Stand Age & Forest Evapotranspiration: Implications for Forest Management, Streamflow and Salmonid Recovery

Effectiveness Monitoring Committee
California Board of Forestry
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Overview

- Forest management (timber harvest and fuel load reduction) can be a tool to enhance streamflow critical to species recovery (e.g. coho salmon)
- Potential demonstrated by collaborative research in Russian River tributaries
  - LiDAR data (Sonoma Ag + Open Space)
  - Hydrologic monitoring (TU & CEMAR & RCD's)
  - Fish population/habitat monitoring (CA Sea Grant)
  - Hydrologic & hydraulic modeling (OEI/CRWI)
- Wildfires & fuel management projects- opportunities for research & demonstration

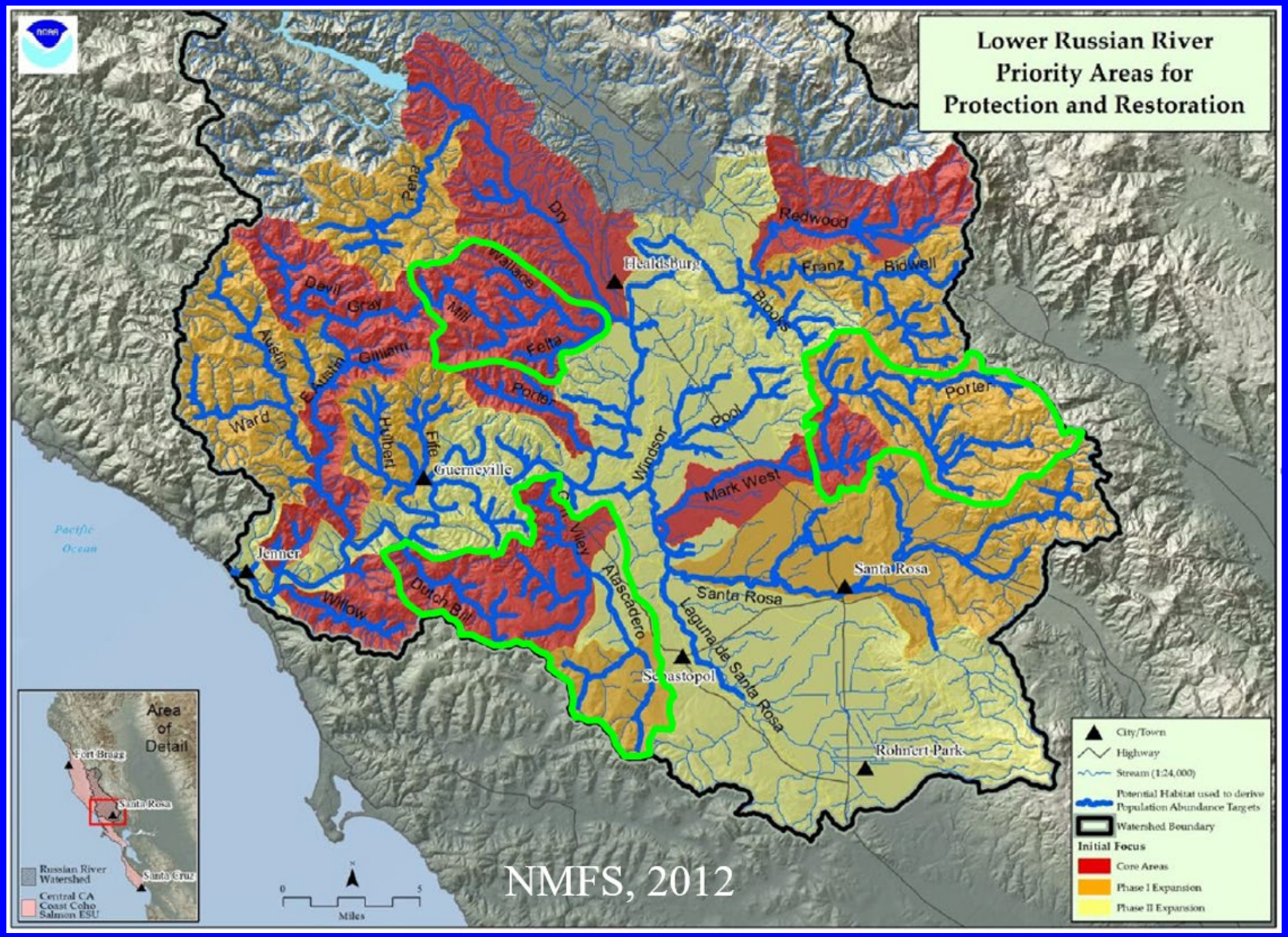
Outline

- Hydrologic Model Development & Objectives
- Evaluation of Streamflow Enhancement Strategies
- Stand Age, Evapotranspiration, Wildfire and Fuel Management Effects on Streamflow

Hydrologic Model Development & Objectives

- Streamflow is a limiting factor for Central Coast coho salmon
- 2012-2021 modeled 4 Russian R. tributaries in collaboration with Gold Ridge and Sonoma RCD's, TU, CA Sea Grant & Coho Partnership
- Grant funding from FRGP & WCB
- Investigated seasonal and spatial variations in flow for restoration prioritization with a physically-based, spatially-distributed hydrologic model (MIKE-SHE)

Modeled Watersheds



Hydrologic Models

Watershed	Drainage Area (sq mi)	Geology
Dutch Bill Creek	12	Franciscan
Green Valley & Atascadero Creek	39	Wilson Grove sandstone & Franciscan
Mark West Creek	40	Sonoma Volcanics & Franciscan
Mill Creek	23	Franciscan

Modeling Approach Overview

- Calibrated Numerical Hydrologic Model ≈ Management Tool
- Quantify watershed hydrologic processes varying over time and space
- Describe stream flow in relation to critical fish habitat
  - Stream connectivity as indicator of over-summer survival
  - Flow depth across riffles as indicator of smolt escapement
- Alternative model scenarios to estimate effects of:
  - Watershed management strategies
  - Human use of water
  - Drought
  - Climate change

