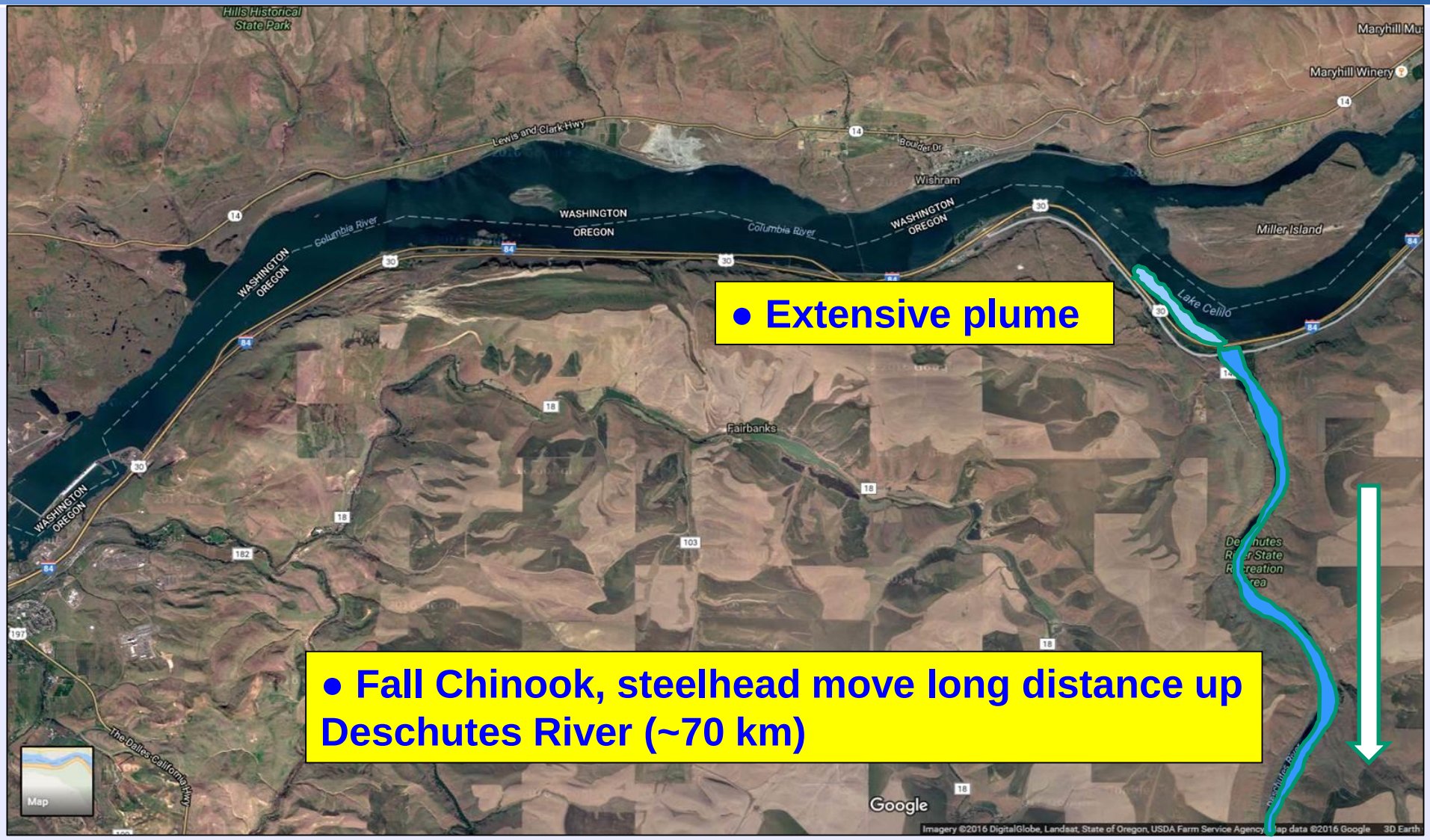
Tributary #135 – Deschutes River

Daily Average Water Temperature



Data Source: NorWest, USFS

Deschutes River CWR

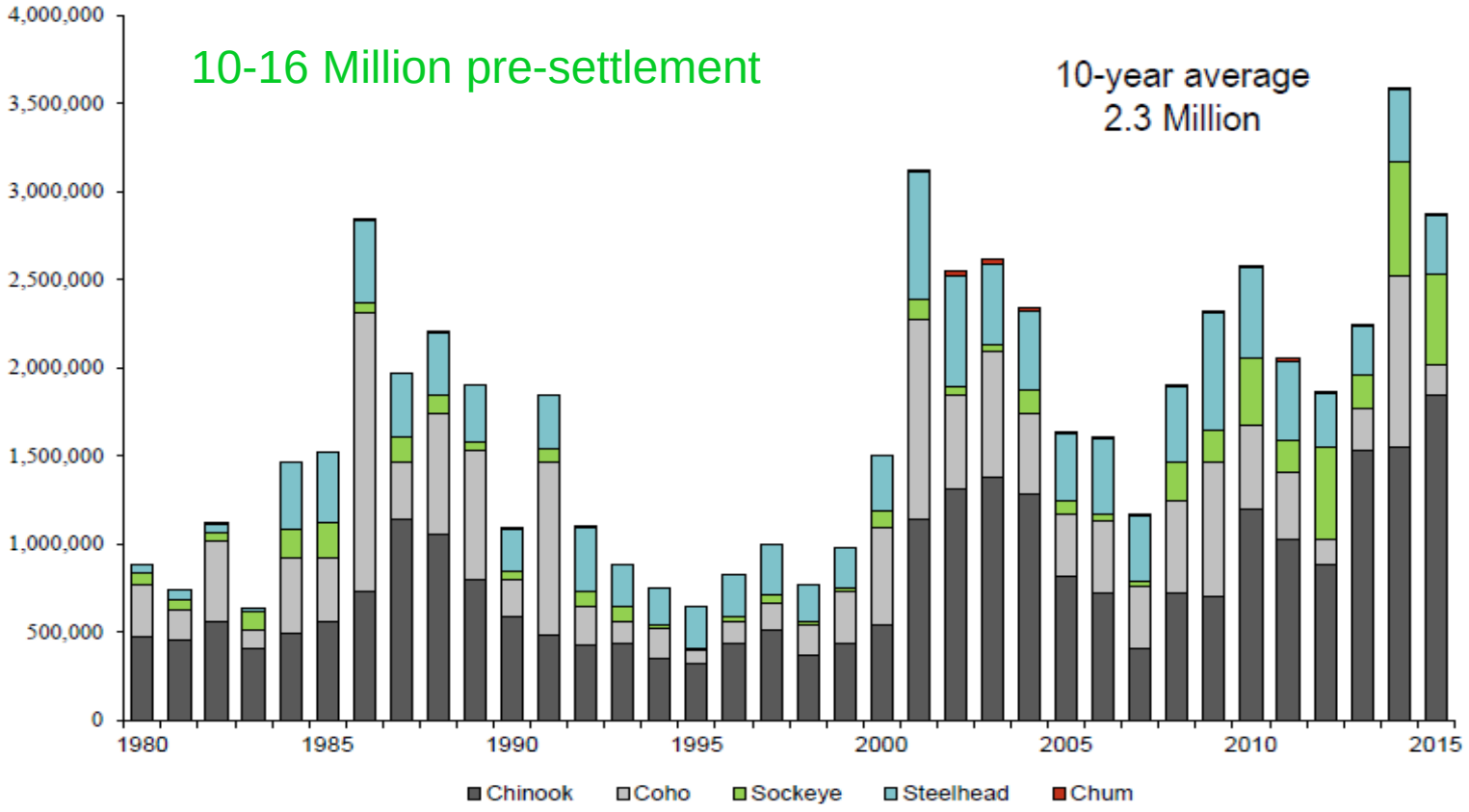


- Extensive plume

- Fall Chinook, steelhead move long distance up Deschutes River (~70 km)

Columbia River Salmon/Steelhead

Columbia River Salmonid Returns



May 4, 2016 - Columbia Basin Partnership Workshop - Norman, Guy - Columbia River Salmon and Steelhead Abundance Trends Including Non-listed Populations

