

Supplementary Material

How interactions between wildfire and seasonal soil moisture fluxes drive nitrogen cycling in Northern Sierra Nevada forests

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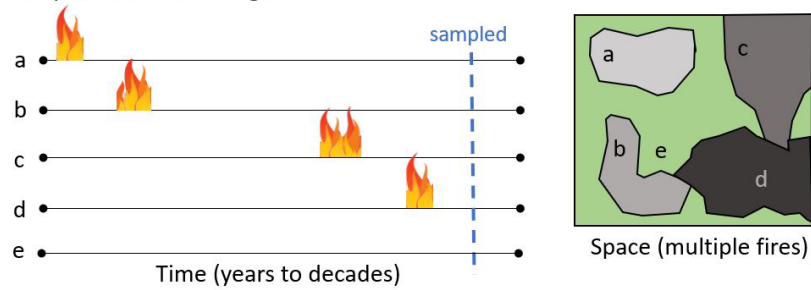
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Supplementary Information

S1. Introduction

A. Space-for-Time Design



B. High Resolution, Repeated Sampling Design

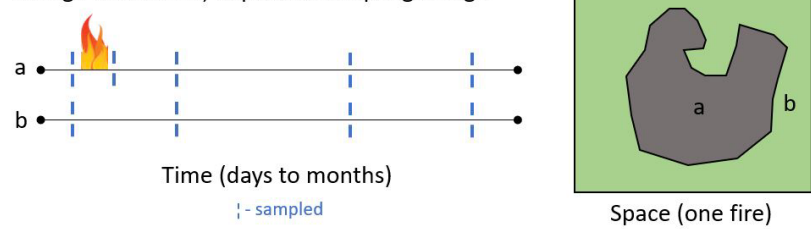


Figure S1. Conceptual diagram comparing A. space-for-time study designs frequently used to study fire effects and B. the repeated sampling design on a single fire that was used in this research. Lower case letters represent sampling areas.

S2. Methods

Total C to N ratios were determined with an elemental analyzer using 0.015 g of ground soil. The ratios were measured pre-fire, immediately post-fire, and one and a half months post-fire for the low and moderate severity samples while control samples were only measured pre-fire as C:N ratios typically change on the scale of decades without a large disturbance (e.g., Schipper and Sparling 2011; Pellegrini *et al.* 2018). For the high severity sampling locations, total C:N ratios were measured at six- and nine months post-fire.



Figure S2. From left to right: a low severity, moderate severity, and high severity sampling location. All three photos were taken in June 2020, nine months after the fire by Mary K. Brady.

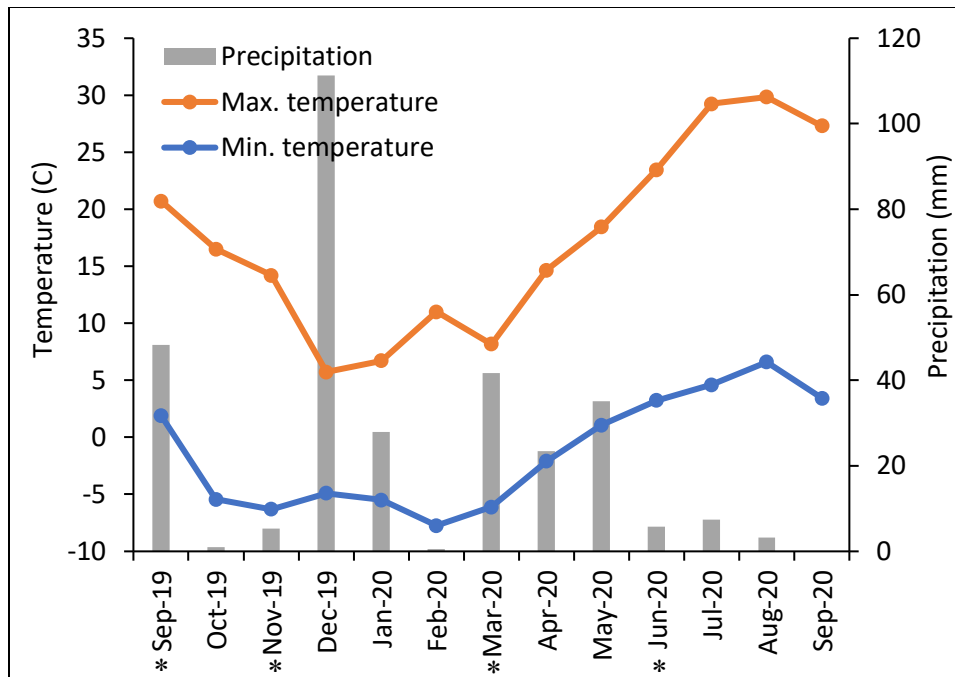


Figure S3. Monthly precipitation and mean maximum and minimum air temperatures from the Coyote, CA Remote Access Weather Station ('RAWS USA Climate Archive' 2020). The timeline covers the Walker Fire (Sep. 2019) and the subsequent year. Much of the spring snowmelt occurred in March. * Indicates months when samples were collected.

Table S1. Site description for plots

Site description from the FBAT report is used for all plots except E1 (Dickinson *et al.* 2019). Additional data added for plot E1.

Silvicultural and hazardous fuels treatment history was determined from the Forest Service data clearinghouse (U.S. Forest Service 2021). Treatments were performed over areas much larger than the plots and, as such, conditions within plots may not always represent average treatment conditions. Wildfire history was determined from perimeters available in the Wildland Fire Decision Support System (WFDSS; U.S. Geological Survey 2019). Coordinates are in NAD83 and mark the southwest corners of each plot.

