Water temperatures for rearing salmonids

Seth Naman, NOAA

TMC meeting

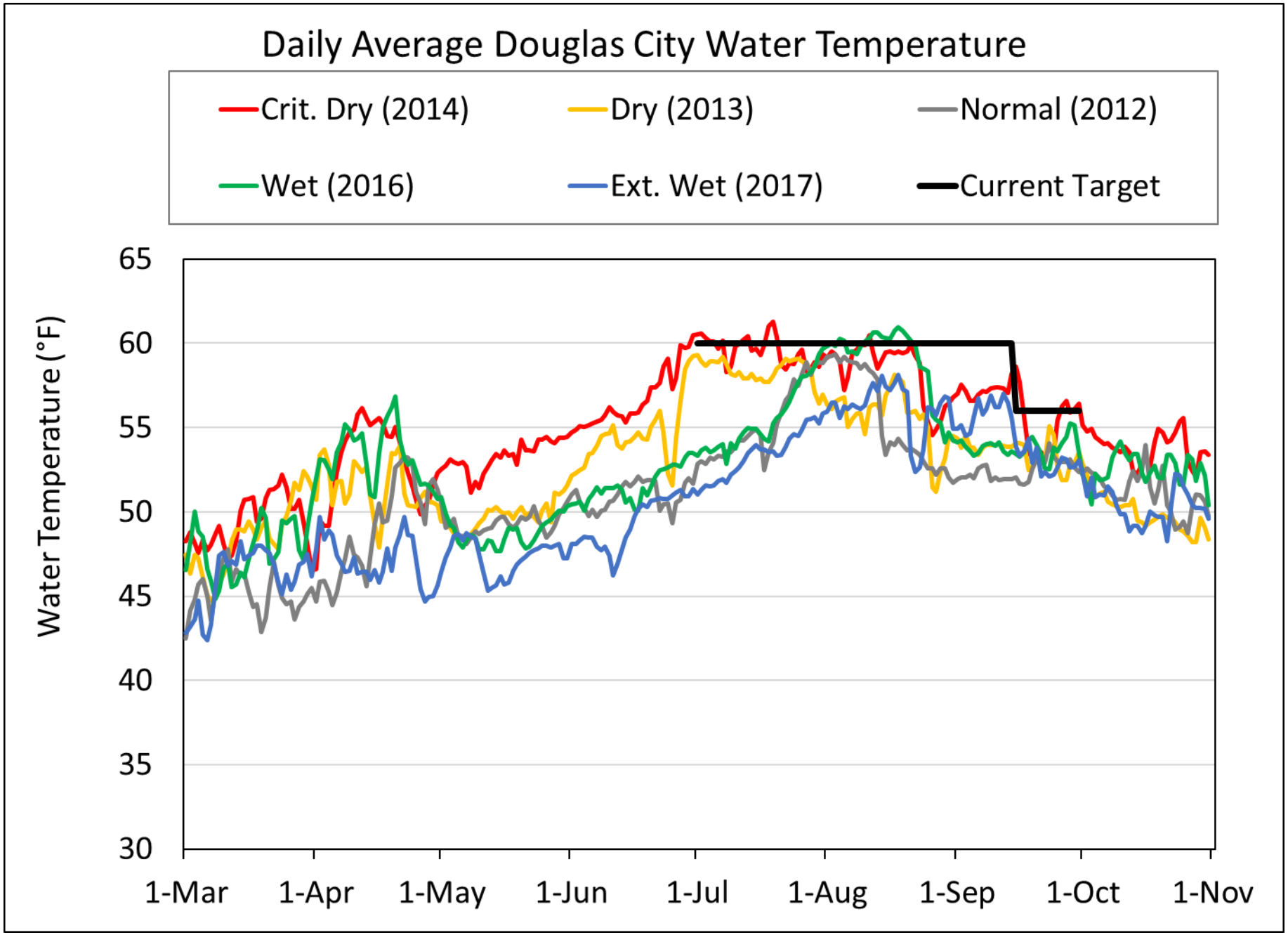
September 11-12, 2019

Weitchpec

(Kyle De Juilio, Justin Alvarez, Katherine Osborne)

Current temperature targets (regulatory)

Date	Temperature Objective (°F)		Regulatory Agencies
	Douglas City (RM 93.8)	North Fork Trinity River (RM 72.4)	
July 1 through Sept 14	60	-	NCRWQCB, NMFS
Sept 15 through Sept 30	56	-	NCRWQCB, NMFS, SWRCB
Oct 1 through Dec 31	-	56	NCRWQCB, NMFS, SWRCB


Daily Average Douglas City Water Temperature
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Ext. Wet (2017)
Current Target
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1-Apr
1-May
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1-Aug
1-Sep
1-Oct
1-Nov

