Exploring the Sensitivity of Watershed Hydrology to Land Cover and Climate Change:

Results from an Experimental Watershed Spanning the Rain-Snow Transition Zone

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PotlatchDeltic

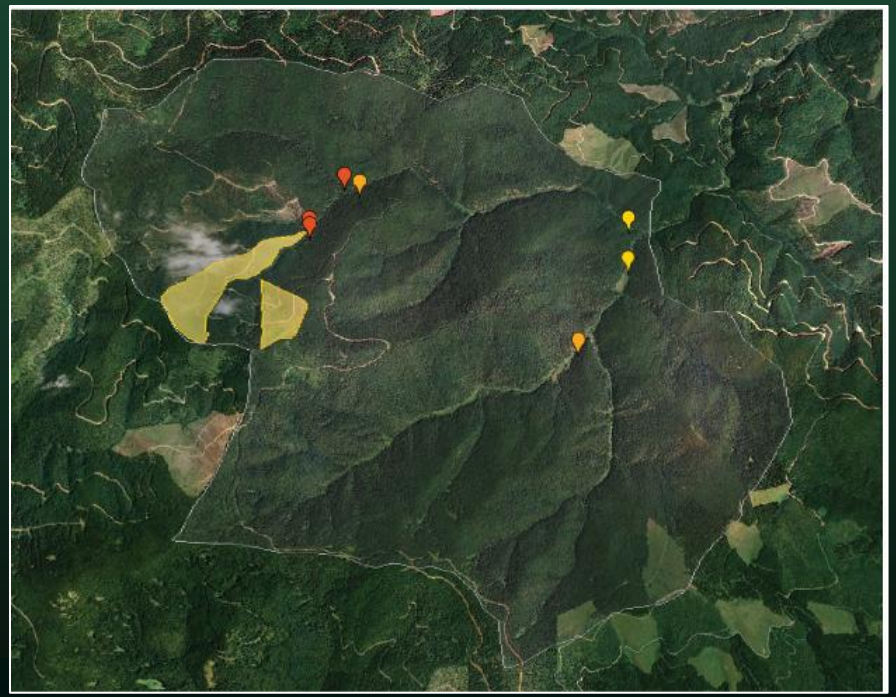
Objective and Questions

- Develop a holistic understanding of the hydrologic future in the interior Pacific Northwest
- Question: How are flow regimes in a watershed spanning the rain/snow transition zone expected to change?
  - Due to climate change?
  - Due to forest harvest and regeneration?
  - Across scales? (1st to 4th order watersheds)
  - Similarities and differences?

Land Cover Change

Many Experimental Forest Studies:

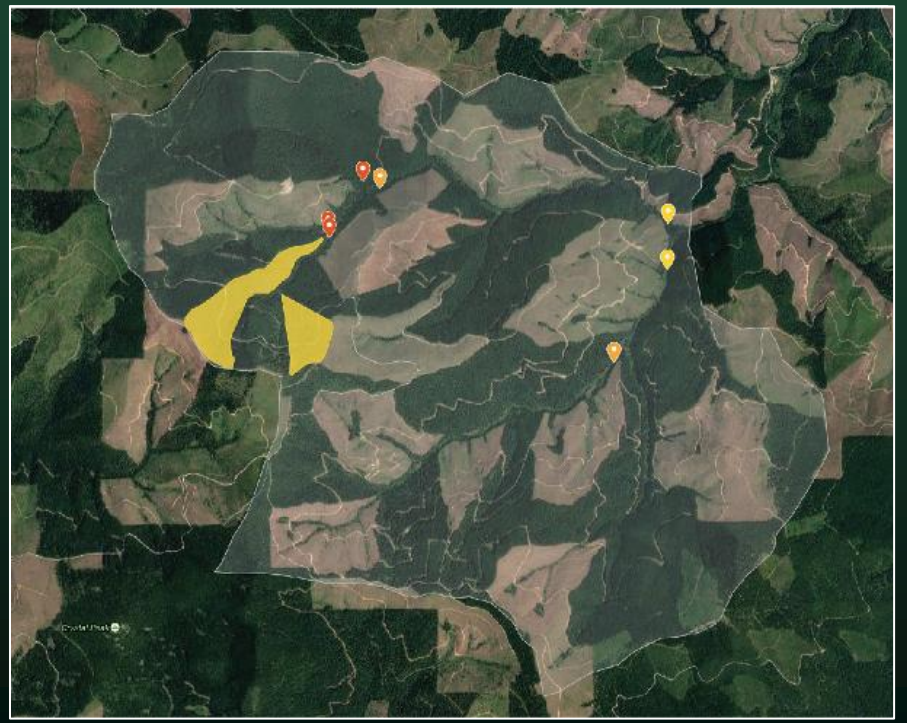
- Discrete Impact → Forest Regeneration
- 50 -100% harvest
- Low age diversity



