Effectiveness of Class II Watercourse and Lake Protection Zone (WLPZ) Prescriptions

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Board of Forestry and Fire Protection

Effectiveness Monitoring Committee

EMC-2018-006 Final Project

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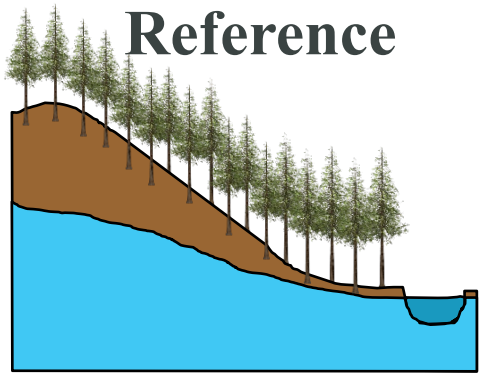
Objectives

- How do the current ASP FPRs, and GDRCs AHCP, and pre-ASP Class II riparian requirements influence canopy closure, solar radiation, near-stream air temperature, and streamflow?

- What is the relative importance of the different drivers in influencing the variability in stream temperature dynamics (e.g., maximum, minimum, diurnal variations), dissolved oxygen, limiting nutrients (N, P), and primary productivity across different Class II riparian prescriptions?

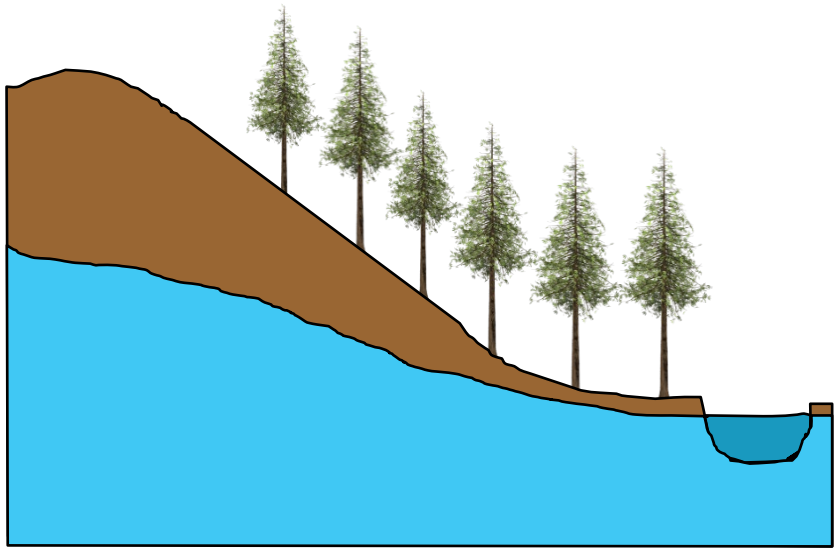
Class II-L (II-2) Riparian Prescriptions

Reference



Pre-ASP

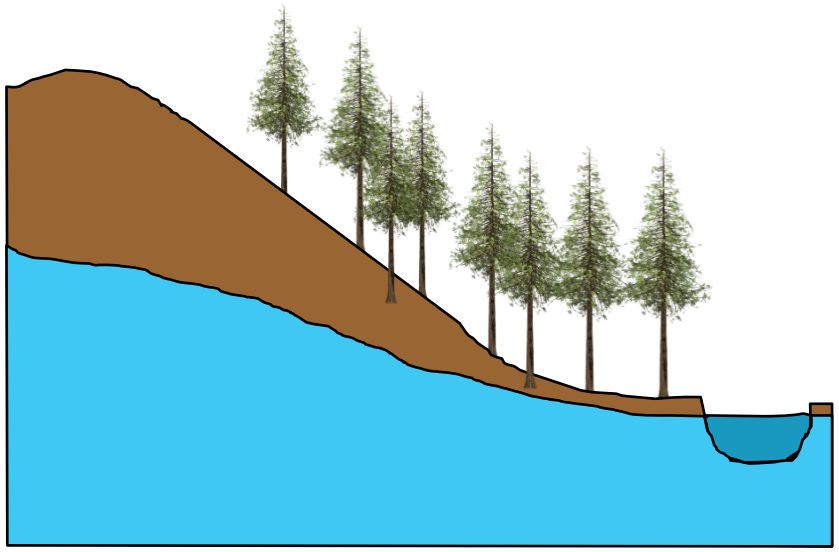
- 100 ft
- 50 % overstory



GDRC AHCP

- 100 ft

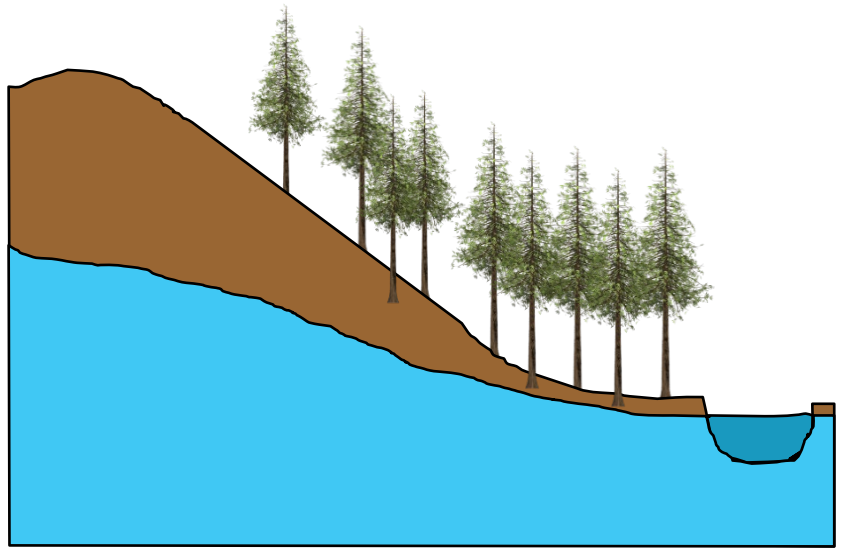
- 70 ft outer
- 70 % overstory
- 30 ft inner
- 85 % overstory



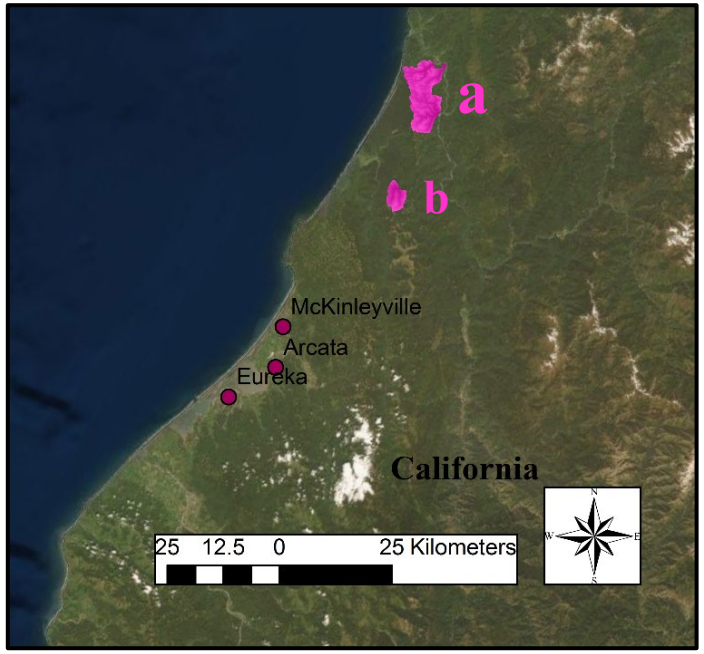
ASP

- 100 ft

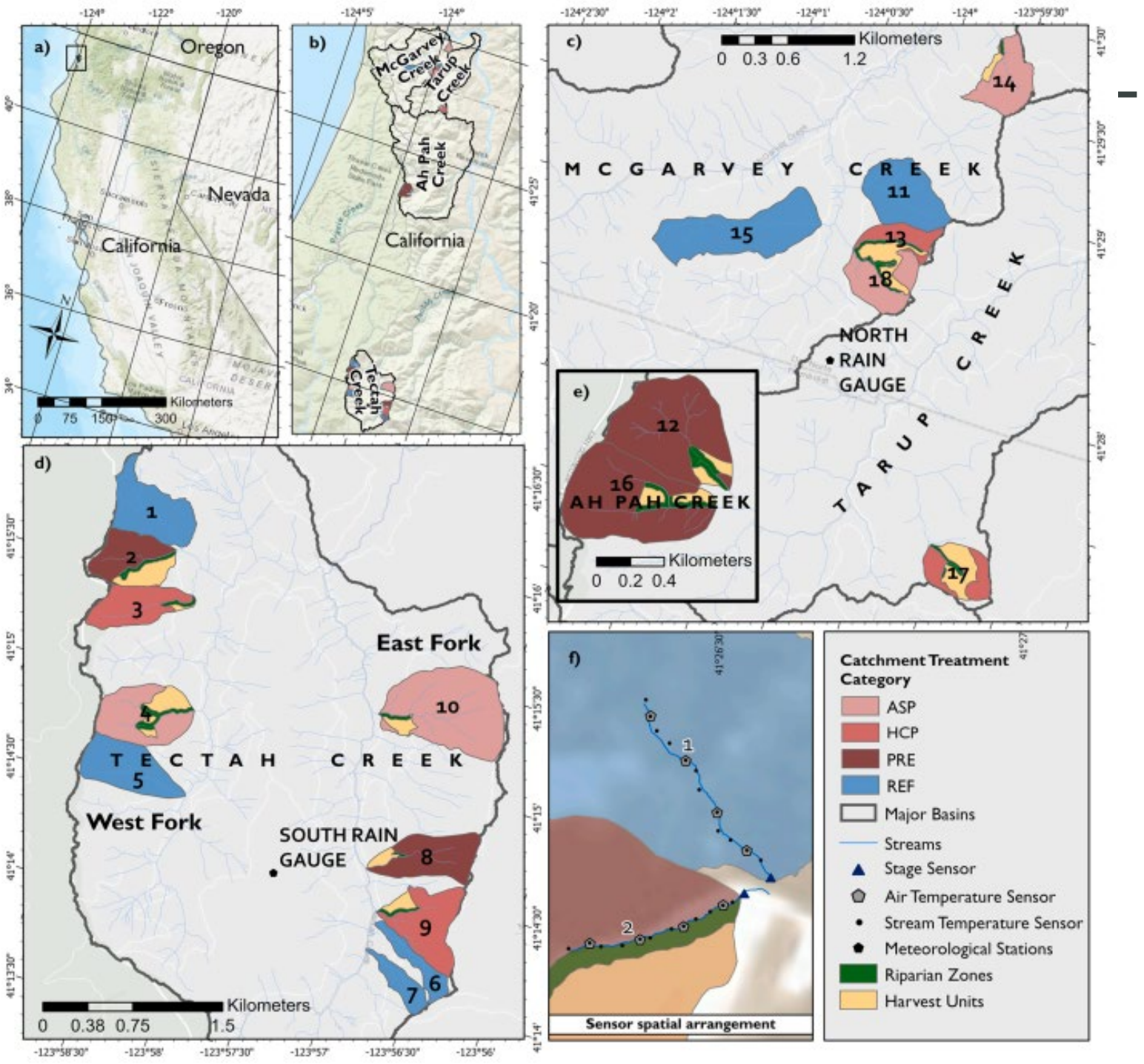
- 70 ft outer
- 80 % overstory
- 30 ft inner
- No harvest



Study Catchments



- 18 watersheds
  - 6 Reference
  - 4 ASP
  - 4 GDRC AHCP
  - 4 Pre-ASP
- Pre- and post-harvest