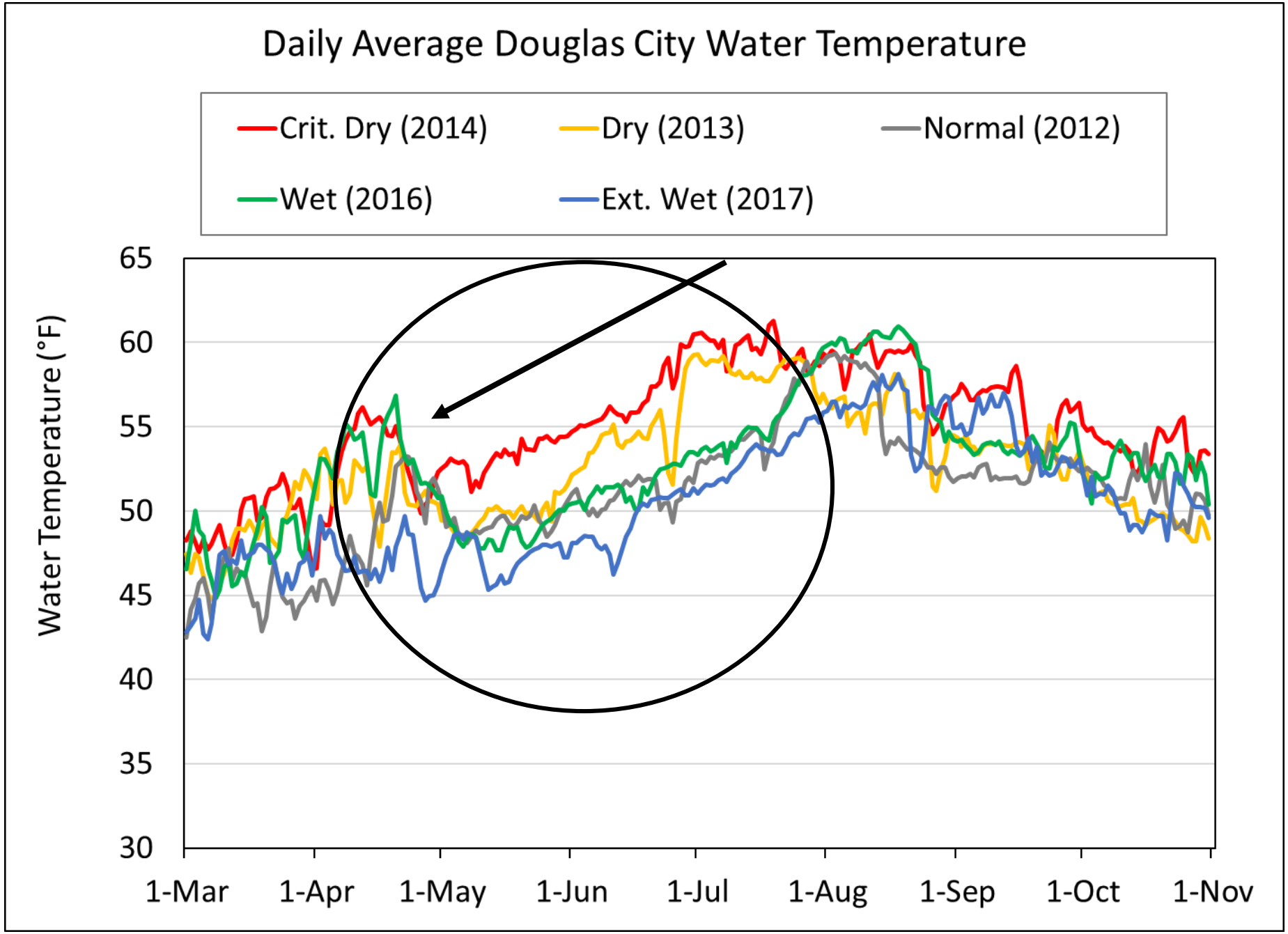
Current temperature targets (non-regulatory)

Table 1. Temperature thresholds for outmigration in the lower Trinity River from USFWS and HVT (1999).

Steelhead (May 22)	<55.4 °F in EW,W, N water years @ Weitchpec
	<59 °F in D, CD water years @ Weitchpec
Coho (June 4)	<59 °F in EW,W, N water years @ Weitchpec
	<62.6 °F in D, CD water years
Chinook (July 9)	<62.6 °F in EW,W, N water years
	<68 °F in D, CD water years

Shortcomings of current targets

- ***No temperature targets for rearing juvenile salmonids***
- Upper Trinity targets developed for holding adult Chinook Salmon
- Current temperature targets in the upper Trinity River lack ecological connection
- Temperature targets are expressed as “less than” a certain value (threshold), so extremely cold water temperatures meet the target
- Temperature targets for outmigrants are at Weitchpec, so the entire length of the Trinity River must always be colder than the targets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Oversummer growth and survival of juvenile coho salmon (Oncorhynchus kisutch) across a natural gradient of stream water temperature and prey availability: an in situ enclosure experiment.

PDF (827 K)
PDF-Plus (667 K)

Lusardi et al. 2019

Robert A. Lusardi, PhD, Bruce G. Hammock, Carson A. Jeffres, Randy A. Dahlgren, Joseph D Kiernan