Plot	Treatment history	Wildfire history	Walker Fire	Slope (%)	Aspect	Elev. (m)	Latitude	Longitude
C1	2008 salvage cut borders the plot	Low severity in 2007 Wheeler Fire	Did not burn	14	S	1656	40.121722	-120.559139
C2	Plot near a 1982 sanitation cut, and near a 2002 precommercial thin in the same area	None recorded	Did not burn	8	N	1680	40.108233	-120.555500
C3	1975 cut, 1994 commercial &	Bore charring consistent with burning	Did not burn	3	N	1704	40.137983	-120.504950

	precommercial thin, 2003 precommercial thin	in 2007 Wheeler Fire but outside official perimeter						
L1	1996 commercial & precommercial thin	Low severity in 2007 Wheeler Fire	Low severity	7	W	1672	40.143311	-120.554603
L2	1996 commercial & precommercial thin	Low severity in 2007 Wheeler Fire	Low severity	9	W	1736	40.143147	-120.557666
M1	None recorded	None recorded	Moderate severity	7	NE	1694	40.116517	-120.529500
E1	2003 precommercial thin, planned salvage cut 2020	None recorded	High severity	17	SW	1704	40.132514	-120.501463

Table S2. Pre-fire plot canopy characteristics

Pre-fire canopy characteristics from the FBAT report is used for all plots except E1 (Dickinson *et al.* 2019). Plot E1 was not surveyed by FBAT before the fire. Canopy height and cover are estimated directly from plot data. Canopy height is the average across all overstory trees in the sample. Quadratic mean diameter (QMD), tree density, basal area, canopy base height, and canopy bulk density are FVS outputs based on plot data. Overstory trees are ≥ 15.3 cm (6 inches) DBH, poles are < 15.3 cm DBH.

	Overstory			Canopy		Canopy	Canopy	Canopy
	density	Pole density		Basal area	cover	height	base height	bulk density
Plot	(trees/hectare)	(trees/hectare)	QMD (cm)	(m2/hectare)	(%)	(m)	(m)	(kg/m2)
C1	597.95	0	40.64	33.06	62	20.73	7.01	0.07
C2	543.04	0	40.64	28.70	31	23.17	9.14	0.05
C3	524.72	0	50.8	41.09	31	27.13	12.19	0.04
L1	518.62	0	48.26	36.73	23	23.47	7.32	0.05
L2	1202.00	0	35.56	45.69	46	20.12	5.79	0.08
M1	2532.12	3514.44	22.86	107.44	62	21.64	1.83	0.27

Table S3. Pre-fire surface fuels

Surface fuel loading and fuel bed depth for all plots except E1 are from the FBAT report (Dickinson *et al.* 2019). Plot E1 was not surveyed by FBAT before the fire.

Plot	Mean fuel loading (tons/hectare)								Fuel Bed	
	Duff	Litter	1-hr	10-hr	100-hr	1000-hr	Forb & grass	Shrub & seedling	total	Depth (cm)
C1	15.32	5.77	0.48	1.93	4.27	0.00	<0.01	0.89	19.33	58.85
C2	25.86	8.03	0.38	1.41	1.83	0.68	<0.01	0.12	37.66	21.16
C3	8.54	5.52	0.05	0.35	0	0.68	<0.01	0.07	14.56	13.54
L1	6.28	8.03	0.23	0.35	0	0.00	0.14	0.49	15.32	13.13
L2	2.76	5.52	0.10	1.23	0.93	9.59	0.03	0.36	17.07	24.56
M1	50.97	5.27	0.23	1.58	0	0.00	<0.01	0.01	58.00	20.32

Table S4. Sampling events for each measured soil characteristic.

“X” indicates the soil characteristic was measured at the time point. C – control locations, L – low severity locations, M – moderate severity locations, H – high severity locations.

	Pre-fire				Immediate				1.5 mo.				6 mo. Post-fire				9 mo. Post-fire			
					Post-fire				Post-fire											
	C	L	M	H	C	L	M	H	C	L	M	H	C	L	M	H	C	L	M	H
Fractional Water Content	X	X	X		X	X			X	X	X		X	X	X	X	X	X	X	X
pH	X	X	X		X	X			X	X	X		X	X	X	X	X	X	X	X
Microbial Biomass	X	X	X		X	X			X	X	X		X	X	X	X	X	X	X	X
C:N ratio	X	X	X		X	X			X	X						X				X
Available NH ₄ ⁺	X	X	X		X	X			X	X	X		X	X	X	X	X	X	X	X
Available NO ₃ ⁻	X	X	X		X	X			X	X	X		X	X	X	X	X	X	X	X
Mineralization, Field Moist									X	X	X		X	X	X	X	X	X	X	X
Mineralization, Wetted Wk 1									X	X	X		X	X	X	X	X	X	X	X
Mineralization, Wetted Wk 3									X	X	X		X	X	X	X	X	X	X	X
Nitrification, Field Moist									X	X	X		X	X	X	X	X	X	X	X
Nitrification, Wetted Wk 1									X	X	X		X	X	X	X	X	X	X	X
Nitrification, Wetted Wk 3									X	X	X		X	X	X	X	X	X	X	X

S3. Results

S3.1 Soil property values and statistical results

Table S5. Mean and standard error for the soil characteristics measured at all sampling events

Mineralization and nitrification show net daily rates (μg of NH_4^+ plus NO_3^- per g dry soil per day and μg NO_3^- per g dry soil per day, respectively) for the soil incubations. Wetted incubations were at 40% soil water holding capacity. The field-moist incubation was one week. All other units are shown on the table.