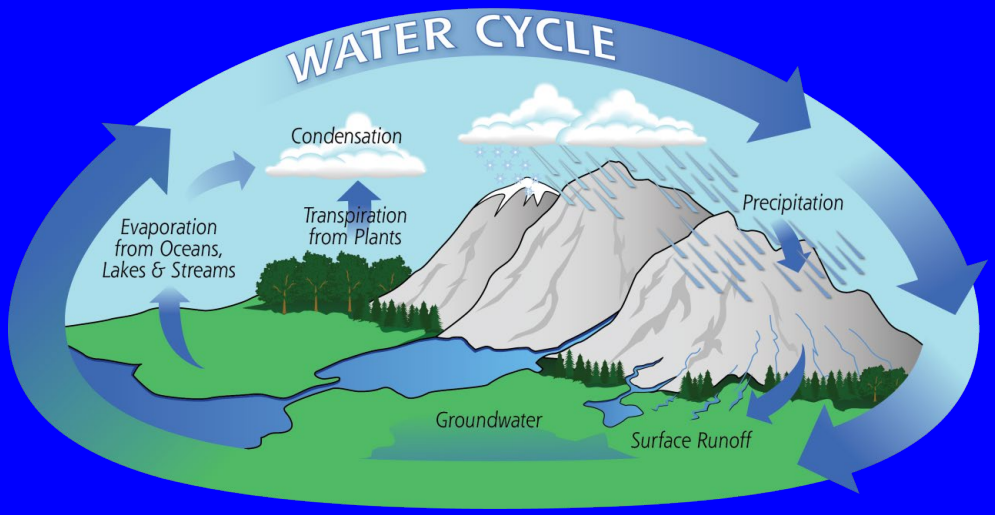
Model Overview

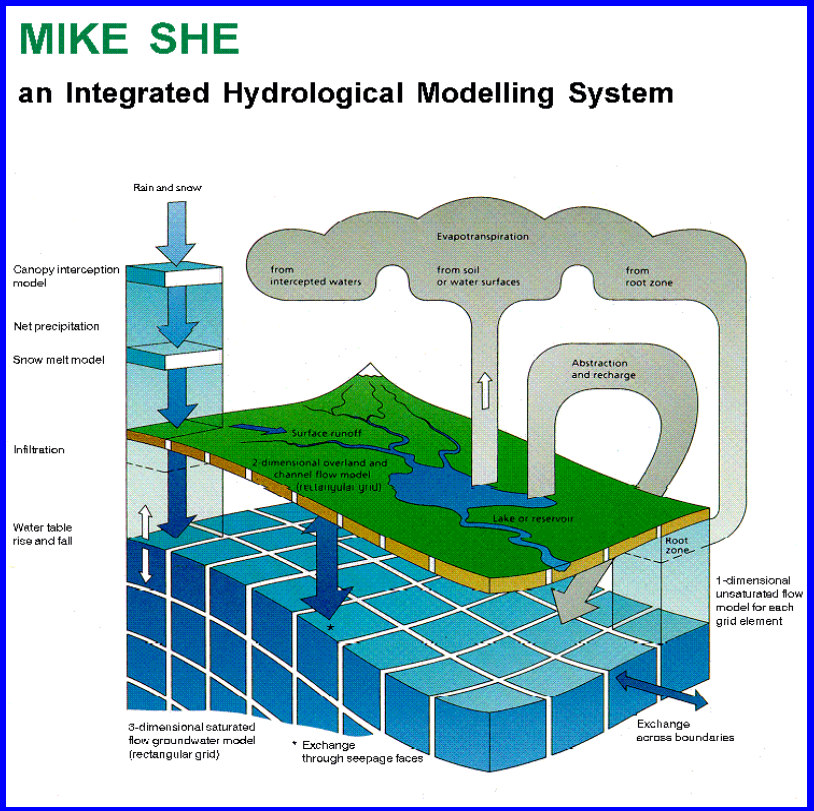
Natural Processes

Precipitation
Evapotranspiration
Runoff
Soil Moisture
Groundwater
Streams

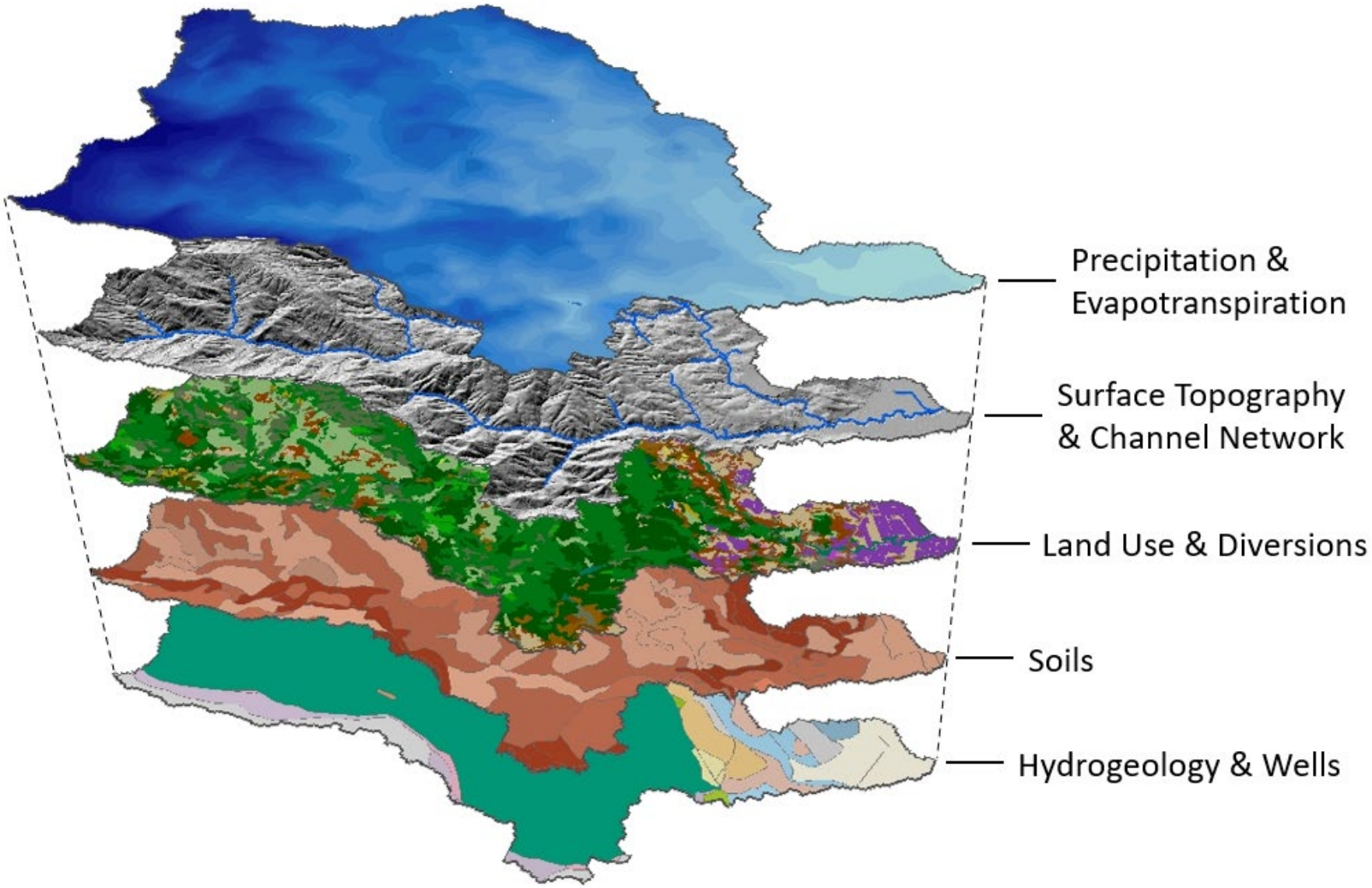
Man-made Influences

Irrigation
Wells
Ponds
Diversions

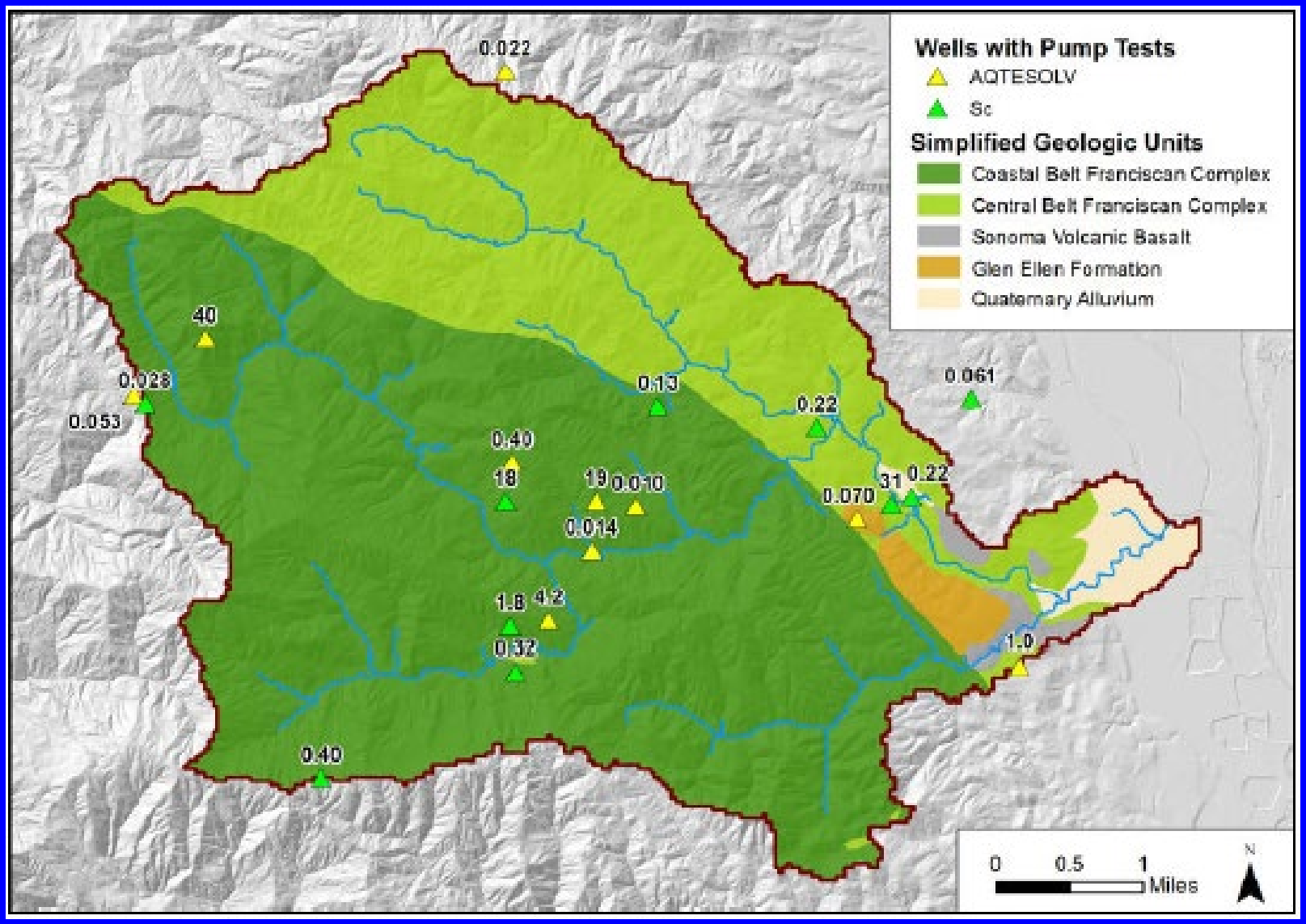




Model Development

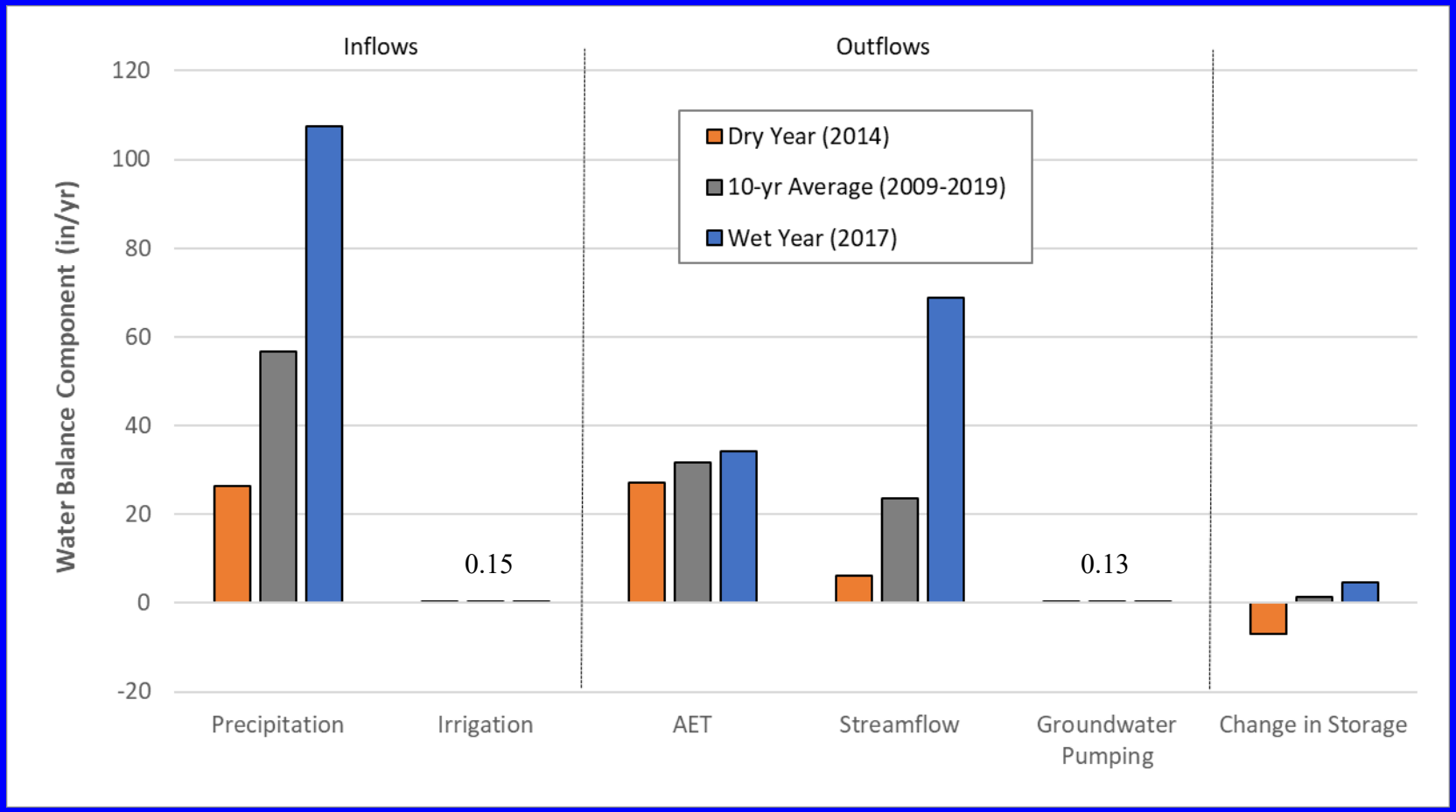


Mill Creek Hydrogeology

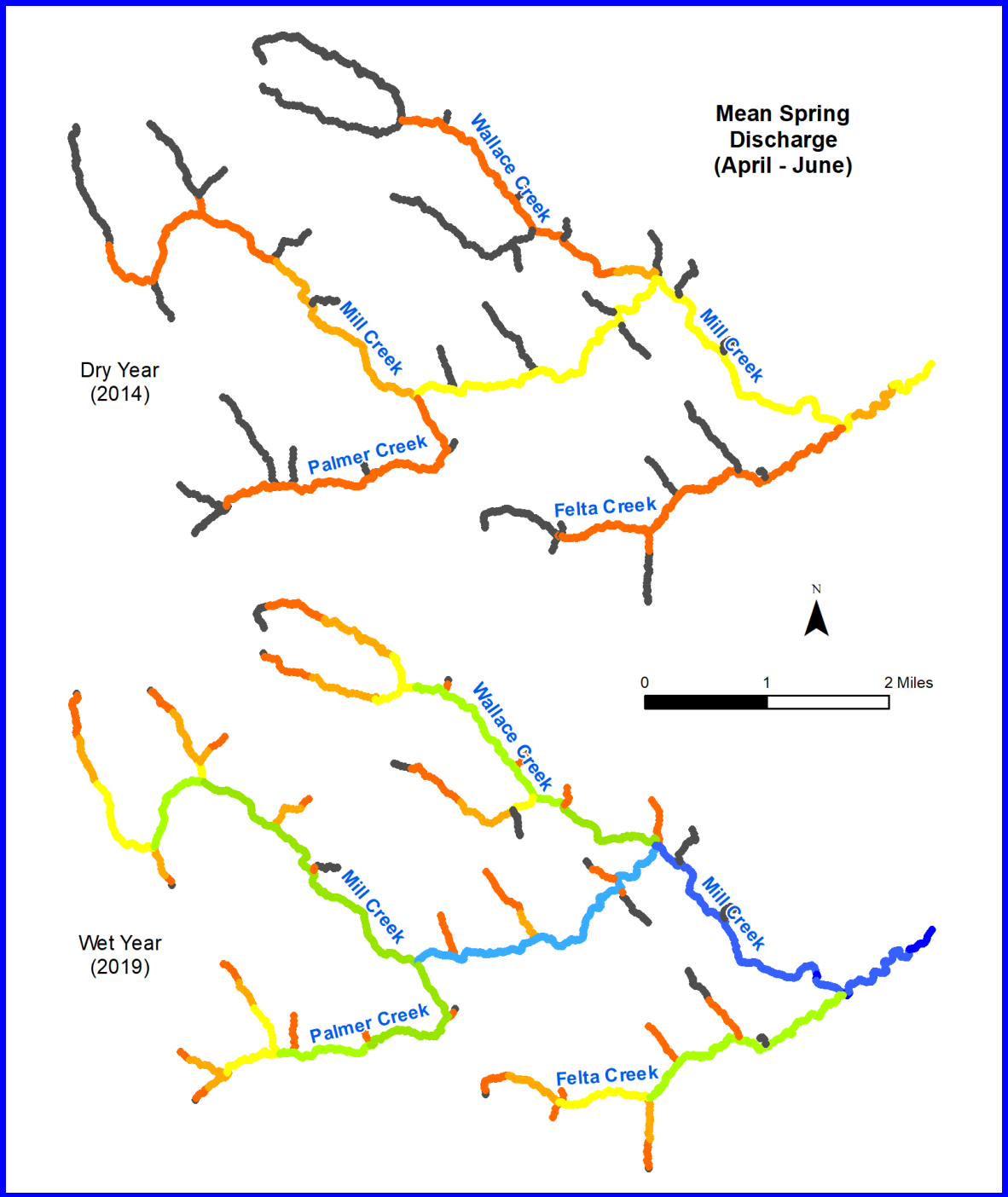


Existing Hydrology-Mill Creek