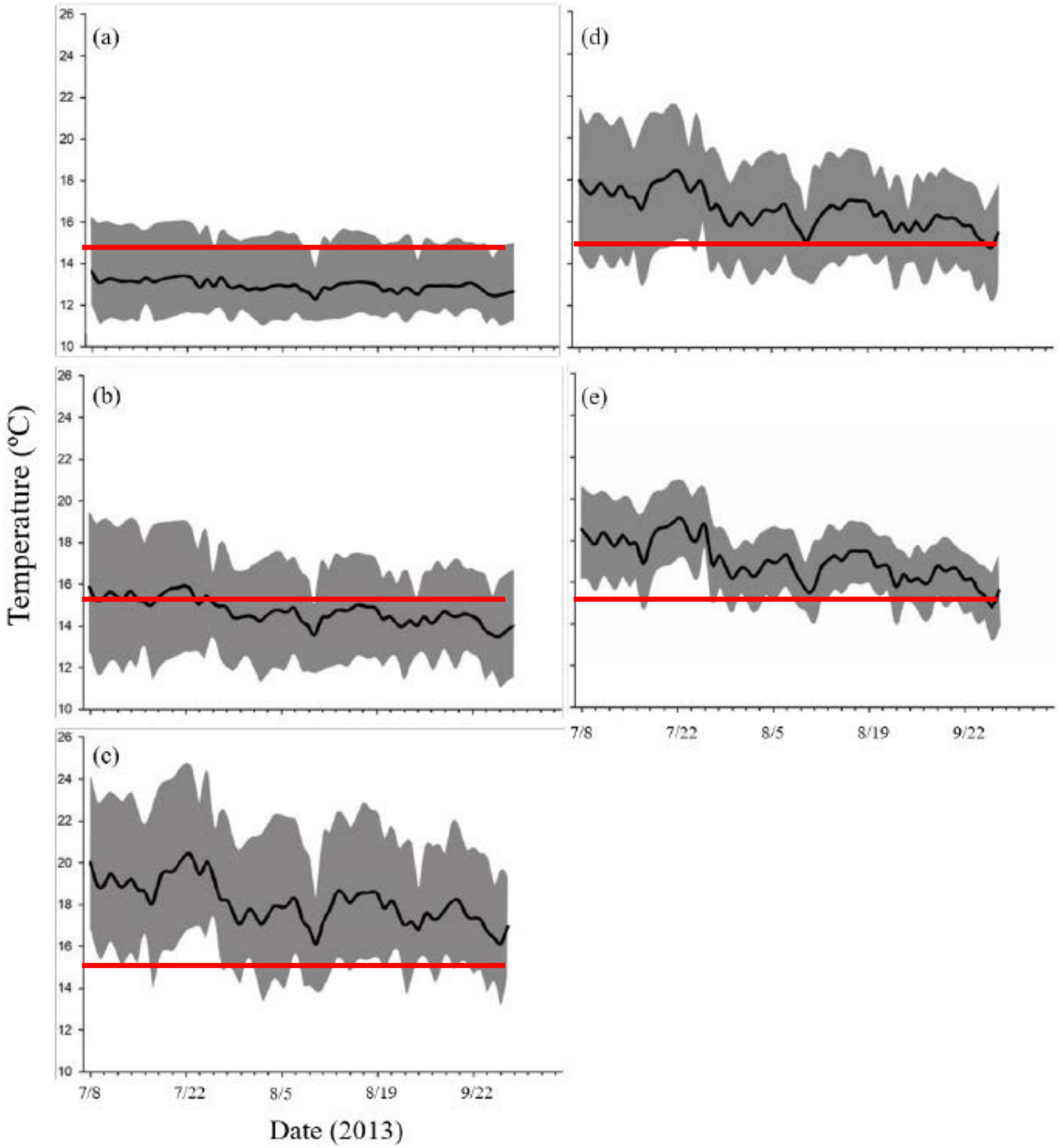
Published on the web 30 July 2019.

Received December 06, 2018.

Canadian Journal of Fisheries and Aquatic Sciences, https://doi.org/10.1139/cjfas-2018-0484

ABSTRACT

Conservation efforts for Pacific salmon (Oncorhynchus spp.) increasingly prioritize maintenance of cool water temperatures that protect all freshwater life stages. However, development of appropriate temperature standards requires a robust understanding of the interactions between water temperature, ecosystem productivity, and fish performance. We used a series of in situ enclosures to examine how natural spatiotemporal gradients in thermal conditions and prey availability affected the summer growth and survival of age-0+ coho salmon. Coho salmon absolute growth rates peaked at a mean daily average water temperature (mean T) of 16.6 ºC and an associated maximum weekly maximum temperature (MWMT) of 21.1 °C. Juvenile growth under these thermal conditions was six-fold greater than the growth rates observed for conspecifics rearing in the coolest study reach (mean T = 13.0 ºC; MWMT = 16.0 °C). Even at the highest