Fish Passage Timing at Bonneville Dam

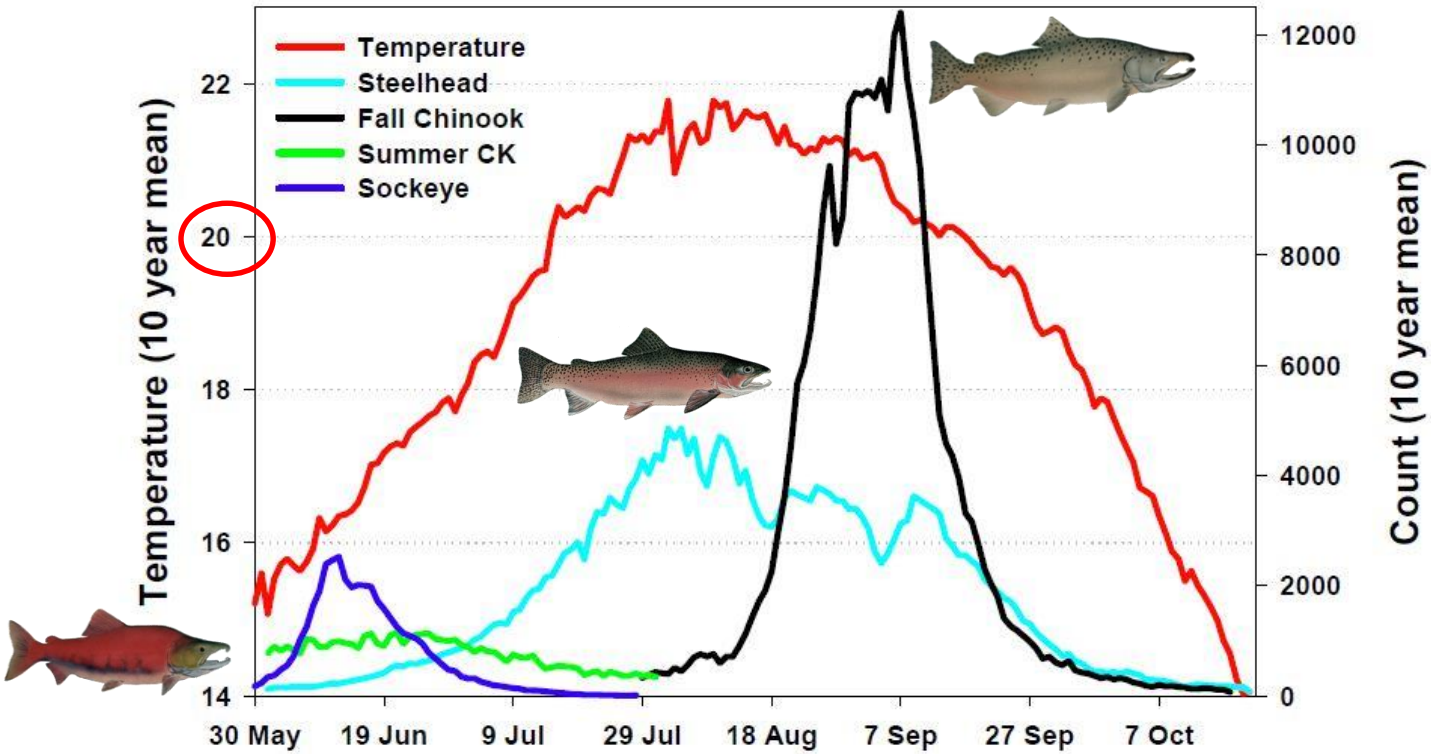
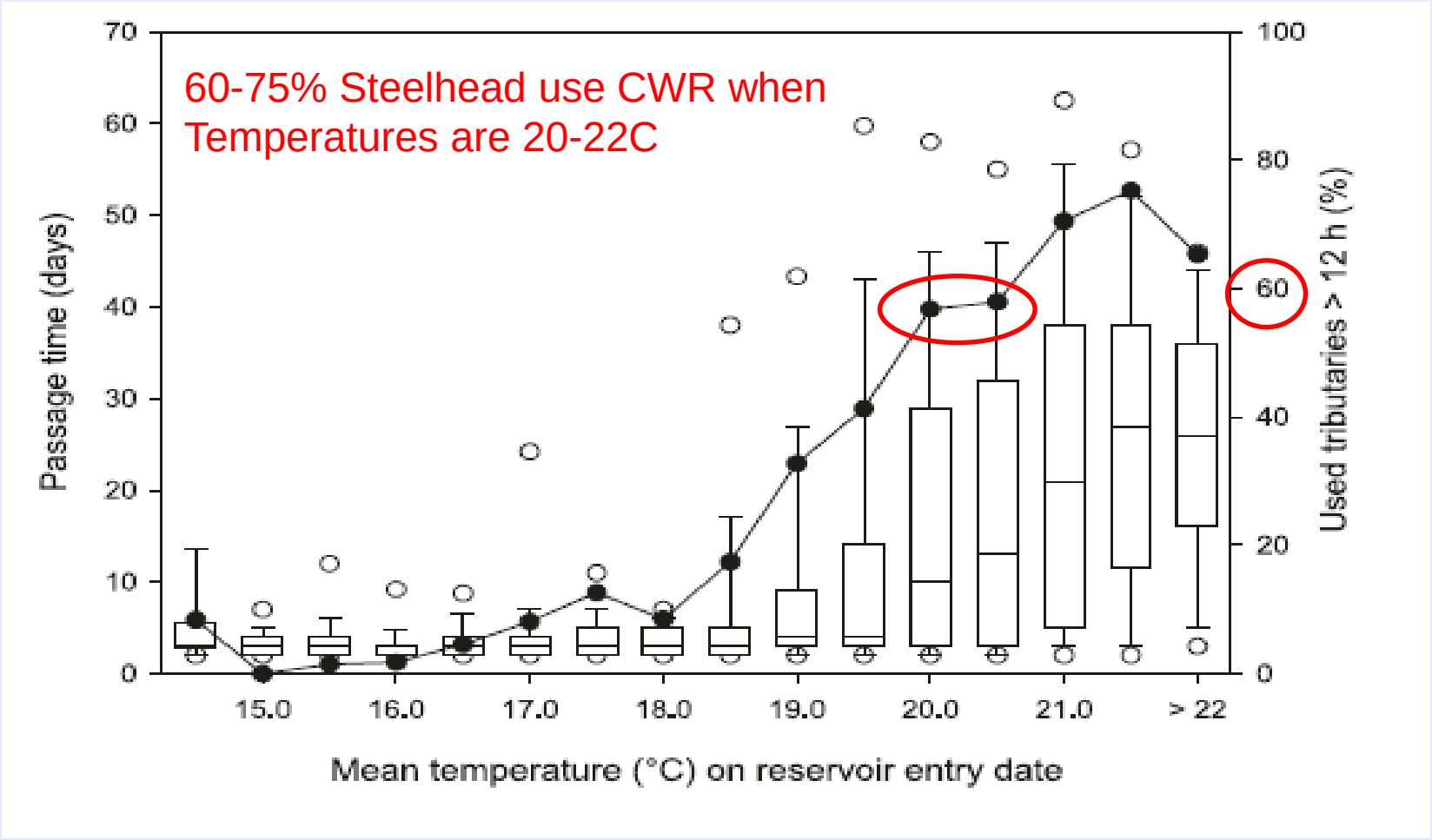


Figure 2. Ten-year (1996-2005) mean lower Columbia River water temperature (°C) and mean run size and timing of adult summer Chinook salmon, fall Chinook salmon, sockeye salmon, and summer steelhead at Bonneville Dam. Thermal refugia use by many adult populations has been associated with water temperatures greater than 19-20 °C.

(Keefer et al. 2011)