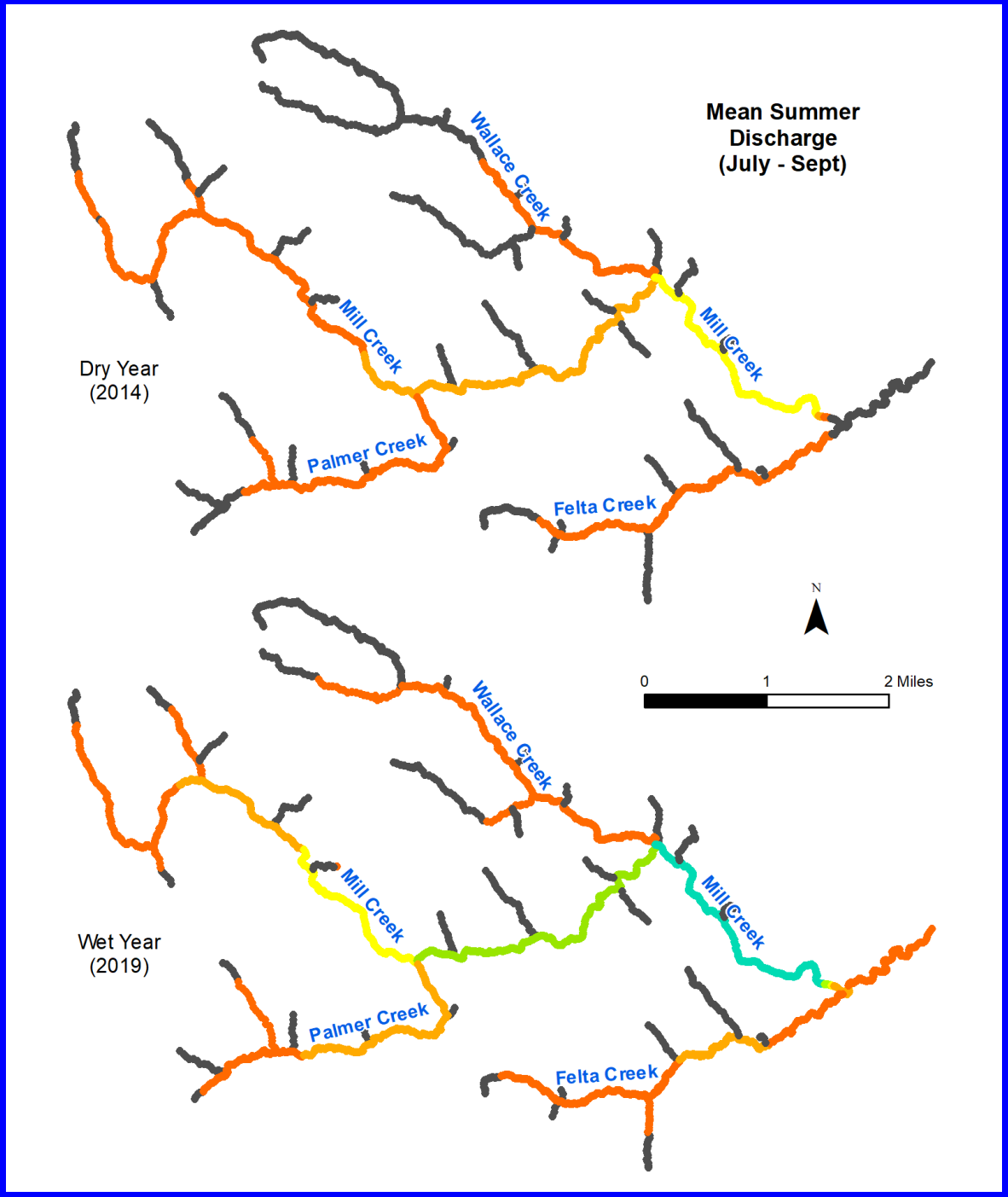
Annual Water Balance



Existing Hydrology Discharges



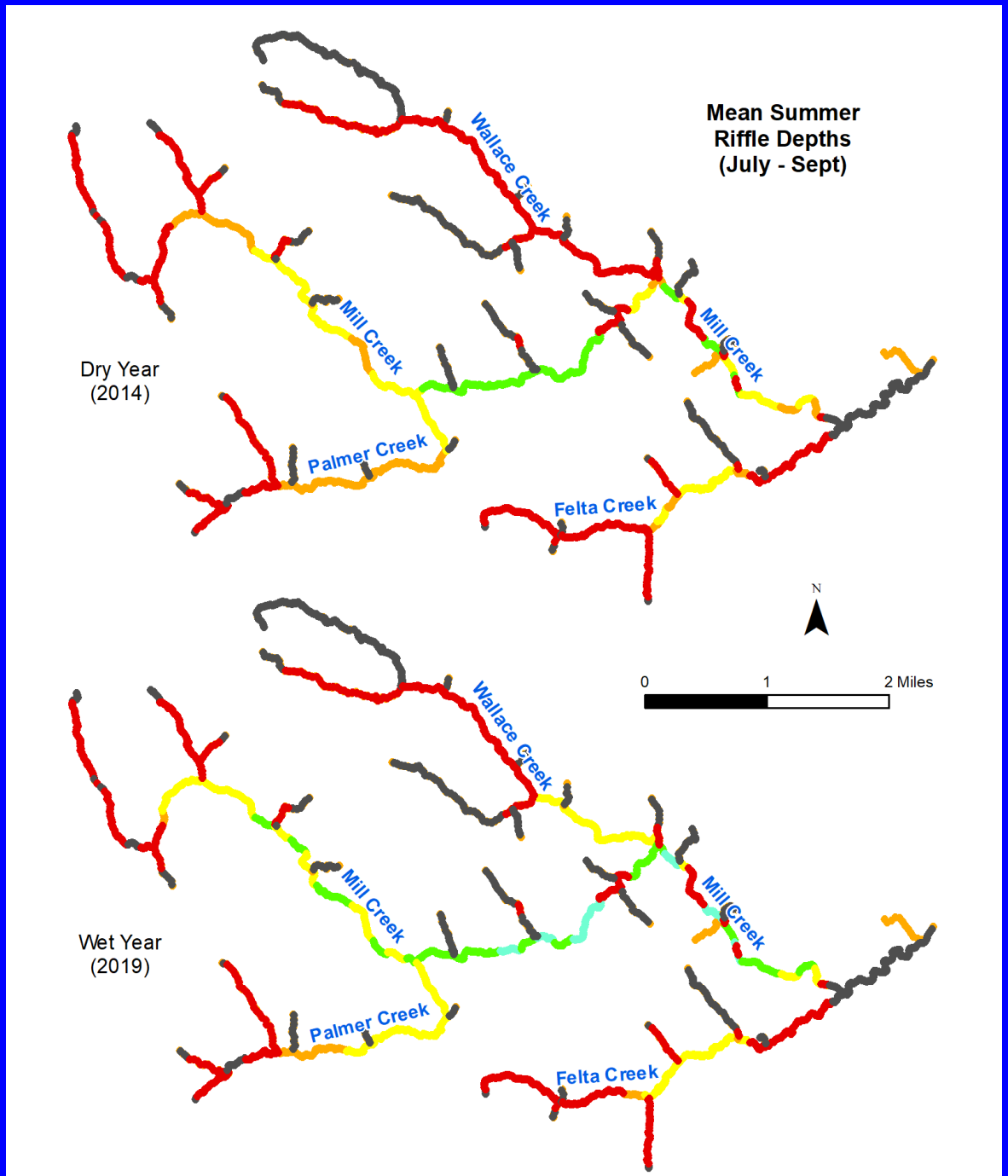
Existing Hydrology Discharges



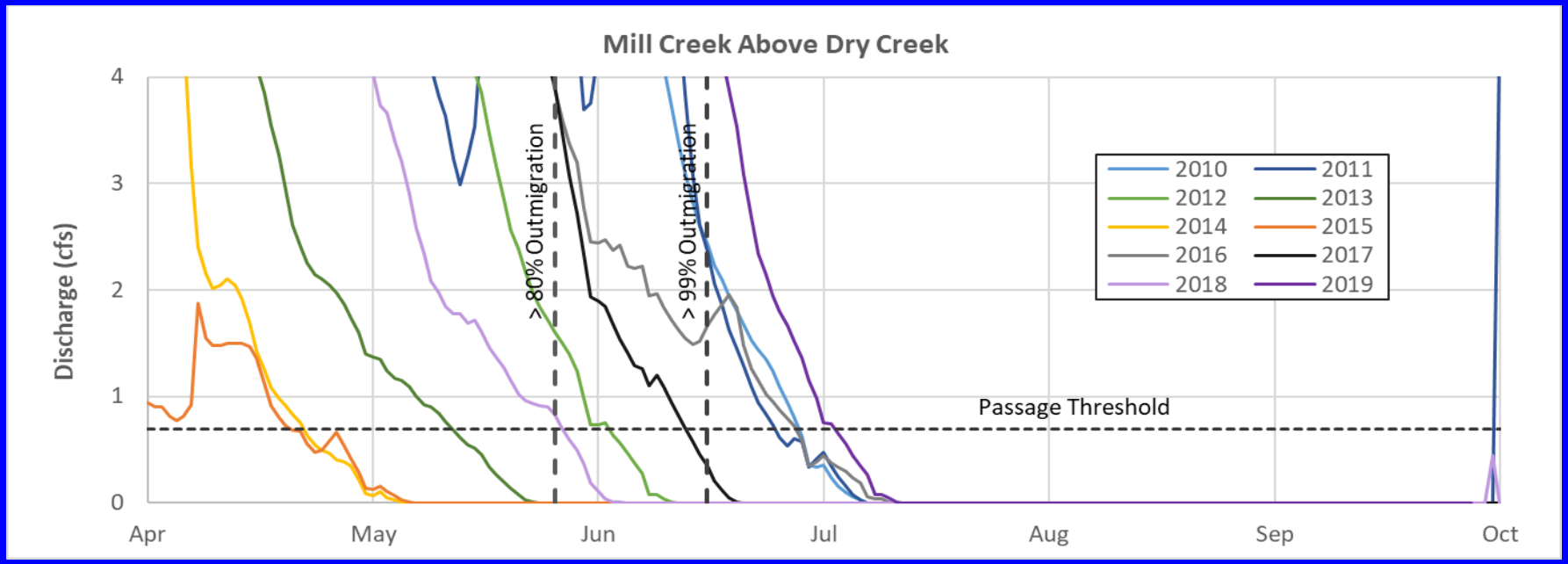
Salmonid Habitat for Coho Life Stages – Stream Flow Criteria

- Juvenile Rearing
  - Maintain summer baseflows protective of water quality, supportive of BMIs, and resilient to climate change
    - Riffle Depths (>0.2-ft)
- Smolt Outmigration
