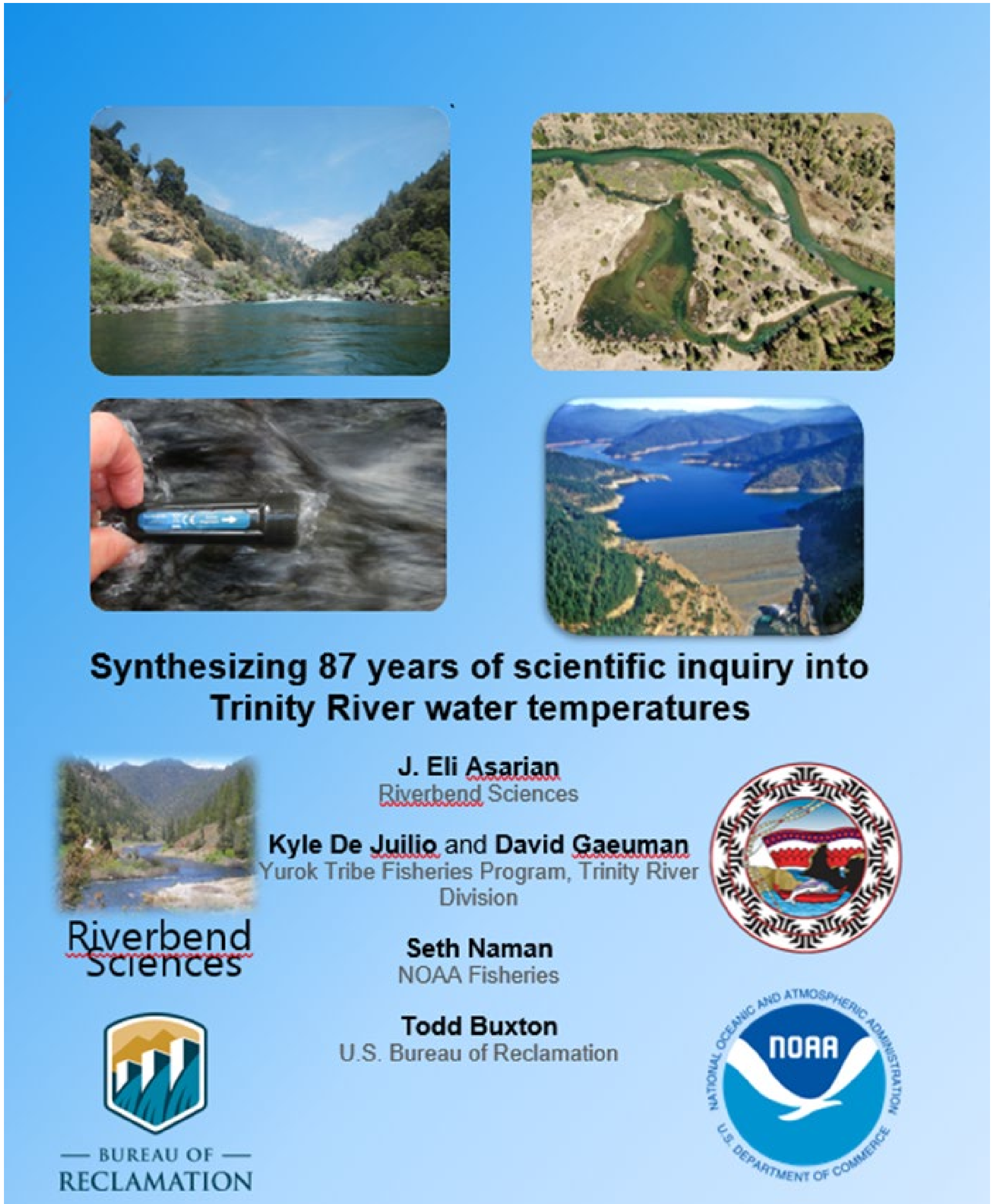
Temperature Synthesis Report



Trinity River Science Symposium

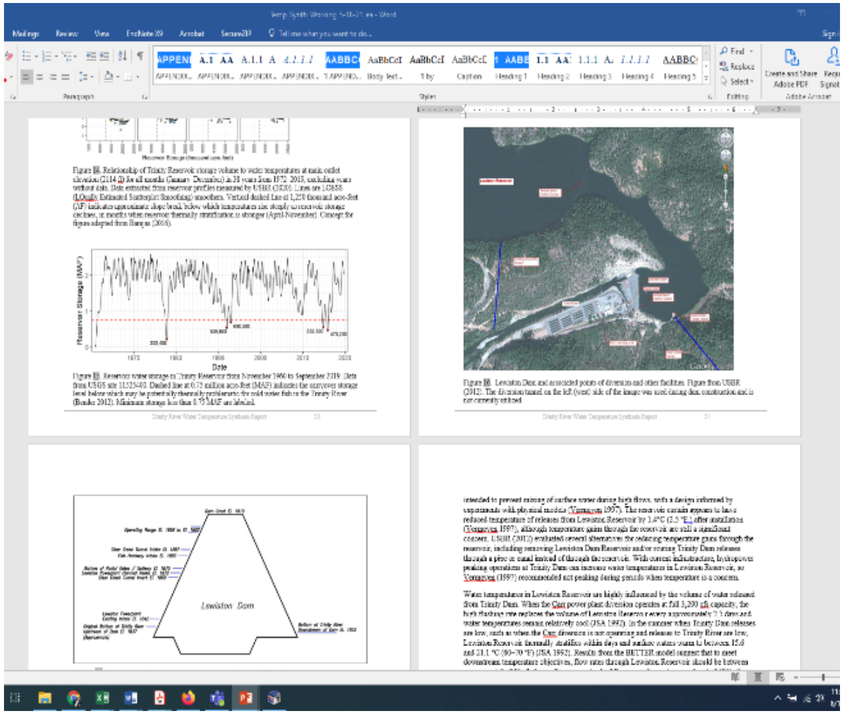
December 2, 2021

Seth Naman

Trinity River Restoration Program

Report Status

- Report in peer review
- Expected to be finalized following peer review in coming months



Report Status

Provisional
Do not cite

Report Objectives

- Construct and populate 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

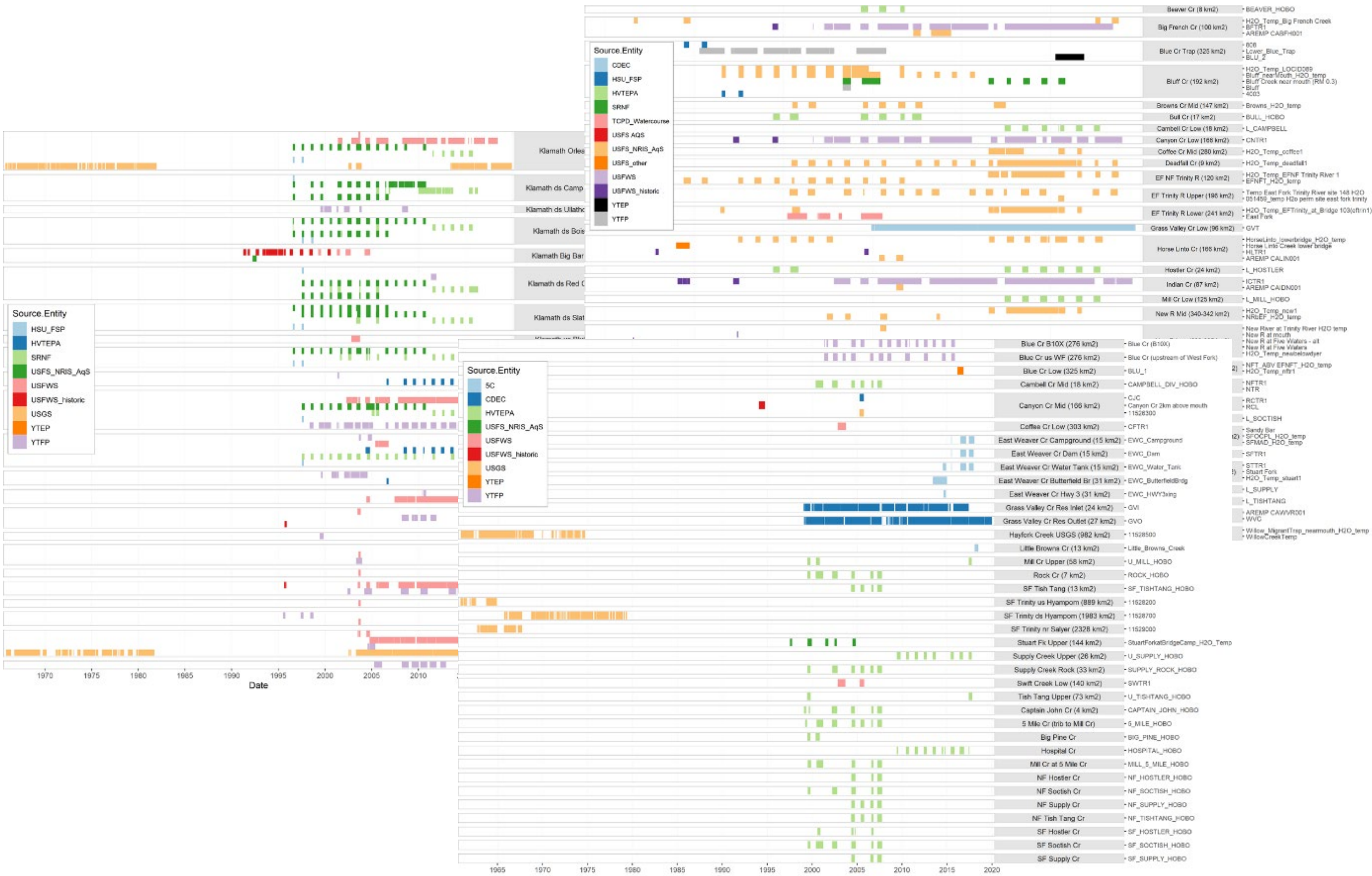
- Approximately:
  - 220 pages overall
  - 180 pages of main body text
  - 40 pages of appendices
- Dozens of reports reviewed spanning decades
- Some datasets spanning over 100 years
- Millions of individual data records analyzed