Characteristic	Severity	Immediately		Immediately		1.5 mo.		6 mo.		9 mo.	
		Pre-fire		Post-fire		Post-fire		Post-fire		Post-fire	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Fractional Water	Control	0.03	0.00	-	-	0.07	0.00	0.22	0.01	0.06	0.00
Content (g H ₂ O per g field-moist soil)	Low severity	0.02	0.00	0.15	0.00	0.04	0.00	0.16	0.01	0.02	0.00
	Mod. severity	0.03	0.00	0.12	0.01	0.06	0.02	0.14	0.00	0.05	0.01
	High severity	-	-	-	-	-	-	0.16	0.01	0.05	0.00
pH	Control	5.84	0.03	-	-	6.13	0.05	6.16	0.05	6.04	0.03
	Low severity	6.14	0.04	6.64	0.04	6.60	0.04	6.71	0.07	6.45	0.02
	Mod. severity	5.52	0.07	6.02	0.10	7.16	0.04	6.06	0.01	6.28	0.06
	High severity	-	-	-	-	-	-	7.38	0.05	7.02	0.03

Microbial Biomass	Control	6.95	0.39	-	-	3.32	0.16	4.45	0.19	3.47	0.19
Estimates	Low severity	7.62	1.12	1.95	0.07	2.82	0.16	2.21	0.20	1.43	0.10
($\mu\text{g C per g dry soil}$	Mod. severity	2.04	0.16	3.46	0.36	6.83	0.49	2.58	0.38	1.13	0.14
per hour)	High severity	-	-	-	-	-	-	9.27	0.81	7.73	0.55
C:N ratio	Control	31.36	0.62	-	-	-	-	-	-	-	-
	Low severity	40.79	1.03	26.93	0.88	82.89	11.13	-	-	-	-
	Mod. severity	38.06	2.51	38.29	2.53	35.92	2.66	-	-	-	-
	High severity	-	-	-	-	-	-	23.91	0.52	0.05	0.00
Available NH_4^+	Control	2.63	0.29	-	-	1.48	0.11	3.10	0.23	1.81	0.14
($\mu\text{g NH}_4^+$ per g dry	Low severity	1.71	0.09	6.80	0.44	3.71	0.50	2.36	0.15	4.62	0.64
soil)	Mod. severity	1.59	0.19	46.26	2.65	29.53	2.39	21.99	2.26	21.63	2.73
	High severity	-	-	-	-	-	-	83.85	13.24	68.04	11.66
Available NO_3^-	Control	0.03	0.01	-	-	0.02	0.01	0.08	0.02	0.00	0.00
($\mu\text{g NO}_3^-$ per g dry	Low severity	0.00	0.00	0.15	0.06	0.33	0.04	0.26	0.04	0.61	0.20
soil)	Mod. severity	0.00	0.00	0.00	0.00	0.01	0.01	0.16	0.09	0.01	0.00
	High severity	-	-	-	-	-	-	0.17	0.06	30.20	0.29

Mineralization:	Control	-	-	-	-	-0.11	0.01	-0.10	0.02	-0.05	0.01
Field-moist	Low severity	-	-	-	-	-0.16	0.03	-0.02	0.03	-0.03	0.03
	Mod. severity	-	-	-	-	-0.87	0.09	-0.38	0.22	-0.16	0.11
	High Severity	-	-	-	-	-	-	0.94	0.12	0.90	0.33
Mineralization:	Control	-	-	-	-	-0.03	0.02	-0.03	0.02	0.02	0.03
1-week wetted	Low severity	-	-	-	-	0.26	0.04	0.54	0.09	0.09	0.05
	Mod. severity	-	-	-	-	-1.02	0.19	-0.15	0.08	0.54	0.02
	High Severity	-	-	-	-	-	-	2.91	0.44	-0.59	1.67
Mineralization:	Control	-	-	-	-	0.06	0.05	-0.03	0.11	0.40	0.05
3-week wetted	Low severity	-	-	-	-	0.95	0.13	1.72	0.26	1.01	0.13
	Mod. severity	-	-	-	-	-3.05	0.37	-3.51	0.53	-3.82	0.51
	High Severity	-	-	-	-	-	-	-7.30	4.15	2.98	1.97
Nitrification	Control	-	-	-	-	0.00	0.00	-0.01	0.00	0.00	0.00
Field-moist	Low severity	-	-	-	-	0.03	0.01	0.17	0.03	-0.02	0.01
	Mod. severity	-	-	-	-	0.00	0.00	-0.02	0.01	0.05	0.03
	High Severity	-	-	-	-	-	-	1.38	0.65	-0.52	0.06

Nitrification	Control	-	-	-	-	0.05	0.01	0.04	0.01	0.25	0.03
1-week wetted	Low severity	-	-	-	-	0.32	0.06	0.56	0.10	1.35	0.20
	Mod. severity	-	-	-	-	0.01	0.00	-0.02	0.01	0.00	0.00
	High Severity	-	-	-	-	-	-	3.14	1.06	0.23	0.34
Nitrification	Control	-	-	-	-	0.15	0.02	0.00	0.00	0.41	0.05
3-week wetted	Low severity	-	-	-	-	0.40	0.03	0.41	0.12	0.54	0.06
	Mod. severity	-	-	-	-	0.08	0.06	0.00	0.00	0.06	0.04
	High Severity	-	-	-	-	-	-	2.12	0.13	-0.23	0.19

Table S6. Statistical results for significant factors affecting each soil characteristic

Time refers to the sampling event, severity refers to the burn severity category, and interaction refers to the sampling event-burn severity interaction. The high severity samples and the immediate post-fire sampling event are not considered in this analysis due to a shortened timeline and a lack of immediate post-fire samples in control plots, respectively. ⁺ indicates the results from linear mixed effects models that had non-normal residuals.

