



Impacts of climate change and wildfire on stream temperature and bull trout in the East Fork Bitterroot River

JFSP sponsored project in collaboration with

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Study Premises

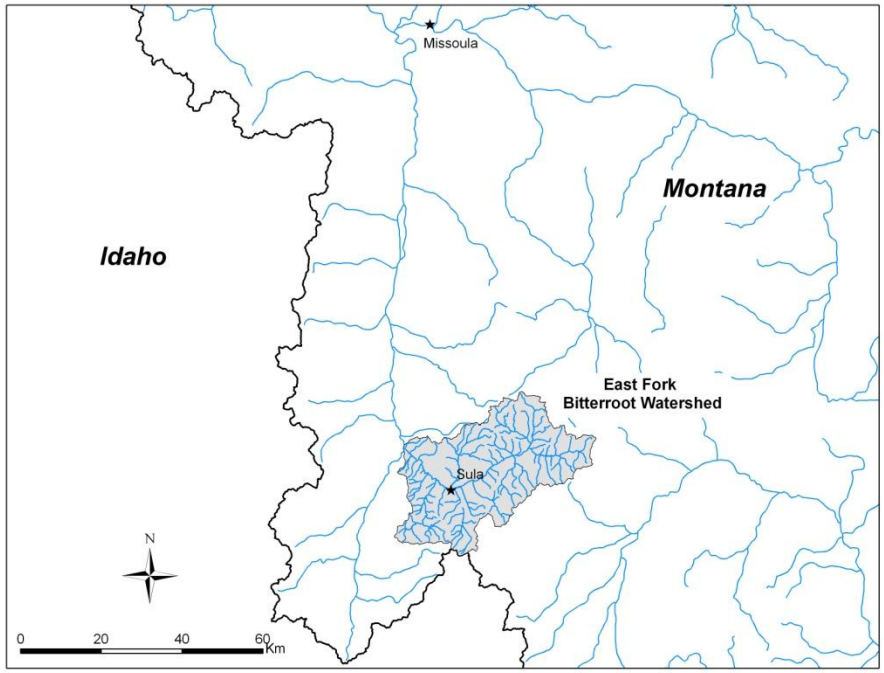


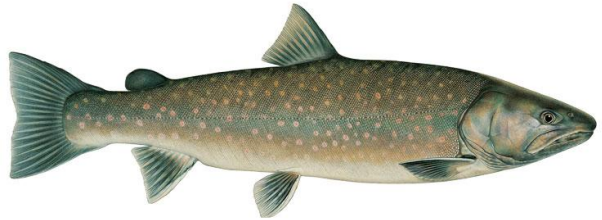
- *Wildfire is a natural disturbance affecting native fish in the Rocky Mountains*
- *Fire can remove vegetation increasing solar radiation to stream, leading to warmer summer water temperatures*
- *Native fish (e.g. bull trout, cutthroat trout) populations are resilient to fire effects given adequate connectivity to robust populations segments elsewhere in a basin*
- *Resiliency may be reduced due to climate change and concomitant changes in fire regimes*

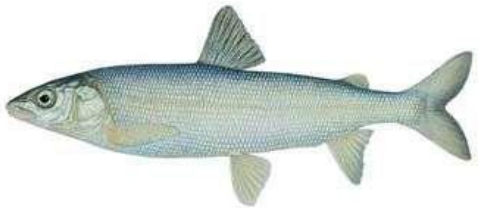
Study Objectives

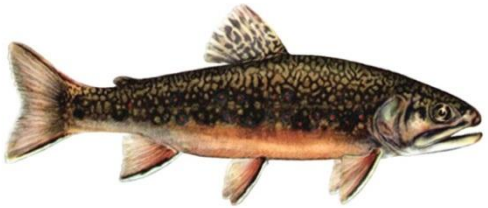
- *How may climate change affect stream temperatures*
- *Do climate-mediated changes to fire regimes affect stream temperatures*
- *Can fire management mitigate changes?*