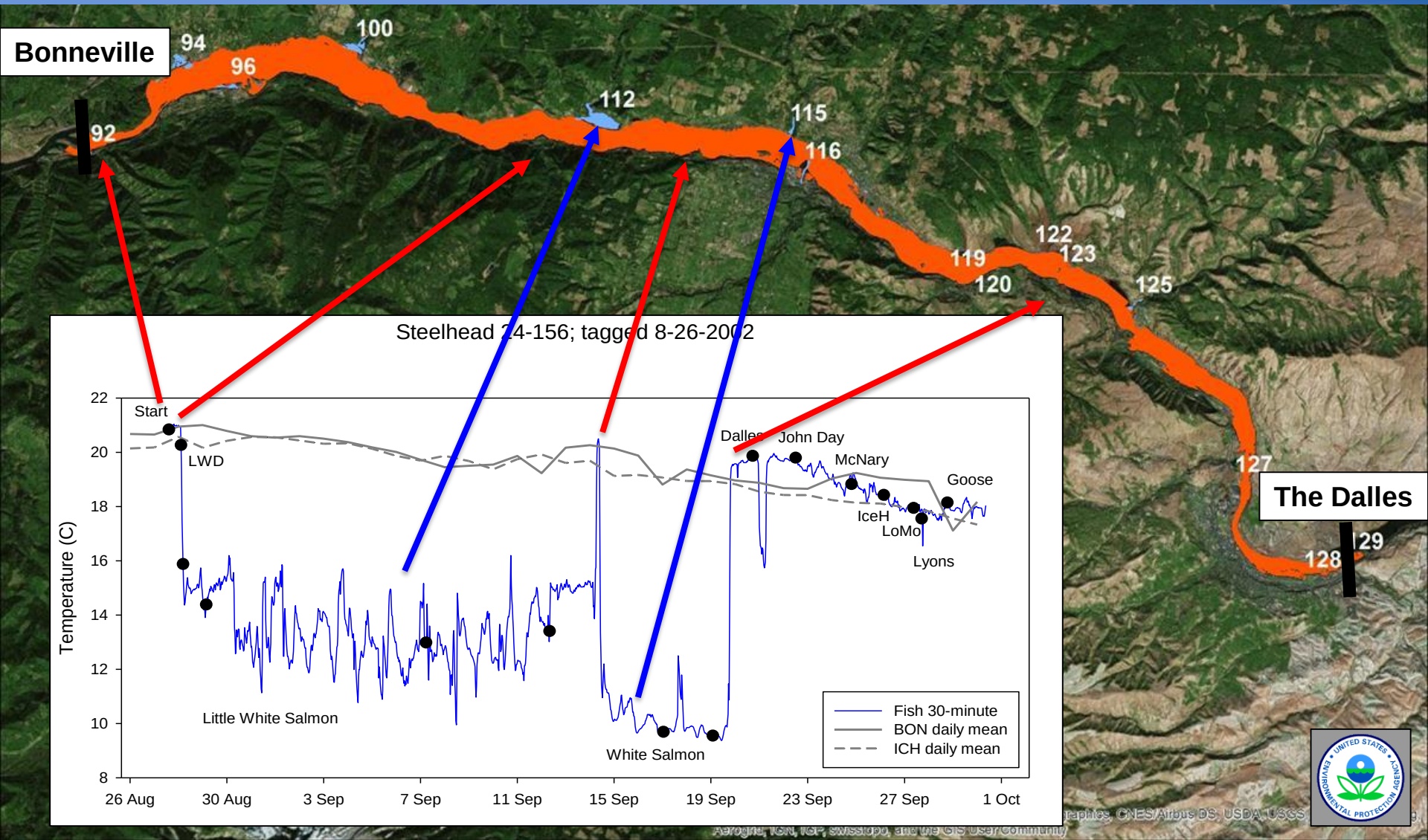
Steelhead use of CWR
(between Bonneville Dam and the Dalles Dam)



Source - Keefer et al. 2009

Steelhead use of CWR

Columbia River between Bonneville Dam and The Dalles Dam



Steelhead holding in CWR Tributaries between Bonneville Dam and John Day Dam

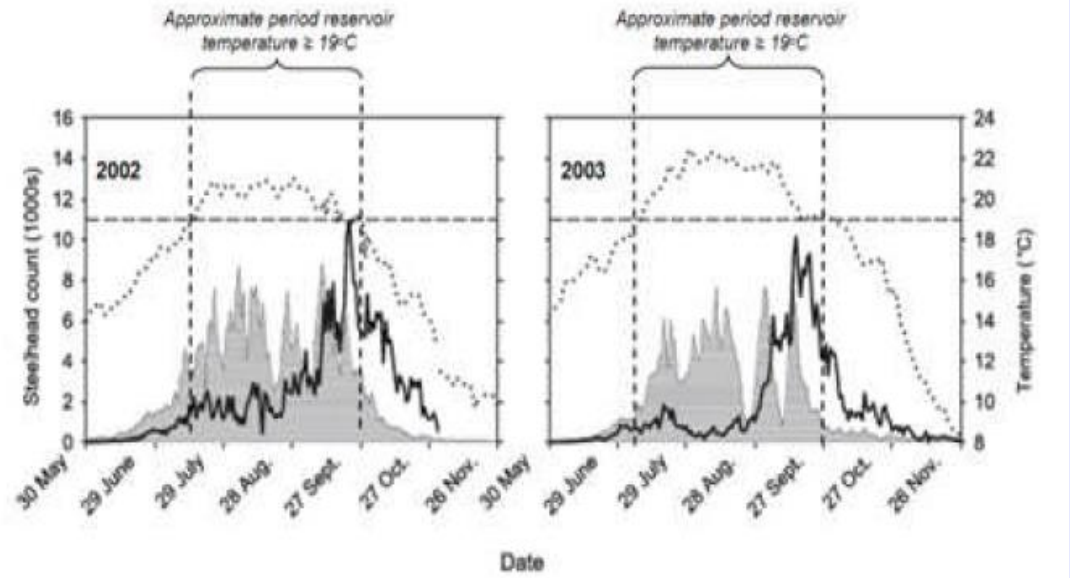


Figure 4. Number of steelhead counted at Bonneville Dam (shaded area) and at John Day (solid black line) for 2002-2003. The vertical dashed lines bound the time periods when an increased use of thermal refuges is observed. The horizontal dashed line at 66.2°F (19 °C) line is a threshold temperature where use of thermal refuges rapidly increases. The dotted lines are the average daily Columbia River water temperature at the Bonneville Dam. *Sources*: Graph modified from Keefer et al 2009, (2002 and 2003 years excerpted); Columbia River temperatures from DART (water quality monitoring site in Bonneville Dam forebay; *www.cbr.washington.edu/dart/river.html*).