  - Maintain passable flow conditions through the spring outmigration window
    - Riffle depths in relation to outmigrant timing
- Winter Rearing/Spawning
  - Not the focus of this project but considered from
    - Prior modeling work, available habitat survey & biological monitoring data

Existing Hydrology Riffle Depths



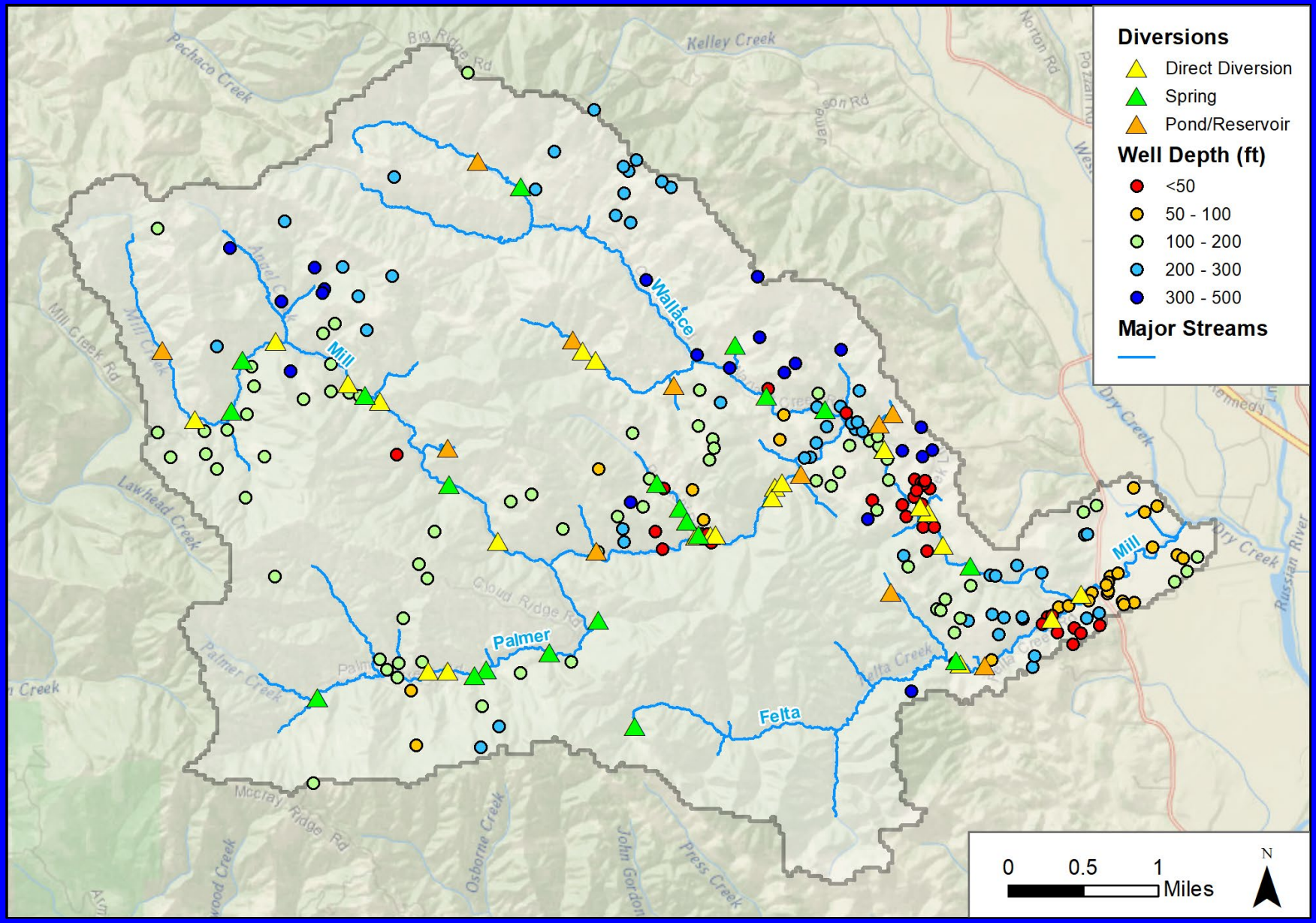
Existing Hydrology – Spring Outmigration



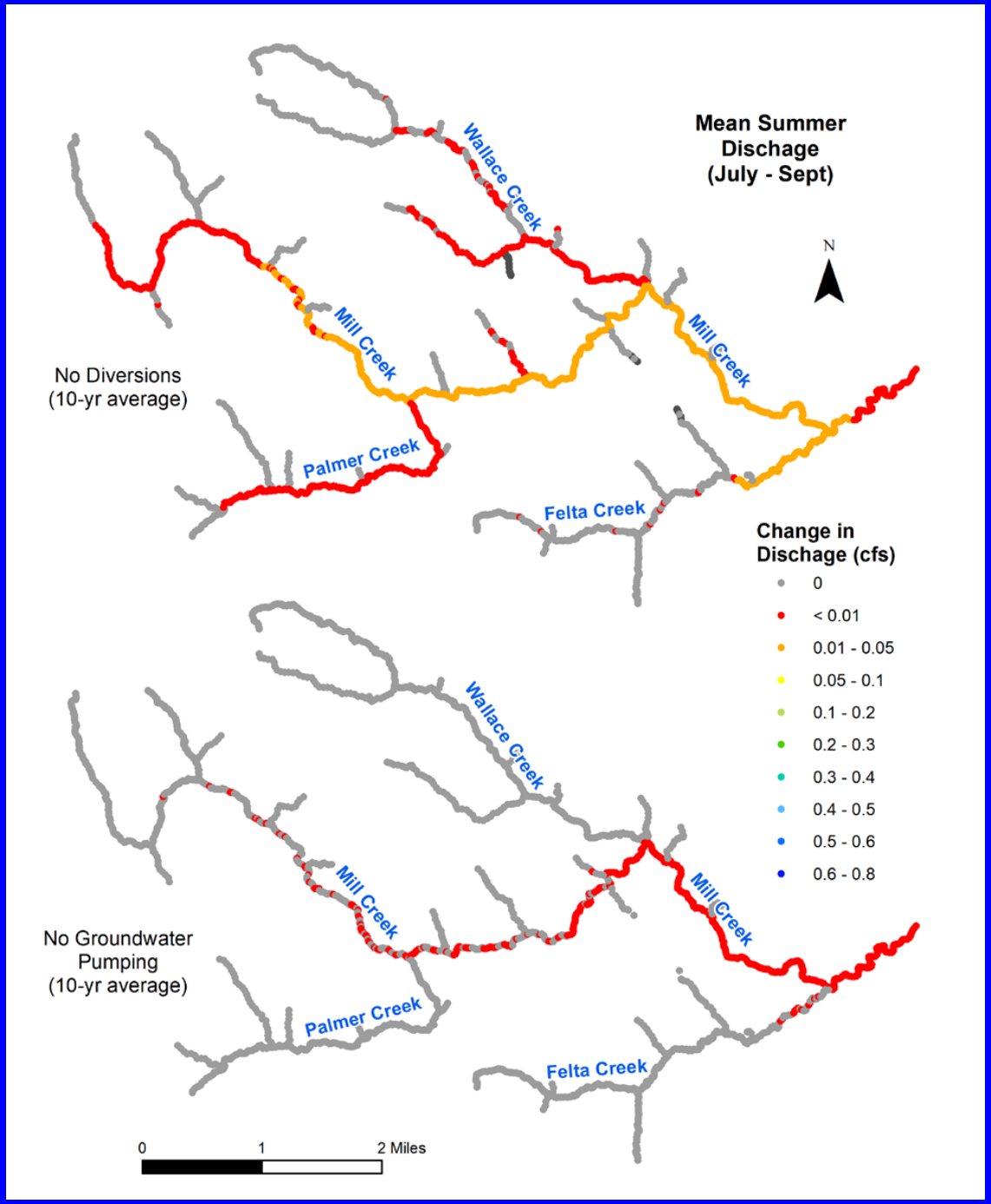
Model Scenarios for Streamflow Enhancement