East Fork Bittterroot River

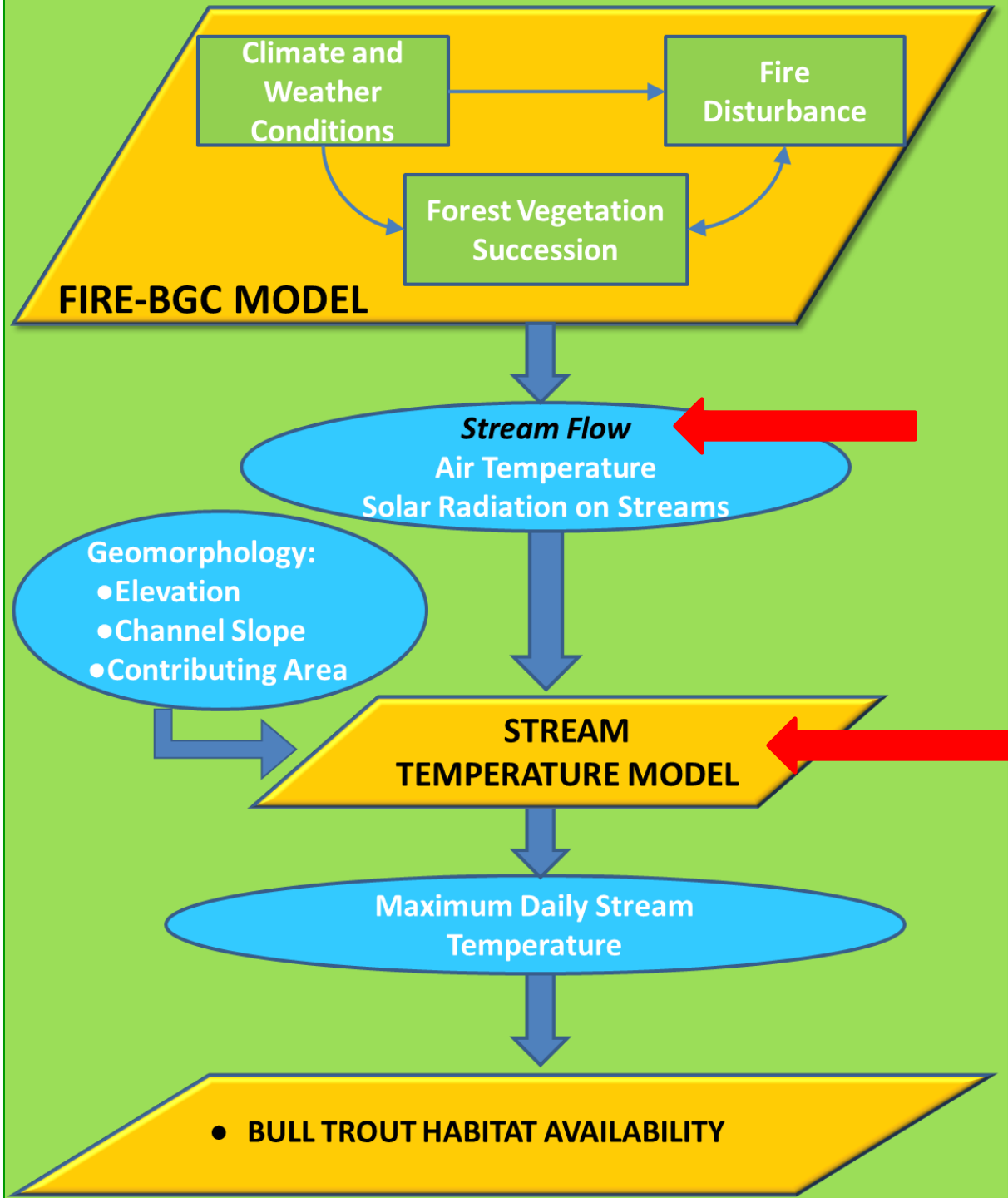




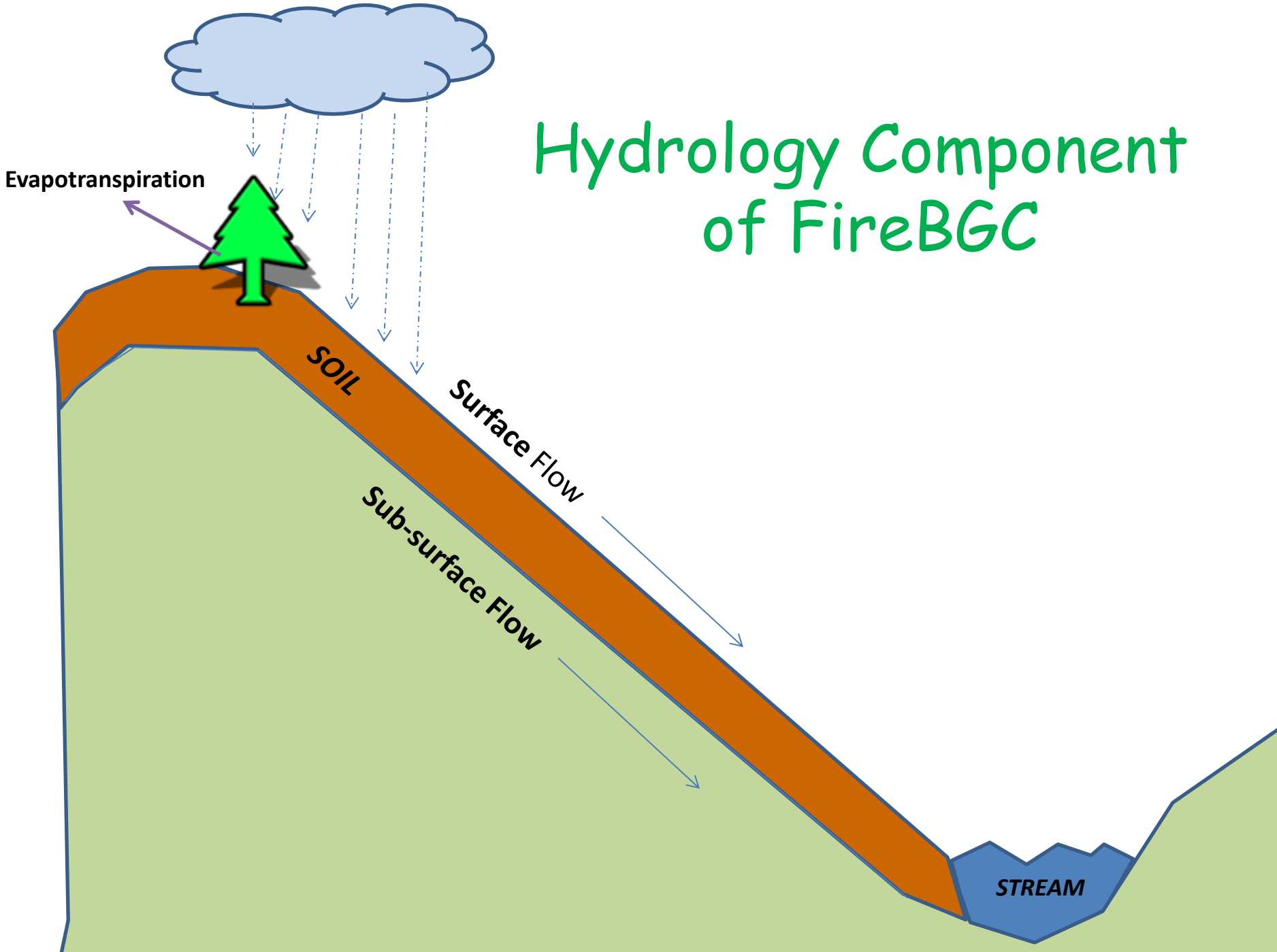


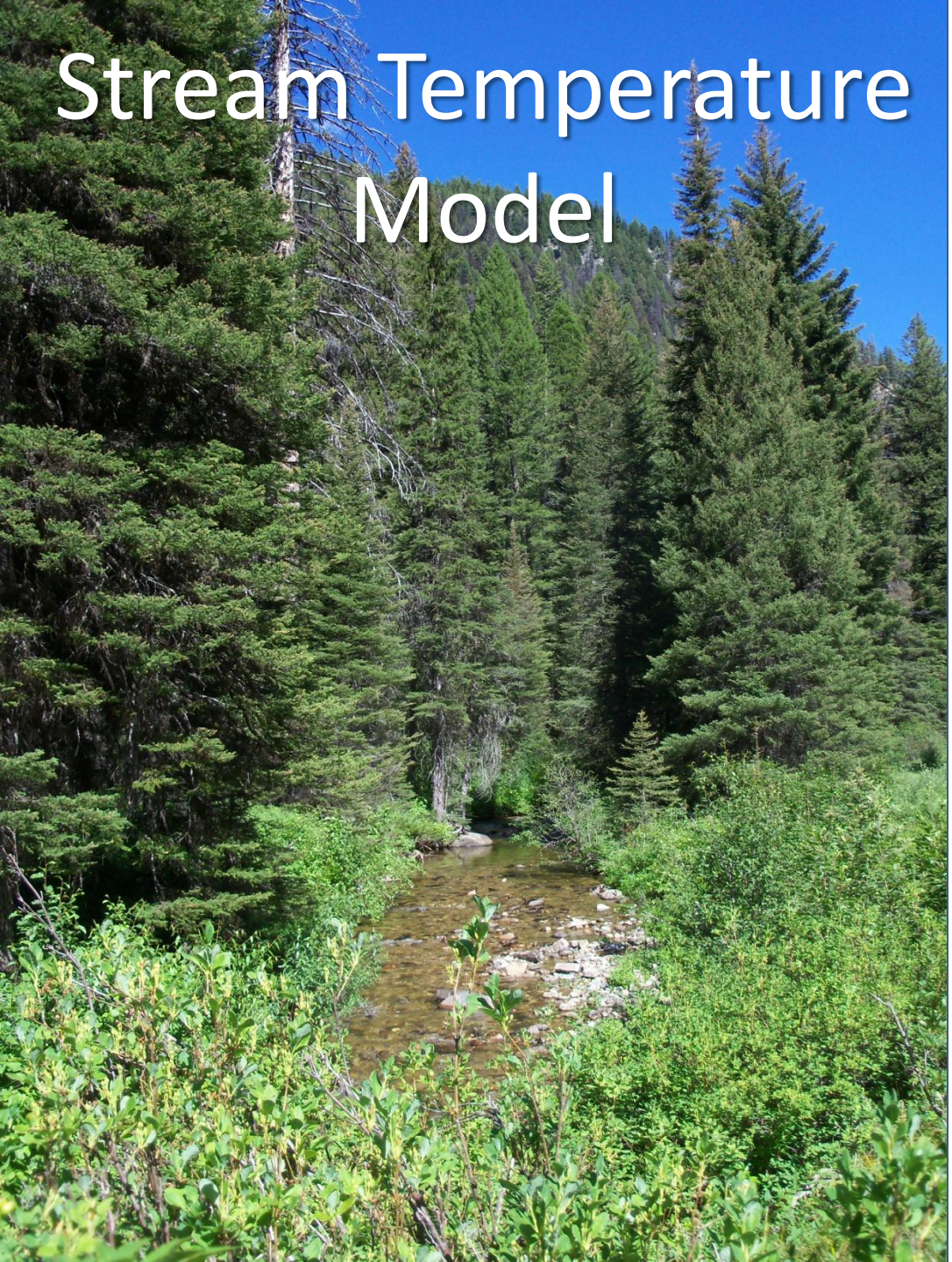


FireBGCv2 simulation modeling



Hydrology Component of FireBGC





Stream Temperature Model

Methods:

1) **RESPONSE VARIABLE: Daily stream temperature data from 116 stream temperature loggers in East Fork from 2001 – 2009.**

2) **PREDICTOR VARIABLES:**
   - **FireBGCv2 dynamic variables – weather, ecosystem, streamflow, vegetation**
   - **Landscape geomorphic variables: elevation, channel slope, drainage area**