- **Approximately 80,000 Steelhead in CWR tributaries on any given day in August**
- Based on following rough estimate:
- BON July 15 – Aug 31 = Approx. 5,000 Steelhead/day = 225,000
- 225,000 x .76 (10 year avg. % expected to pass JDA) = 171,000
- JDA July 15 – Aug 31 = Approx. 2,000 Steelhead/day = 90,000
- 171,000 – 90,000 = 81,000 of Steelhead using CWR between BON- JDA

Source - Cramer Fish Sciences, 2011

Steelhead population use of specific CWR areas in the Columbia River

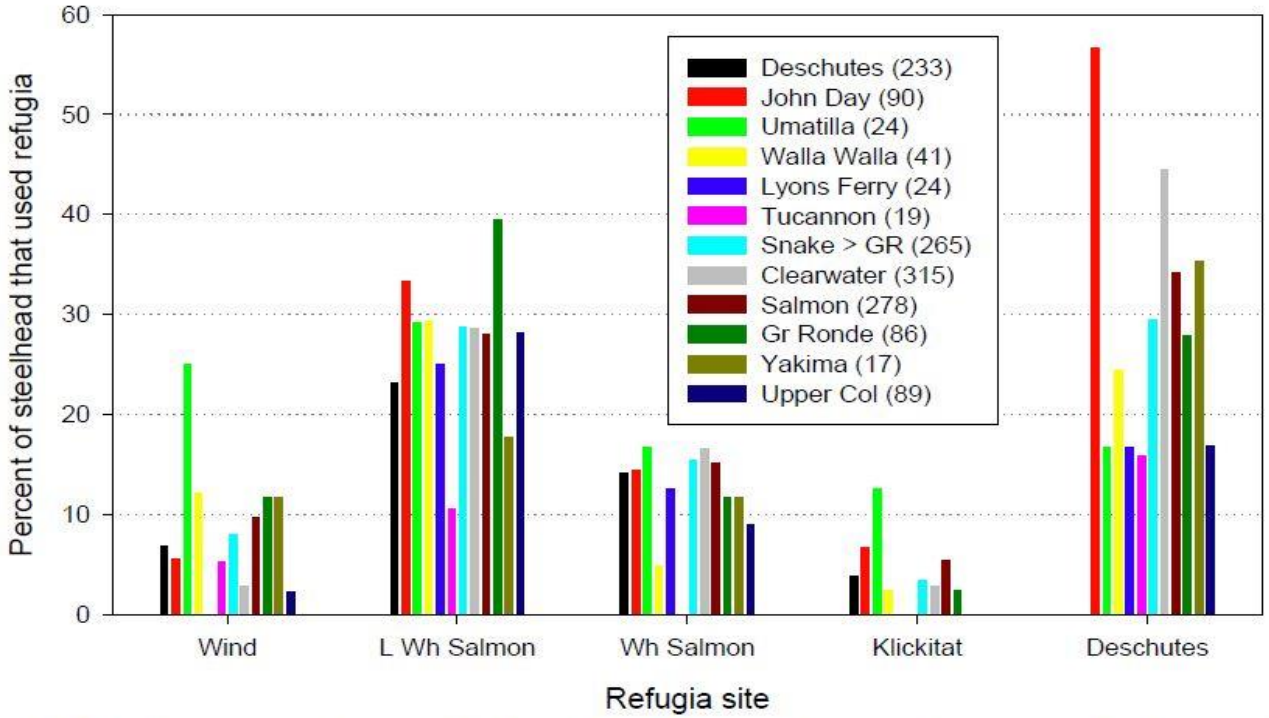


Figure 7. Population-specific use of selected cool-water refugia tributaries in the Bonneville-John Day reach by radio-tagged summer steelhead in 1996-1997 and 2000. Bar colors represent upriver populations, with sample sizes in parentheses. Steelhead additionally used Herman and Eagle creeks, but these small sites were inconsistently monitored in these study years. A small number of steelhead temporarily used the Hood River (not shown).

Source - Keefer et al. 2011

Chinook use of CWR

- CWR use associated with 21C temperature
- 20-40% use CWR with 21-22C
- Migration rate cut in half
- Plume use as well (not fully counted as CWR use – so above statistics don't account for this)
- Fall Chinook likely use CWR more than Summer Chinook

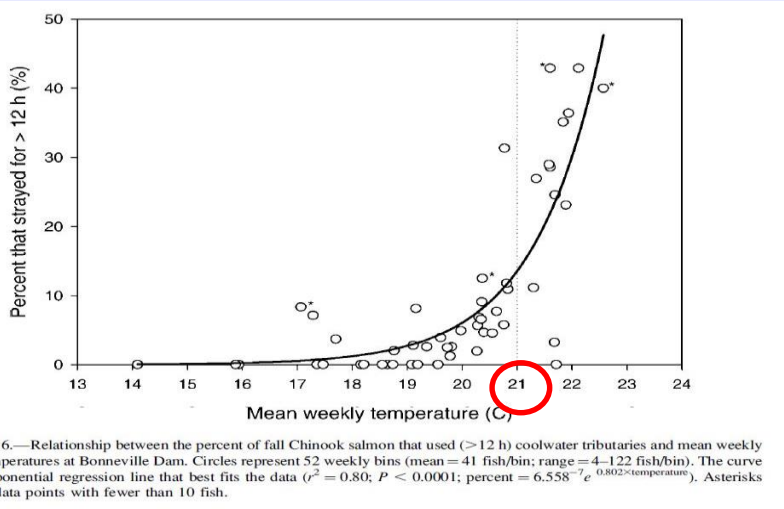


FIGURE 6.—Relationship between the percent of fall Chinook salmon that used (>12 h) coolwater tributaries and mean weekly water temperatures at Bonneville Dam. Circles represent 52 weekly bins (mean = 41 fish/bin; range = 4–122 fish/bin). The curve is the exponential regression line that best fits the data ($r^2 = 0.80$; $P < 0.0001$; percent = $6.558^{-7}e^{0.802\times\text{temperature}}$). Asterisks indicate data points with fewer than 10 fish.

