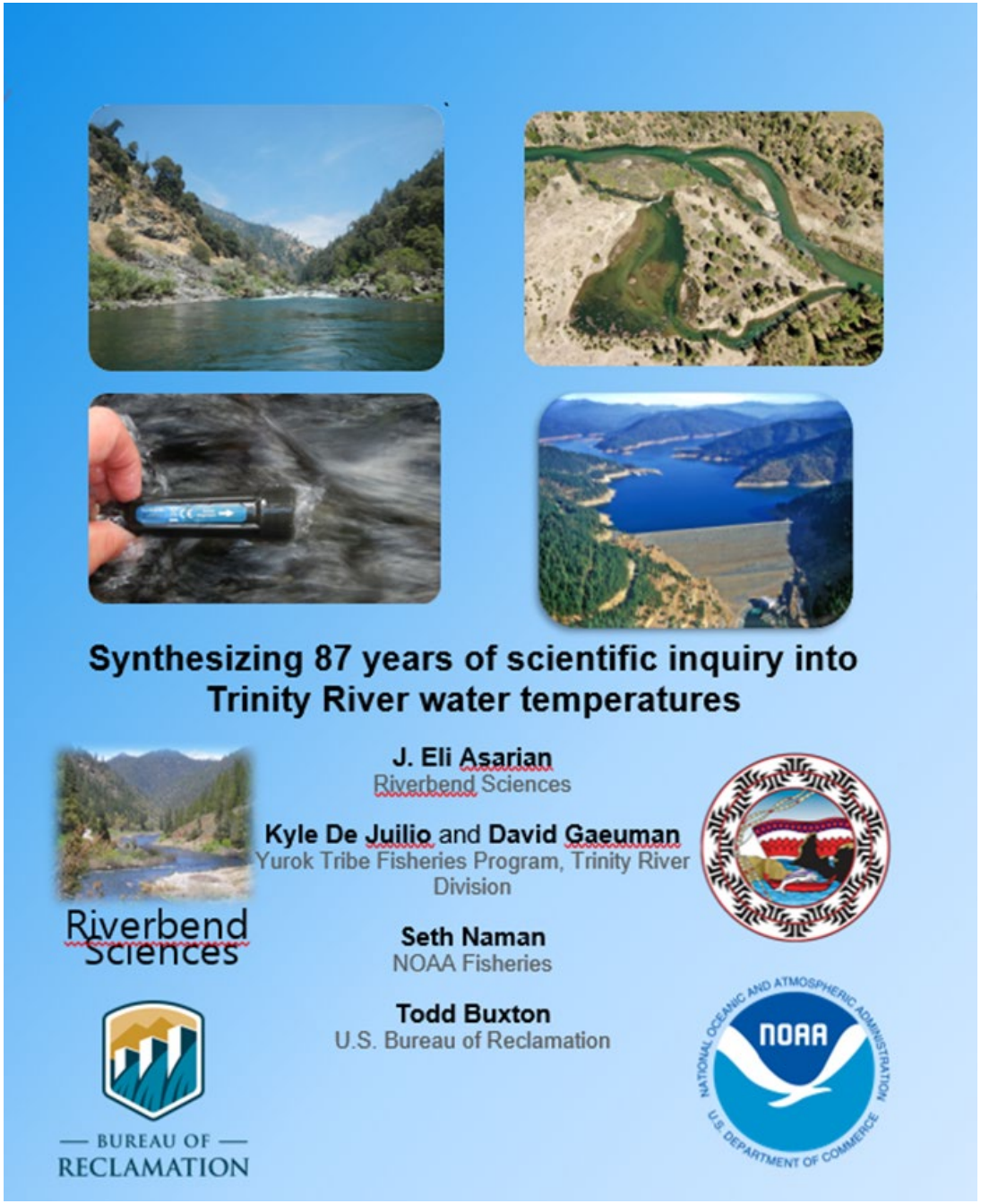


Trinity Management Council Meeting

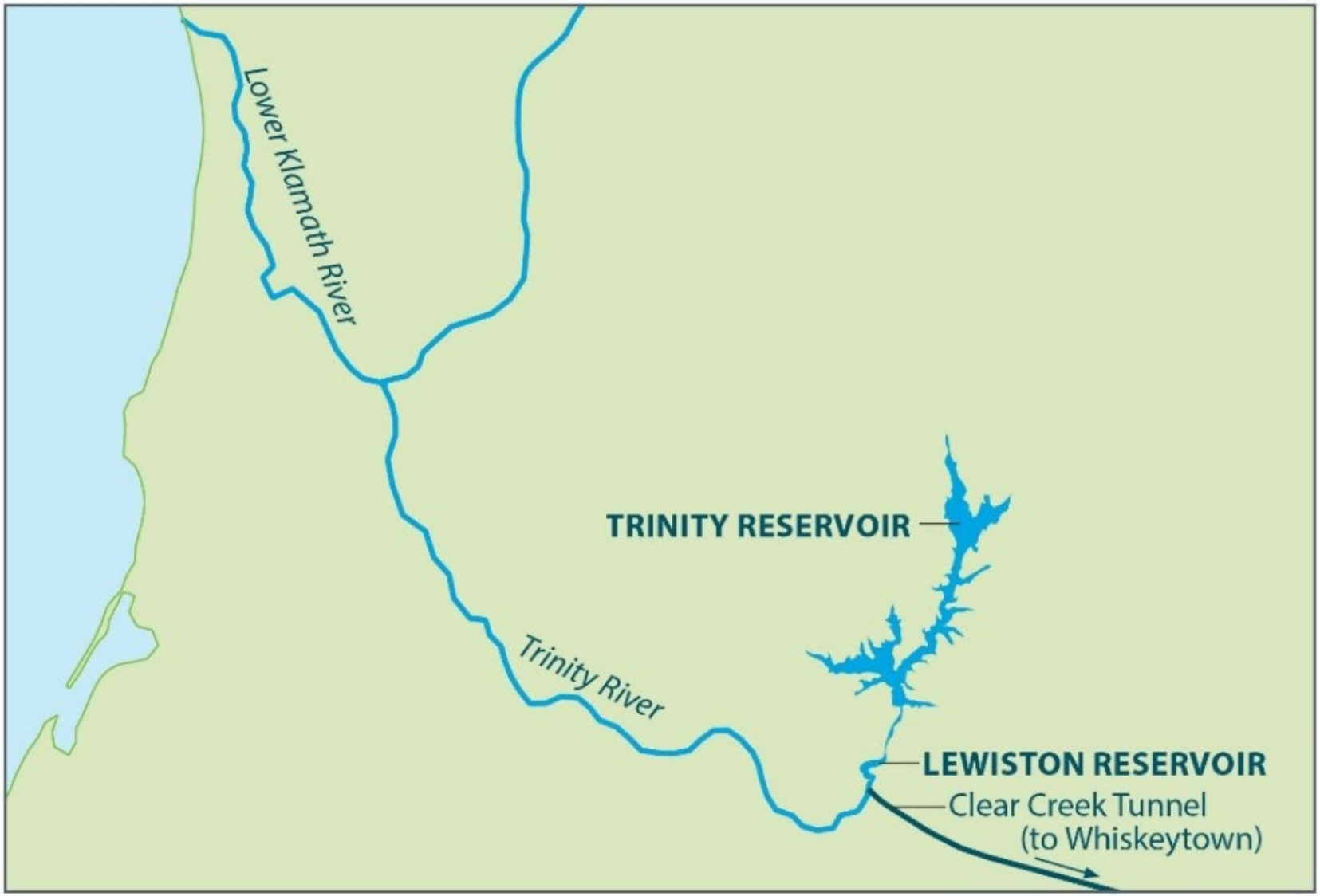
Weitchpec, California
September 13-14, 2023

Seth Naman

Trinity River Restoration Program

Photo: Edward Curtis, 1923

Photo: khsu.org

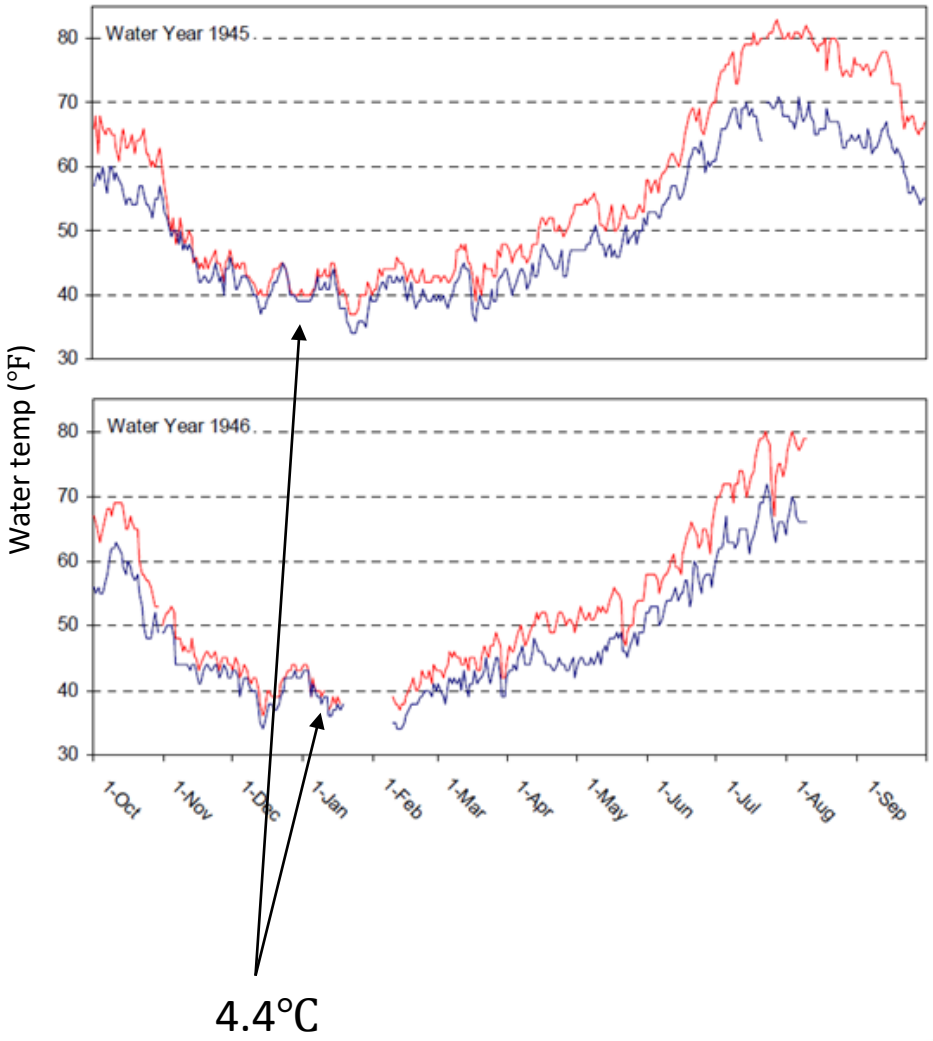

Lower Klamath River
TRINITY RESERVOIR
Trinity River
LEWISTON RESERVOIR
Clear Creek Tunnel
(to Whiskeytown)