3) **Developed linear stream temperature regression model**

Stream Temperature Model

Maximum Daily Stream Temperature

Predictive accuracy: $R^2 = 0.78$

RMSE = 1.54 C

Sample size: 26,200 observations

Interaction term →

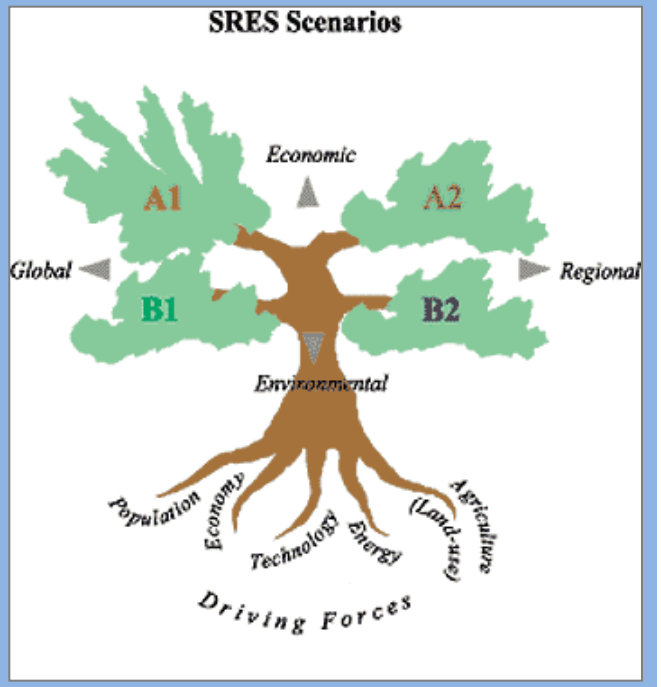
	Coefficients	*Standard Error*	*P-value*
Intercept	13.86	0.1449317	< 0.001
Air Temperature	0.5267	0.0032509	< 0.001
Air Temperature x Stream Flow	0.01885	0.0018033	< 0.001
Stream Flow	-0.2550	0.0209089	< 0.001
Solar Radiation at Stream	0.005738	0.0001432	< 0.001
Elevation	-0.007027	0.0000832	< 0.001
Stream Channel Slope	-5.653	0.2623144	< 0.001
Drainage Area	1.607 E-09	0.0000000	< 0.001

How may climate change affect stream temperatures ?

CLIMATE:

Historical: mid-1950s to present

A2: hot, dry



How may climate-mediated changes to fire regimes affect stream temperatures ?

Bitterroot National Forest photo, 2012

FIRE REGIME:

Fire Severity: Biomass consumed by fire

Fire Size

Can fire management mitigate changes to stream temperatures?

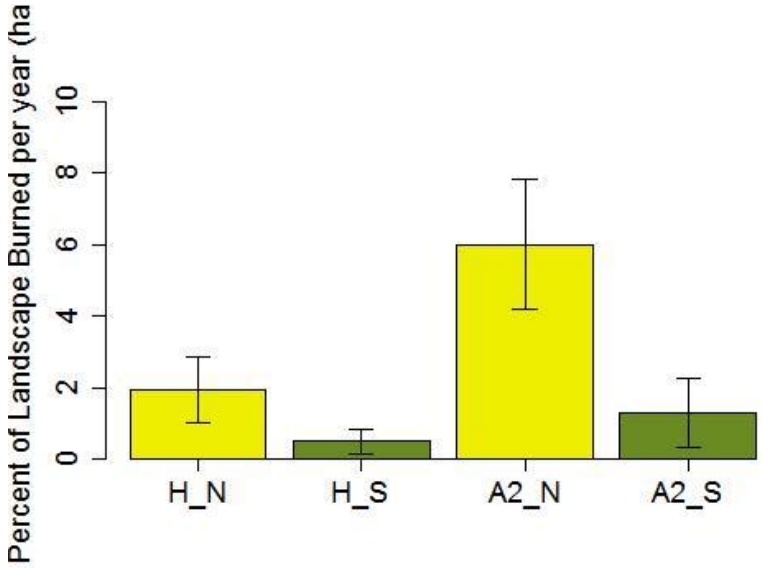
FIRE MANAGEMENT:

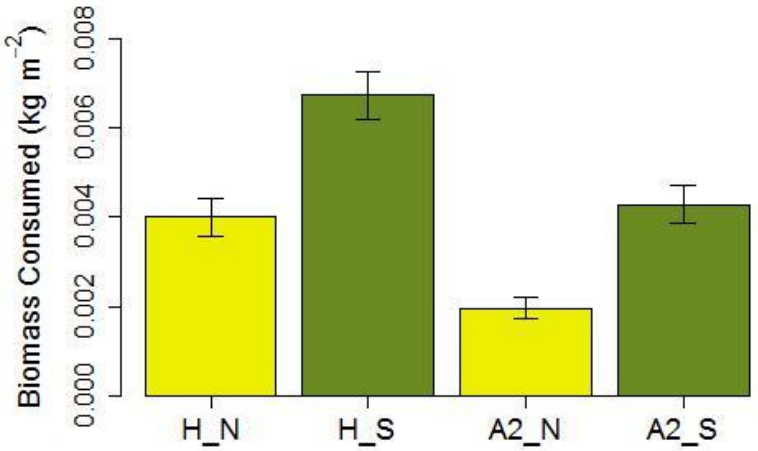
No Active Management: Use climate-fire history studies as baseline for modeling.

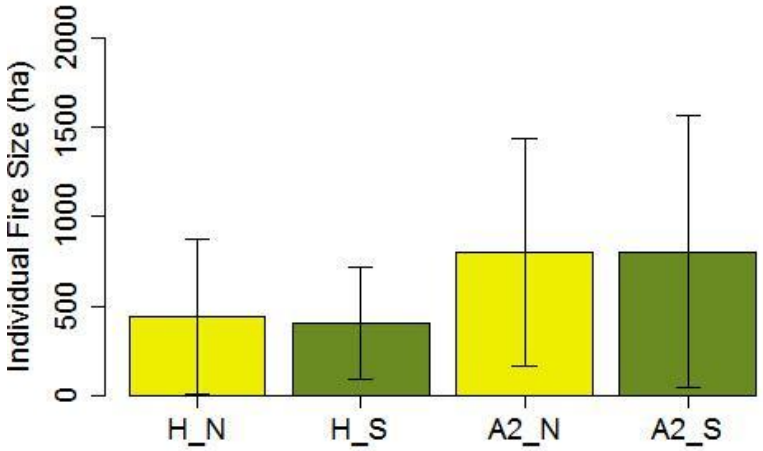
Fire Suppression: 90% of fires actively suppressed