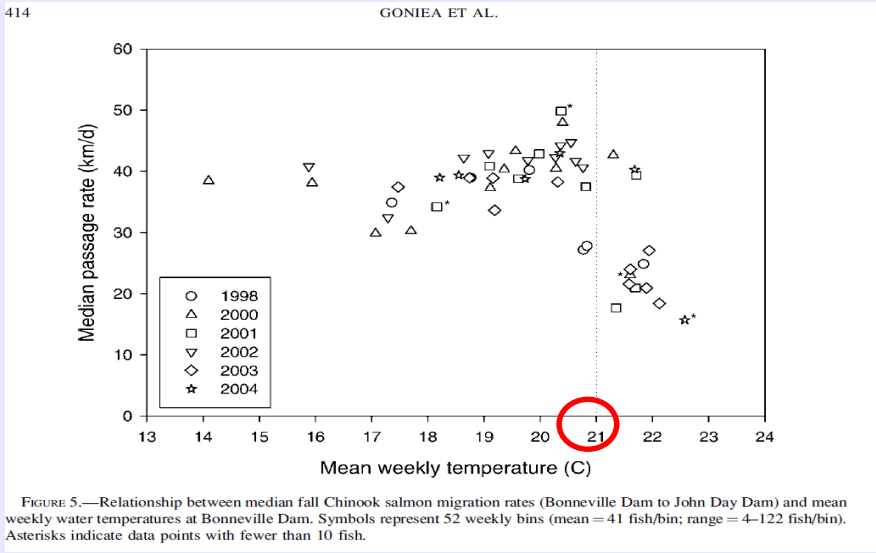


FIGURE 5.—Relationship between median fall Chinook salmon migration rates (Bonneville Dam to John Day Dam) and mean weekly water temperatures at Bonneville Dam. Symbols represent 52 weekly bins (mean = 41 fish/bin; range = 4–122 fish/bin). Asterisks indicate data points with fewer than 10 fish.

Sources - Goniea et. al. 2006; Keefer et. al., 2011

Sockeye use of CWR

- Appears to be minimal CWR use
- Most sockeye typically migrate before peak temperatures
- Delay in migration would result in exposure to higher temperatures
- 2015 - early warm temperatures during peak migration resulting very high mortality

Most of the nearly 500,000 Sockeye died prior to spawning in 2015 due high temperatures

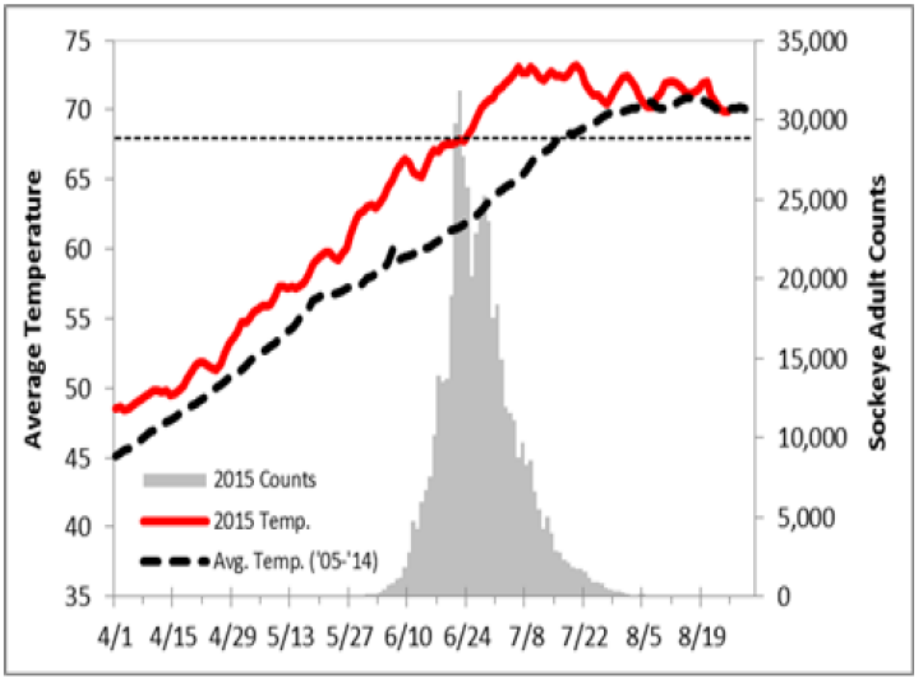
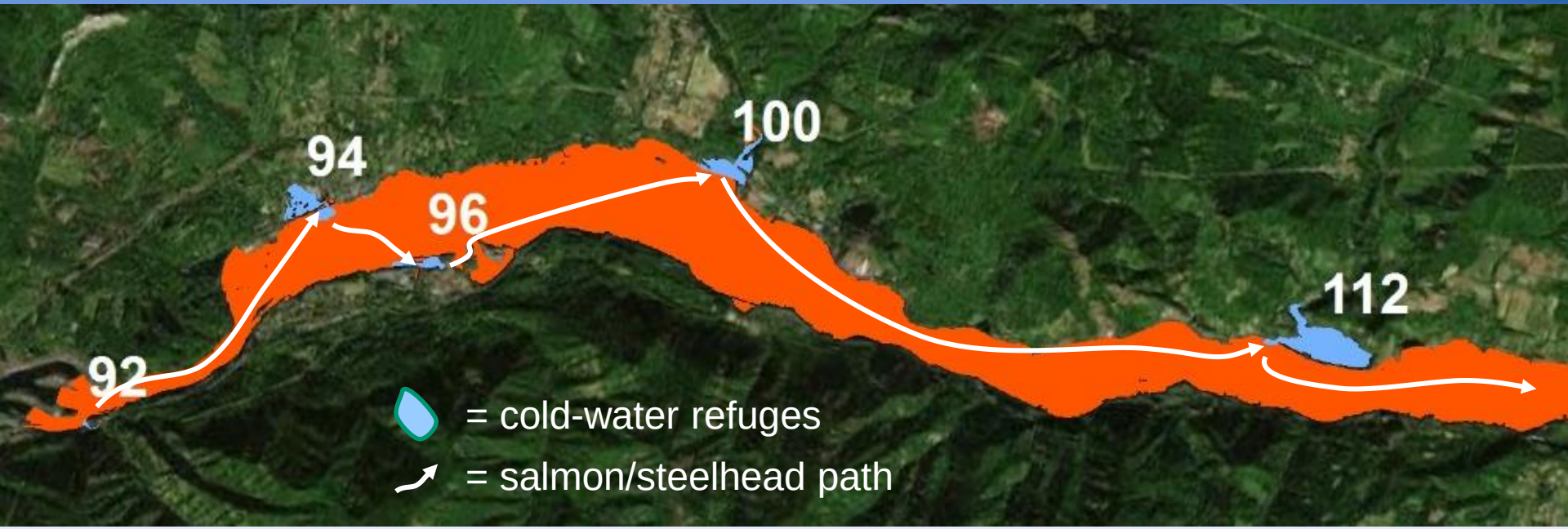