Trinity Dam and Trinity Reservoir

Lewiston Dam and Trinity Hatchery

Objectives

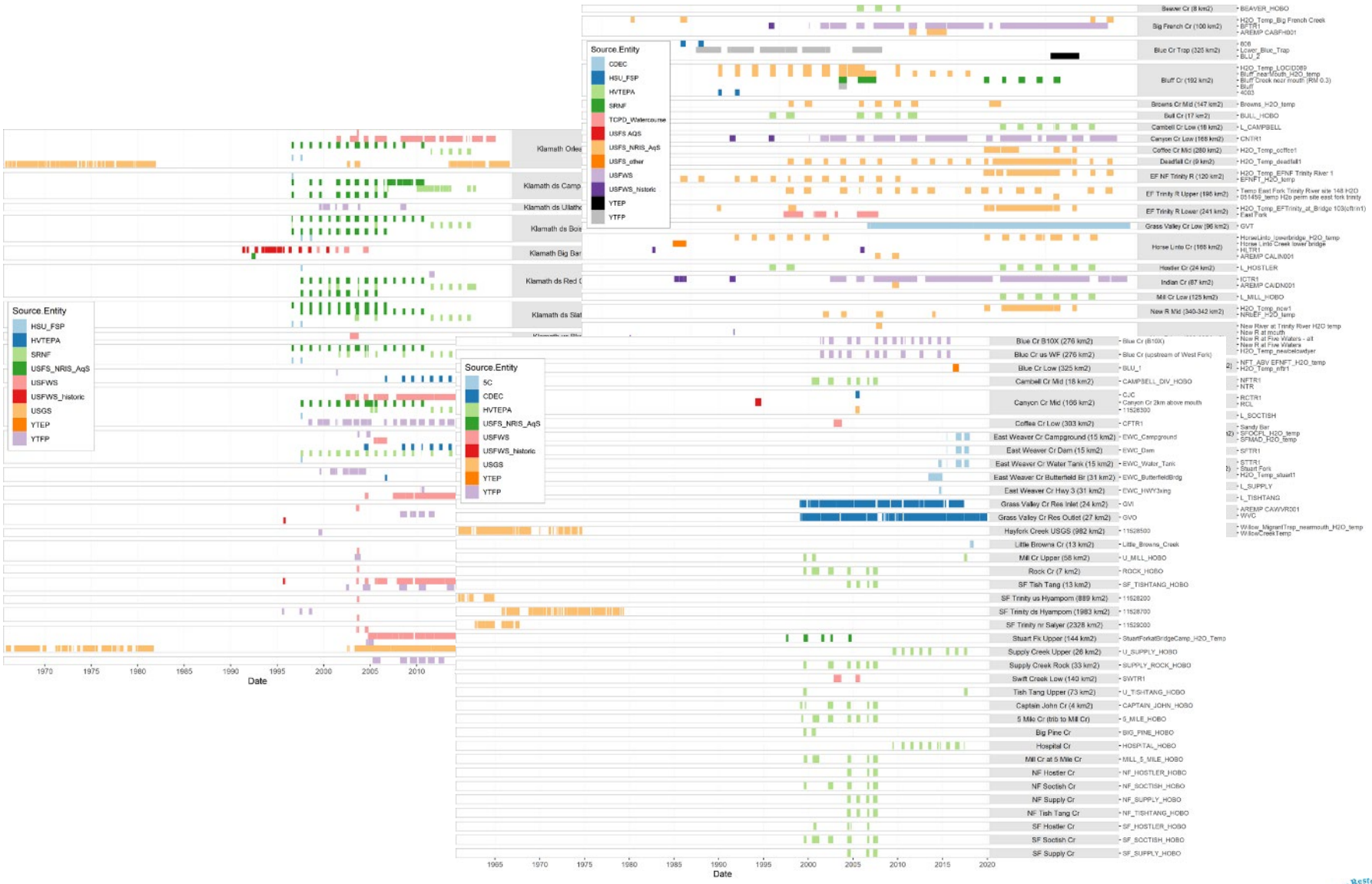
- Construct and populate a comprehensive quality-controlled water temperature dataset
- Evaluate:
  - Patterns in the relationship between flow and temperature in time and space
  - Temperature effects on biological objectives
  - Temperature compliance with regulatory objectives
- Update conceptual models
- Develop management recommendations



Methods

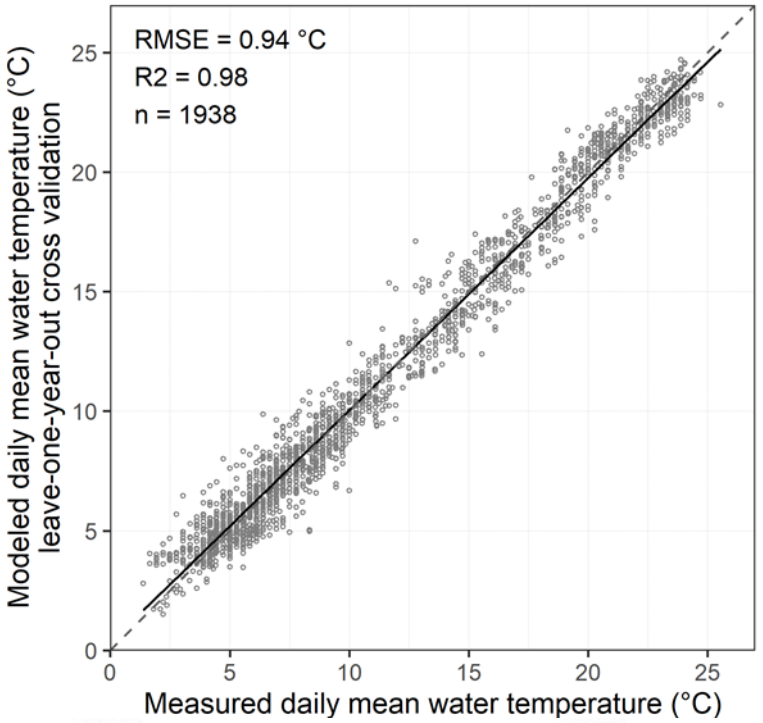
- Time separated into four eras
  - Pre-dam era (1911–1961)
  - Full diversion era (1963–1978)
  - Transitional era (1978–1999)
  - ROD era (2000–2019)
- Datasets gathered from
  - USFWS
  - USGS
  - USFS
  - Hoopa Tribe
  - Yurok Tribe
  - Others
- Statistical and modeling
  - RBM10
  - FYFAM, invertebrate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

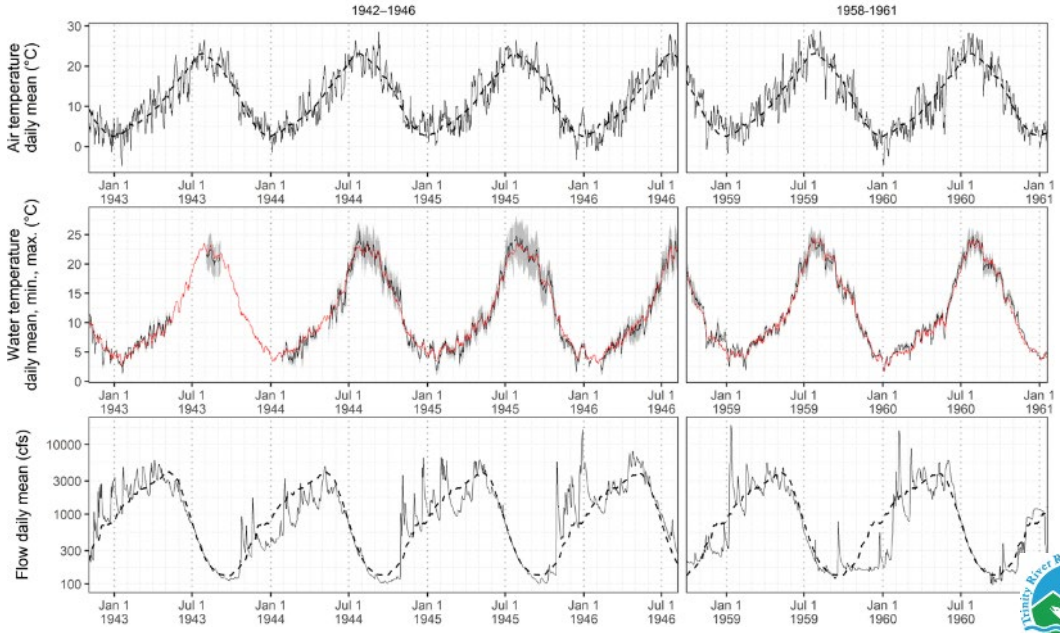
Methods


Source.Entity
HSU_FSP
HVTEPA
SRNF
USFS_NRIS_AqS
USFWS
USFWS_historic
USGS
YTEP
YTFP
Date
Source.Entity
5C
CDEC
HVTEPA
USFS_NRIS_AqS
USFWS
USFWS_historic
USGS
YTEP
YTFP
Date
Source.Entity
CDEC
HSU_FSP
HVTEPA
SRNF
TCPD_Watercourse
USFS AQS
USFS_NRIS_AqS
USFS_other
USFWS
USFWS_historic
YTEP
YTFP