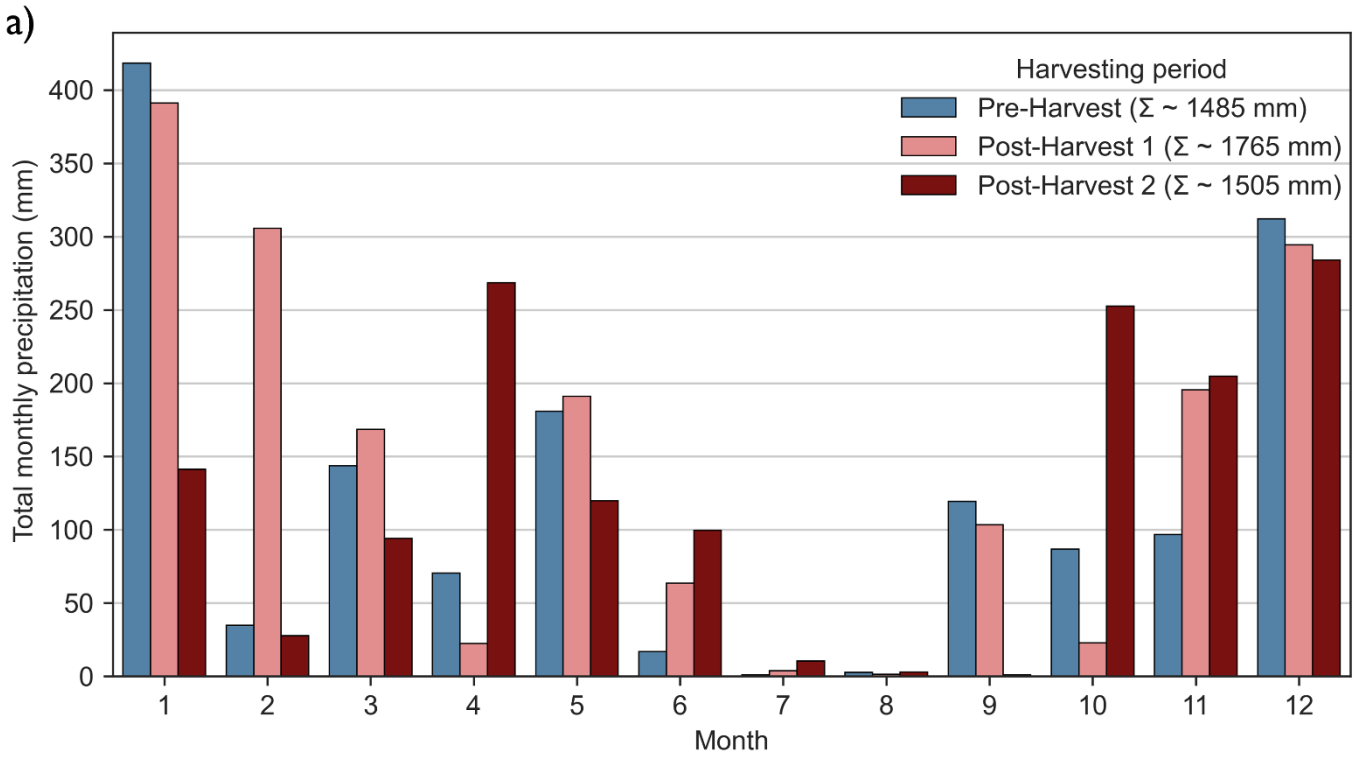
Study Catchments

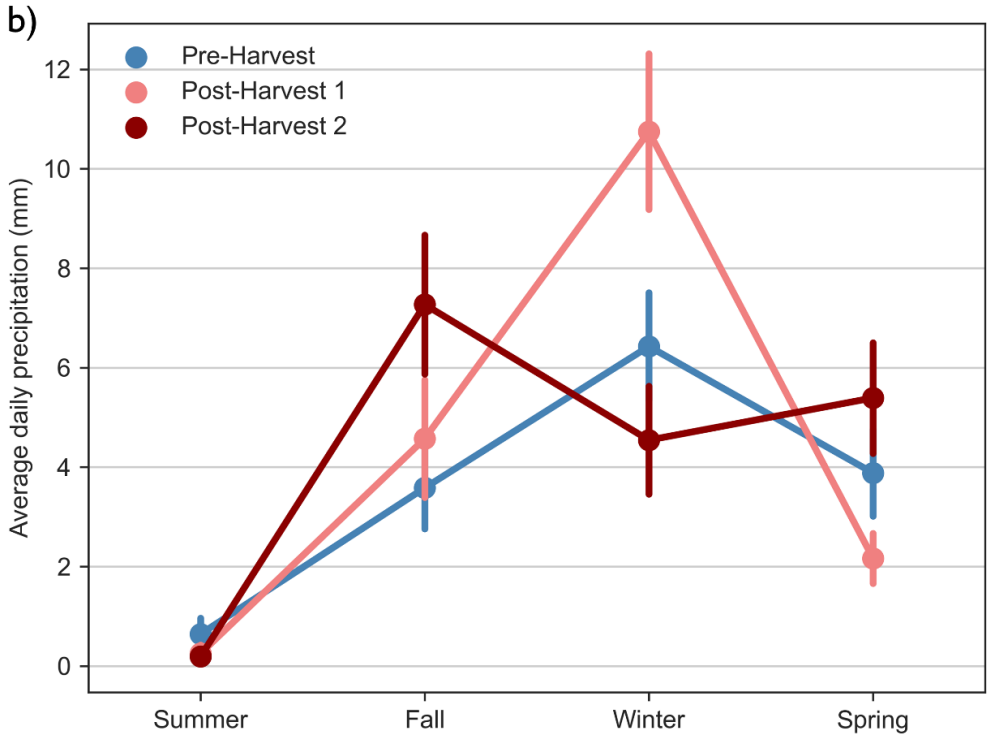
Riparian Buffer Prescription	Catchment Area (ha; range)	Catchment Harvested Area (ha)	Catchment Harvested Area (%)	Riparian Area (ha)	Mean Elevation (m)	Mean Slope (%)
REF	30.9 (10.4-61)	-	-	-	437.8	46.7
ASP	41.5 (29.1-66.2)	4.7	11%	2.3	386.3	46.2
HCP	26.4 (18.8-33.5)	4.8	18%	1.5	437.8	46.7
PRE	35 (28.5-41.9)	3.8	11%	1.7	506.0	43.2

Site selection focused on controlling:

- Vegetation type (~40–45 yr old Douglas-fir, Coastal redwood)
- Catchment area
- Elevation
- Slope
- Aspect (generally SE to SW)

Precipitation During Study





- $P_{30\text{-}year}$: ~2,110 mm yr^{-1} (83 in yr^{-1})

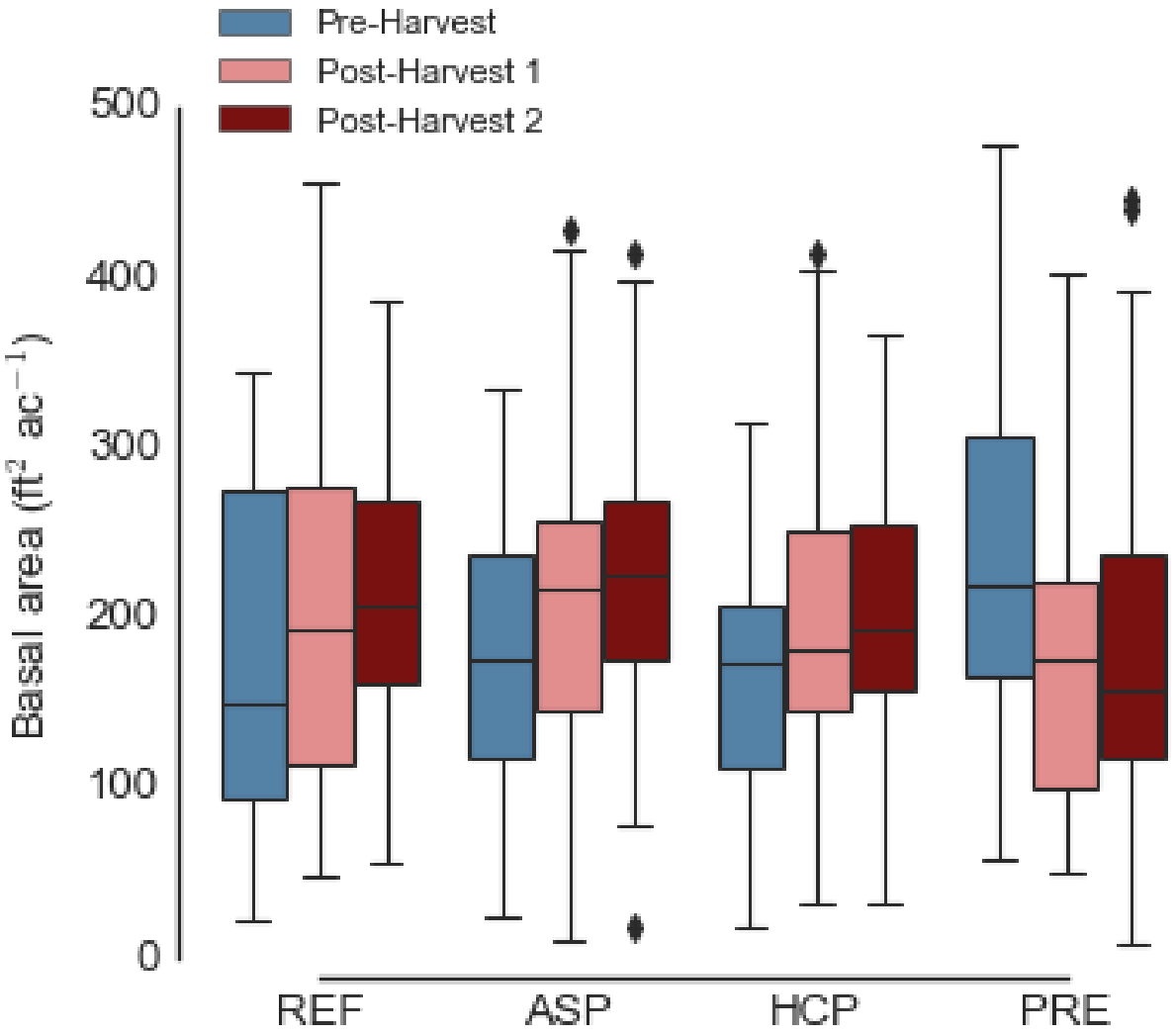
Riparian mensuration

- 6 x 1/10 acre (~37.2 ft radius) fixed area plots per stream reach

- Data:
  - Tree species
  - Tree diameter
  - Basal area
  - Canopy class (D, CD, U)
  - Mortality agent or decay class
  - Hemispherical photos for canopy closure

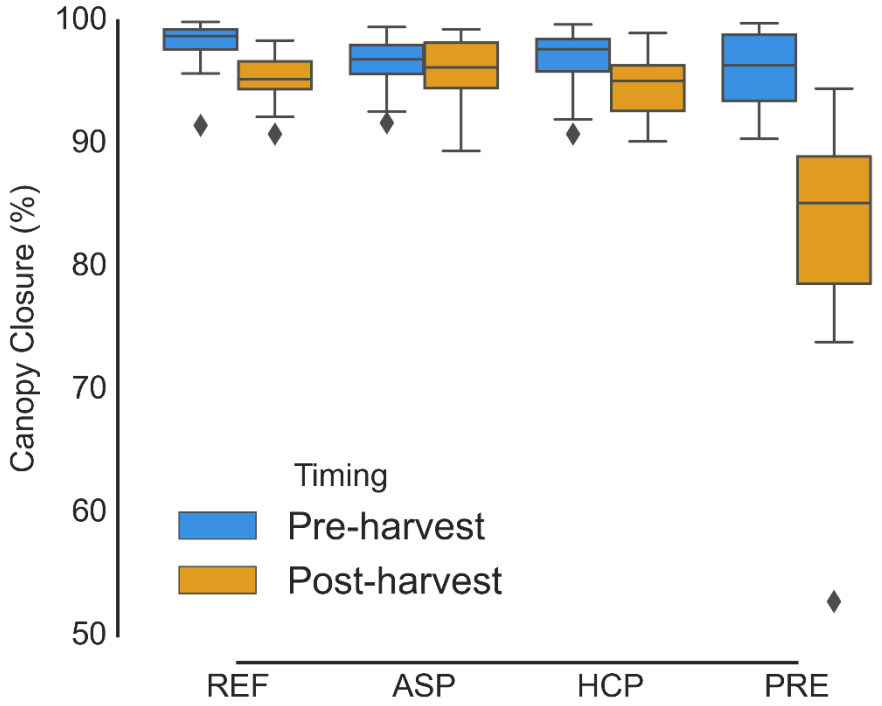
- Pre-harvest – collected 2019–2020
- Post-harvest – collected 2021–2022

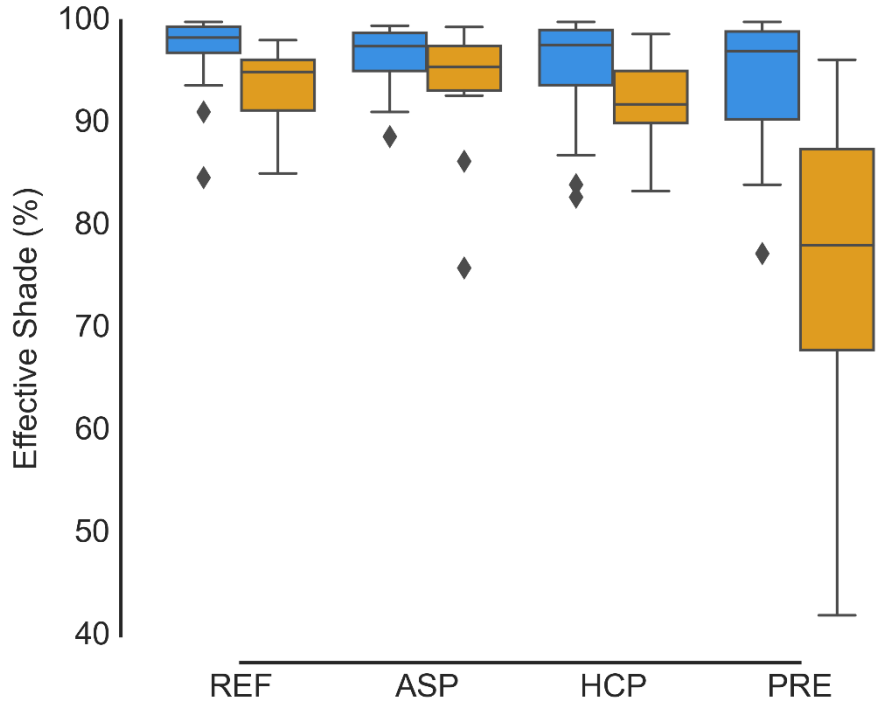
Riparian mensuration data – Basal area



Timing	Basal Area (ft^2/ac) per Treatment			
	REF	ASP	HCP	PRE
Pre-Harvest	174.5 ± 103.3	170.8 ± 94.1	169 ± 85.1	244.5 ± 108.4
Post-Harvest 1	211 ± 116.4	205.5 ± 112.5	199.8 ± 99.5	178.1 ± 102.5
Post-Harvest 2	206.4 ± 85.4	216 ± 95.9	196.6 ± 79.2	182 ± 116.9