	category	Chi ²	df	p value
pH	time	5.81	3	0.12
	severity	4.94	2	0.08
	interaction	27.83	6	<0.01
Microbial Biomass	time	11.9	3	0.01
Estimates	severity	7.96	2	0.02
	interaction	18.77	6	<0.01
Fractional Water	time	150.21 ⁺	3 ⁺	<0.01 ⁺
Content	severity	0.66 ⁺	2 ⁺	0.72 ⁺
	interaction	8.81 ⁺	6 ⁺	0.18 ⁺
Available NH ₄ ⁺	time	1.63	3	0.65

	severity	0.37	2	0.83
	interaction	120.71	6	<0.01
Available NO ₃ ⁻	time	0.24 ⁺	3 ⁺	0.97 ⁺
	severity	0.03 ⁺	2 ⁺	0.99 ⁺
	interaction	7.16 ⁺	6 ⁺	0.31 ⁺
Net Mineralization	time	0.32	2	0.85
Field-moist	severity	28.13	2	<0.01
incubation	interaction	11.27	4	0.02
Net Mineralization	time	0.21	2	0.9
1-week wetted	severity	26.34	2	<0.01
incubation	interaction	50.68	4	<0.01
Net Mineralization	time	1.23	2	0.54
3-week wetted	severity	20.22	2	<0.01
incubation	interaction	5.17	4	0.27
Net Nitrification	time	0.15	2	0.93
Field-moist	severity	0.56	2	0.75

incubation	interaction	30.4	4	<0.01
Net Nitrification	time	0.18	2	0.91
1-week wetted	severity	1.11	2	0.57
incubation	interaction	1.91	4	0.75
Net Nitrification	time	1.88	2	0.39
3-week wetted	severity	0.68	2	0.71
incubation	interaction	13.95	4	0.01

Table S7. Multiple comparison of means for soil characteristics within each sampling event

Statistical results from multiple comparisons of the burn severity category means in the linear mixed effects models for each soil characteristic within a sampling event. ⁺ indicates the results from linear mixed effects models that had non-normal residuals.

Characteristic	Comparison	Immediately		Immediately		1.5 mo. Post-					
		Pre-fire		Post-fire		fire		6 mo. Post-fire		9 mo. Post-fire	
		z	p	z	p	z	p	z	p	z	p
		score	value	score	value	score	value	score	value	score	value
Fractional	Control/Low	-3.39 ⁺	0.00 ⁺	-	-	-2.76 ⁺	0.02 ⁺	-1.86 ⁺	0.24 ⁺	-2.33	0.09

Water	Control/Mod.	-0.17 ⁺	0.98 ⁺	-	-	-0.85 ⁺	0.67 ⁺	-2.16 ⁺	0.13 ⁺	-0.62	0.92
Content	Control/High	-	-	-	-	-	-	-1.56 ⁺	0.40 ⁺	-0.45	0.97
	Low/Mod.	2.37 ⁺	0.05 ⁺	-1.39 ⁺	0.16 ⁺	1.25 ⁺	0.42 ⁺	-0.65 ⁺	0.91 ⁺	1.15	0.65
	Low/High	-	-	-	-	-	-	-0.08 ⁺	1.00 ⁺	1.31	0.55
	Mod./High	-	-	-	-	-	-	0.49 ⁺	0.96 ⁺	0.14	1.00
pH	Control/Low	2.06	0.10	-	-	2.09	0.09	2.56	0.05	2.56	0.05
	Control/Mod.	-1.80	0.17	-	-	3.66	<0.01	1.18	0.63	1.18	0.63
	Control/High	-	-	-	-	-	-	4.85	<0.01	4.85	<0.01
	Low/Mod.	-3.23	0.00	-3.09 ⁺	0.00 ⁺	1.89	0.14	-0.80	0.85	-0.80	0.85
	Low/High	-	-	-	-	-	-	2.66	0.04	2.66	0.04
	Mod./High	-	-	-	-	-	-	2.99	0.01	2.99	0.01
Microbial	Control/Low	0.25	0.97	-	-	-0.62	0.81	-2.61	0.04	-1.73	0.30
Biomass	Control/Mod.	-1.48	0.30	-	-	3.44	0.00	-1.73	0.30	-1.58	0.39
Estimates	Control/High	-	-	-	-	-	-	4.43	<0.01	2.86	0.02
	Low/Mod.	-1.58	0.25	3.12	0.00	3.70	0.00	0.32	0.99	-0.19	1.00
	Low/High	-	-	-	-	-	-	6.13	<0.01	3.99	<0.01

	Mod./High	-	-	-	-	-	-	5.03	<0.01	3.63	0.00
C:N ratio	Control/Low	2.95	0.01	-	-	-	-	-	-	-	-
	Control/Mod.	1.66	0.22	-	-	-	-	-	-	-	-
	Control/High	-	-	-	-	-	-	-	-	-	-
	Low/Mod.	-0.64	0.80	2.67 ⁺	0.01 ⁺	-1.17 ⁺	0.24 ⁺	-	-	-	-
	Low/High	-	-	-	-	-	-	-	-	-	-
	Mod./High	-	-	-	-	-	-	-	-	-	-
Available	Control/Low	-0.81 ⁺	0.70 ⁺	-	-	1.31	0.39	-0.10	1.00	0.43	0.97
NH ₄ ⁺	Control/Mod.	-0.72 ⁺	0.75 ⁺	-	-	13.08	<0.01	2.04	0.17	2.37	0.08
	Control/High	-	-	-	-	-	-	8.71	<0.01	7.93	<0.01
	Low/Mod.	-0.08 ⁺	1.00 ⁺	11.61	<0.01	11.35	<0.01	2.00	0.19	1.92	0.21
	Low/High	-	-	-	-	-	-	8.29	<0.01	7.16	<0.01
	Mod./High	-	-	-	-	-	-	5.45	<0.01	4.54	<0.01
Available	Control/Low	-0.78 ⁺	0.72 ⁺	-	-	2.53	0.03	1.26 ⁺	0.58 ⁺	1.34 ⁺	0.53 ⁺
NO ₃ ⁻	Control/Mod.	-0.61 ⁺	0.81 ⁺	-	-	-0.10	0.99	0.45 ⁺	0.97 ⁺	0.01 ⁺	1.00 ⁺
	Control/High	-	-	-	-	-	-	0.52 ⁺	0.95 ⁺	52.63 ⁺	<0.01 ⁺

