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

September 2016
John Palmer
EPA Region 10
What are cold water refuges?

From the image:

- Cold water refuges
- Warm water refuges
- Fish

Images show mapped areas labeled as cold and warm, indicating potential refuges for fish species.
Background - Oregon Temperature Water Quality Standards

Columbia & Lower Willamette River Temperature Criteria

- Salmon and Trout Migration Corridor Use
- 20°C 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 2°C colder than the daily maximum temperature of the adjacent well mixed flow of the water body”
- EPA approved in 2004
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

Mainstem and Tributary Stream Temperature Difference
- Tributary temperatures warmer than the mainstem
- Tributary temperatures between 0°C and 2°C cooler than the mainstem
- Tributary temperatures between 2°C and 4°C cooler than the mainstem
- Tributary temperatures >4°C cooler than the mainstem

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

Source - Keefer et. al. 2011
Tributary #112 – Little White Salmon River

Daily Average Water Temperature

Data Source: NorWest, USFS
Little White Salmon / Drano Lake CWR

- Cold source
- Cool Lake
- Mixed Temp Plume
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

10-16 Million pre-settlement

10-year average 2.3 Million

Chinook  Coho  Sockeye  Steelhead  Chum

May 4, 2016 - Columbia Basin Partnership Workshop - Norman, Guy - Columbia River Salmon and Steelhead Abundance Trends Including Non-listed Populations
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.
Steelhead use of CWR (between Bonneville Dam and the Dalles Dam)

60-75% Steelhead use CWR when Temperatures are 20-22°C

Source - Keefer et al. 2009
Steelhead use of CWR
Columbia River between Bonneville Dam and The Dalles Dam

Steelhead 24-156; tagged 8-26-2002
26 Aug 30 Aug 3 Sep 7 Sep 11 Sep 15 Sep 19 Sep 23 Sep 27 Sep 1 Oct

Temperature (C)

Fish 30-minute
ICH daily mean

Bonneville

Little White Salmon
White Salmon
Dalles John Day
McNary
IceH
LoMo
Goose
Start
Lyons
LWD

The Dalles

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

• **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

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 steelhead (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 **less** 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 2-4°C colder than Columbia River
- TMDL: potential to cool the river by 3-4°C
- 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

Temperature

- Lethal threshold for Columbia steelhead (69.8°)
- Adult migration blockage (66.2°)

Optimal for eggs survival (42-52°)

Source: Oregon Department of Fish and Wildlife

2014 2015

MARK GRAVES/STAFF

Figure 3-18. Fifteenmile Creek temperature simulation results (ND=natural disturbance).

- Applicable Numeric Criteria
- Natural Thermal Potential w/o ND
- Natural Thermal Potential w/ND
- Current Condition

Potential CWR