Figure 6. Water temperature at Bonneville Dam in 2015 compared to the average for the past 10 years, and the adult sockeye dam counts at Bonneville Dam in 2015.

Is The Current CWR Sufficient?

- What do we know?
  - High migrations temperatures (above 19/20C) associated with mortality and reduced egg viability
  - T&E salmon populations experience about 10% mortality (excluding harvest) between Bonneville Dam and McNary Dam (temperature exposure likely a contributing factor)
  - Presume use of CWR reduces thermal exposure and risk
- Key questions
  - If more CWR available, would mortality rates decrease?
  - If so, what's the quantitative relationship?
  - What is the CWR abundance vs mortality relationship at recovered/harvestable populations levels of salmon and steelheed (e.g., 8 million vs 2 million fish)
  - What Columbia River mainstem temperatures do we apply?
    - Current temperatures (cool, average, warm years)
    - Future projected temperatures due to climate change
    - 20C (numeric criteria)

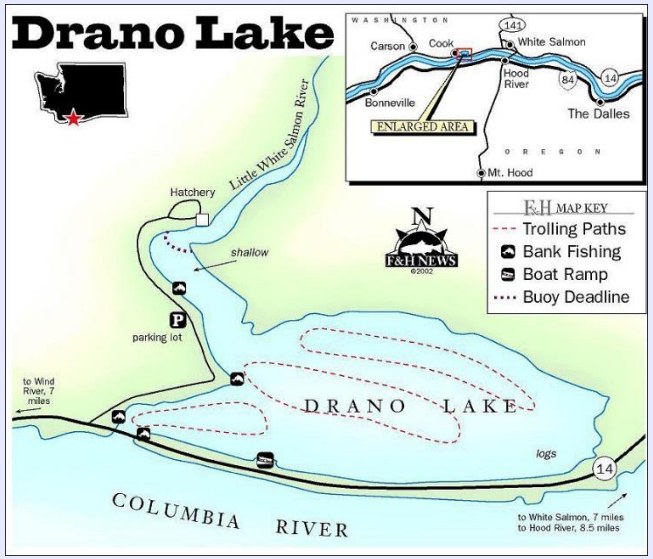
HexSim Model – EPA Corvallis Lab



- Track individual fish over time
  - Accumulated thermal exposure as fish migrate
  - Net effect on survival, egg viability
  - Differential exposure to other risks (harvest, predation, disease)
- Allows comparison of travel paths, spacing, size, quality of cold-water refuges

How does the availability and use of cold-water matter to salmon and steelhead?

Complicating Factors



Steelhead that used CWR had <u>less</u> survival to natal streams than those that don't due to a higher harvest rate (Keefer, et. al. 2009)

Human use of CWR (Oneonta Creek) on a hot Portland day

Protect & Enhance - Wind River

- ✓ Documented CWR use
- ✓ Currently 2-4C colder than Columbia River
- ✓ TMDL: potential to cool the river by 3-4C
- ✓ Federal land protection (USFS)
- ✓ Targeted restoration