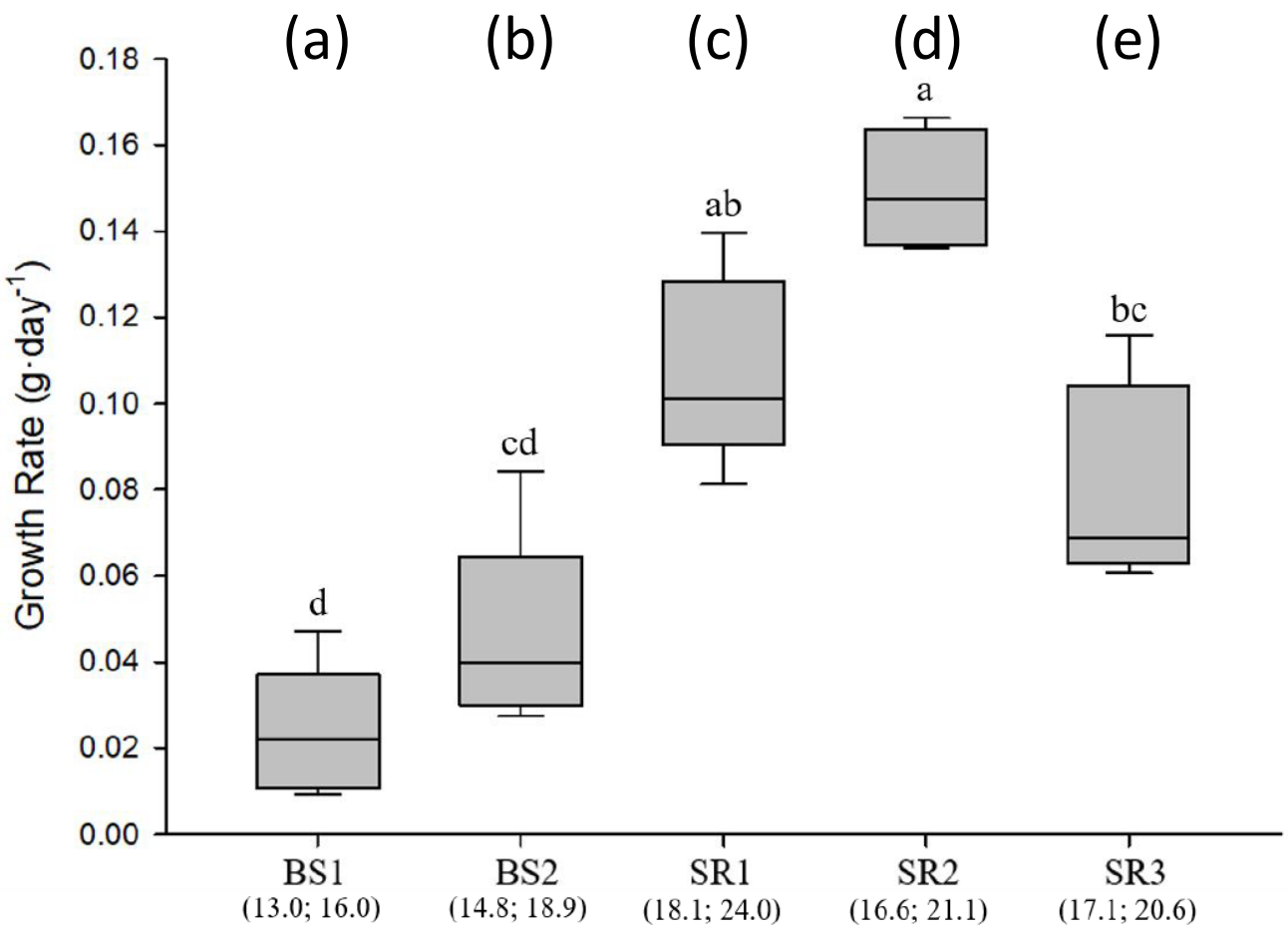


Lusardi et al. 2019

Water temperature (°C)

- Growth rate measured at 5 sites
- Invertebrate density, biomass and stream temperature monitored at each site
- Average temperature at coldest site (13.0°C, 55.4°F) similar, or greater than typical Lewiston Dam release temperatures

Lusardi et al. 2019
Growth



- Coho salmon absolute growth rates peaked at a mean daily average water temperature (mean T) of 16.6 °C.
- Of sites with similar invertebrate biomass (a, b, e), coldest site (a) had the lowest growth rate.
- Juvenile salmonid metabolism slows with decreasing stream temperature

Take Aways from Lusardi et al. 2019

- ***Colder is not better for juvenile salmonid growth!*** Biologists often forget this.
- Invertebrate density and abundance the top predictor in the model of juvenile growth rate.
- Temperature and food targets can be combined to optimize juvenile salmonid growth

Literature Review

The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stage

Implications for Klamath Basin TMDLs

Katharine Carter
Environmental Scientist
California Regional Water Quality Control Board
North Coast Region

August 2005

Oversummer growth and survival of juvenile coho salmon (Oncorhynchus kisutch) across a natural gradient of stream water temperature and prey availability: an in situ enclosure experiment.

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North American Journal of Fisheries Management 21:464–470, 2001

Distribution of Juvenile Coho Salmon in Relation to Water Temperatures in Tributaries of the Mattole River, California

