

# FISH HATCHERY INFRASTRUCTURE AND WATER VULNERABILITY ASSESSMENTS

## Phase 1: Watershed Characterizations

Kathleen Hemeon<sup>1</sup>, Doug Peterson<sup>1</sup>, Rod Engle<sup>1</sup>, John Erhardt<sup>1</sup>, Greg Burak<sup>1</sup>, Shane Vatland<sup>2</sup>, Eli Felts<sup>1</sup>



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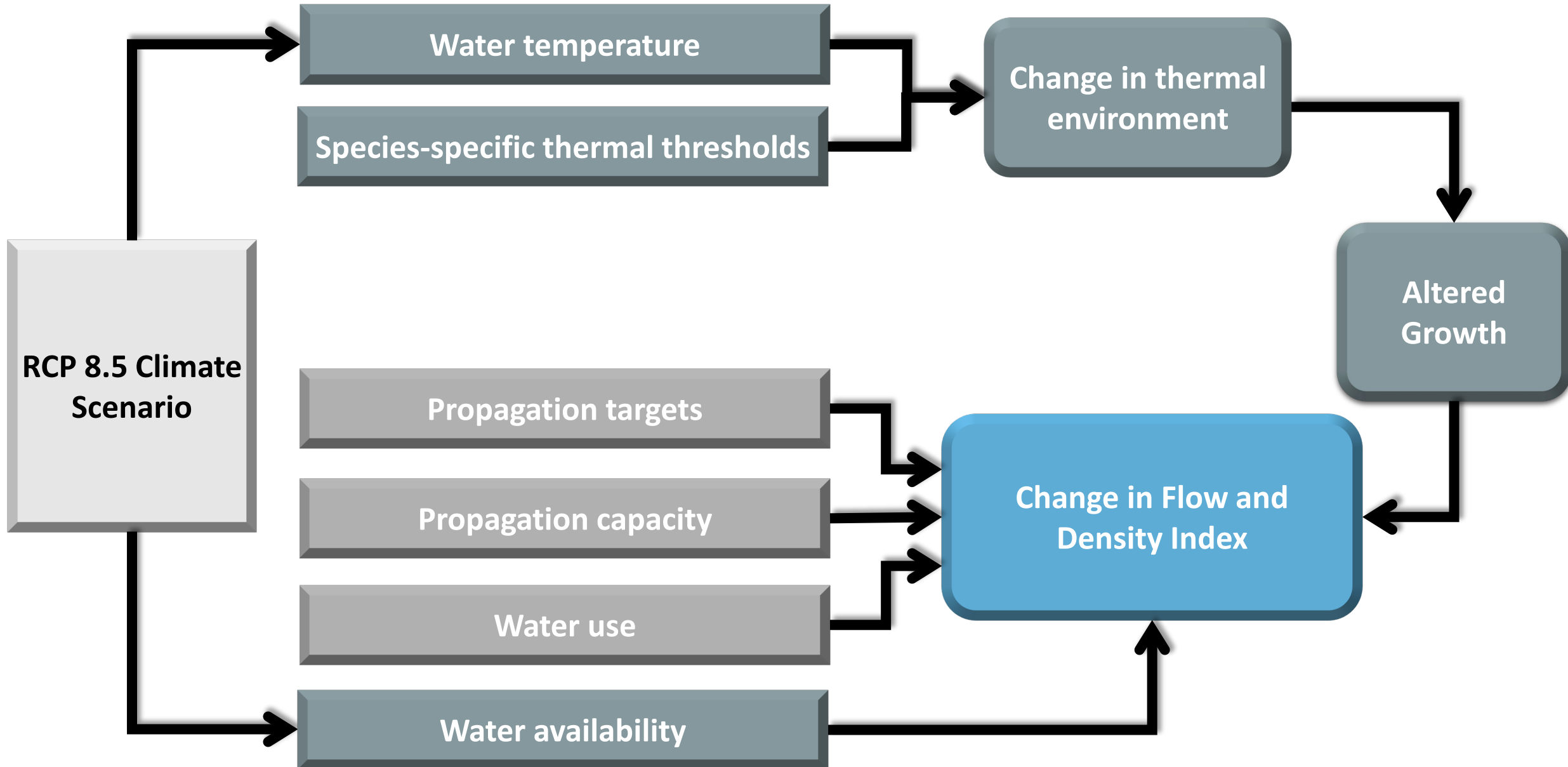


# Climate Change Vulnerability Assessments at Pacific Northwest National Fish Hatcheries

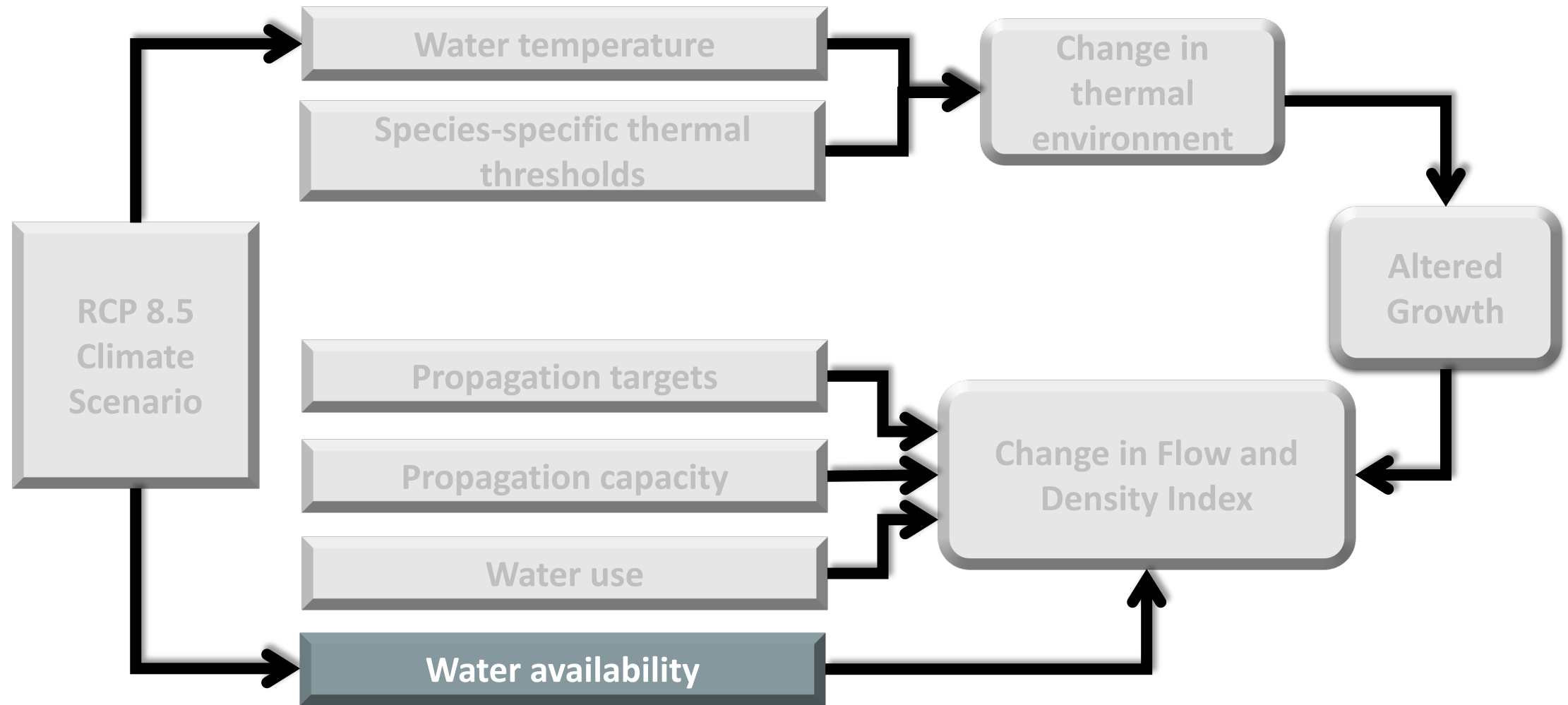
FISHERIES MANAGEMENT

Quantitative Assessments on the Impacts of Climate Change to Pacific Region National Fish Hatcheries and Current and Future Operations

# Modeling Framework | Production Vulnerability



# Modeling Framework | Production Vulnerability

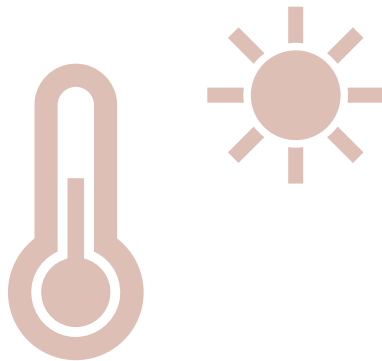


1 ) Evaluate future water availability to hatcheries: watershed characteristics (e.g., SWE, precipitation)



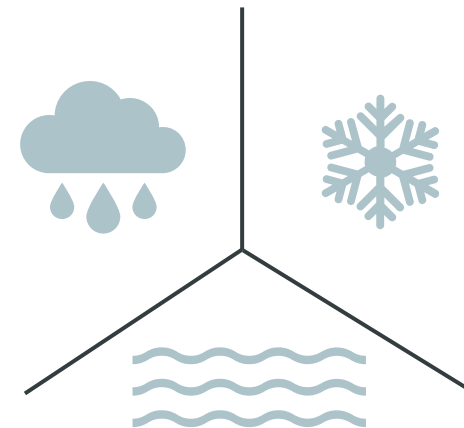
## Climate

- Mean average surface air temperature (°C)
- Mean minimum surface air temperature (°C)
- Mean maximum surface air temperature (°C)



## Hydrology

- Precipitation (mm/month)
- Snow water equivalent [SWE] (mm on 1<sup>st</sup> day of month)
- Total runoff (mm/month)