- Water Use Scenarios
  - no diversions, no groundwater pumping, no water use (unimpaired)
- Flow Releases
  - spring outmigration releases, summer baseflow releases
- Recycled Water
  - Re-use of treated wastewater for irrigation & recharge/streamflow enhancement
- Landscape Management
  - Forestry/fuel mgt., grassland OM, hardscape runoff BMP's
- Climate Change

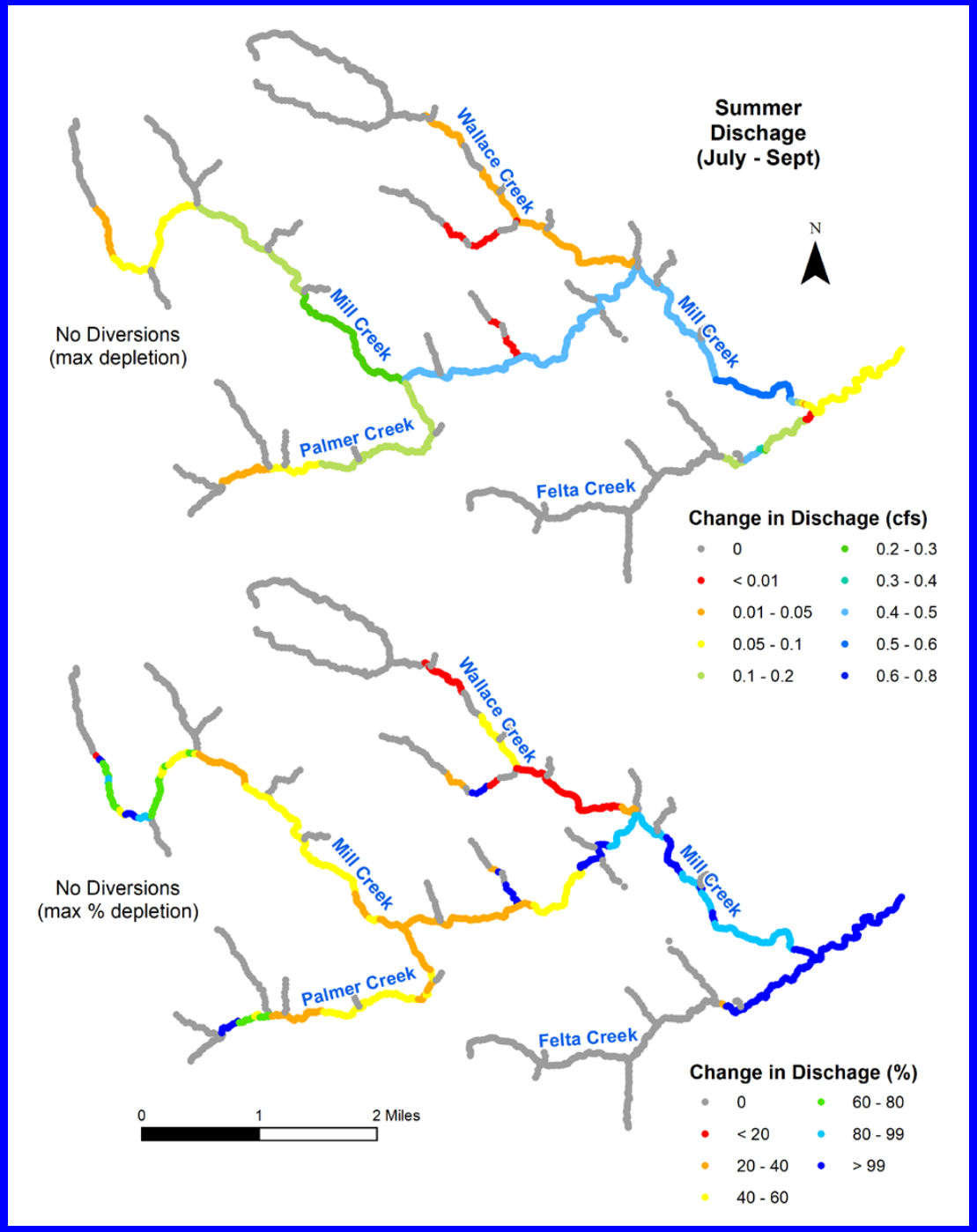
Scenario Analysis – Water Use



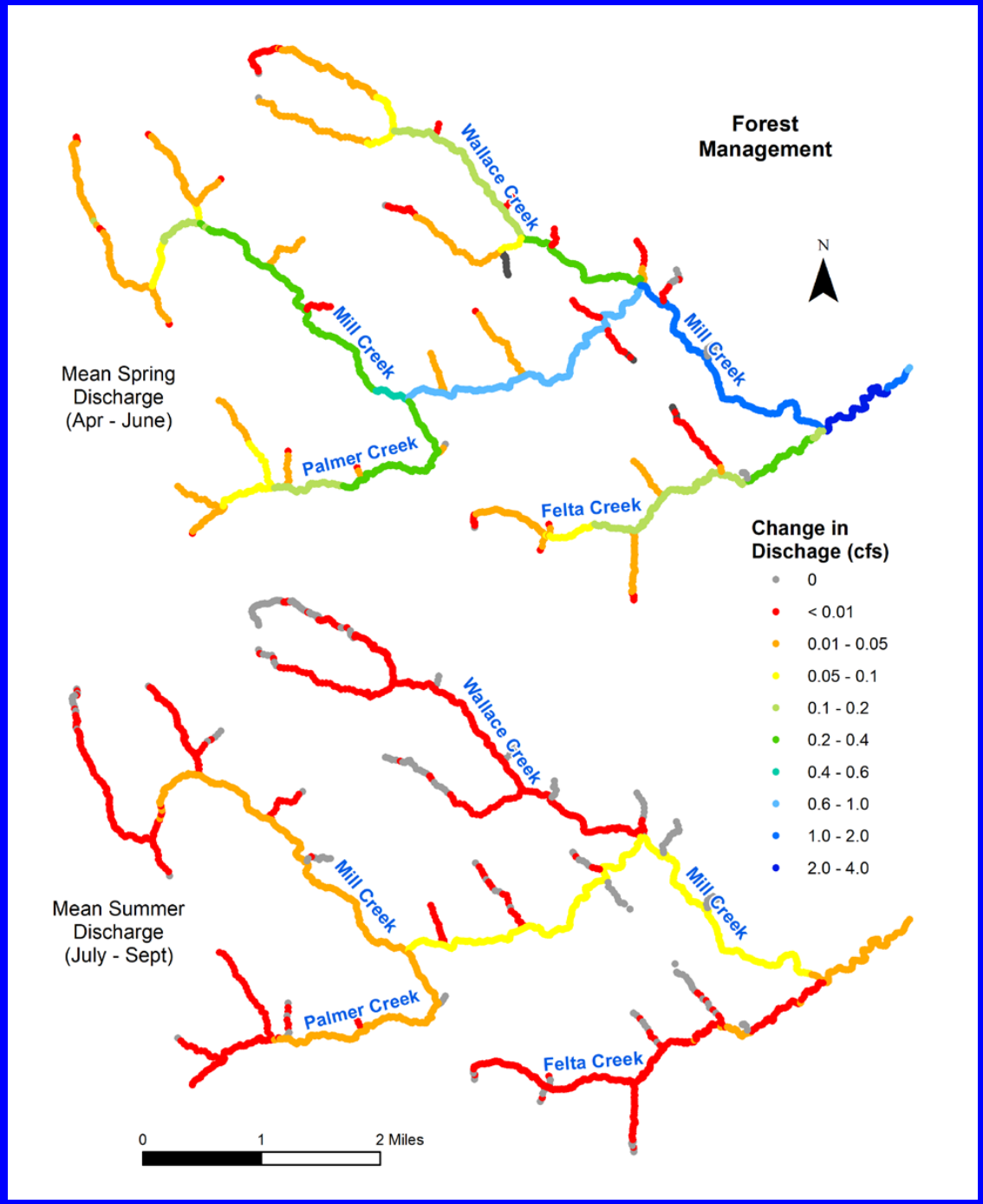
Mean Changes in Summer Flow: No Human Use