HARTWELL H. WELSH, JR.,* GARTH R. HODGSON, AND BRET C. HARVEY

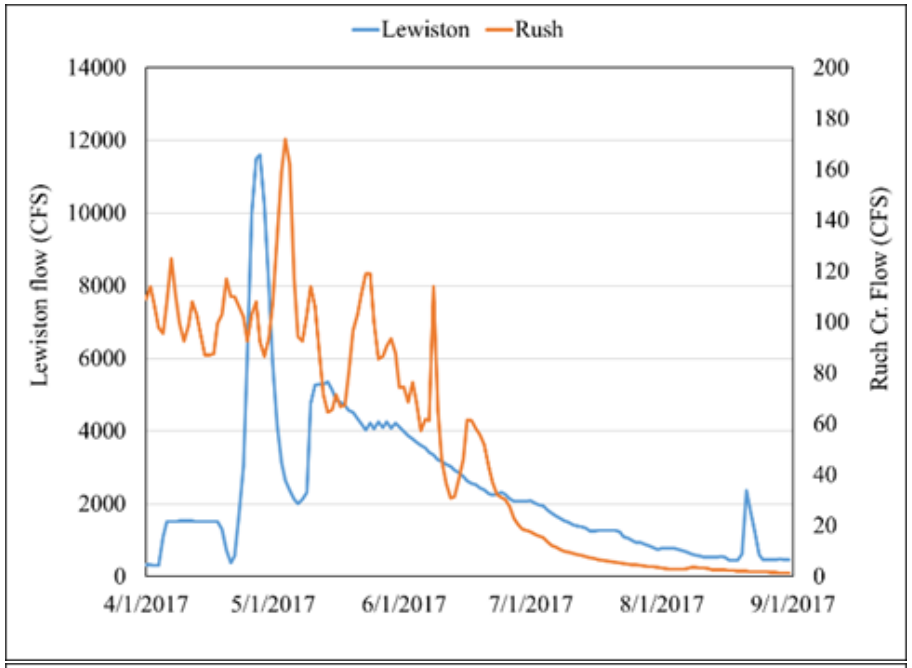
U.S. Forest Service, Pacific Southwest Research Station, Redwood Sciences Laboratory, 1700 Bayview Drive, Arcata, California 95521, USA

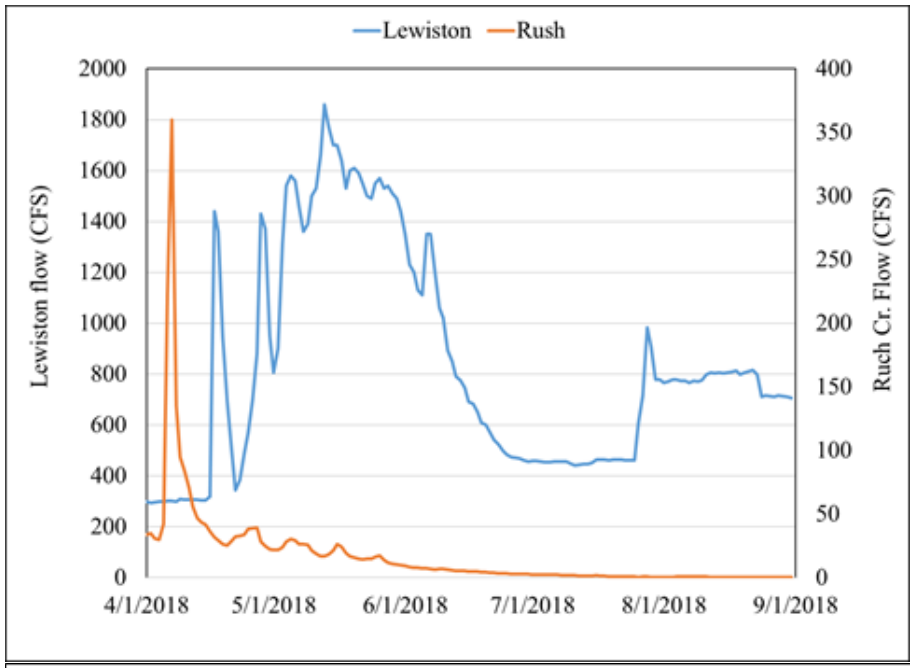
MAUREEN F. ROCHE

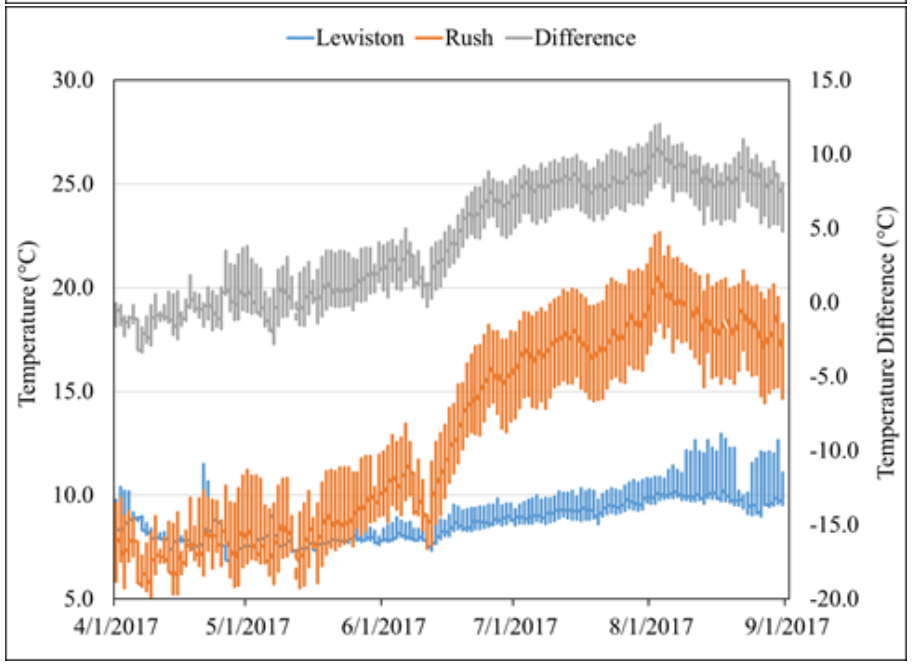
Mattole Salmon Group, Post Office Box 188, Petrolia, California 95558, USA

