Biogeosciences

Supplement of

Divergent biophysical responses of western United States forests to wildfire driven by eco-climatic gradients

Surendra Shrestha et al.

Correspondence to: Surendra Shrestha (surshrestha@clarku.edu, sbs.stha111@gmail.com)

Table S1: Study area characteristics

Ecoregions	Total Area (km2)	Forest Area (km2)	Total Burned Area (km2)	Mean Annual Precipitation (mm)	Mean Monthly Temperature (°C)
Eastern Cascades	56187.34	27846.81	1703.32	575	7.6
Coastal Sage	101081.91	5411.55	5891.52	507	16
Baja CA	17919.06	3006.51	3084.86	454	14.2
Klamath Mountians	48541.20	29947.89	3736.13	1397	11.6
Sierra Nevada	52706.85	29632.99	3033.34	1016	8.6
Canadian Rockies	18880.52	8788.56	1455.60	1125	3.1
Middle Rockies	156471.79	48140.21	4977.51	609	3.3
Southern Rockies	145700.65	57834.20	1698.16	575	4.6
North Cascades	30391.80	15061.96	1252.96	1817	5.7
Idaho-Batholith	60280.66	29981.59	5883.15	828	4.3
Columbia Mountains	81957.75	41911.46	1580.32	798	6.4
Blue Mountains	70906.05	24066.24	3917.74	520	7.5
Great Plains	201807.49	3092.37	3126.93	391	7.3
Temperate Sierras	108628.45	56339.32	7753.26	431	11.7
AZ-NM Plateau	150081.62	18455.92	914.66	245	11.3
Central Basin	309971.20	33496.20	13084.30	258	9.6
Colorado Plateau	134929.93	25656.65	933.34	291	10.2
Mojave Basin	129602.96	2505.71	2444.75	148	17.8
NA highland	42926.15	4686.64	2147.02	345	16.6
Wasatch Mountains	45686.02	15710.65	680.04	585	5.4
Cascades	46429.60	35354.93	806.69	1803	7.9

Table S2: Pre-fire and post-fire summer LAI (post-fire/pre-fire) across ecoregions of each forest type.

Forest Types/Ecoregions	Pre-fire	1-Yr Post-fire	10-Yr Post-fire	20-Yr Post-fire	25-Yr Post-fire
Douglas-fir					
Cascades	3.61	1.10(30)	2.35(65)	3.23(89)	3.55(98)
Columbia Mountains	2.72	0.85(31)	1.84(68)	2.70(99)	3.37(124)
Idaho Batholith	1.70	0.66(39)	1.08(63)	1.11(65)	1.22(72)
Klamath Mountains	2.84	0.94(33)	2.02(71)	3.11(110)	3.08(108)
Middle Rockies	1.84	0.72(39)	1.21(66)	1.48(81)	1.63(89)
North Cascades	2.20	0.59(27)	1.31(59)	1.84(84)	1.93(88)
Southern Rockies	1.69	0.47(28)	0.69(41)	1.71(101)	
Temperate Sierra	1.73	0.61(35)	1.13(65)	1.43(82)	1.31(76)
Lodgepole Pine					
Canadian Rockies	1.94	0.66(34)	1.64(85)	1.34(69)	1.52(78)
Columbia Mountains	2.39	0.62(26)	1.58(66)	2.22(93)	2.84(119)
Idaho Batholith	1.66	0.66(40)	1.03(62)	1.19(72)	1.31(79)
Middle Rockies	1.68	0.59(35)	1.05(62)	1.08(64)	1.22(73)
Northern Cascades	1.69	0.54(32)	1.14(67)	1.14(67)	1.27(75)
Southern Rockies	1.54	0.80(52)	1.10(72)	1.38(89)	1.35(87)
Mixed Conifer					
Baja California	1.53	0.59(38)	1.16(76)	1.58(103)	1.24(81)
Coastal Sage	2.88	0.84(29)	2.15(75)	2.72(94)	
Eastern Cascades	2.13	0.789(37)	1.51(71)	3.06(144)	3.31(155)
Klamath Mountains	3.05	1.02(33)	2.27(74)	2.63(86)	2.72(89)
Sierra Nevada	2.68	0.78(29)	1.76(66)	2.47(92)	2.61(97)
Pinyon-Juniper					
AZ-NM Plateau	0.75	0.48(65)	0.84(113)	0.86(115)	0.79(105)
Central Basin	0.72	0.40(56)	0.54(75)	0.47(66)	0.47(65)
Colorado Plateau	0.90	0.52(58)	0.80(89)	0.70(78)	0.71(78)
Mojave Basin	0.63	0.34(53)	0.48(76)	0.75(120)	0.43(68)
Temperate Sierras	0.92	0.48(52)	0.82(90)	0.85(93)	0.89(97)
Ponderosa Pine					
Blue Mountains	1.41	0.64(45)	1.04(74)	0.99(70)	0.83(59)
Eastern Cascades	1.61	0.66(41)	1.45(91)	1.28(80)	1.51(94)
Great Plains	1.37	0.83(60)	0.71(51)	1.42(104)	1.46(106)
Sierra Nevada	1.94	0.46(24)	1.03(53)	1.18(61)	1.28(66)
Temperate Sierras	1.48	0.54(37)	0.90(60)	1.30(87)	1.23(83)
Southern Rockies	1.45	0.58(40)	0.84(58)	1.37(95)	
Oak					
Baja CA	1.88	0.72(38)	1.51(80)	1.44(77)	1.34(71)
Coastal Sage	2.40	0.69(29)	1.55(64)	2.20(92)	1.89(79)
North America Highland	1.31	0.68(52)	0.86(66)	0.88(67)	0.85(65)
Temperate Sierras	1.22	0.66(54)	1.09(90)	1.42(117)	1.07(88)

