APPENDIX 4A

Detailed Information on Contaminants in Vegetation, Including Elevation Trends

Appendix 4A.1. Comparison of Mean SOC Concentrations in Different Lichen Species Sampled from the Same Sites.

Notes

Standard error uses a pooled estimate of variance.
One way analysis of variance by site and SOC was conducted for all sites where more than one species of lichen was sampled.
If no values for a site were > EDLs, then no data was used for that SOC.
If any value for a site was > EDLs, then 1/2 EDLS were used for samples below EDLS.

DENA5

Flavocetraria cucullata had 7-50X higher concentrations than *Masonhalea richardsonii* of all SOCs but dacthal

One-way Analysis of Dacthal by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Increase (fold)
Species	1	0.01020833	0.010208	0.075	0.8099	NA
Error	2	0.27226667	0.136133			
C. Total	3	0.282475				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	0.77	0.36896	-0.8175	2.3575
Masonhalea richardsonii	3	0.886667	0.21302	-0.0299	1.8032

One-way Analysis of Endosulfans by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	76.608533	76.6085	898.8095	**0.0011**	6.7
Error	2	0.170467	0.0852			
C. Total	3	76.779				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	11.87	0.29195	10.614	13.126

Masonhalea richardsonii	3	1.7633	0.16856	1.038	2.489	

One-way Analysis of HCB by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	219.85707	219.857	22434.39	**0.0043**	22.6
Error	1	0.0098	0.01			
C. Total	2	219.86687				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	19	0.09899	17.74	20.258
Masonhalea richardsonii	2	0.84	0.07	-0.05	1.729

One-way Analysis of a-HCH by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	111.2643	111.264	4295.919	**0.0002**	15.9
Error	2	0.0518	0.026			
C. Total	3	111.3161				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	13	0.16093	12.308	13.692
Masonhalea richardsonii	3	0.82	0.09292	0.42	1.22

One-way Analysis of g-HCH by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	18.0075	18.0075	720300	**<.0001**	50.0
Error	2	0.00005	0			
C. Total	3	18.00755				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	5	0.005	4.9785	5.0215
Masonhalea richardsonii	3	0.1	0.00289	0.0876	0.1124

One-way Analysis of PAHs by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	81870.642	81870.6	1062.527	**0.0009**	48.2
Error	2	154.106	77.1			
C. Total	3	82024.748				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	337.4	8.778	299.6	375.17
Masonhalea richardsonii	3	7.005	5.068	-14.8	28.81

One-way Analysis of Total Current Use by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	74.850075	74.8501	290.4543	**0.0034**	4.8
Error	2	0.5154	0.2577			
C. Total	3	75.365475				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	12.64	0.50764	10.456	14.824
Masonhalea richardsonii	3	2.65	0.29309	1.389	3.911

One-way Analysis of Total Historic Use by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	946.2528	946.253	2344.096	**0.0004**	25.0
Error	2	0.80735	0.404			
C. Total	3	947.06015				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	37	0.63535	34.27	39.734
Masonhalea richardsonii	3	1.48	0.36682	-0.1	3.058

One-way Analysis of Total Pesticides by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	1553.3701	1553.37	1189.615	**0.0008**	12.0
Error	2	2.6115	1.31			
C. Total	3	1555.9816				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	49.64	1.1427	44.723	54.557
Masonhalea richardsonii	3	4.13	0.6597	1.291	6.969

One-way Analysis of % Current Use by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	0.11955714	0.119557	26.5354	**0.0357**	26.5
Error	2	0.00901114	0.004506			
C. Total	3	0.12856828				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Flavocetraria cucullata	1	0.254633	0.06712	-0.0342	0.54344
Masonhalea richardsonii	3	0.653895	0.03875	0.4872	0.82064

WRST1

Platismatia glauca has 2.5x higher HCBs and PAHs compared to *Hypogymnia apinnata.*

One-way Analysis of Dacthal ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Increase (fold)
Species	1	1.7066667	1.70667	21.3333	0.1357	NA
Error	1	0.08	0.08			
C. Total	2	1.7866667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia apinnata	2	1.8	0.2	-0.7412	4.3412	
Platismatia glauca	1	3.4	0.28284	-0.1939	6.9939	