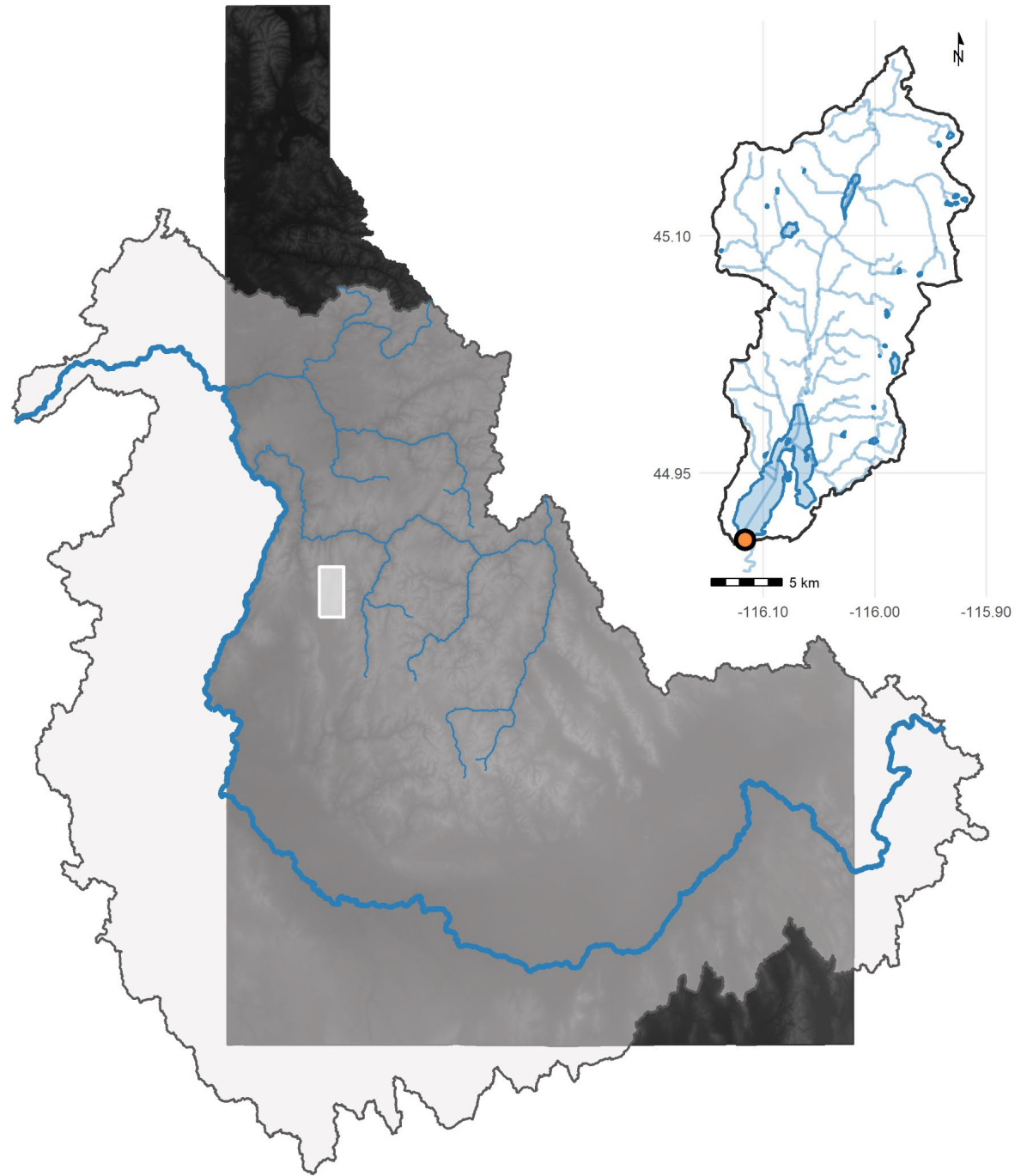


# Preliminary Project Sites



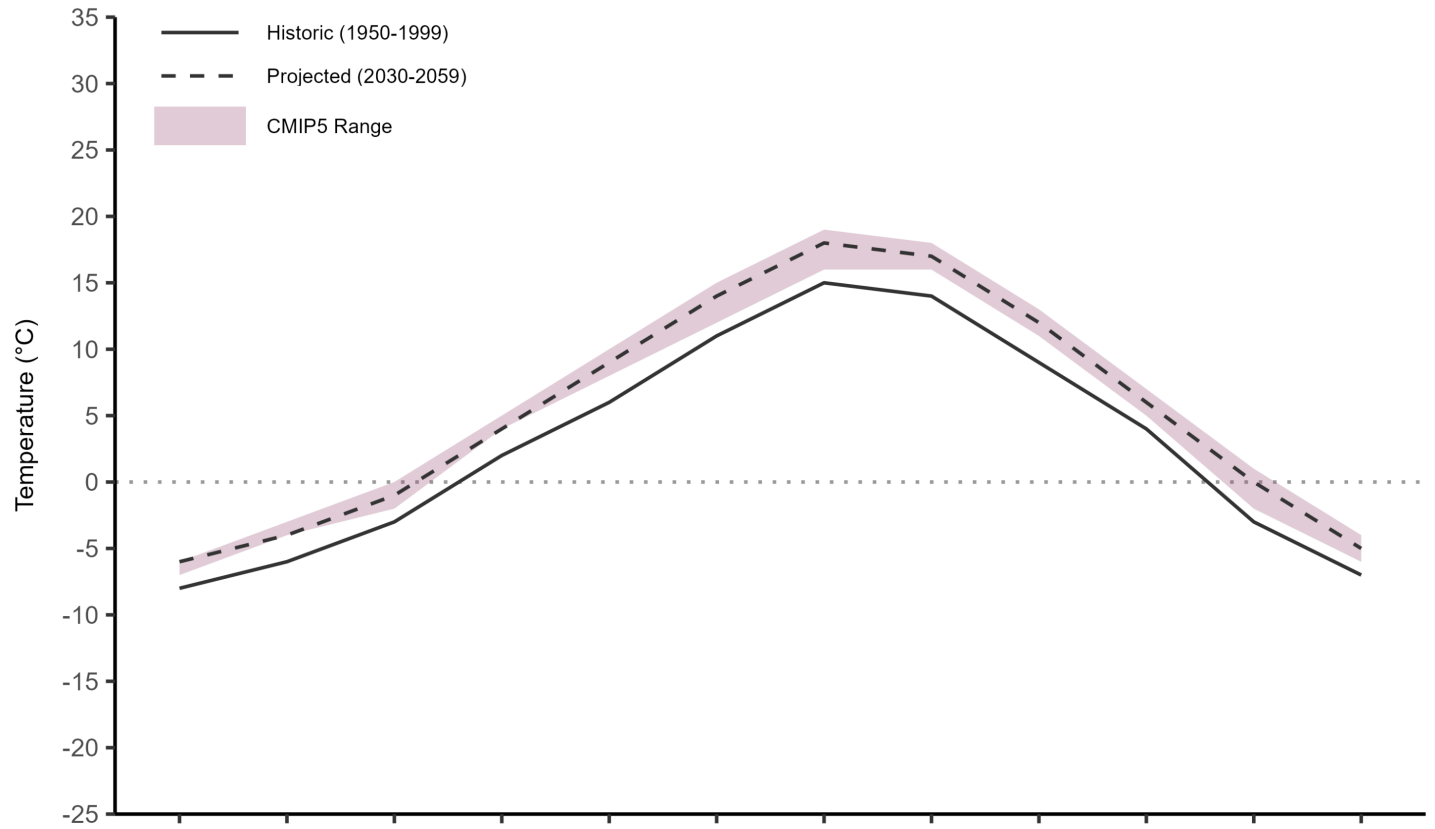


# McCall | Hatchery

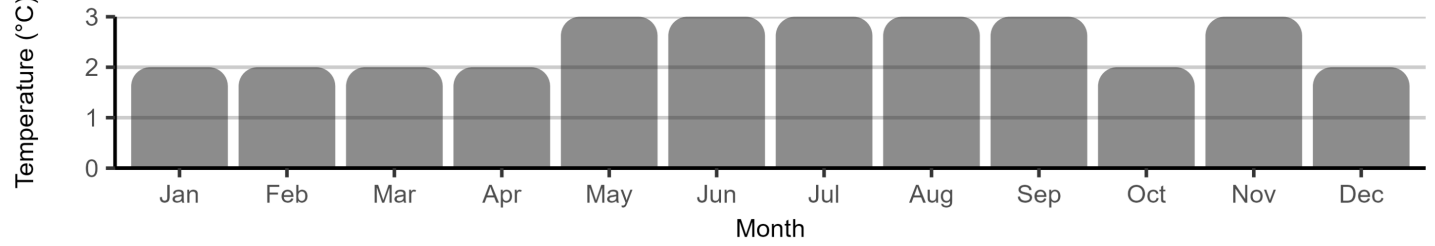


# McCall Hatchery | Climate

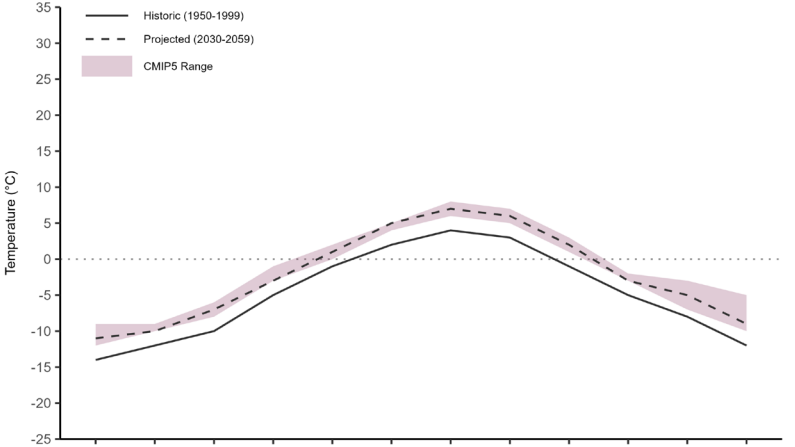
Average Surface Air Temperature



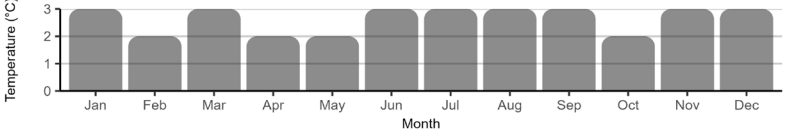
Mean Δ Temperature



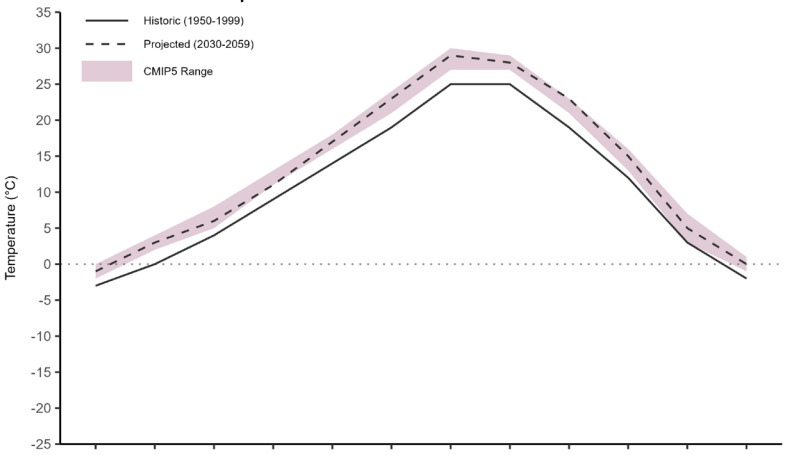
Minimum Surface Air Temperature