Land Cover Change

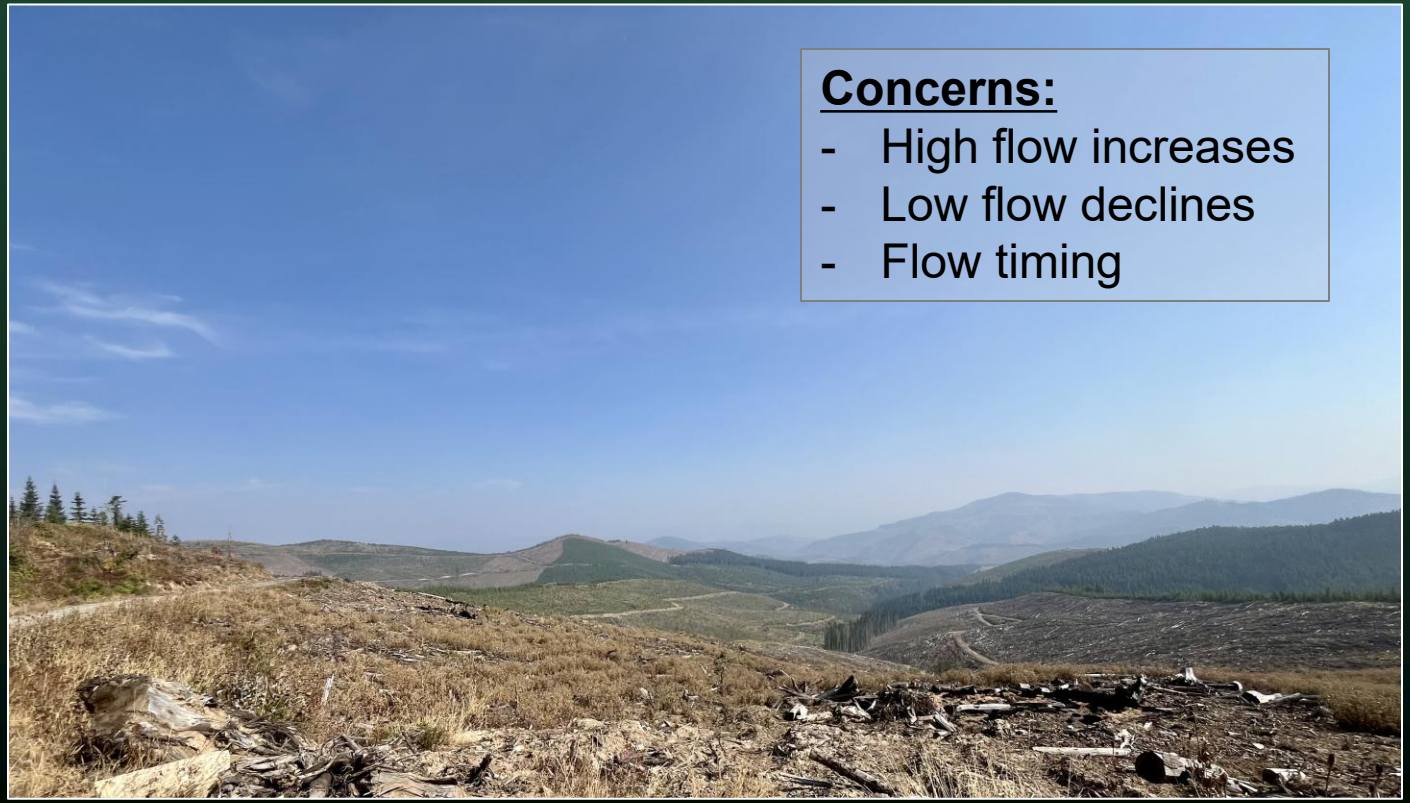
Working Forests:

- Successive Disturbance → Continuous Regeneration



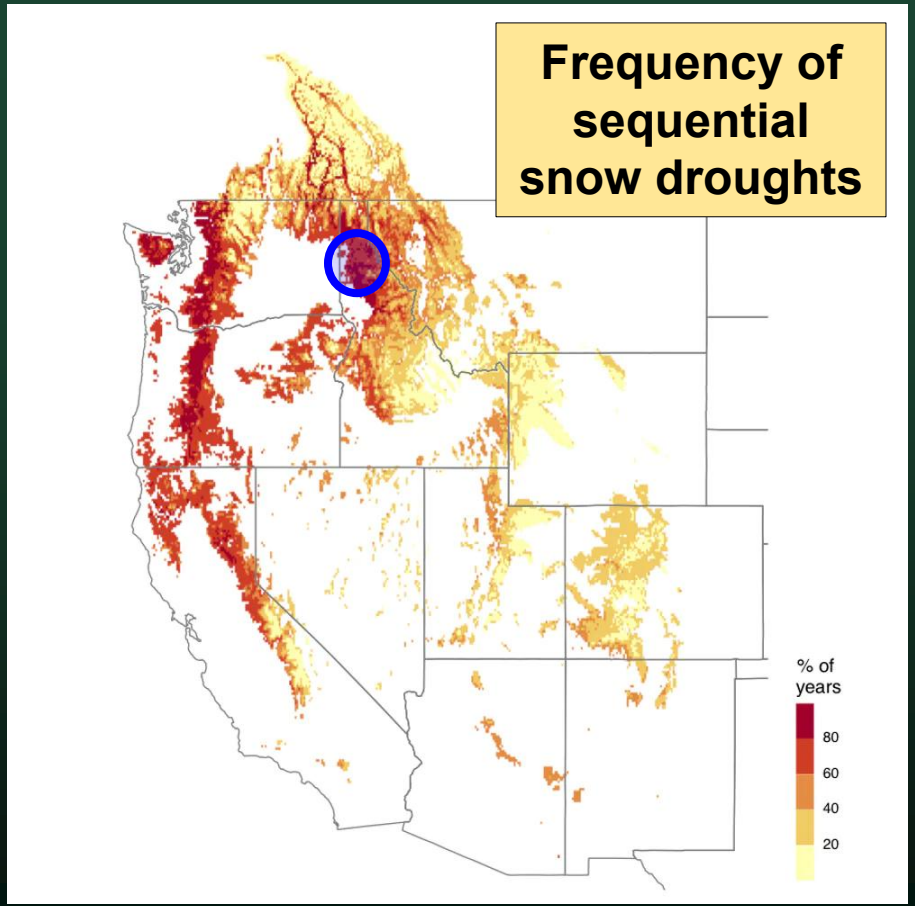
Age diversity generally increases with scale

Land Cover Change on Private Forestland



Climate Change

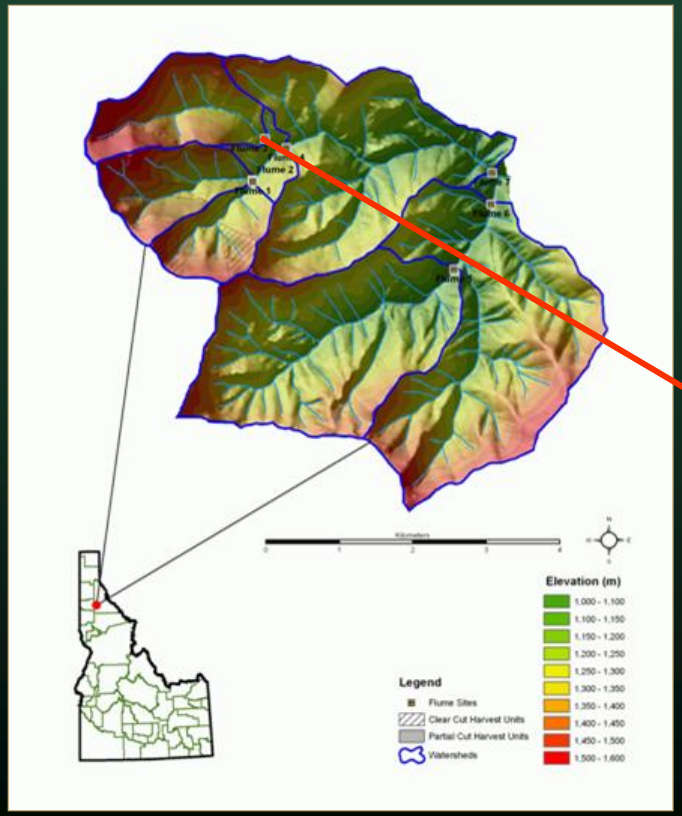
- Patterns of snow metrics are all similar:
  - Successive snow droughts
  - Rain:snow ratio
  - Peak snow depth
  - Melt timing
- Declining low flows…