TABLE OF CONTENTS

Methods

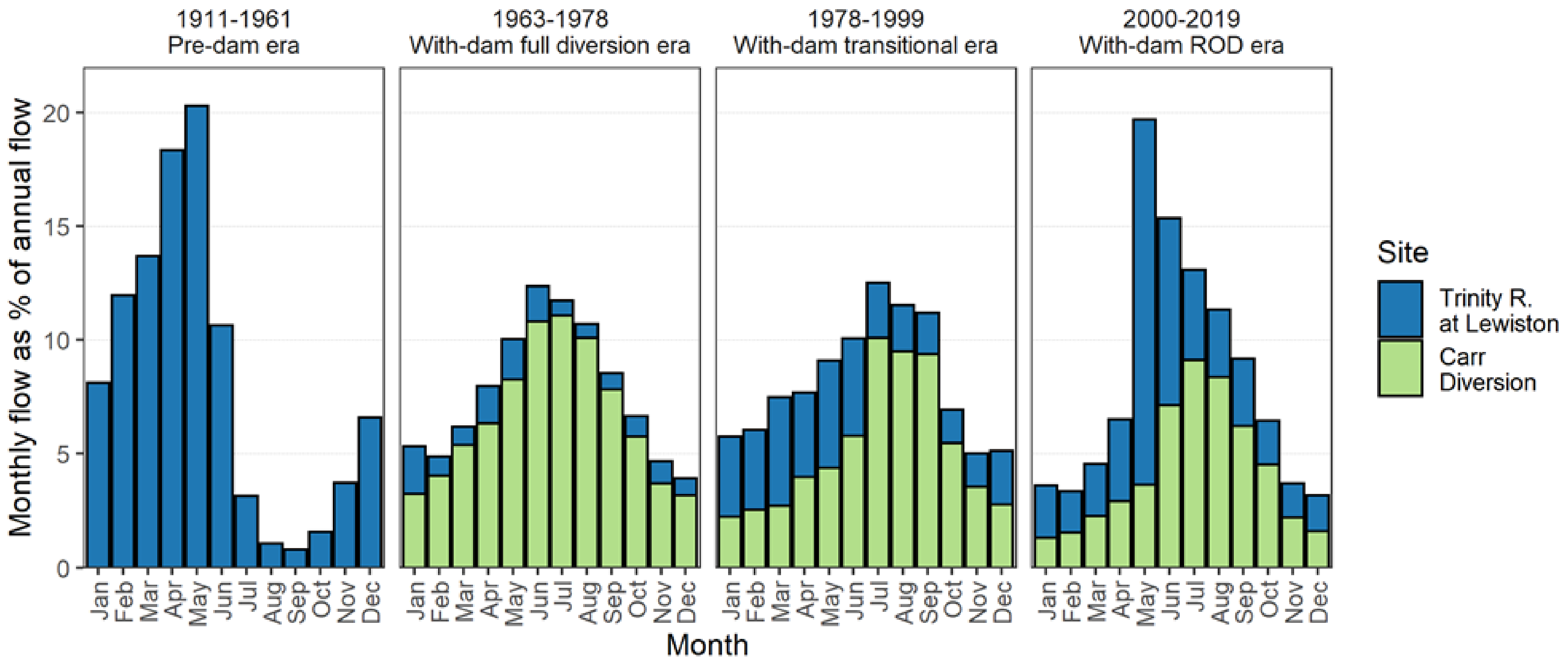
- Time separated into four eras
  - Pre-dam era (1911–1961)
  - Full diversion era (1963–1978)
  - Transitional era (1978–1999)
  - ROD era (2000–2019)
- Datasets gathered from
  - USFWS
  - USGS
  - USFS
  - Hoopa Tribe
  - Yurok Tribe
  - Others
- Statistical and modeling
  - RBM10
  - FYFAM, invertebrate lifecycle, salmonid bioenergetics
  - SRH-2D
  - Climate change models
  - Reservoir dynamics
  - Gap filling
  - Linear regression, linear mixed effects models, generalized additive models, and LOESS.

Methods



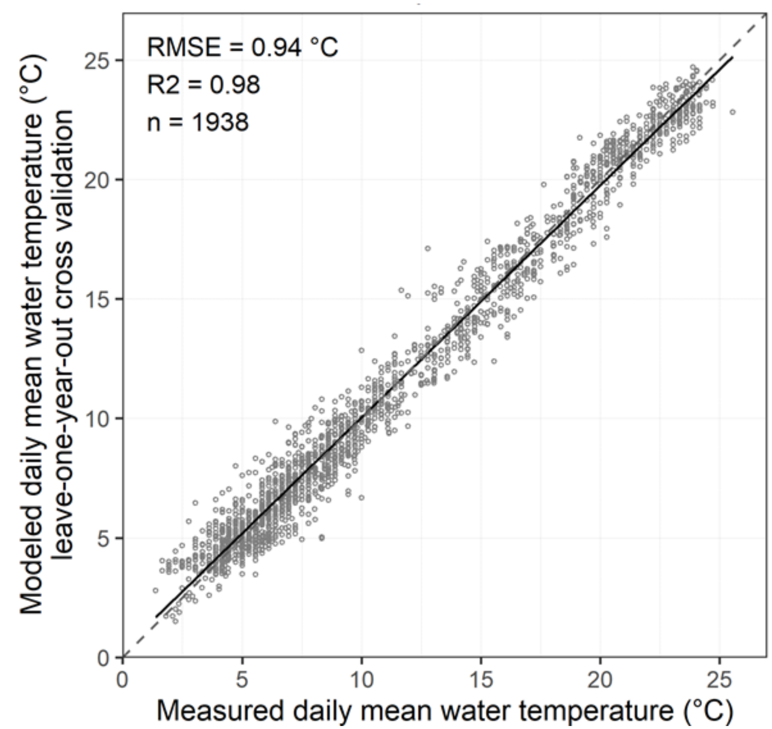
Source.Entity
CDEC
HSU_FSP
HVTEPA
SRNF
TCPD_Watercourse
USFS AQS
USFS_NRIS_AqS
USFS_other
USFWS
USFWS_historic
YTEP
YTFP
Source.Entity
HSU_FSP
HVTEPA
SRNF
USFS_NRIS_AqS
USFWS
USFWS_historic
USGS
YTEP
YTFP
Source.Entity
5C
CDEC
HVTEPA
USFS_NRIS_AqS
USFWS
USFWS_historic
USGS
YTEP
YTFP
1970 1975 1980 1985 1990 1995 2000 2005 2010
Date
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Date