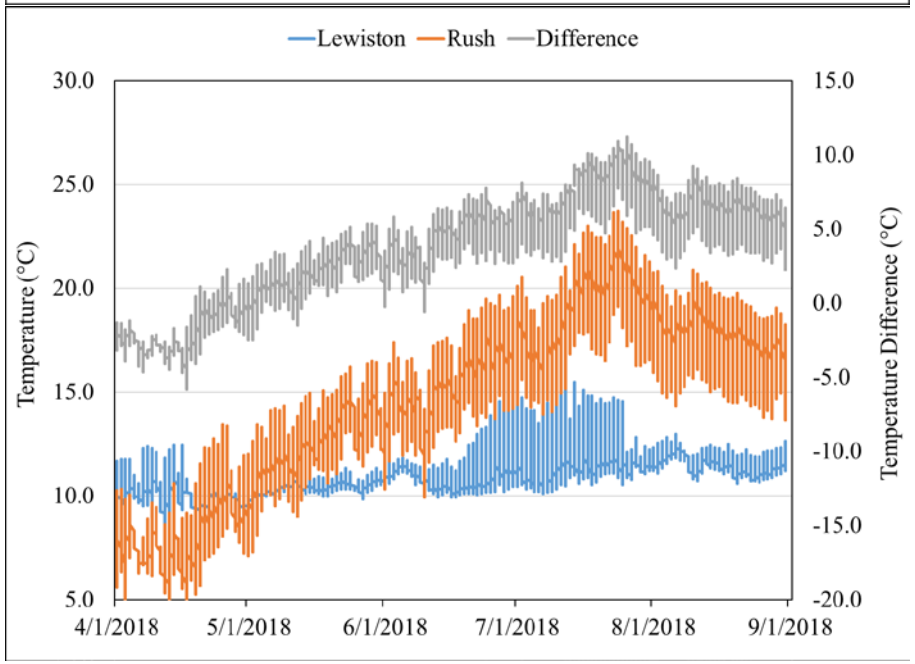
Abstract.—In an attempt to define the upper thermal tolerance of coho salmon *Oncorhynchus kisutch*, we examined the relationship between the presence of this species and the summer temperature regime in 21 tributaries of the Mattole River of northwestern California. We characterized the temperature regime of each tributary by determining the highest average of maximum daily temperatures over any 7-d period (maximum weekly maximum temperature, MWMT) and the highest average of mean daily temperatures over any 7-d period (maximum weekly average temperature MWAT), by the use of hourly measurements throughout the summer. Coho salmon presence was determined by divers in late summer. Both variables that were used to describe the temperature regime provided good-fitting models of the presence or absence of coho salmon in separate logistic regressions, and both correctly determined the presence or absence in 18 of 21 streams, given the previous probability of a 50% likelihood of coho salmon presence. Temperature regimes in the warmest tributaries containing juvenile coho salmon had MWMT of 18.0°C or less or MWAT of 16.7°C or less; conversely, all of the streams where MWMT was less than 16.3°C or MWAT was less than 14.5°C contained juvenile coho salmon. These results, combined with historical and current watershed conditions that affect stream temperatures, suggest that management strategies to restore and conserve coho salmon in the Mattole River drainage should focus on the water temperature regime. Such a focus is also likely to benefit other declining species

Upper Trinity River temps vs tributaries









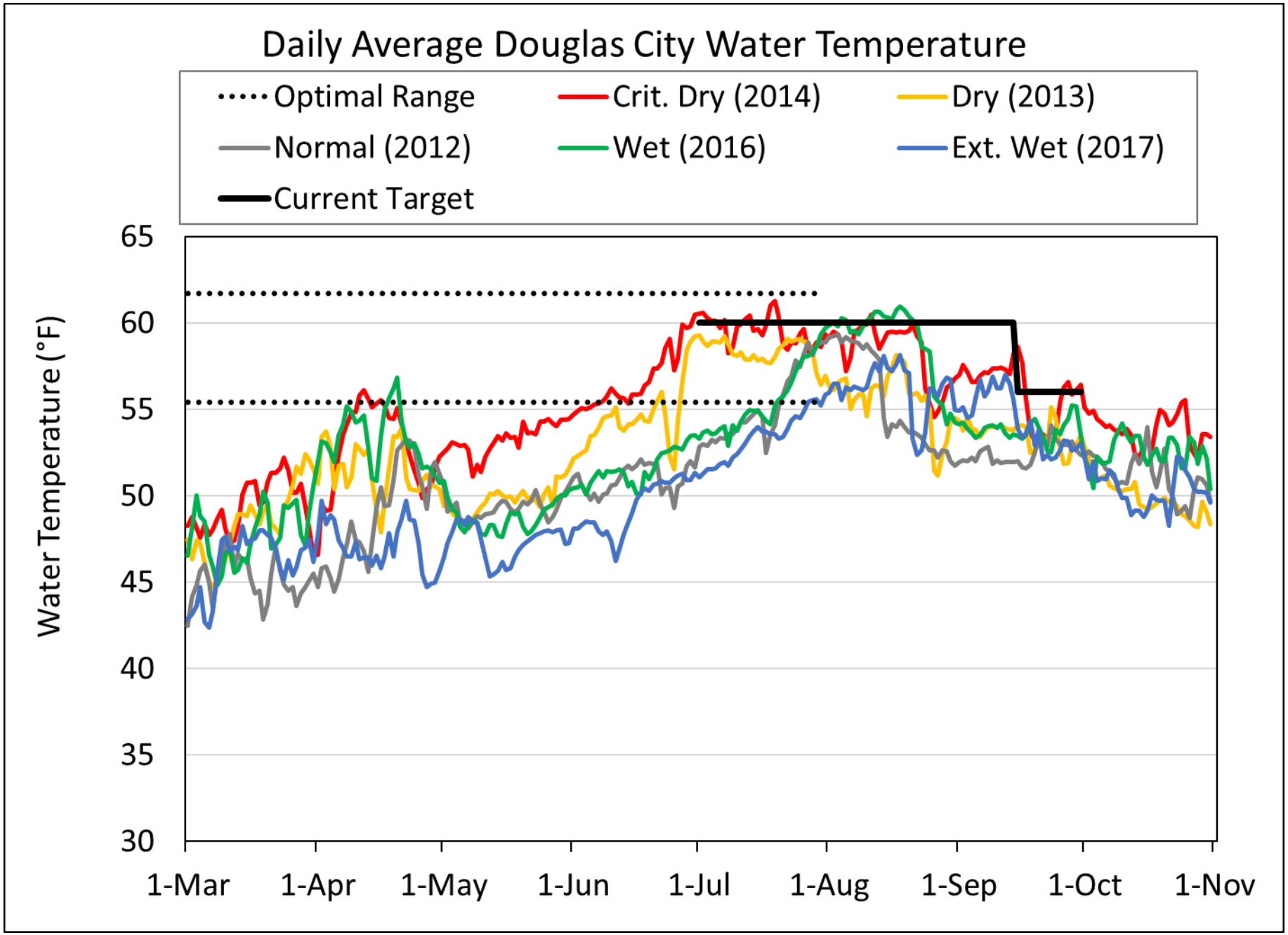
- 20°F difference!
- Much colder than historically
- Lacking ecological connection
- Impacting growth, migration, behavior?
- Possible hypothesis for Klamath outperforming Trinity?