Riparian mensuration data – Effective shade/ canopy closure

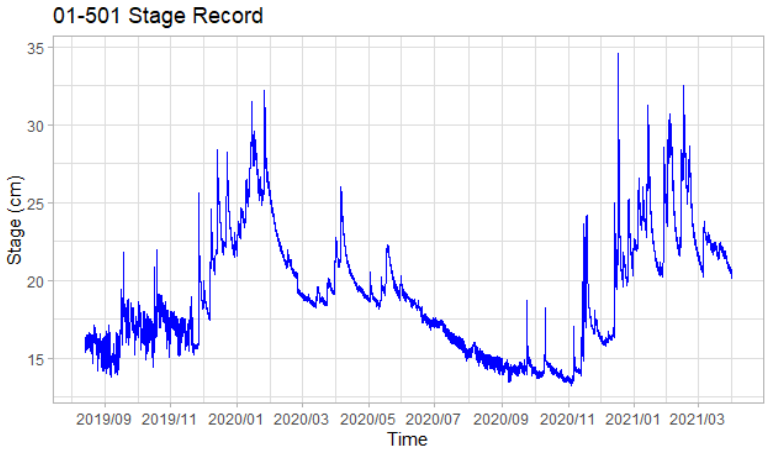


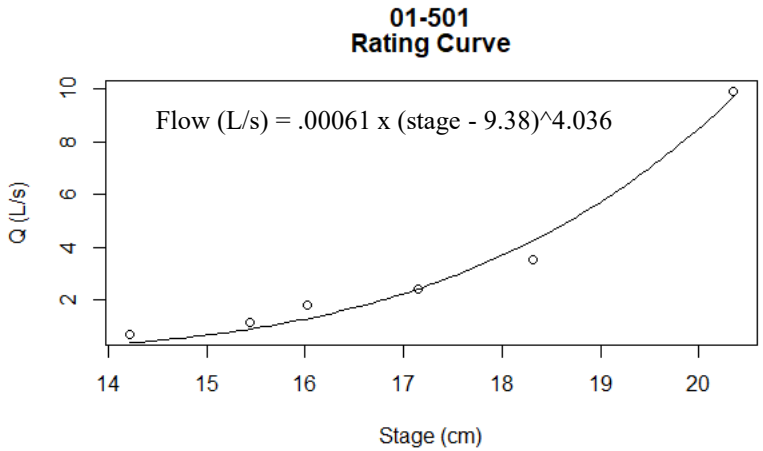


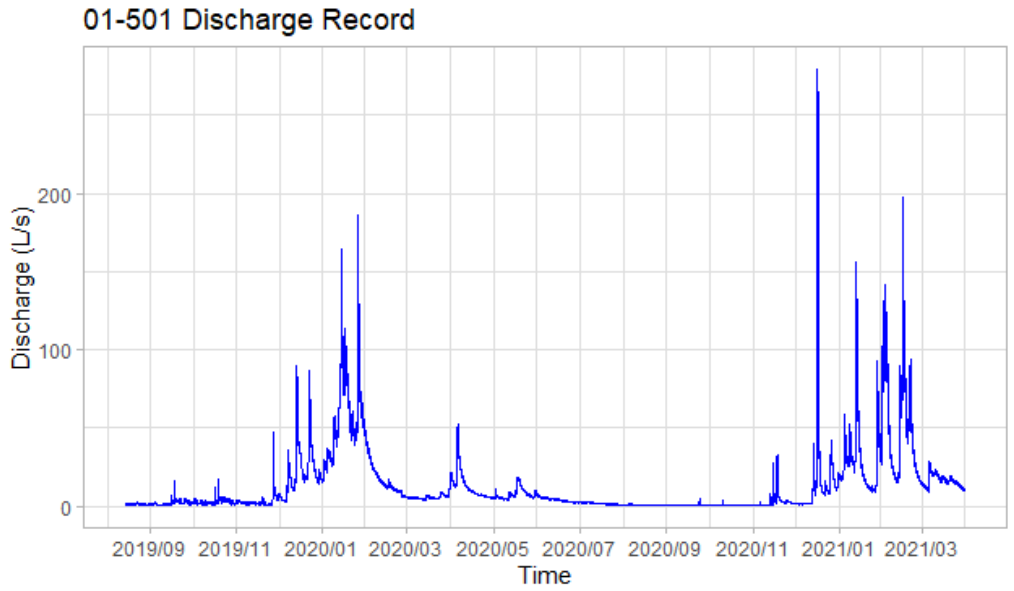
Timing	Treatment	Effective Shade (%)	Canopy Closure (%)	LAI
Pre-harvest	REF	98.35	98.75	4.89
	ASP	97.50	96.85	4.28
	HCP	97.65	97.70	5.02
	PRE	97.05	96.35	4.23
Post-harvest	REF	95.00	95.25	3.64
	ASP	95.50	96.20	3.79
	HCP	91.85	95.10	3.42
	PRE	78.10	85.20	2.08

Stage and discharge data

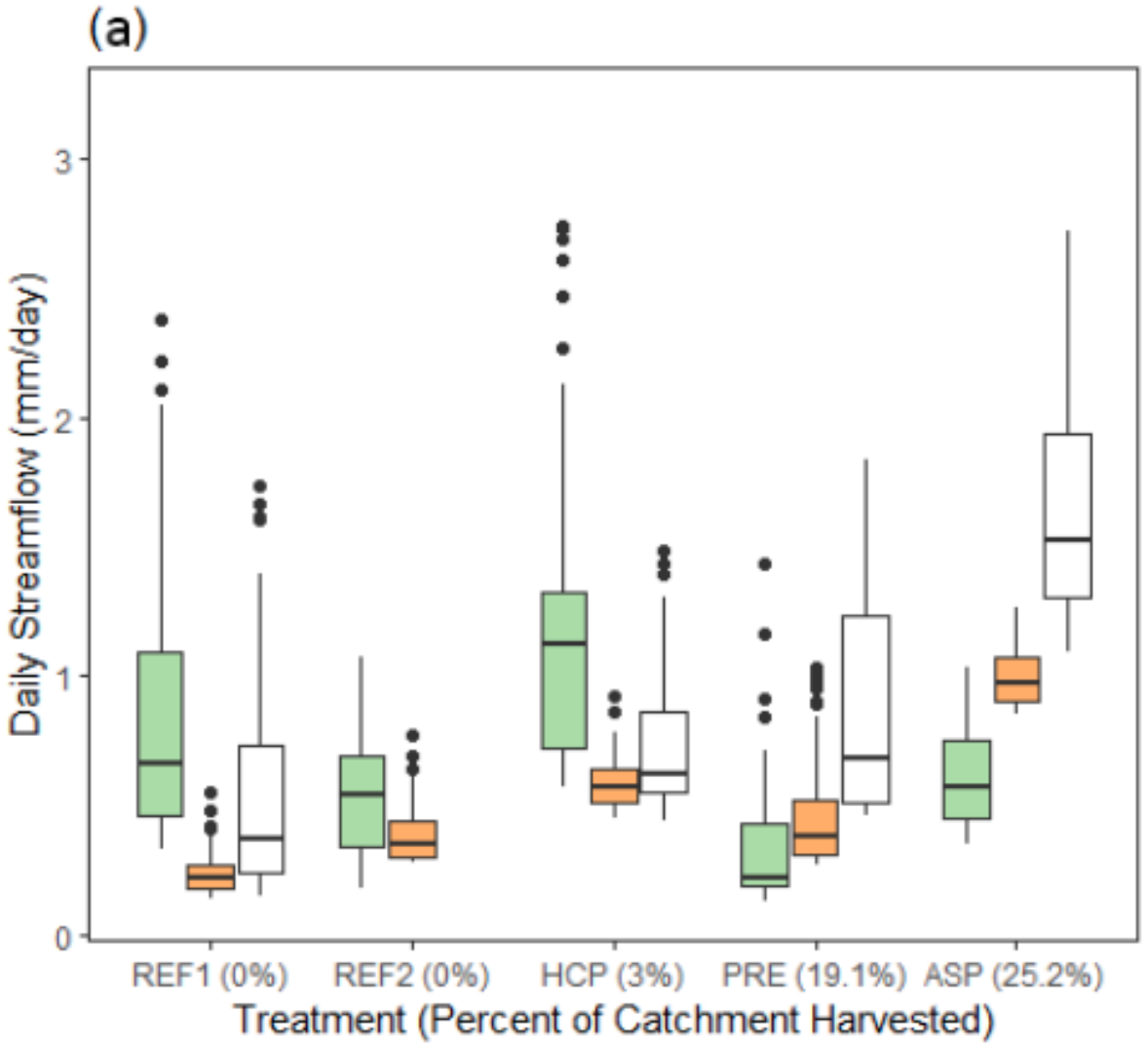
- Record stream stage (every 15 mins) in all 18 streams
- Salt dilution gauging to develop unique rating curve for each stream
- Using rating curve relationship to estimate stream discharge

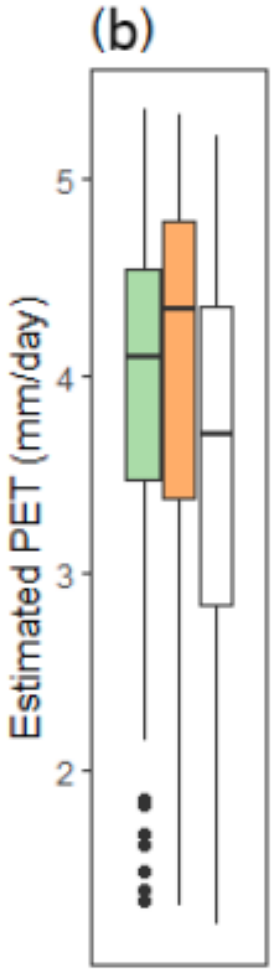


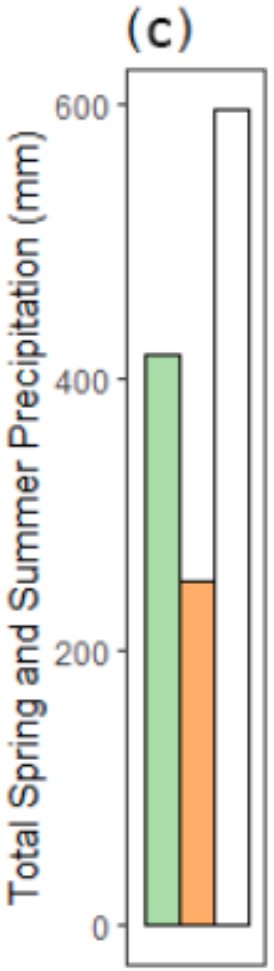


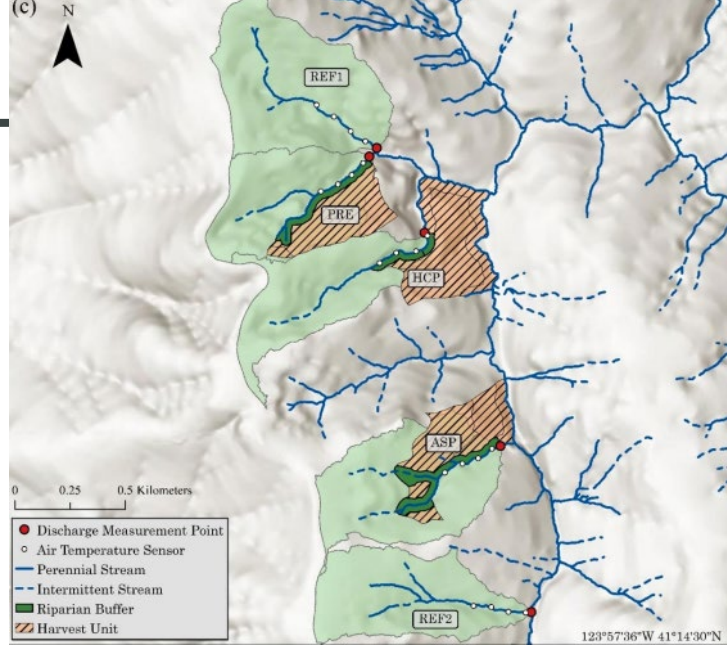


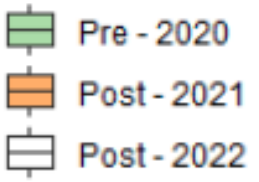
Daily Streamflow (June–August)