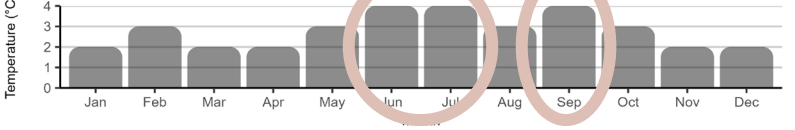
Mean Δ Temperature



Maximum Surface Air Temperature

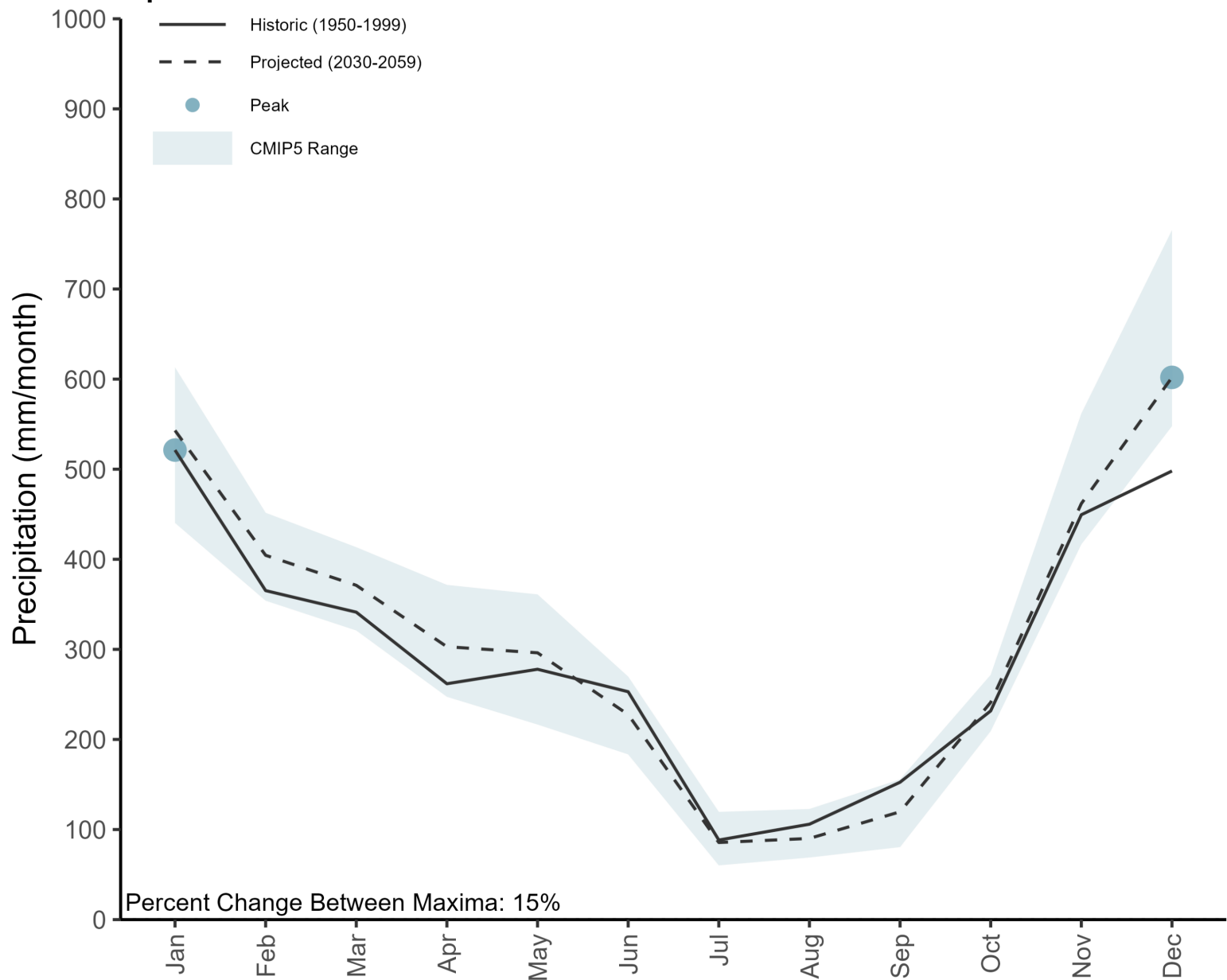


Mean Δ Temperature

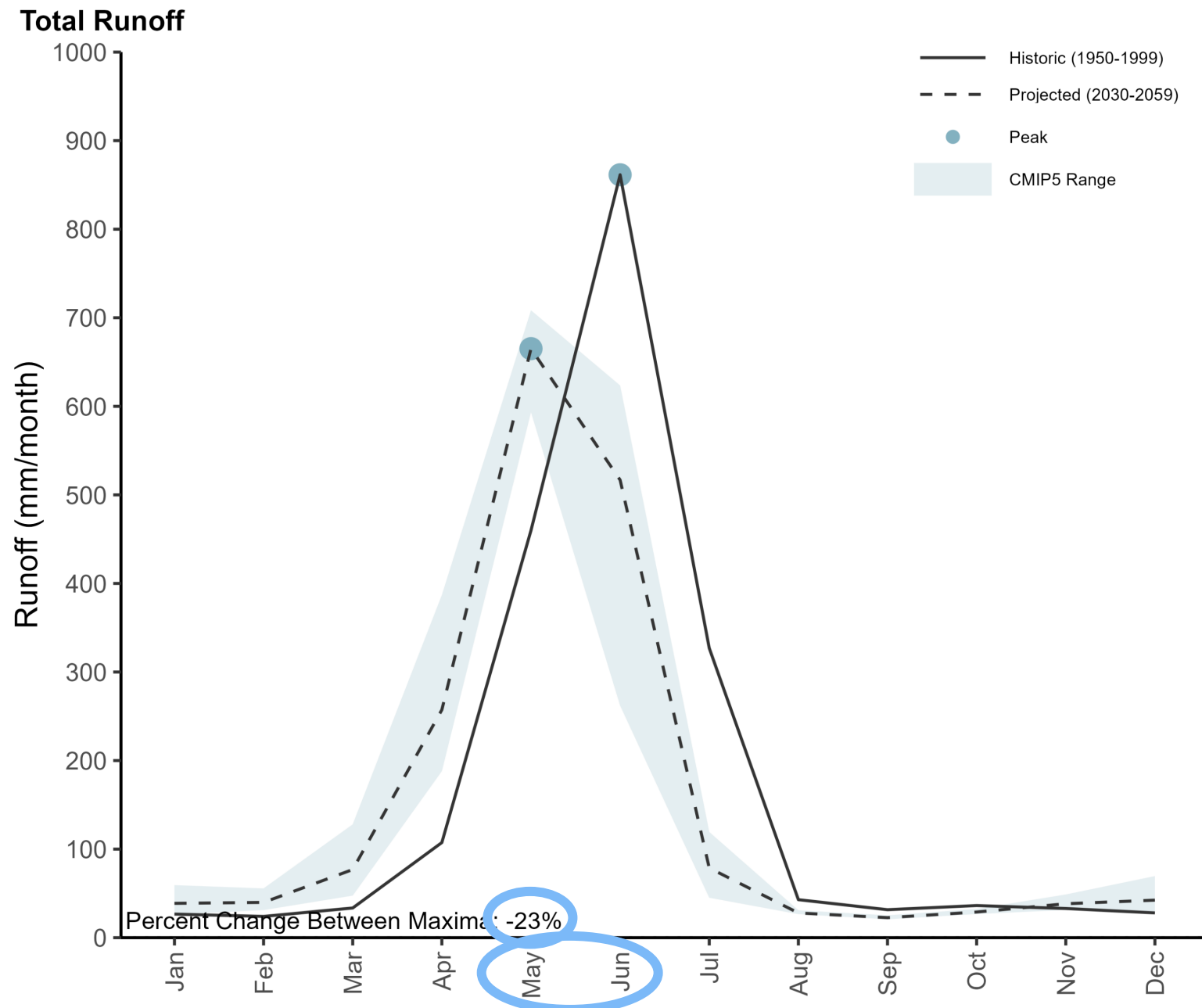


# McCall Hatchery | Hydrology

Total Precipitation

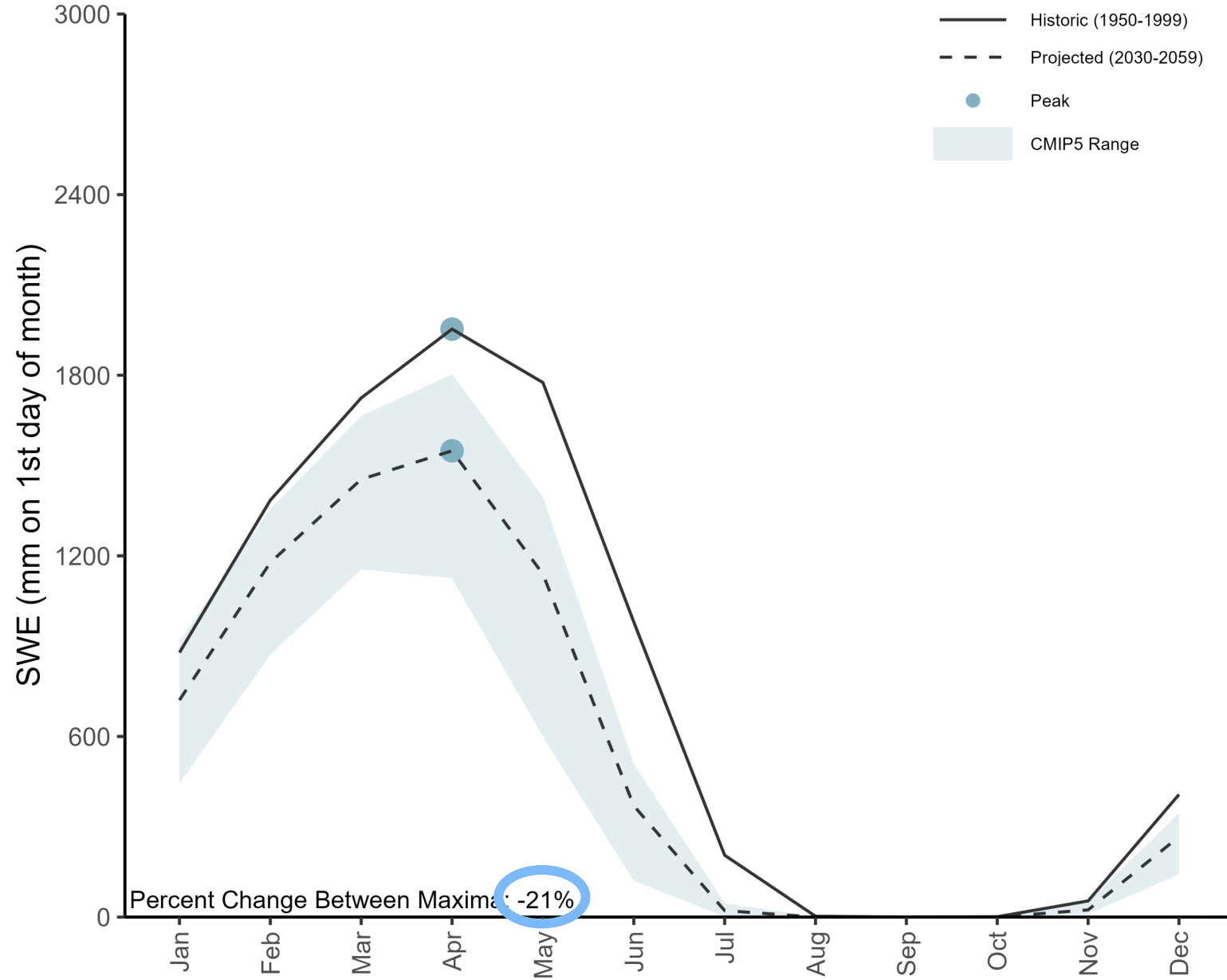


# McCall Hatchery | Hydrology



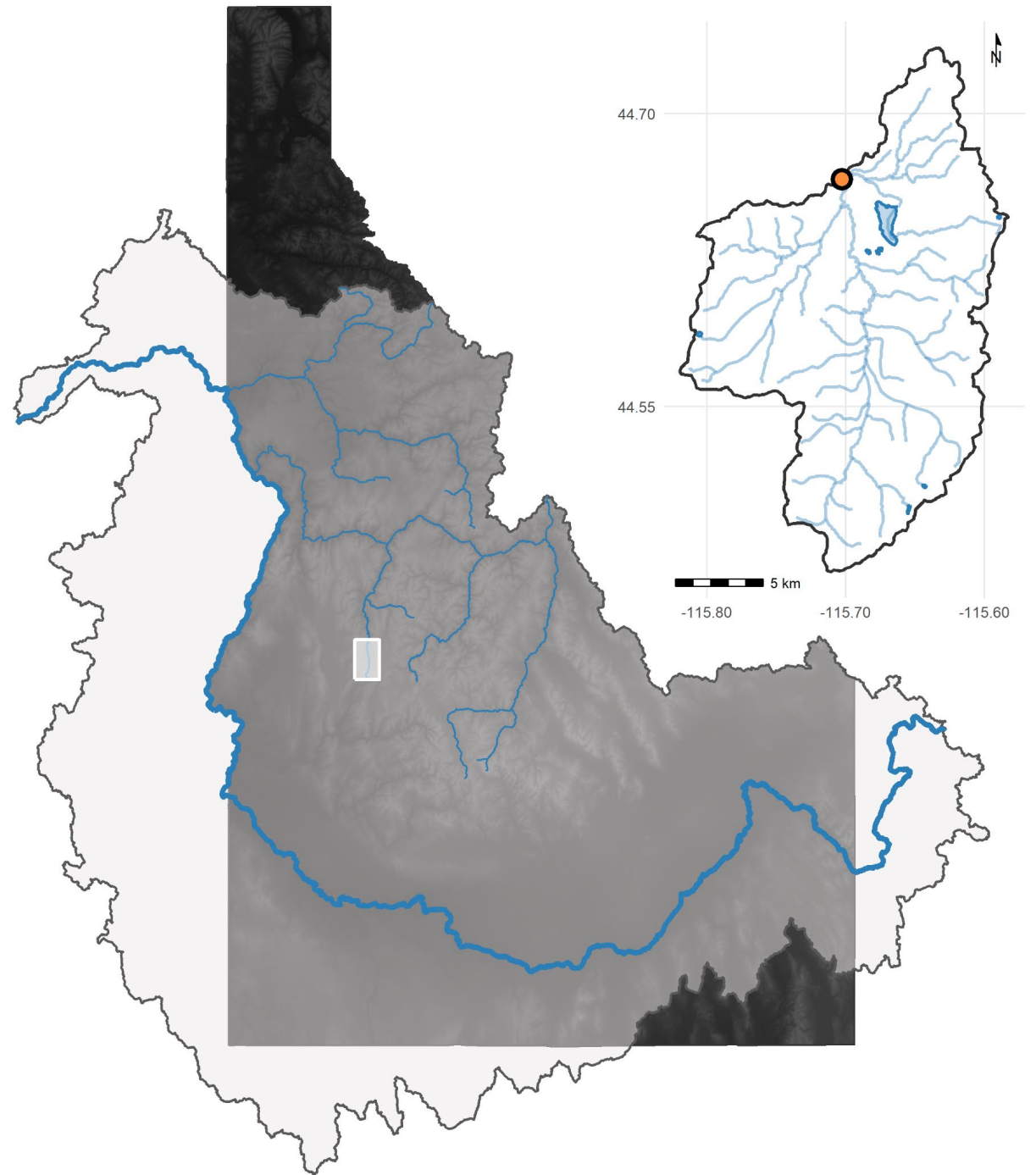
# McCall Hatchery | Hydrology

Total Snow Water Equivalent [SWE]