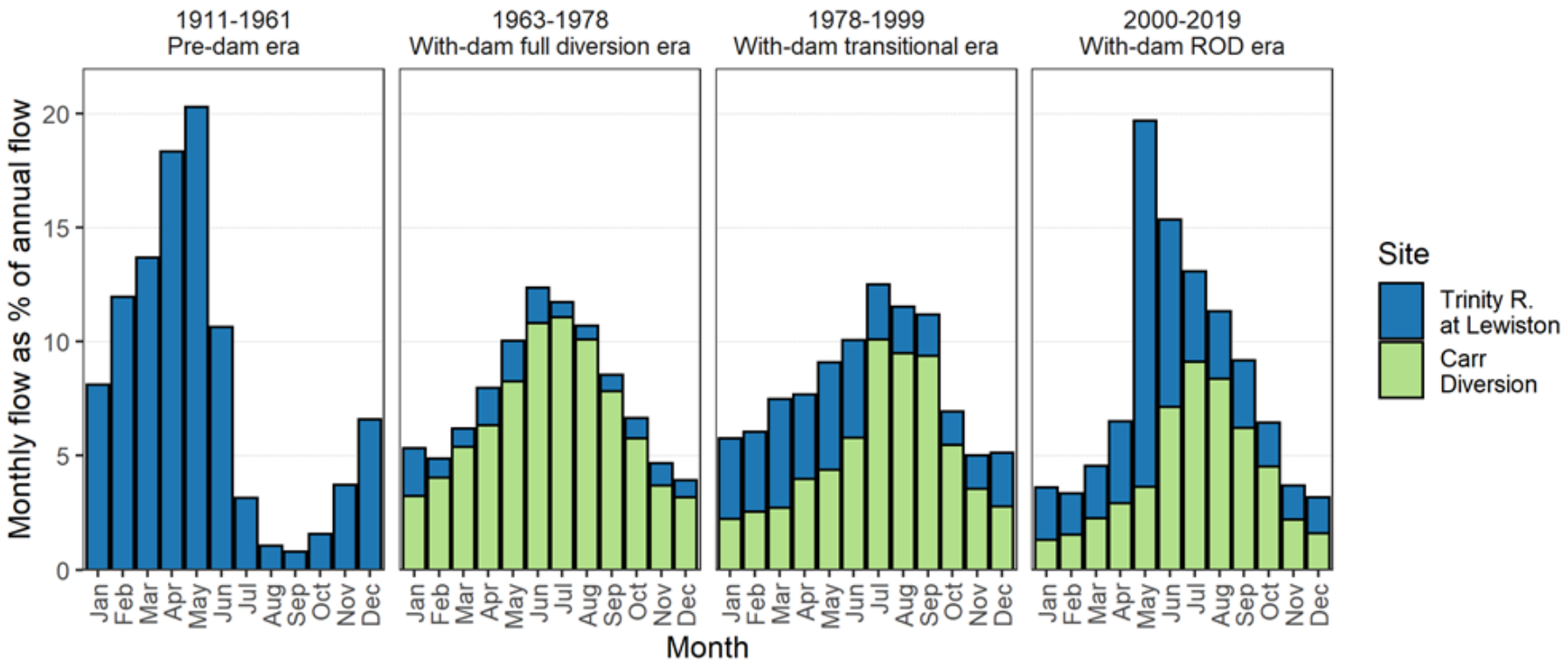
Methods – Unimpaired Temperature

- Need for baseline for comparisons
- Selected pre dam years had flow and temperature data, air temperature generated from gridded models
- Used existing data to develop GAMM (included autocorrelation structure) for Lewiston water temperature under unimpaired condition
- Generated unimpaired flow and temperature record for all time periods



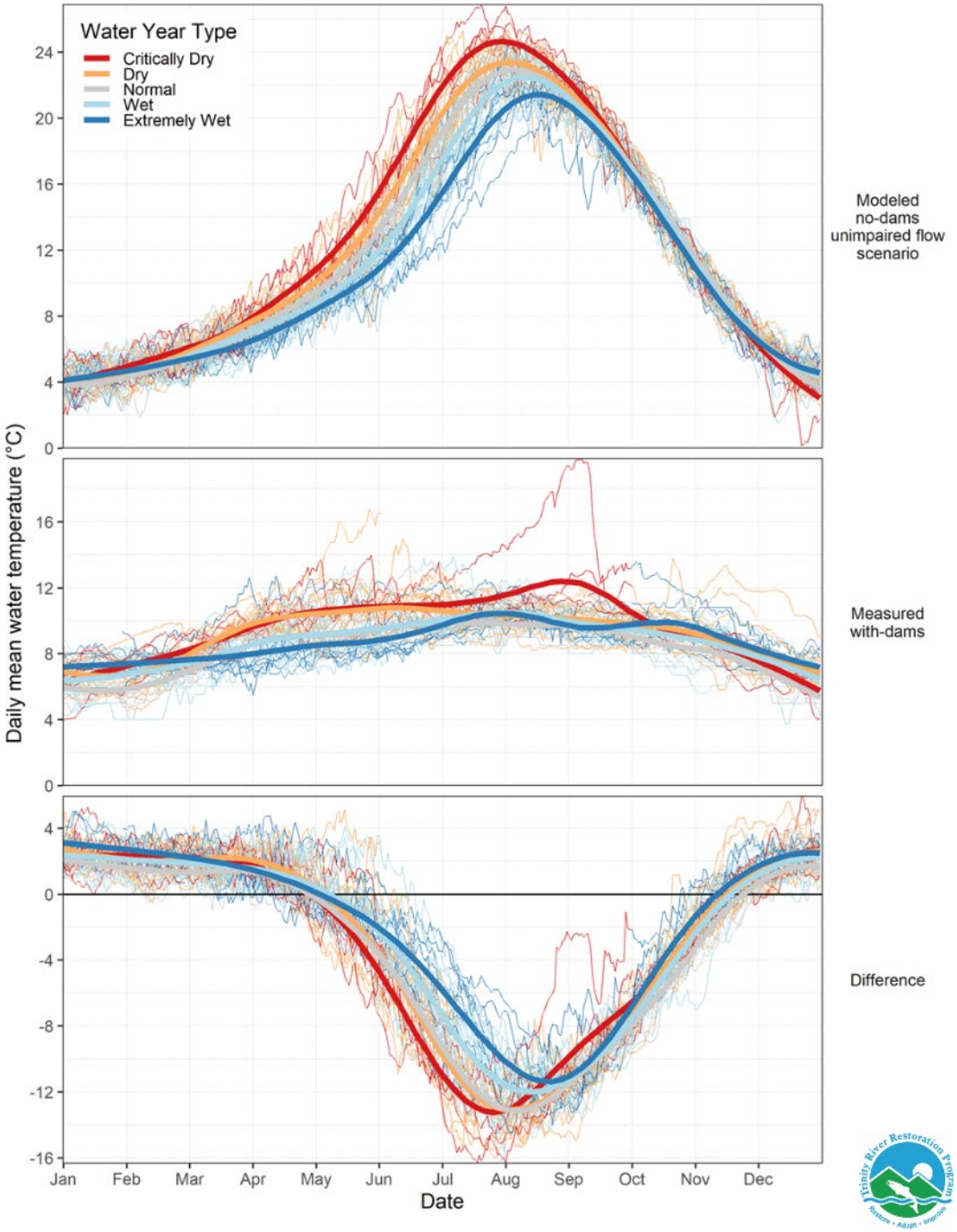


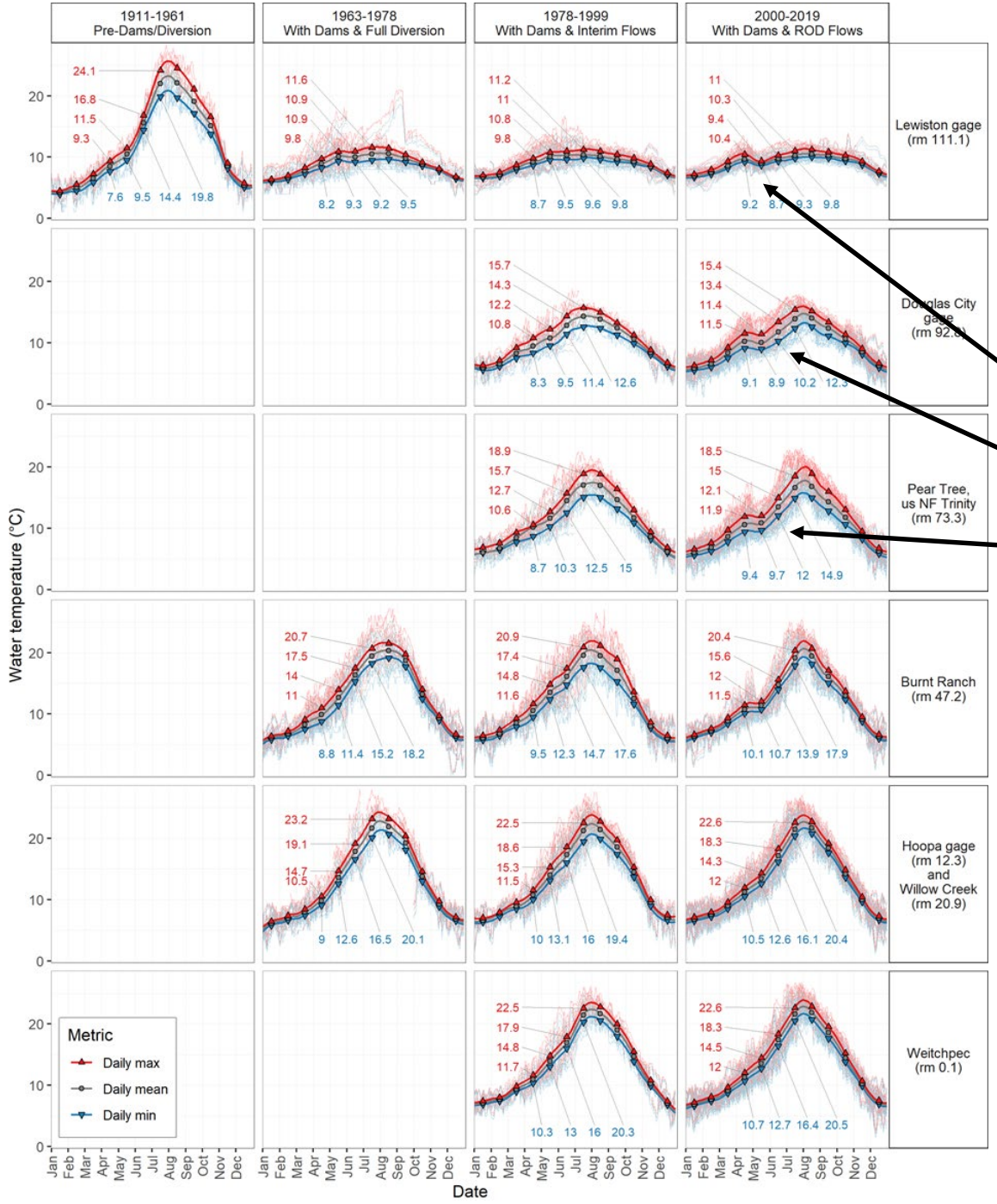
Results-Flows



Results- Temperatures

- With dams, water temperatures are warmer in the winter, and colder in the summer
- Effect is most pronounced near Lewiston Dam