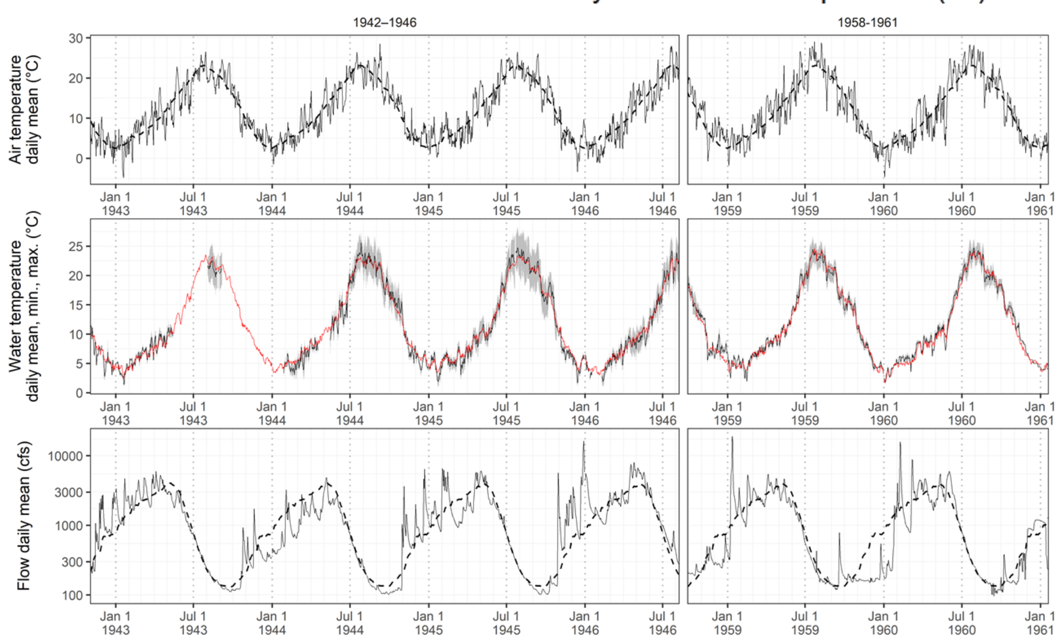
Results-Flows

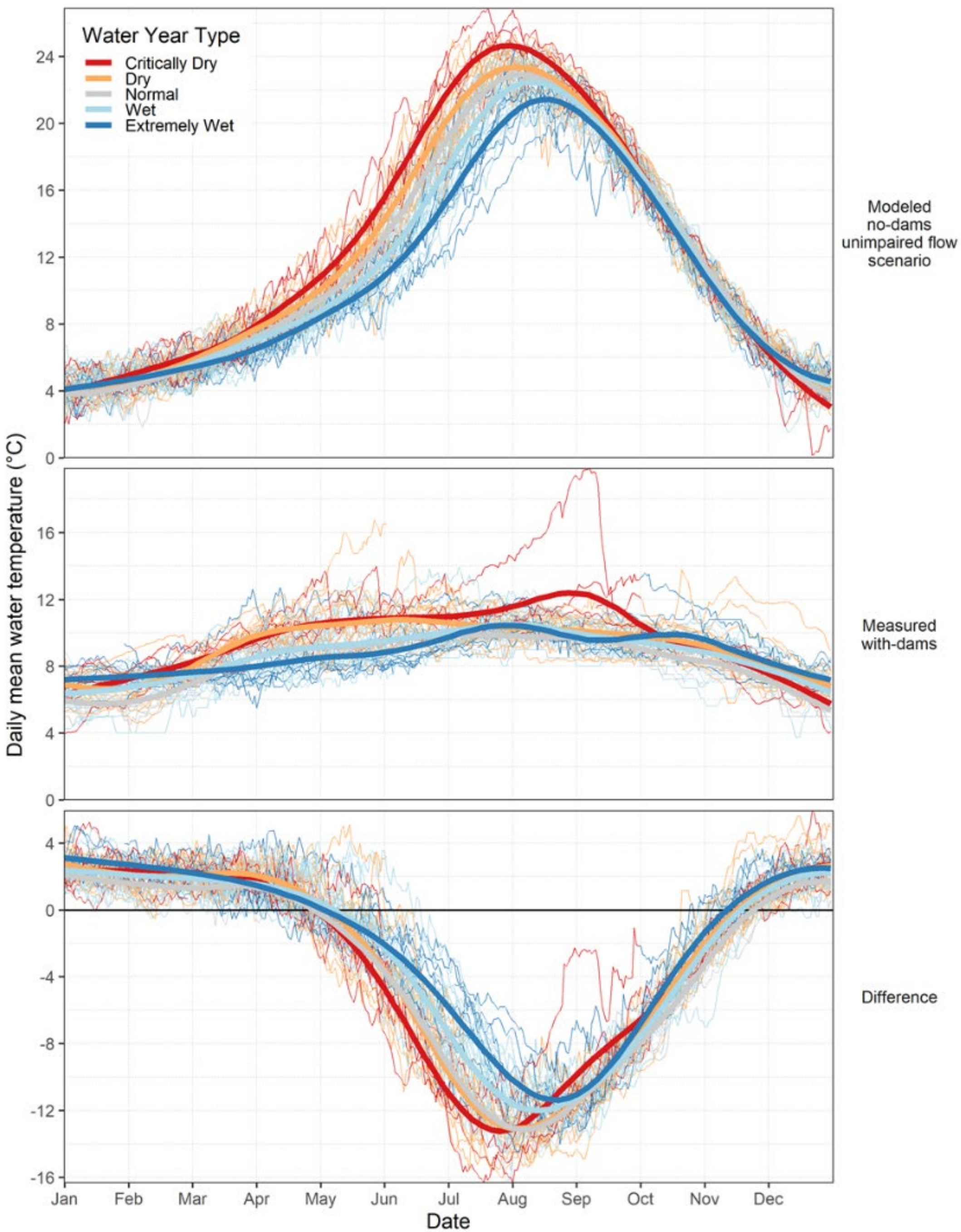


Results – Unimpaired Temperature

- Need for baseline for comparisons
- Used existing data to develop model for Lewiston water temperature under unimpaired condition
- Generated unimpaired flow and temperature record for all time periods