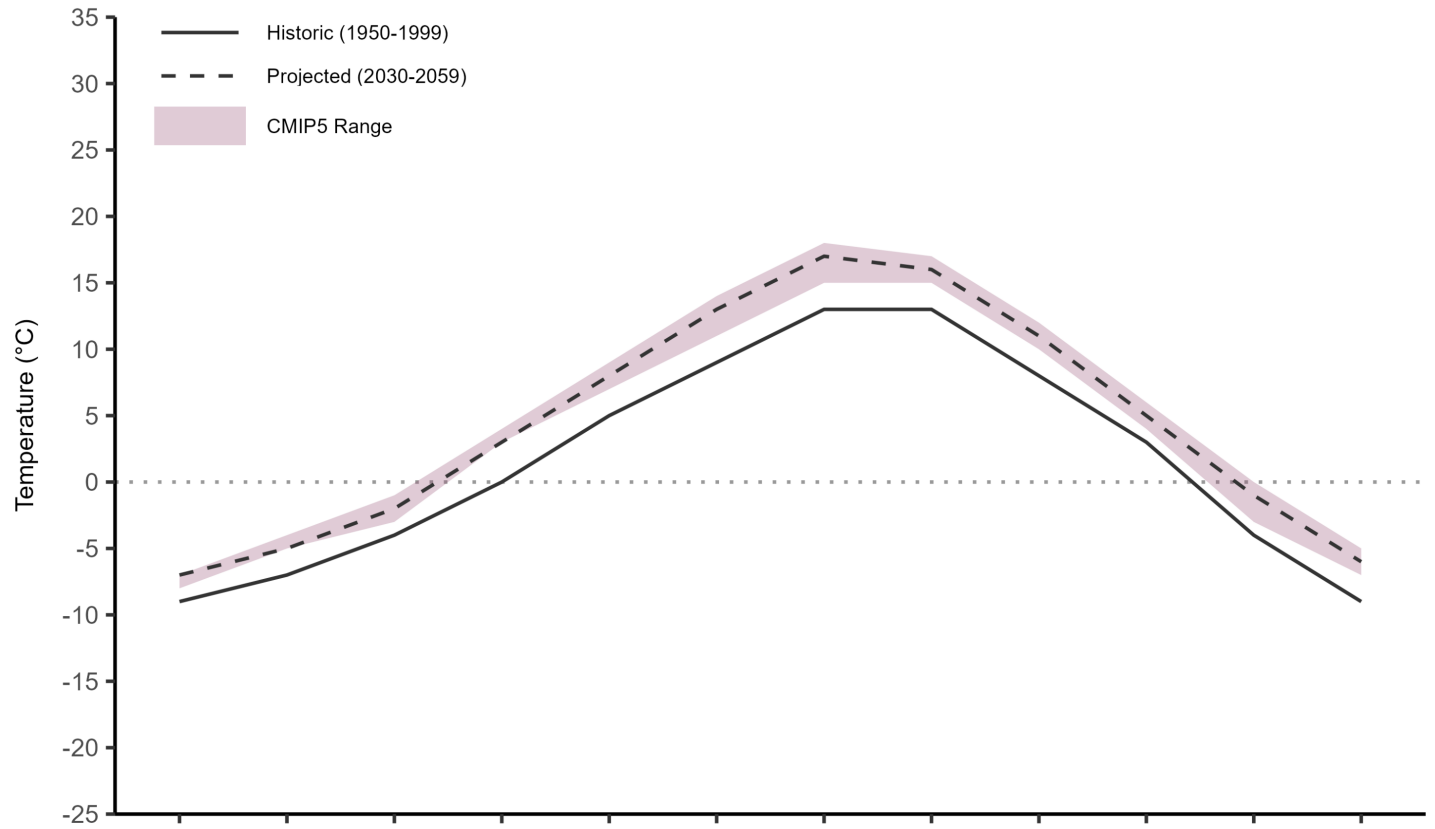


# McCall | Satellite

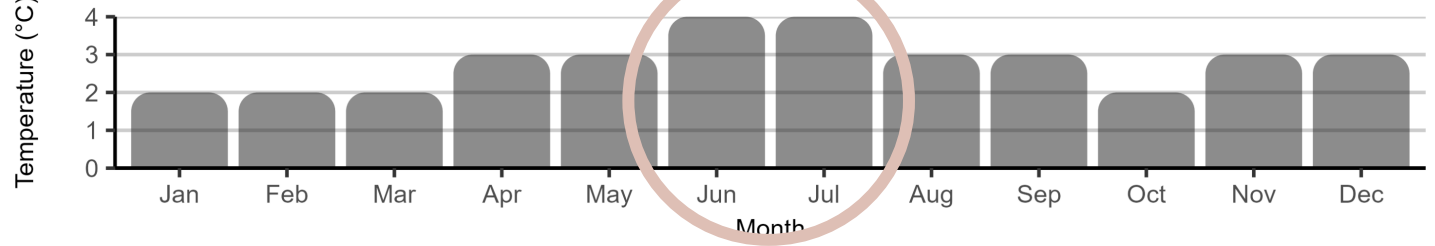


# McCall Satellite | Climate

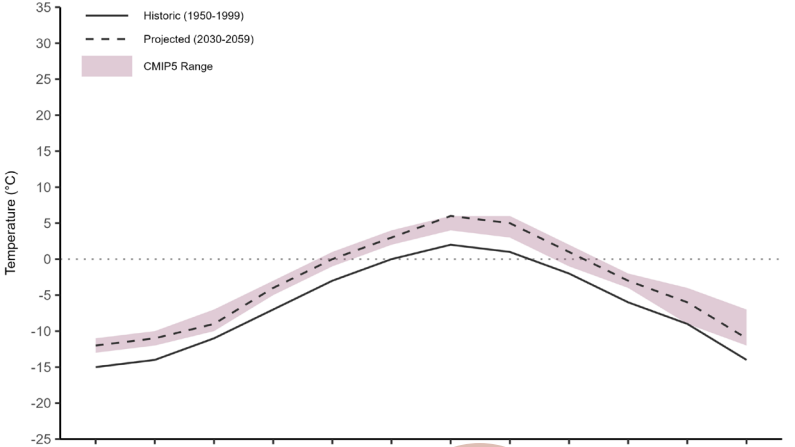
Average Surface Air Temperature



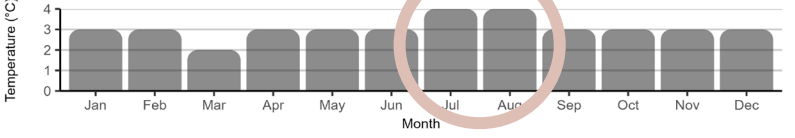
Mean Δ Temperature



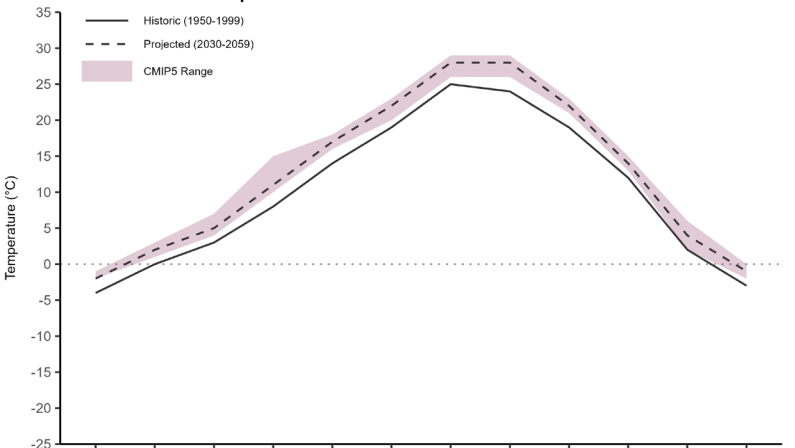
Minimum Surface Air Temperature



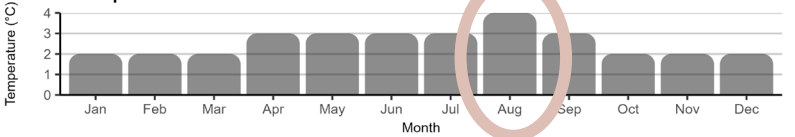
Mean Δ Temperature



Maximum Surface Air Temperature

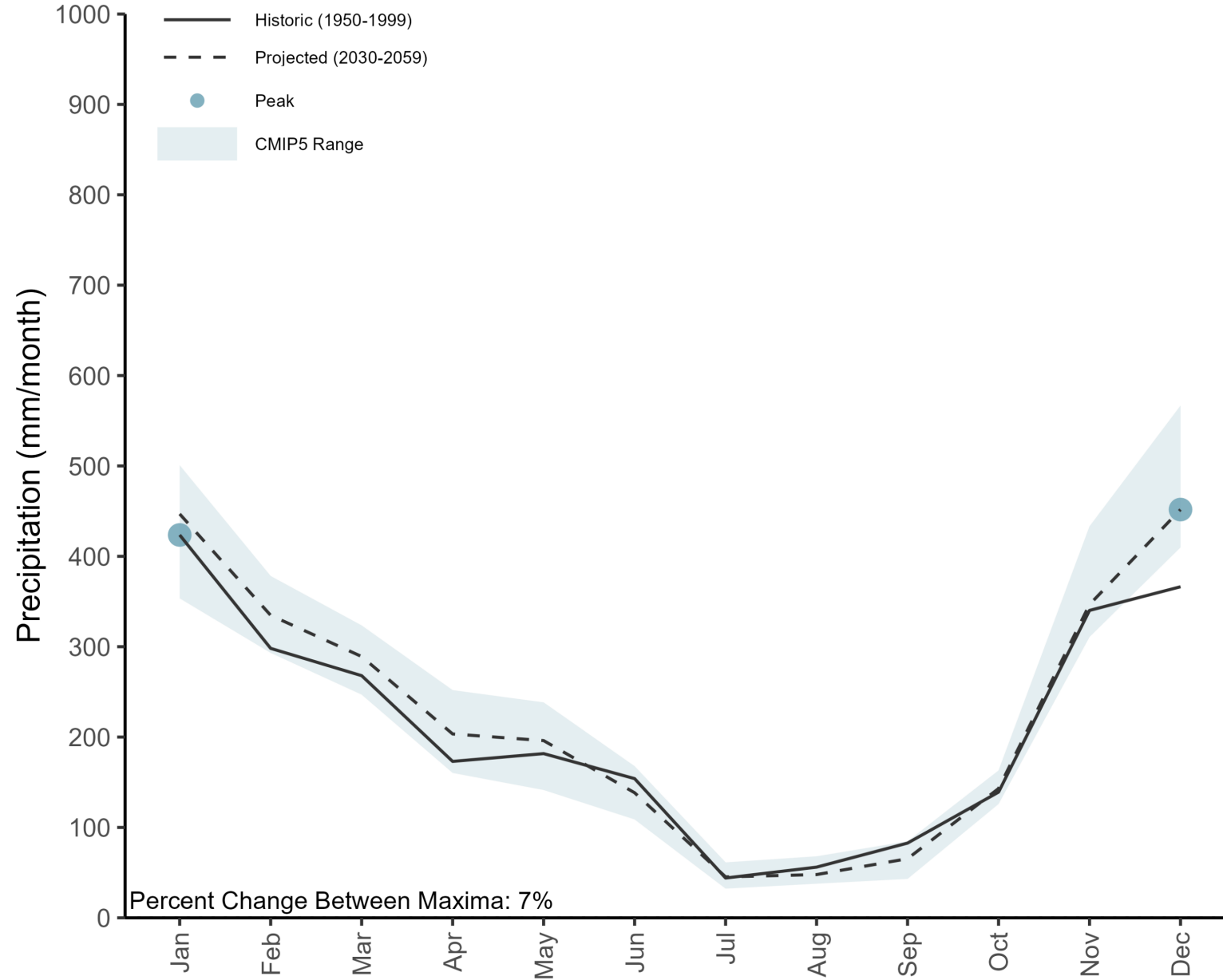


Mean Δ Temperature

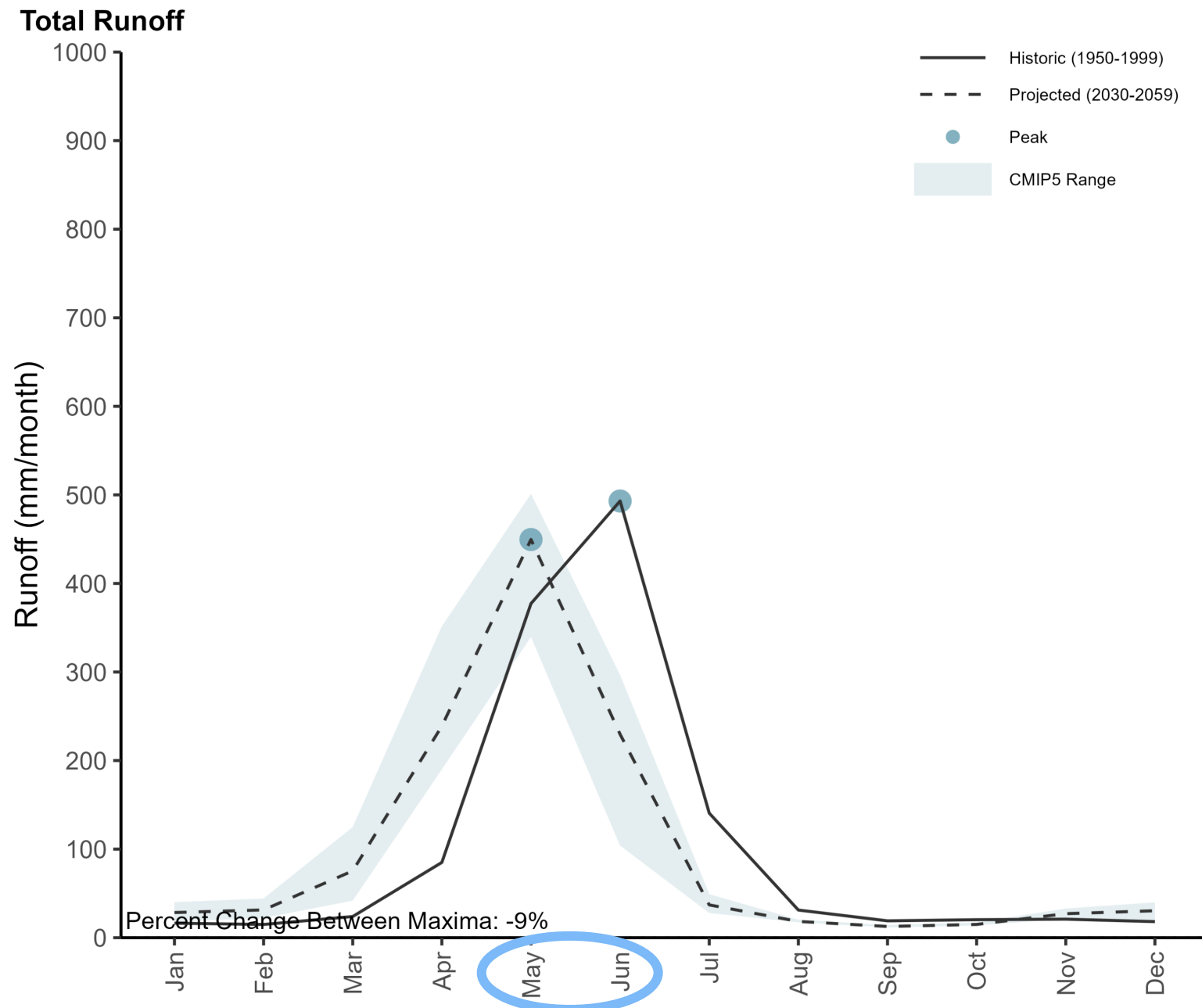


# McCall Satellite | Hydrology

## Total Precipitation

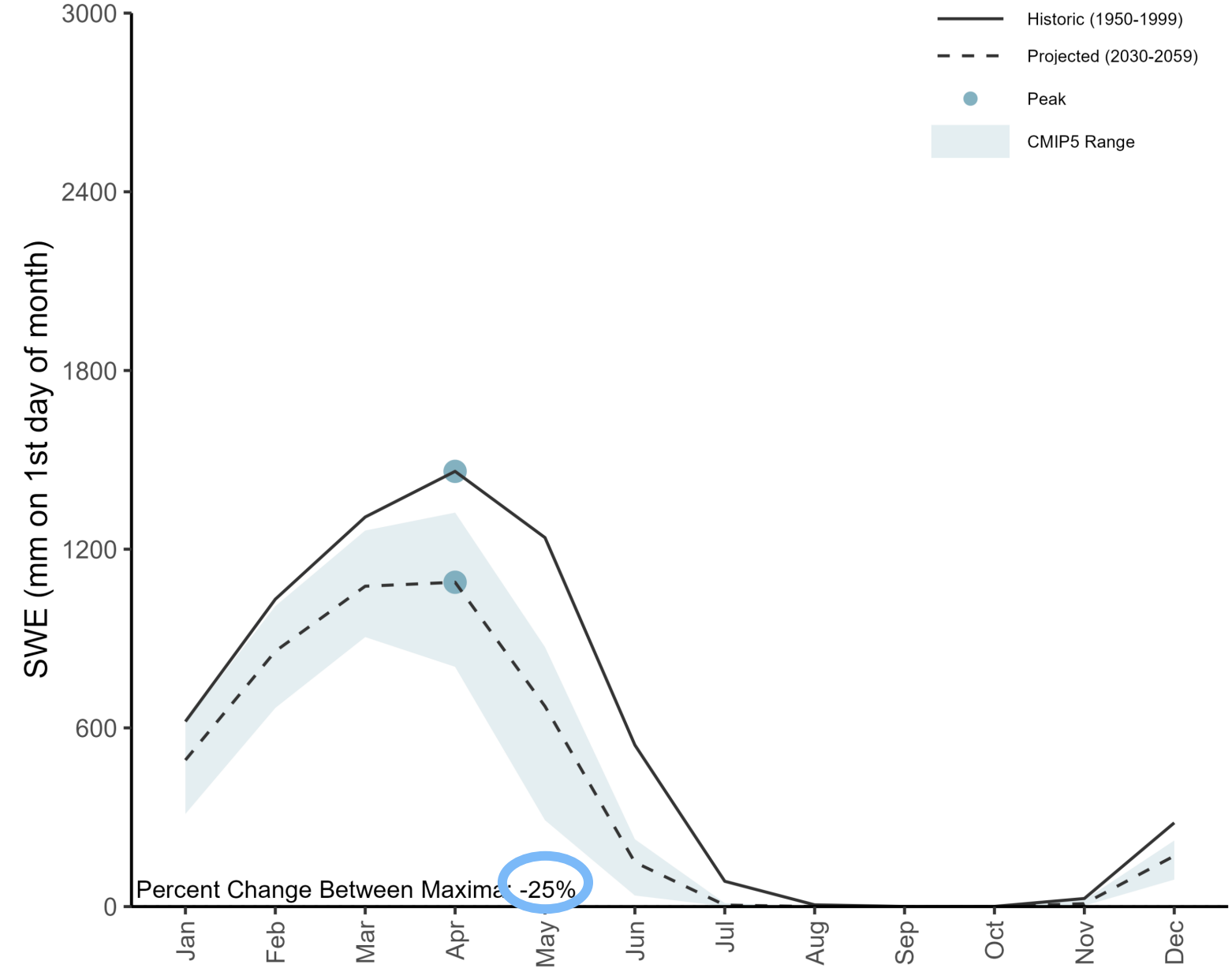


# McCall Satellite | Hydrology

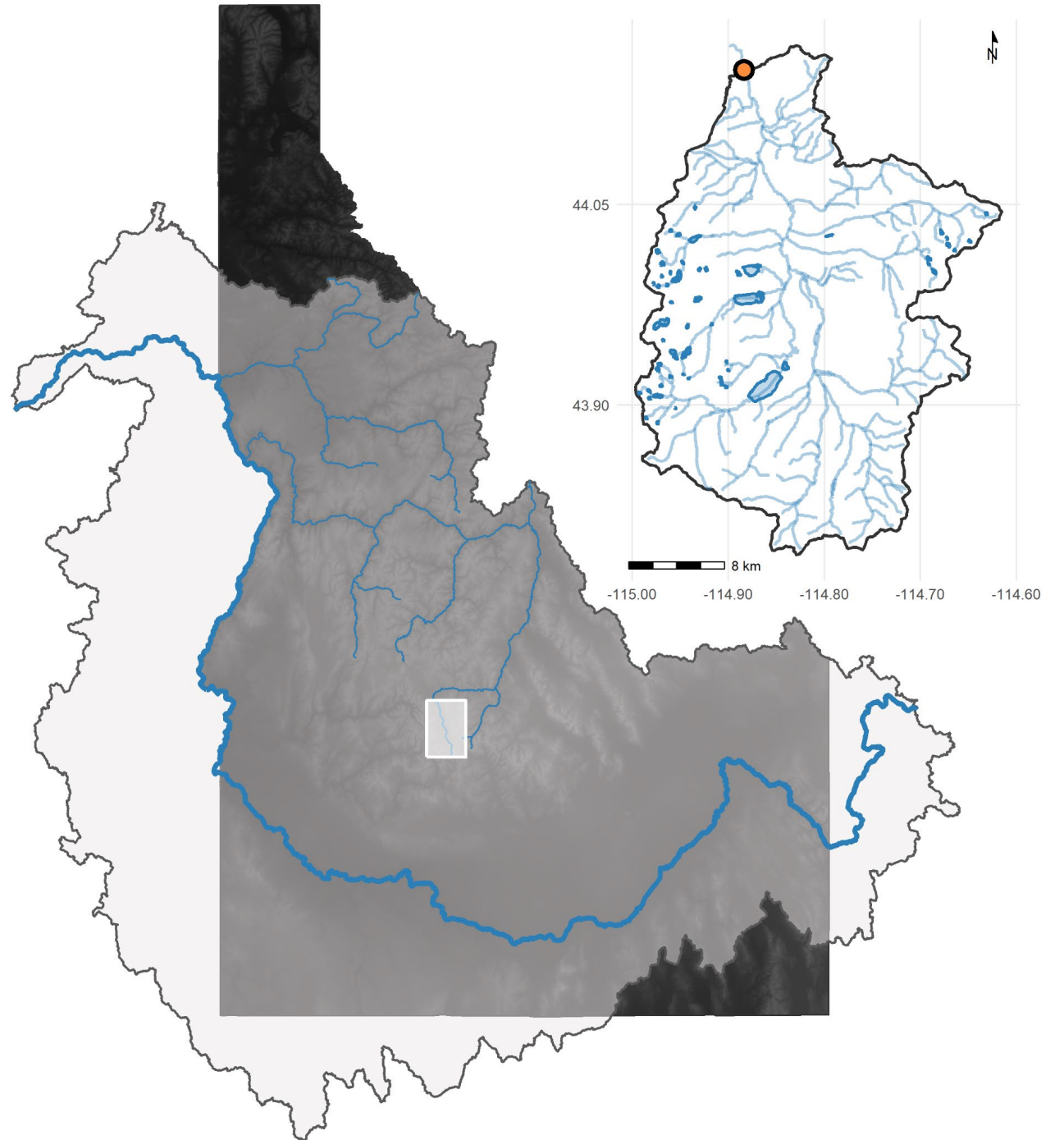


# McCall Satellite | Hydrology

Total Snow Water Equivalent [SWE]