Spruce/Fir/Hemlock

Blue Mountains	1.98	0.71(36)	1.35(68)	1.47(75)	1.61(81)
Columbia Mountains	2.20	0.68(31)	1.40(64)	2.23(101)	2.62(119)
Idaho Batholith	1.59	0.58(36)	0.89(56)	1.01(64)	1.15(72)
Canadian Rockies	1.96	0.66(34)	1.38(70)	1.01(52)	1.20(61)
Middle Rockies	1.44	0.49(34)	0.91(63)	0.78(54)	0.91(63)
Northern Cascades	1.80	0.49(27)	1.12(62)	1.17(65)	1.13(63)
Southern Rockies	1.52	0.77(51)	1.12(74)	1.36(90)	
Wasatch/Unita Mountains	1.57	0.69(44)	1.05(67)	2.44(156)	

Table S3: Pre-fire and post-fire summer albedo (post-fire/pre-fire) across ecoregions of each forest type.

Forest Types/Ecoregions	Pre-fire	1-Yr Post-fire	10-Yr Post-fire	20-Yr Post-fire	25-Yr Post-fire
Douglas-fir					
Cascades	0.10	0.08(84)	0.11(115)	0.11(118)	0.11(117)
Columbia Mountains	0.10	0.09(90)	0.12(126)	0.12(129)	0.12(124)
Idaho Batholith	0.09	0.09(95)	0.12(126)	0.13(137)	0.13(140)
Klamath Mountains	0.11	0.09(80)	0.11(104)	0.12(115)	0.12(110)
Middle Rockies	0.10	0.09(98)	0.12(128)	0.12(126)	0.12(124)
North Cascades	0.09	0.08(95)	0.11(131)	0.13(154)	0.13(149)
Southern Rockies	0.10	0.10(99)	0.13(139)	0.14(143)	
Temperate Sierra	0.10	0.09(91)	0.12(123)	0.13(130)	0.13(130)
Lodgepole Pine					
Canadian Rockies	0.09	0.09(95)	0.12(129)	0.11(127)	0.12(129)
Columbia Mountains	0.08	0.08(89)	0.11(131)	0.12(137)	0.11(134)
Idaho Batholith	0.08	0.08(95)	0.11(130)	0.11(138)	0.11(140)
Middle Rockies	0.08	0.08(93)	0.11(130)	0.11(141)	0.11(139)
Northern Cascades	0.08	0.07(98)	0.10(134)	0.11(140)	0.11(143)
Southern Rockies	0.10	0.10(100)	0.13(132)	0.11(113)	0.10(108)
Mixed Conifer					
Baja California	0.11	0.11(101)	0.15(133)	0.13(122)	0.13(115)
Coastal Sage	0.11	0.09(87)	0.13(119)	0.12(112)	
Eastern Cascades	0.10	0.10(99)	0.14(137)	0.13(128)	0.13(123)
Klamath Mountains	0.10	0.09(85)	0.11(109)	0.12(117)	0.12(118)
Sierra Nevada	0.10	0.09(89)	0.14(133)	0.13(123)	0.12(118)
Pinyon-Juniper					
AZ-NM Plateau	0.12	0.14(117)	0.14(121)	0.13(114)	0.12(106)
Central Basin	0.12	0.13(112)	0.15(127)	0.15(125)	0.14(120)
Colorado Plateau	0.11	0.13(111)	0.15(130)	0.15(128)	0.14(125)
Mojave Basin	0.14	0.16(117)	0.16(117)	0.14(105)	0.15(109)
Temperate Sierras	0.12	0.13(103)	0.14(112)	0.13(106)	0.13(107)
Ponderosa Pine					
Blue Mountains	0.11	0.11(92)	0.14(123)	0.14(122)	0.13(114)
Eastern Cascades	0.11	0.10(93)	0.13(124)	0.12(114)	0.12(112)
Great Plains	0.13	0.13(104)	0.17(132)	0.16(123)	0.16(125)
Sierra Nevada	0.12	0.12(99)	0.15(124)	0.14(118)	0.14(116)
Temperate Sierras	0.10	0.10(99)	0.13(138)	0.12(127)	0.12(120)
Southern Rockies	0.11	0.10(95)	0.13(123)	0.13(119)	
Oak					
Baja CA	0.12	0.13(108)	0.13(111)	0.13(108)	0.12(101)
Coastal Sage	0.12	0.12(95)	0.13(108)	0.13(104)	0.11(90)
North America Highland	0.12	0.14(111)	0.14(117)	0.14(112)	0.14(116)
Temperate Sierras	0.12	0.13(105)	0.14(111)	0.13(104)	0.13(105)