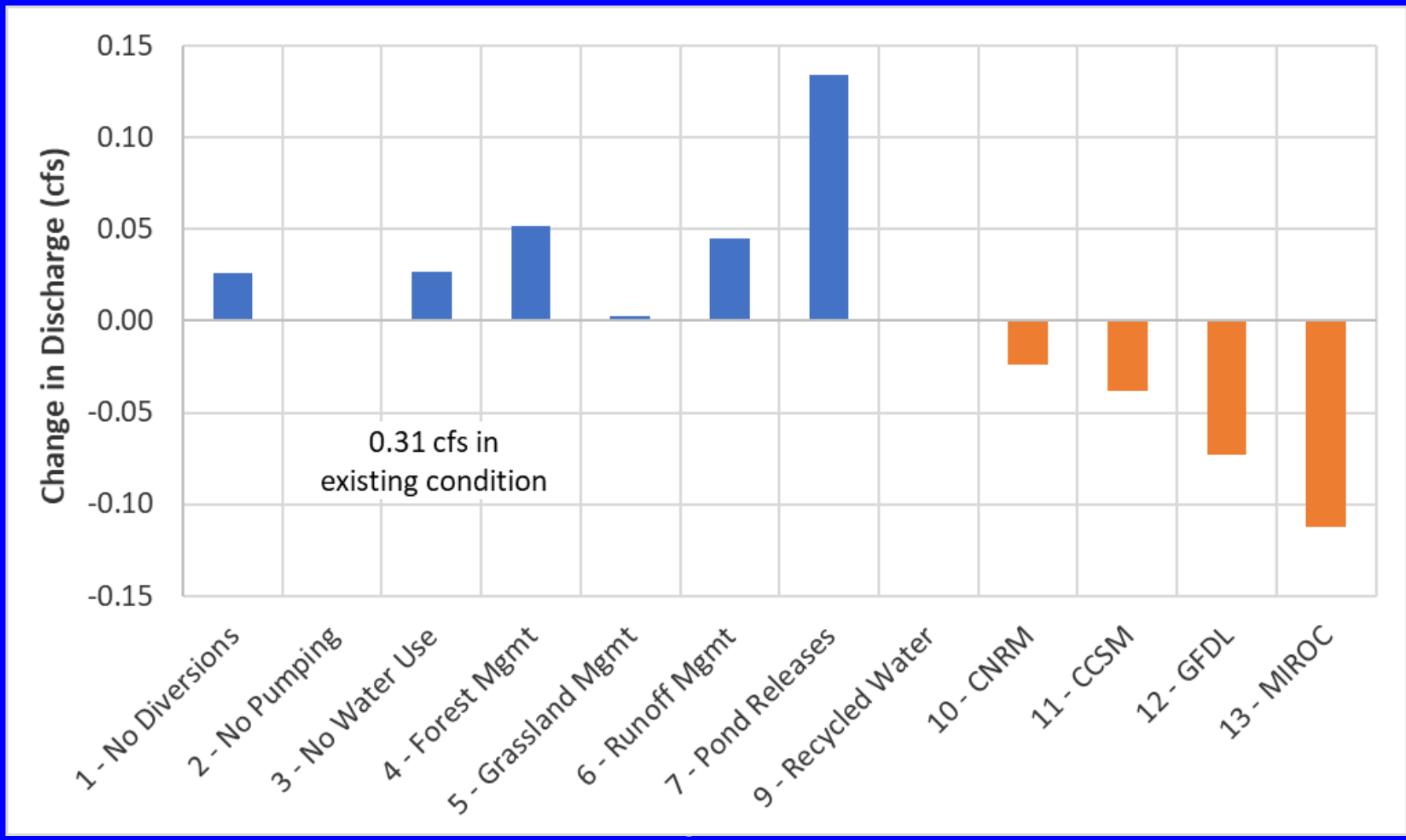
Short-term Changes in Summer Flow: No Human Use