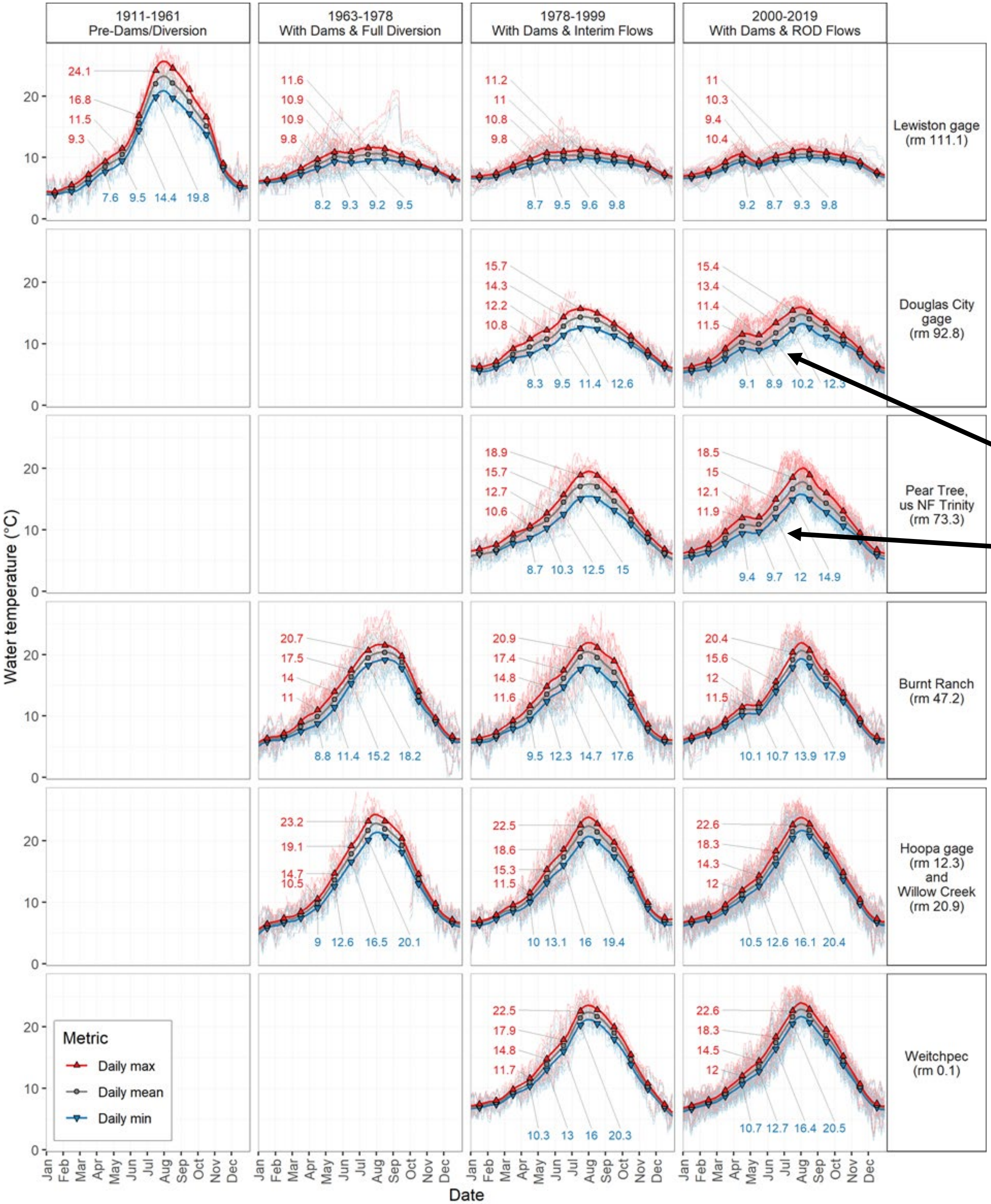




Results- Temperatures

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

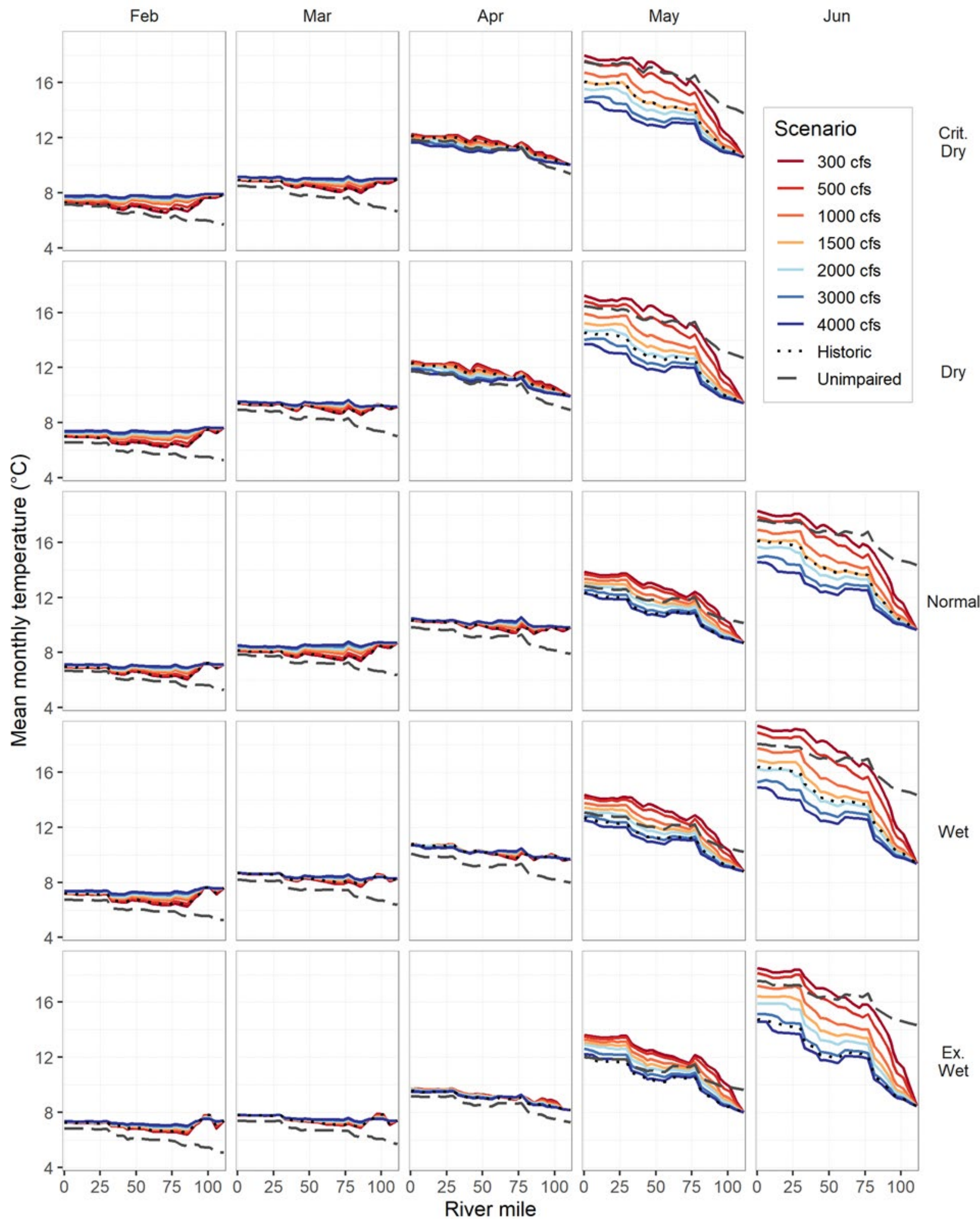
Results-Temperatures

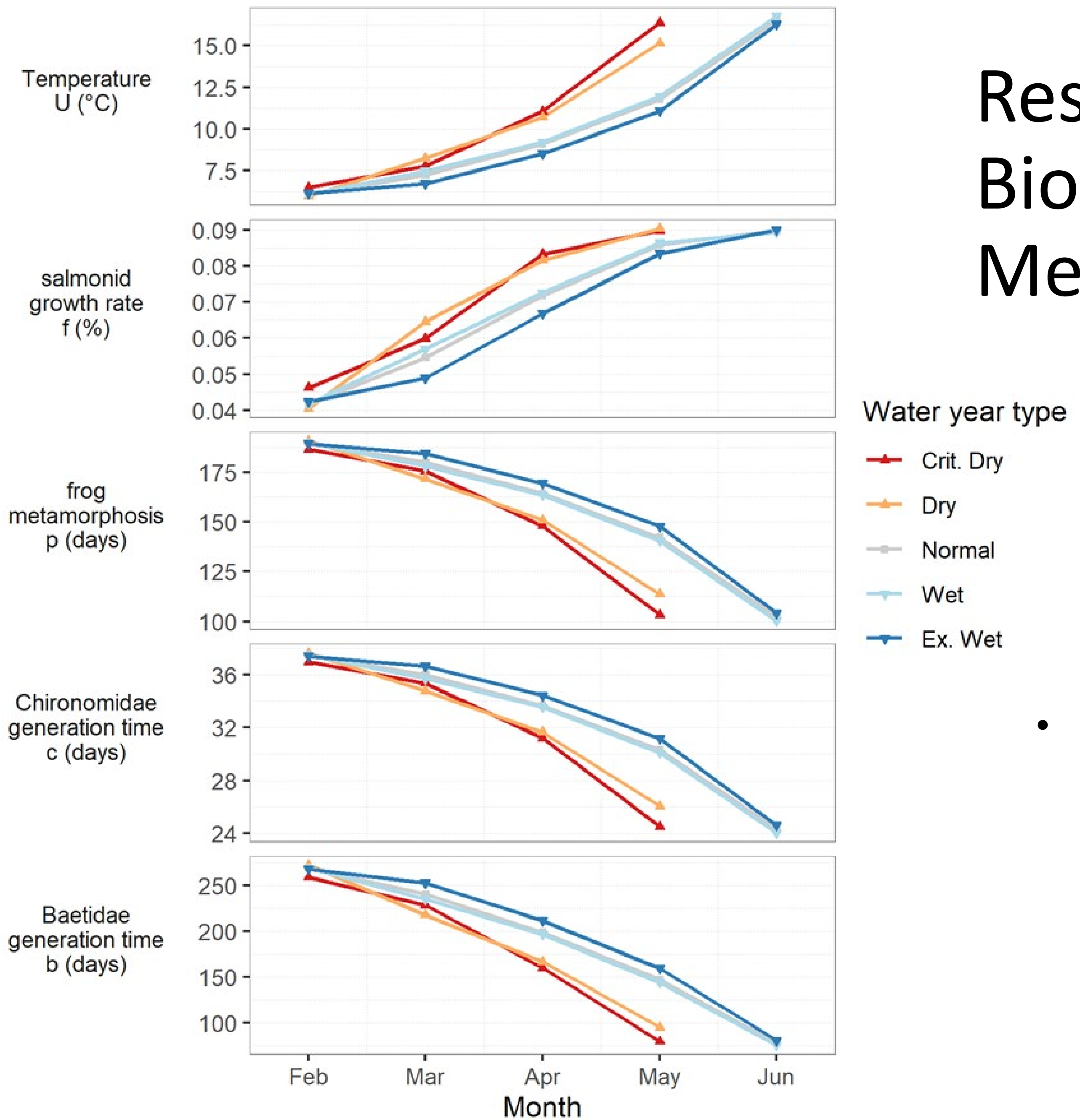


- ROD flows have resulted in a "kink" in normal warming patterns in the spring

Results- Temperature

- Sensitivity analysis for discharge during critical rearing period
- Release temperature is warmer than unimpaired temperatures at Lewiston from February thru April and colder starting in May
- Relative impacts to stream temperature from discharge are much greater starting in May of Dry and Critically Dry years and June of Normal and wetter years