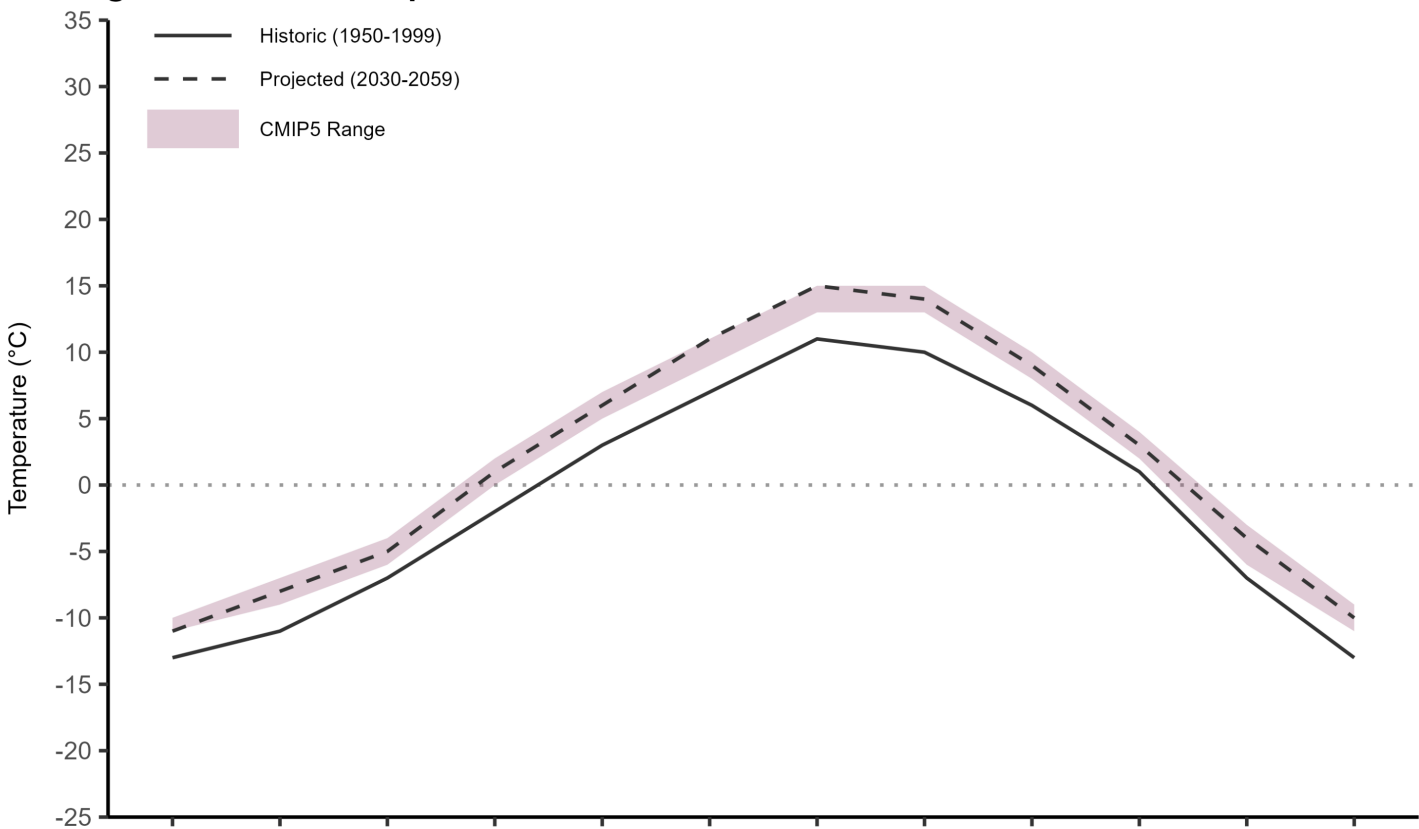


# Sawtooth | Hatchery

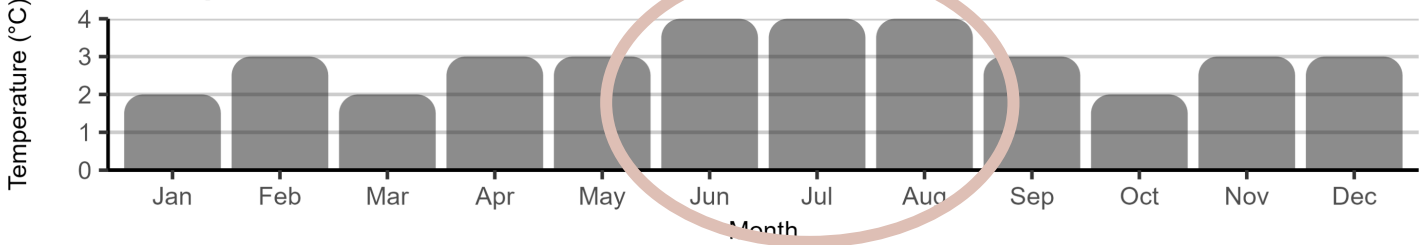


# Sawtooth Hatchery | Climate

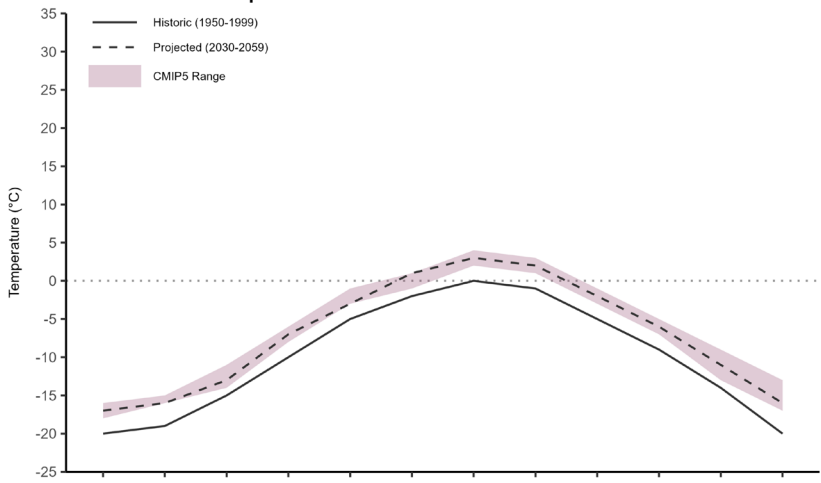
Average Surface Air Temperature



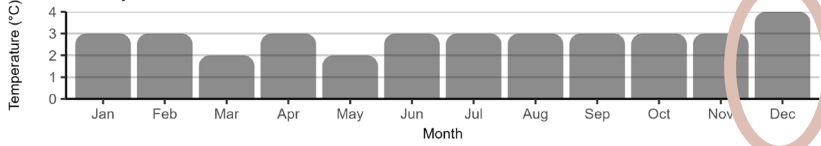
Mean  $\Delta$  Temperature



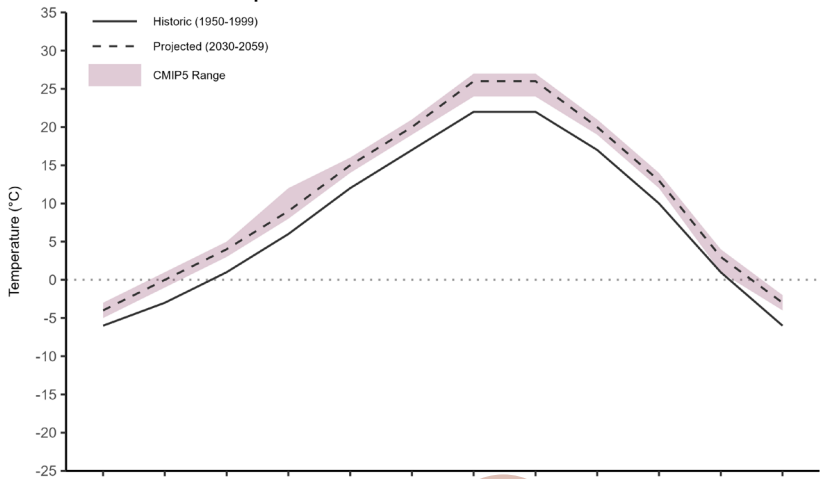
Minimum Surface Air Temperature



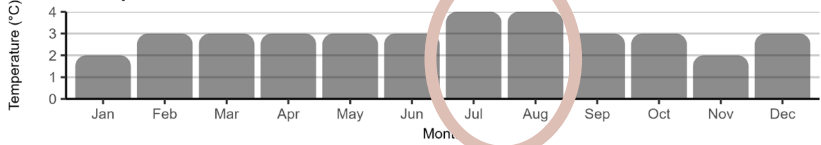
Mean  $\Delta$  Temperature



Maximum Surface Air Temperature



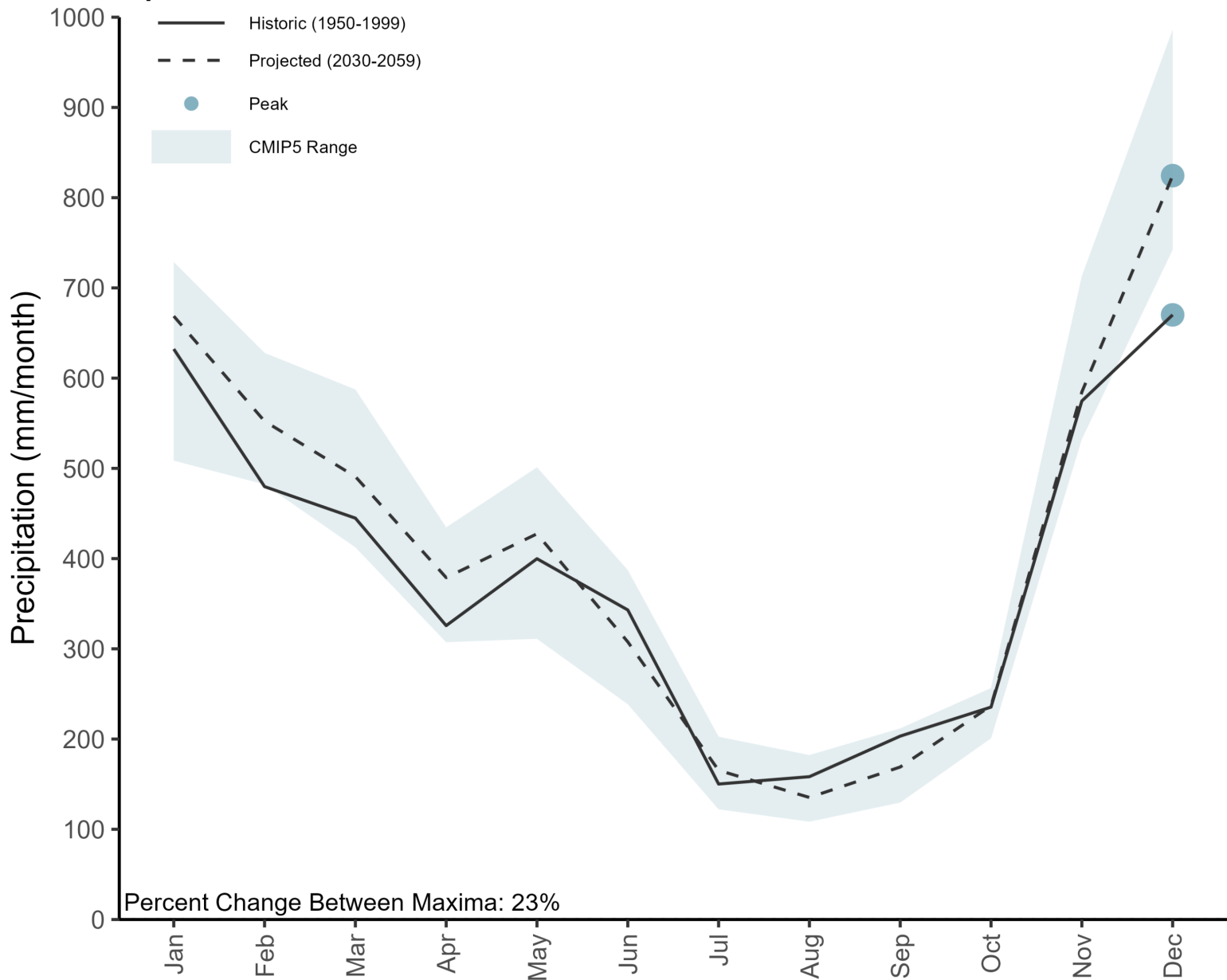
Mean  $\Delta$  Temperature



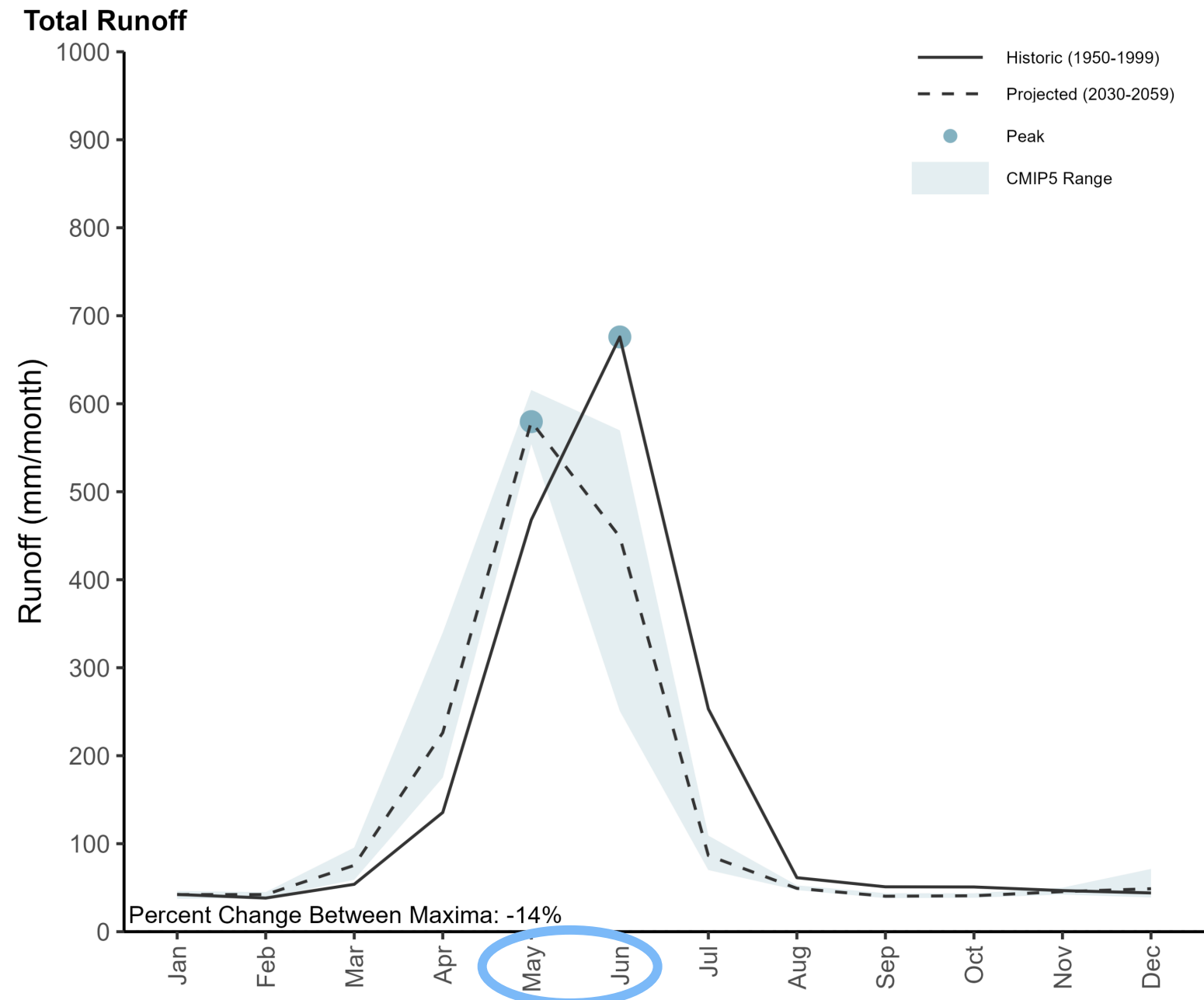


# Sawtooth Hatchery | Hydrology

Total Precipitation

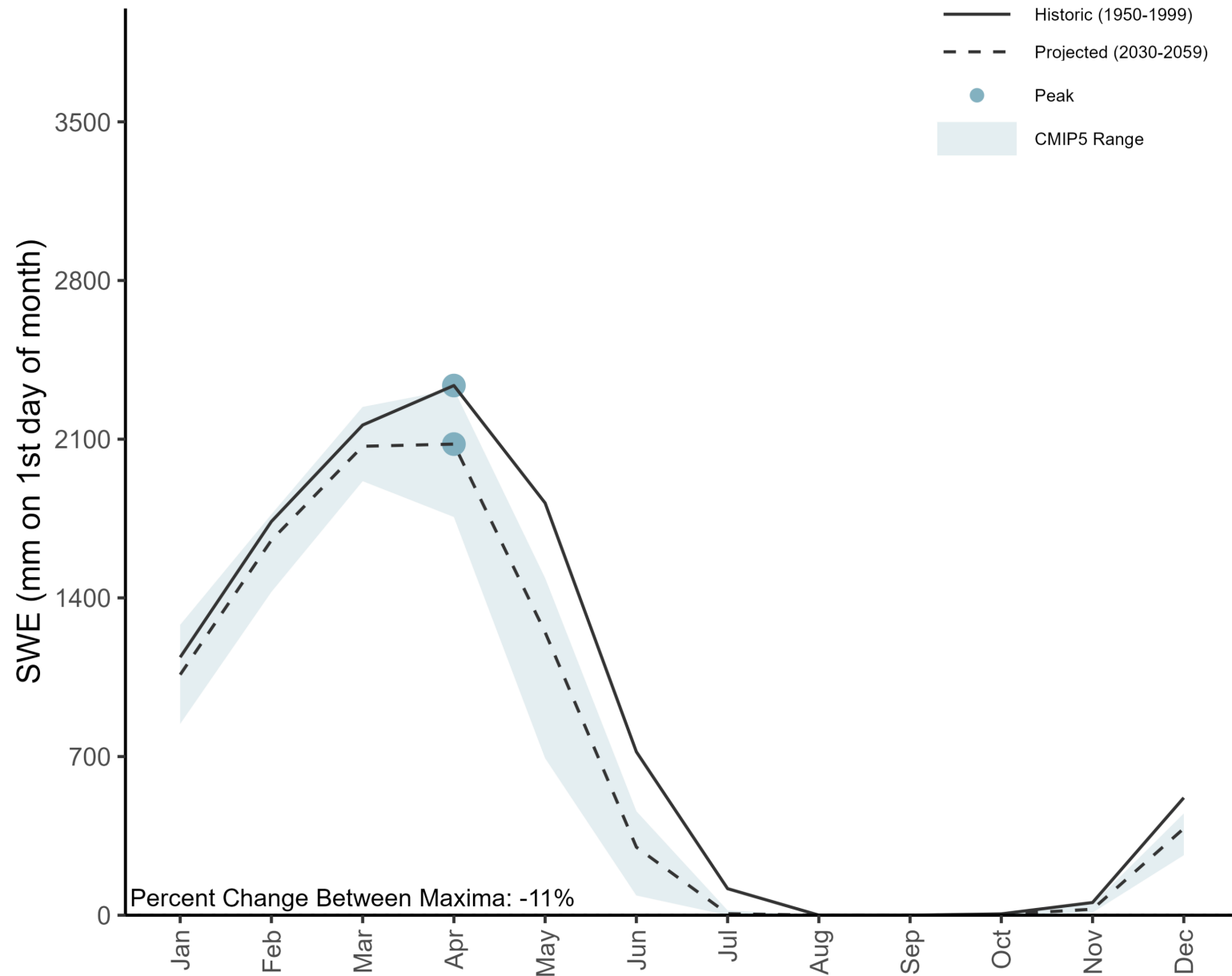


# Sawtooth Hatchery | Hydrology

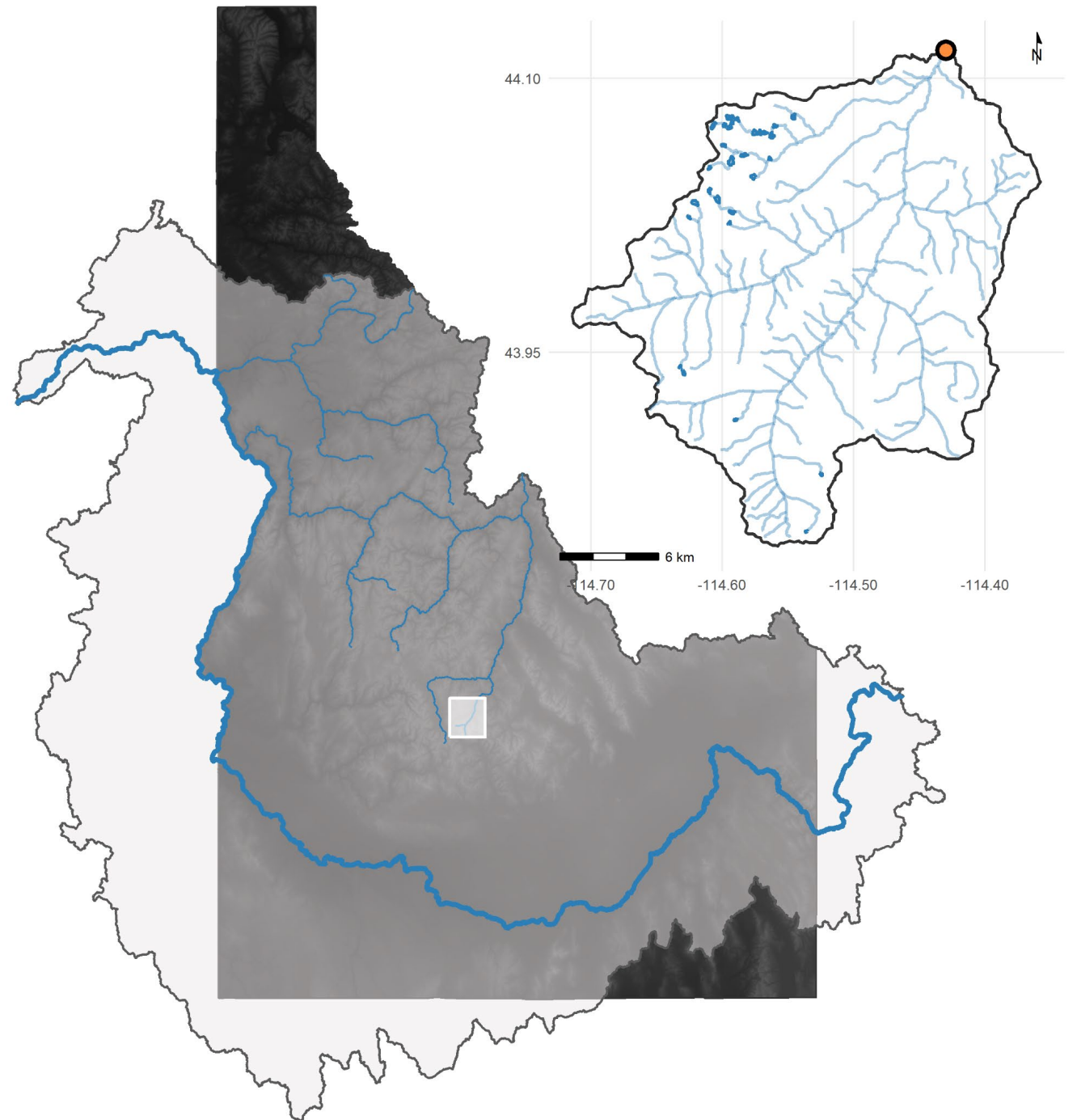


# Sawtooth Hatchery | Hydrology

Total Snow Water Equivalent [SWE]