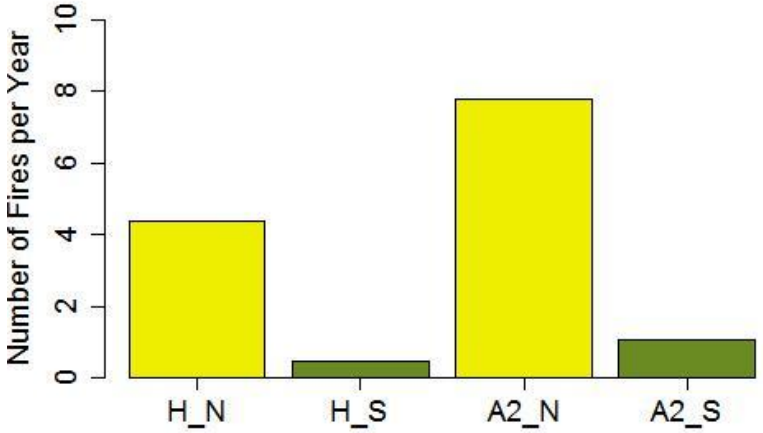
Fire Regime Results

	No fire management	*90% wildfire suppressed*
Historic	H_N	H_S
A2	A2_N	A2_S



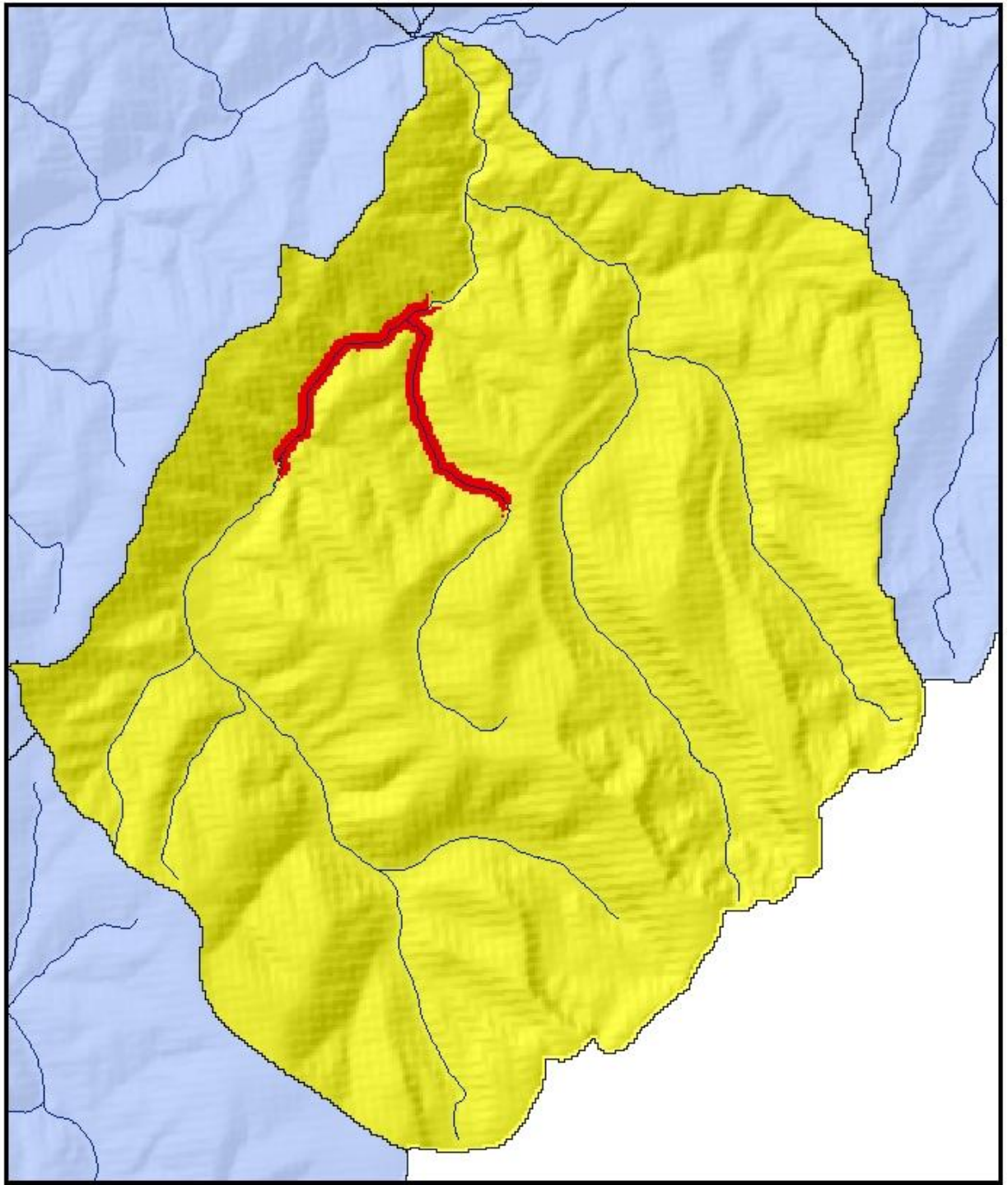


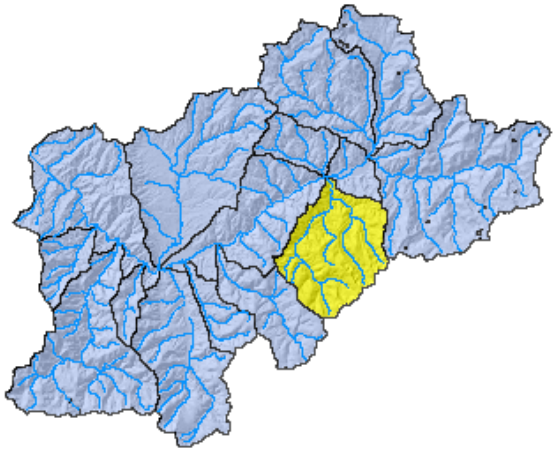




Stream Temperature Results:

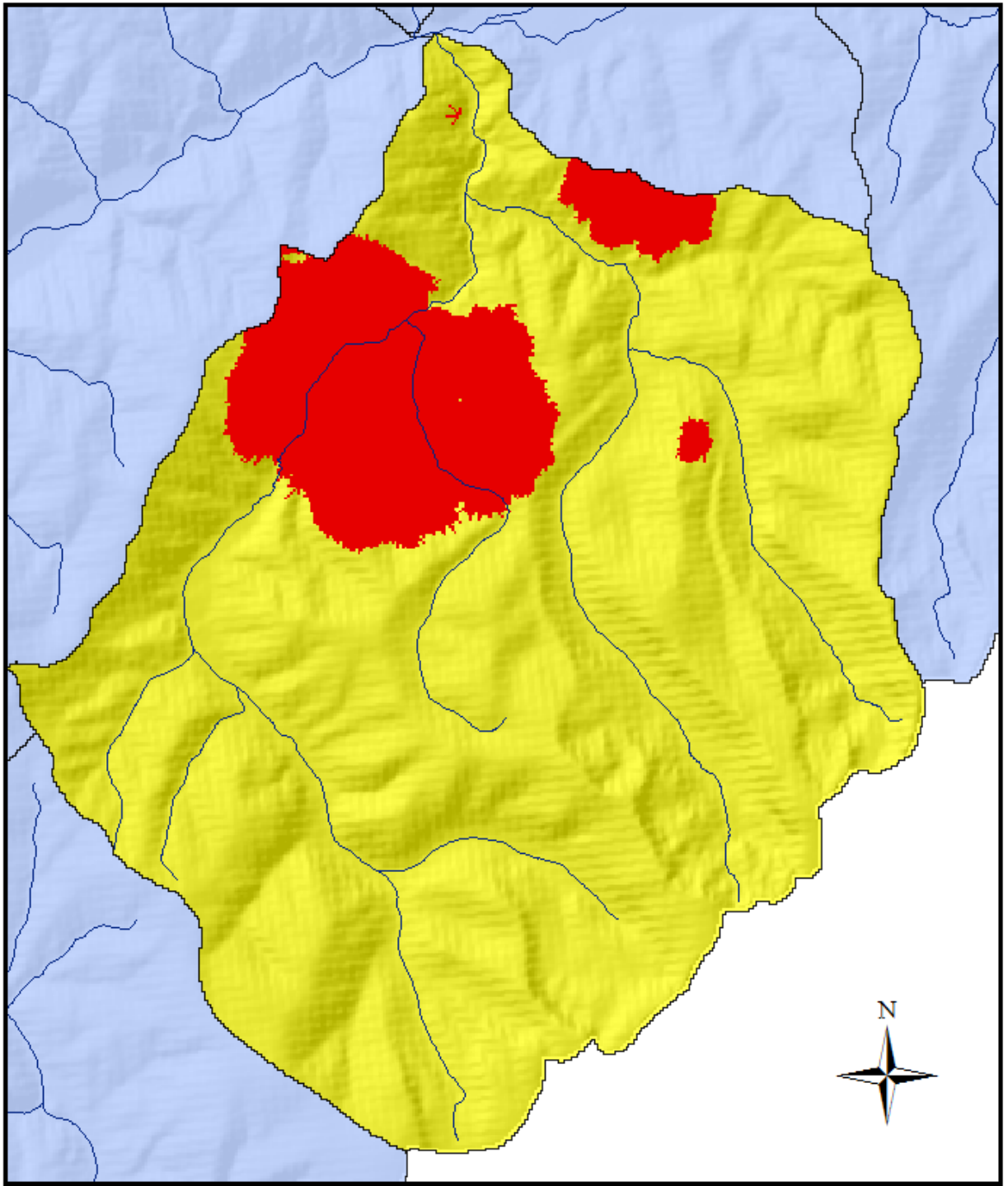
Riparian Scale



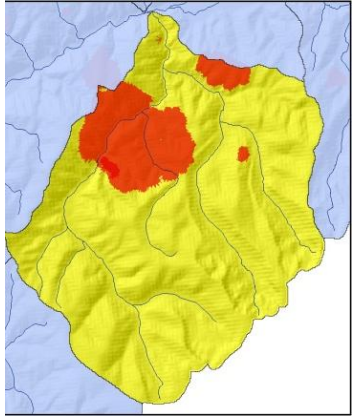


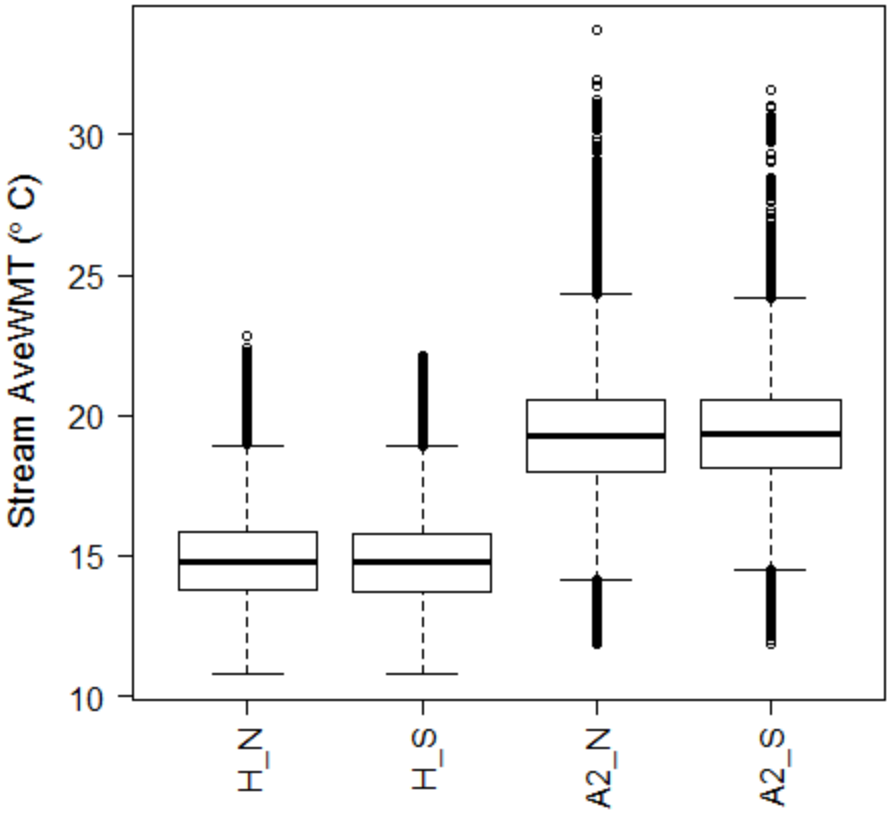
Stream Temperature Results:

Subwatershed Scale



Subwatershed Scale



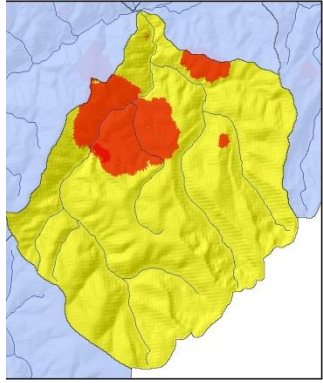


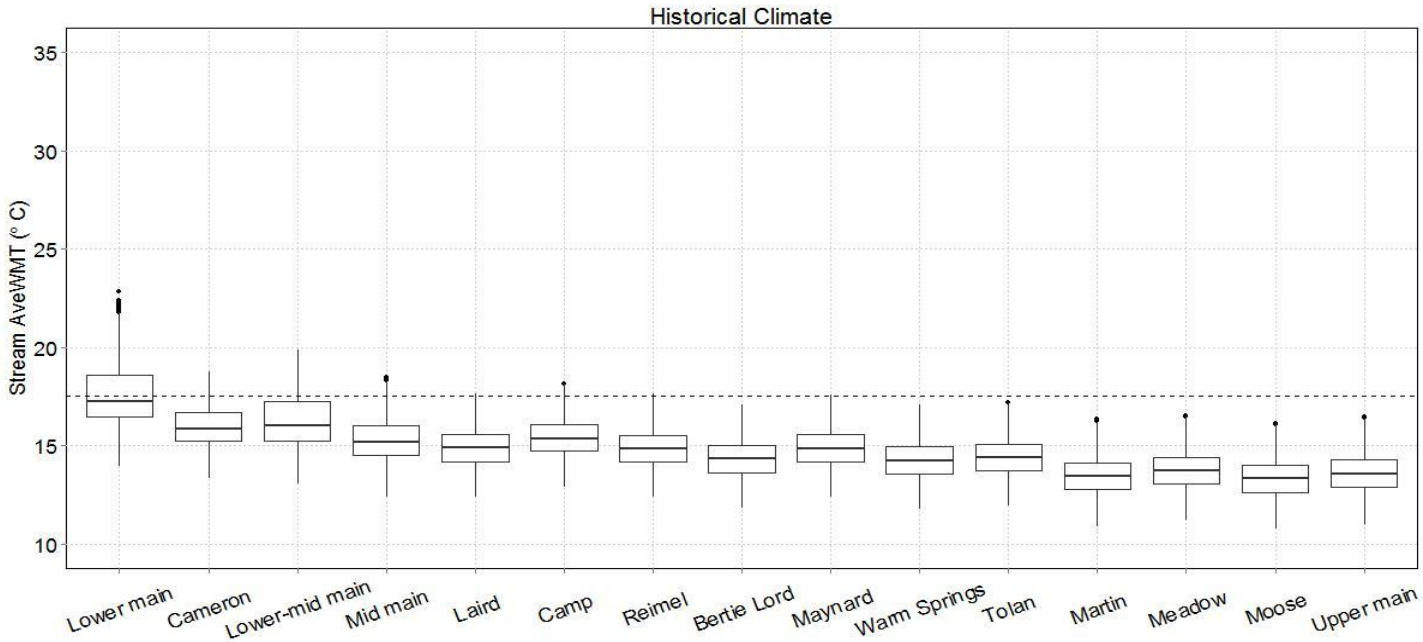
	No fire management	*90% wildfire suppressed*
Historic	H_N	H_S
A2	A2_N	A2_S