	Low/Mod.	0.00 ⁺	1.00 ⁺	-0.58 ⁺	0.56 ⁺	-1.98	0.11	-0.52 ⁺	0.96 ⁺	-0.99 ⁺	0.75 ⁺
	Low/High	-	-	-	-	-	-	-0.46 ⁺	0.97 ⁺	48.62 ⁺	<0.01 ⁺
	Mod./High	-	-	-	-	-	-	0.05 ⁺	1.00 ⁺	42.96 ⁺	<0.01 ⁺
Mineralization	Control/Low	-	-	-	-	-0.44	0.90	0.49	0.96	0.13 ⁺	1.00 ⁺
Field-moist	Control/Mod.	-	-	-	-	-5.42	<0.01	-1.36	0.52	-0.43 ⁺	0.97 ⁺
	Control/High	-	-	-	-	-	-	4.98	<0.01	3.82 ⁺	<0.01 ⁺
	Low/Mod.	-	-	-	-	-4.79	<0.01	-1.65	0.35	-0.50 ⁺	0.96 ⁺
	Low/High	-	-	-	-	-	-	4.33	<0.01	3.50 ⁺	0.00 ⁺
	Mod./High	-	-	-	-	-	-	5.18	<0.01	3.47 ⁺	0.00 ⁺
Mineralization	Control/Low	-	-	-	-	1.94	0.13	1.64	0.35	0.07	1.00
1-week wetted	Control/Mod.	-	-	-	-	-5.35	<0.01	-0.28	0.99	0.45	0.97
	Control/High	-	-	-	-	-	-	6.68	<0.01	-0.53	0.95
	Low/Mod.	-	-	-	-	-6.48	<0.01	-1.48	0.44	0.37	0.98
	Low/High	-	-	-	-	-	-	5.07	<0.01	-0.55	0.95
	Mod./High	-	-	-	-	-	-	5.68	<0.01	-0.80	0.85
Mineralization	Control/Low	-	-	-	-	1.72 ⁺	0.20 ⁺	0.75	0.87	0.54	0.95

3-week wetted	Control/Mod.	-	-	-	-	-4.71 ⁺	<0.01 ⁺	-1.18	0.64	-2.92	0.02
	Control/High	-	-	-	-	-	-	-2.46	0.06	1.79	0.27
	Low/Mod.	-	-	-	-	-5.72 ⁺	<0.01 ⁺	-1.67	0.34	-3.15	0.01
	Low/High	-	-	-	-	-	-	-2.88	0.02	1.29	0.56
	Mod./High	-	-	-	-	-	-	-1.05	0.72	3.85	<0.01
Nitrification	Control/Low	-	-	-	-	1.04	0.55	0.51	0.96	-0.52	0.95
Field-moist	Control/Mod.	-	-	-	-	0.08	1.00	-0.03	1.00	1.01	0.74
	Control/High	-	-	-	-	-	-	3.07	0.01	-10.76	<0.01
	Low/Mod.	-	-	-	-	-0.69	0.77	-0.40	0.98	1.34	0.54
	Low/High	-	-	-	-	-	-	2.52	0.06	-9.76	<0.01
	Mod./High	-	-	-	-	-	-	2.53	0.05	-9.61	<0.01
Nitrification	Control/Low	-	-	-	-	1.59	0.25	0.86	0.82	1.60 ⁺	0.37 ⁺
1-week wetted	Control/Mod.	-	-	-	-	-0.17	0.98	-0.09	1.00	0.01 ⁺	1.00 ⁺
	Control/High	-	-	-	-	-	-	4.08	<0.01	6.59 ⁺	<0.01 ⁺
	Low/Mod.	-	-	-	-	-1.35	0.37	-0.72	0.89	-1.18 ⁺	0.63 ⁺
	Low/High	-	-	-	-	-	-	3.20	0.01	5.02 ⁺	<0.01 ⁺

	Mod./High	-	-	-	-	-	-	3.40	0.00	5.37 ⁺	<0.01 ⁺
Nitrification	Control/Low	-	-	-	-	2.37	0.05	1.39 ⁺	0.50 ⁺	0.61	0.93
3-week wetted	Control/Mod.	-	-	-	-	-0.54	0.85	-0.25 ⁺	0.99 ⁺	-1.33	0.54
	Control/High	-	-	-	-	-	-	-0.02 ⁺	1.00 ⁺	-2.42	0.07
	Low/Mod.	-	-	-	-	-2.27	0.06	-1.27 ⁺	0.58 ⁺	-1.71	0.31
	Low/High	-	-	-	-	-	-	-1.05 ⁺	0.72 ⁺	-2.74	0.03
	Mod./High	-	-	-	-	-	-	0.19 ⁺	1.00 ⁺	-0.89	0.81

Table S8. Multiple comparison of the means for each soil characteristic across sampling events

Statistical results from multiple comparisons of the mean values within a burn severity category in the linear mixed effects models for each soil characteristic across sampling events. ⁺ indicates the results from linear mixed effects models that had non-normal residuals.