One-way Analysis of Endosulfans ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	NA
Species	1	1.706667	1.7067	0.0386	0.8765	
Error	1	44.18	44.18			
C. Total	2	45.886667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia apinnata	2	50.8	4.7	-8.92	110.52	
Platismatia glauca	1	52.4	6.6468	-32.06	136.86	

One-way Analysis of HCB ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	5280.6667	5280.67	293.3704	**0.0371**	2.5
Error	1	18	18			
C. Total	2	5298.6667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia apinnata	2	61	3	22.881	99.12	
Platismatia glauca	1	150	4.2426	96.092	203.91	

One-way Analysis of a-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	682.66667	682.667	13.6533	0.1683	NA
Error	1	50	50			
C. Total	2	732.66667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia apinnata	2	22	5	-41.53	85.53	

Platismatia glauca	1	54	7.0711	-35.85	143.85	

One-way Analysis of g-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	26.46	26.46	10.9339	0.187	NA
Error	1	2.42	2.42			
C. Total	2	28.88				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia apinnata	2	7.7	1.1	-6.277	21.677
Platismatia glauca	1	14	1.5556	-5.766	33.766

One-way Analysis of Chlordanes ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	1.0250667	1.02507	0.4394	0.6273	NA
Error	1	2.3328	2.3328			
C. Total	2	3.3578667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia apinnata	2	2.81	1.08	-10.91	16.533
Platismatia glauca	1	4.05	1.5274	-15.36	23.457

One-way Analysis of PCBs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	0.7280167	0.72802	0.4648	0.6191	NA
Error	1	1.56645	1.56645			
C. Total	2	2.2944667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia apinnata	2	3.455	0.885	-7.79	14.7
Platismatia glauca	1	4.5	1.2516	-11.4	20.403

One-way Analysis of PAHs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	4676368.2	4676368	660.4573	**0.0248**	2.6
Error	1	7080.5	7081			
C. Total	2	4683448.7				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia apinnata	2	1697.5	59.5	941.5	2453.5
Platismatia glauca	1	4346	84.146	3276.8	5415.2

WRST5

Platismatia glauca has 5-17X higher dacthal, endosulfans, HCBs, a-HCH, g-HCH, chlordanes, pcbs, & PAHs compared to *Alectoria sarmentosa*

One-way Analysis of Dacthal ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Increase (fold)
Species	1	7.3704167	7.37042	510.0634	**0.0282**	9.9
Error	1	0.01445	0.01445			
C. Total	2	7.3848667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	0.375	0.085	-0.705	1.455
Platismatia glauca	1	3.7	0.12021	2.173	5.2274

One-way Analysis of Endosulfans ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	3952.41	3952.41	20899.78	**0.0044**	17.1
Error	1	0.1891	0.19			
C. Total	2	3952.5991				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	4.7825	0.3075	0.875	8.69
Platismatia glauca	1	81.78	0.43487	76.254	87.306

One-way Analysis of HCB ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	1713.66	1713.66	1338.797	**0.0174**	10.6
Error	1	1.28	1.28			
C. Total	2	1714.94				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	5.3	0.8	-4.86	15.465
Platismatia glauca	1	56	1.1314	41.62	70.375

One-way Analysis of a-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	468.16667	468.167	477.7211	**0.0291**	8.6
Error	1	0.98	0.98			
C. Total	2	469.14667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	3.5	0.7	-5.39	12.394
Platismatia glauca	1	30	0.98995	17.42	42.579

One-way Analysis of g-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	18.235267	18.2353	83.7248	**0.0693**	5.9
Error	1	0.2178	0.2178			
C. Total	2	18.453067				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	1.07	0.33	-3.123	5.263
Platismatia glauca	1	6.3	0.46669	0.37	12.23

One-way Analysis of Chlordanes ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	2.57415	2.57415	142.6122	**0.0532**	5.1
Error	1	0.01805	0.01805			
C. Total	2	2.5922				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	0.485	0.095	-0.7221	1.6921
Platismatia glauca	1	2.45	0.13435	0.7429	4.1571

One-way Analysis of PCBs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	4.2909127	4.29091	709.2418	**0.0239**	5.6
Error	1	0.00605	0.00605			
C. Total	2	4.2969627				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	0.553	0.055	-0.146	1.2518
Platismatia glauca	1	3.09	0.07778	2.102	4.0783