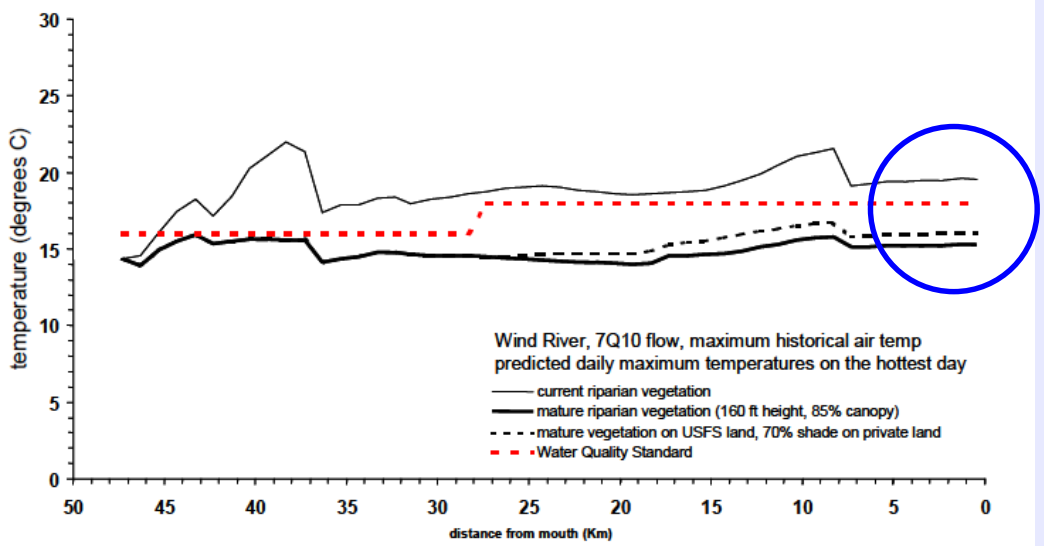
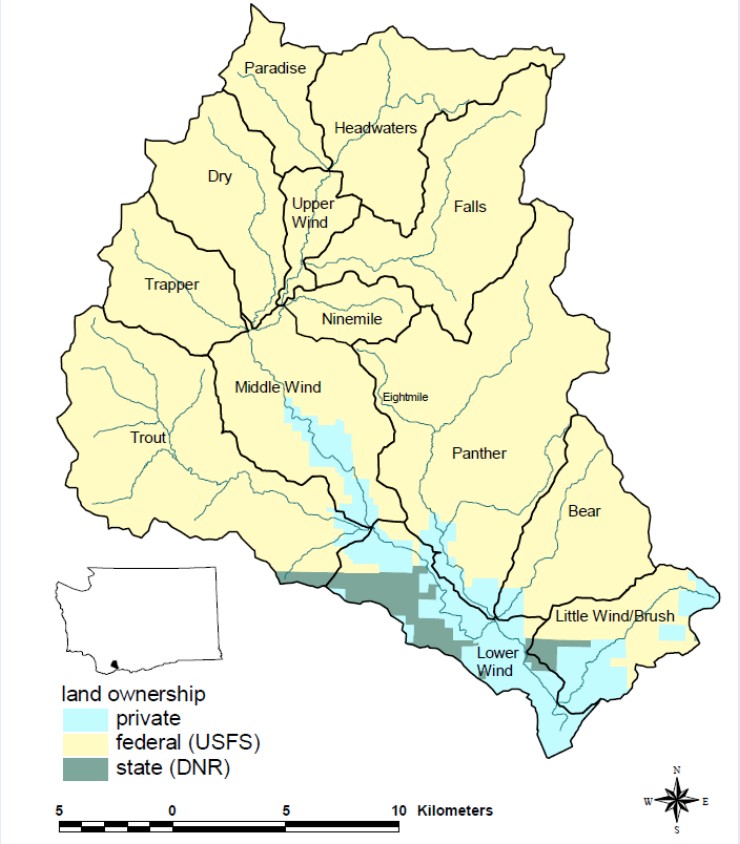
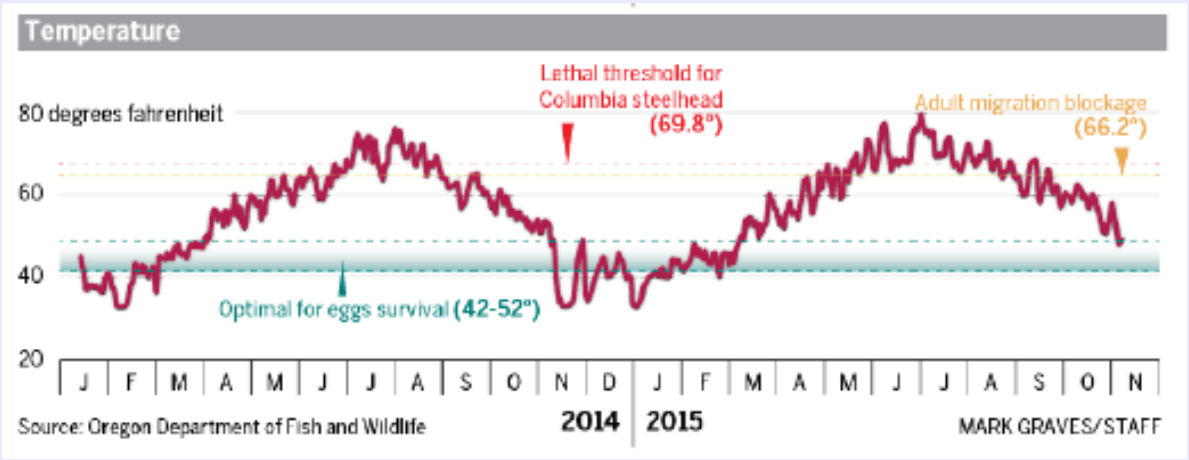
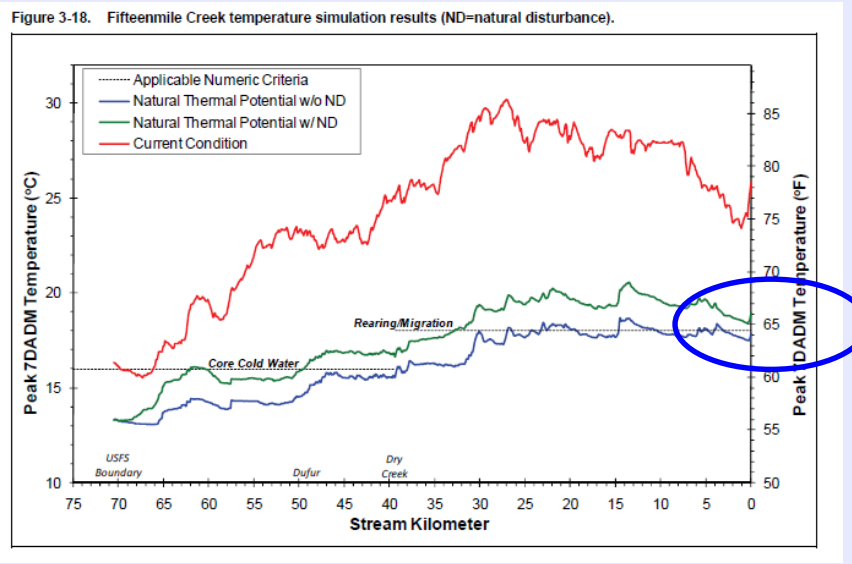


Figure 17. Predicted daily maximum temperature in Wind River under critical conditions for the TMDL.



Potential Restore - Fifteenmile Creek





Potential CWR