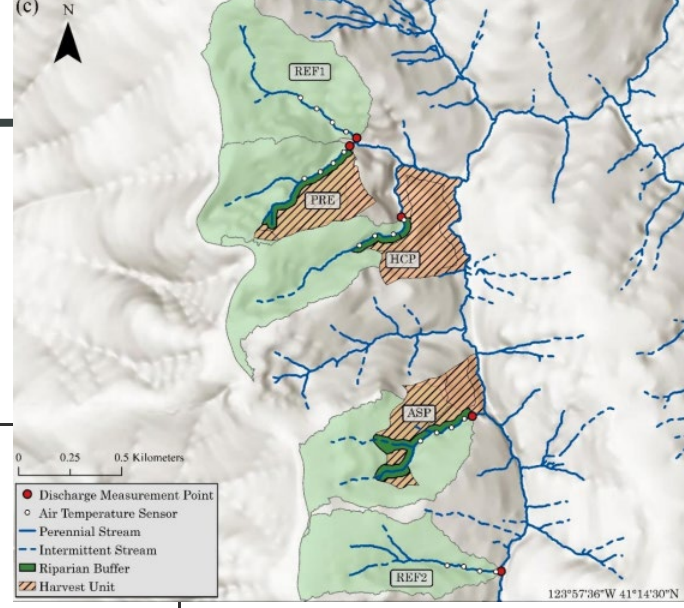


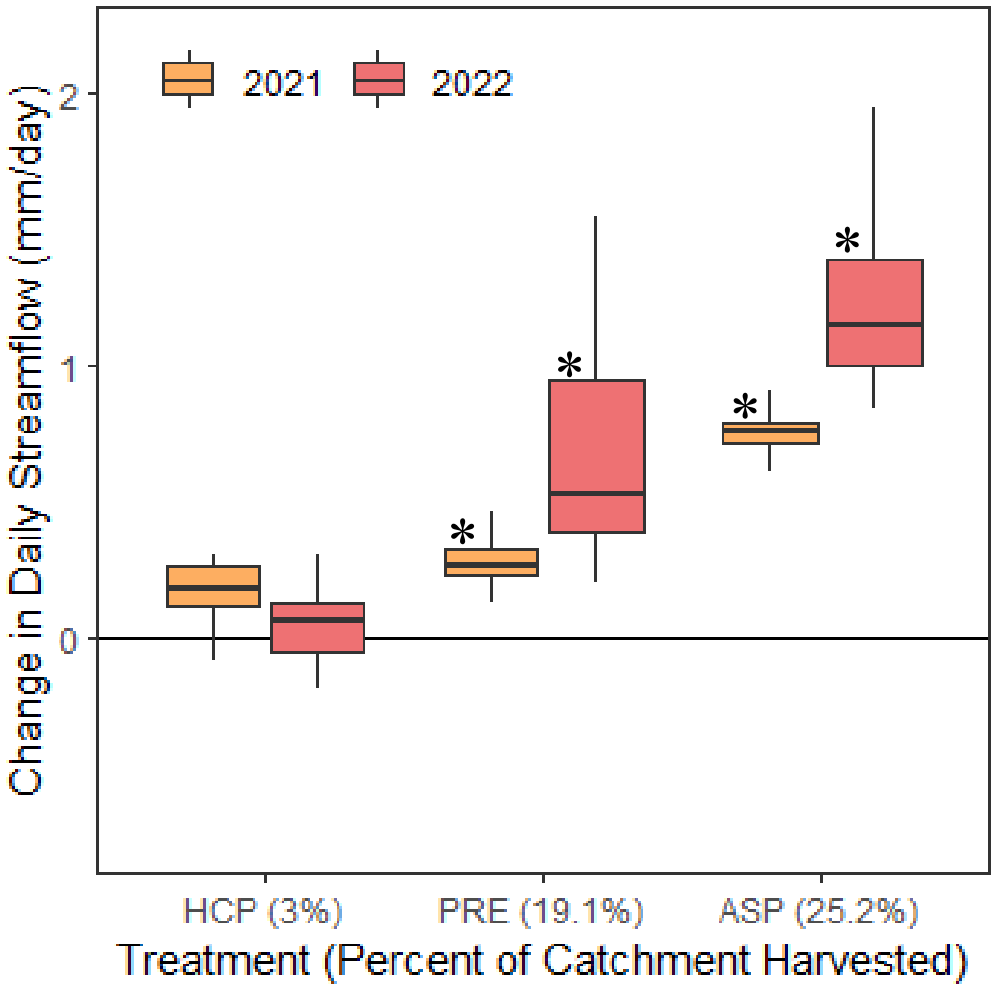


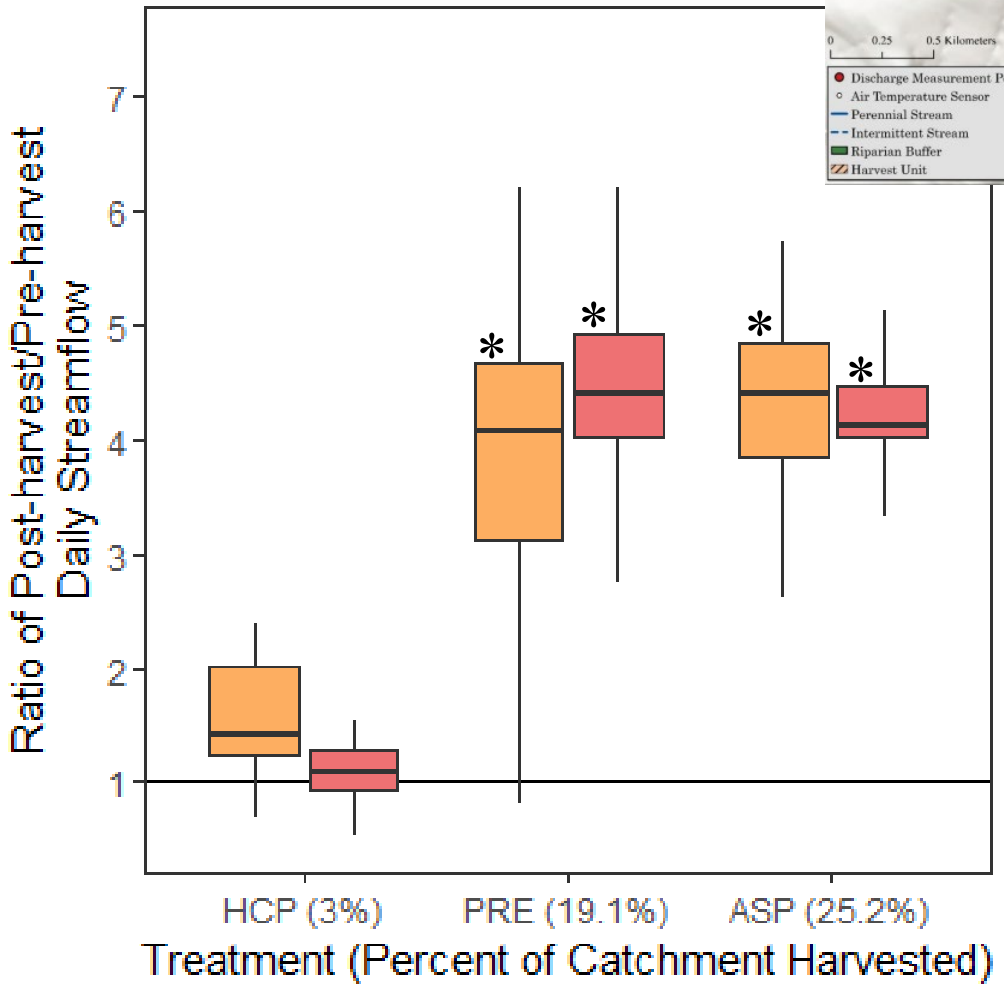




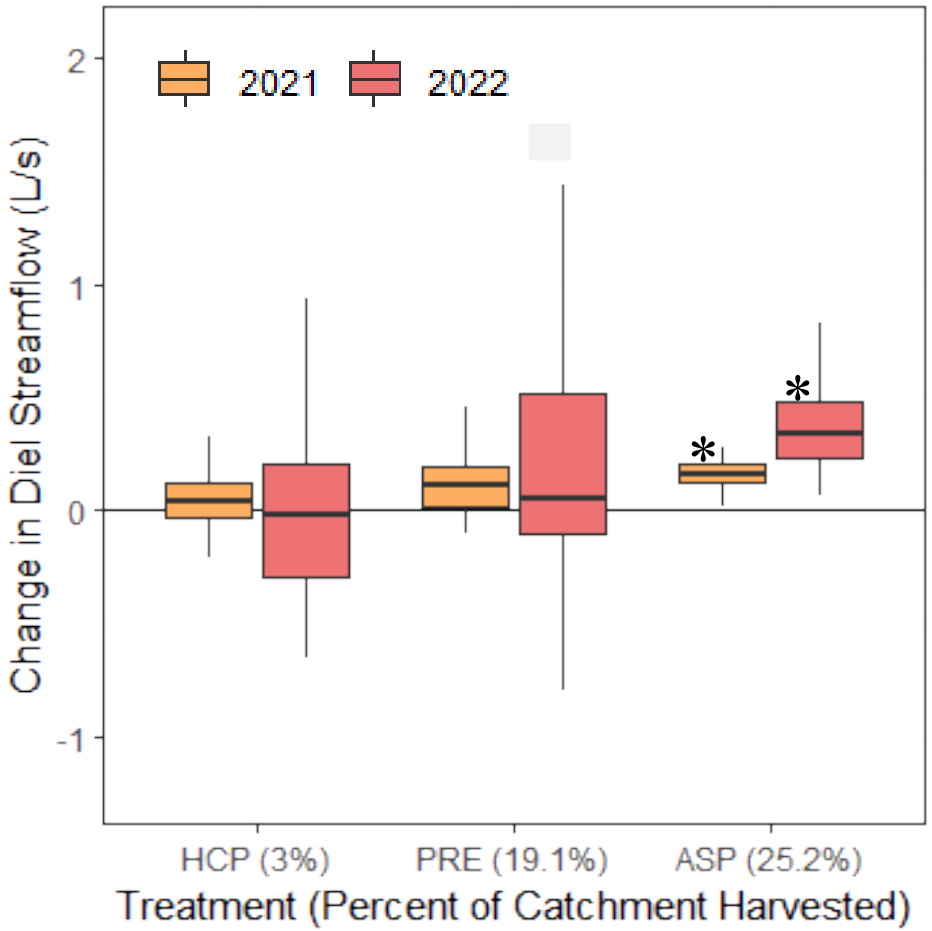
Change in Daily Streamflow (June–August)

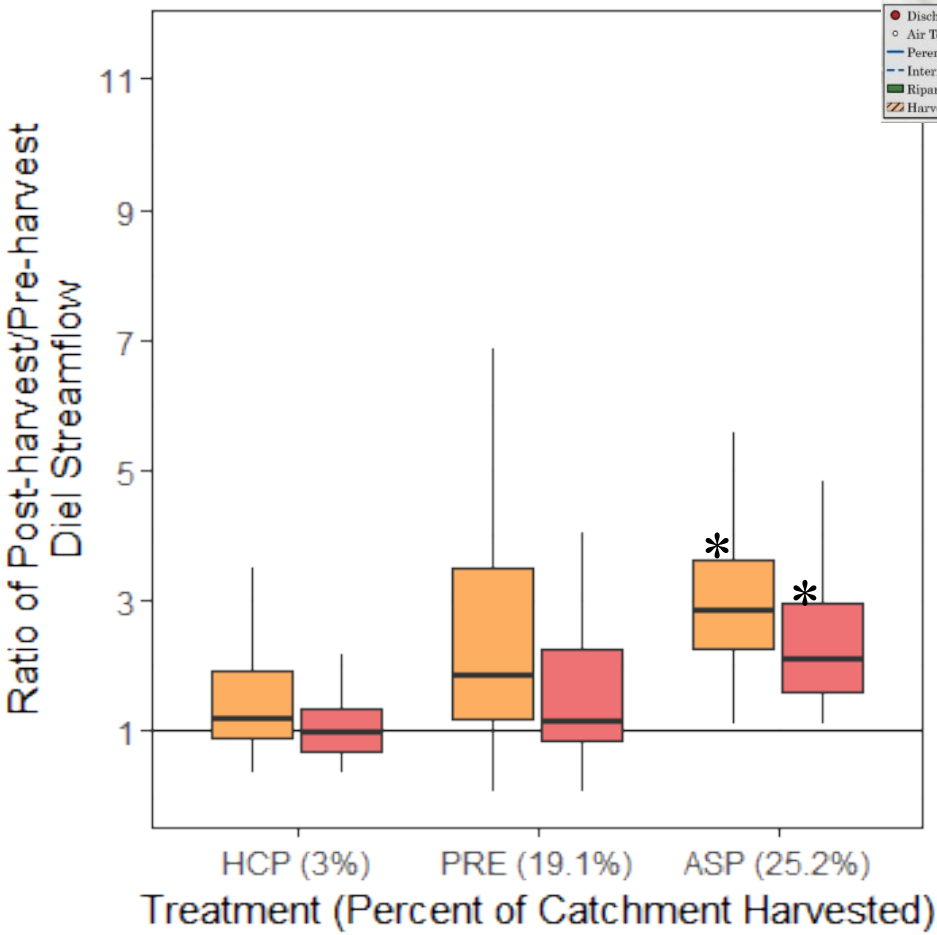


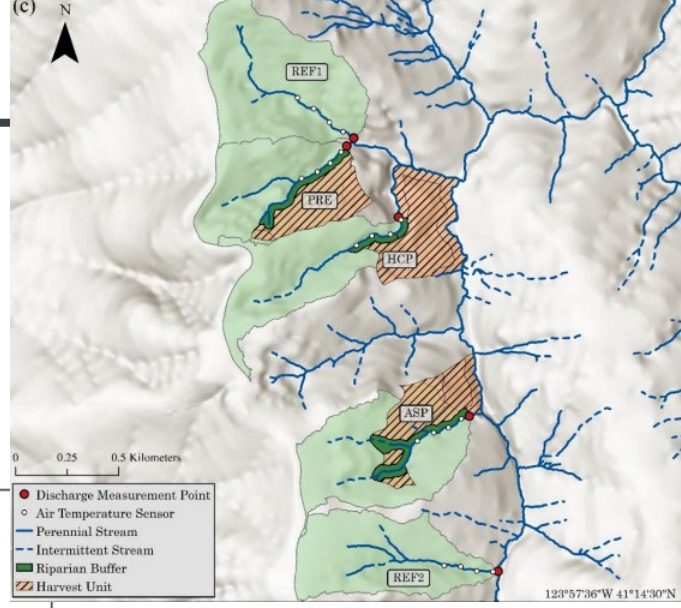




Change in Diel Streamflow (June–August)



