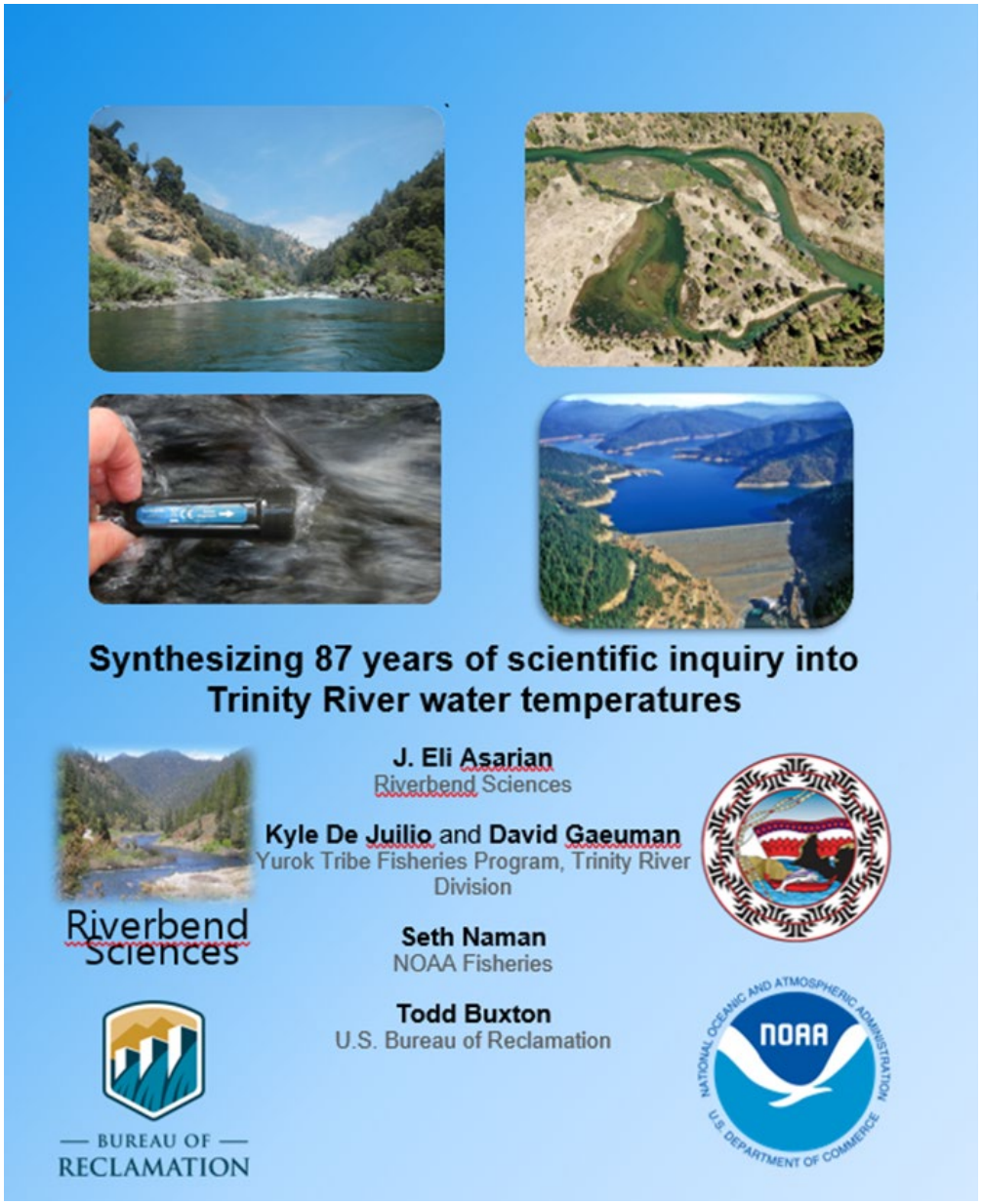
Temperature Synthesis Report



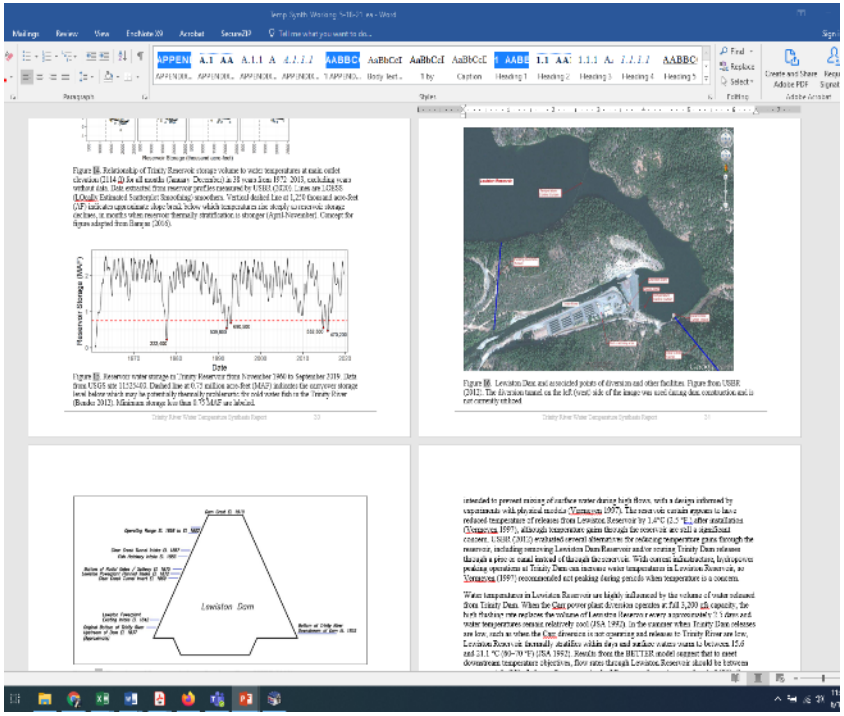
Trinity Management Council
June 16-17, 2021
Virtual Meeting

Seth Naman

Trinity River Restoration Program

Report Status

- Report in final author review
- Expected to enter TRRP/peer review in coming weeks
- Expected to be finalized following peer review in coming months



Report Status

Provisional

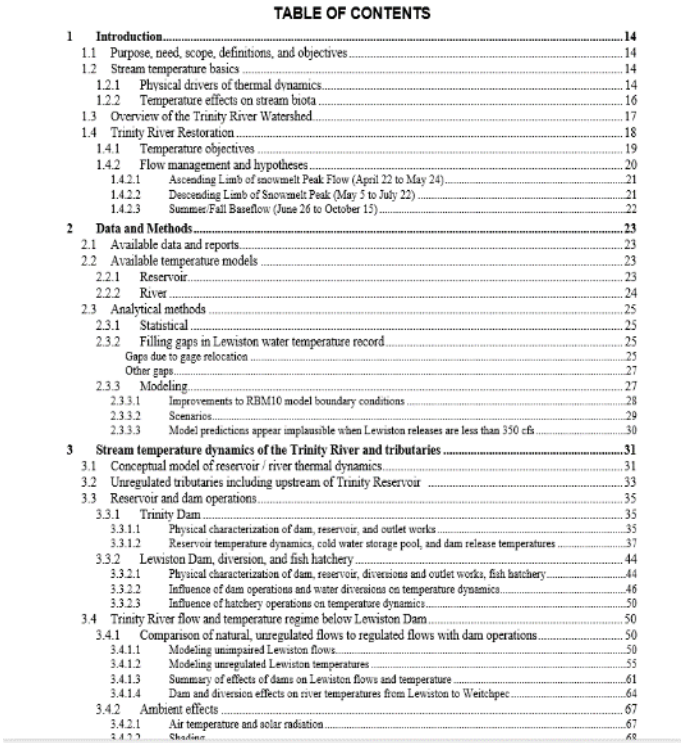
Do not cite

Report Objectives

- Compile a comprehensive quality-controlled water temperature dataset for analysis and archive it for future use;
- Evaluate patterns in the relationship between flow and temperature in space and time prior to the Trinity River Record of Decision (ROD);
- Evaluate how ROD flows have affected the thermal regime, temperature compliance, and biological objectives on the Trinity River;
- Evaluate temperature compliance across multiple years (pre-ROD and post-ROD);
- Update conceptual models on stream temperature dynamics in the Trinity River; and
- Develop management recommendations to provide water temperatures in the Trinity River that more efficiently meet objectives of the Trinity River Restoration Program (TRRP).