Marshall, A. M., J. T. Abatzoglou, T. E. Link, and C. Tennant. 2019. Projected changes in interannual variability of peak snowpack amount and timing in the western United States. Geophysical Research Letters, 46(15), 8882-8892. https://doi.org/10.1029/2019GL083770.

Mica Creek Experimental Watershed

v. 1.0



Location:

N. Central Idaho

Climate:

- Continental/Maritime
- Transitional Snow Zone

Site Characteristics

- Size
  - 27 km^2
- Elevation
  - 1000-1625 m
- Precipitation
  - 1440 mm/yr
- Vegetation:
  ~80 yr Mixed conifers
- Active Forest Management
  - **<u>Diversity of age classes</u>**

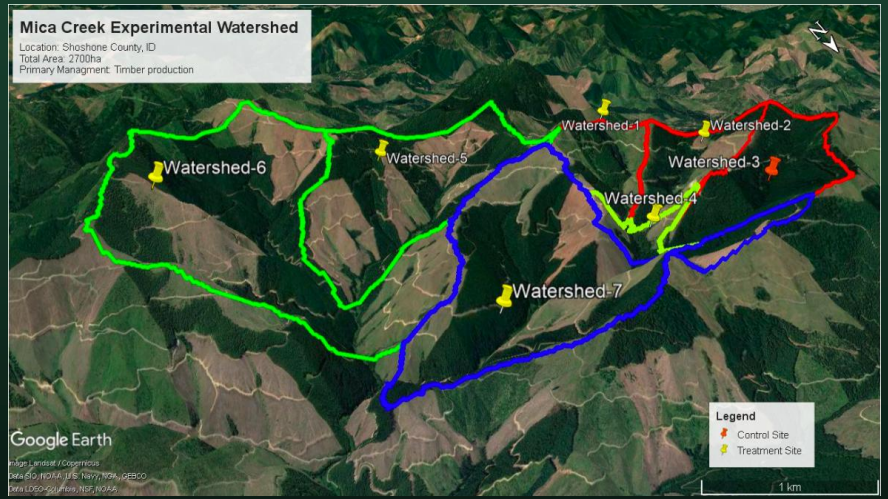


Image courtesy of C. Deval

Mica Creek: Data collection

Soil properties

Soil moisture

Flow, chemistry & isotopes

Distributed Hydro-meteorology

Throughfall

Sap Flux

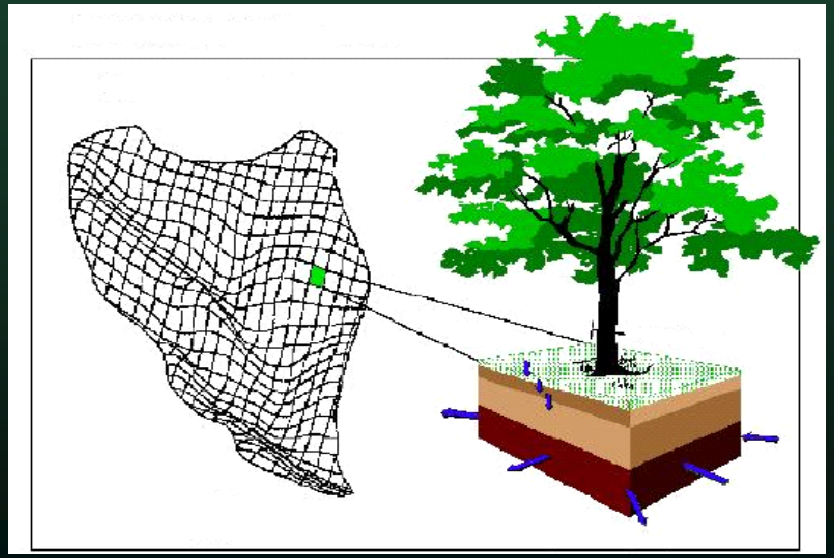
Snowpack properties

Reducing the Potential for Equifinality

Simulation Approach:
Physically-Based, Virtual Experimental Watershed

- Distributed Hydrology Soil Vegetation Model (**DHSVM**)
- Detailed Internal Watershed Data
  - Parameterization
  - Validation
    - Du et al., 1994 & 1996
- Quasi Monte-Carlo Parameterization
- **Simulate Alternative Futures**