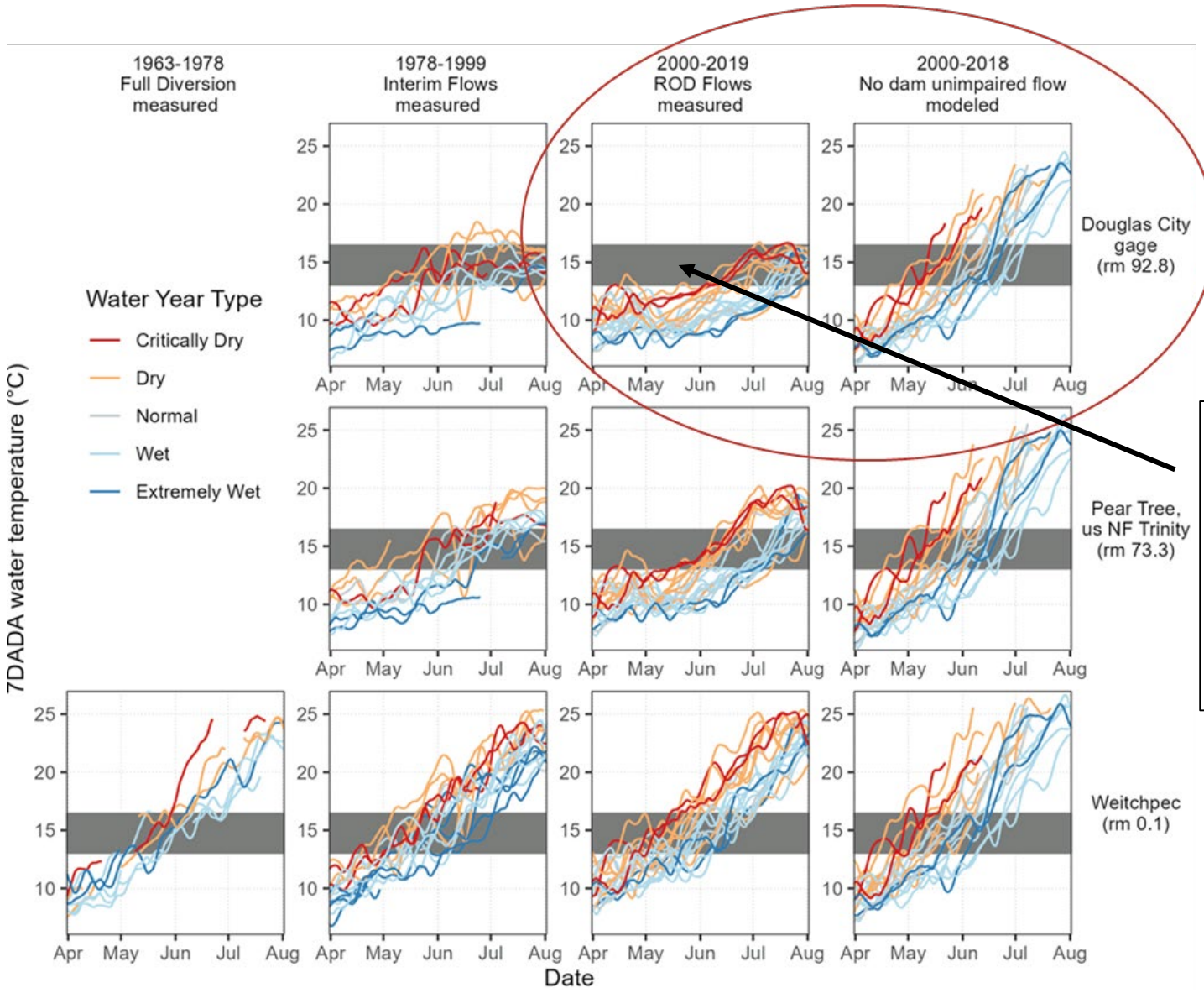




Results-Temperatures

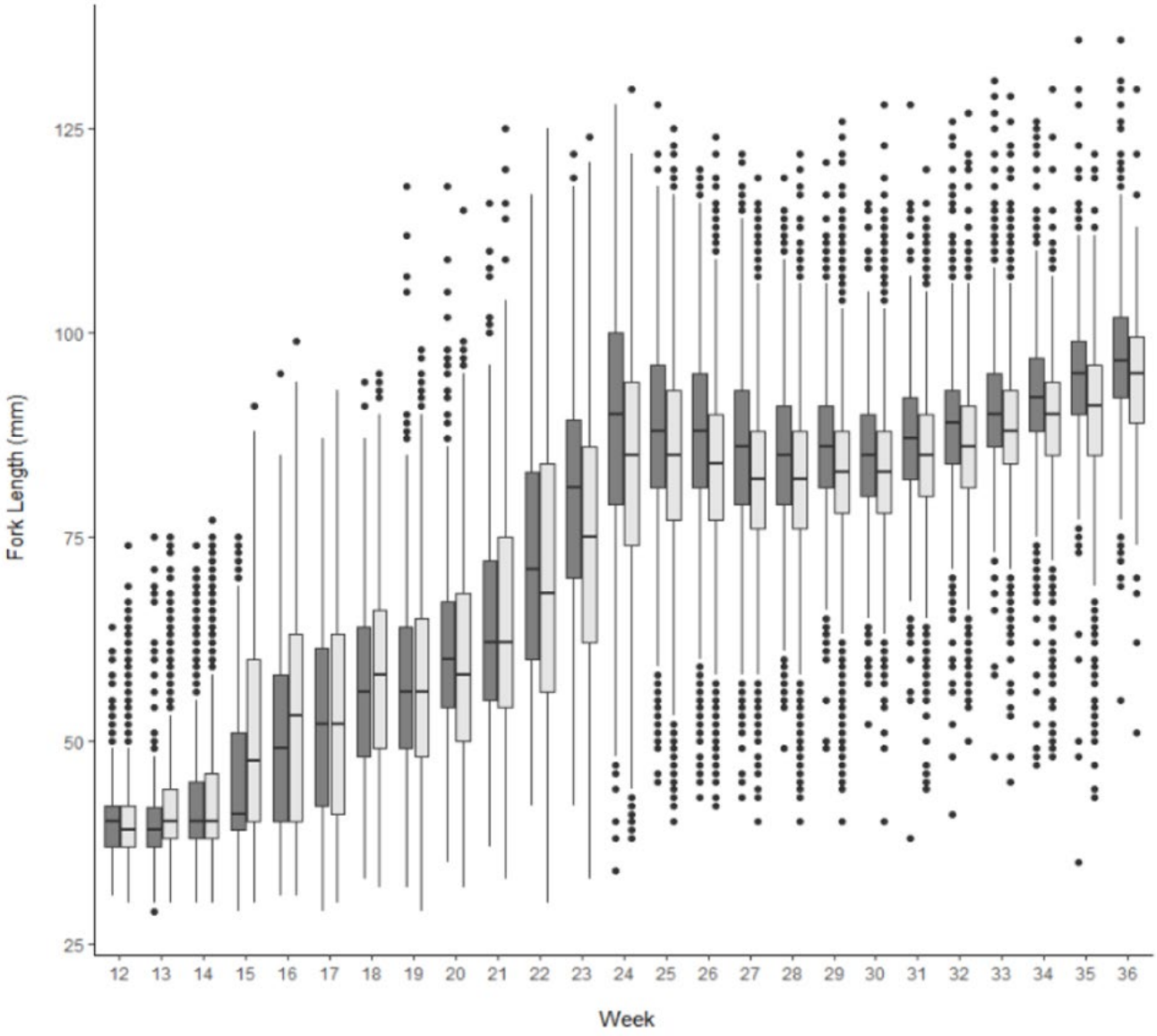
ROD flows have resulted in a “kink” in normal warming patterns in the spring

Results-Salmonid Growth



ROD flows have reduced time duration water temperatures are optimal for juvenile growth