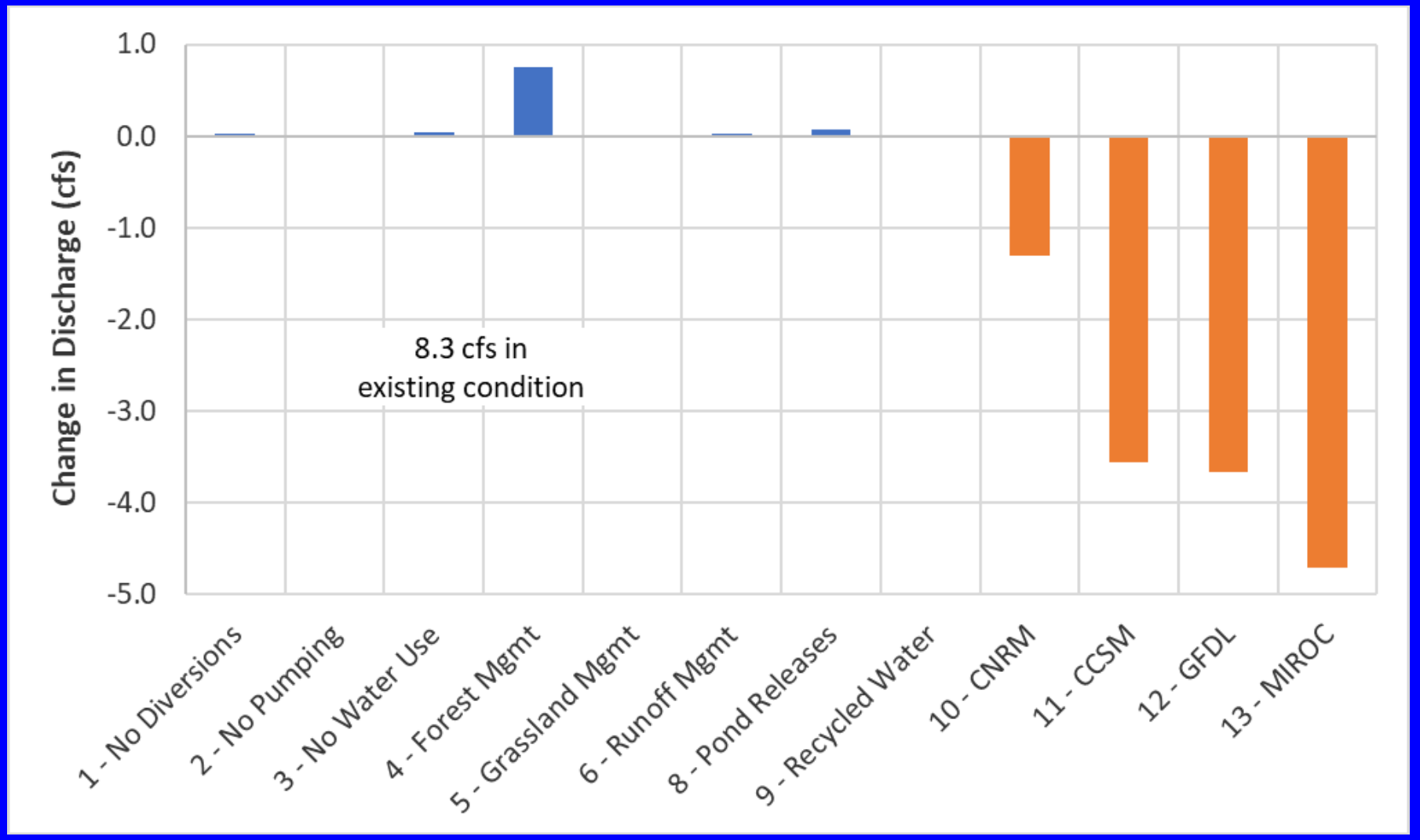
Mean Changes in Flow: Forest Management



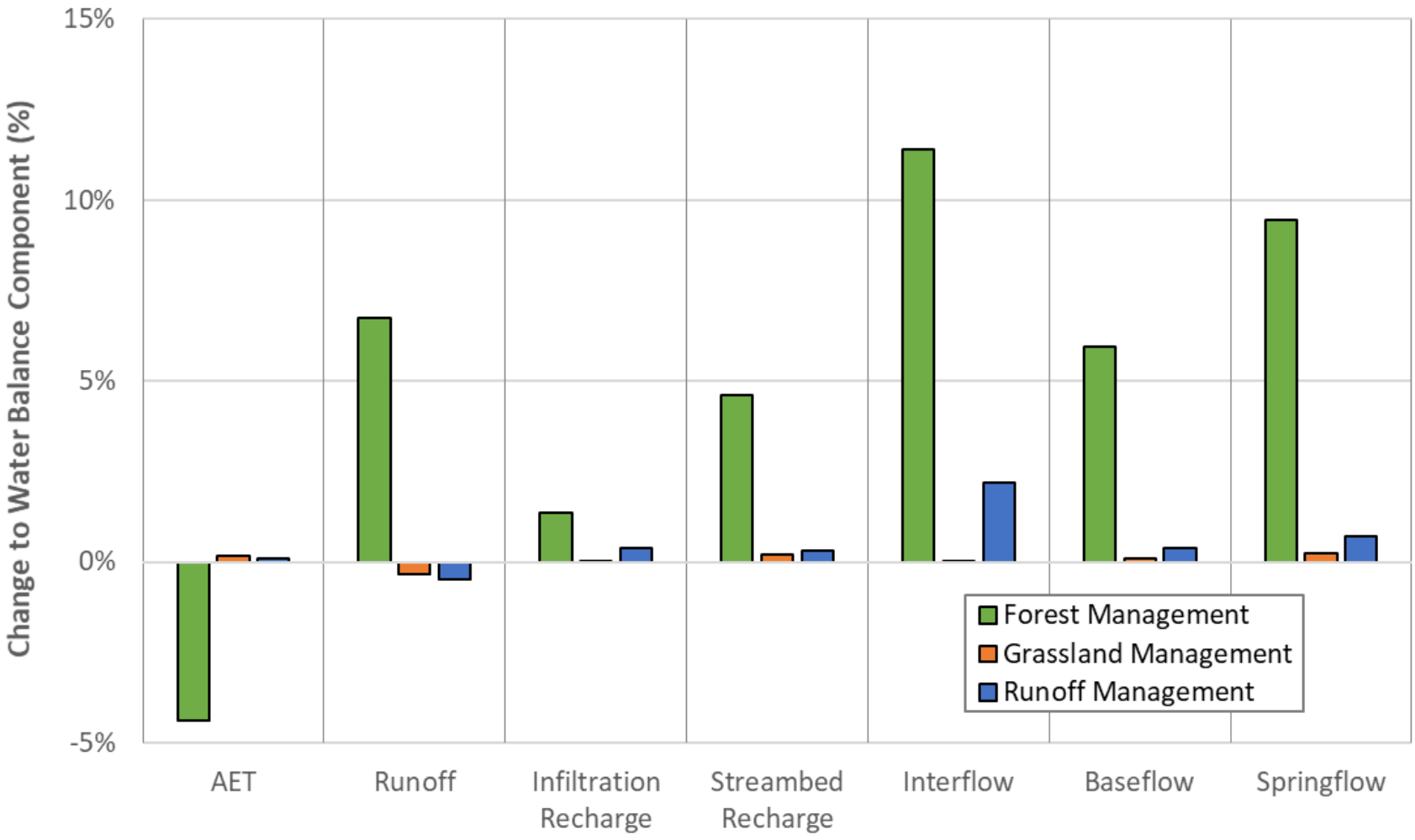
Scenario Results
Mean Summer Streamflow



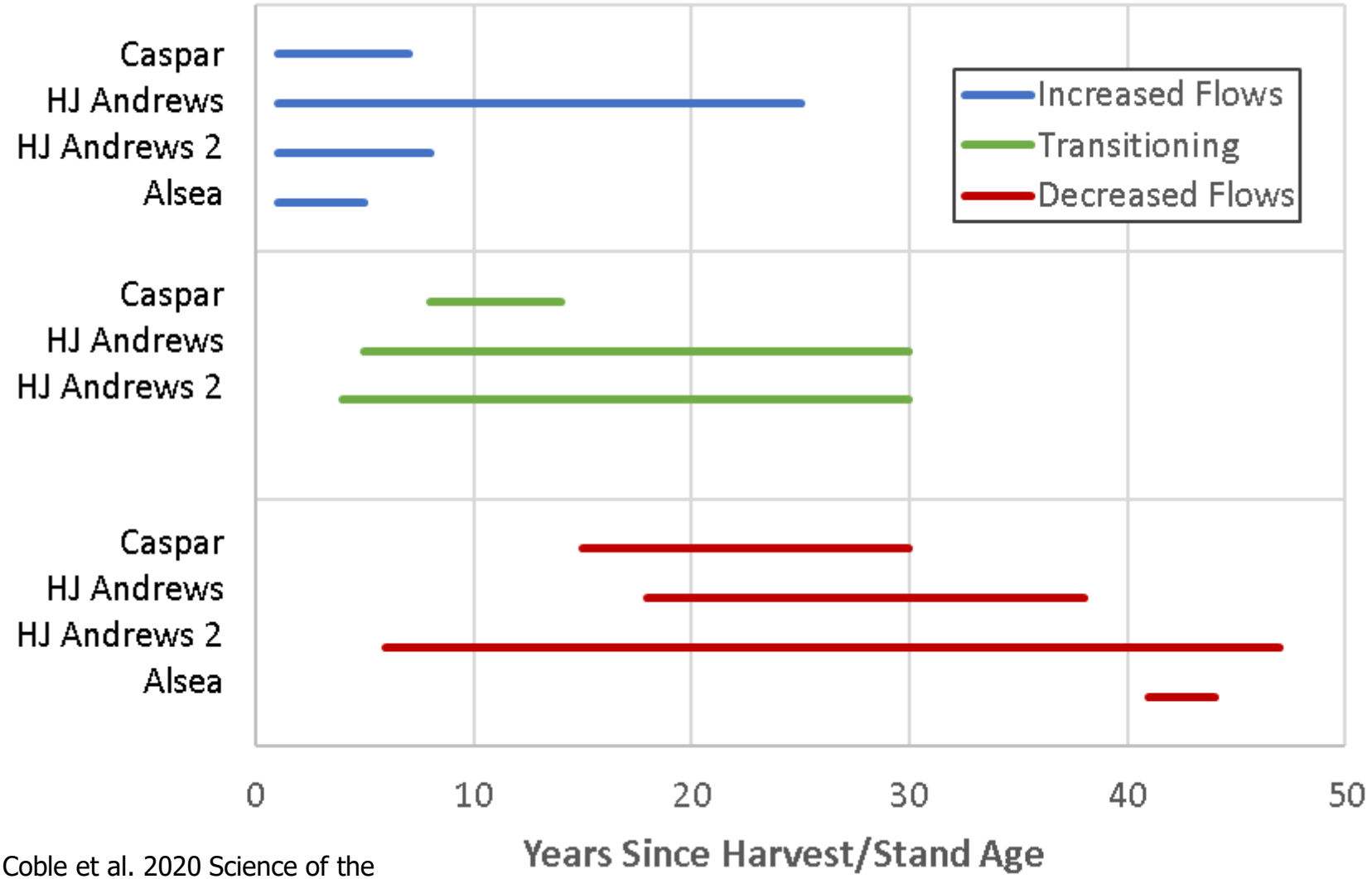
Scenario Results
Mean Spring Streamflow



Water Balance Changes



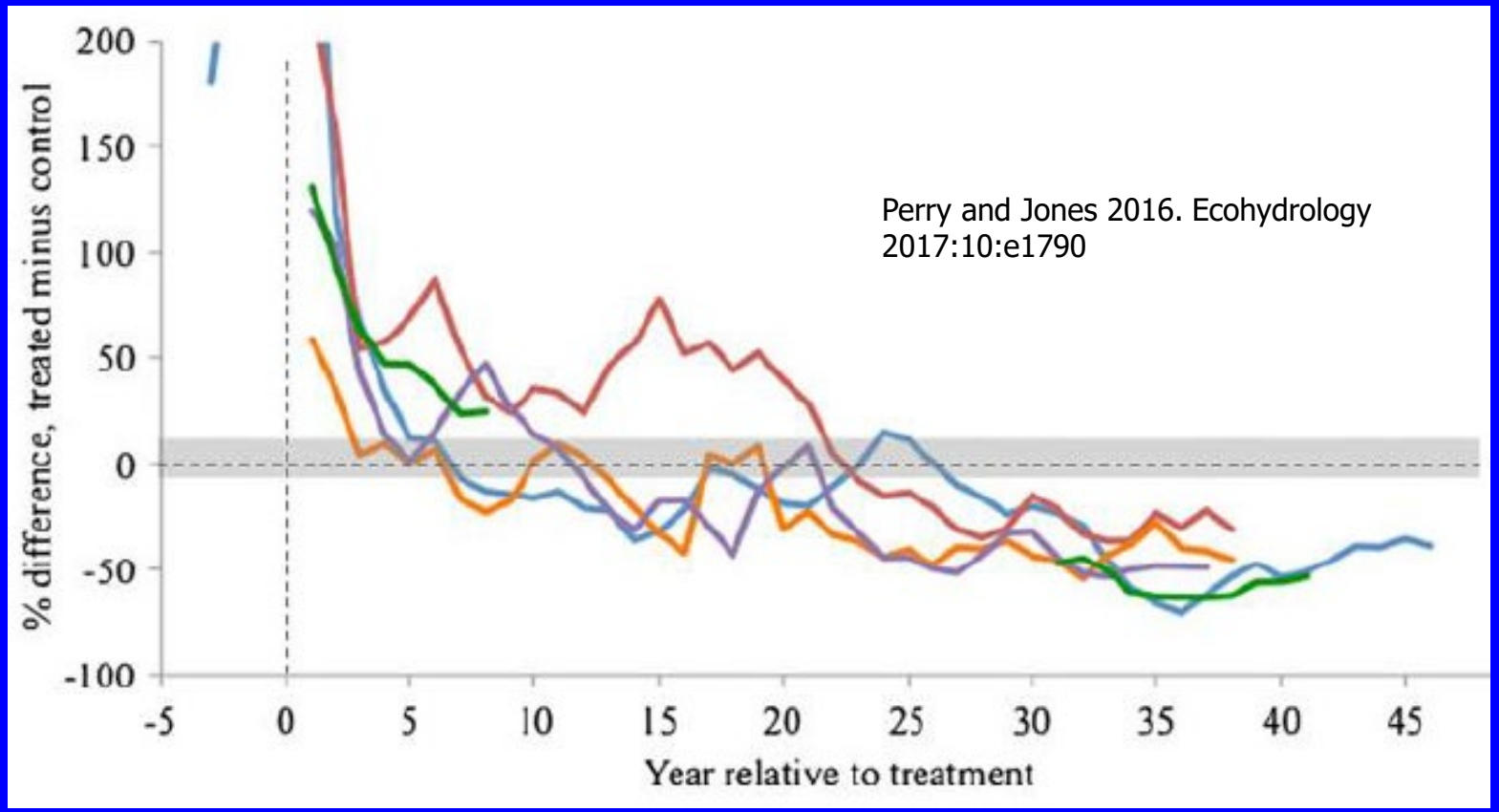
Paired Watershed Experiments
Flow Trends Over Time



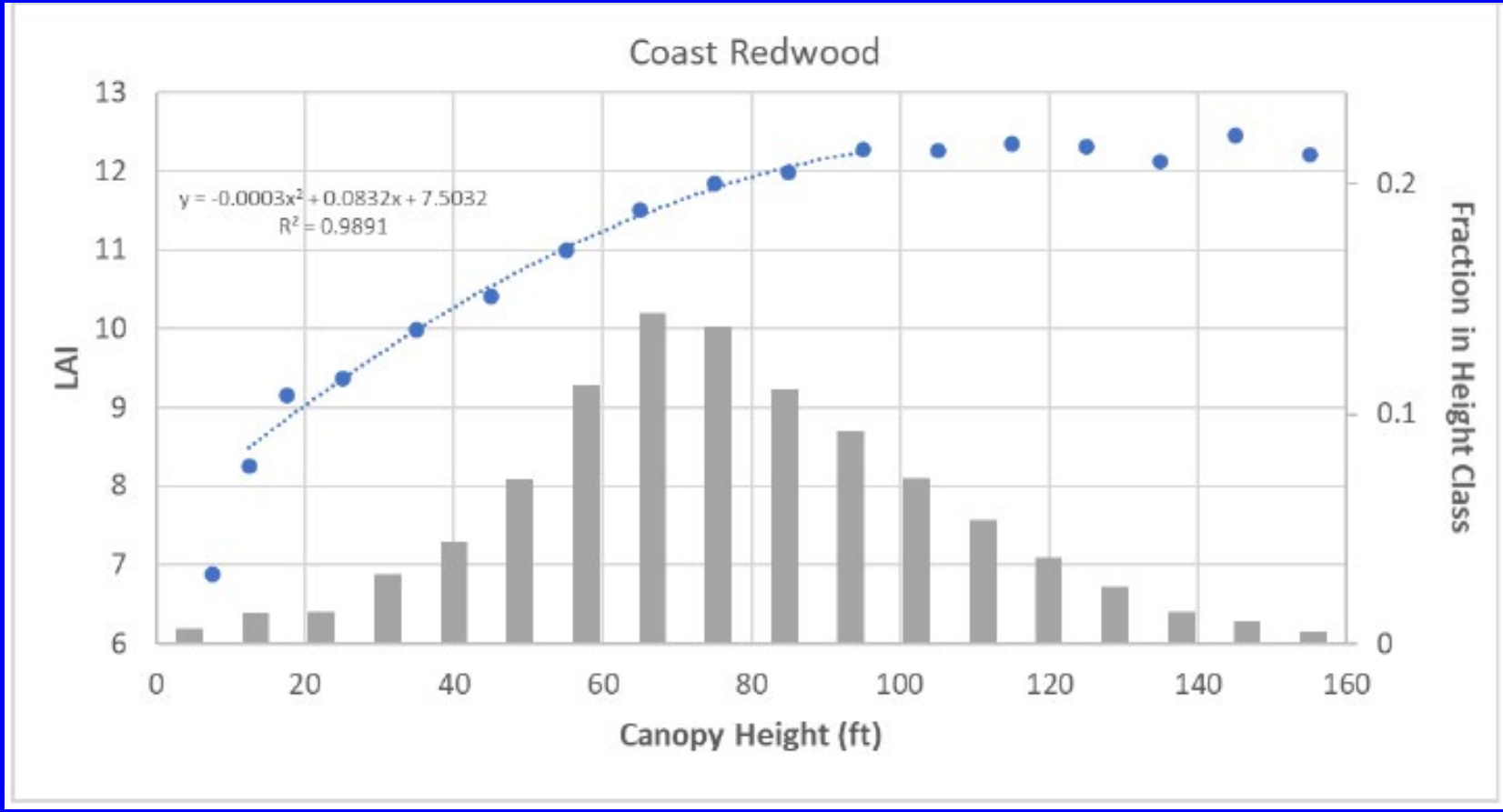
Coble et al. 2020 Science of the Total Environment 730, 138296