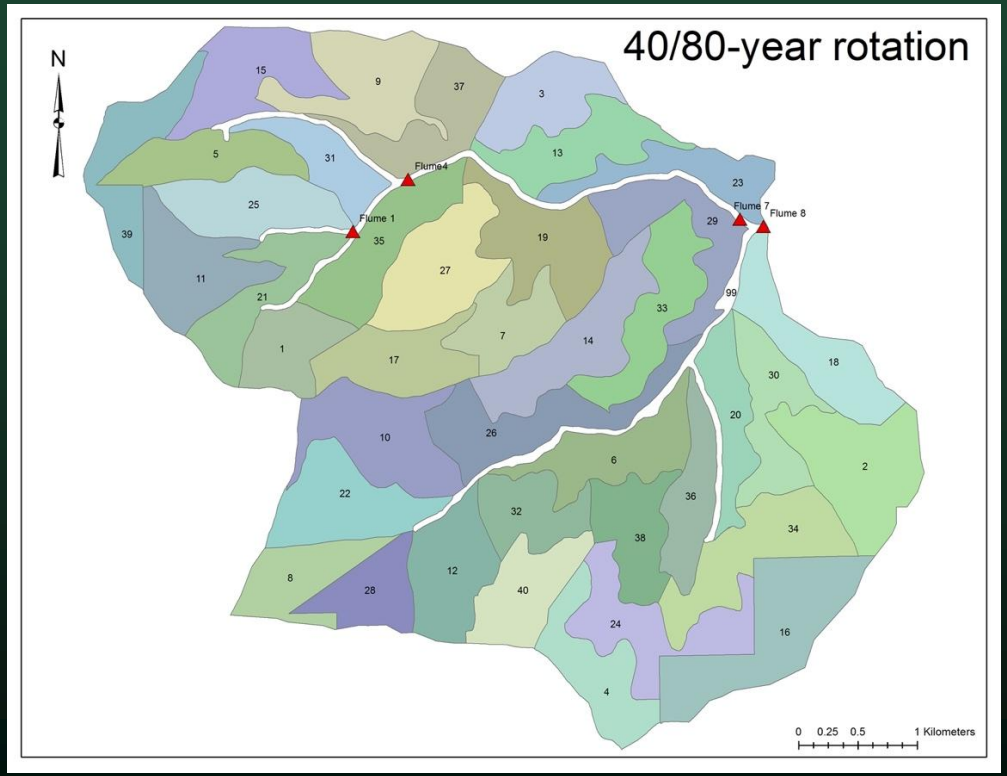
DHSVM schematic



(Wigmosta, 1994)

Simulated Harvest Units

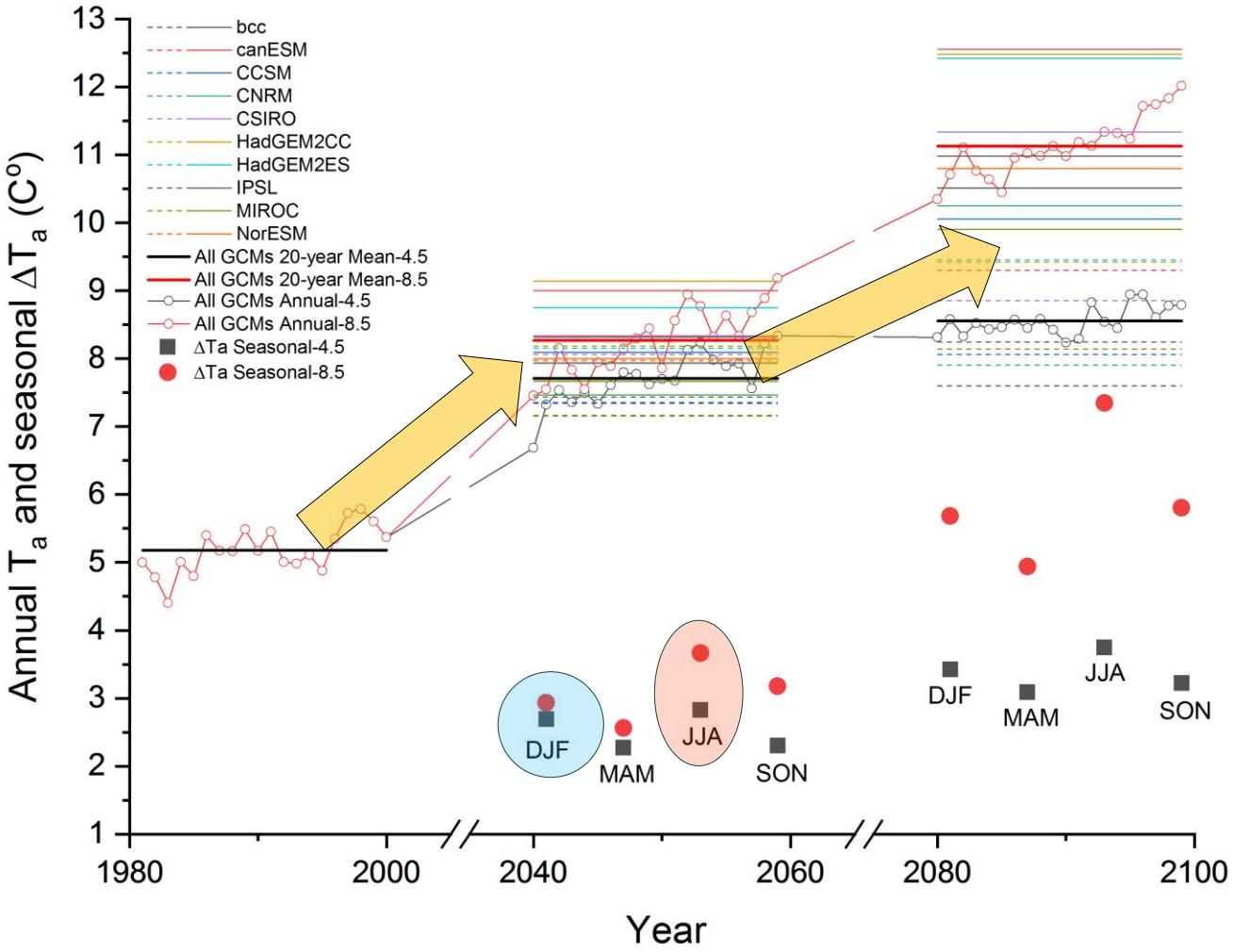
- 40 yr rotation …
- ~2.5% per year
  - Higher than in practice