Report Generalities

- Approximately:
  - 220 pages overall
  - 180 pages of main body text
  - 40 pages of appendices
- Dozens of reports reviewed spanning decades
- Some datasets spanning over 100 years
- Hundreds of thousands of individual data records analyzed



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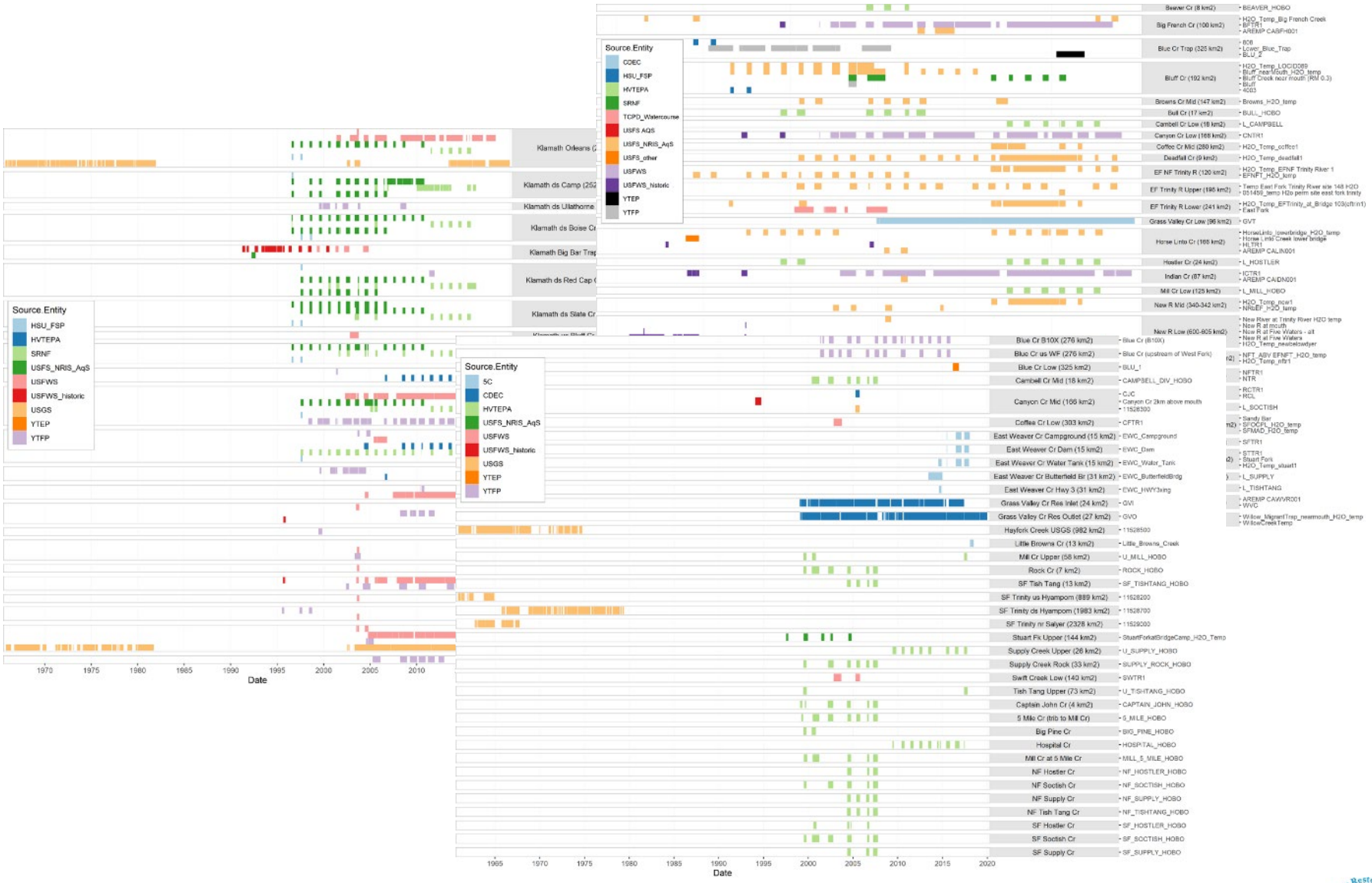
Methods

- Time separated into four eras
  - Pre-dam era (1911–1961)
  - Full diversion era (1963–1978)
  - Transitional era (1978–1999)
  - ROD era (1999–2019)
- Datasets gathered from
  - USFWS
  - USGS
  - USFS
  - Hoopa Tribe
  - Yurok Tribe
  - Others
- Statistical and modeling
  - RBM10
  - SRH-2D
  - Climate change models
  - Reservoir dynamics
  - Gap filling
  - Linear regression, linear mixed effects models, generalized additive models, and LOESS.