HJ Andrews Watershed Experiments

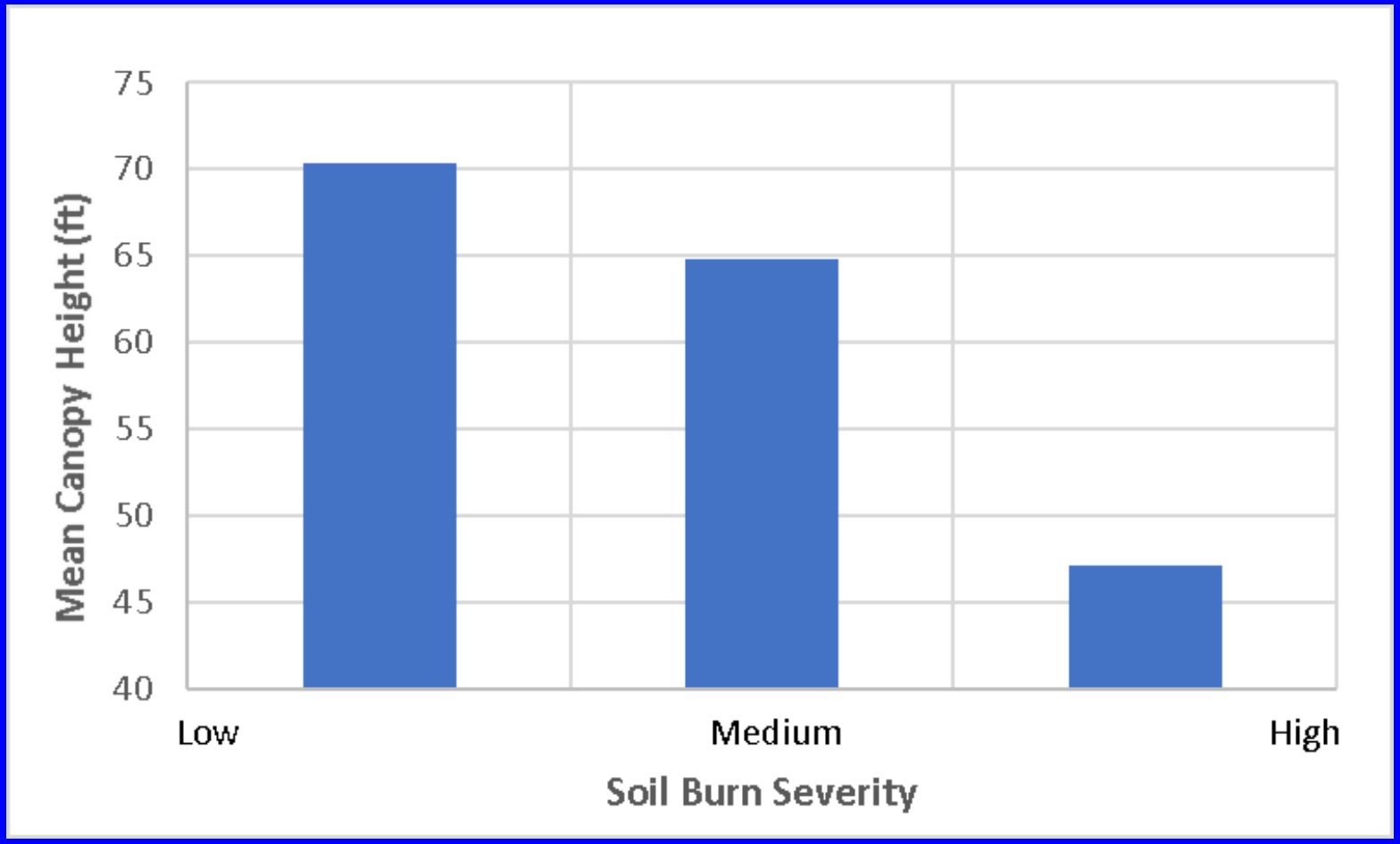
Summer streamflow in clear-cut watersheds relative to unharvested control watersheds



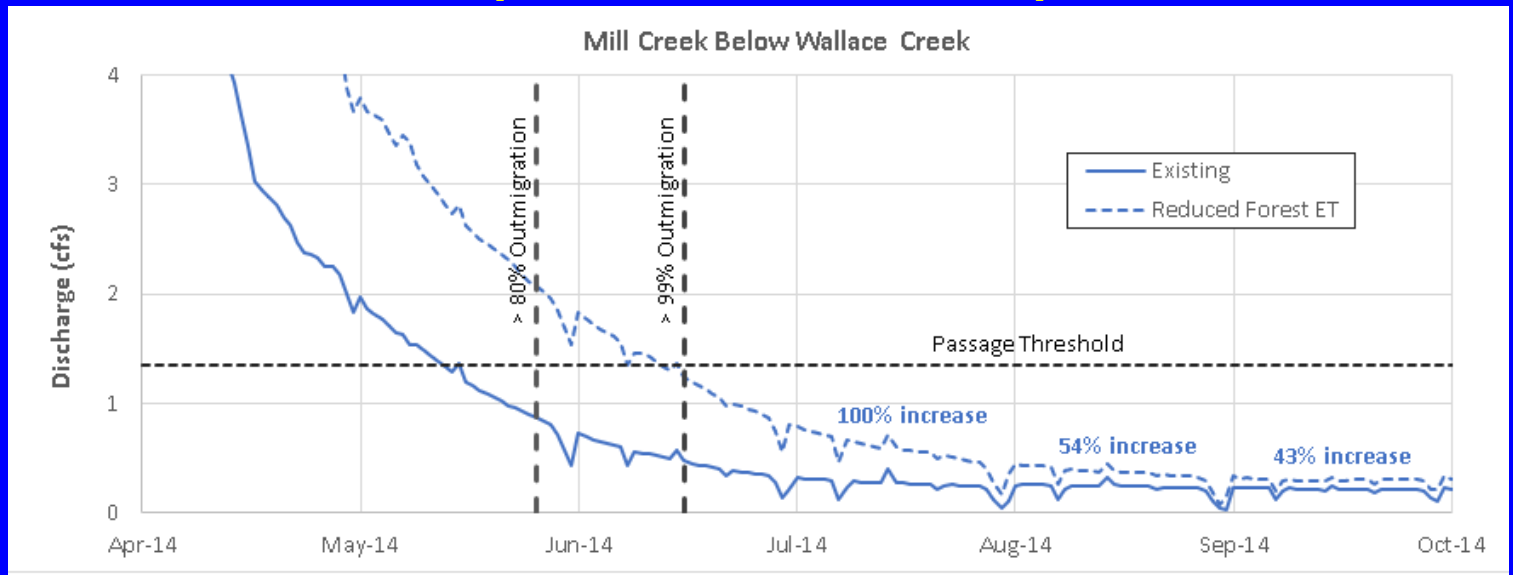
Mill Creek Forest Stand Conditions

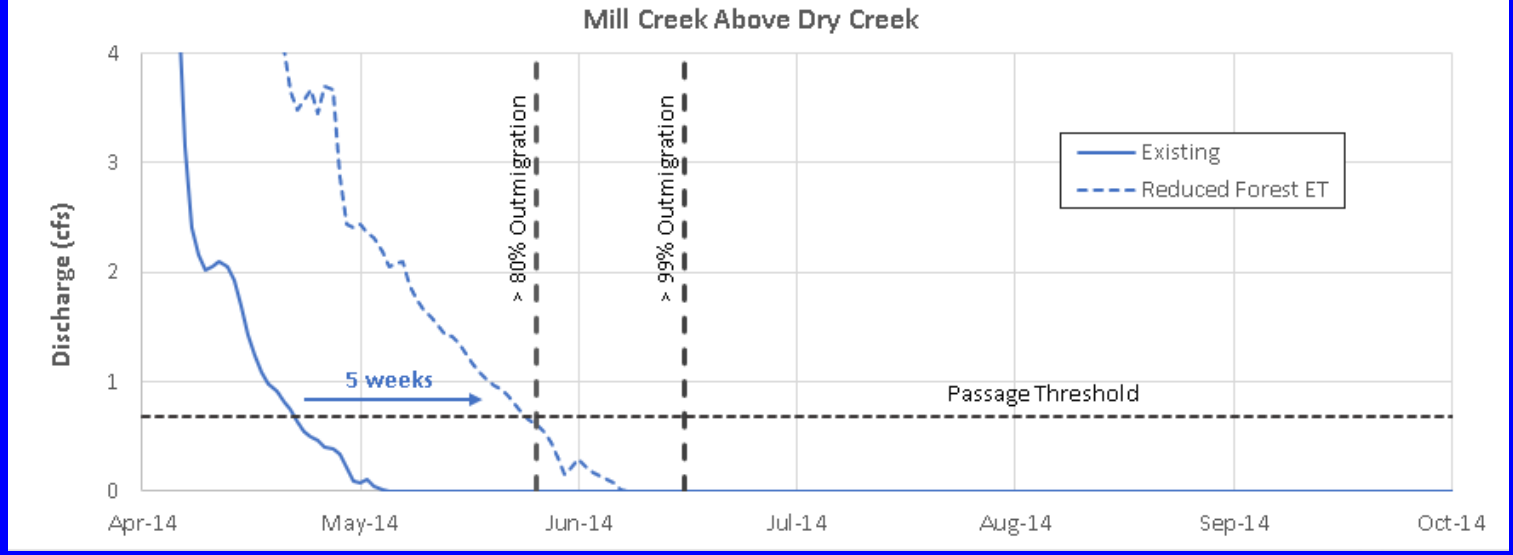


Mill Creek-Walbridge Fire Burn Severity



Mill Creek-Hypothetical Effect of Wildfire or Significant Fuel Treatment on Streamflow (15% ET Reduction)





Mill Creek above Wallace Creek – 2021 Forecast Streamflow v. Observed Streamflow