Projected Temperatures

AR5, RCP 4.5 & 8.5

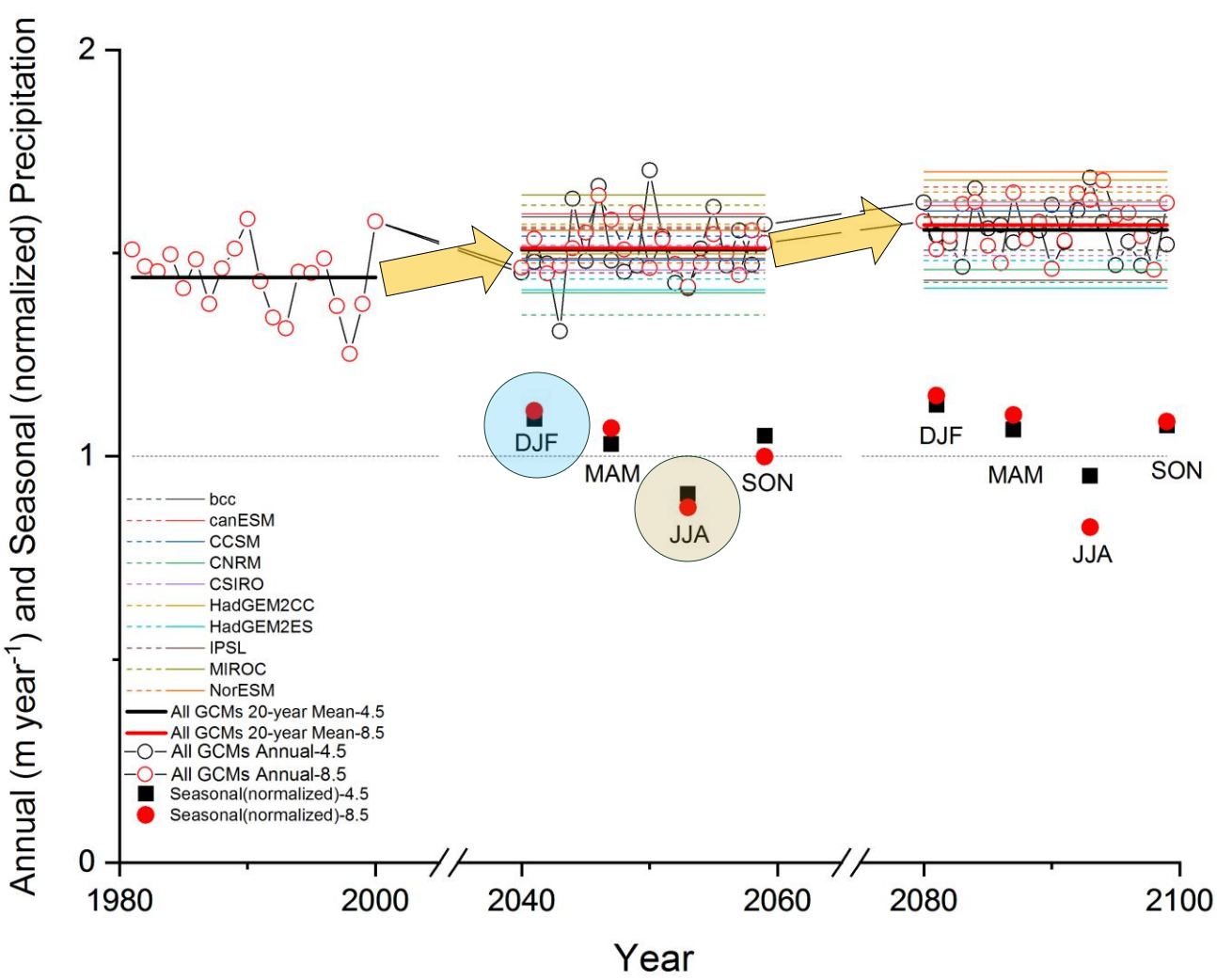
- Warmer
- Less in winter
- High uncertainty