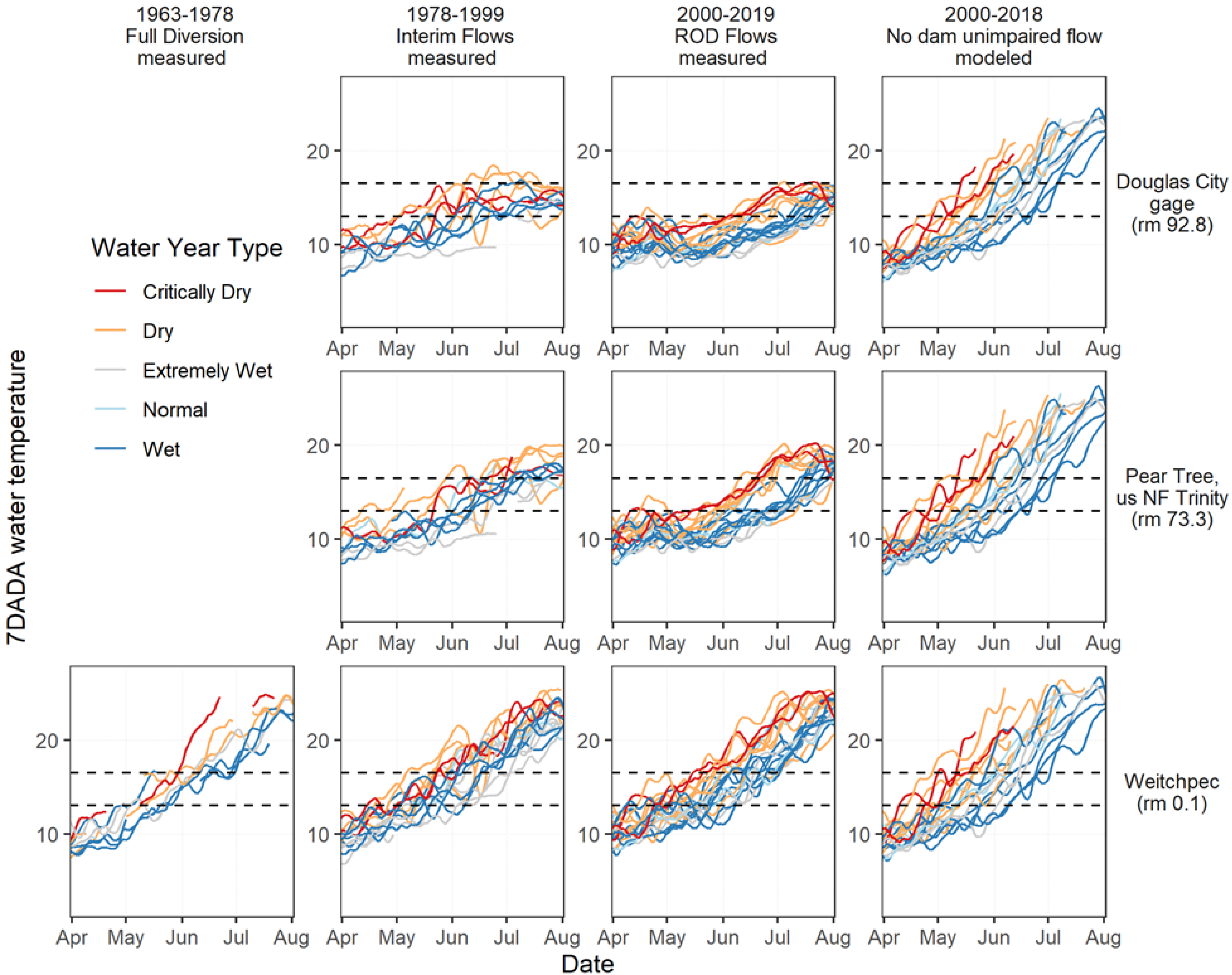


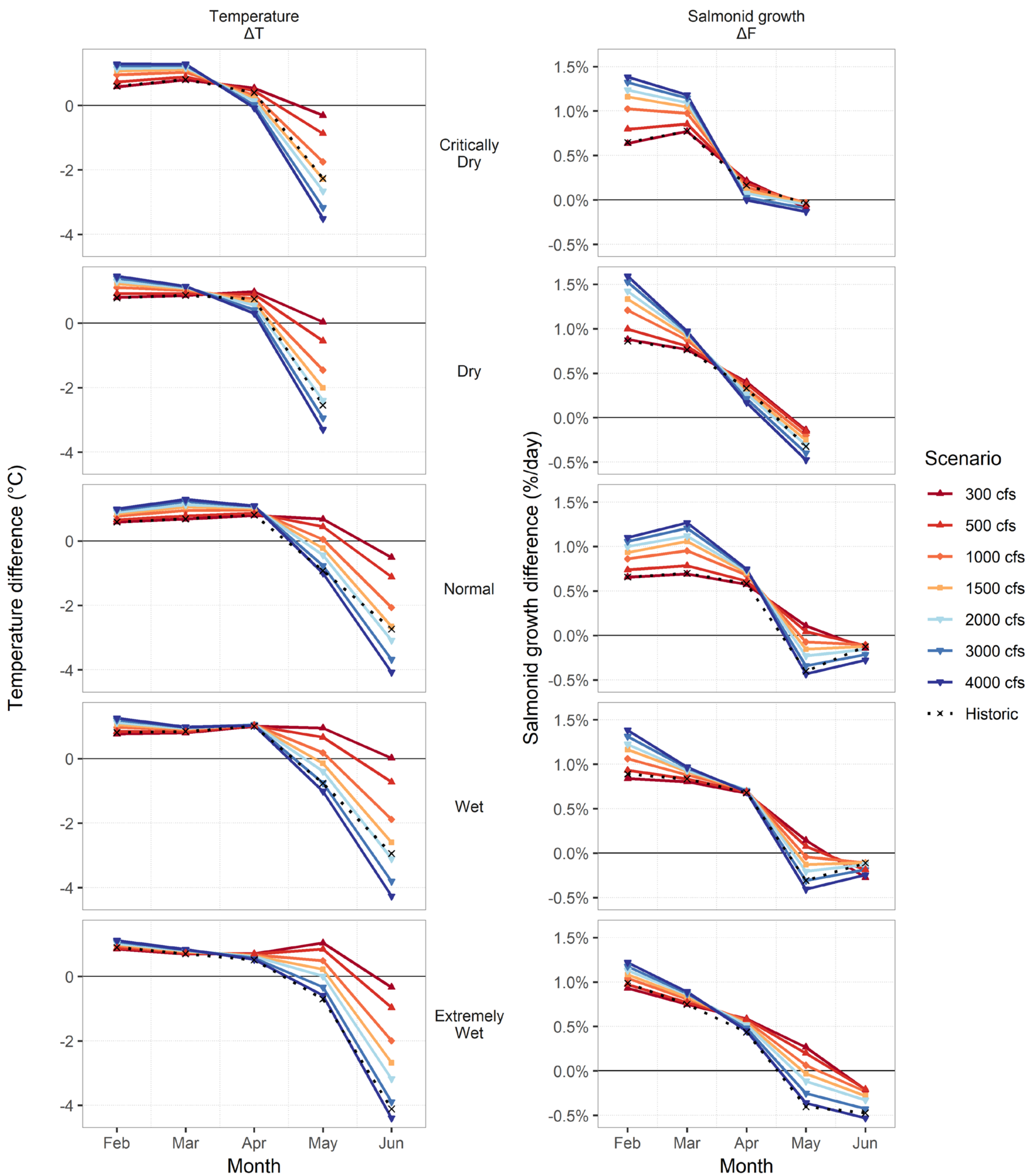


Results-Biological Metrics

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

Results-Salmonid Growth



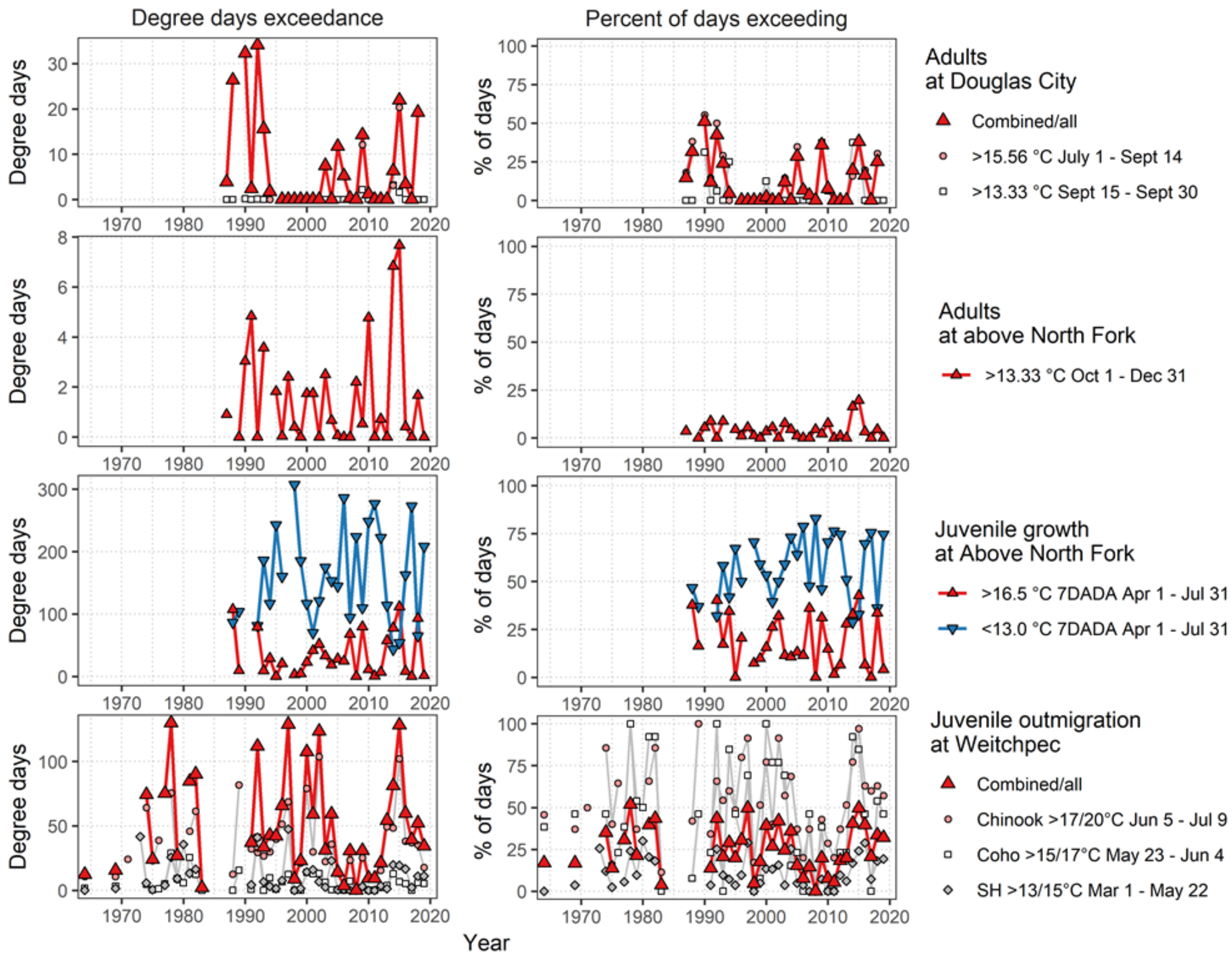


Results- Salmonid Growth

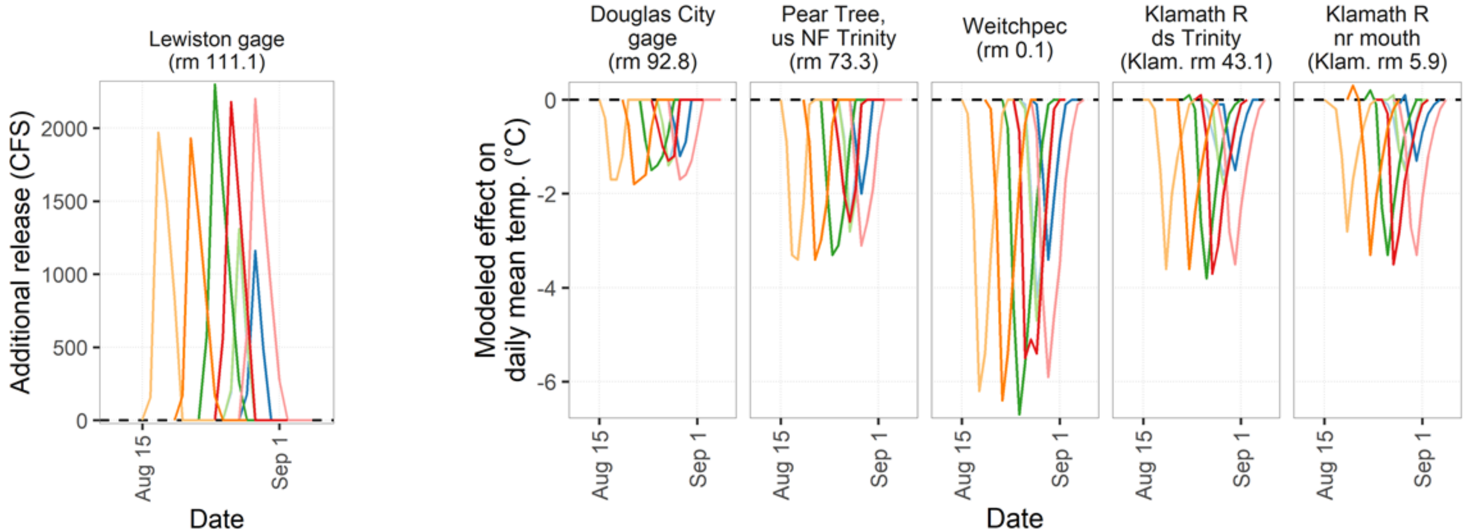
- Greater flows in the winter months and lower flows in the spring result in greater salmonid growth
- In part a function of flows and stratification from Trinity Reservoir