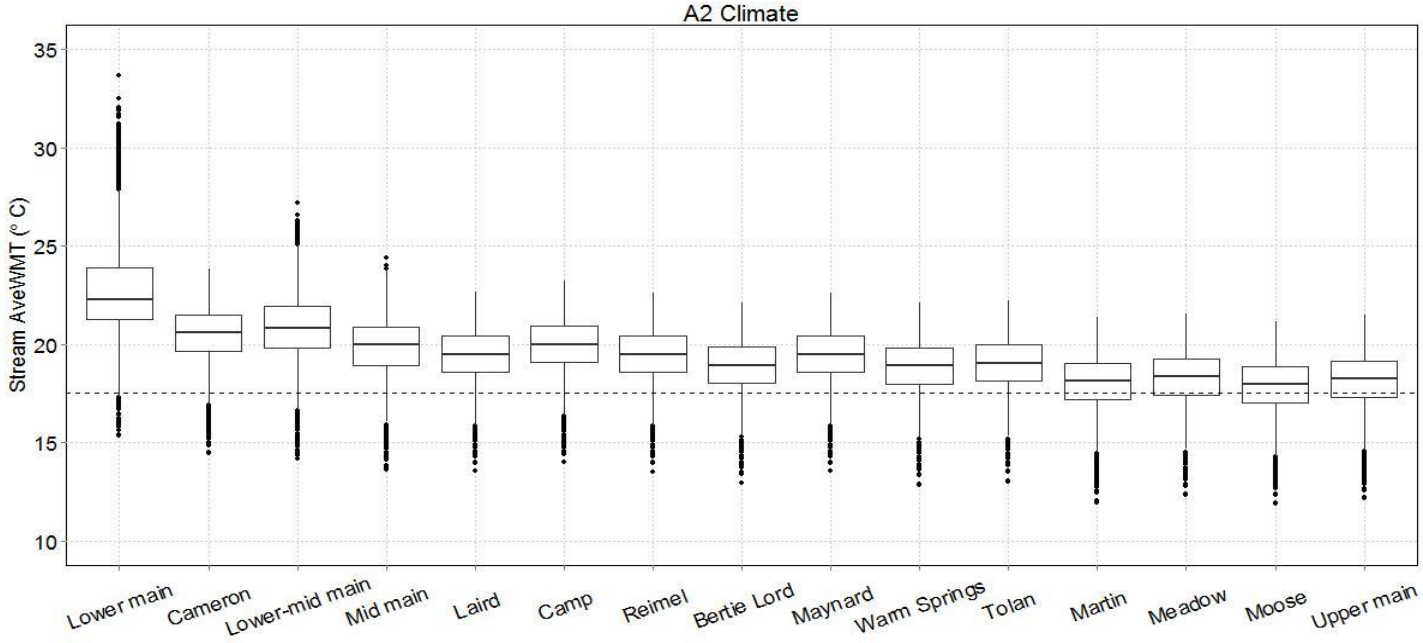
OTHER PREDICTIONS

2 C - 5 C ↑: Mantua et al. 2010, Cristea & Burges 2010, Mosheni et al. 1999

Subwatershed Scale







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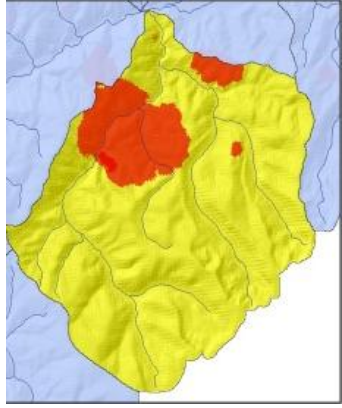
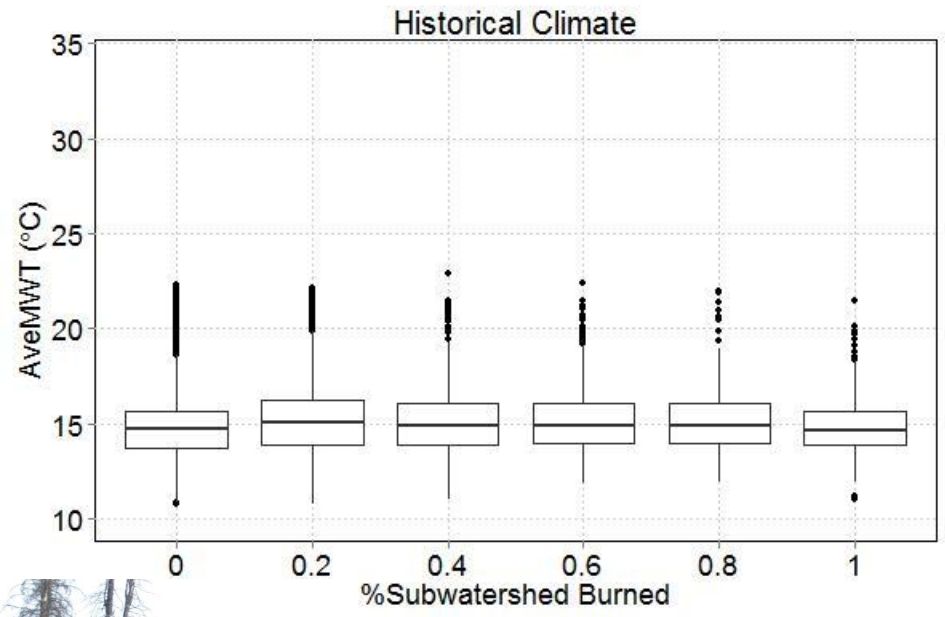
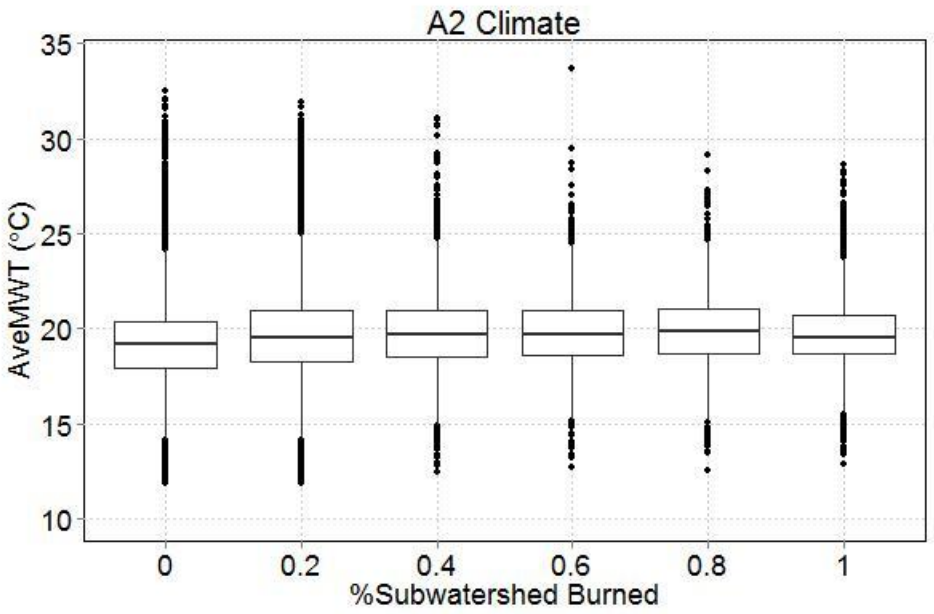






Stream Temperature Results

Scale	*Climate*	*Fire Regime*	*Fire Management*
Subwatershed	★	●	—
Fire Perimeter			
Riparian			