Projected Precipitation

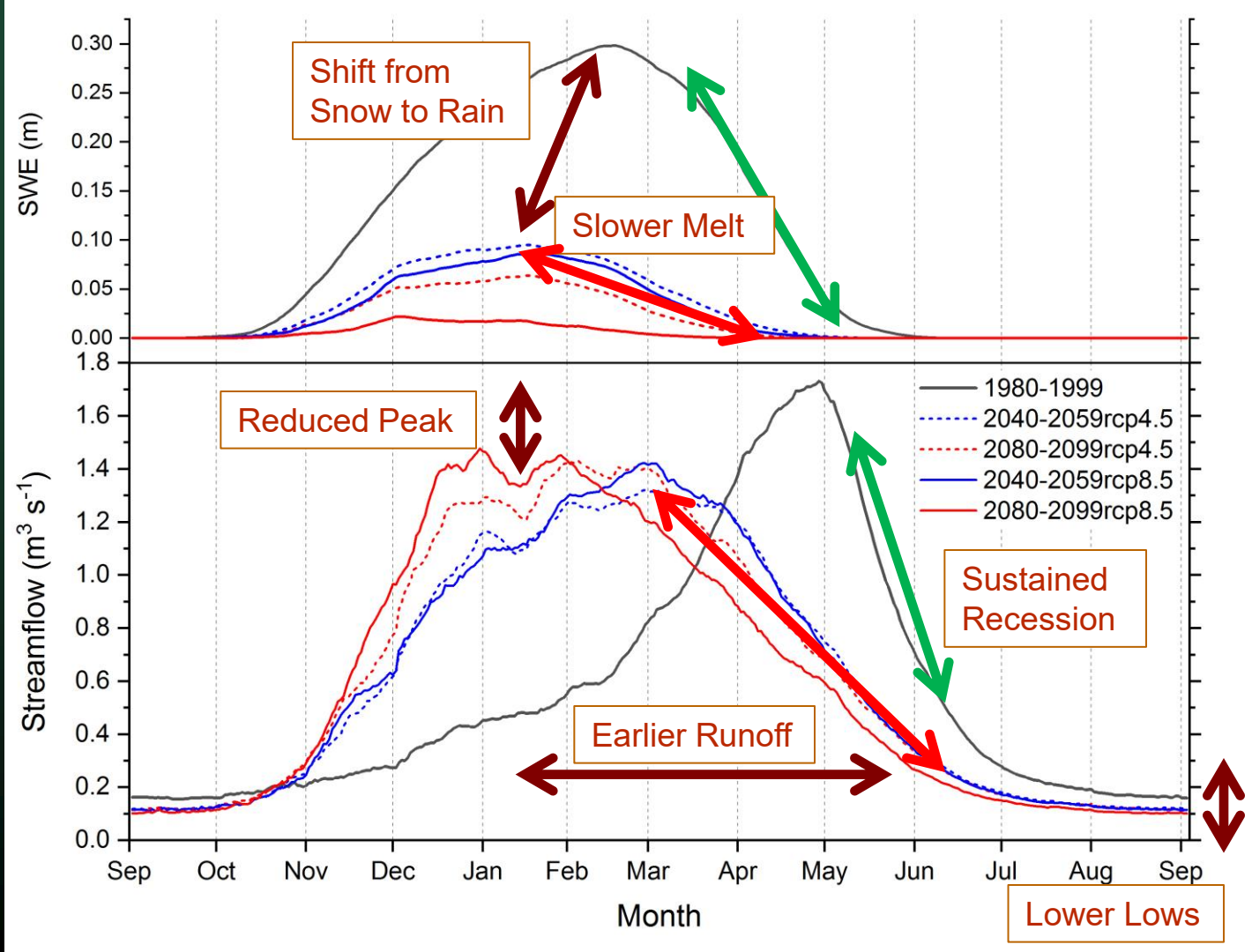
AR5, RCP 4.5 & 8.5

- Annual increase
- Wetter winters
- Drier summers

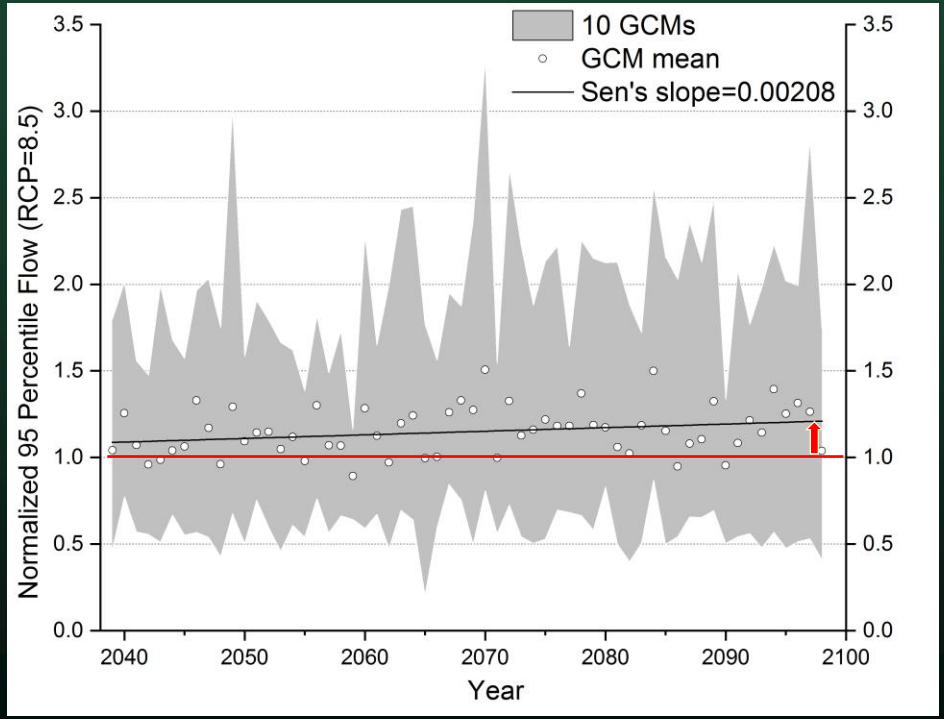


Projected Snow and Streamflow

10 GCM ensemble



95th Percentile Flows
RCP 8.5



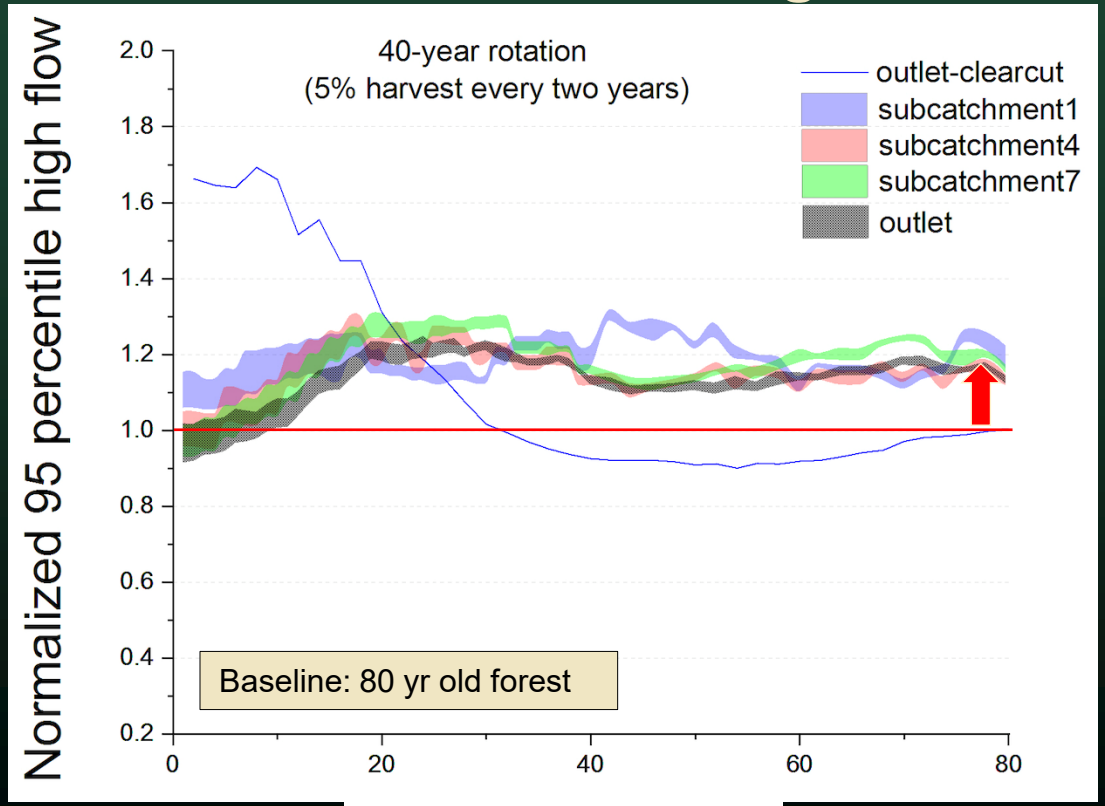
Slight Increasing trend

Rain-on-snow declining?
Musselman et al., 2018

Baseline: 1980- 2000

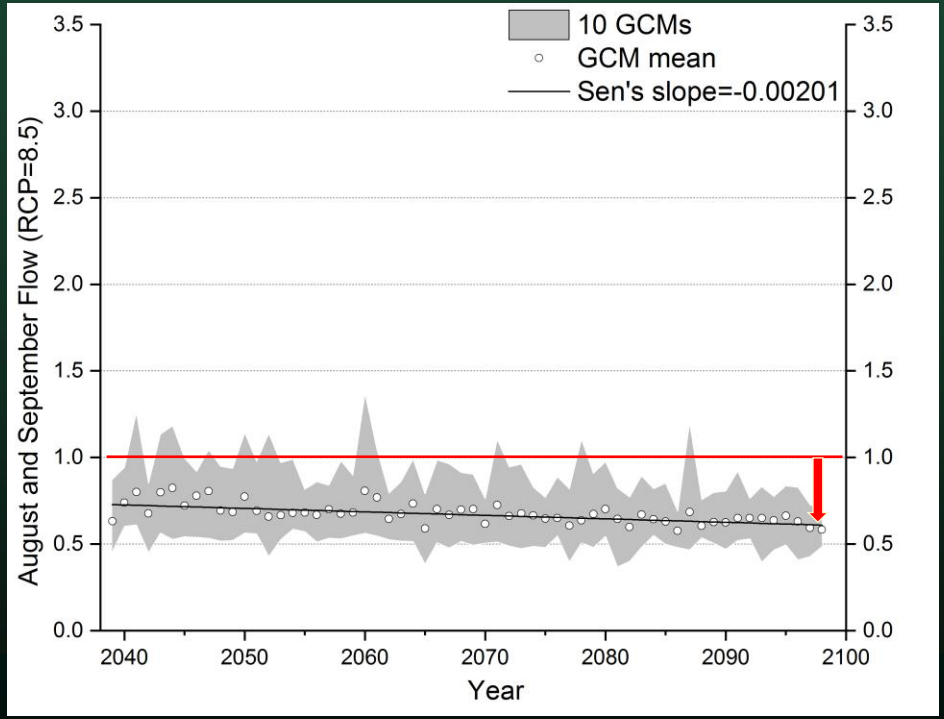
*preliminary simulations

95th Percentile Flows
Land Cover Change



Sustained increases at larger scales

Aug - Sep Low Flows
RCP 8.5

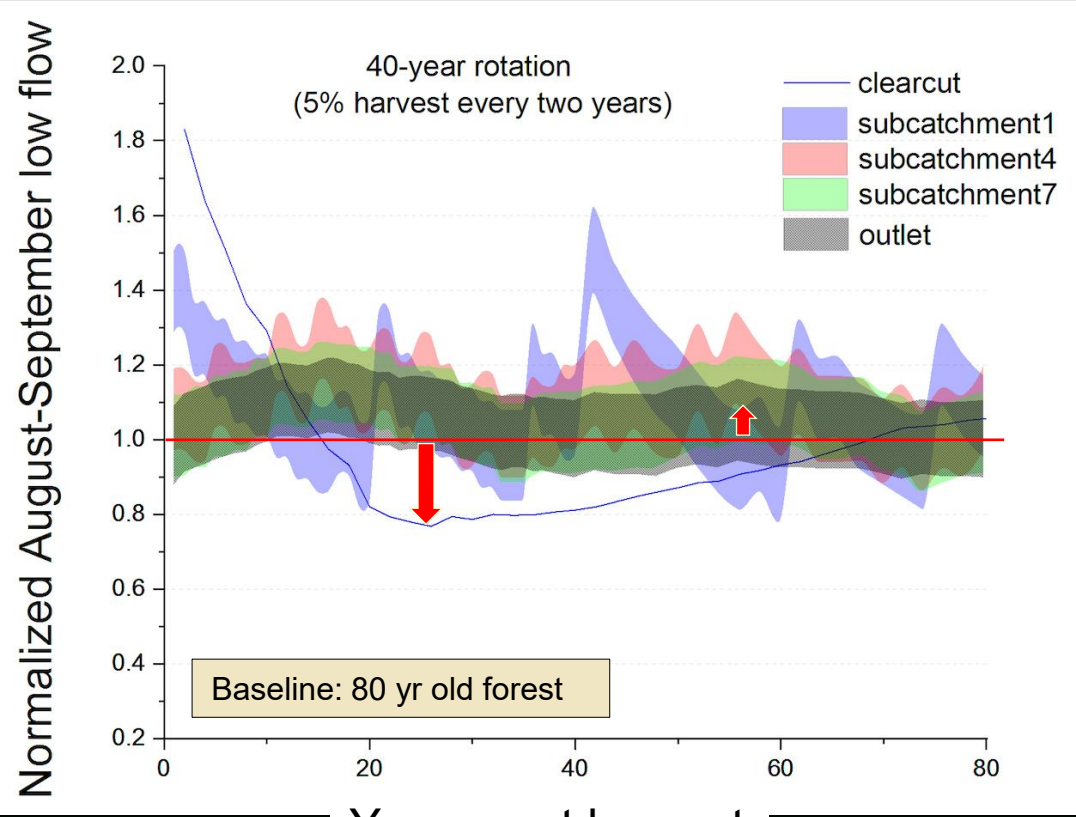