One-way Analysis of PAHs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	2623046.5	2623047	62660.49	**0.0025**	8.4
Error	1	41.9	42			
C. Total	2	2623088.4				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2	267.43	4.575	209.3	325.6
Platismatia glauca	1	2251	6.47	2168.8	2333.2

STLE1

Platismatia glauca has 3.4 to 17.1x higher concentrations of dacthal, endosulfans,HCB, a-HCH, chlordanes, PCBs and PAHs than *Alectoria sarmentosa*

One-way Analysis of Dacthal by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Increase (fold)
Species	1.00	7.37	7.37	510.06	**0.03**	9.9
Error	1.00	0.01	0.01			
C. Total	2.00	7.38				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	0.38	0.09	-0.71	1.46
Platismatia glauca	1.00	3.70	0.12	2.17	5.23

One-way Analysis of Endosulfans by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1.00	3952.41	3952.41	20899.78	**0.00**	17.1
Error	1.00	0.19	0.19			
C. Total	2.00	3952.60				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	4.78	0.31	0.88	8.69
Platismatia glauca	1.00	81.78	0.43	76.25	87.31

One-way Analysis of HCB by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1.00	1713.66	1713.66	1338.80	**0.02**	10.6
Error	1.00	1.28	1.28			
C. Total	2.00	1714.94				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	5.30	0.80	-4.86	15.47
Platismatia glauca	1.00	56.00	1.13	41.62	70.38

One-way Analysis of a-HCH by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F

Species	1.00	468.17	468.17	477.72	**0.03**	8.6
Error	1.00	0.98	0.98			
C. Total	2.00	469.15				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	3.50	0.70	-5.39	12.39
Platismatia glauca	1.00	30.00	0.99	17.42	42.58

One-way Analysis of g-HCH by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1.00	18.24	18.24	83.72	0.07	5.9
Error	1.00	0.22	0.22			
C. Total	2.00	18.45				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	1.07	0.33	-3.12	5.26
Platismatia glauca	1.00	6.30	0.47	0.37	12.23

One-way Analysis of Chlordanes by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1.00	2.57	2.57	142.61	**0.05**	5.1
Error	1.00	0.02	0.02			
C. Total	2.00	2.59				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	0.49	0.10	-0.72	1.69
Platismatia glauca	1.00	2.45	0.13	0.74	4.16

One-way Analysis of PCBs by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1.00	1.19	1.19	196.98	**0.05**	3.4

Error	1.00	0.01	0.01			
C. Total	2.00	1.20				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	0.55	0.06	-0.15	1.25
Platismatia glauca	1.00	1.89	0.08	0.90	2.88

One-way Analysis of PAHs by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1.00	2623046.50	2623047.00	62660.49	**0.00**	8.4
Error	1.00	41.90	42.00			
C. Total	2.00	2623088.40				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	2.00	267.43	4.58	209.30	325.60
Platismatia glauca	1.00	2251.00	6.47	2168.80	2333.20

OLYM5

Bryoria has 2.5-5x higher concentrations of dacthal, endosulfans, and pcbs compared to *Alectoria sarmentosa*

One-way Analysis of Trifluralin ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Increase (fold)
Species	0	0	.	.	.	NA
Error	2	5.2866667	2.64333			
C. Total	2	5.2866667				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Bryoria	3	2.23333	0.93868	-1.805	6.2721

One-way Analysis of Chlorpyrifos ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	10.120033	10.12	2.5664	0.2503	NA
Error	2	7.886667	3.9433			
C. Total	3	18.0067				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	1	0.16	1.9858	-8.384	8.7041
Bryoria	3	3.83333	1.1465	-1.1	8.7663

One-way Analysis of Dacthal ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	280.33333	280.333	9.2418	**0.0933**	2.5
Error	2	60.66667	30.333			
C. Total	3	341				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	1	13	5.5076	-10.7	36.697
Bryoria	3	32.3333	3.1798	18.65	46.015

One-way Analysis of Endosulfans ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	60847.521	60847.5	24.1044	**0.0391**	5.4
Error	2	5048.667	2524.3			
C. Total	3	65896.188				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	1	64.5	50.243	-151.7	280.68
Bryoria	3	349.333	29.008	224.5	474.14

One-way Analysis of HCB ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	4.083333	4.0833	0.1012	0.7805	NA