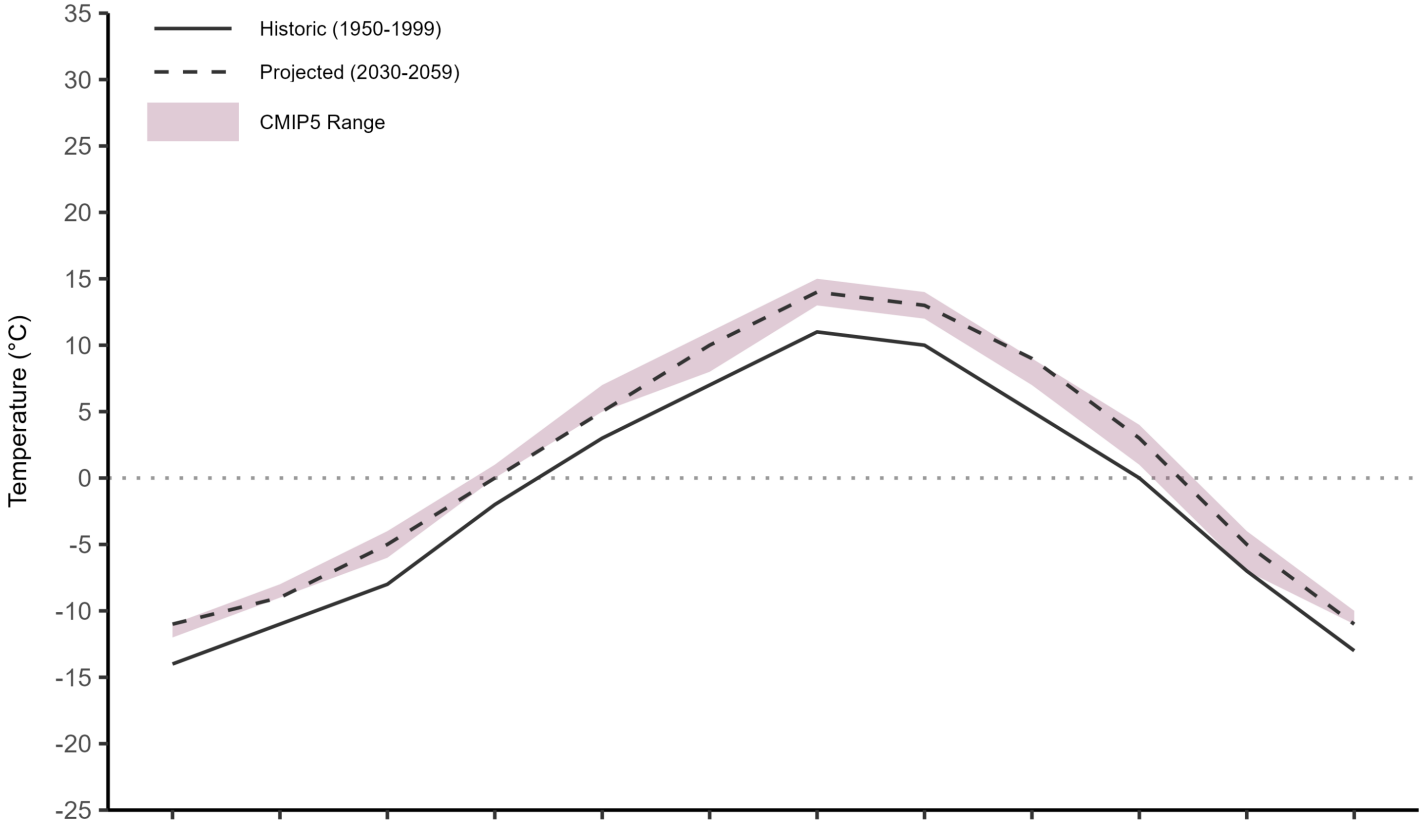


# Sawtooth | Satellite

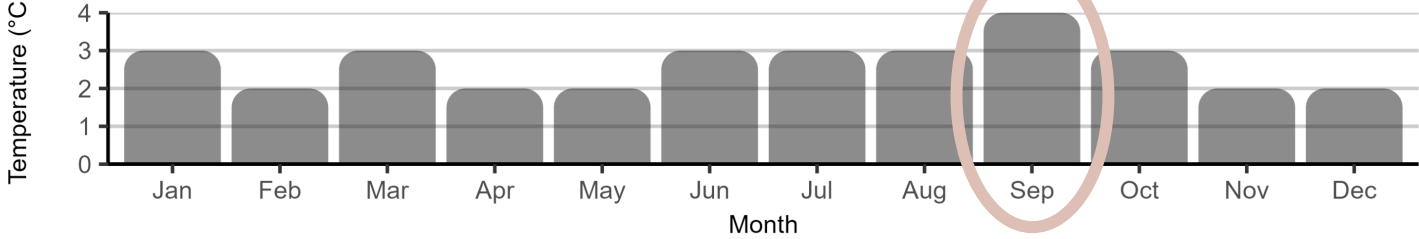


# Sawtooth Satellite | Climate

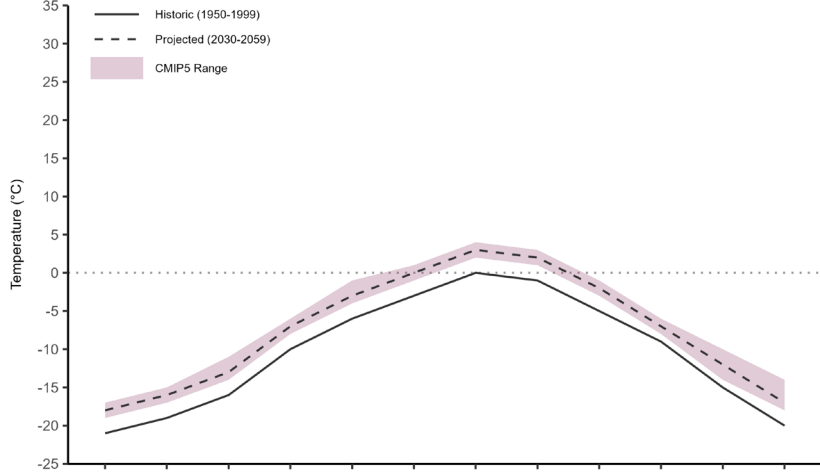
Average Surface Air Temperature



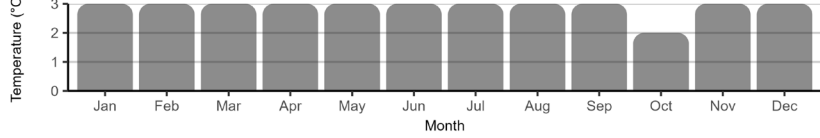
Mean  $\Delta$  Temperature



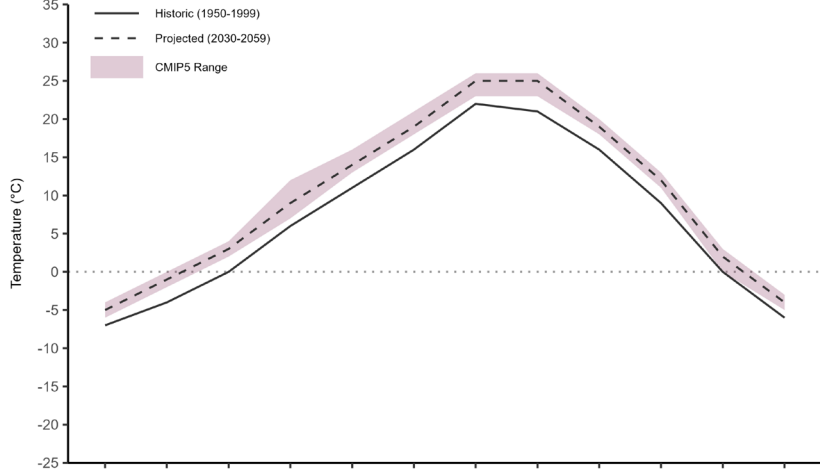
Minimum Surface Air Temperature



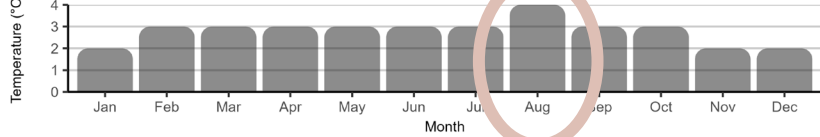
Mean  $\Delta$  Temperature



Maximum Surface Air Temperature

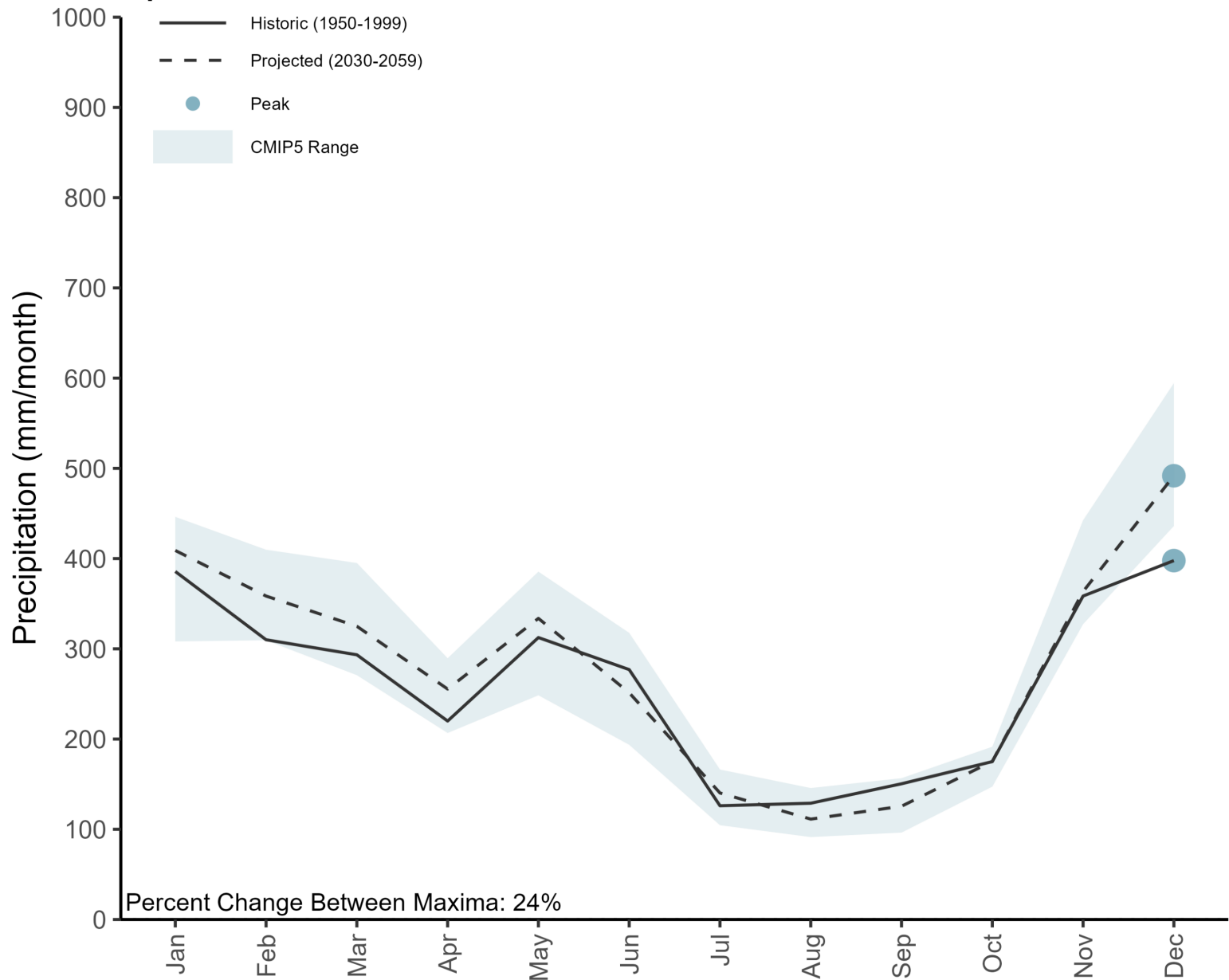


Mean  $\Delta$  Temperature

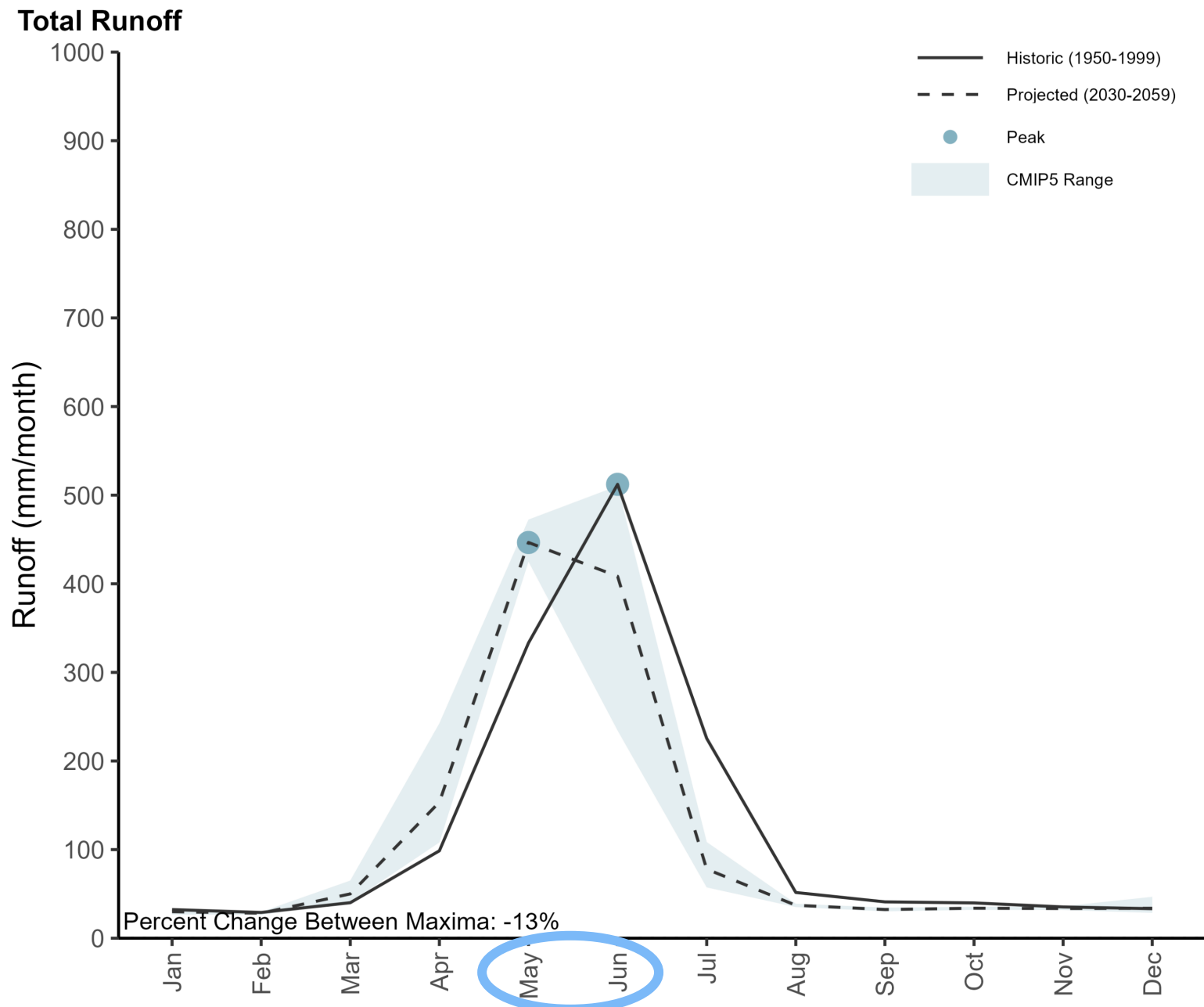


# Sawtooth Satellite | Hydrology

Total Precipitation



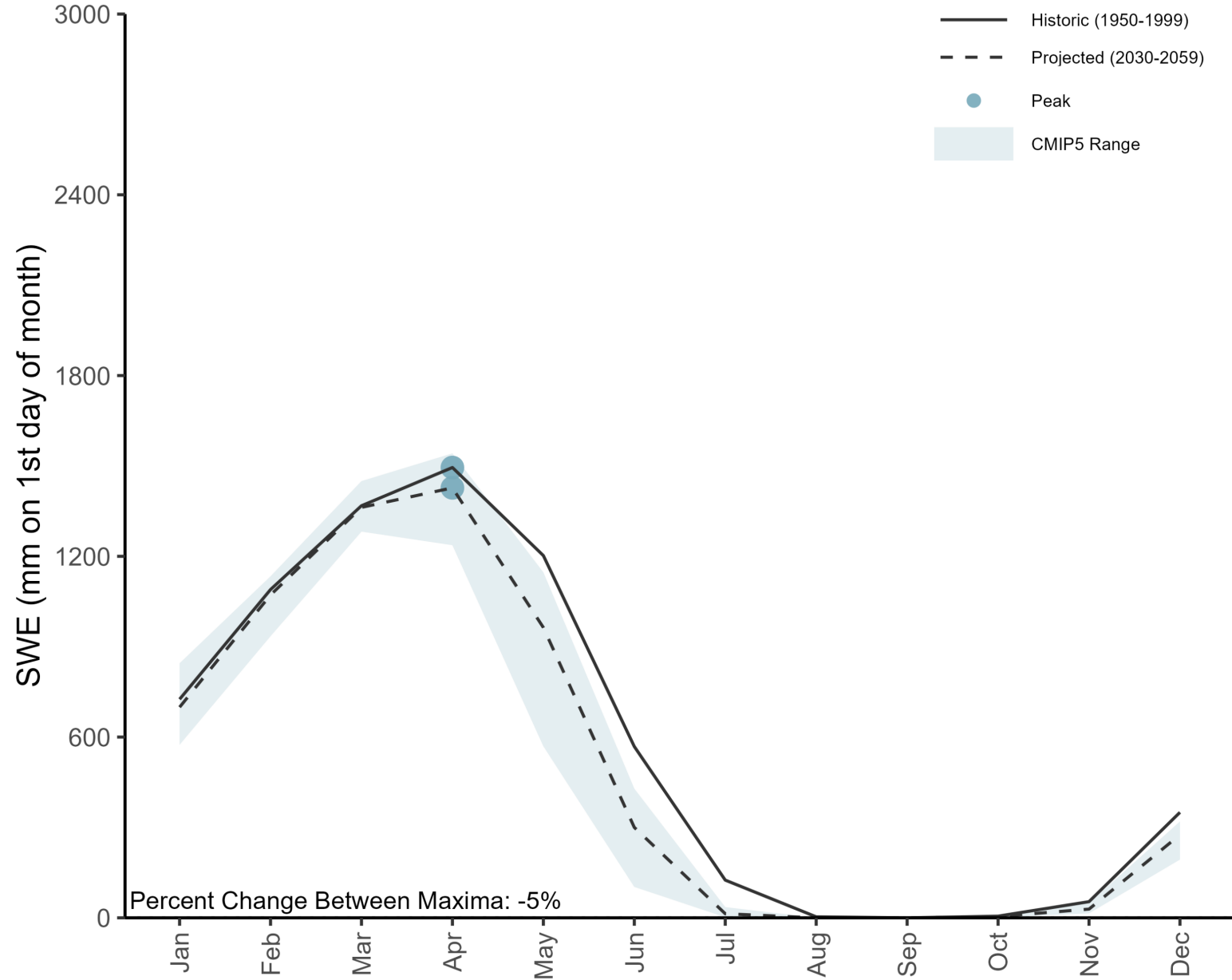
# Sawtooth Satellite | Hydrology



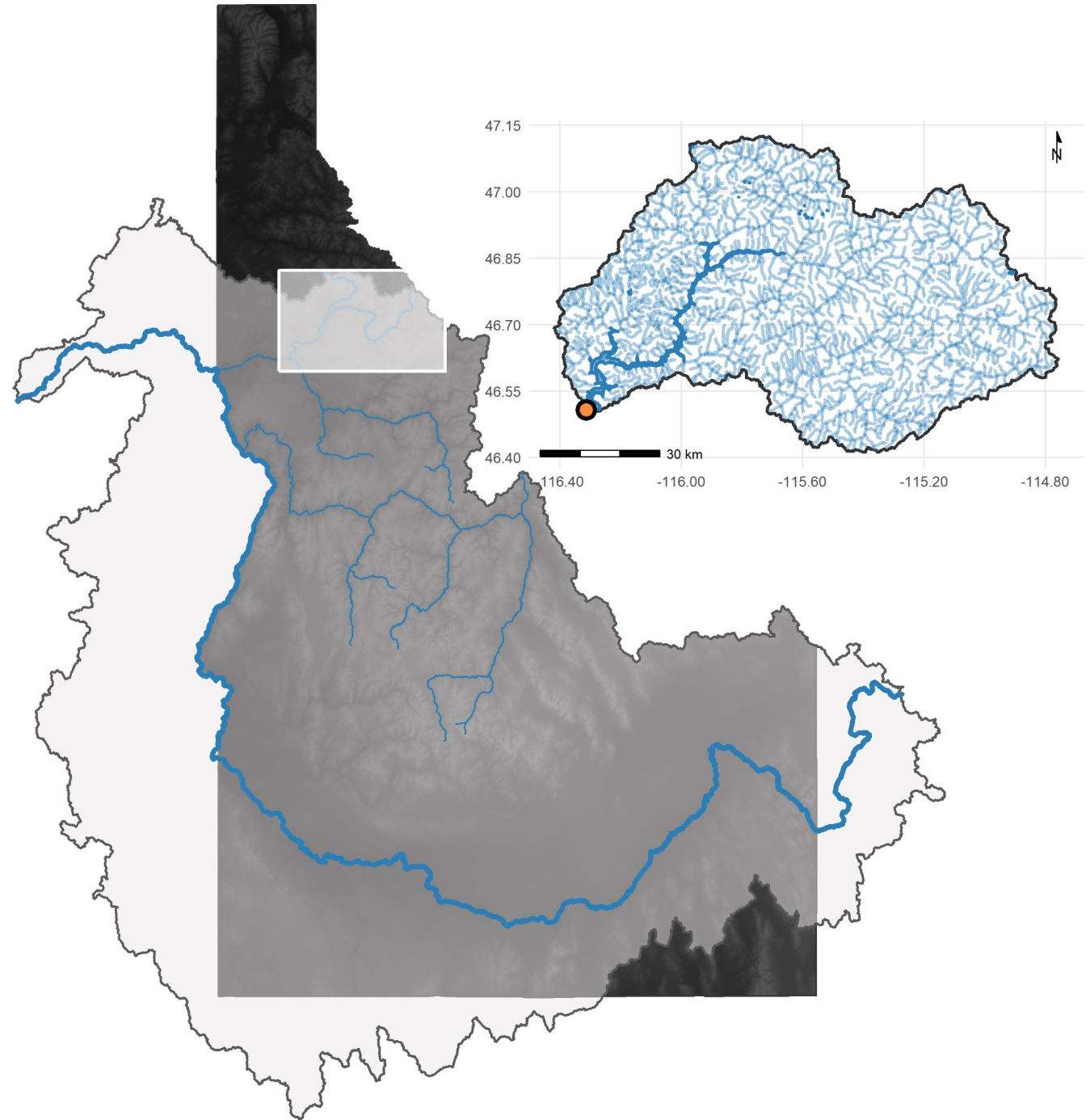


# Sawtooth Satellite | Hydrology

Total Snow Water Equivalent [SWE]