Spruce/Fir/Hemlock

Blue Mountains	0.09	0.08(93)	0.12(132)	0.12(132)	0.11(128)
Columbia Mountains	0.08	0.07(91)	0.11(131)	0.12(152)	0.12(146)
Idaho Batholith	0.08	0.08(97)	0.11(133)	0.13(148)	0.13(152)
Canadian Rockies	0.09	0.09(96)	0.12(133)	0.12(140)	0.13(142)
Middle Rockies	0.09	0.08(94)	0.11(129)	0.12(145)	0.12(145)
Northern Cascades	0.07	0.07(95)	0.10(133)	0.11(150)	0.11(150)
Southern Rockies	0.09	0.09(97)	0.12(132)		
Wasatch/Unita Mountains	0.11	0.10(97)	0.13(124)	0.13(123)	

Table S4: Pre-fire and post-fire winter albedo (post-fire/post-fire) across ecoregions of each forest type.

Forest Types/Ecoregions	Pre-fire	1-Yr Post-fire	10-Yr Post-fire	20-Yr Post-fire	25-Yr Post-fire
Regions					
Idaho Batholith	0.39	0.37(95)	0.44(112)	0.51(131)	0.51(130)
Middle Rockies	0.43	0.46(108)	0.49(115)	0.50(117)	
Northern Cascades	0.15	0.37(240)	0.45(292)	0.40(258)	0.36(231)
Lodgepole Pine					
Idaho Batholith	0.39	0.39(100)	0.46(117)	0.53(136)	0.45(115)
Middle Rockies	0.25	0.38(153)	0.50(204)	0.56(227)	0.50(202)
Southern Rockies	0.42	0.47(113)	0.43(104)		
Mixed Conifer					
Eastern Cascades	0.26	0.40(152)	0.55(209)	0.44(167)	0.70(266)
Klamath Mountains	0.16	0.10(65)	0.17(105)	0.24(151)	0.15(97)
Sierra Nevada	0.17	0.25(149)	0.44(264)	0.26(157)	0.25(151)
Pinyon-Juniper					
Central Basin	0.36	0.45(125)	0.52(144)	0.54(150)	0.52(145)
Colorado Plateau	0.36	0.53(146)	0.56(153)	0.58(159)	0.48(131)
Ponderosa Pine					
Eastern Cascades	0.31	0.38(120)	0.50(161)	0.43(138)	0.49(157)
Sierra Nevada	0.24	0.31(130)	0.49(205)	0.33(136)	0.34(143)
Temperate Sierra	0.29	0.38(129)	0.46(157)	0.40(138)	
Southern Rockies	0.45	0.42(94)	0.48(106)	0.37(82)	
Spruce-Fir_Hemlock					
Idaho Batholith	0.37	0.41(111)	0.44(119)	0.48(130)	0.49(132)
Canadian Rockies	0.27	0.33(123)	0.43(163)	0.47(177)	0.44(166)
Middle Rockies	0.51	0.48(95)	0.56(110)	0.60(117)	
Northern Cascades	0.31	0.35(112)	0.38(122)	0.42(136)	0.38(123)