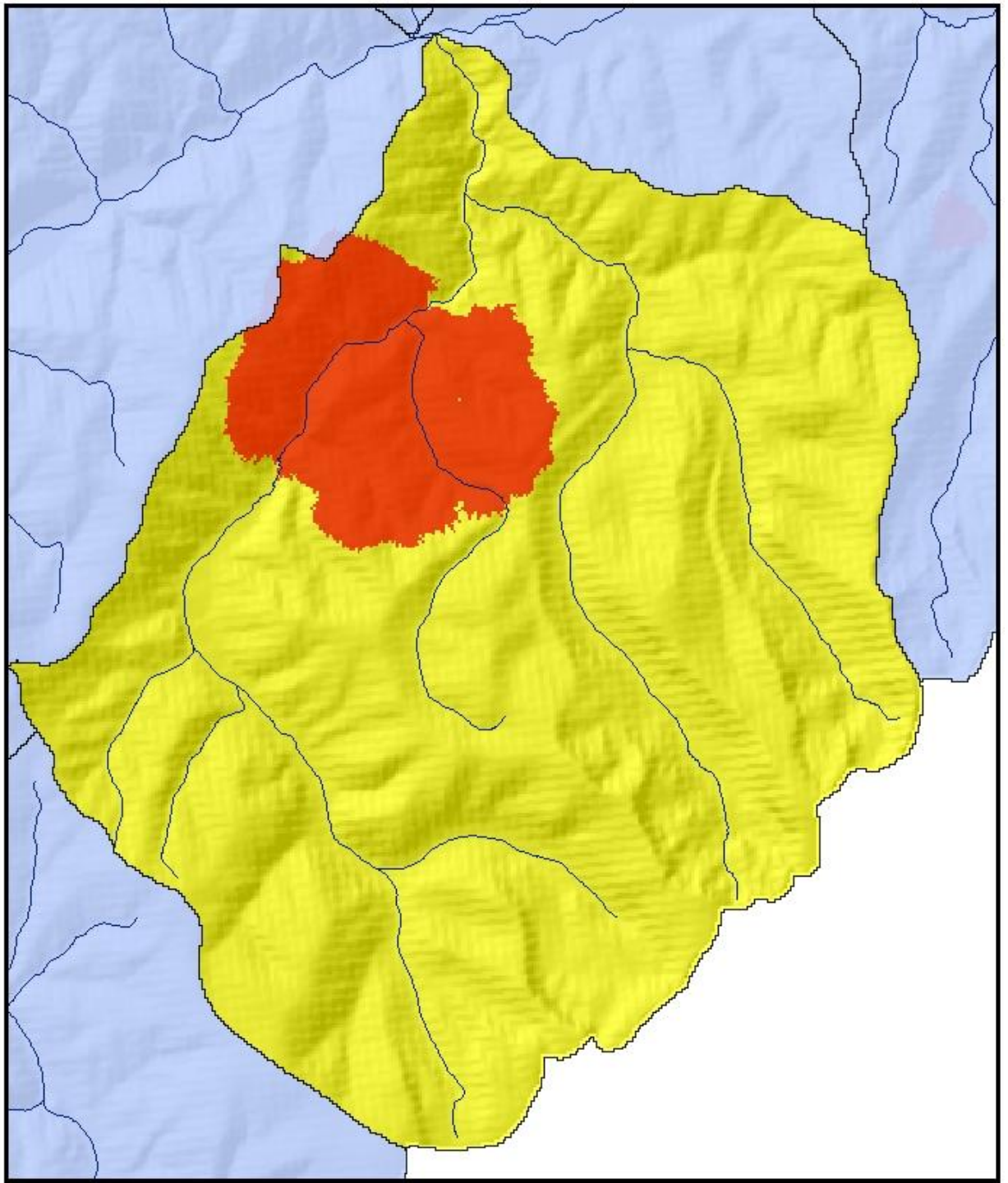
★ **Key Driver**

● **Significant Influence**

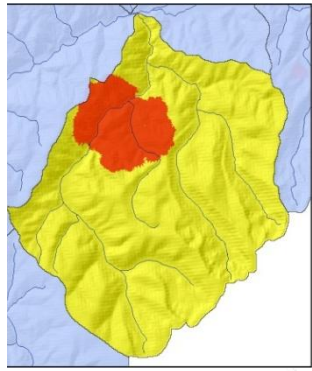
— **No Significant Influence**

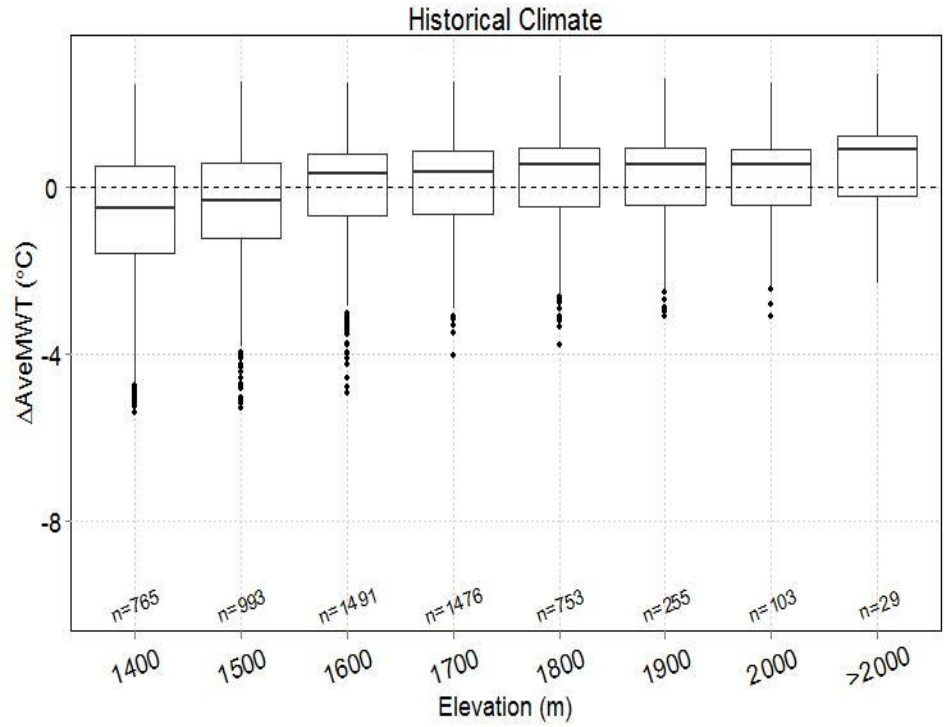
Fire Scale

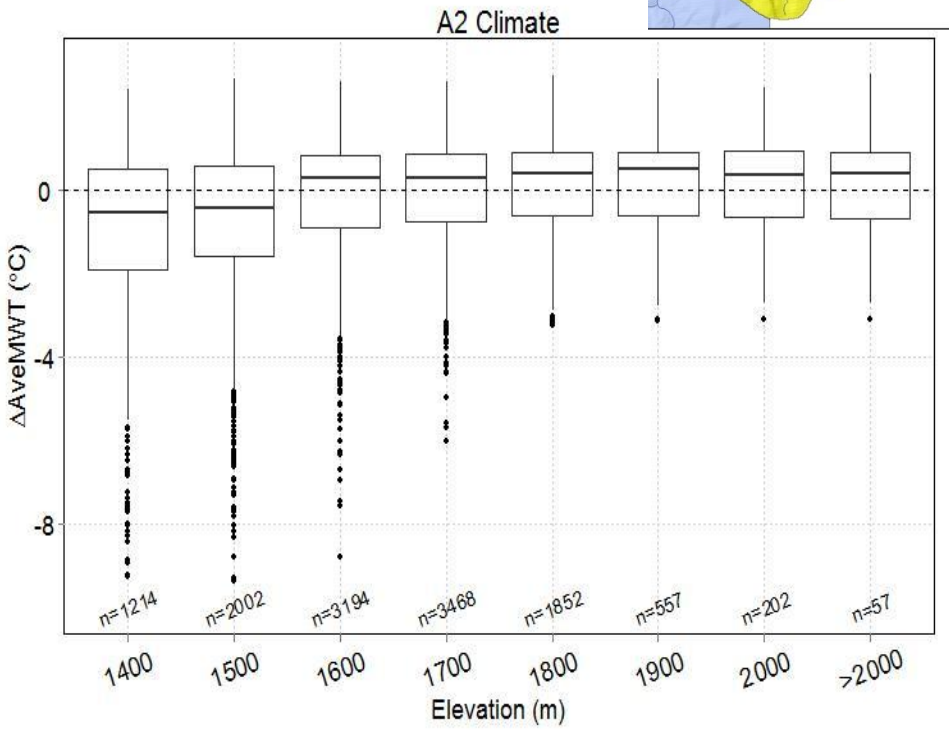
Δ AveMWT one year after fire



Fire Perimeter Scale







BITTERROOT FIELD OBSERVATIONS

- 2 C - 6 C ↑ with fire, Sestrich et al. 2011
- 1.4 C-2.2 C ↑ with fire, Mahlum et al. 2011

Stream Temperature Results

Scale	*Climate*	*Fire Regime*	*Fire Management*
Subwatershed	★	●	—
Fire Perimeter	★	—	—
Riparian			