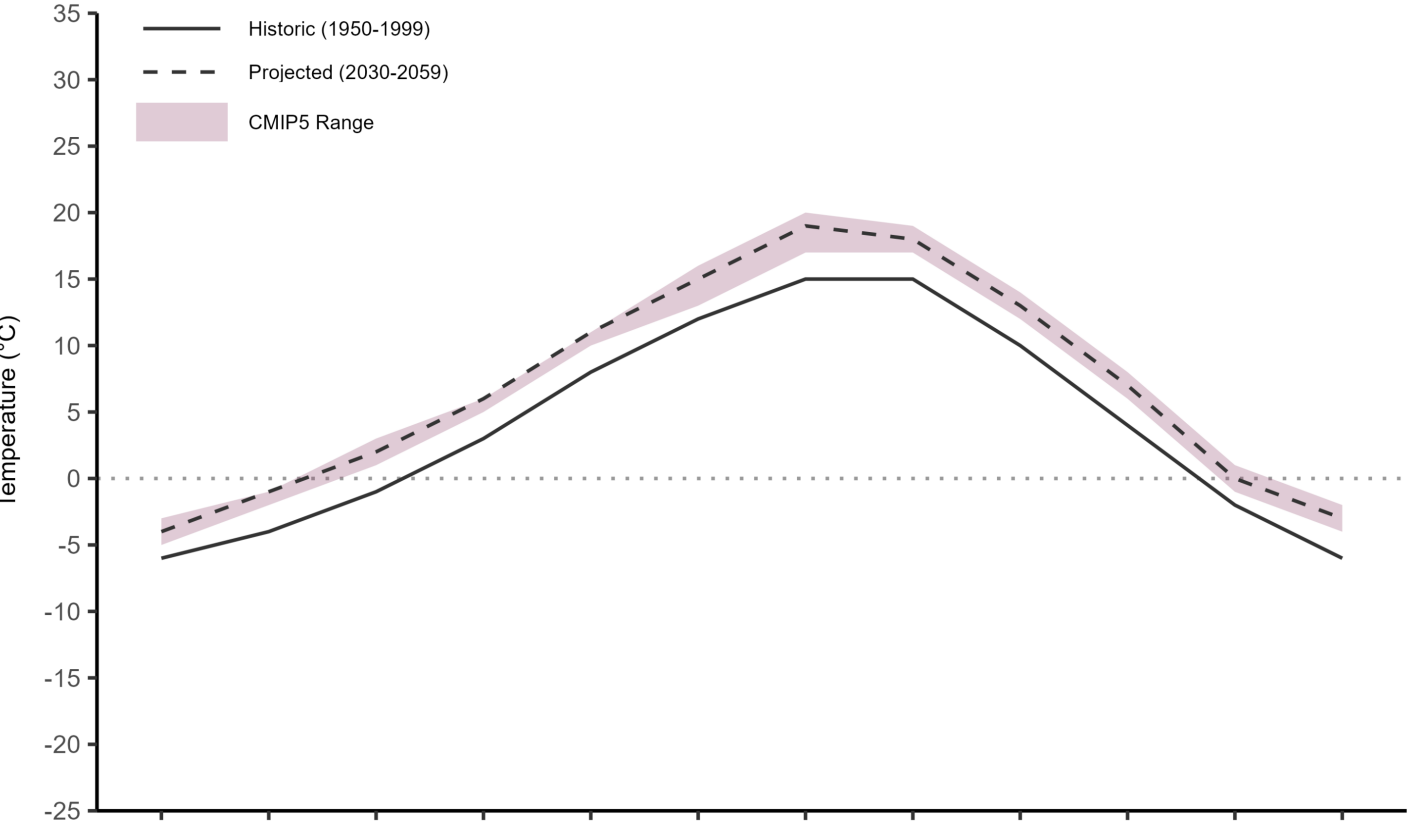


# Dworshak | Hatchery

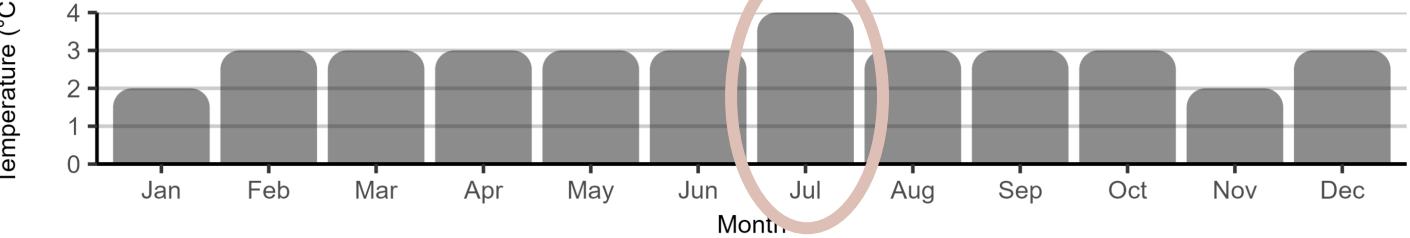


# Dworshak Hatchery | Climate

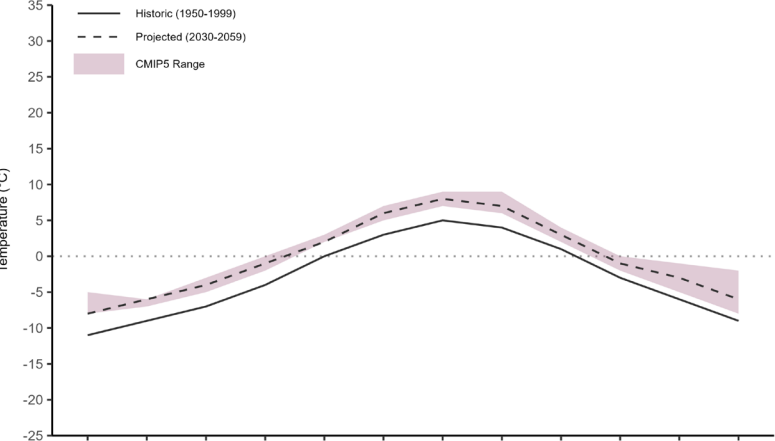
Average Surface Air Temperature



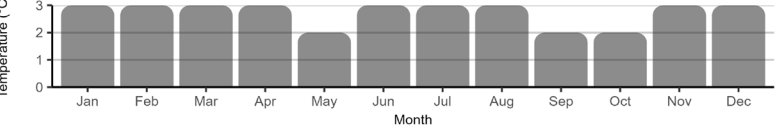
Mean  $\Delta$  Temperature



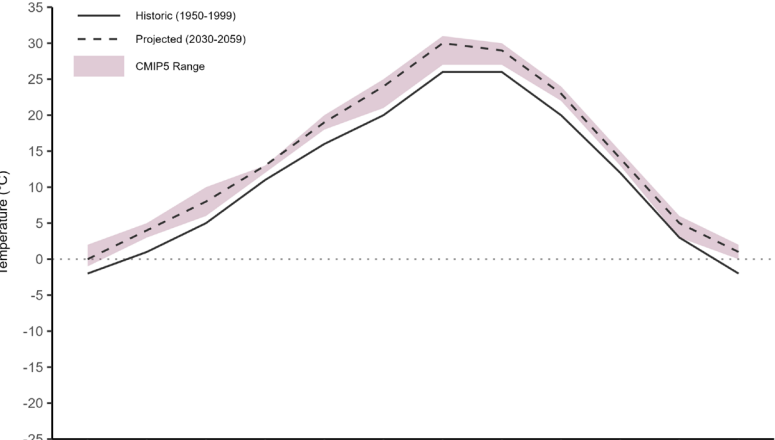
Minimum Surface Air Temperature



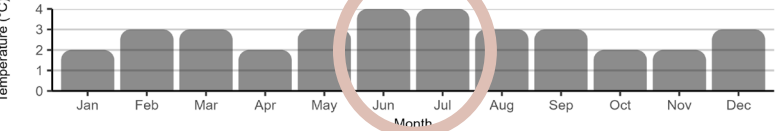
Mean  $\Delta$  Temperature



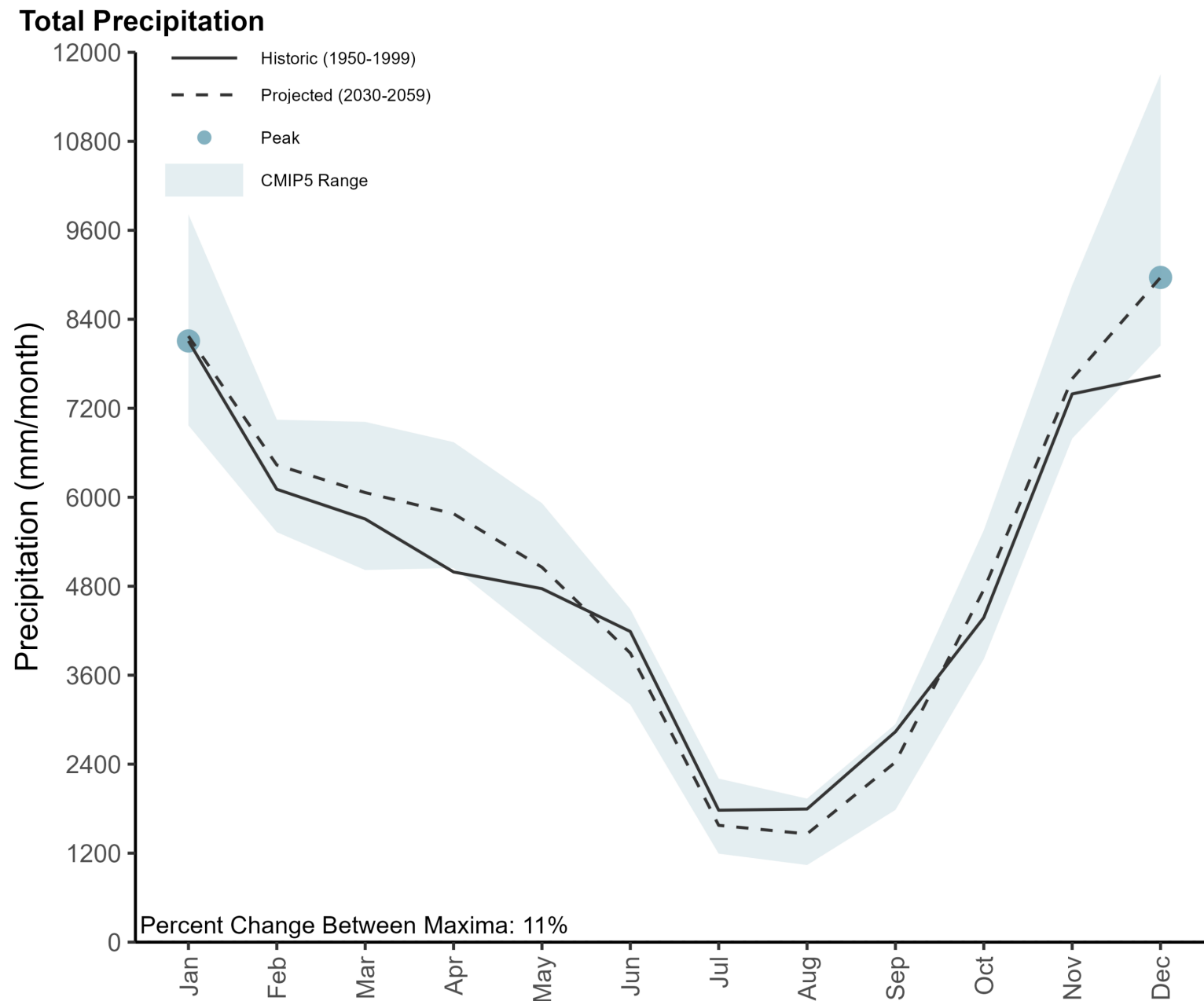
Maximum Surface Air Temperature



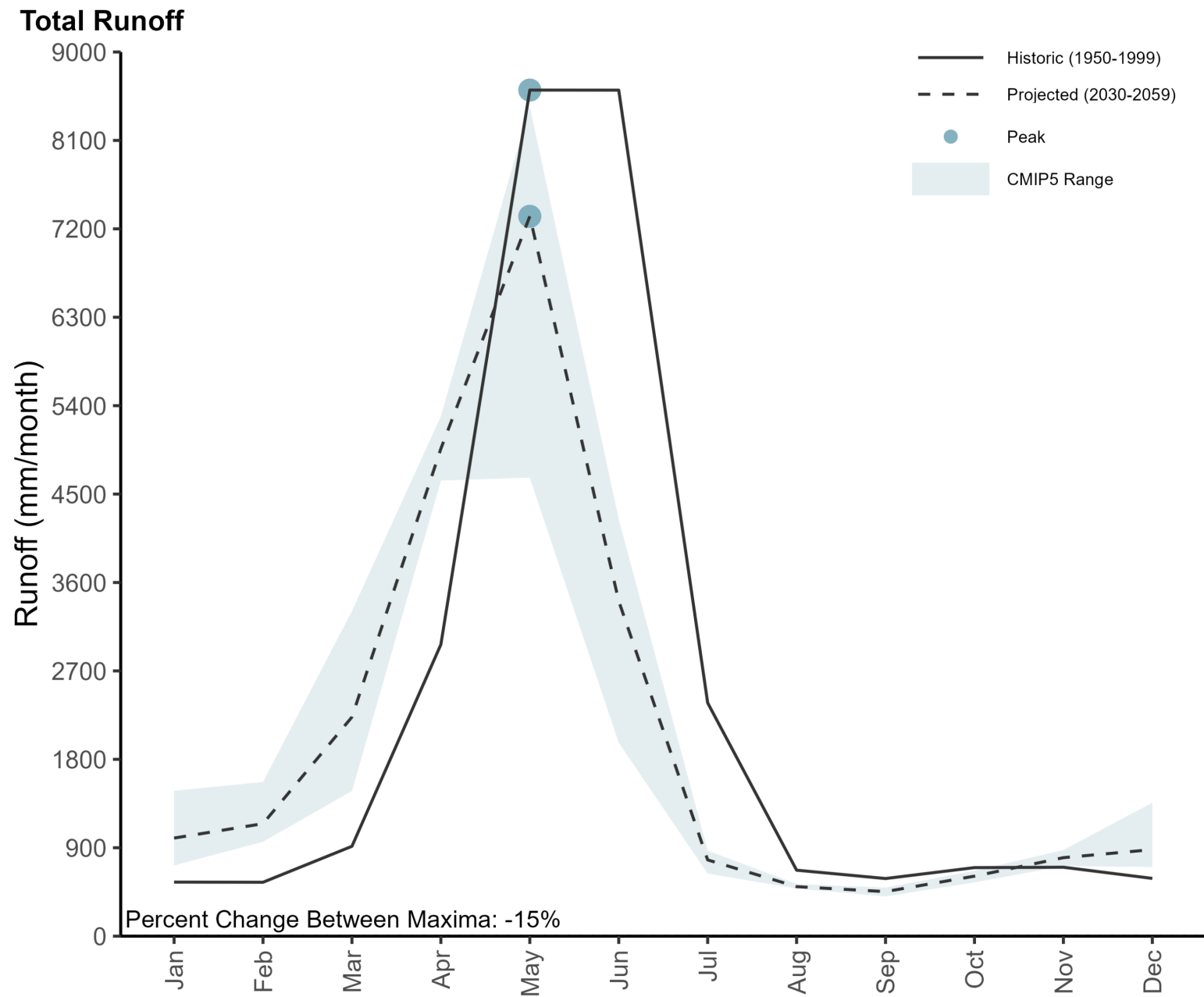
Mean  $\Delta$  Temperature



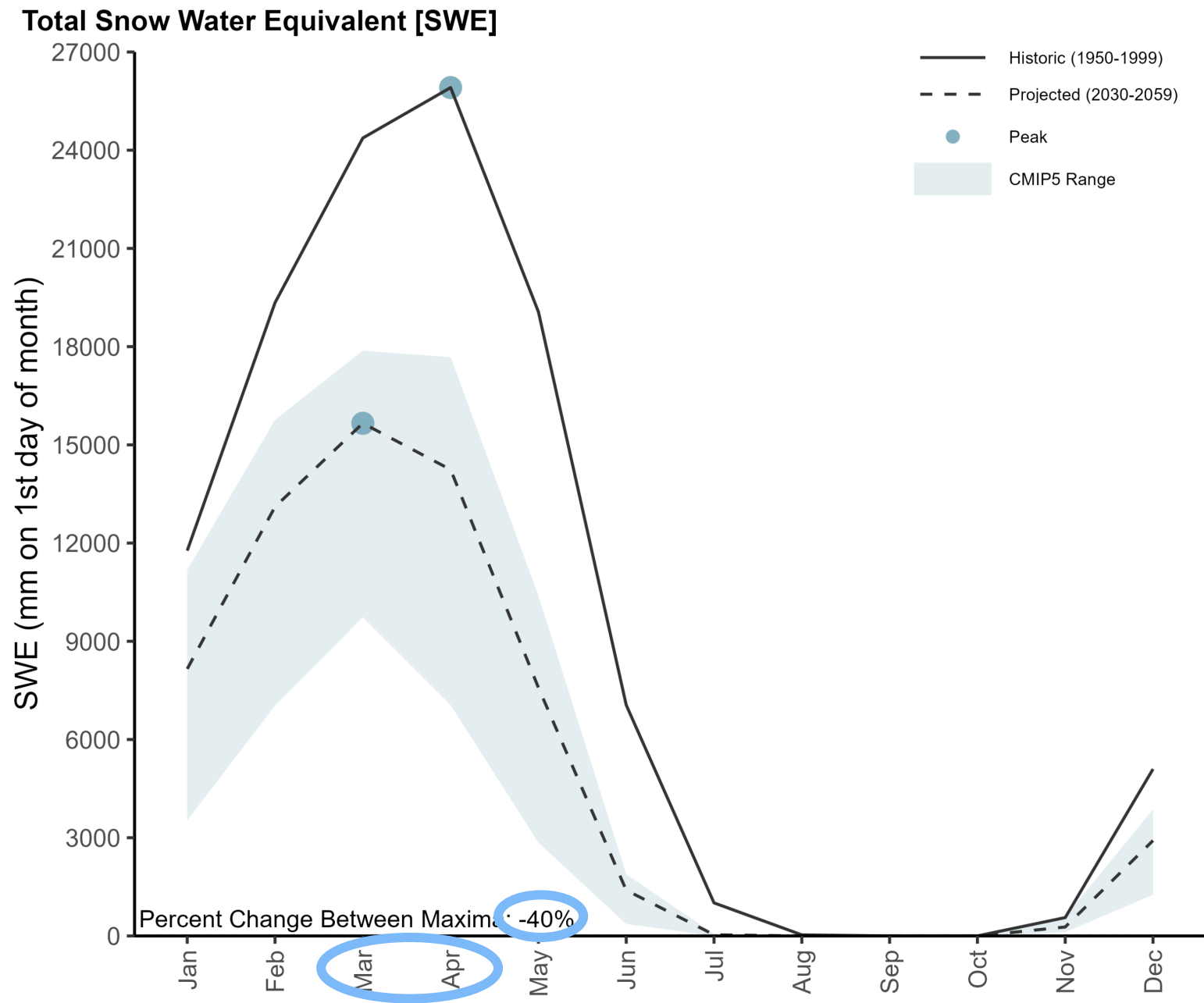
# Dworshak Hatchery | Hydrology



# Dworshak Hatchery | Hydrology



# Dworshak Hatchery | Hydrology

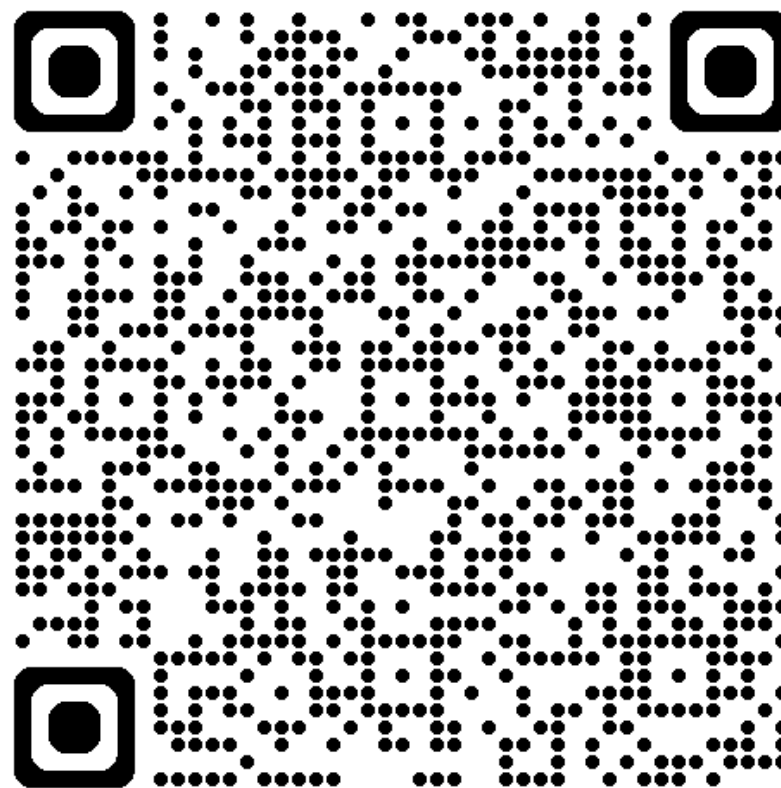


| FACILITY | TYPE      | TEMPERATURE | RUNOFF | SWE |
|----------|-----------|-------------|--------|-----|
| McCall   | Hatchery  |             |        |     |
|          | Satellite |             |        |     |
| Sawtooth | Hatchery  |             |        |     |
|          | Satellite |             |        |     |
| Dworshak | Hatchery  |             |        |     |