Measured Salmonid Growth

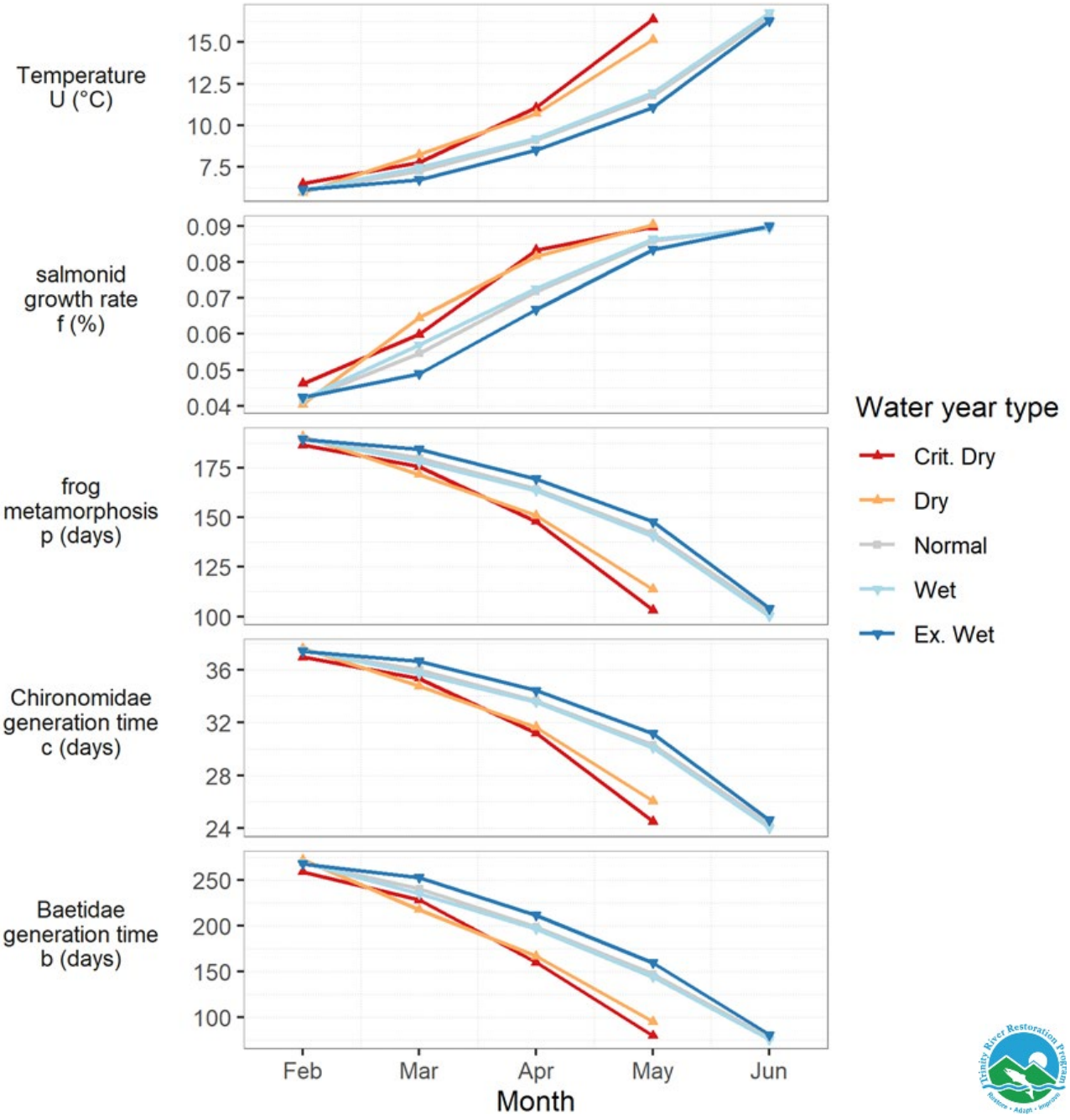


- Juvenile chinook are smaller after ROD implementation (RST results 1989-2018)

