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Appendix. Supplementary Material

Figure A1. Standard error as a function of aboveground biomass density, from research that included formal error analysis (Harmon et al. 2007, Battles et al. 2008, Fahey et al. 2010, Gonzalez et al. 2010). The tree measurement plots (n = 302) cover the most abundant forest types in California.

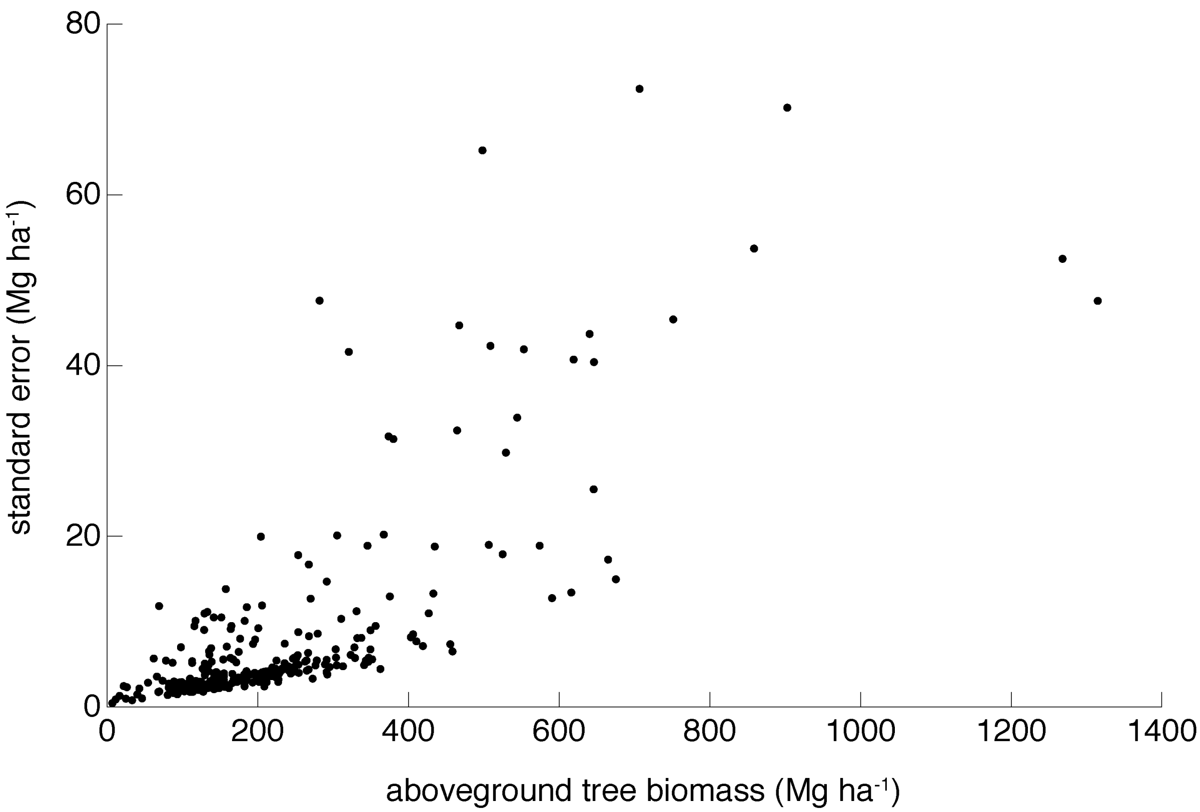

Figure A2. Net primary productivity, annual average, 2000-2010, using data from MODIS (Running et al. 2004, Turner et al. 2006).