Decreasing trend

Baseline: 1980- 2000

*preliminary simulations

Aug – Sep Low Flows
Land Cover Change



Large Scales:
May slightly offset climate effects

Small Scales:
May offset or exacerbate climate effects

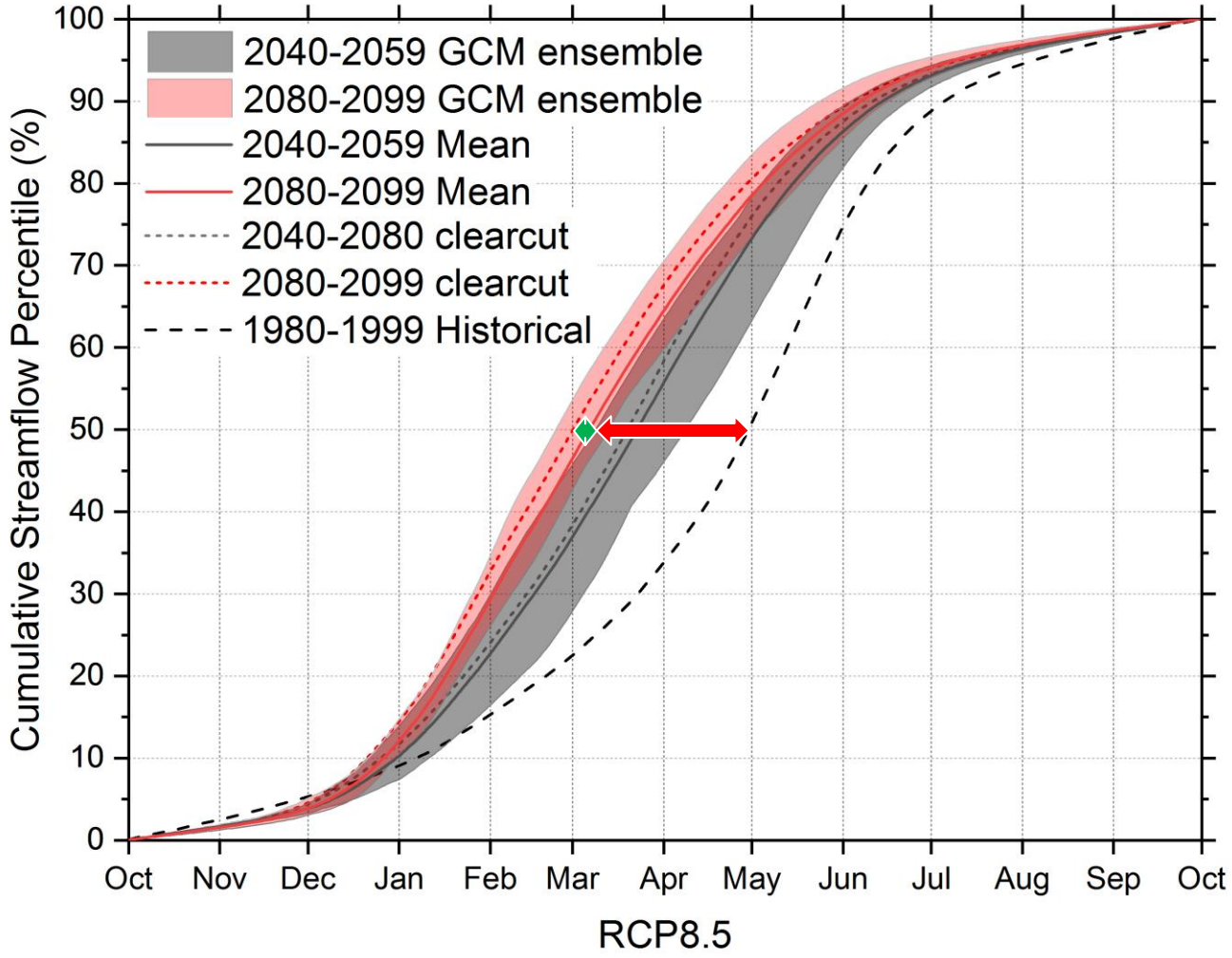
Depends on age

Land + Climate Effect:

Cumulative Streamflow

Harvest
Effect is Minimal
Compared to Climate

- Based on 100% Harvest!

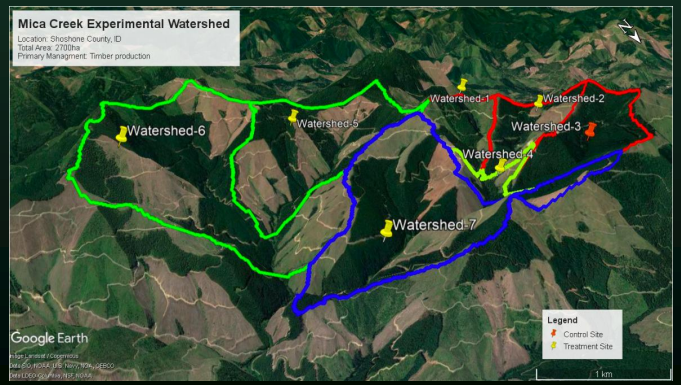


Summary

- Profound climate-driven flow regime changes are underway
  - Across all scales
  - Expected to slow in late century
- Climate changes have larger effects on timing