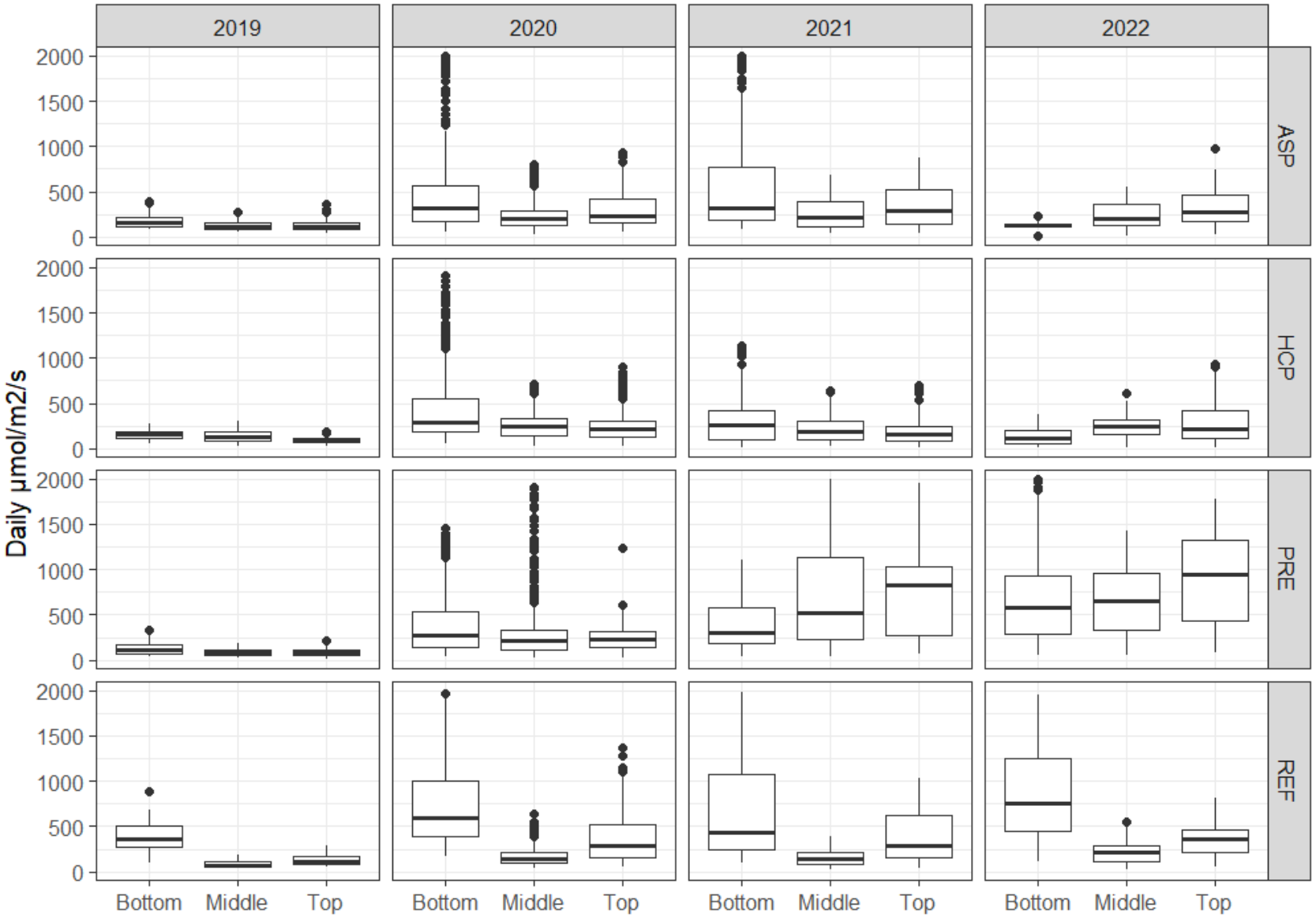




PAR and Dissolved Oxygen

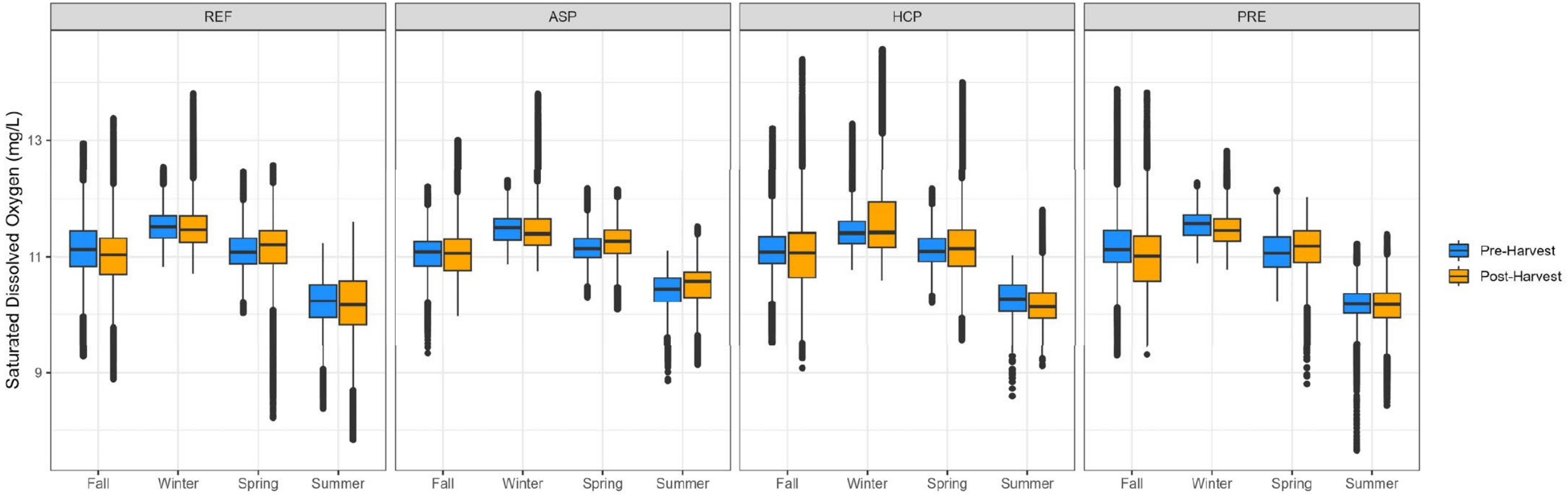
- DO sensors installed at outlet of all 18 catchments
- PAR sensors installed at outlet, mid-reach, and upper reach of all 18 catchments
- Sensors measure every 60 seconds and store data every 15 minutes

Photosynthetically Active Radiation



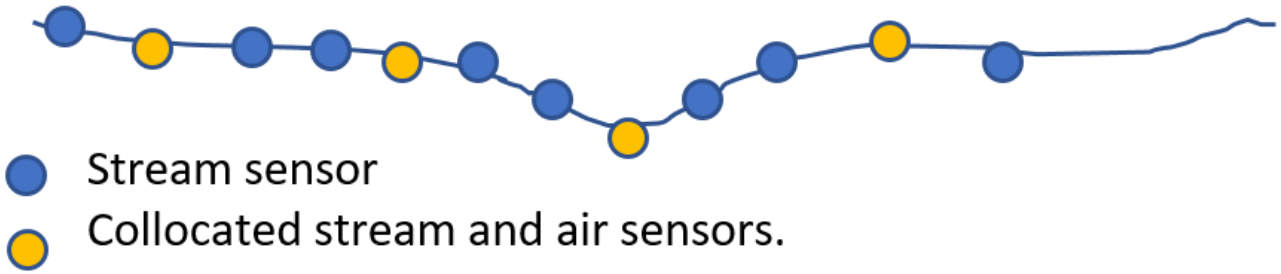
Treatment	Timing	MEAN	SD
REF	Pre-Harvest	388.8	367.2
	Post-Harvest	389.4	388.8
ASP	Pre-Harvest	345.9	324.1
	Post-Harvest	301.1	265.4
HCP	Pre-Harvest	282.4	241.7
	Post-Harvest	239.1	181.7
PRE	Pre-Harvest	209.0	182.9
	Post-Harvest	606.2	462.8

Dissolved Oxygen



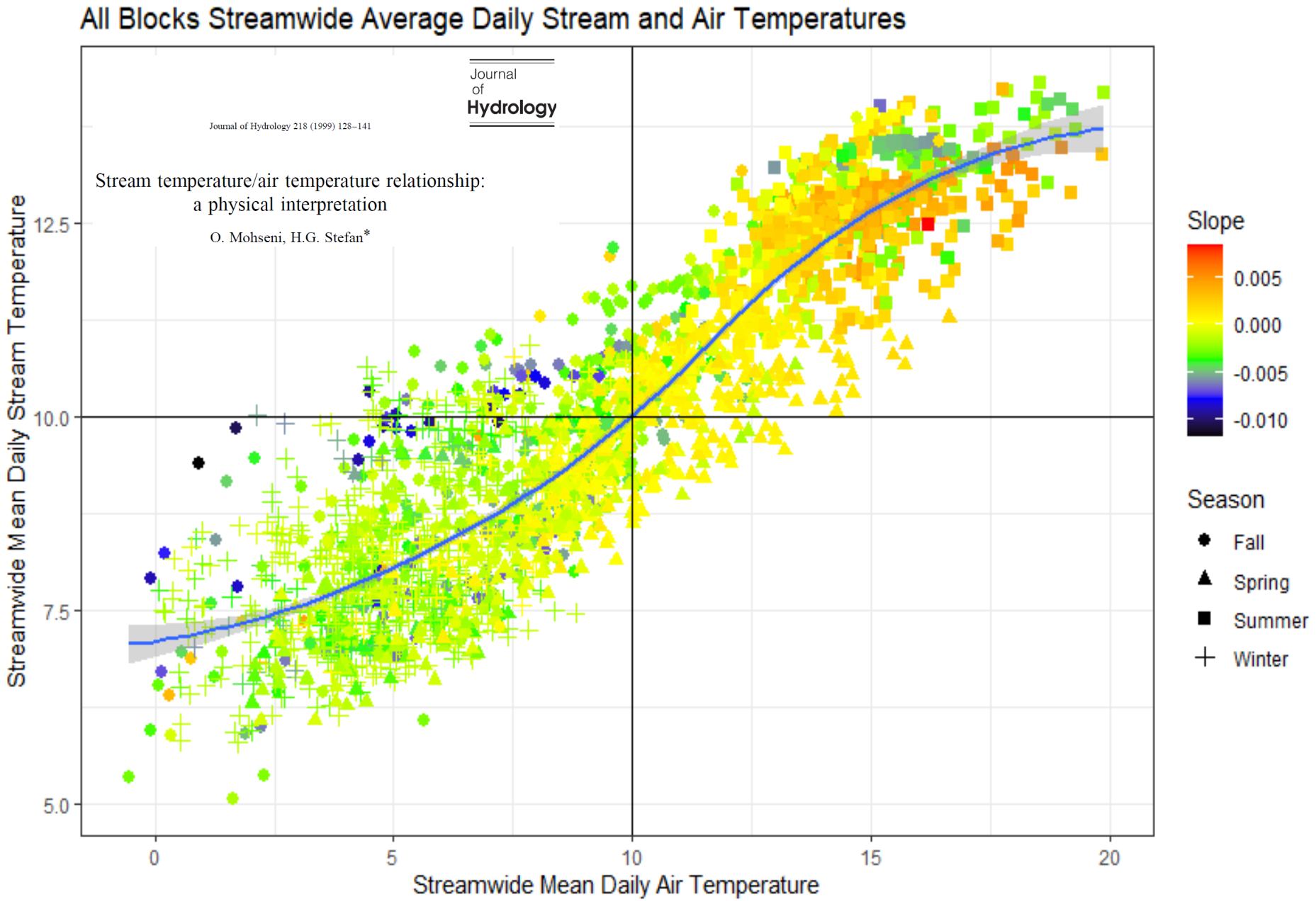
Stream and air temperature

- Installed longitudinally along the ~300 m (1000 ft) of each of the 18 study streams:
  - 12 stream temperature sensors
  - 4 air temperature sensors
  - Total: 288 sensors