Methods


Source.Entity
HSU_FSP
HVTEPA
SRNF
USFS_NRIS_AqS
USFWS
USFWS_historic
USGS
YTEP
YTFP
Klamath Orleans (2
Klamath ds Camp (252
Klamath ds Ullathorne
Klamath ds Boise Cr
Klamath Big Bar Trap
Klamath ds Red Cap (
Klamath ds Slate Cr
1970
1975
1980
1985
1990
1995
2000
2005
2010
Date
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5C
CDEC
HVTEPA
USFS_NRIS_AqS
USFWS
USFWS_historic
USGS
YTEP
YTFP
Source.Entity
CDEC
HSU_FSP
HVTEPA
SRNF
TCPD_Watercourse
USFS AQS
USFS_NRIS_AqS
USFS_other
USFWS
USFWS_historic
YTEP
YTFP
Beaver Cr (8 km2)
BEAVER_HOBO
Big French Cr (100 km2)
H2O_Temp_Big French Creek
BFTR1
AREMP CABFH001
Blue Cr Trap (325 km2)
BLU_2
Bluff Cr (192 km2)
H2O_Temp_LOCID389
Bluff_near_Mouth_H2O_temp
Bluff Creek near mouth (RM 0.3)
Bluff
4003
Browns Cr Mid (147 km2)
Browns_H2O_temp
Bull Cr (17 km2)
BULL_HOBO
Cambell Cr Low (18 km2)
L_CAMPBELL
Canyon Cr Low (166 km2)
CNTR1
Coffee Cr Mid (280 km2)
H2O_Temp_coffee1
Deadfall Cr (9 km2)
H2O_Temp_deadfall1
EF NF Trinity R (120 km2)
H2O_Temp_EFNF Trinity River 1
EFNFT_H2O_temp
EF Trinity R Upper (195 km2)
Temp East Fork Trinity River site 148 H2O
051459_temp H2o perm site east fork trinity
EF Trinity R Lower (241 km2)
H2O_Temp_EFTrinity_at_Bridge 103(left:rt1)
East Fork
Grass Valley Cr Low (96 km2)
GVT
Horse Linto Cr (165 km2)
HorseLinto_lowerbridge_H2O_temp
Horse Linto Creek lower bridge
HLTR1
AREMP CALIN001
Hostler Cr (24 km2)
L_HOSTLER
Indian Cr (87 km2)
ICTR1
AREMP CAIDN001
Mill Cr Low (125 km2)
L_MILL_HOBO
New R Mid (340-342 km2)
H2O_Temp_new1
NRdEF_H2O_temp
New R Low (600-605 km2)
New River at Trinity River H2O temp
New R at mouth
New R at Pine Waters - alt
New R at Pine Waters
H2O_Temp_newbelowdyer
Blue Cr B10X (276 km2)
Blue Cr (B10X)
Blue Cr us WF (276 km2)
Blue Cr (upstream of West Fork)
NFT_ABV EFNFT_H2O_temp
Blue Cr Low (325 km2)
BLU_1
NFTR1
Cambell Cr Mid (18 km2)
CAMPBELL_DIV_HOBO
NTR
Canyon Cr Mid (166 km2)
CJC
Canyon Cr 2km above mouth
11526300
RCTR1
RCL
L_SOCTISH
Coffee Cr Low (303 km2)
CFTR1
Sandy Bar
SFOCFL_H2O_temp
SFMAD_H2O_temp
East Weaver Cr Campground (15 km2)
EWC_Campground
SFTR1
East Weaver Cr Dam (15 km2)
EWC_Dam
STTR1
East Weaver Cr Water Tank (15 km2)
EWC_Water_Tank
Stuart Fork
H2O_Temp_stuart1
East Weaver Cr Butterfield Br (31 km2)
EWC_ButterfieldBrdg
L_SUPPLY
East Weaver Cr Hwy 3 (31 km2)
EWC_HWY3xing
L_TISHTANG
Grass Valley Cr Res Inlet (24 km2)
GVI
AREMP CAWVR001
WVC
Grass Valley Cr Res Outlet (27 km2)
GVO
Willow_MigrantTrap_nearmouth_H2O_temp
WillowCreekTemp
Hayfork Creek USGS (982 km2)
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Little Browns Cr (13 km2)
Little_Browns_Creek
Mill Cr Upper (58 km2)
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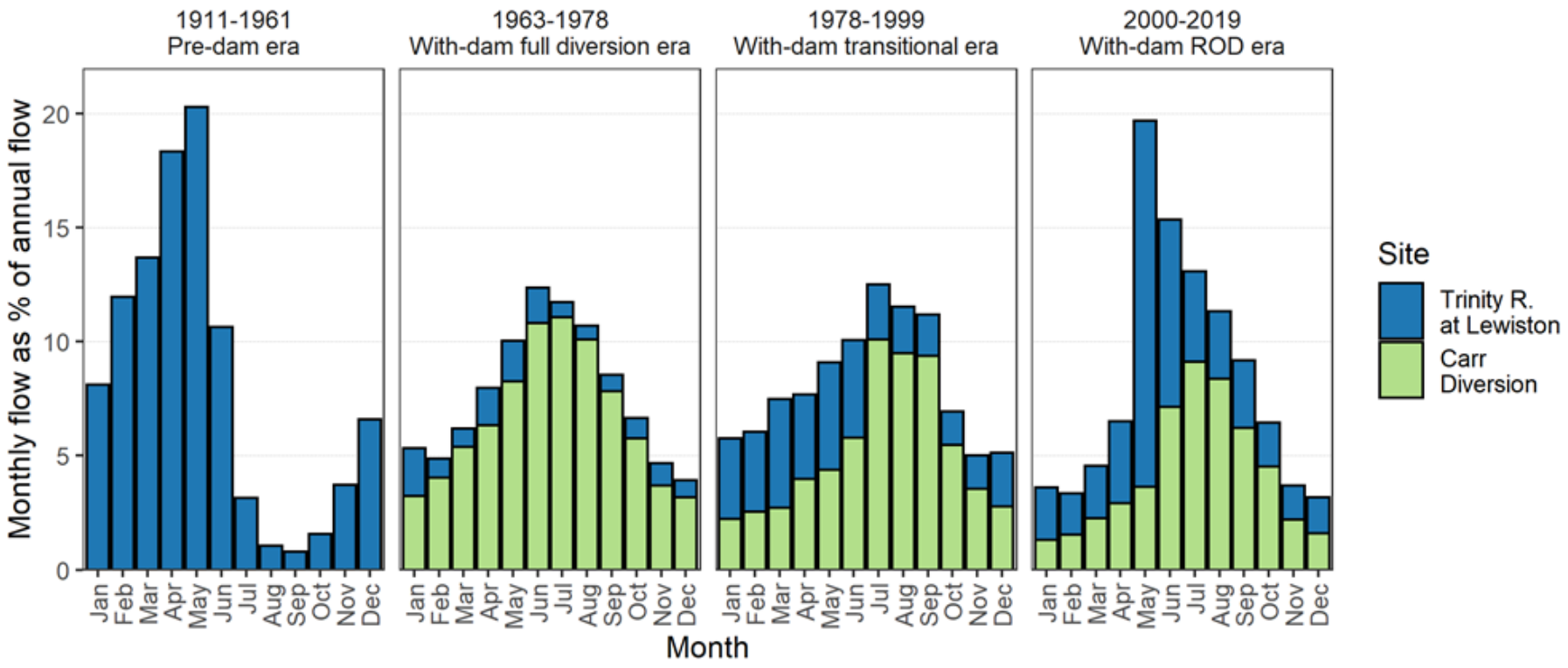
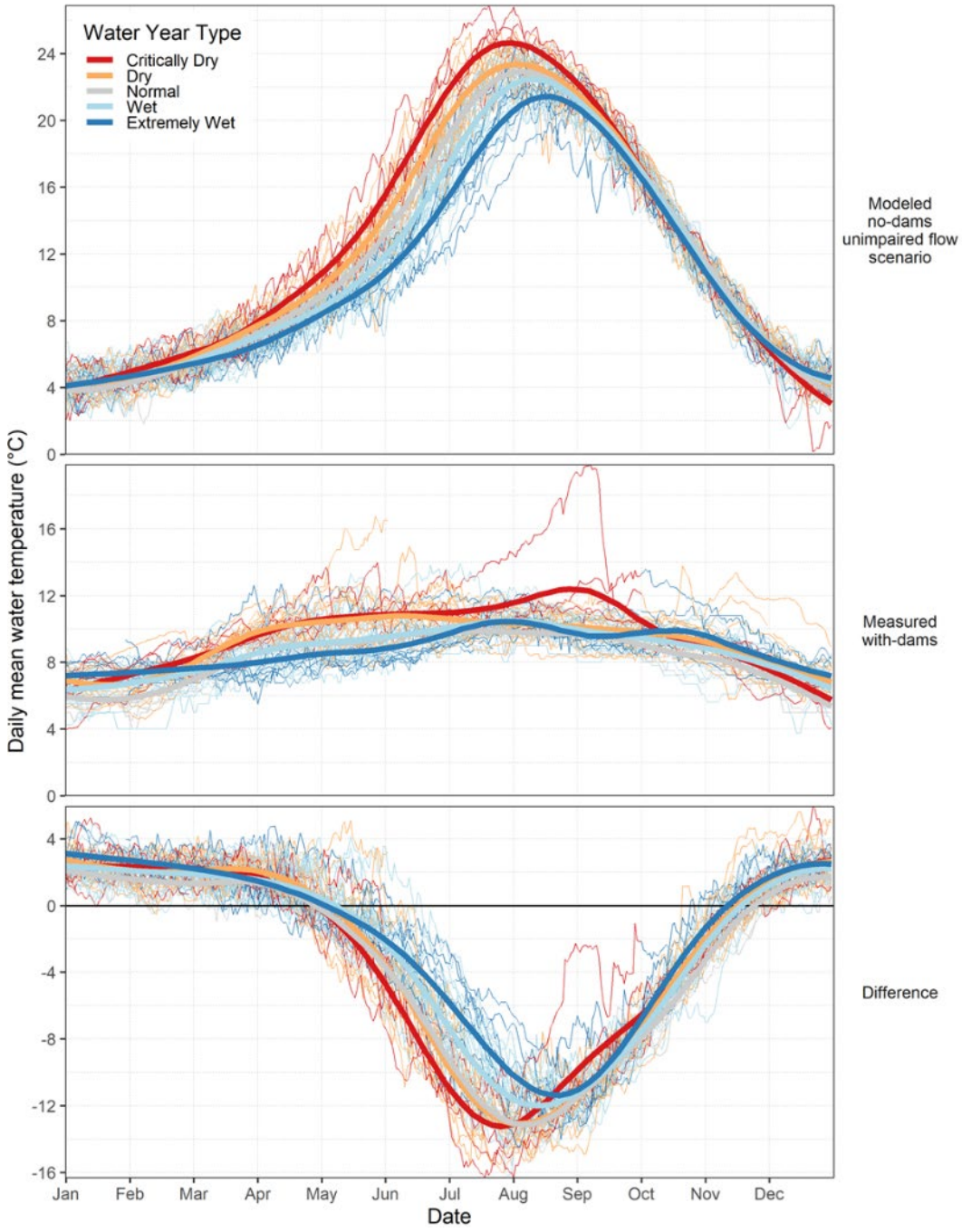
Rock Cr (7 km2)
ROCK_HOBO
SF Tish Tang (13 km2)
SF_TISHTANG_HOBO
SF Trinity us Hyampom (889 km2)
11528200
SF Trinity ds Hyampom (1983 km2)
11528700
SF Trinity nr Salyer (2328 km2)
11529000
Stuart Fk Upper (144 km2)
StuartForkatBridgeCamp_H2O_Temp
Supply Creek Upper (26 km2)
U_SUPPLY_HOBO
Supply Creek Rock (33 km2)
SUPPLY_ROCK_HOBO
Swift Creek Low (140 km2)
SWTR1
Tish Tang Upper (73 km2)
U_TISHTANG_HOBO
Captain John Cr (4 km2)
CAPTAIN_JOHN_HOBO
5 Mile Cr (trib to Mill Cr)
5_MILE_HOBO
Big Pine Cr
BIG_PINE_HOBO
Hospital Cr
HOSPITAL_HOBO
Mill Cr at 5 Mile Cr
MILL_5_MILE_HOBO
NF Hostler Cr
NF_HOSTLER_HOBO
NF Soctish Cr
NF_SOCTISH_HOBO
NF Supply Cr
NF_SUPPLY_HOBO
NF Tish Tang Cr
NF_TISHTANG_HOBO
SF Hostler Cr
SF_HOSTLER_HOBO
SF Soctish Cr
SF_SOCTISH_HOBO
SF Supply Cr
SF_SUPPLY_HOBO
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Date