Characteristic	Comparison	Control		Low Severity		Mod. Severity		High Severity	
		z score	p value	z score	p value	z score	p value	z score	p value
pH	Pre-fire/imm. Post-fire	-	-	3.288 ⁺	0.01 ⁺	3.277 ⁺	0.01 ⁺	-	-
	Pre-fire/1.5 mo.	1.666	0.34	3.023 ⁺	0.02 ⁺	10.649 ⁺	<0.01 ⁺	-	-
	Pre-fire/6 mo.	1.826	0.26	3.751 ⁺	<0.01 ⁺	3.514 ⁺	<0.01 ⁺	-	-
	Pre-fire/9 mo.	1.108	0.68	2.03 ⁺	0.25 ⁺	4.915 ⁺	<0.01 ⁺	-	-
	imm. Post-fire/1.5 mo.	-	-	-0.265 ⁺	1.00 ⁺	7.372 ⁺	<0.01 ⁺	-	-
	imm. Post-fire/6 mo.	-	-	0.463 ⁺	0.99 ⁺	0.237 ⁺	1.00 ⁺	-	-
	imm. Post-fire/9 mo.	-	-	-1.258 ⁺	0.72 ⁺	1.638 ⁺	0.47 ⁺	-	-
	1.5 mo./6 mo.	0.16	1.00	0.728 ⁺	0.95 ⁺	-7.135 ⁺	<0.01 ⁺	-	-
	1.5 mo./9 mo.	-0.557	0.95	-0.993 ⁺	0.86 ⁺	-5.734 ⁺	<0.01 ⁺	-	-
	6 mo./9 mo.	-0.718	0.89	-1.721 ⁺	0.42 ⁺	1.401 ⁺	0.63 ⁺	-3.596	<0.01
Microbial	Pre-fire/imm. Post-fire	-	-	-3.17 ⁺	0.01 ⁺	1.736 ⁺	0.41 ⁺	-	-

Biomass	Pre-fire/1.5 mo.	-3.88	< 0.01	-2.681 ⁺	0.06 ⁺	5.828 ⁺	<0.01 ⁺	-	-
Estimates	Pre-fire/6 mo.	-2.67	0.04	-3.026 ⁺	0.02 ⁺	0.656 ⁺	0.97 ⁺	-	-
	Pre-fire/9 mo.	-3.722	0.01	-3.46 ⁺	<0.01 ⁺	-1.109 ⁺	0.80 ⁺	-	-
	imm. Post-fire/1.5 mo.	-	-	0.489 ⁺	0.99 ⁺	4.092 ⁺	<0.01 ⁺	-	-
	imm. Post-fire/6 mo.	-	-	0.144 ⁺	1.00 ⁺	-1.08 ⁺	0.82 ⁺	-	-
	imm. Post-fire/9 mo.	-	-	-0.346 ⁺	1.00 ⁺	-2.845 ⁺	0.04 ⁺	-	-
	1.5 mo./6 mo.	1.21	0.62	-0.346 ⁺	1.00 ⁺	-5.172 ⁺	<0.01 ⁺	-	-
	1.5 mo./9 mo.	0.159	1.00	-0.779 ⁺	0.94 ⁺	-6.937 ⁺	<0.01 ⁺	-	-
	6 mo./9 mo.	-1.052	0.72	-0.434 ⁺	0.99 ⁺	-1.764 ⁺	0.39 ⁺	-0.912	0.36
C:N ratio	Pre-fire/imm. Post-fire	-	-	-0.618 ⁺	0.81 ⁺	0.038 ⁺	1.00 ⁺	-	-
	Pre-fire/1.5 mo.	-	-	1.877 ⁺	0.15 ⁺	-0.34 ⁺	0.94 ⁺	-	-
	Pre-fire/6 mo.	-	-	2.495 ⁺	0.03 ⁺	-0.377 ⁺	0.92 ⁺	-	-
	6 mo./9 mo.	-	-	-	-	-	-	-1.452	0.15
Available NH ₄ ⁺	Pre-fire/imm. Post-fire	-	-	4.007 ⁺	<0.01 ⁺	8.099 ⁺	<0.01 ⁺	-	-
	Pre-fire/1.5 mo.	-1.352	0.53	1.573 ⁺	0.52 ⁺	5.065 ⁺	<0.01 ⁺	-	-
	Pre-fire/6 mo.	0.556	0.95	0.515 ⁺	0.99 ⁺	3.698 ⁺	<0.01 ⁺	-	-