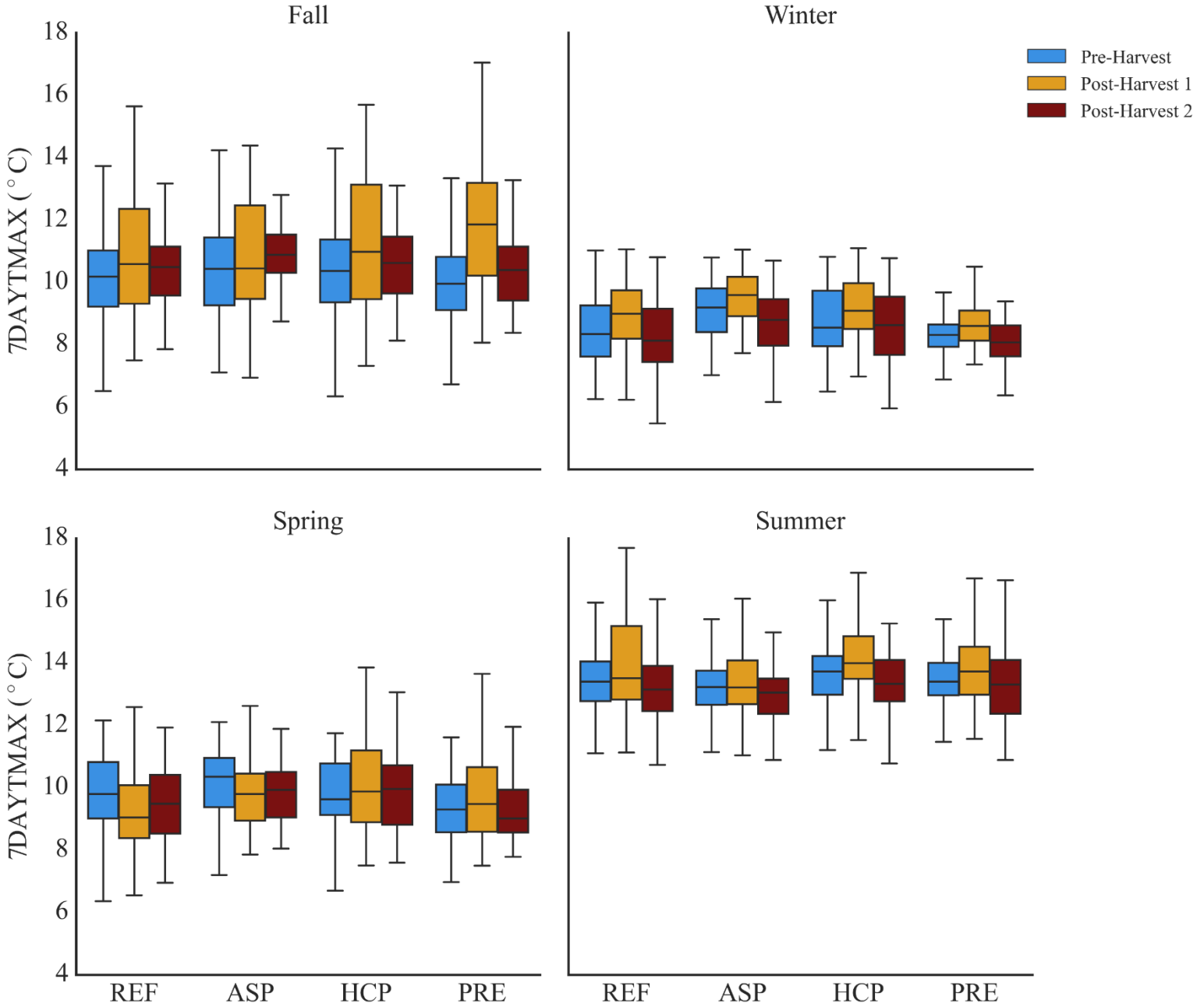


- Sensors measure every 60 seconds and store data every 15 minutes

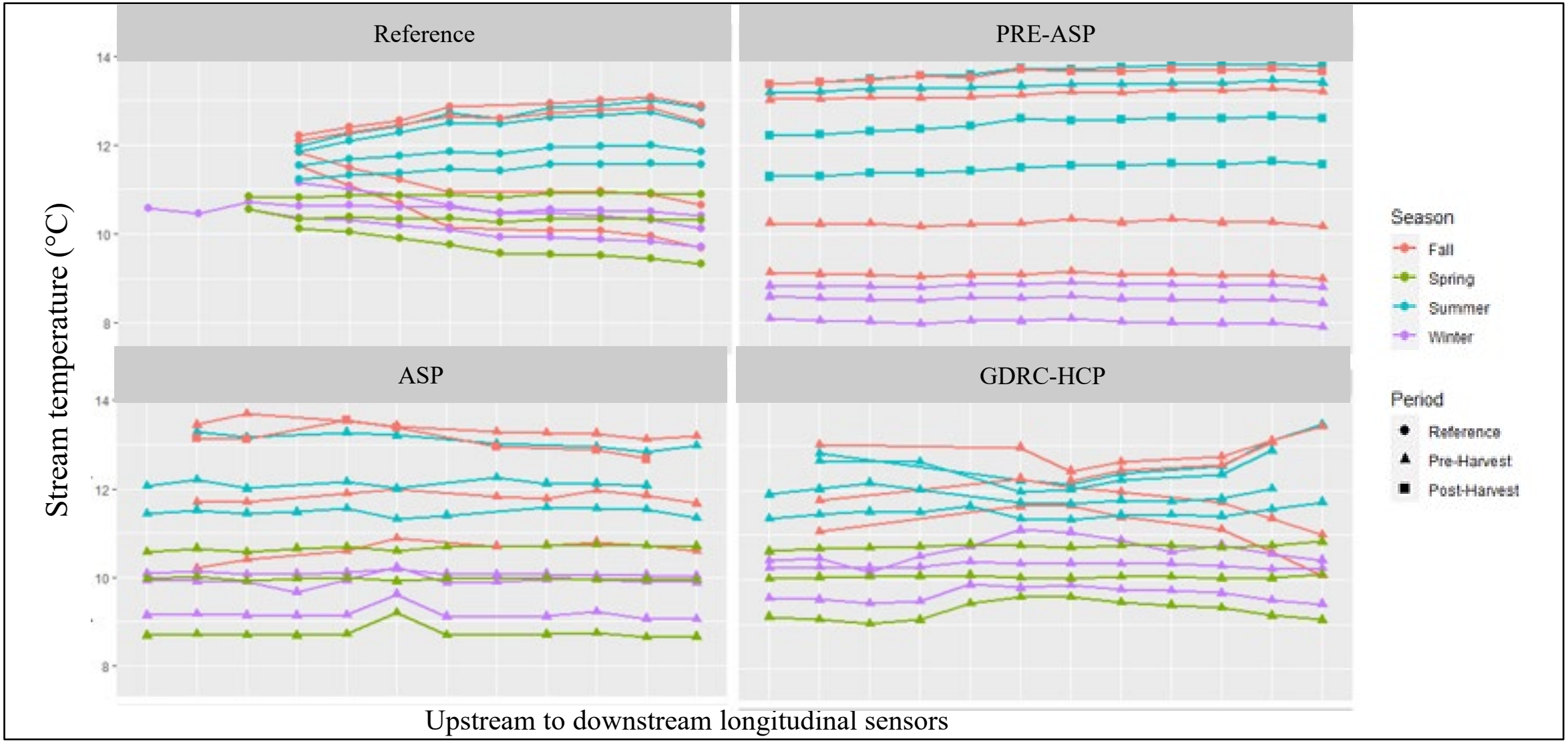
Stream temperature and air temperature relationship