# Next Steps ...

## Stream temperature data



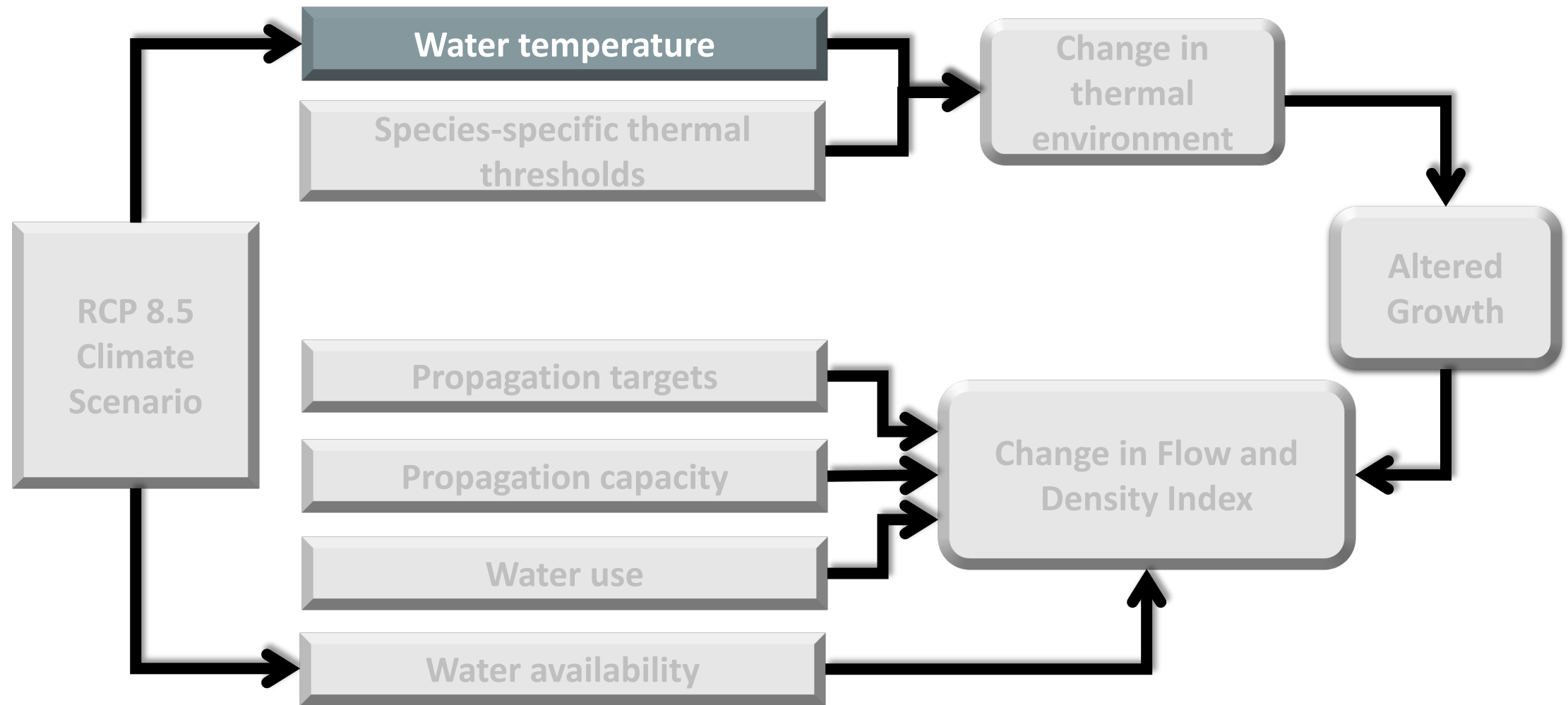
**Kathleen M Hemeon, PhD**

Abernathy Fish Technology Center  
Kathleen\_Hemeon@fws.gov



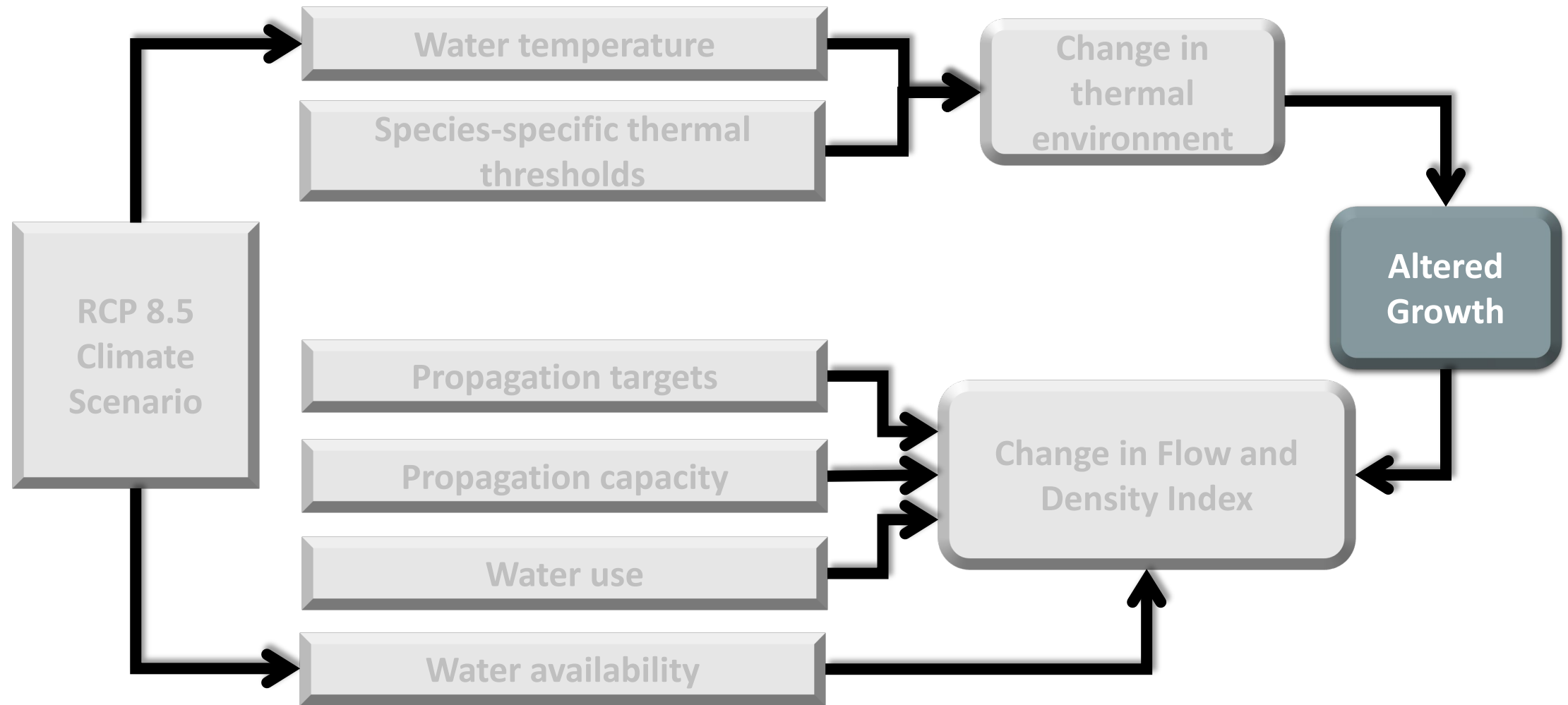
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# Modeling Framework | Production Vulnerability



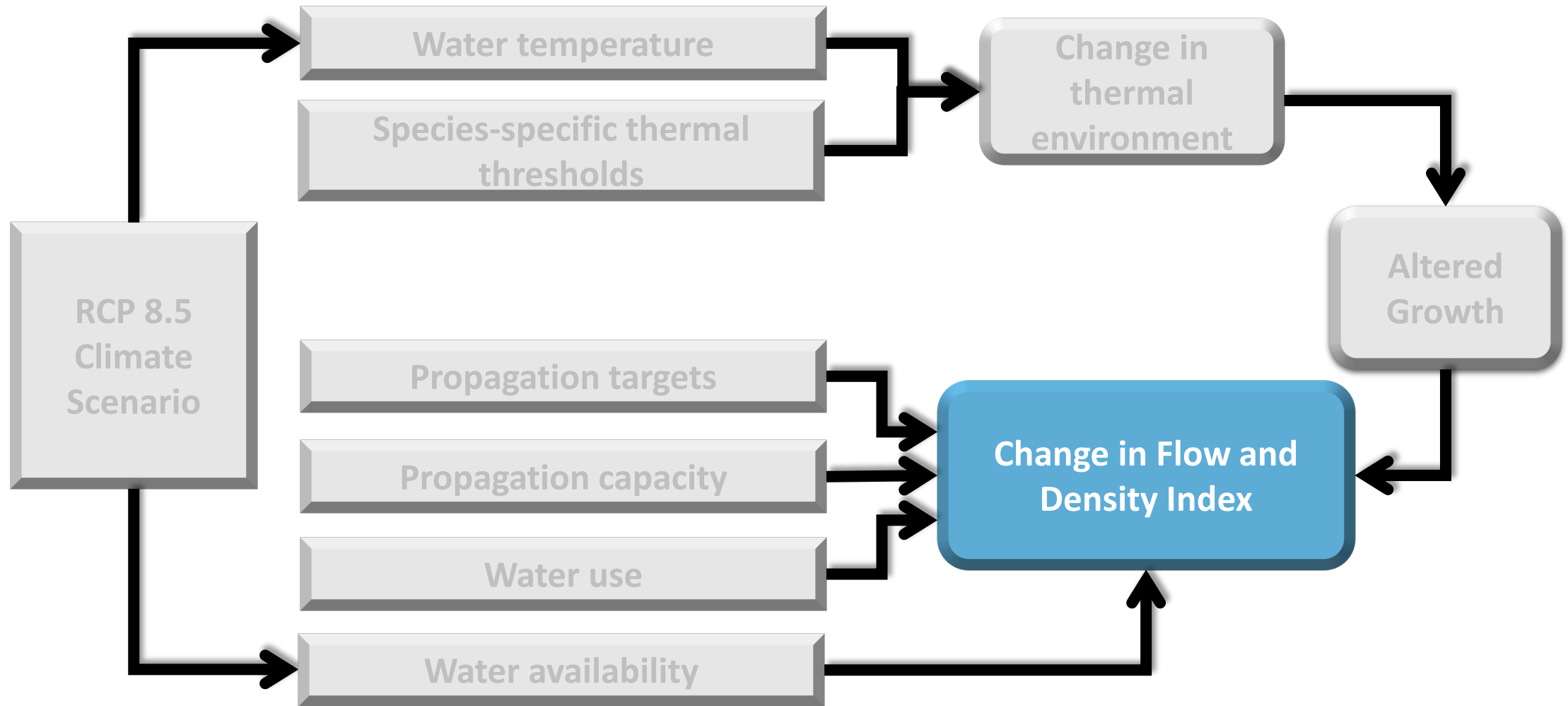
2 ) Evaluate future water temperatures available to hatcheries: modeled stream water temperatures

# Modeling Framework | Production Vulnerability



3) Evaluate future water temperature effects on fish growth: hatchery- and program-specific growth models

# Modeling Framework | Production Vulnerability



4 ) Evaluate future changes to flow and density indices: discuss hatchery intervention and infrastructure

## PHASE 1 | Watershed Characteristics

- Gather historic and projected climate data for the Pacific Northwest with equivalent parameters as our stream water temperature models:

RCP: 8.5

CMIP5 Scenarios:

1. MRI-CGCM3 (Least Warm)
2. HadGEM2-ES (Hot)
3. IPSL-CM5A-MR (Dry)
4. CNRM-CM5 (Wet)
5. NorESM1-M (Middle)

Downscaling: **Bias Correction and Spatial Downscaling (uses monthly General Circulation Models)**

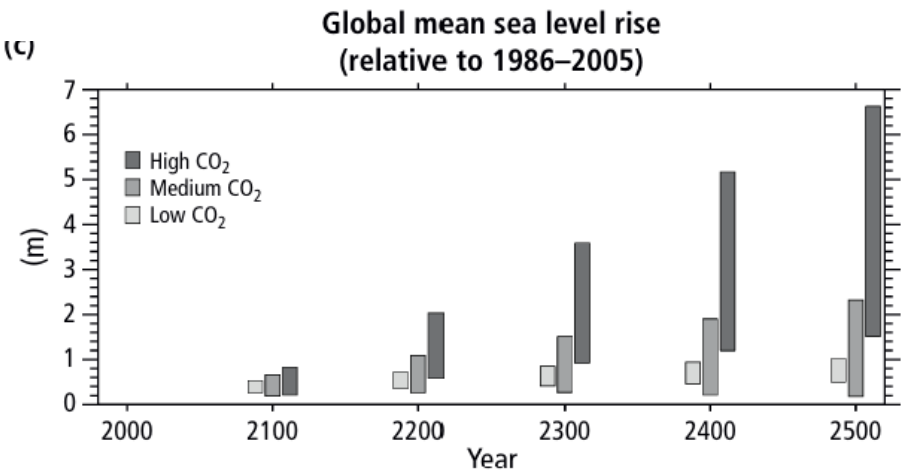
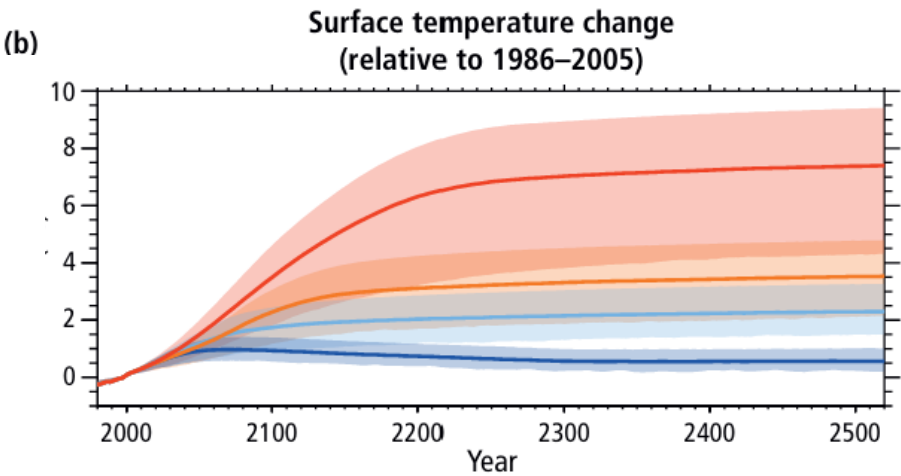
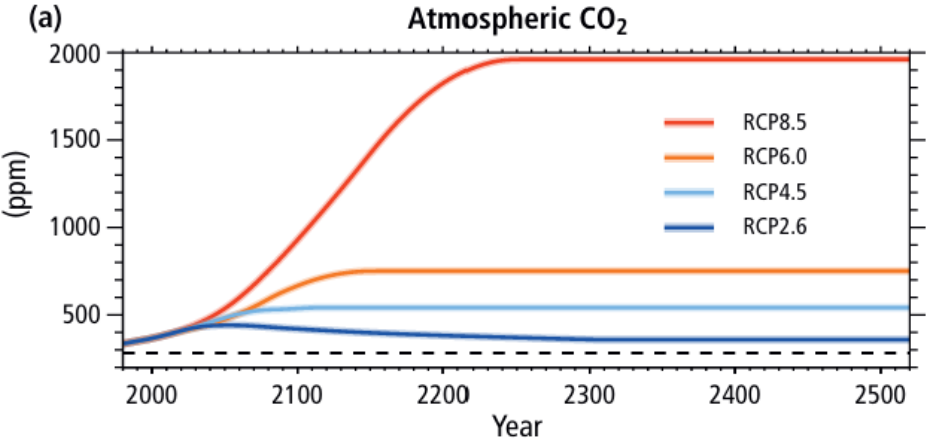
Historic Time Frame: Jan 1950- Dec 1999

Projected Time Frame: Jan 2030- Dec 2059

Data Units: Monthly | 1/8<sup>th</sup> Degree

- Clip multi-dimensional climate data to hatchery delineated watershed.
- Summarize data across watershed.

# Representative Concentration Pathways [RCPs] Special Report on Emission Scenarios [SRES]



# References

## Hydrology Data:

Reclamation, 2014. Downscaled CMIP3 and CMIP5 Hydrology Projections – Release of Hydrology Projections, Comparison with Preceding Information and Summary of User Needs. U.S. Department of the Interior, Bureau of Reclamation, 110 p., available at: [http://gdo-dcp.ucllnl.org/downscaled\\_cmip\\_projections/techmemo/BCSD5HydrologyMemo.pdf](http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/techmemo/BCSD5HydrologyMemo.pdf).

## Climate Data:

Reclamation, 2013. Downscaled CMIP3 and CMIP5 Climate Projections Release of Downscaled CMIP5 Climate Projections, Comparison with Preceding Information, and Summary of User Needs. U.S. Department of the Interior, Bureau of Reclamation, 104 p., available at: [http://gdo-dcp.ucllnl.org/downscaled\\_cmip\\_projections/techmemo/downscaled\\_climate.pdf](http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/techmemo/downscaled_climate.pdf).



# Acknowledgements

For Coupled Model Intercomparison Project phase 5 (CMIP5), the model output should be referred to as “the CMIP5 multi-model ensemble [archive/output/results/of simulations/dataset/ ...].” In publications, you should include a table (referred to below as Table XX) listing the models and institutions that provided model output used in your study. In this table, and as appropriate in figure legends, you should use the CMIP5 “official” model names found in “CMIP5 Modeling Groups and their Terms of Use”: ([http://cmip-pcmdi.llnl.gov/cmip5/docs/CMIP5\\_modeling\\_groups.pdf](http://cmip-pcmdi.llnl.gov/cmip5/docs/CMIP5_modeling_groups.pdf))

In addition, an acknowledgment similar to the following should be included in your publication: “We acknowledge the World Climate Research Programme's Working Group on Coupled Modelling, which is responsible for CMIP, and we thank the climate modeling groups (listed in Table XX of this paper) for producing and making available their model output. For CMIP, the U.S. Department of Energy's Program for Climate Model Diagnosis and Intercomparison provides coordinating support and led development of software infrastructure in partnership with the Global Organization for Earth System Science Portals.”

where “Table XX” of your paper should list the models and modeling groups that provided the data you used. In addition, it may be appropriate to cite one or more of the CMIP5 experiment design articles listed on the CMIP5 reference page.

“Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections” archive at: [http://gdo-dcp.ucllnl.org/downscaled\\_cmip\\_projections](http://gdo-dcp.ucllnl.org/downscaled_cmip_projections).

We acknowledge the World Climate Research Programme's Working Group on Coupled Modelling, which is responsible for CMIP, and we thank the climate modeling groups for producing and making available their model output. For CMIP, the U.S. Department of Energy's Program for Climate Model Diagnosis and Intercomparison provides coordinating support and led development of software infrastructure in partnership with the Global Organization for Earth System Science Portals.