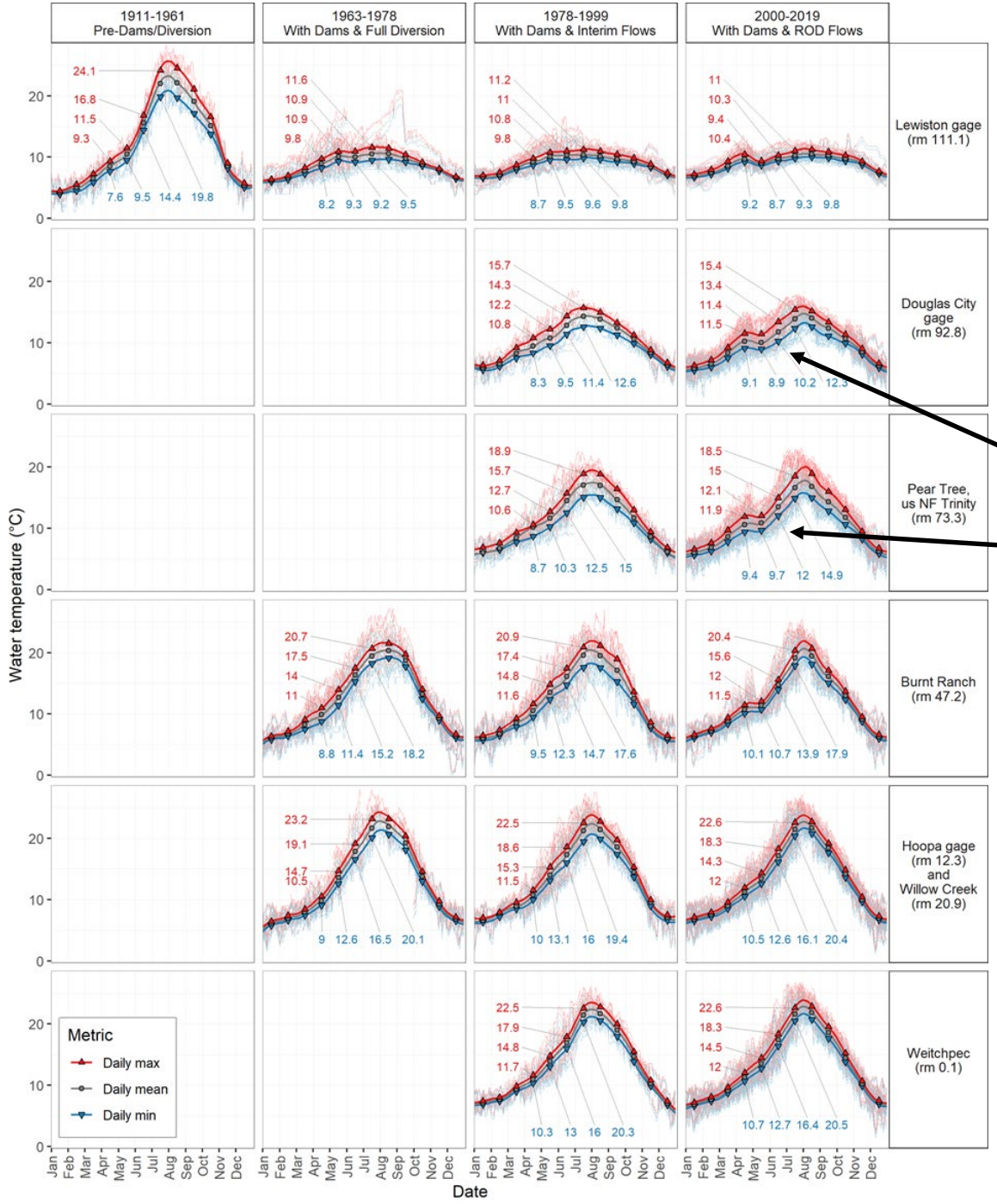
Results-Flows



Results- Temperatures



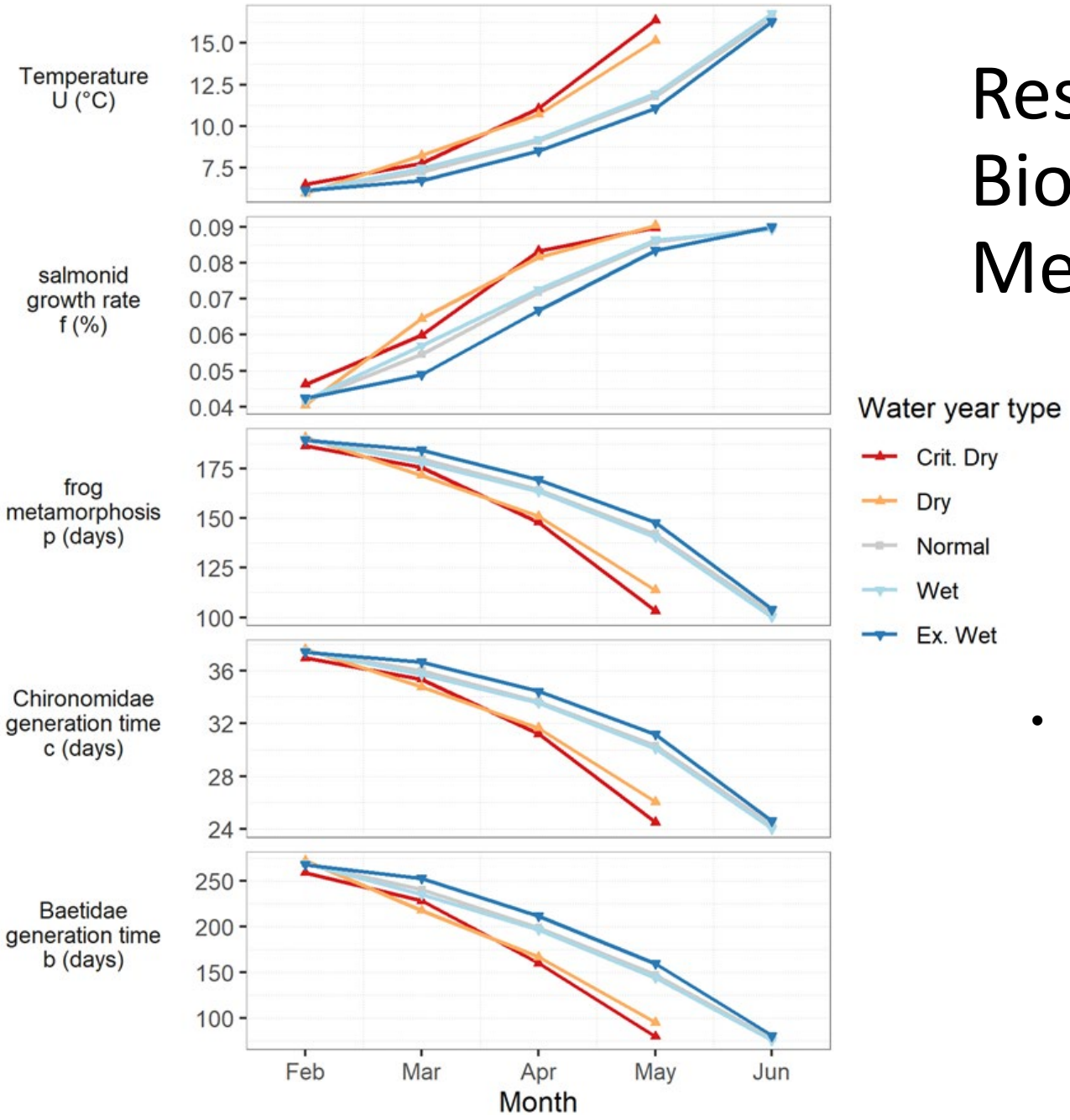
- With dams, water temperatures are warmer in the winter, and colder in the summer