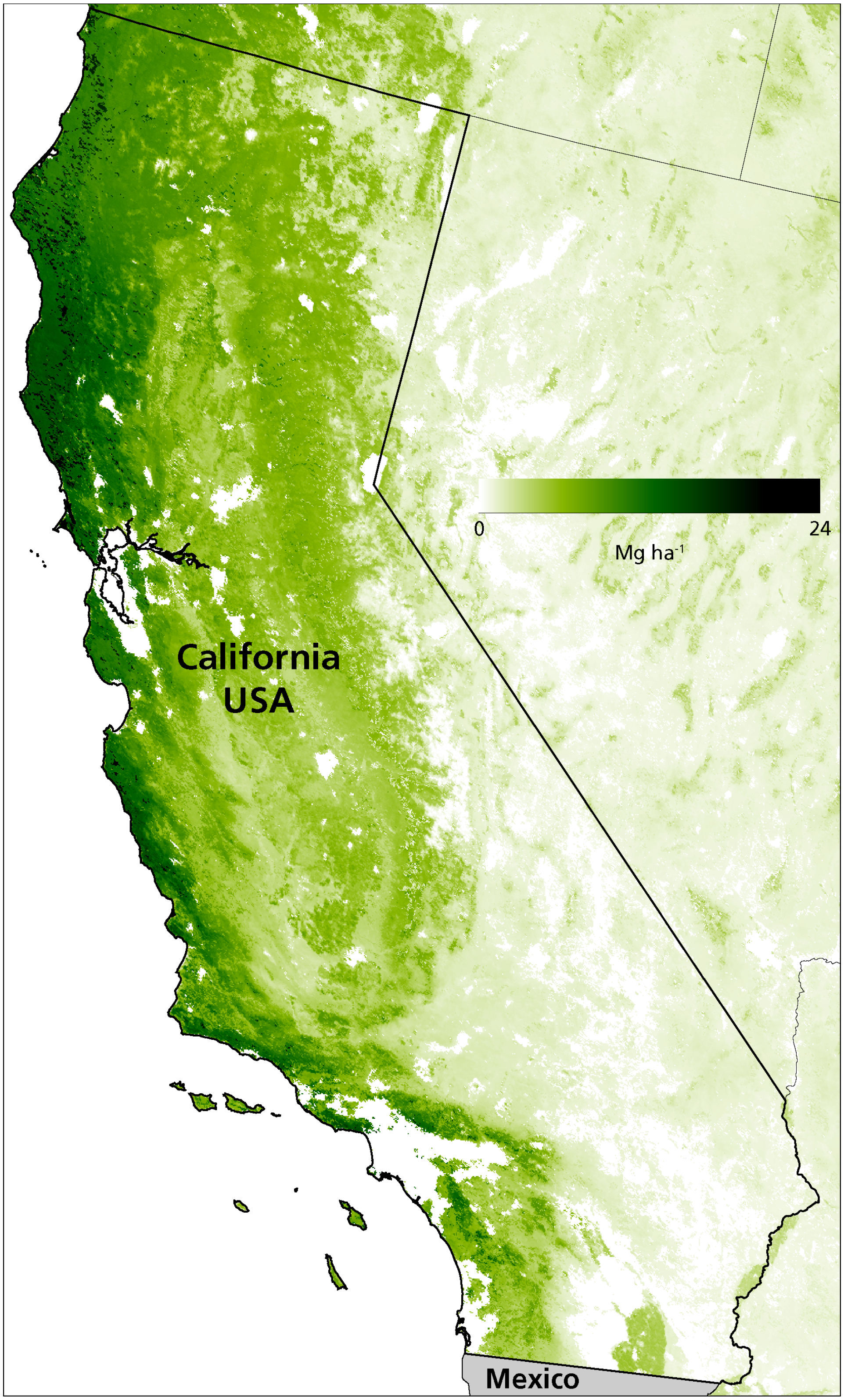

Table A1. IPCC (2006) land categories (text labels) and Landfire vegetation types (numbers).

Forest land

3008, 3011, 3014, 3015, 3016, 3017, 3018, 3019, 3020, 3021, 3022, 3027, 3028, 3029, 3030, 3031, 3032, 3033, 3034, 3035, 3036, 3037, 3039, 3041, 3042, 3043, 3044, 3045, 3051, 3052, 3053, 3054, 3056, 3057, 3058, 3060, 3061, 3062, 3063, 3067, 3068, 3071, 3079, 3080, 3081, 3082, 3083, 3084, 3087, 3088, 3090, 3091, 3092, 3095, 3096, 3097, 3098, 3099, 3103, 3104, 3105, 3106, 3107, 3108, 3109, 3110, 3112, 3113, 3114, 3117, 3118, 3123, 3124, 3125, 3126, 3127, 3128, 3151, 3152, 3153, 3154, 3155, 3156, 3158, 3159, 3160, 3165, 3167, 3170, 3172, 3173, 3174, 3177, 3200, 3201, 3202, 3203, 3206, 3208, 3210, 3211, 3220, 3227, 3229, 3230, 3231, 3251, 3252, 3255, 3257, 3258, 3259, 3260, 3261, 3262, 3263, 3264, 3265, 3266, 3267