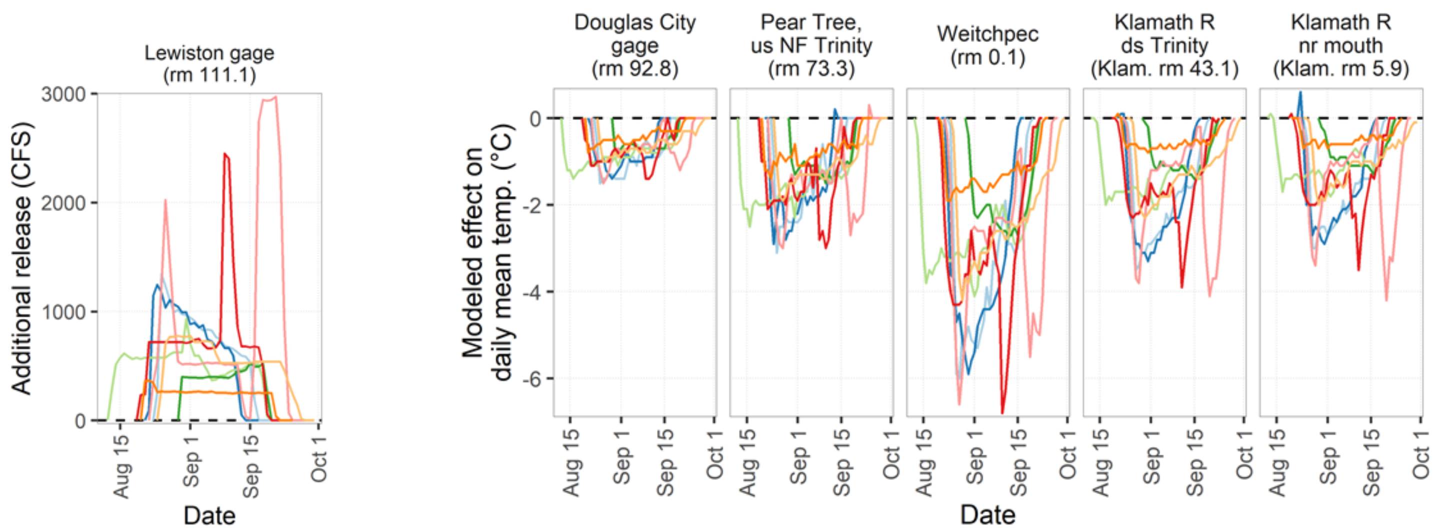
Results – Temperature compliance

- Records by which to assess compliance are limited
- It is not clear that compliance has been increased by ROD flows