Results- Temperatures

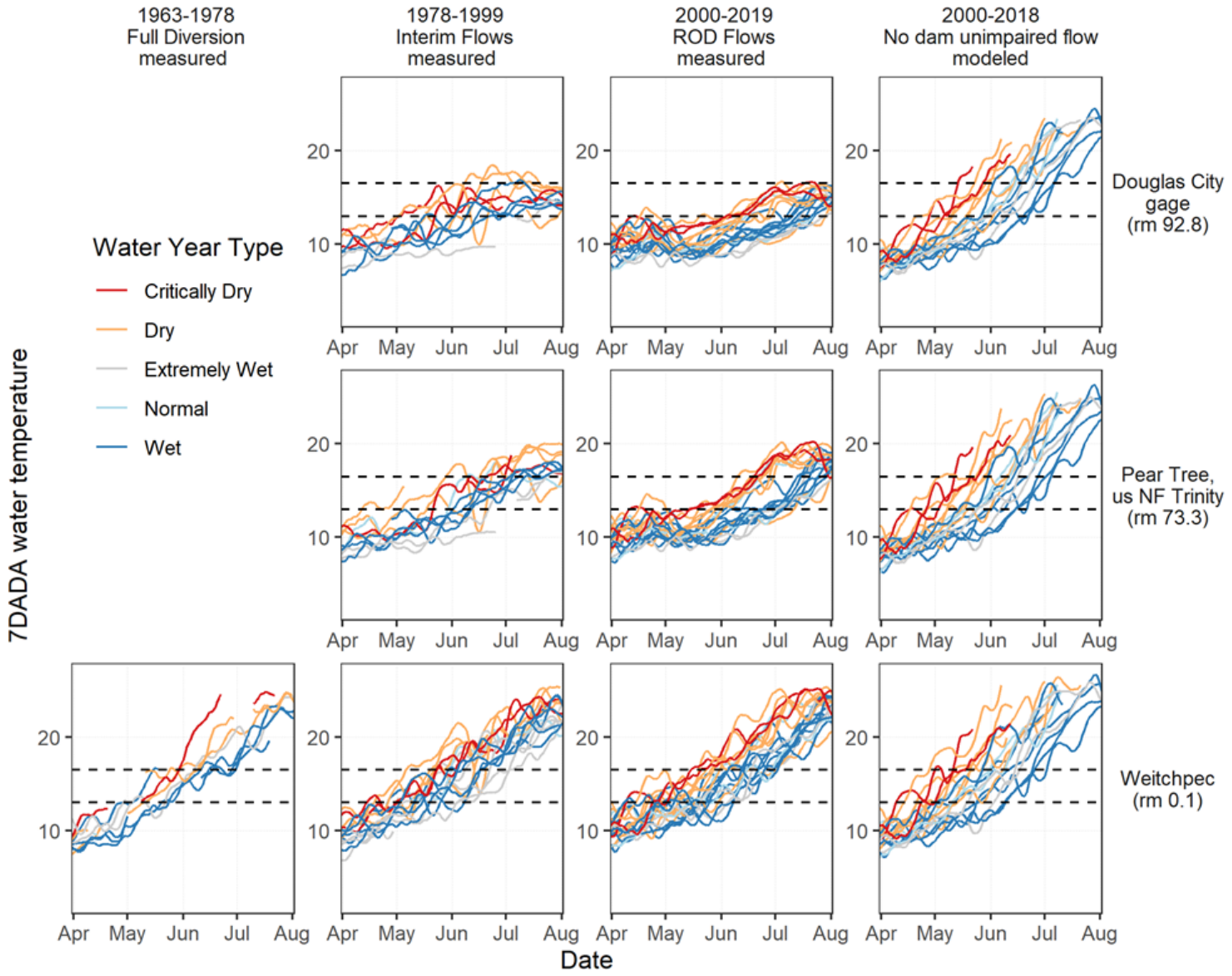
- ROD flows have resulted in a “kink” in normal warming patterns in the spring

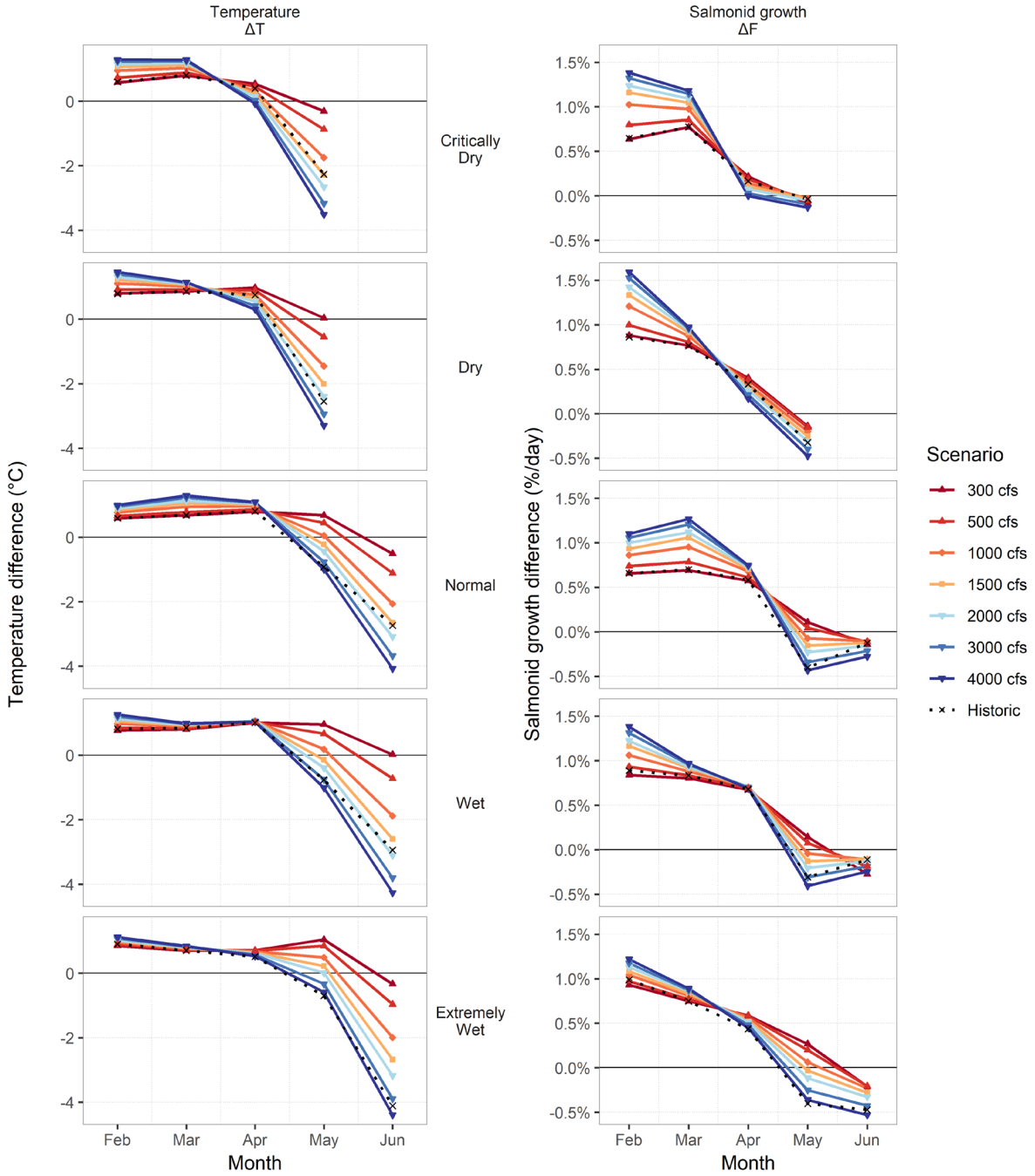
Results- Biological Metrics



- Colder temperatures reduce salmonid growth rate, increase invertebrate generation time, and increase frog metamorphisis time