Pinnix et al. 2022

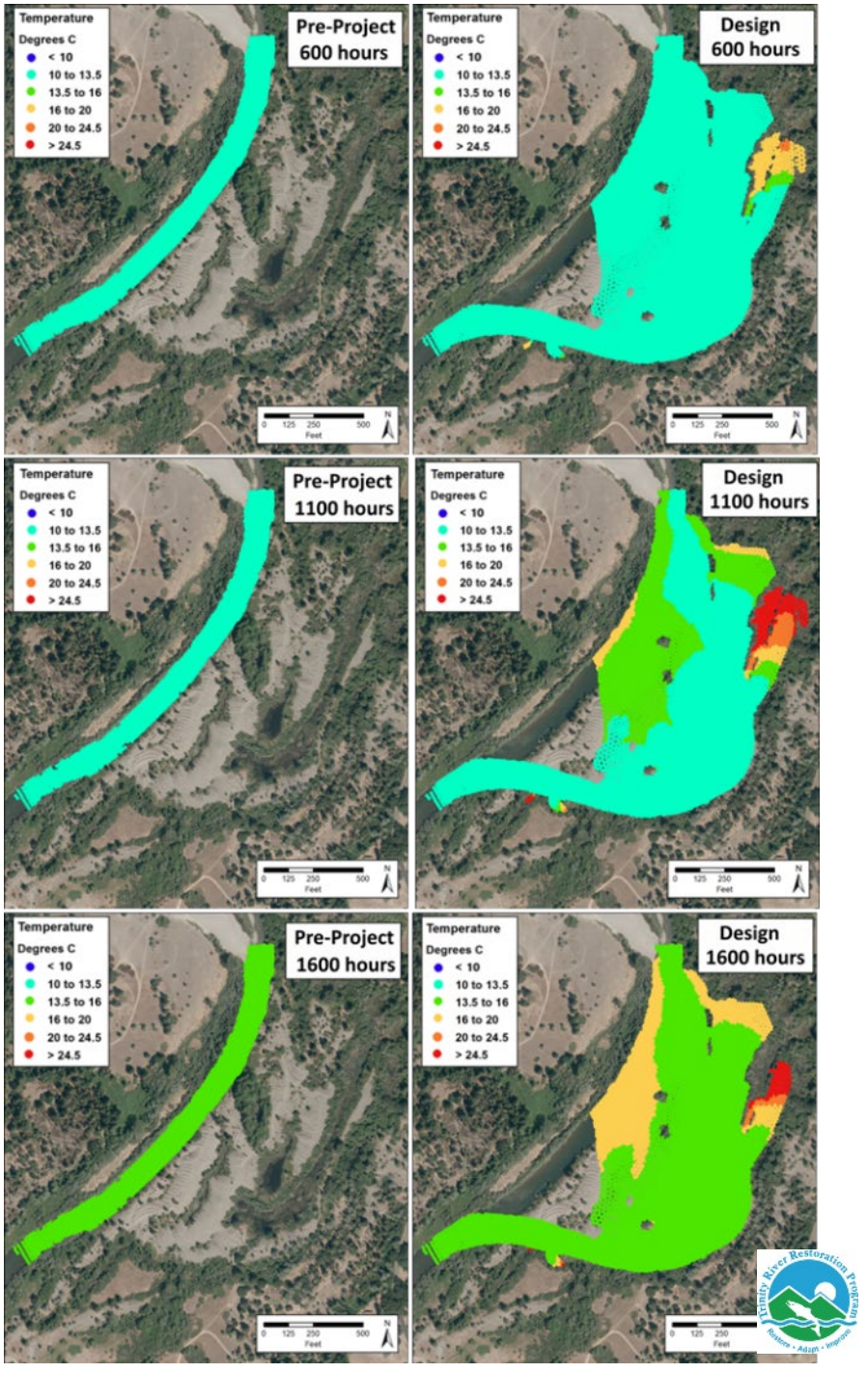
Results- Biological Metrics

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

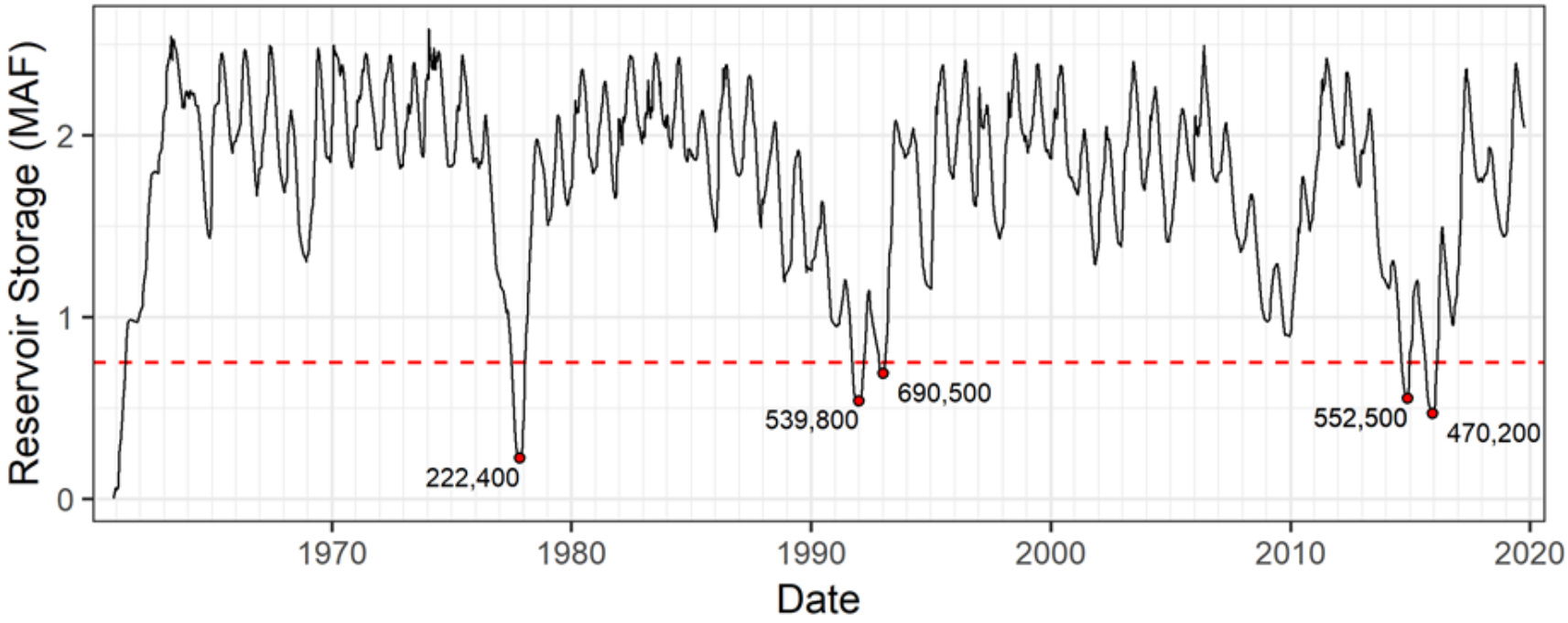


Results – lateral thermal diversity

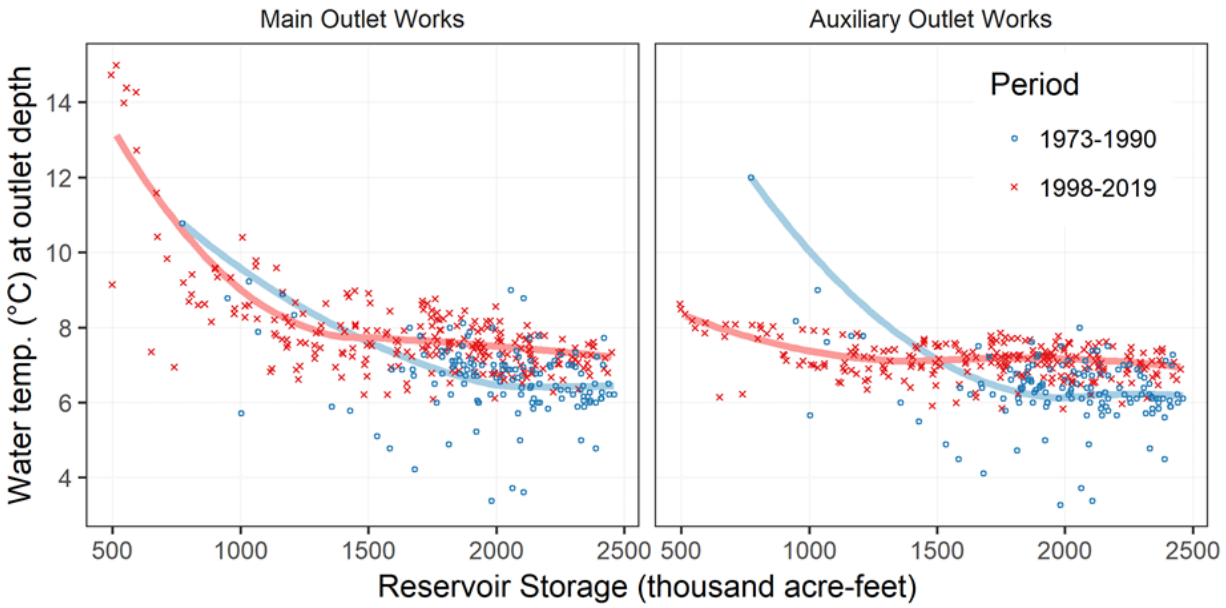
- SRH-2D model results for the Oregon Gulch restoration site
- Channel form can influence local thermal diversity
- The impaired channel offers little choice for mobile ectothermic organisms
- Topographically influenced thermal diversity could be substantial at channel rehab sites
- Thermal diversity: New evaluation metric for restoration site designs?