Wetland

3145, 3157, 3163, 3164

Grassland

3129, 3130, 3131, 3135, 3136, 3137, 3138, 3139, 3142, 3171, 3181, 3182, 3183, 3184

Other land

3001, 3002, 3003, 3004, 3006, 3293, 3294,

Cropland

3960, 3961, 3962, 3963, 3964, 3965, 3966, 3967, 3968, 3969, 3980, 3981, 3982, 3983, 3984, 3985, 3986, 3987, 3988, 3989

Settlements

3295, 3296, 3297, 3298, 3299, 3900, 3901, 3902, 3903, 3904, 3910, 3911, 3912, 3913, 3914, 3920, 3921, 3922, 3923, 3924, 3925, 3926, 3927, 3928, 3929, 3940, 3941, 3942, 3943, 3944, 3945, 3946, 3947, 3948, 3949

Table A2. Regression equation coefficients (*a, b, c*), sample size (*n*; Forest Inventory and Analysis program plots), and coefficients of determination (R^2) for equations to estimate aboveground tree biomass density for tree-dominated landscapes:

$$\sqrt{B_{\text{vegetation}}} = a + b\ cover + c\ height$$

where $B_{\text{vegetation}}$ is oven-dry plot-level biomass density (Mg ha^{-1}), *cover* is the upper limit of the Landfire fractional cover class (%), and height is the upper limit of the Landfire height class (m). $E_{\text{regression}}$ is the error of the regression, expressed as the standard deviation divided by the mean of plot-level biomass.

	a	*b*	*c*	$E_{\text{regression}}$	*n*	R^2
Landfire vegetation type						
California coastal redwood forest	-8.46	0.19	0.25	0.39	184	0.30
California lower montane blue oak-foothill pine woodland and savanna	0.00	0.13	0.05	0.43	284	0.85
California montane jeffrey and ponderosa pine) woodland	0.00	0.12	0.12	0.39	298	0.87
California montane riparian systems	3.31	0.08	0.17	0.30	88	0.31
Central and southern California mixed evergreen woodland	-2.84	0.14	0.14	0.42	84	0.32
Great Basin pinyon-juniper woodland	1.76	0.05	0.06	0.50	115	0.09
Klamath-Siskiyou upper montane serpentine mixed conifer woodland	0.00	0.00	0.33	0.39	31	0.87
Mediterranean California dry-mesic mixed conifer forest and woodland	-2.25	0.15	0.15	0.27	506	0.48
Mediterranean California lower montane black oak-conifer forest and woodland	0.00	0.09	0.19	0.35	97	0.89
Mediterranean California mesic mixed conifer forest and woodland	-3.28	0.16	0.19	0.31	766	0.38
Mediterranean California mixed evergreen forest	-6.82	0.20	0.18	0.32	222	0.29
Mediterranean California mixed oak woodland	0.00	0.12	0.09	0.40	180	0.87
Mediterranean California red fir forest	-3.62	0.20	0.18	0.31	347	0.41
Mediterranean California subalpine woodland	0.00	0.19	0.00	0.42	40	0.86
Northern Rocky Mountain ponderosa pine woodland and savanna	0.00	0.15	0.05	0.36	114	0.89
Sierra Nevada subalpine lodgepole pine forest and woodland	0.00	0.19	0.12	0.27	44	0.93
Southern California oak woodland and savanna	0.00	0.10	0.10	0.38	35	0.88
California Coastal redwood forest	-8.46	0.19	0.25	0.39	184	0.30
NVCS Subclass						
Deciduous open tree canopy	0.00	0.15	0.01	0.44	33	0.85
Evergreen closed tree canopy	-2.03	0.14	0.18	0.32	1053	0.36
Evergreen open tree canopy	-2.55	0.13	0.21	0.36	2063	0.53
Mixed evergreen-deciduous open tree canopy	0.00	0.14	0.13	0.38	145	0.88
Mixed evergreen-deciduous sparse tree canopy	0.00	0.13	0.05	0.42	321	0.86

Table A3. Scientific literature used for biomass densities of shrub-dominated vegetation types, listed by National Vegetation Classification System (NVCS; Jennings et al. 2009) subclass.