Recommended new juvenile rearing targets

- 7DADA of 13°C to 16.5°C (Carter 2005; Welsh et al. 2001)

(55.4°F to 61.7°F)

- May through July
- Expressed as a range
- Consideration should be given to holding spring-run Chinook Salmon, incubating steelhead, etc.
- Model in S3
- Allow adult holding/migration targets to take over in August and reduce river temperatures
- Recommend more nuanced and complex temperature regime to bolster growth and survival
- Recommend a more natural flow regime, more flows in winter, not as much in spring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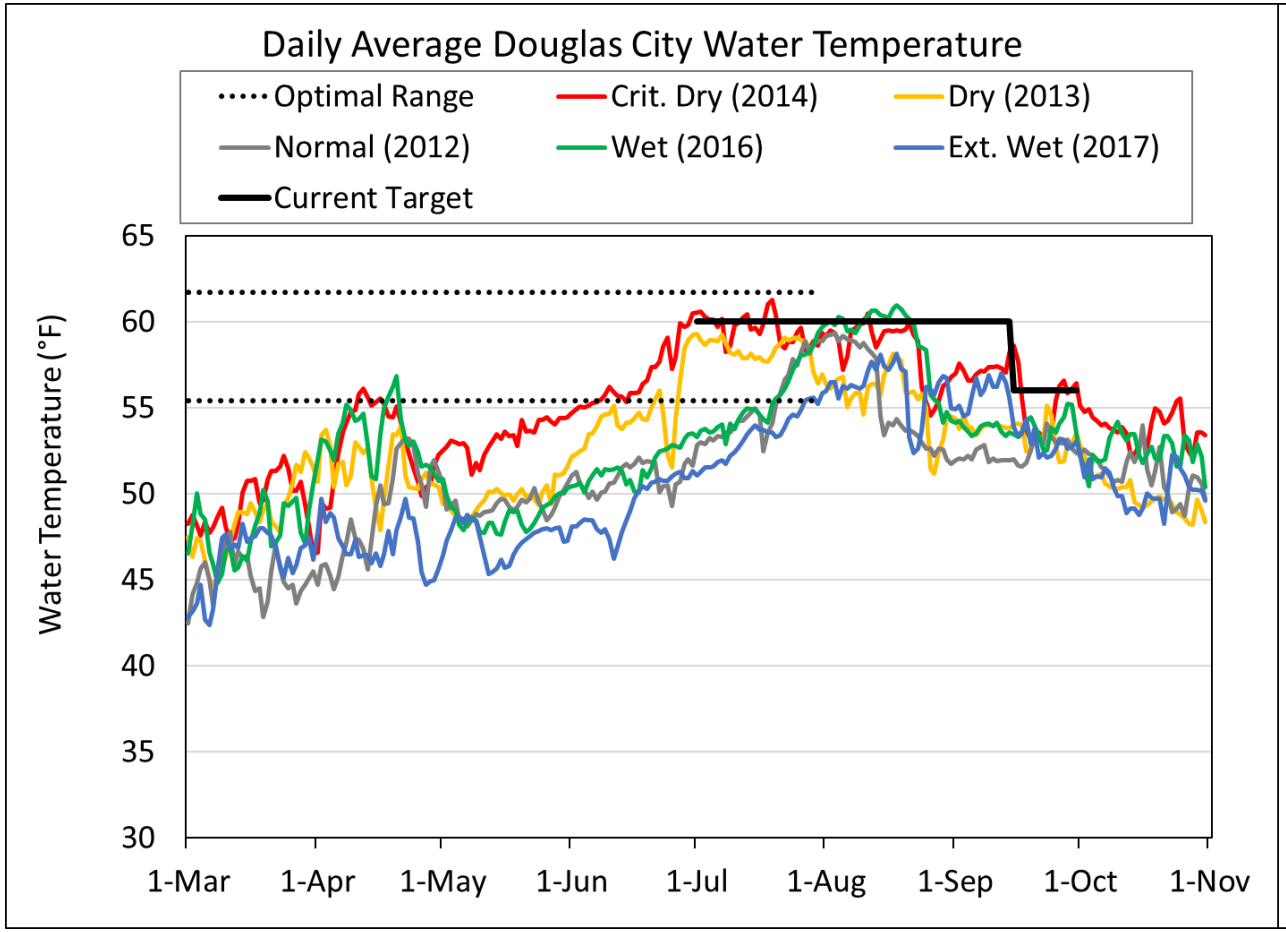
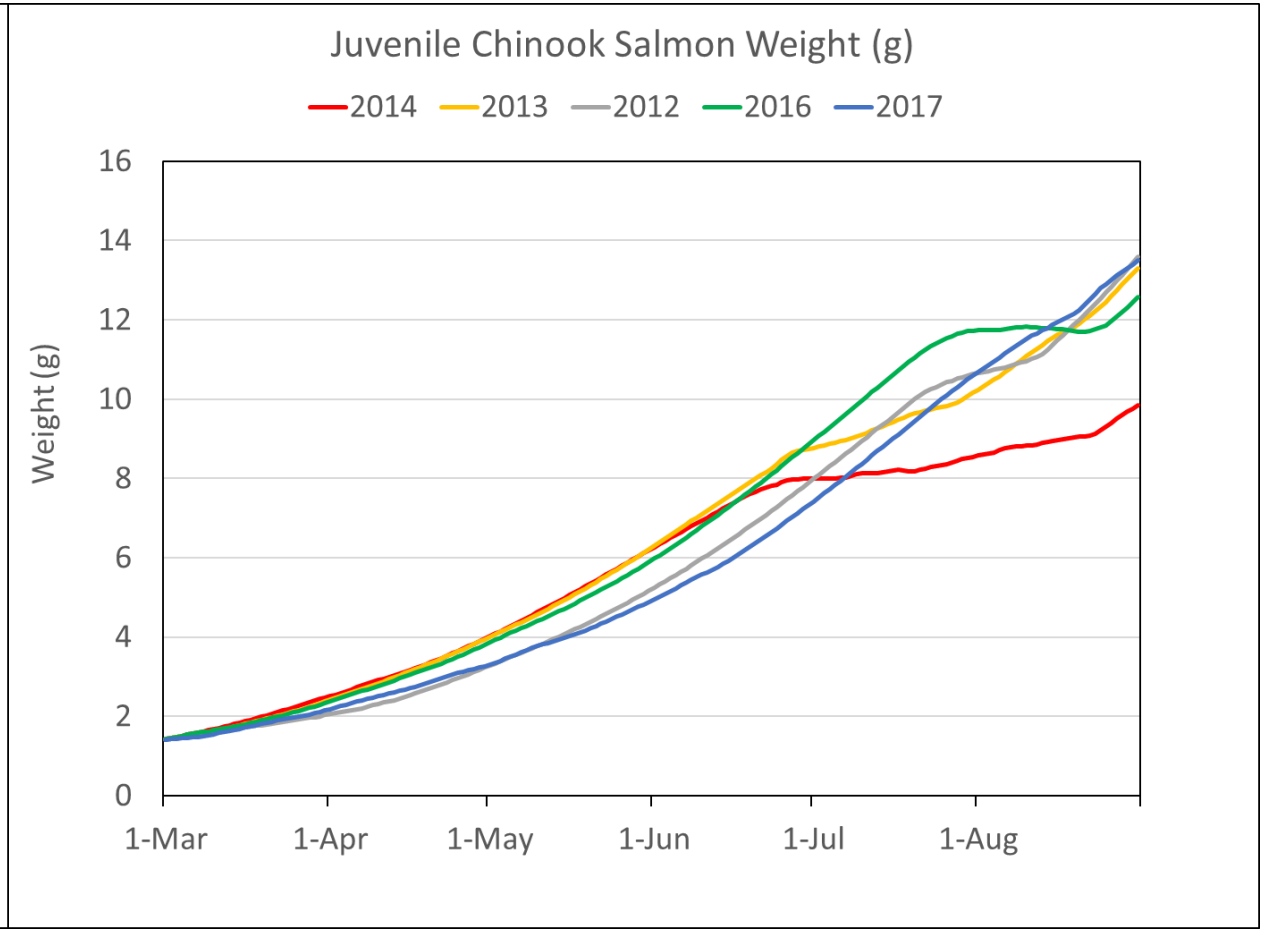
Water temperatures and modeled juvenile Chinook Salmon growth





Recommendations

- TRRP should adopt a juvenile salmonid rearing target (range)
- TRRP should develop invertebrate abundance target-top predictor of juvenile growth in model by Lusardi et al. 2019
- Combine with a juvenile rearing temperature target and invertebrate target to optimize growth in the spring