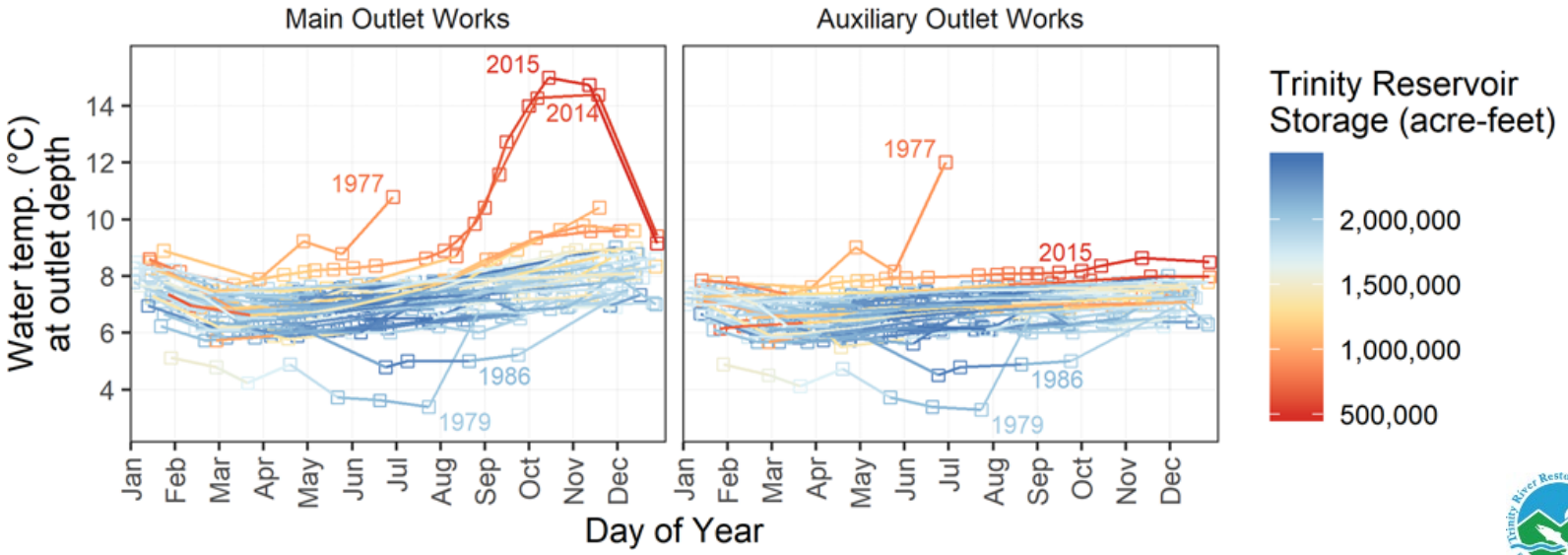


Results-Measure Trinity Reservoir storage

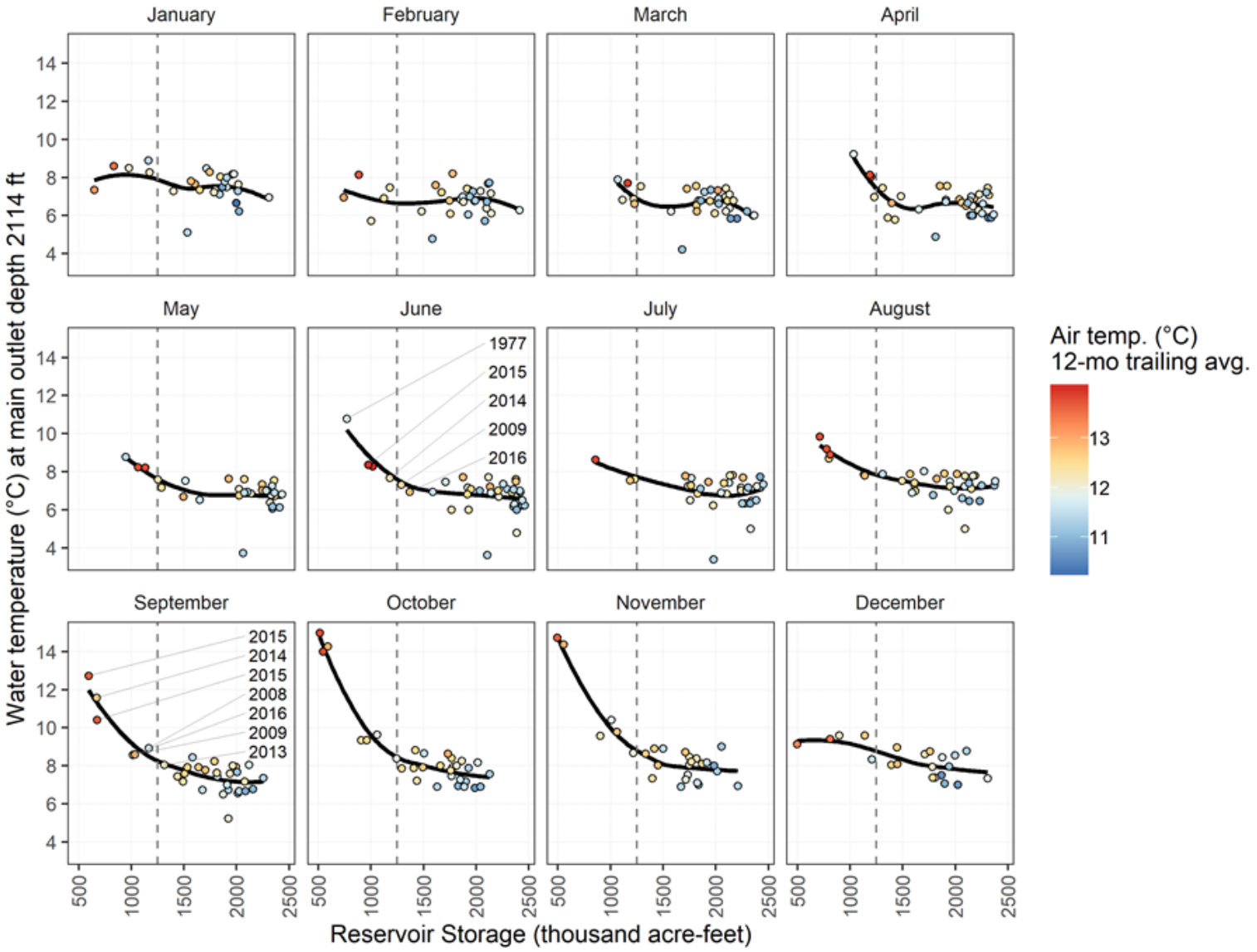


Results-Trinity Reservoir



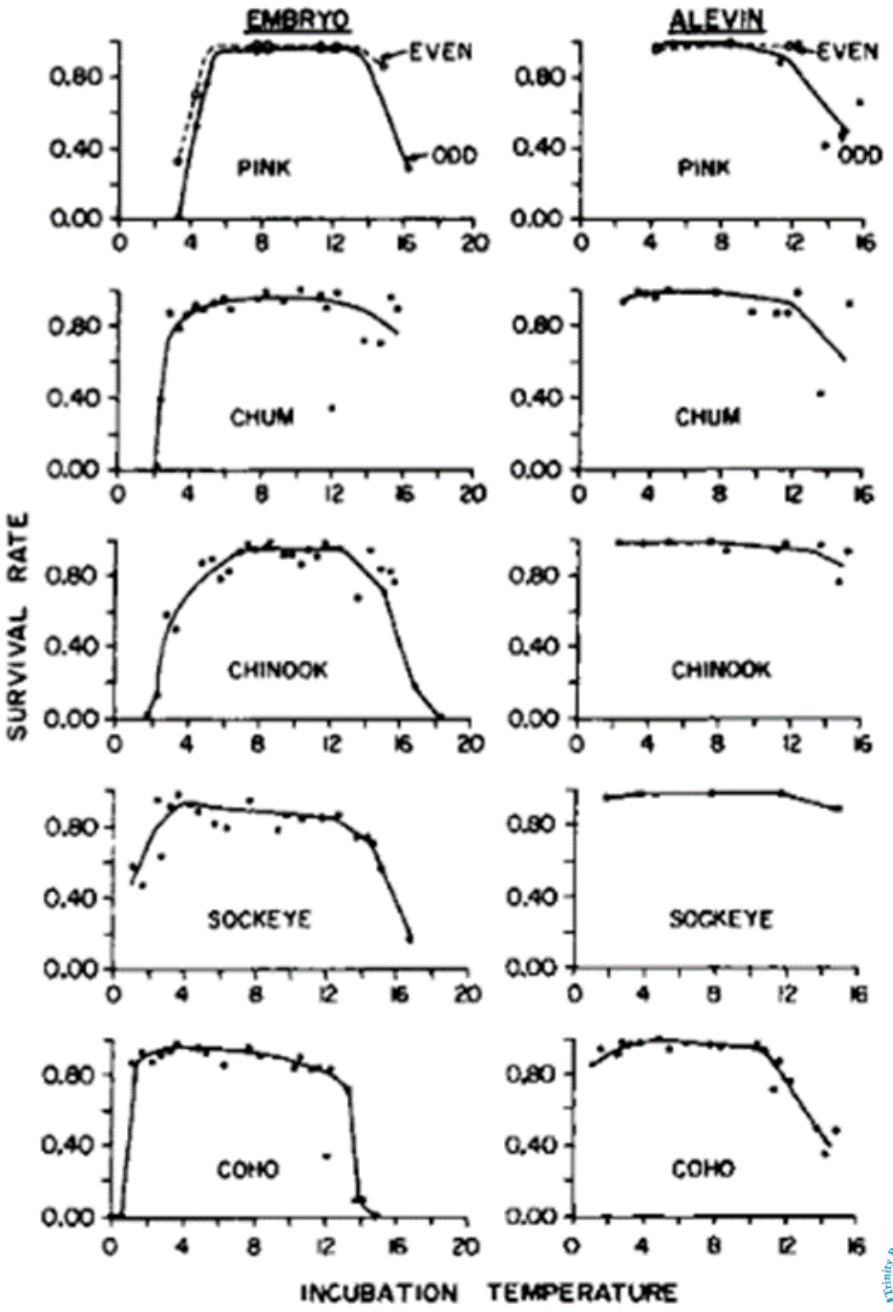


Results-Trinity Reservoir



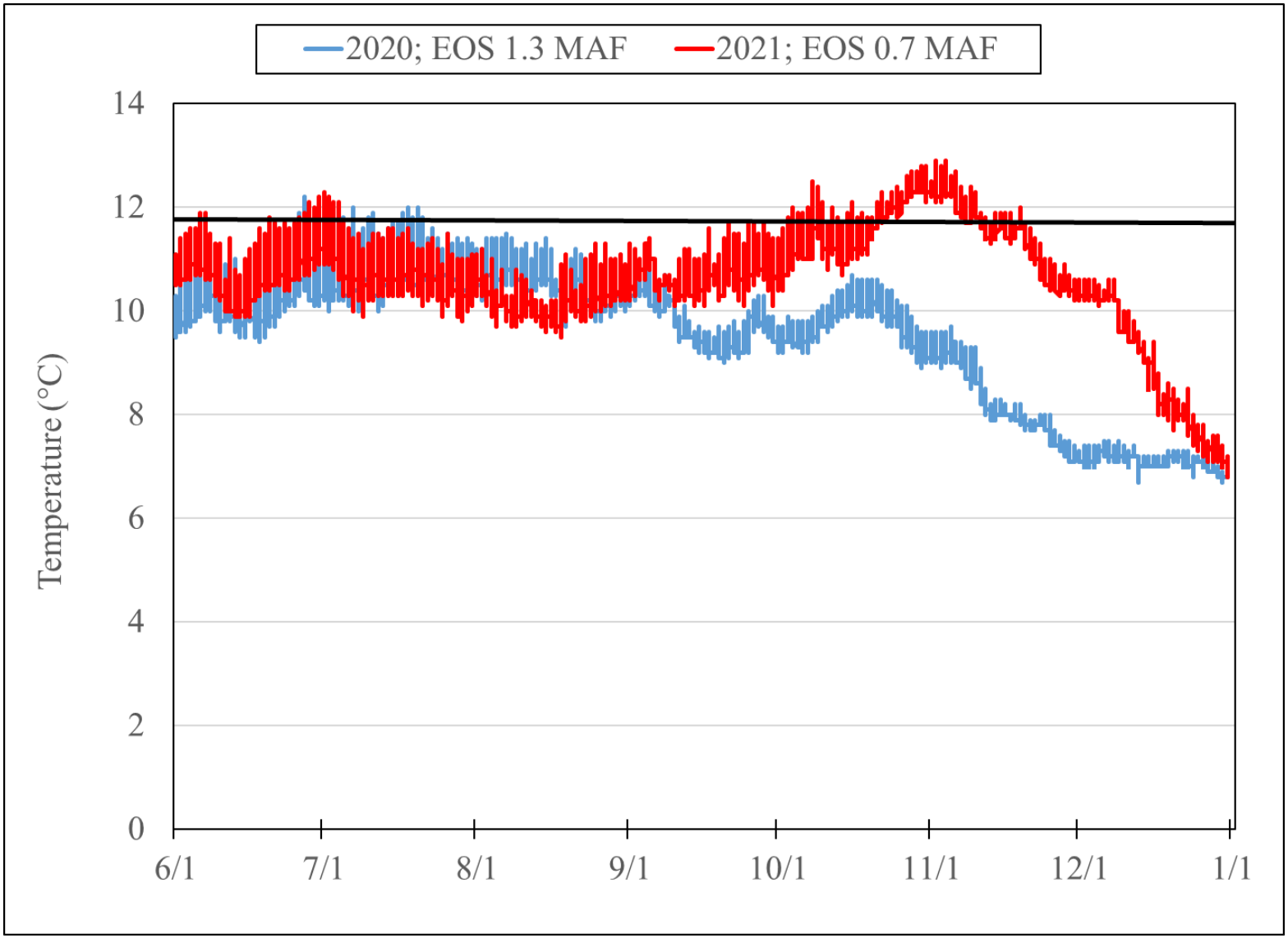
Salmonid egg survival versus temperature

- Highest Coho Salmon embryo and alevin survival rates were at 4°C or 5°C…the pre-dam temperatures during egg incubation!
- Coho salmon egg survival rapidly falls at temperatures greater than 12°C