NVCS Shrub Subclass	Reference
California Mesic Chaparral	McGinnis et al. 2010, Sampson 1944
Inter-Mountain Basins Big Sagebrush Shrubland	Martin et al. 1981
Mojave Mid-Elevation Mixed Desert Scrub	Wallace et al. 1972
Northern and Central California Dry-Mesic Chaparral	Hobbs and Mooney 1986, Mooney 1980, Parsons and Stohlgren 1986, Rundel and Parsons 1979, Stohlgren et al. 1984, 1989
Sonora-Mojave Creosote-White Bursage Desert Scrub	Bamberg et al. 1976, Hunter et al. 1981
Sonora-Mojave Semi-Desert Chaparral	Sharifi et al. 1982
Southern California Coastal Scrub	Gray and Schlesinger 1981, Gray 1982
Southern California Dry-Mesic Chaparral	Black 1987, Chandler 1955, Conard and Regelbrugge 1994, DeBano and Conrad 1978, Dodge 1975, Gray 1982, Green 1970, Green 1982, Mooney 1977, Mooney and Rundel 1979, Regelbrugge and Conard 1996, Riggan and Lopez 1982, Riggan et al. 1988, Riggan and Dunn 1982, Schlesinger and Gill 1980, Schlesinger et al. 1982, Specht 1969

Table A4. Changes among Intergovernmental Panel on Climate Change (IPCC 2006) land categories in California, fraction (%) of total category area. The Landfire program re-defined some classes from wetlands in 2001 to forest land in 2010.

		2010 Water	2010 Forest land	2010 Wet-lands	2010 Grass-land	2010 Other land	2010 Crop-land	2010 Settle-ments
2001	Water							
2001	Forest land	0.1	**91**	<0.1	5.3	2.7	0.6	<0.1
2001	Wetlands	11	36	**13**	12	0.6	20	7.2
2001	Grassland	<0.1	1.8	<0.1	**94**	0.9	3.4	0.4
2001	Other land	0.4	15	<0.1	<0.1	**85**	0.2	<0.1
2001	Cropland	0.3	<0.1	<0.1	<0.1	0.2	**76**	24
2001	Settlements	0.3	0	0	0	<0.1	<0.1	**99.7**

Table A5. Stocks and changes of carbon in aboveground biomass for subsets of forests and other terrestrial ecosystems in California, excluding agricultural and urban areas. Fire = areas of wildfire after 2001 and through 2010. No fire = areas with no wildfire after 2001 and through 2010. Public = local, state, and federal government lands. Private = non-government lands.

	2010 Carbon	2010 95% CI	2010 Area	2001-2010 Carbon	2001-2010 95% CI	2001-2010 Uncertainty	2001-2010 Area	2001-2010 Emissions	2001-2010 95% CI	2010 Carbon	2010 95% CI	2010 Area
	Tg	Tg	10^3 km^2	Tg	Tg	%	km^2	Fraction of total analysis area (%)				
Forest land remaining forest land												
Fire	39	11	8	-13	4	29	0	46	14	5	1	3
No fire	804	172	238	-16	4	26	0	54	14	95	2	97
Total	842	208	246	-29	10	35	0	100		100		100
Fire areas												
Public	35	10	15	-35	10	29	-0.1	81	23	86	24	73
Private	6	2	6	-8	3	34	-0.5	19	6	14	5	27
Total	40	11	21	-43	12	28	-0.6	100		100		100
No fire areas												
Public	470	140	190	-13	3	26	-5	49	13	58	18	61
Private	340	80	120	-13	4	28	-27	51	14	42	10	39
Total	810	160	310	-26	7	28	-32	100		100		100
Public lands												
Fire	35	10	15	-35	10	29	-0.1	73	21	7	2	7
No fire	470	140	190	-13	3	26	-5	27	7	93	28	93
Total	500	150	200	-48	12	25	-5	100		100		100
Private lands												
Fire	6	2	6	-8	3	34	-0.5	38	13	2	1	4
No fire	340	79	120	-13	4	28	-27	62	17	98	23	96
Total	350	84	130	-21	5	25	-28	100		100		100