Table S5: Model performance

Forest Types	OOBE (r^2)		OOBE (r^2)	
	10-Yr LAI	20-Yr LAI	10-Yr Albedo	20-Yr Albedo
Mixed Conifer	0.0306 (0.73)	0.0385 (0.66)	0.0044 (0.79)	0.0034 (0.76)
Lodgepole pine	0.0323 (0.65)	0.0258 (0.69)	0.0129 (0.65)	0.0091 (0.52)
Douglas-fir	0.042 (0.78)	0.058 (0.65)	0.0079 (0.68)	0.009 (0.7)
Ponderosa pine	0.039 (0.7)	0.049 (0.72)	0.0054 (0.83)	0.0052 (0.82)
Pinyon-Juniper	0.05 (0.66)	0.052 (0.67)	0.0081 (0.77)	0.0079 (0.77)
Oak	0.079 (0.77)	0.092 (0.78)	0.004 (0.72)	0.0041 (0.72)
Spruce/Fir/Hemlock	0.046 (0.69)	0.035 (0.71)	0.0139 (0.55)	0.016 (0.52)
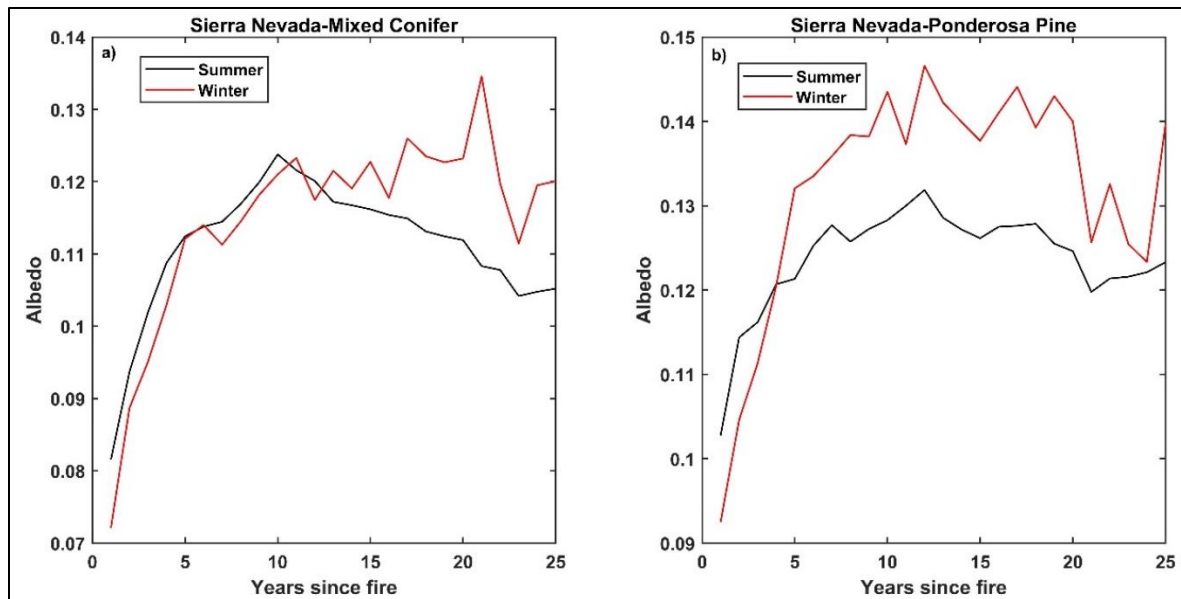
Figure S1: Mean snow-free summer and winter post-fire albedo as a function of time since fire in mixed conifer and ponderosa pine forests of Sierra Nevada.
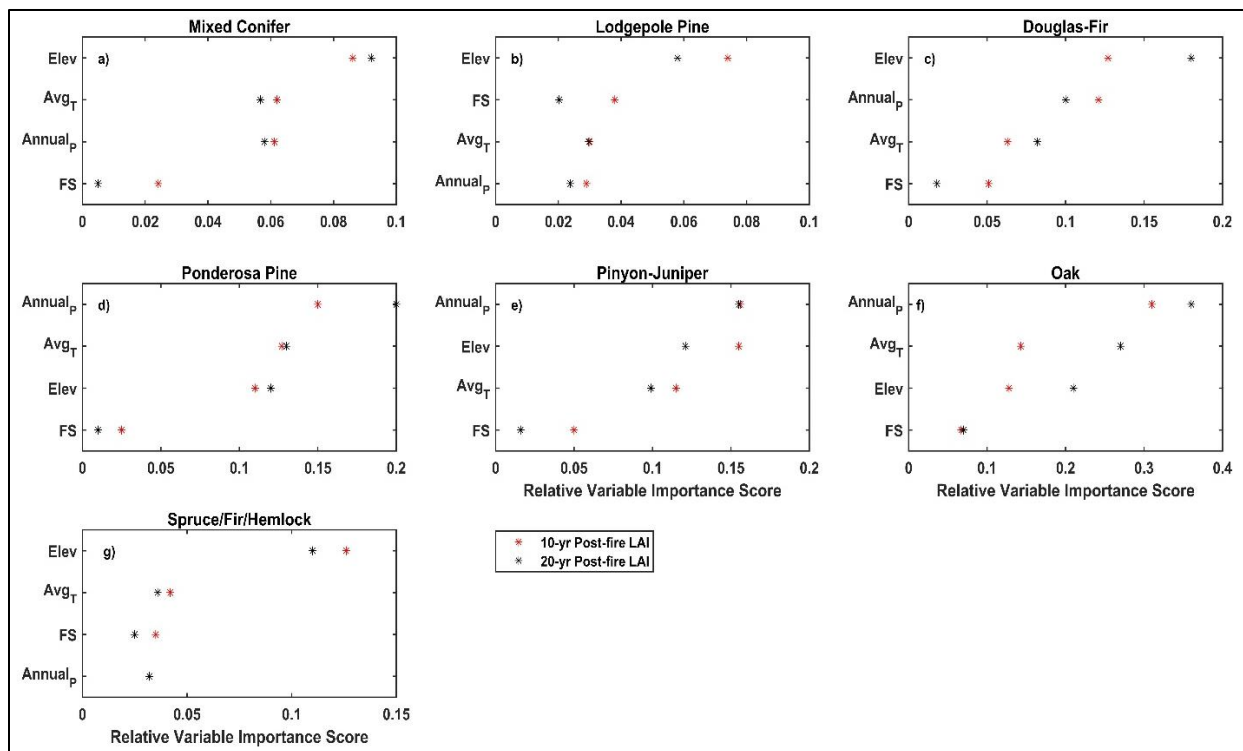
Figure S2: Relative variable importance scores for simulating degree of post-fire summer LAI recovery. (Predictors: Elev = elevation; Avg$_T$ = mean summer temperature; Annual$_P$ = annual total precipitation; FS – fire severity).
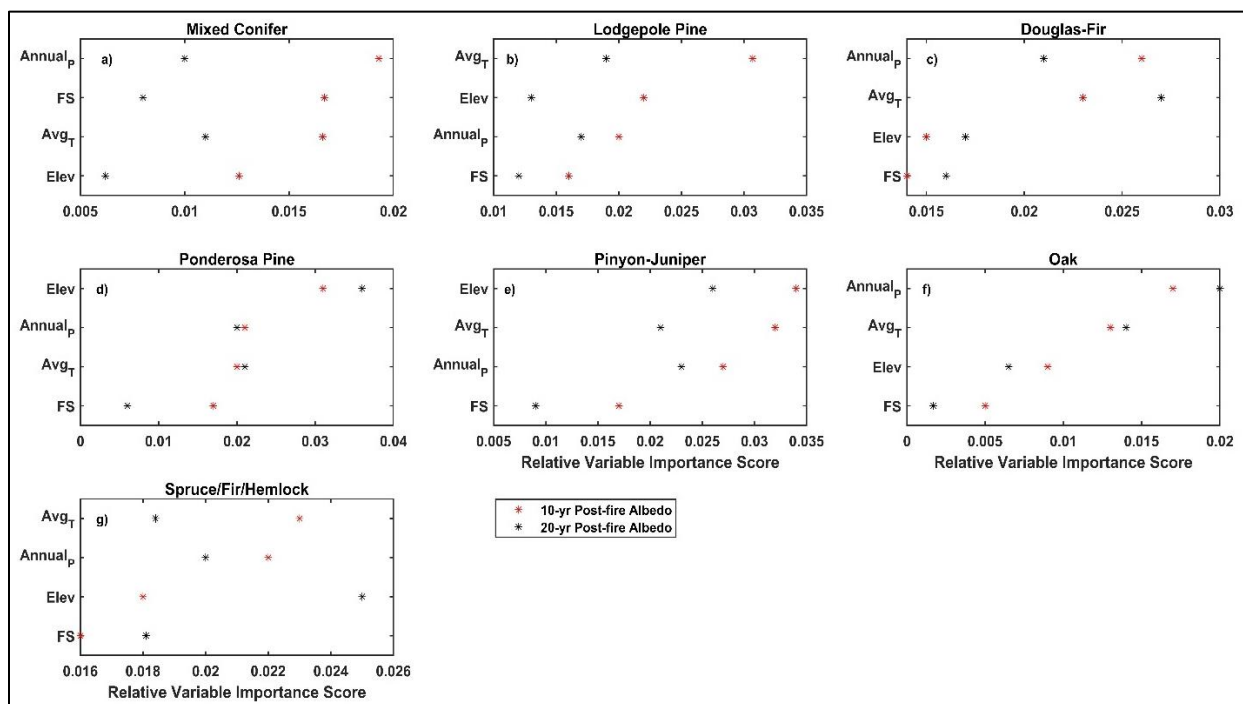