Stream temperature – Pre- vs. Post-harvest

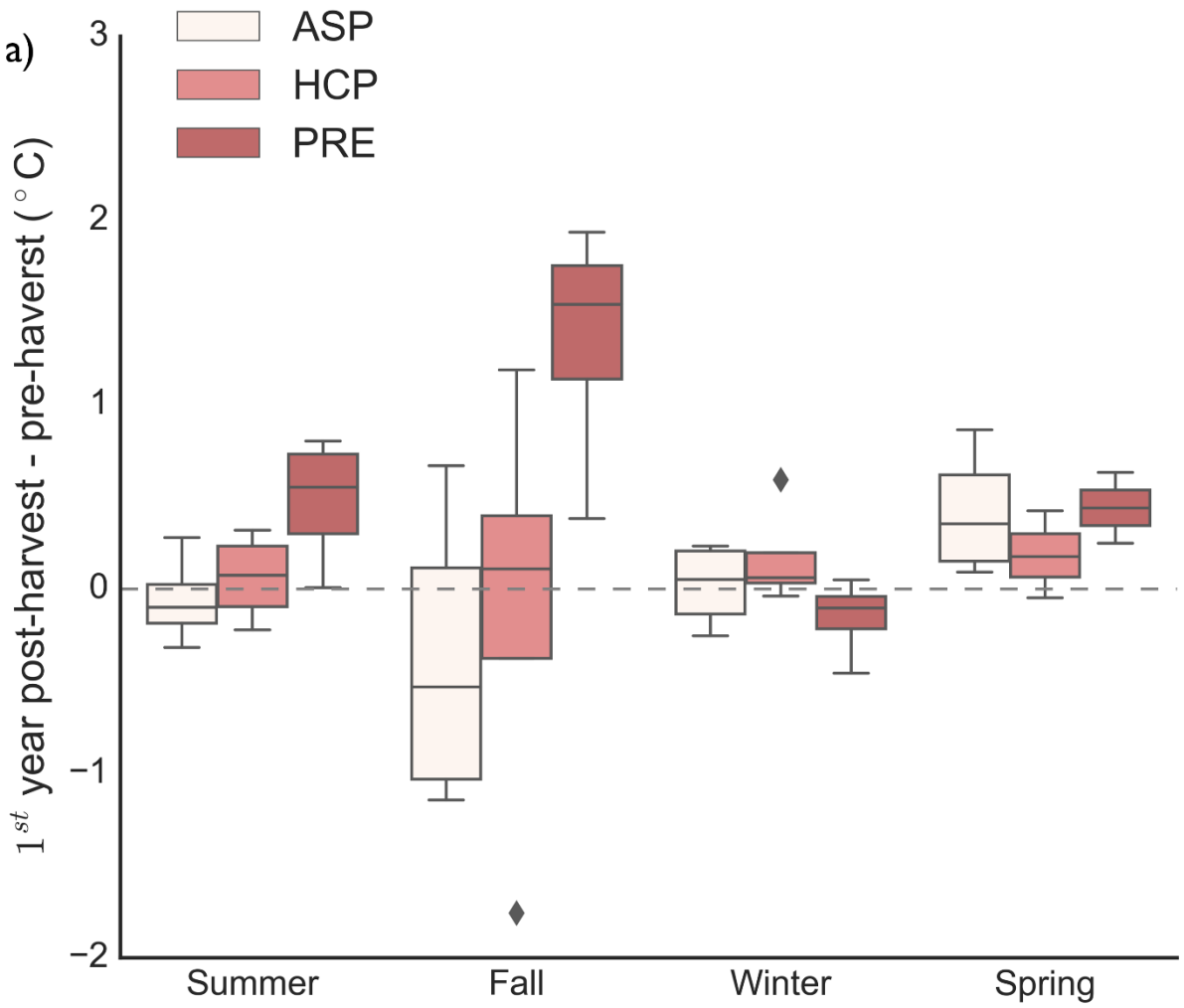


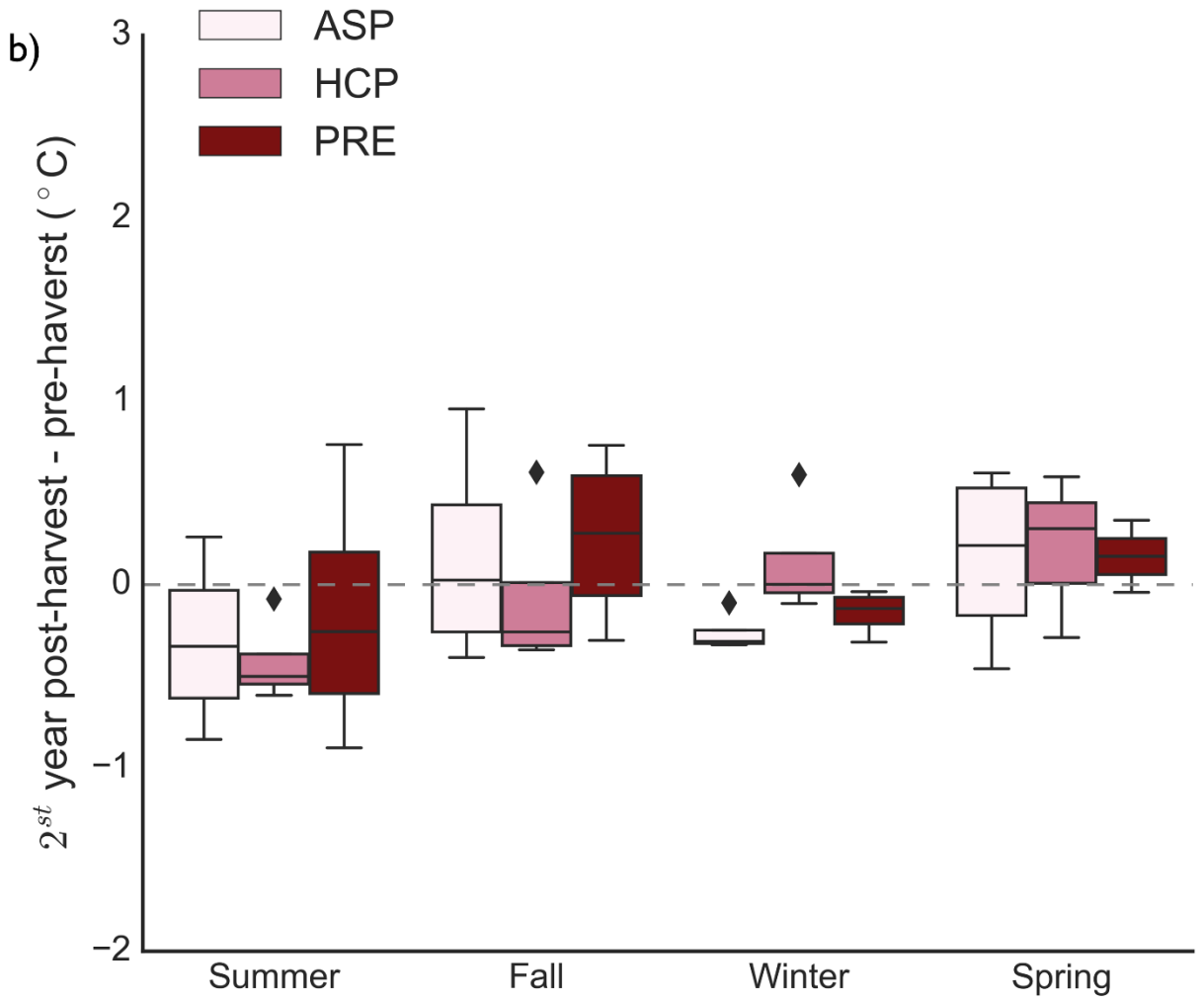
Longitudinal stream temperature



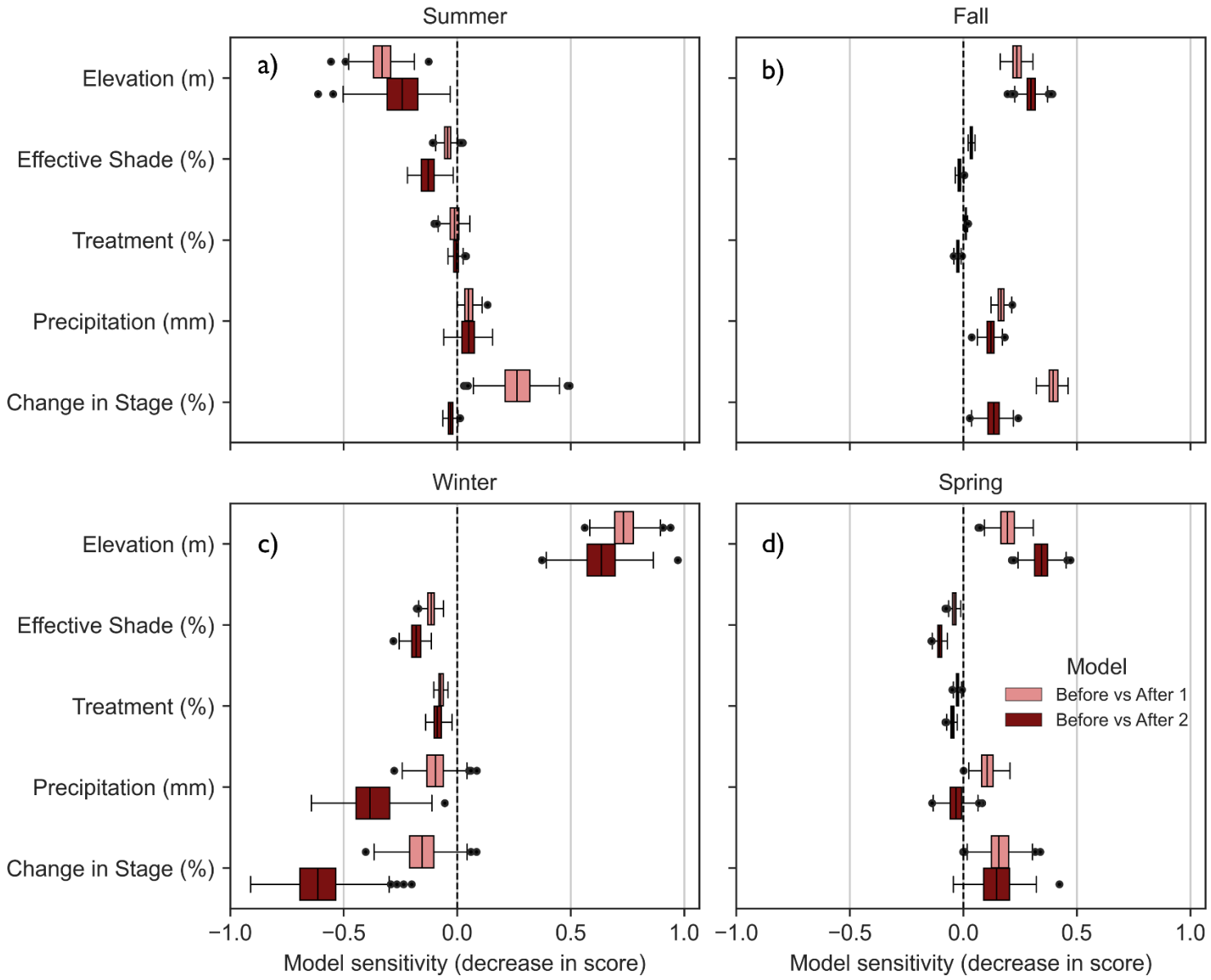
- Little evidence of downstream warming or cooling
- Little evidence of discrete locations of groundwater discharge

Stream temperature – Pre- vs. Post-harvest



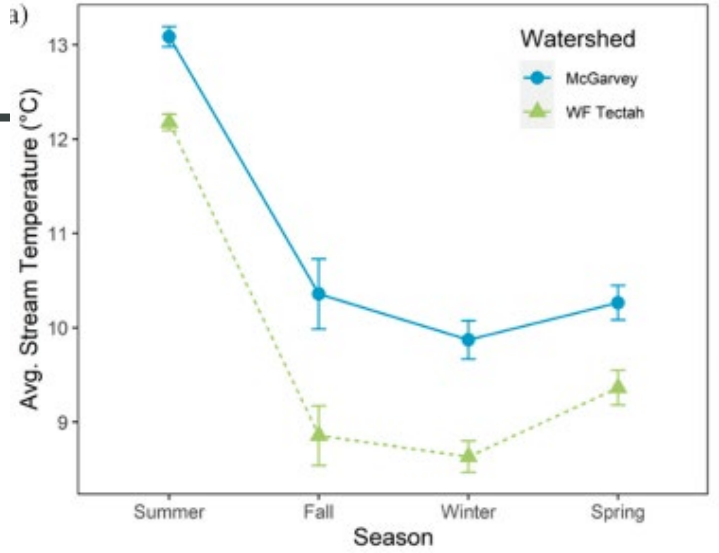


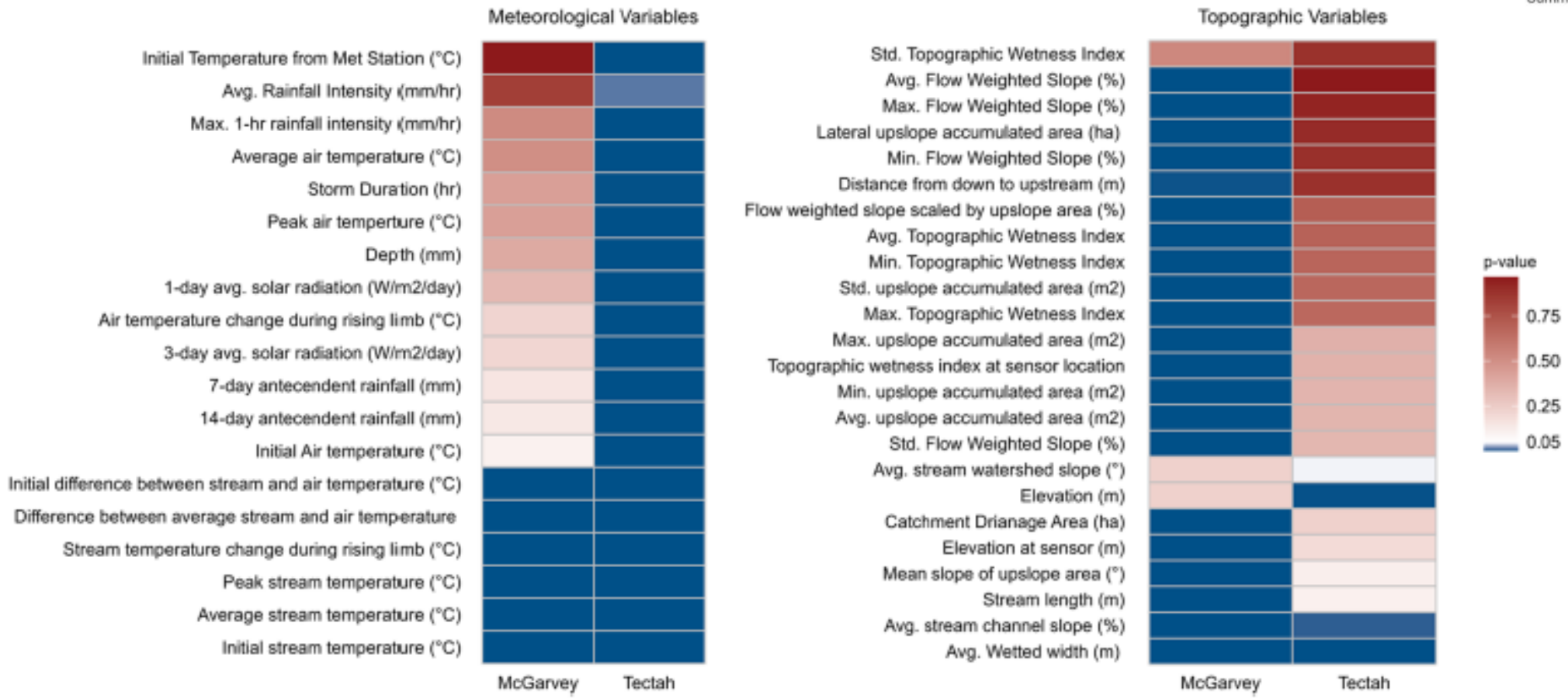
Stream temperature – Pre- vs. Post-harvest



Stream temperature – Regional Differences

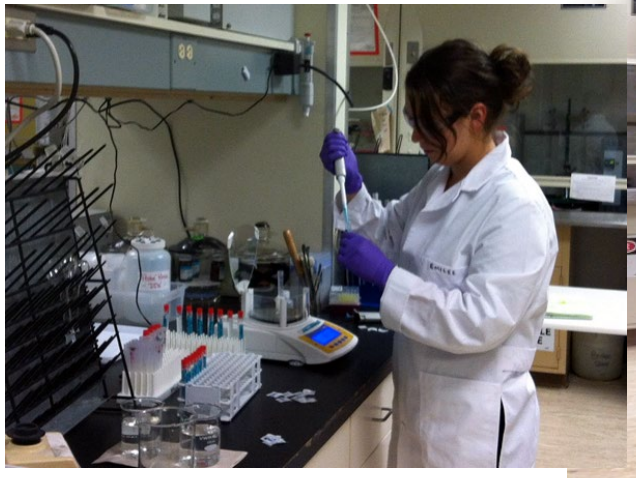
- consistently warmer stream temperatures in McGarvey relative to WF Tectah
- Tectah → T_s co-varied with meteorology
- McGarvey → T_s co-varied with topography



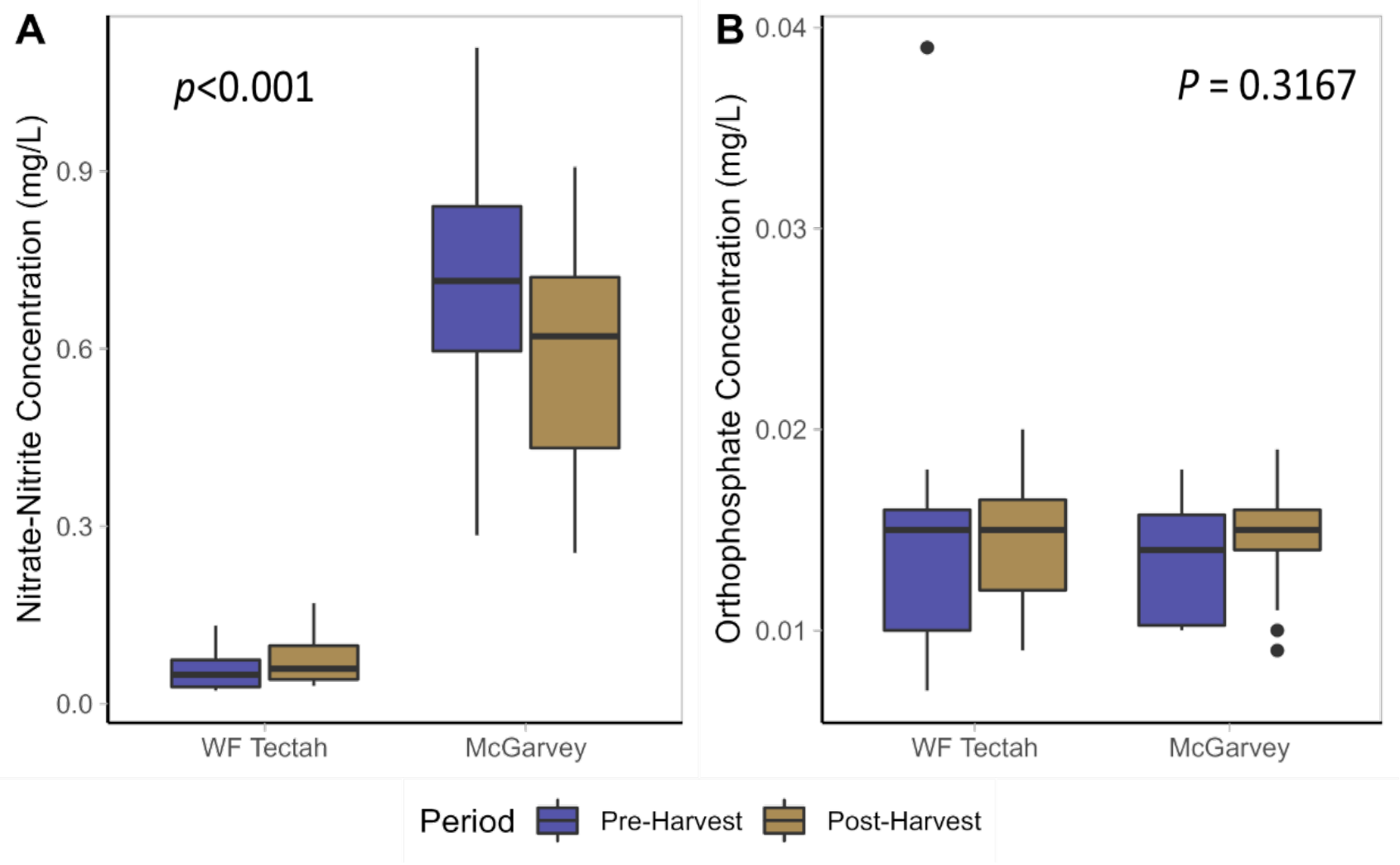


Chemical water quality

- Monthly grab sample of water from each stream (Pre-harvest: 2019–2020, Post-harvest 2020–2022)
- Analyzed in the laboratory for NO_3^-, PO_4^{3-}, and DOC