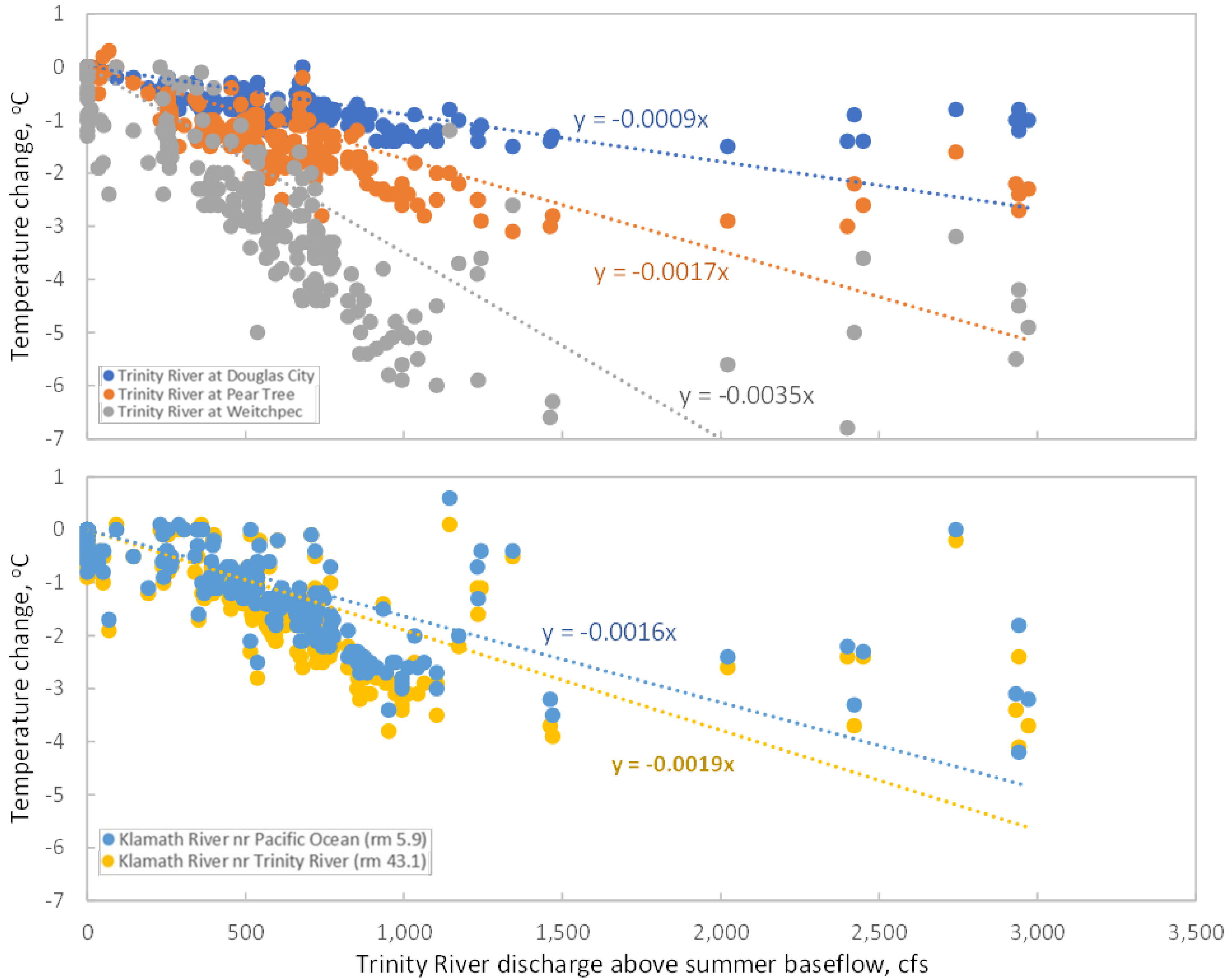


Results-Ceremonial and Adult Salmonid Fall Flow Releases



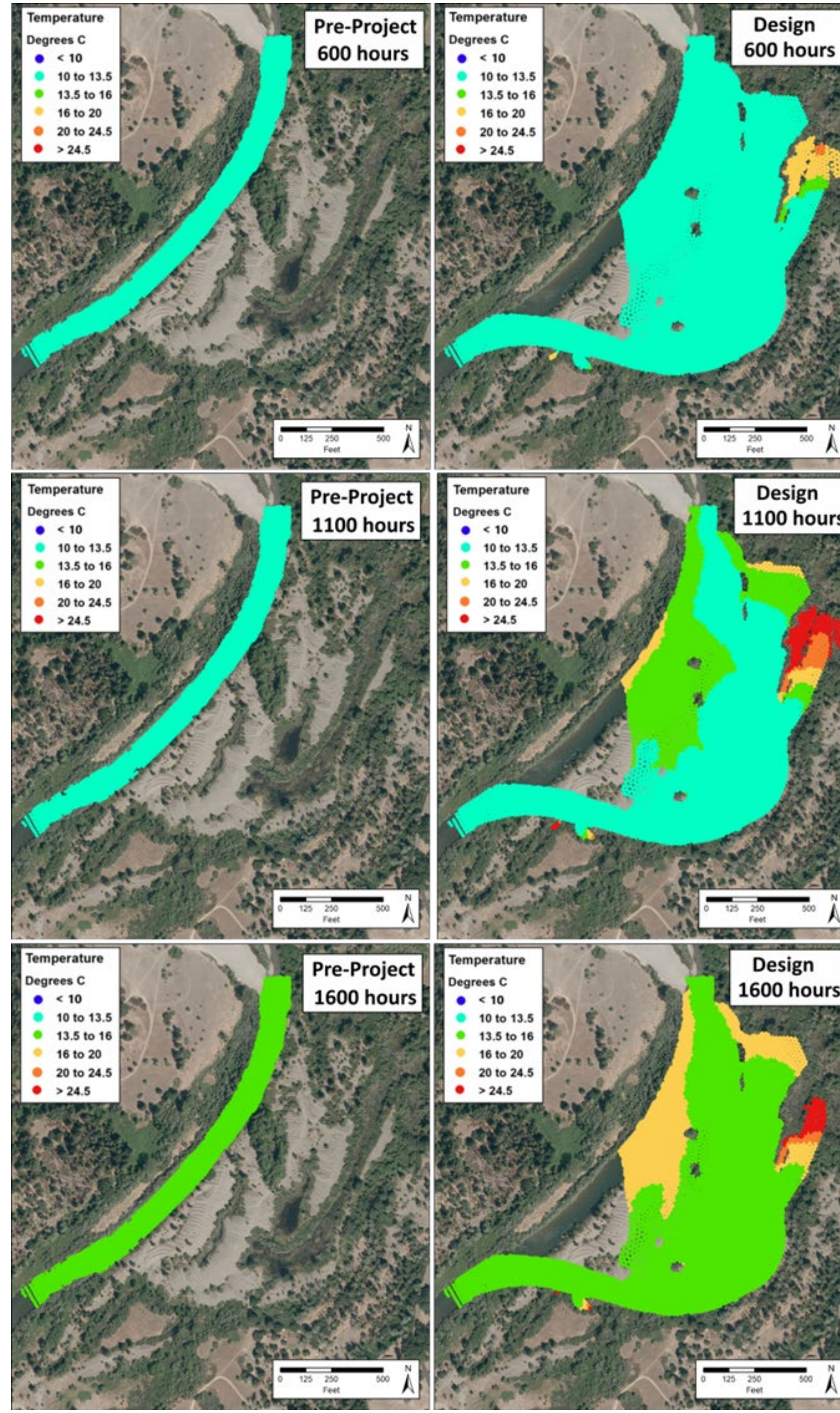


Results-Ceremonial and Adult Salmonid Fall Flow Releases

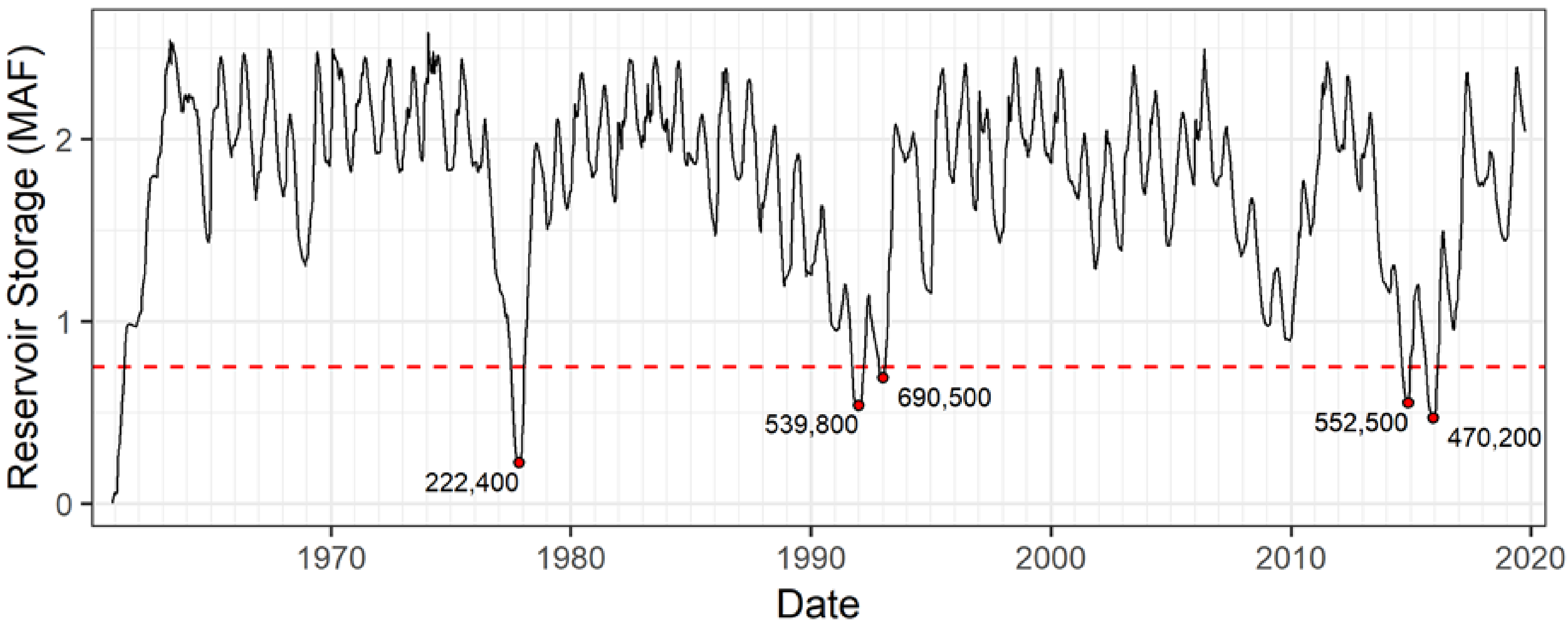


Results – lateral thermal diversity

- Channel form can influence local thermal diversity
- The impaired channel offers little choice for mobile ectothermic organisms
- Topographically influenced thermal diversity could be substantial at channel rehab sites



Results-Trinity Reservoir



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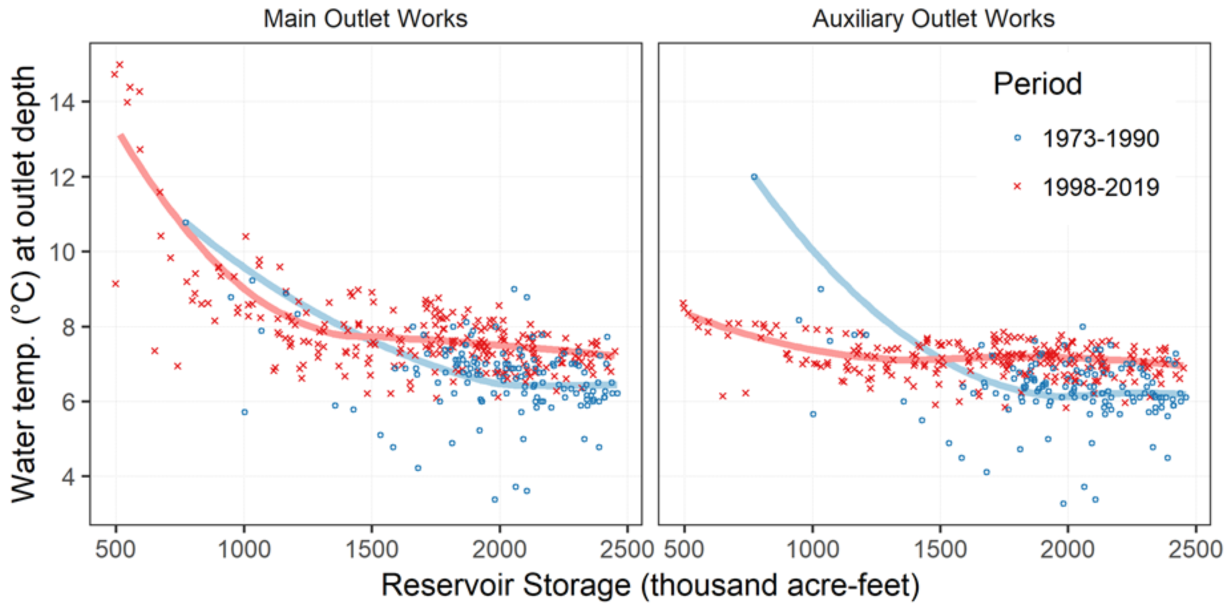