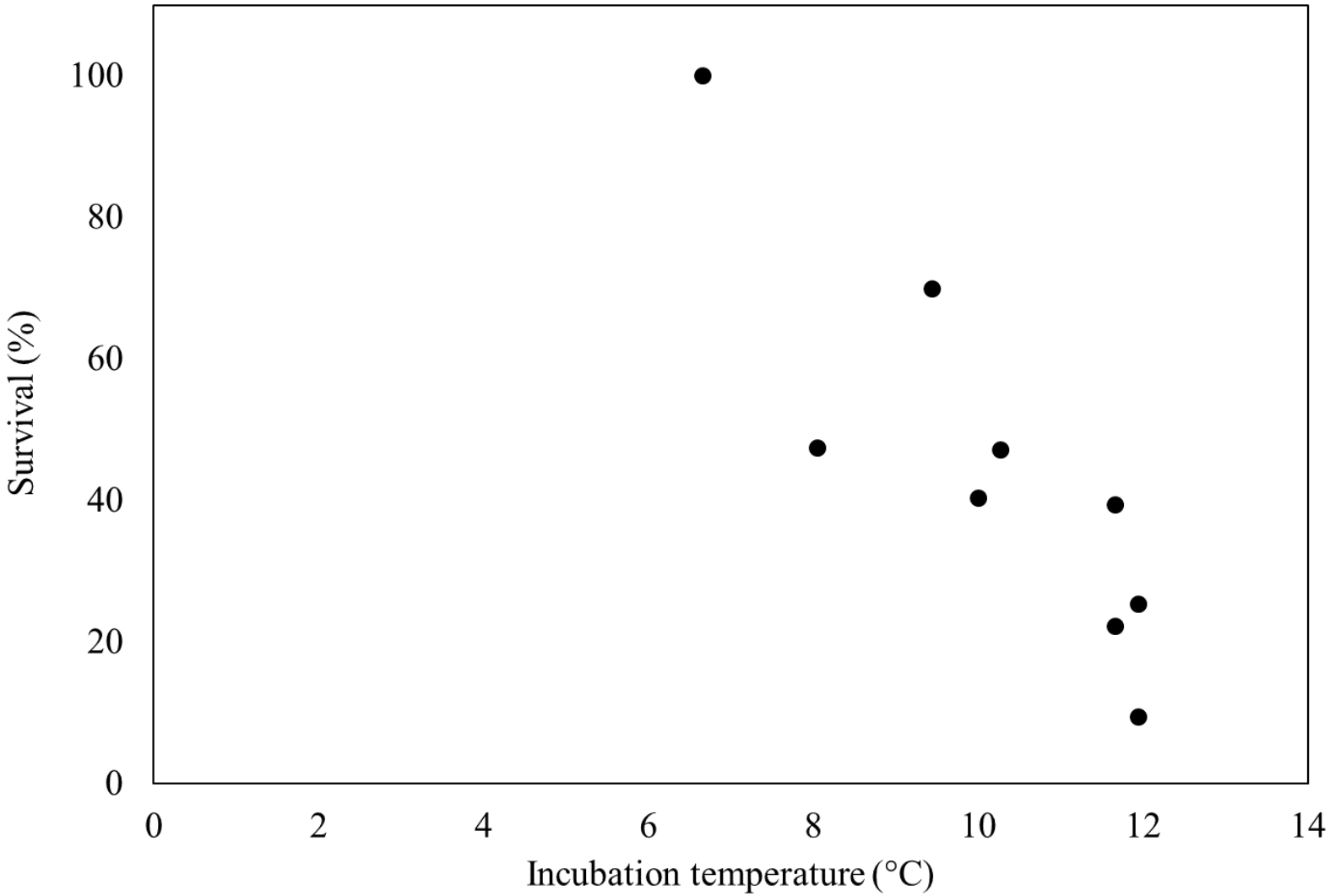


Beacham and Murray 1990

Trinity River at Lewiston temperatures 2021

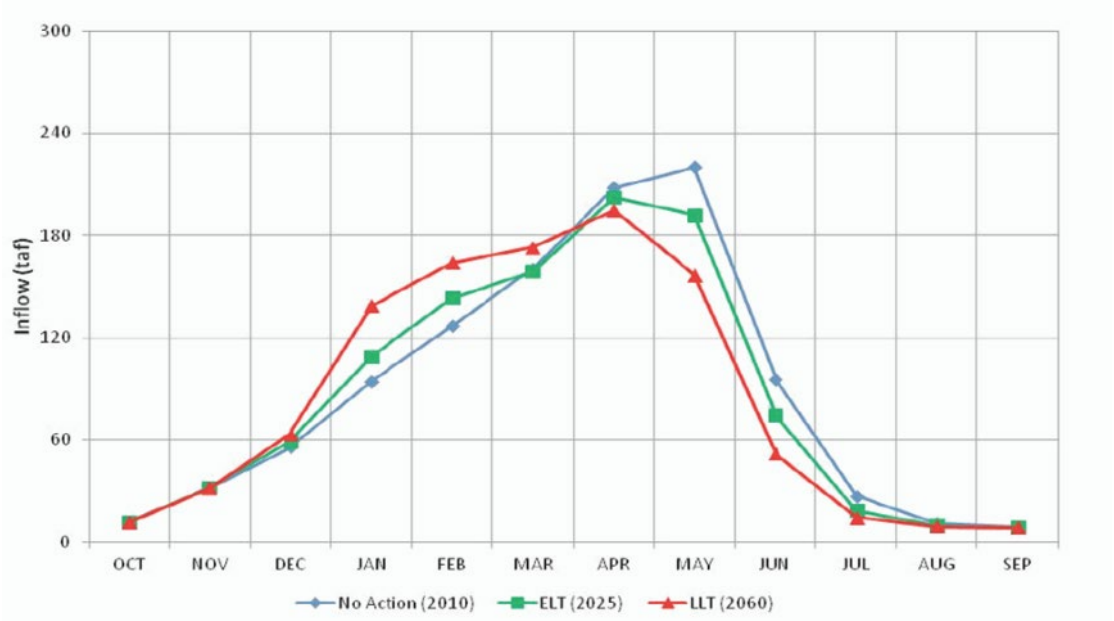


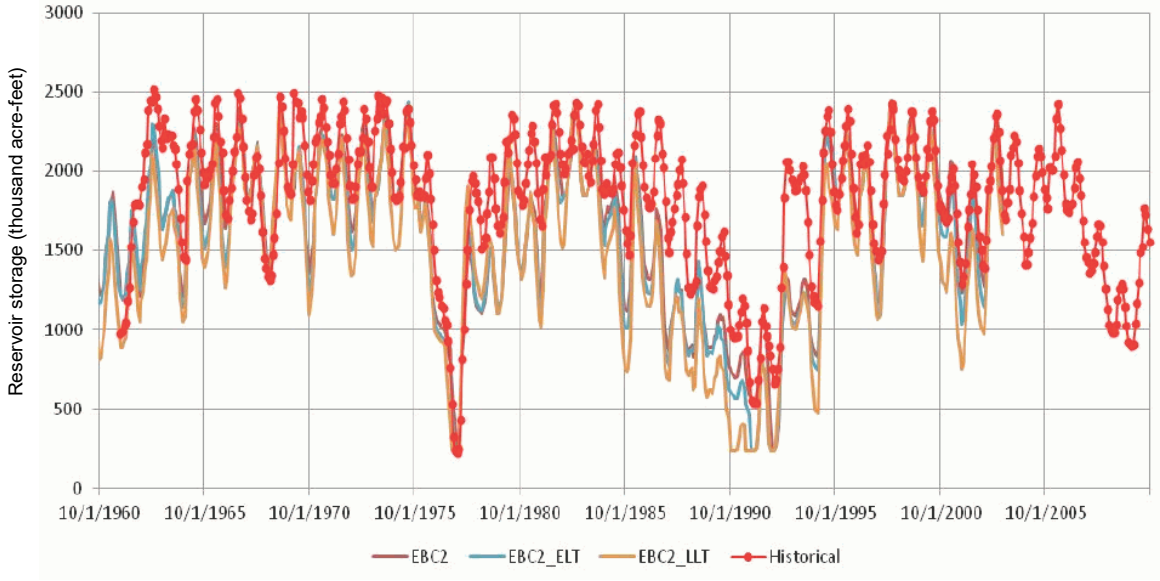
Measured hatchery Coho Salmon egg survival 2021



Data provided by CDFW

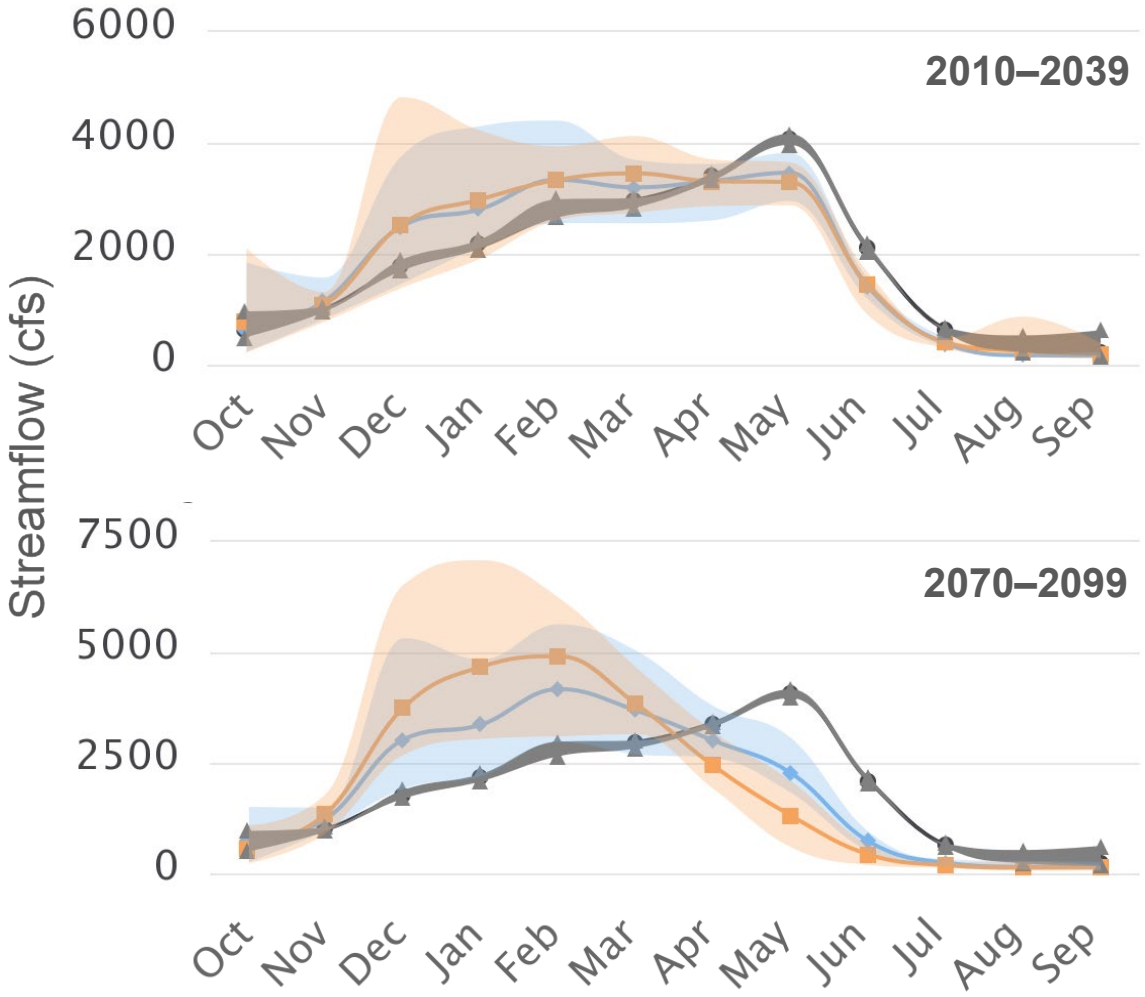
Results-Climate Change





SWE above 3,000 ft elevation is predicted to decline from 11.6 inches in 1981-2010 to 1.6 inches in 2070-2099 (Micheli et al. 2018).

Results-Climate Change



Climate Scenario

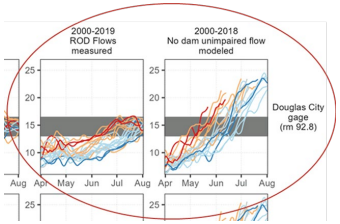
- High emissions (RCP 8.5)
- Reduced emissions (RCP 4.5)
- Historical 1950–2005

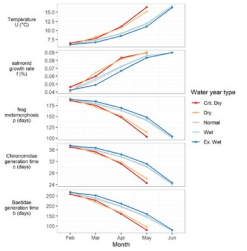
Water temps for Salmon River 2070-2099: 1.7–3.3°C warmer under the high-emission RCP8.5 scenario

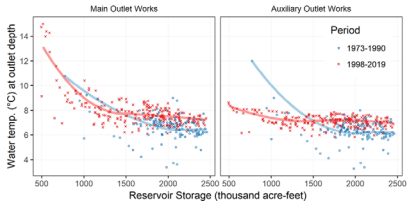
(Asarian et al. 2019)

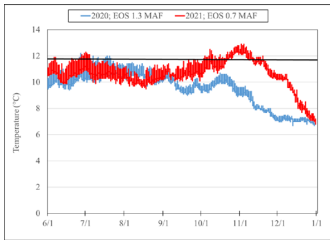
Major Findings

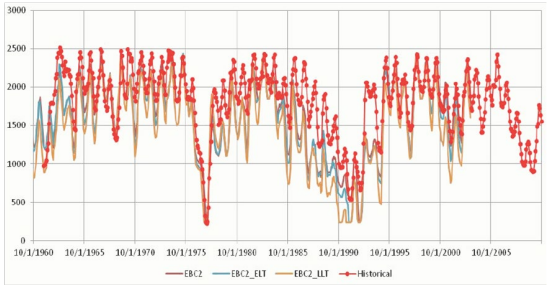
- 1999-2022 flow releases have unnaturally reduced spring temperatures
- Flows and temperatures from Lewiston Dam cannot be manipulated separately in an effective manner
- Trinity Reservoir temperatures are warming
- At storage less than 750 TAF, release temperatures can threaten spawning adult salmonids
- Exacerbated by climate change











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 (13-16.5 °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!

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