	Pre-fire/9 mo.	-0.967	0.77	2.288 ⁺	0.15 ⁺	3.634 ⁺	<0.01 ⁺	-	-
	imm. Post-fire/1.5 mo.	-	-	-2.434 ⁺	0.11 ⁺	-3.034 ⁺	0.02 ⁺	-	-
	imm. Post-fire/6 mo.	-	-	-3.492 ⁺	<0.01 ⁺	-4.401 ⁺	<0.01 ⁺	-	-
	imm. Post-fire/9 mo.	-	-	-1.719 ⁺	0.42 ⁺	-4.465 ⁺	<0.01 ⁺	-	-
	1.5 mo./6 mo.	1.907	0.23	-1.057 ⁺	0.83 ⁺	-1.367 ⁺	0.65 ⁺	-	-
	1.5 mo./9 mo.	0.385	0.98	0.715 ⁺	0.95 ⁺	-1.431 ⁺	0.61 ⁺	-	-
	6 mo./9 mo.	-1.523	0.42	1.772 ⁺	0.39 ⁺	-0.064 ⁺	1.00 ⁺	-0.517	0.61
Available NO ₃ ⁻	Pre-fire/imm. Post-fire	-	-	0.461 ⁺	0.99 ⁺	0.000 ⁺	1.00 ⁺	-	-
	Pre-fire/1.5 mo.	-0.226 ⁺	1.00 ⁺	0.992 ⁺	0.86 ⁺	0.090 ⁺	1.00 ⁺	-	-
	Pre-fire/6 mo.	1.055 ⁺	0.72 ⁺	0.784 ⁺	0.94 ⁺	1.578 ⁺	0.51 ⁺	-	-
	Pre-fire/9 mo.	-0.821 ⁺	0.85 ⁺	1.844 ⁺	0.35 ⁺	0.053 ⁺	1.00 ⁺	-	-
	imm. Post-fire/1.5 mo.	-	-	0.532 ⁺	0.98 ⁺	0.090 ⁺	1.00 ⁺	-	-
	imm. Post-fire/6 mo.	-	-	0.323 ⁺	1.00 ⁺	1.578 ⁺	0.51	-	-
	imm. Post-fire/9 mo.	-	-	1.383 ⁺	0.64 ⁺	0.053 ⁺	1.00 ⁺	-	-
	1.5 mo./6 mo.	1.281 ⁺	0.58 ⁺	-0.209 ⁺	1.00 ⁺	1.488 ⁺	0.57 ⁺	-	-
	1.5 mo./9 mo.	-0.594 ⁺	0.93 ⁺	0.852 ⁺	0.91 ⁺	-0.037 ⁺	1.00 ⁺	-	-

	6 mo./9 mo.	-1.875 ⁺	0.24 ⁺	1.061 ⁺	0.83 ⁺	-1.525 ⁺	0.55 ⁺	59.03	<0.01
Mineralization	1.5 mo./6 mo.	0.128	0.99	1.369 ⁺	0.36 ⁺	1.317	0.39	-	-
Field-moist	1.5 mo./9 mo.	0.922	0.63	1.297 ⁺	0.40 ⁺	1.919	0.13	-	-
incubation	6 mo./9 mo.	0.795	0.71	-0.072 ⁺	1.00 ⁺	0.602	0.82	-0.057 ⁺	0.96 ⁺
Mineralization	1.5 mo./6 mo.	-0.054 ⁺	1.00 ⁺	1.387 ⁺	0.35 ⁺	2.959 ⁺	0.01 ⁺	-	-
1-week wetted	1.5 mo./9 mo.	0.656 ⁺	0.79 ⁺	-0.835 ⁺	0.68 ⁺	5.342 ⁺	<0.01 ⁺	-	-
incubation	6 mo./9 mo.	0.71 ⁺	0.76 ⁺	-2.222 ⁺	0.07 ⁺	2.383 ⁺	0.05 ⁺	-1.168 ⁺	0.24 ⁺
Mineralization	1.5 mo./6 mo.	-0.292	0.95	1.598	0.25	-0.39 ⁺	0.92 ⁺	-	-
3-week wetted	1.5 mo./9 mo.	1.101	0.51	0.113	0.99	-0.657 ⁺	0.79 ⁺	-	-
incubation	6 mo./9 mo.	1.393	0.35	-1.486	0.30	-0.267 ⁺	0.96 ⁺	1.292 ⁺	0.20 ⁺
Nitrification	1.5 mo./6 mo.	-1.489	0.30	2.56 ⁺	0.03 ⁺	-0.578	0.83	-	-
Field-moist	1.5 mo./9 mo.	0.044	1.00	-1.016 ⁺	0.57 ⁺	1.011	0.57	-	-
incubation	6 mo./9 mo.	1.534	0.28	-3.576 ⁺	<0.01 ⁺	1.589	0.25	-1.672 ⁺	0.09 ⁺
Nitrification	1.5 mo./6 mo.	-0.29 ⁺	0.96 ⁺	0.912	0.63	-1.912 ⁺	0.14 ⁺	-	-
1-week wetted	1.5 mo./9 mo.	-1.546 ⁺	0.27 ⁺	0.332	0.94	-0.482 ⁺	0.88 ⁺	-	-
incubation	6 mo./9 mo.	-1.256 ⁺	0.42 ⁺	-0.58	0.83	1.431 ⁺	0.33 ⁺	-0.552	0.58

Nitrification	1.5 mo./6 mo.	0.773	0.72	2.647	0.02	-0.827 ⁺	0.69 ⁺	-	-
3-week wetted	1.5 mo./9 mo.	2.054	0.10	0.392	0.92	-0.187 ⁺	0.98 ⁺	-	-
incubation	6 mo./9 mo.	1.282	0.41	-2.255	0.06	0.639 ⁺	0.80 ⁺	-0.693 ⁺	0.49 ⁺

S3.2 Additional data

Before fire, the control, low severity, and moderate severity sampling locations all had similar C:N ratios (Table S9). The moderate severity sampling locations had negligible change after the fire. The low severity sampling locations, on the other hand, decreased immediately after and then increased substantially at one and a half months post-fire to more than double the pre-fire value; however, the variability was high (Table S9).

Table S9. Mean total C:N ratios and standard error for the burn severity categories over time

Severity	Immediately		Immediately		1.5 mo. Post-		6 mo. Post-		9 mo. Post-	
	Pre-fire		Post-fire		fire		fire		fire	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Control	31.36	0.62	-	-	-	-	-	-	-	-
Low Sev.	40.79	1.03	26.93	0.88	82.89	11.13	-	-	-	-
Mod. Sev.	38.06	2.51	38.29	2.53	35.92	2.66	-	-	-	-
High Sev.	-	-	-	-	-	-	23.91	0.52	22.53	0.18

The sampling event-severity interaction was significant for available NH_4^+ ($p < 0.01$; Table S6). The available NH_4^+ concentrations were nearly identical among sampling locations before the fire (Fig. 6; Table S5). Immediately after fire, moderate severity sampling locations had a greater than 40-fold increase, but they dropped by more than 15 μg per g of dry soil from that peak by one and half months after fire and declined only slightly after that. The control and low severity sampling locations had lower values than moderate severity at all sampling events after the fire. Although the low severity locations had an increase immediately after fire,

available NH_4^+ concentrations differed only slightly from the control locations at all subsequent sampling events. High severity had the highest values by a large margin at both six and nine months after fire, although it decreased from six to nine months after fire (Fig. 6; Table S5).