★ **Key Driver**

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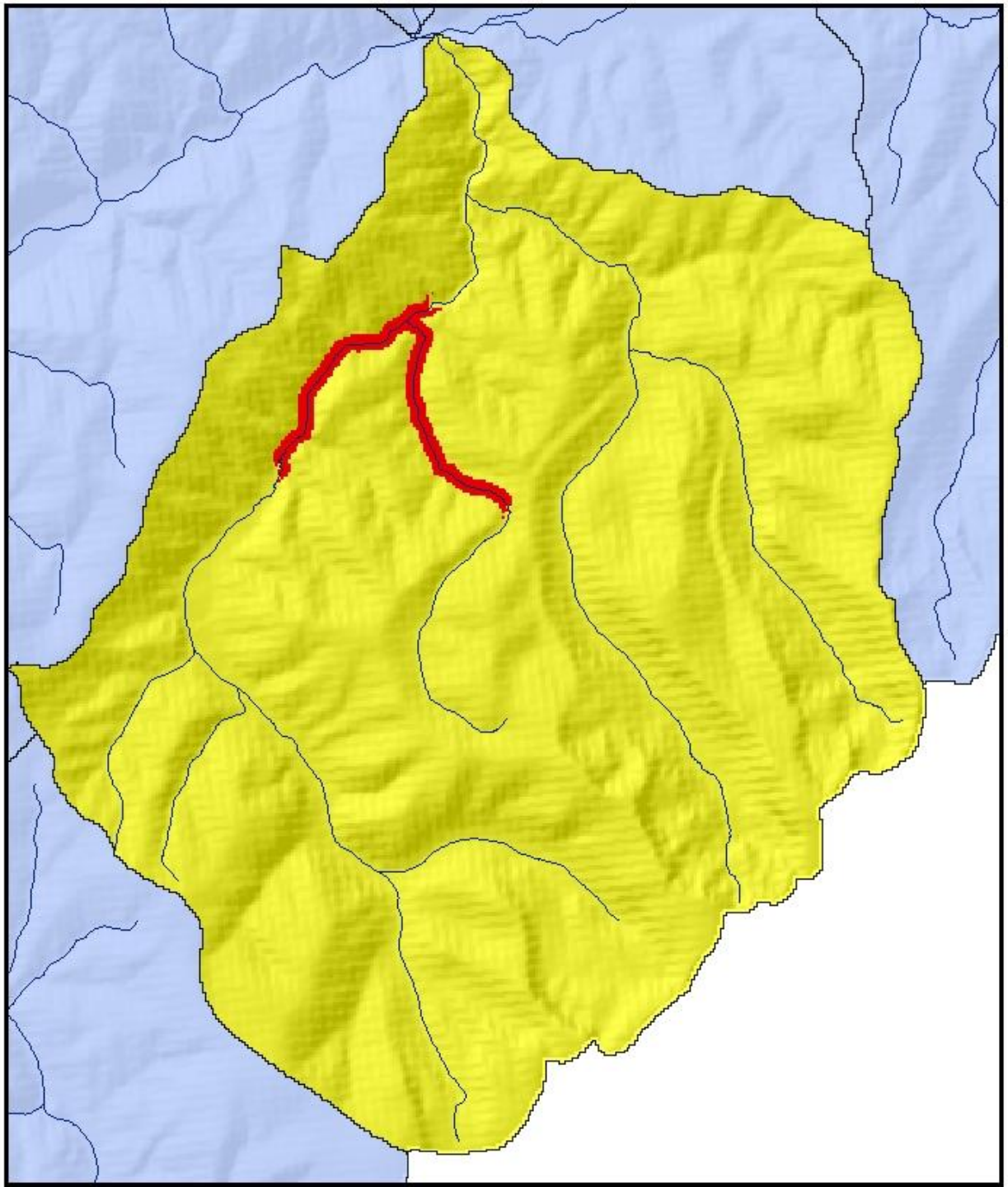
— **No Significant Influence**

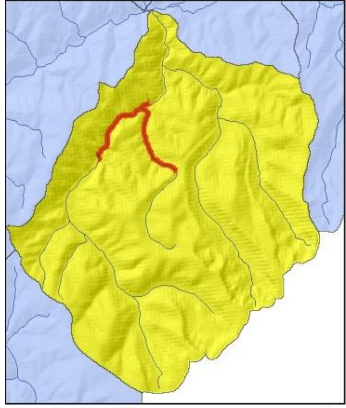
Stream Temperature Results:

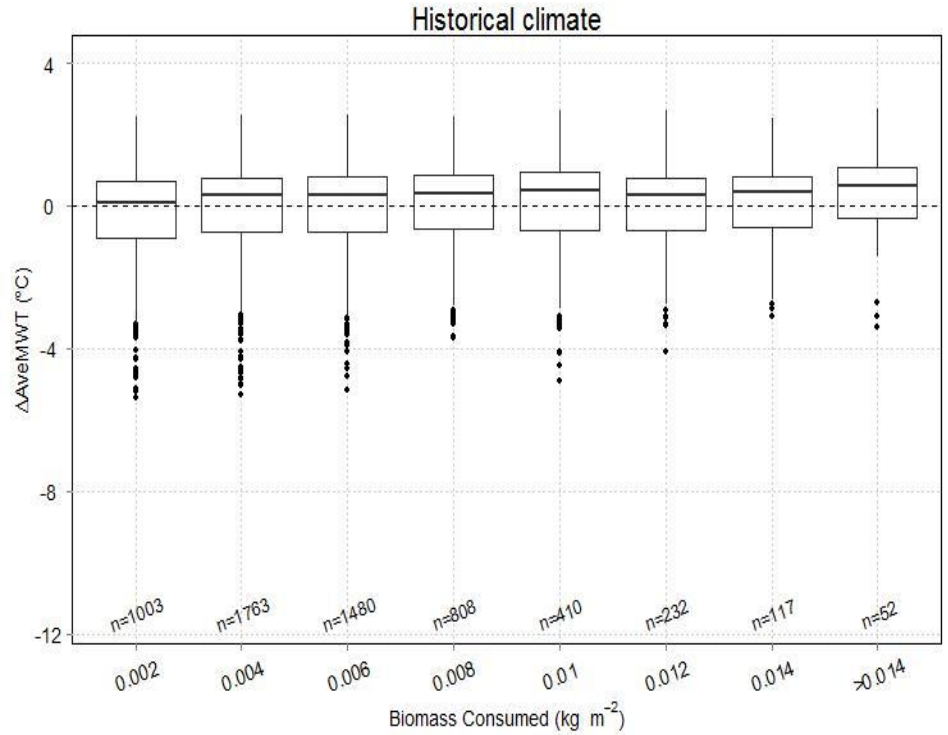
Riparian Scale

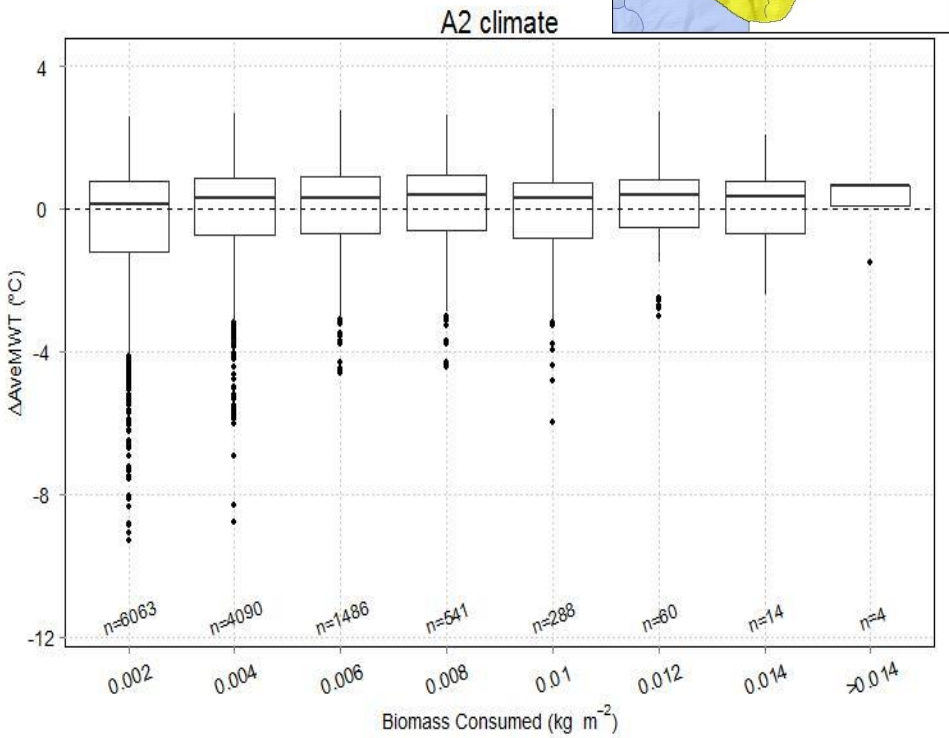
Δ AveMWT one year after fire



Riparian Fire Scale







Key Findings

Scale	Climate	Fire Regime	Fire Management
Subwatershed	★	●	—
Fire Perimeter	★	—	—
Riparian	★	●	—

★ Climate interacting with elevation - main driver: 5°C ↑ with A2 climate

● Fire regime shift from climate warming - nominal influence: <1°C ↑ with large fire extents & high severity

— Fire Management → no influence

Historic climate

AveWMT (°C)

- ≤11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21

A2 climate

AveWMT (°C)

- ≤11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21

Thank You!

Questions?