Table A6. Stocks and changes of carbon in aboveground biomass of forests and other terrestrial ecosystems, excluding agricultural and urban areas, in the 26 U.S. national parks in California. One Gigagram (Gg) = 1000 tons. One Megagram (Mg) = 1 ton.

	2010	2010	2010	2010	2001-2010	2001-2010	2001-2010	2001-2010	2001-2010	2001-2010
National park	Area	Carbon	95% CI	Carbon density	Carbon change	95% CI	Carbon change	95% CI	Uncertainty	Area change
	km^2	Gg	Gg	Mg ha^{-1}	Gg	Gg	%	%	%	ha
Channel Islands NP	500	220	160	4	-4	4	-2	2	110	-2
Death Valley NP	13 300	600	710	0.5	-27	14	-4	2	53	~0
Joshua Tree NP	3 200	140	200	0.4	+16	21	+14	18	130	-1
Kings Canyon NP	1 800	4300	1800	24	-610	260	-12	5	43	~0
Lassen Volcanic NP	420	3400	2100	81	-230	120	-6	3	52	-3
Mojave N. Preserve	6 400	350	370	0.5	+10	14	+3	4	140	-1
Pinnacles NP	110	180	170	17	-28	24	-14	12	85	-8
Point Reyes NS	230	910	530	39	+19	13	+2	1	67	-3
Redwood NP	430	7100	4100	170	-74	38	-1	1	52	~0
Santa Monica NRA	500	710	390	14	-100	63	-12	8	64	-150
Sequoia NP	1 600	6900	2800	42	-410	200	-6	3	49	-1
Yosemite NP	3 000	14 800	7900	50	-1300	630	-8	4	48	-4
Others	590	1900	600	33	-150	44	-7	2	29	-50
All	32 100	41 500	14 900	13	-2900	1100	-7	2	37	-220

U.S. national parks in California: Cabrillo National Monument, César E. Chávez National Monument, Channel Islands National Park, Death Valley National Park, Devils Postpile National Monument, Eugene O'Neill National Historic Site, Fort Point National Historic Site, Golden Gate National Recreation Area, John Muir National Historic Site, Joshua Tree National Park, Kings Canyon National Park, Lassen Volcanic National Park, Lava Beds National Monument, Manzanar National Historic Site, Mojave National Preserve, Muir Woods National Monument, Pinnacles National Park, Point Reyes National Seashore, Port Chicago Naval Magazine National Memorial, Redwood National Park, Rosie the Riveter WWII Home Front National Historical Park, San Francisco Maritime National Historical Park, Santa Monica Mountains National Recreation Area, Sequoia National Park, Whiskeytown National Recreation Area, Yosemite National Park

Table A7. Analysis of the sensitivity of estimates of 2001-2010 carbon stock change to errors in the three variables in the carbon stock change equation. The three middle columns give the standard error values used in the Monte Carlo analysis for the three variables. For the biomass variable, the table gives the ranges of values for trees and shrubs and for other vegetation life forms. The last column on the right gives the uncertainty of the resulting estimate. All results are expressed as a fraction (%) of the mean.

Situation	Carbon fraction variation	Error in the estimate of biomass by vegetation type	Landfire vegetation classification error	Total uncertainty
	SE	SE	SE	95% CI
Best estimate	5	1-120 (trees, shrubs); 86-770 (other)	61	22
Sensitivity with error for only one variable				
Carbon fraction error only	5	0	0	11
Biomass error only	0	1-120 (trees, shrubs); 86-770 (other)	0	11
Landfire error only	0	0	61	20
Sensitivity with error for one variable set to zero				
No carbon fraction error	0	1-120 (trees, shrubs); 86-770 (other)	61	21
No biomass error	5	0	61	22
No Landfire error	5	1-120 (trees, shrubs); 86-770 (other)	0	14

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