Results-Salmonid Growth

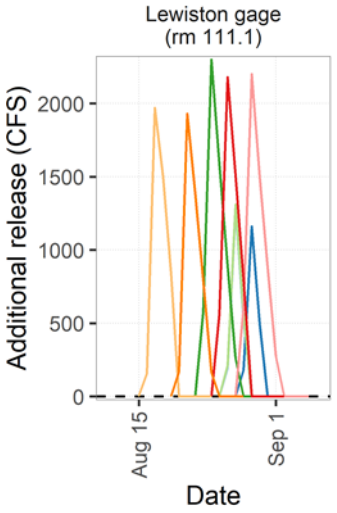


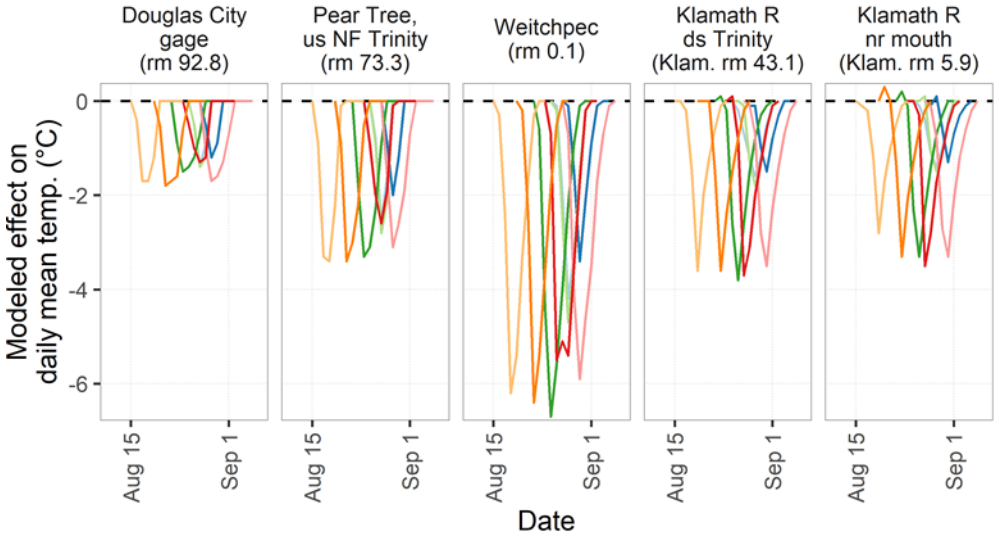


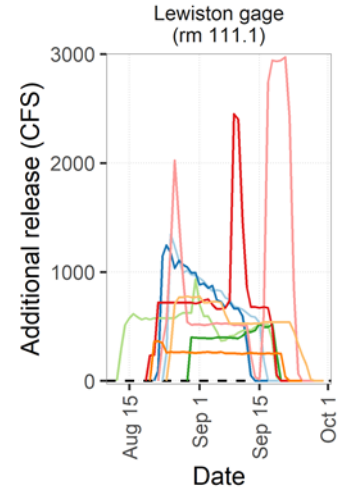
Results- Salmonid Growth

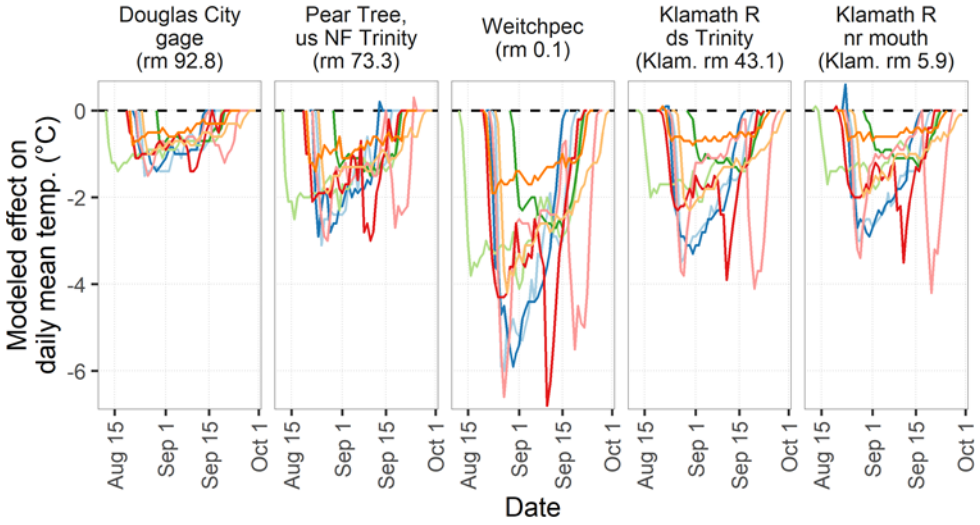
- Greater flows in the winter months and lower flows in the spring result in greater salmonid growth
- In part a function of flows and stratification from Trinity Reservoir