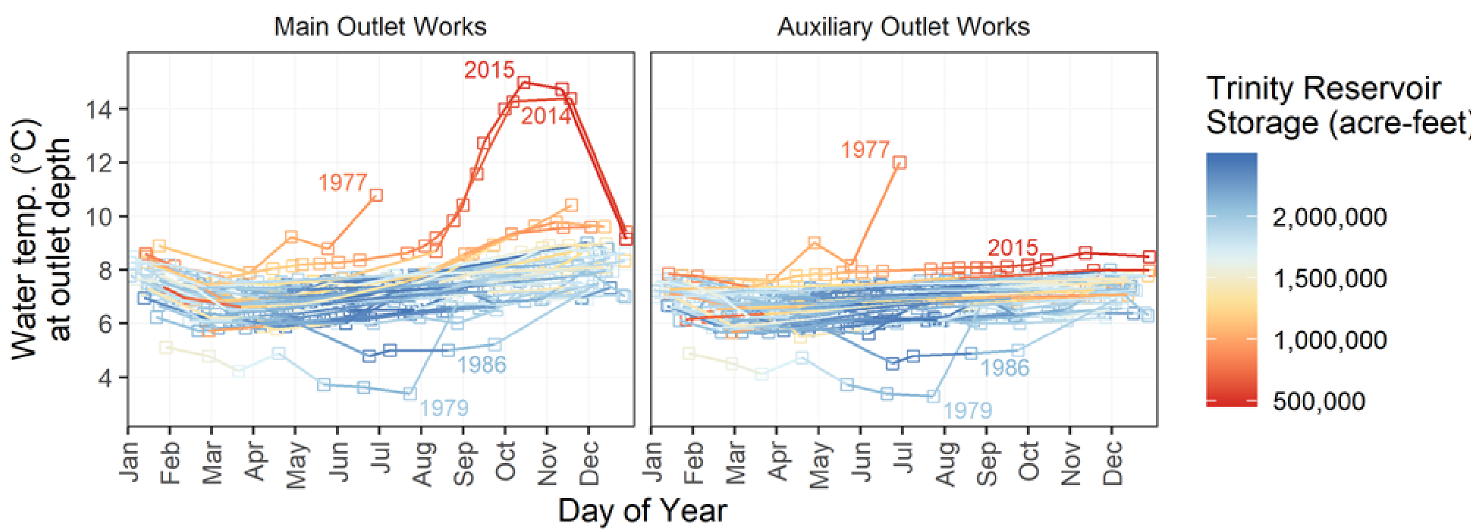

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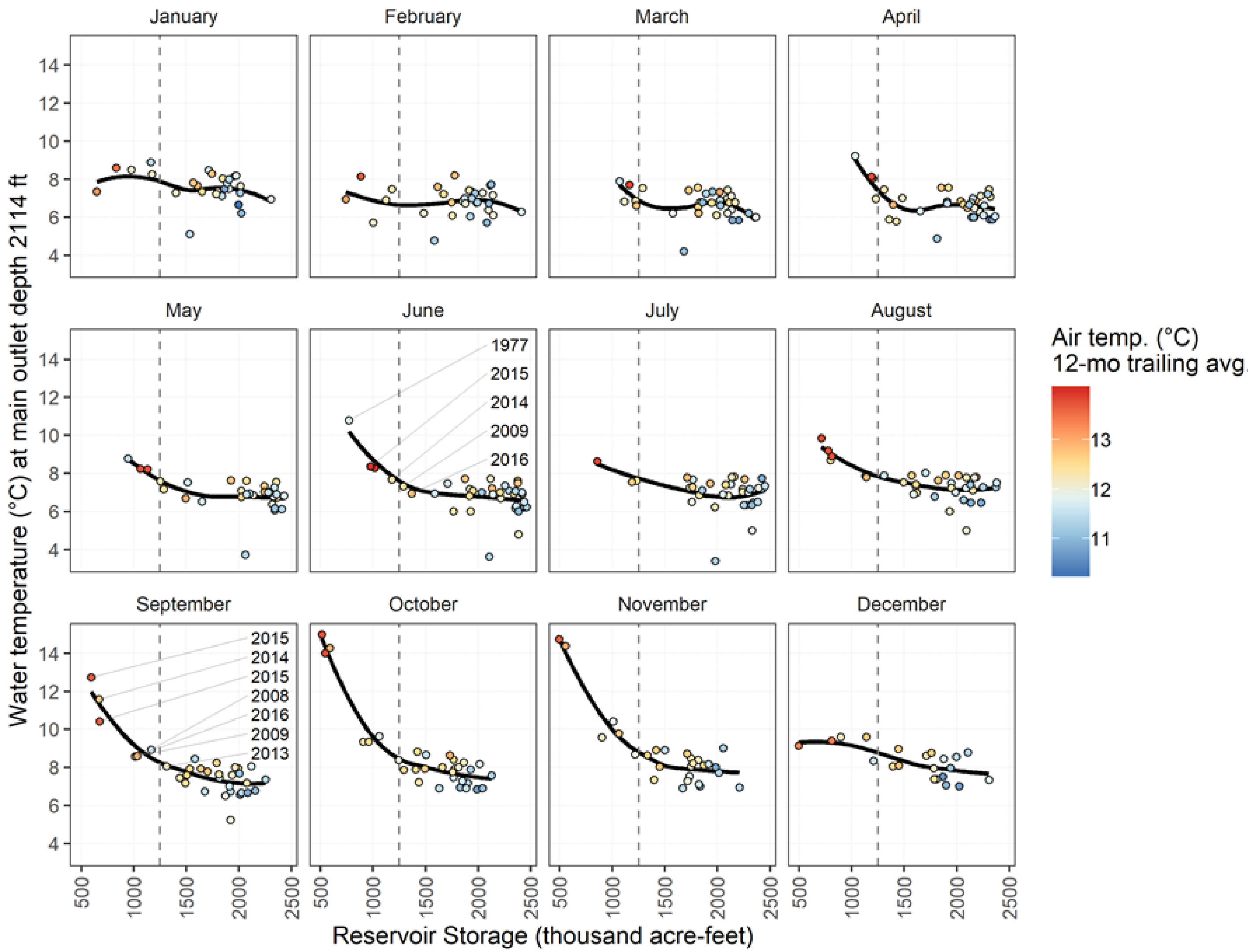
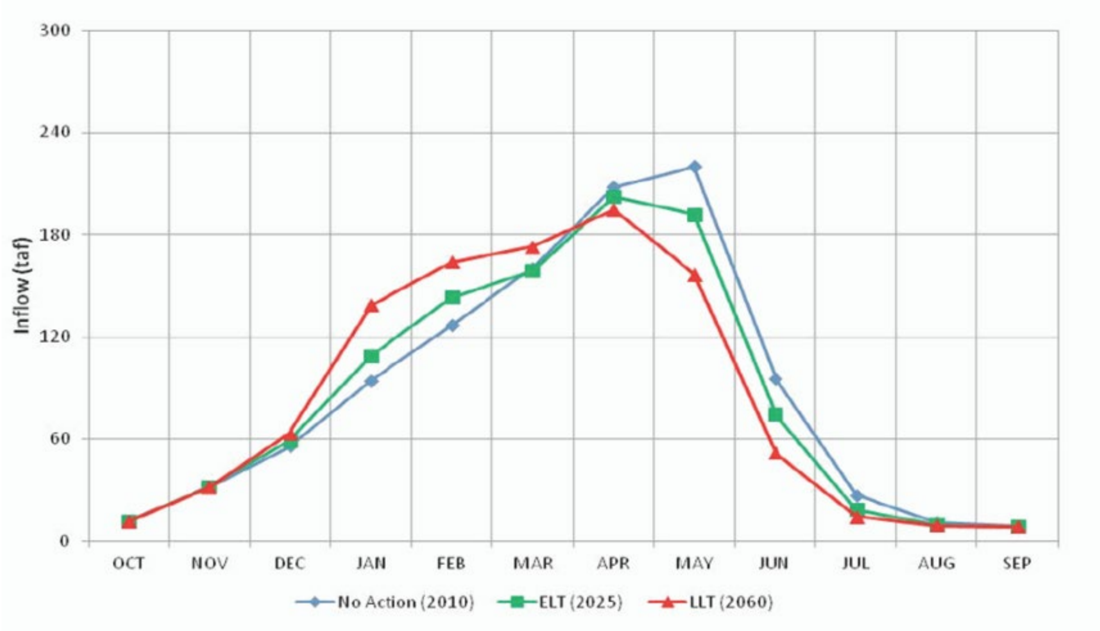
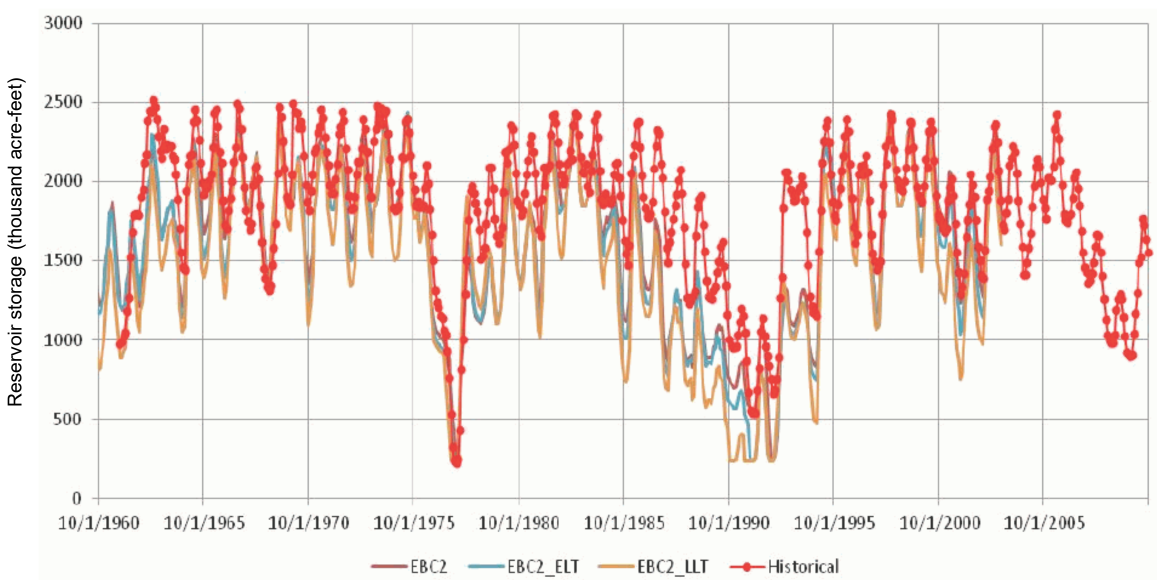


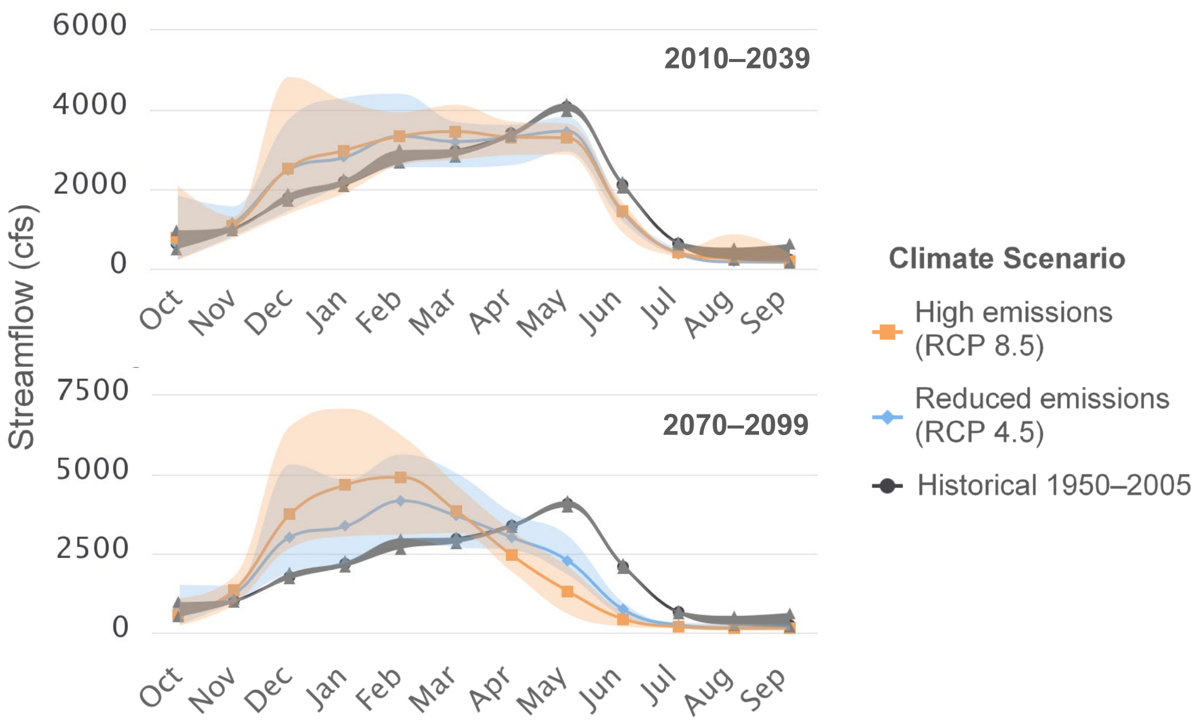
Results-Climate Change





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.

Words of Caution

- What we’re not saying:
  - Lewiston Dam releases are always too cold
  - Less water is needed to be released from the Trinity River to TRD
- What we are saying:
  - In the spring, Lewiston Dam releases are colder than the optimal growth temperatures for rearing juvenile salmonids
  - Management options are currently limited by the fact that flow and temperature cannot be managed separately
  - A more nuanced approach to temperature and flow management is needed to maximize juvenile salmonid growth in the spring, and to protect adult salmonids and their eggs in the late summer and fall

Thank you!

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