Chemical water quality – nitrogen and phosphorus

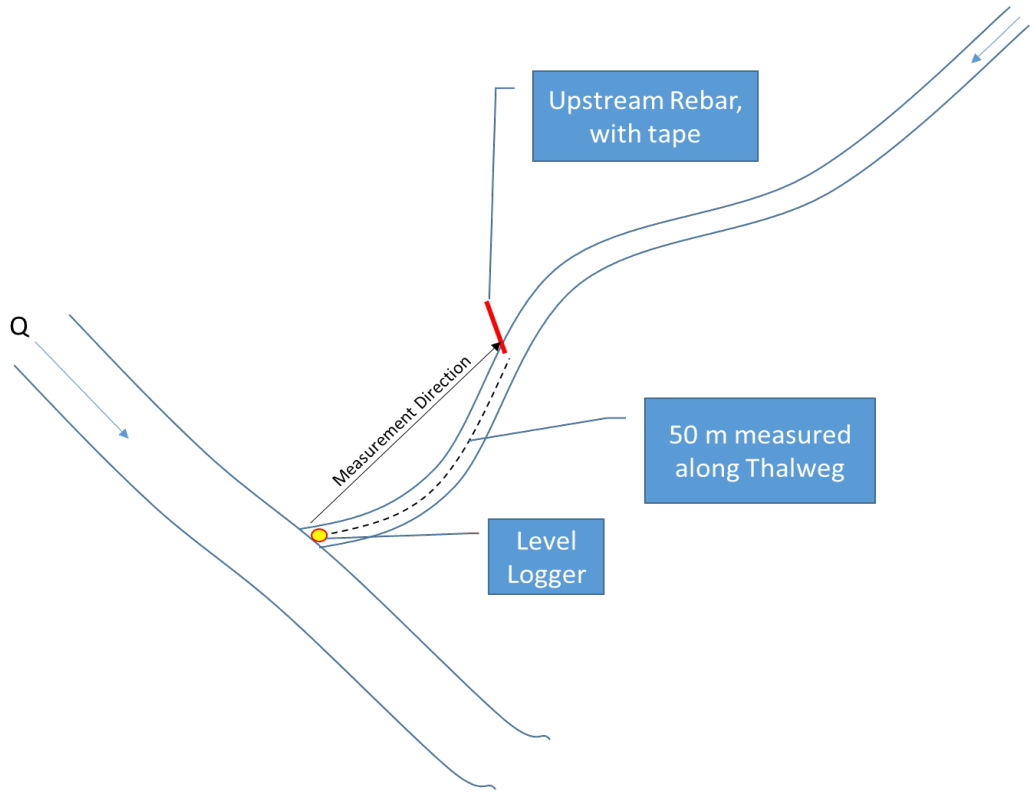


- Differences in nitrogen primarily explained by % watershed area harvest, catchment slopes, and alder cover

Primary productivity

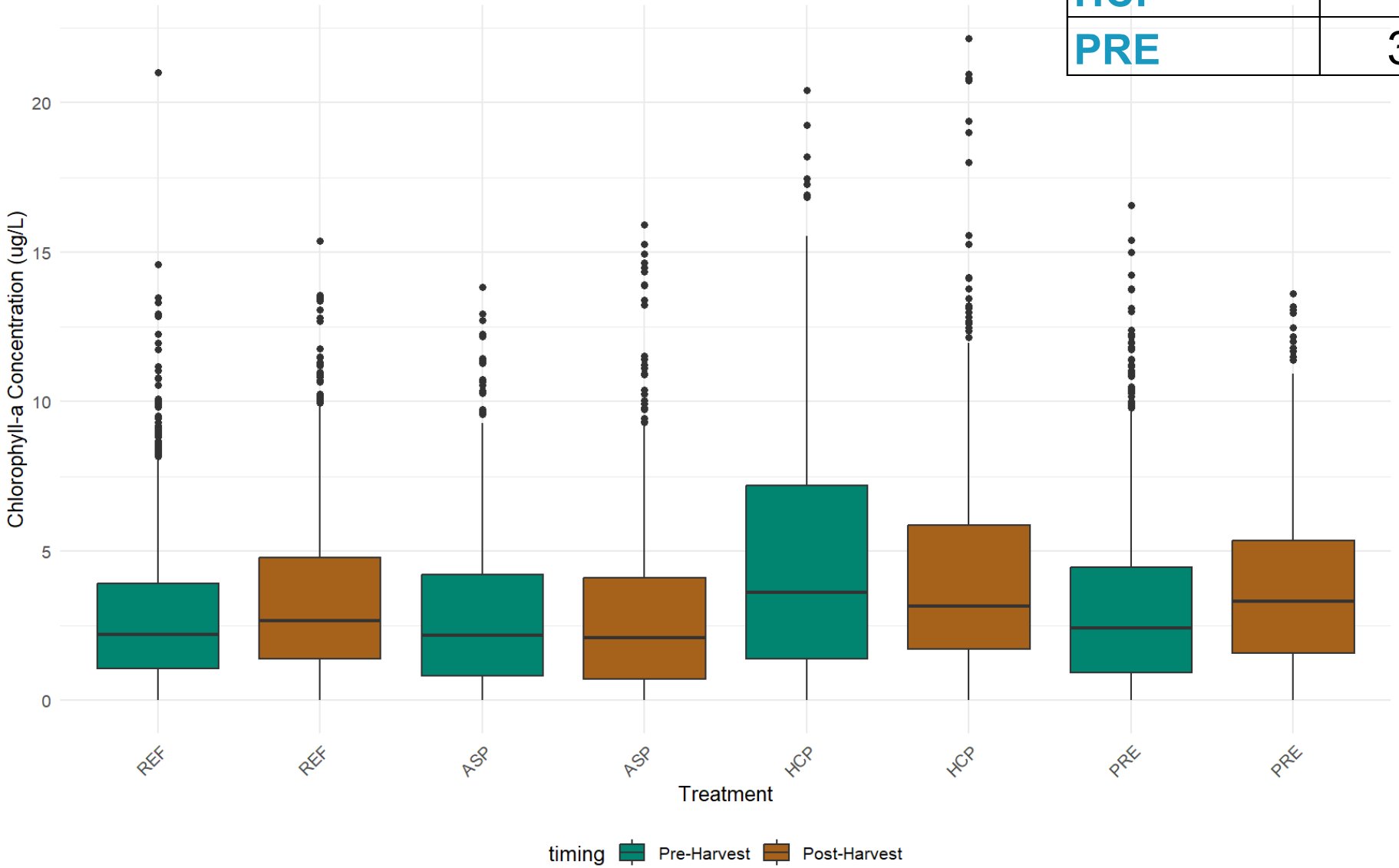
- benthic chlorophyll *a* concentrations of in-stream substrate

- 100 measurements per stream, measuring every 50 cm along the thalweg

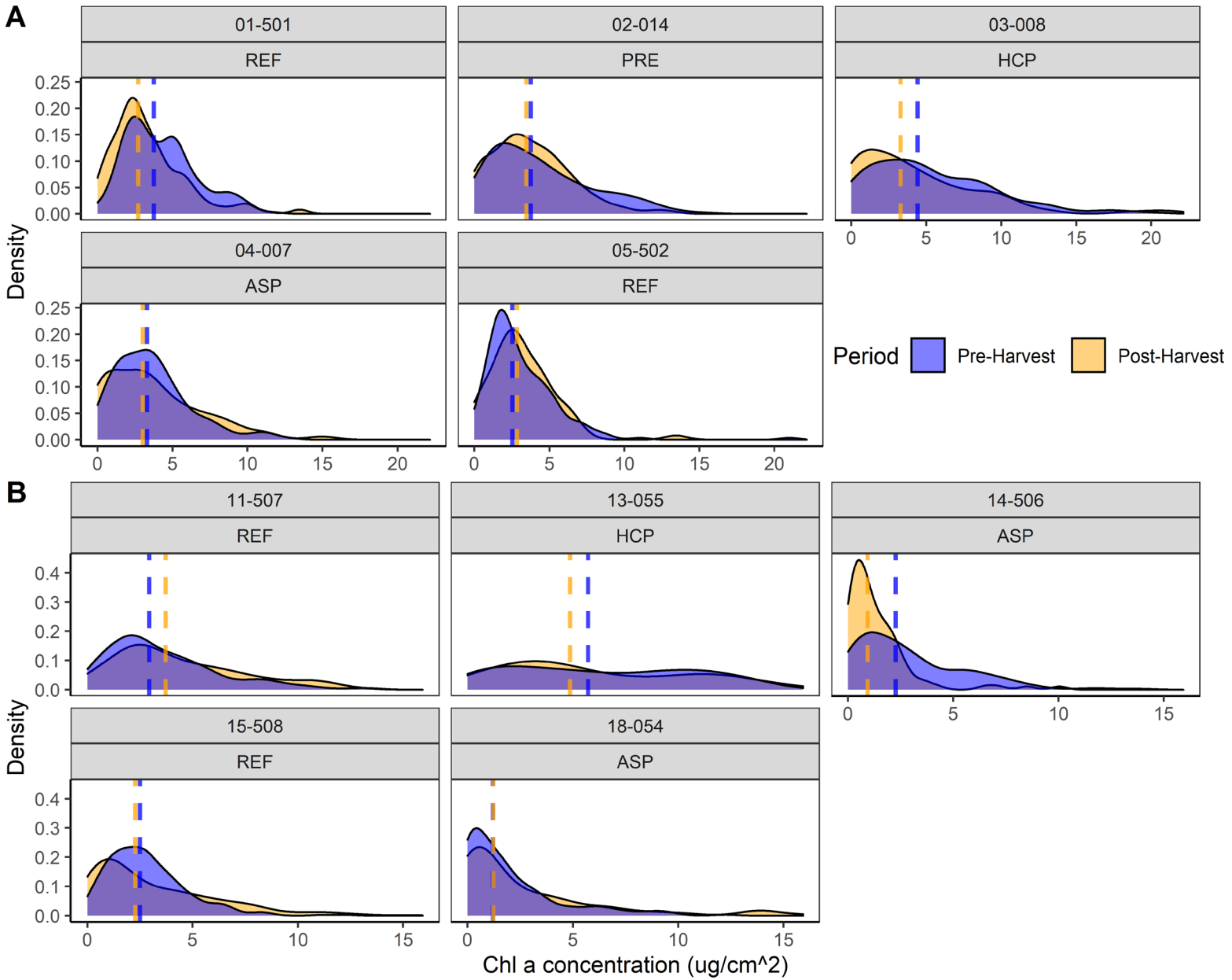


Primary productivity

Site Type	Pre-harvest	Post-harvest
REF	2.8 ± 2.3	3.4 ± 2.8
ASP	2.8 ± 2.6	3.0 ± 3.0
HCP	4.6 ± 4.0	4.3 ± 3.9
PRE	3.1 ± 3.0	3.7 ± 2.8



Primary productivity



- Substantial variability across study area
- Localized primary productivity
- No clear trends related to harvest and riparian buffer prescriptions

Summary

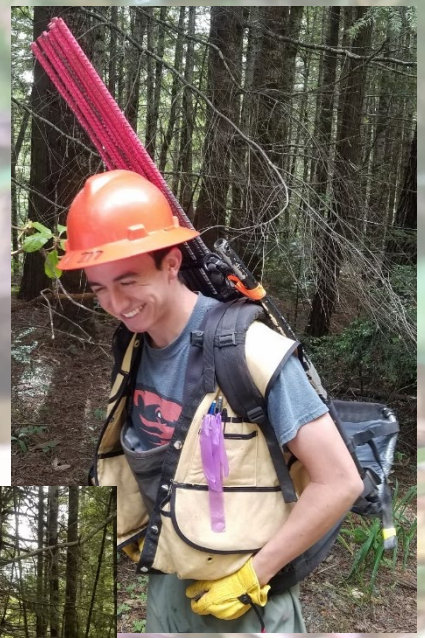
- Strongest change in riparian canopy characteristics in Pre-ASP sites
- Increased streamflow during summer low flow → related to catchment area harvested
- No evidence for impacts on nutrients or primary productivity
- No evidence that riparian management prescription was a major driver of seasonal $T_{7\text{-}day\text{-}max}$ response
- Thermal regimes most strongly related to climatic variability and catchment topography

Acknowledgements













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