Results-Ceremonial and Adult Salmonid Fall Flow Releases

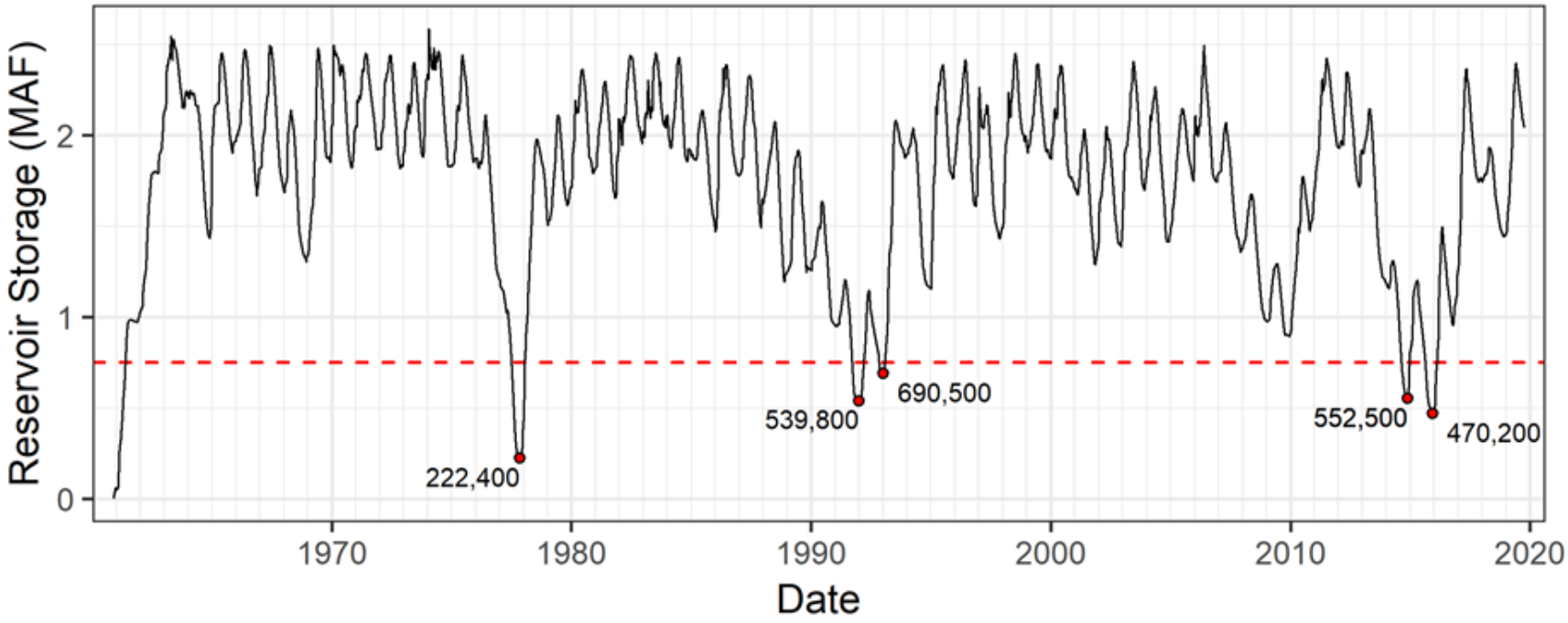




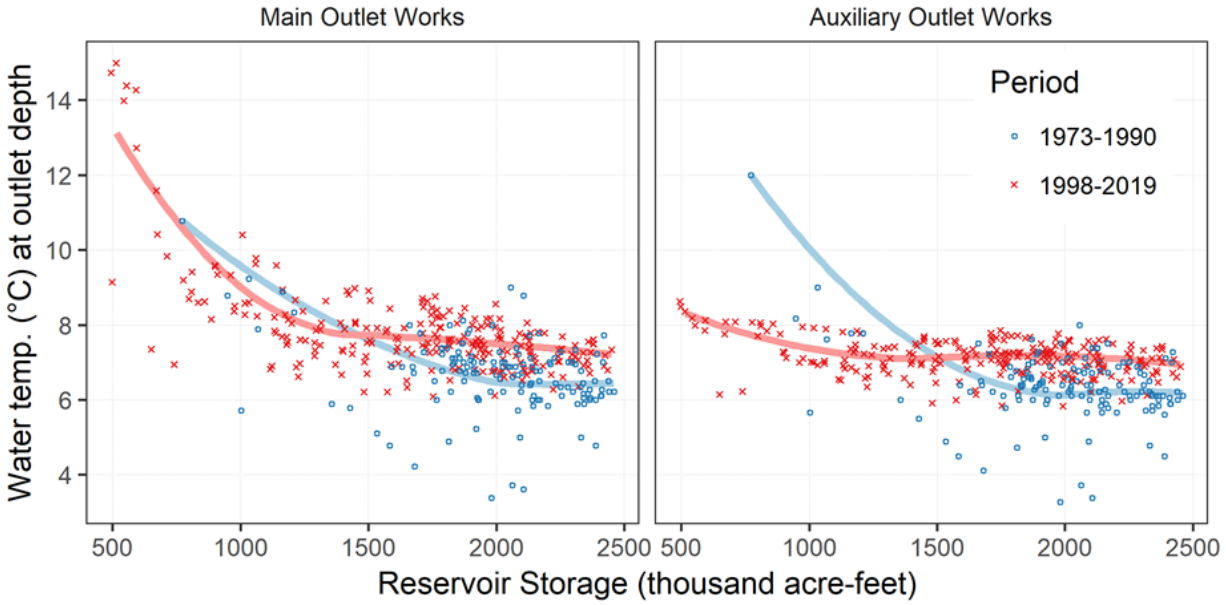


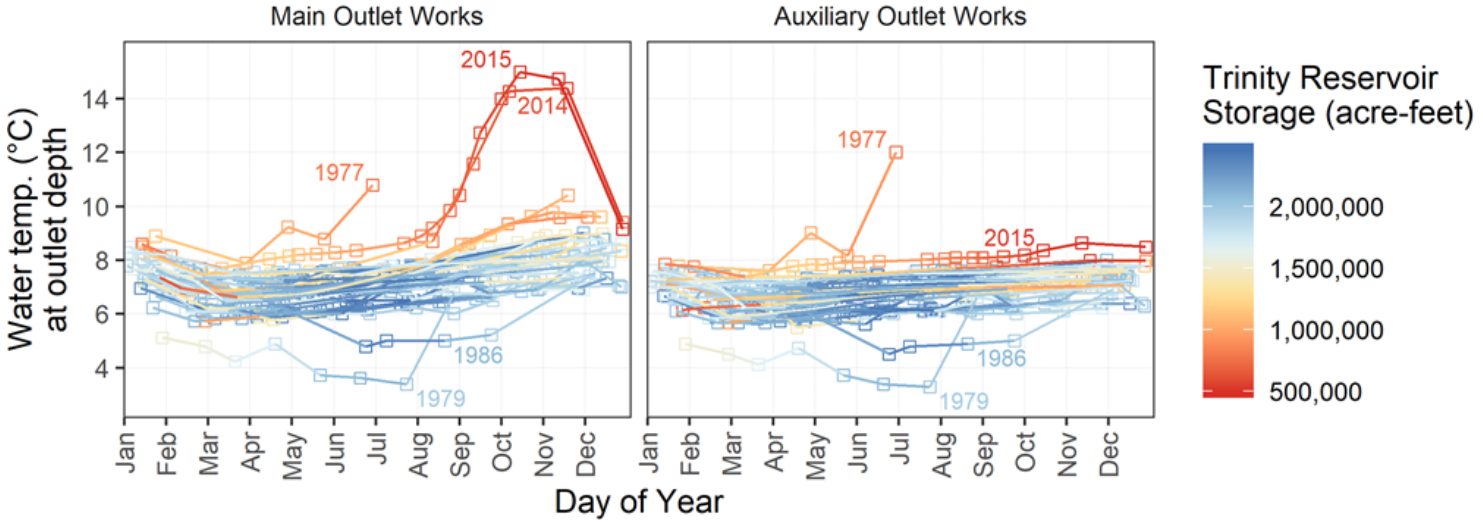


Results-Trinity Reservoir

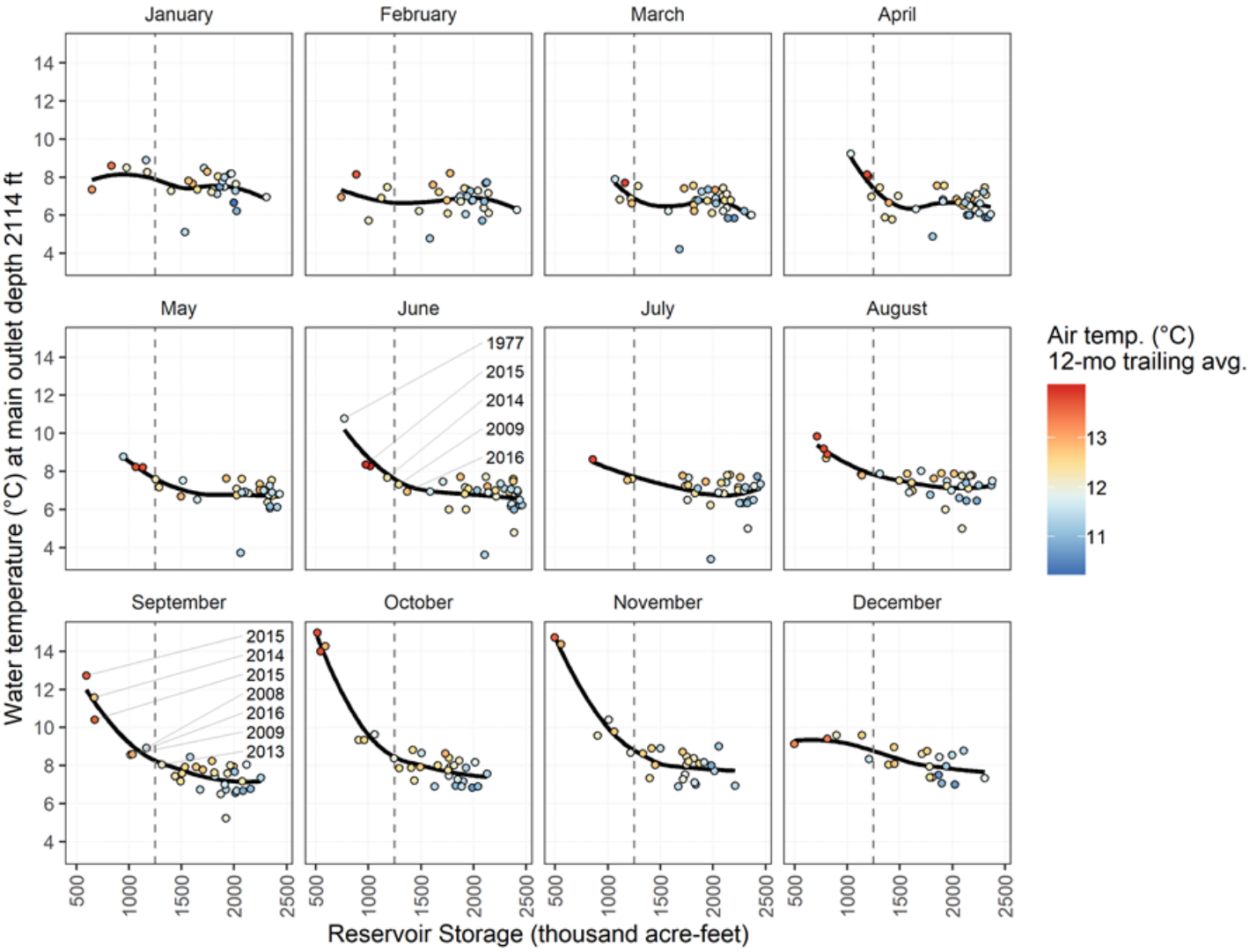


Results-Trinity Reservoir

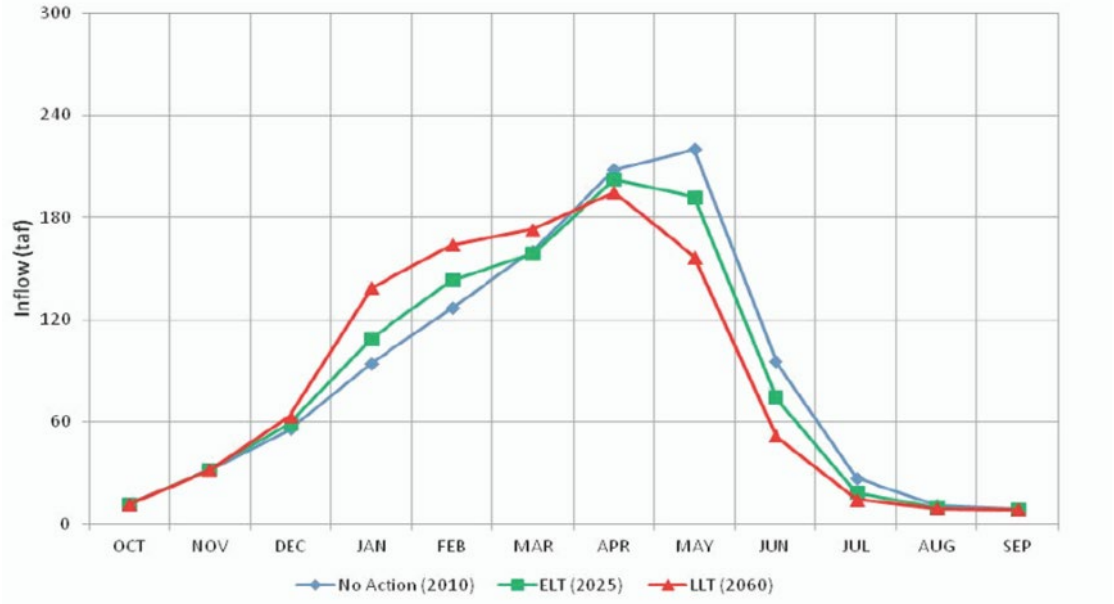


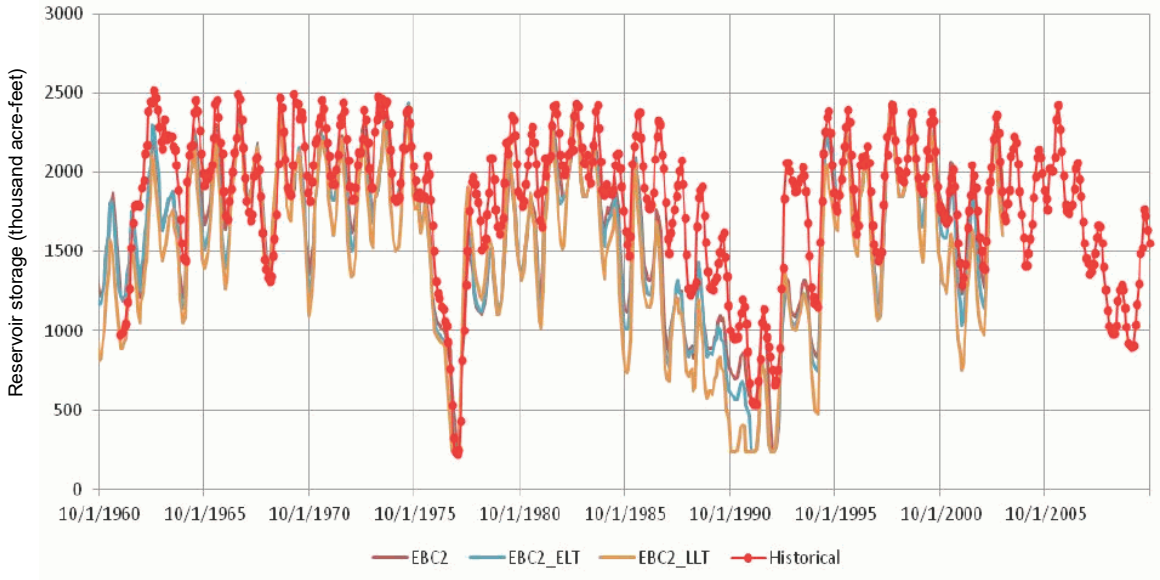


Results-Trinity Reservoir



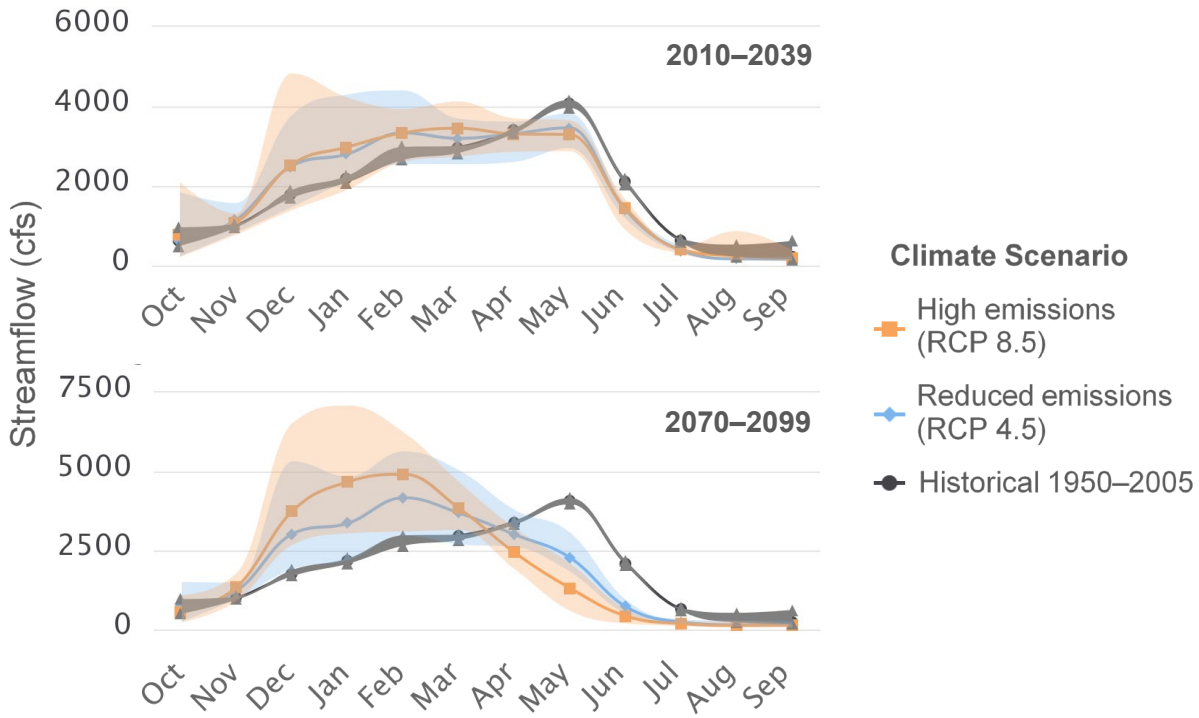
Results-Climate Change





Under a high-emissions scenario, average snow water equivalent in areas above 3,000 ft elevation is predicted to decline from 11.6 inches in 1981-2010 to 4.3 inches in 2040-2069 and 1.6 inches in 2070-2099 (Micheli et al. 2018).

Results-Climate Change



For the Salmon River watershed (Asarian et al. 2019) predicted that in the 2070–2099 period, mean daily maximum August stream temperatures will be warmer than the 1990–2017 baseline by 0.9–2.0°C under the reduced-emission RCP4.5 scenario or 1.7–3.3°C under the high-emission RCP8.5 scenario

Major Findings

- ROD flows have reduced spring temperatures to be less than pre-dam and pre-ROD scenarios, affecting biological processes
- Flows and temperatures from Lewiston Dam cannot be manipulated separately in an effective manner (aside from reservoir storage and diversion rate)
    - Forces spring ROD flows to be colder than optimal rearing temperatures for salmonids
    - Increases production time for important invertebrate food sources for salmonids
    - Coldwater pool cannot be maximized
- Trinity Reservoir temperatures appear to be warming
- Meeting temperature objectives in the fall for returning adult salmonids and eggs will become more challenging in the future, without infrastructure changes

Recommendations

1. Monitor temperatures in the Trinity River upstream of Trinity Lake to more fully understand the natural temperature regime and its effects on water temperatures in Trinity Reservoir.