- Land cover changes have larger effects on flows
  - Harvest effects on flows ***diminish or reverse as scale increases***
  - Reduces or exacerbates climate effects

Future Directions:

- Role of microclimate and snowpack variations
- Shifting lowflows and stream temperatures
- First update the watershed!




Toward Mica v. 2.0…
From Paired Watershed Experiment
to
Research Basin

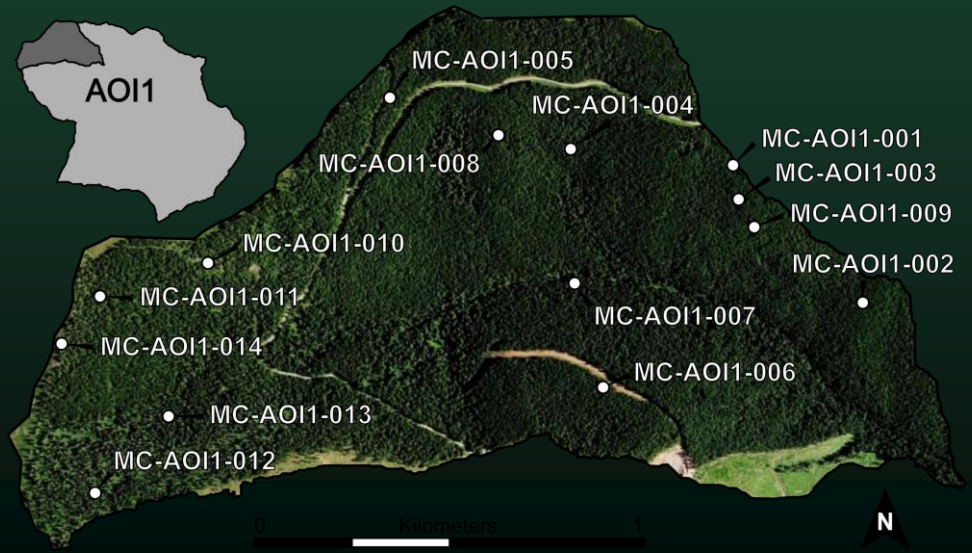
Site Access Improvements

Core Meteorological Monitoring Improvements

Core Gauging Stations Improvements

Expanded Subsurface Characterization

(Lohse & Patton, ISU)



Detailed Regeneration Monitoring

Thank You!

Questions?