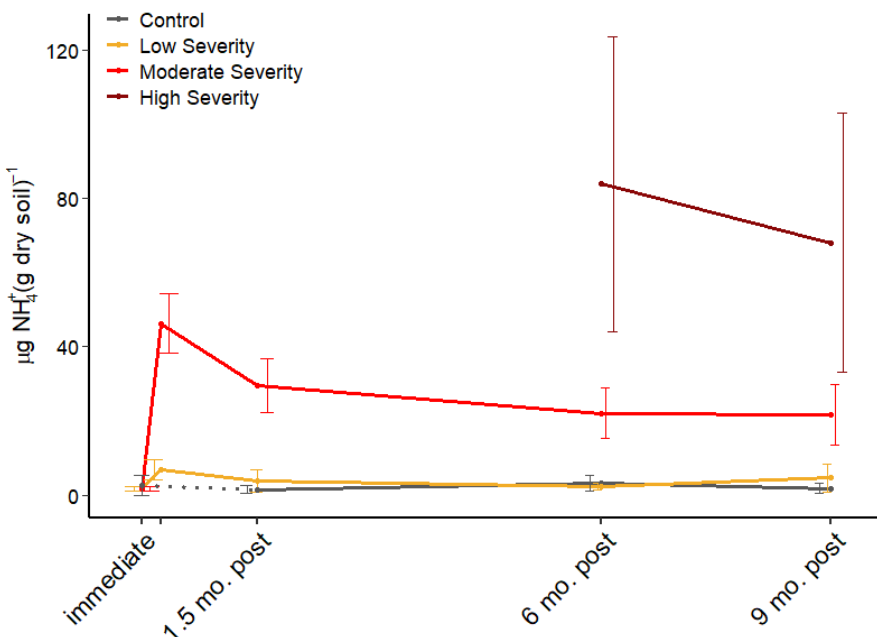


Figure S3. Amount of NH_4^+ per gram of dry soil for the four burn severity categories measured immediately after sample collection. The x-axis is scaled with time. The two tick marks labeled “immediate” are immediately pre- and post-fire samples. Control (unburned) sites were not sampled immediately post-fire. Error bars show standard deviation within severity categories.

Sampling event, severity, and the sampling event-severity interaction did not significantly affect available NO_3^- ($p = 0.97, 0.99, 0.31$ respectively; Table S6). Before the fire, only the control locations had measurable NO_3^- , and even those concentrations were low (Fig. 7; Table S5). The control locations were only marginally above 0 at any sampling event. After the fire, low severity locations maintained the highest available NO_3^- concentrations except for high

severity locations at nine months post-fire, which had a concentration approximately 30 times higher than any other value. Moderate severity sampling locations were nearly identical to the control locations except at six months after the fire when they had slightly higher available NO_3^- concentrations (Fig. 7; Table S5).

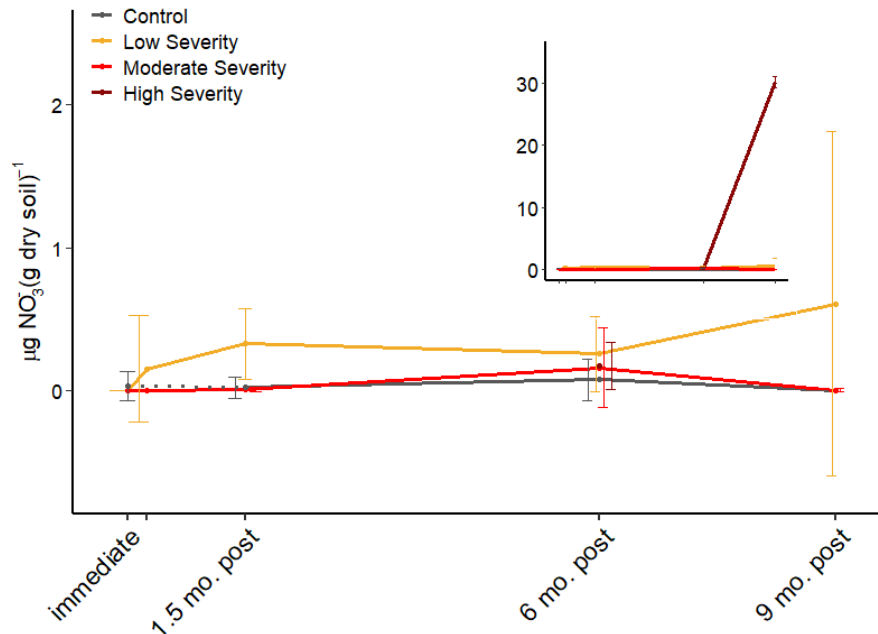


Figure S4. Amount of NO_3^- per g dry soil for the four burn severity categories measured immediately after sample collection. The inset plot shows the data with high severity at nine months post-fire, the larger plot shows closer view of the data without that point. The x-axis is scaled with time. The two tick marks labeled “immediate” are immediately pre- and post-fire samples. Control (unburned) sites were not sampled immediately post-fire. Error bars show standard deviation within severity categories.

Supplementary Works Cited

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