2. Until a TCD can be installed in Trinity Reservoir and/or other infrastructure changes, flows in spring months should recede beginning in April of Dry and Critically Dry and in May of Normal and wetter years for optimal juvenile salmonid growth (13-18 °C).
3. Reduce emphasis on meeting ROD temperature targets for smoltification at Weitchpec. Instead, balance between growth, encouraging timely outmigration, and mitigating temperatures in the lower river as they approach the thermal limits of juvenile salmonids.
4. Infrastructure of the TRD should be modified to enable flow and temperature management actions to be implemented for the benefit of the river ecosystem, including:
    a. Installation of a multi-level temperature control device in Trinity Reservoir;
    b. Removal of Lewiston Dam, or a new type of conveyance through or around Lewiston; and
    c. Ability to vary dam releases to the river at two-hour intervals without negatively impacting infrastructure at Lewiston Dam.

Recommendations continued

5. End of September storage minimum of 0.75 million acre-feet (MAF) should be adhered to following the recommendations of Bender (2012), and multi-year drought contingency planning that specifies steps taken when reservoir storage is predicted to be less than 1.25 MAF in any year, assuming a multi-year drought is possible at any time.

6. An assessment of multiyear drought effects on Trinity Reservoir storage levels, water temperatures, and the resulting ability to meet temperature criteria in the Trinity River should be conducted.

7. Development of a tool for accurately predicting Trinity River water temperatures in summer at flows lower than RBM10's current limit of approximately 350 cfs.

Thank you!

- USFWS
- USGS
- USFS
- Hoopa Tribe
- Yurok Tribe
- Reclamation
- Other collaborators