Figure S3: Relative variable importance scores for simulating degree of post-fire summer albedo recovery.
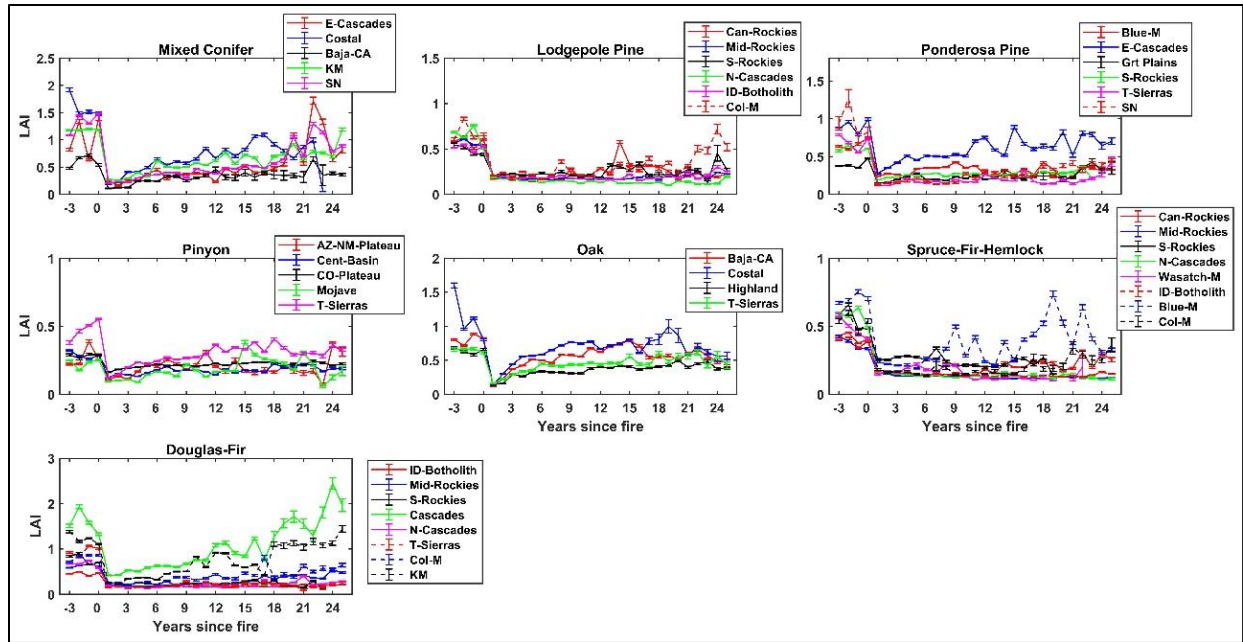
Figure S4: Mean winter post-fire LAI (± SE) as a function of time since fire in seven different forest types of the western US.