Error	2	80.666667	40.3333			
C. Total	3	84.75				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	1	35	6.3509	7.674	62.326
Bryoria	3	32.6667	3.6667	16.89	48.443

One-way Analysis of a-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	2581.3333	2581.33	5.2644	0.1487	NA
Error	2	980.6667	490.33			
C. Total	3	3562				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	1	36	22.143	-59.28	131.28
Bryoria	3	94.6667	12.785	39.66	149.67

One-way Analysis of g-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	918.75	918.75	6.25	0.1296	NA
Error	2	294	147			
C. Total	3	1212.75				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Alectoria sarmentosa	1	11	12.124	-41.17	63.167
Bryoria	3	46	7	15.88	76.119

One-way Analysis of Chlordanes ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	7.061002	7.061	1.4601	0.3504	NA
Error	2	9.671667	4.83583			
C. Total	3	16.732669				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Alectoria sarmentosa	1	1.765	2.1991	-7.697	11.227	
Bryoria	3	4.83333	1.2696	-0.629	10.296	

One-way Analysis of PCBs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	195.8592	195.859	18.7684	**0.0494**	5.1
Error	2	20.8712	10.436			
C. Total	3	216.7304				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Alectoria sarmentosa	1	3.94	3.2304	-9.96	17.839	
Bryoria	3	20.1	1.8651	12.08	28.125	

One-way Analysis of PAHs ng/g Lipid by Species

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	15624.083	15624.1	0.6356	0.5089	NA
Error	2	49162.167	24581.1			
C. Total	3	64786.25				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Alectoria sarmentosa	1	3841.5	156.78	3166.9	4516.1	
Bryoria	3	3697.17	90.52	3307.7	4086.6	

GLAC5

Letharia vulpina has higher concentrations of 50 x more chlorpyrifos and 2x more g-HCH than *Hypogymnia physodes.*

H. physodes has higher concentrations of 2-10X higher HCB, a-HCH (p > F =0.06), chlordanes, ddts, PCBs and PAHs than *L. vulpina.*

One-way Analysis of Triallate ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Increase (fold)
Species	1	0.440833	0.44083	0.0476	0.8475	
Error	2	18.526667	9.26333			
C. Total	3	18.9675				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia physodes	3	12.7667	1.7572	5.206	20.327
Letharia vulpina	1	12	3.0436	-1.095	25.095

One-way Analysis of Chlorpyrifos ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	161.48003	161.48	15514.49	**<.0001**	45.9
Error	2	0.02082	0.01			
C. Total	3	161.50085				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia physodes	3	0.3267	0.0589	0.073	0.58
Letharia vulpina	1	15	0.10202	14.561	15.439

One-way Analysis of Dacthal ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	2700	2700	3.8571	0.1885	NA
Error	2	1400	700			
C. Total	3	4100				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia physodes	3	220	15.275	154.28	285.72
Letharia vulpina	1	160	26.458	46.16	273.84

One-way Analysis of Endosulfans ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	3104.0833	3104.08	1.5081	0.3443	NA

Error	2	4116.6667	2058.33			
C. Total	3	7220.75				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia physodes	3	814.333	26.194	701.63	927.04
Letharia vulpina	1	750	45.369	554.79	945.21

One-way Analysis of HCB ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	752.08333	752.083	33.6754	**0.0284**	2.4
Error	2	44.66667	22.333			
C. Total	3	796.75				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia physodes	3	53.6667	2.7285	41.927	65.406
Letharia vulpina	1	22	4.7258	1.666	42.334

One-way Analysis of a-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	690.08333	690.083	13.1863	**0.0682**	2.7
Error	2	104.66667	52.333			
C. Total	3	794.75				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Hypogymnia physodes	3	48.3333	4.1767	30.36	66.304
Letharia vulpina	1	18	7.2342	-13.13	49.126

One-way Analysis of g-HCH ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	1656.75	1656.75	33.8112	**0.0283**	1.7
Error	2	98	49			
C. Total	3	1754.75				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia physodes	3	63	4.0415	45.611	80.39	
Letharia vulpina	1	110	7	79.881	140.12	

One-way Analysis of Chlordanes ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	48.400833	48.4008	104.4622	**0.0094**	2.1
Error	2	0.926667	0.4633			
C. Total	3	49.3275				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia physodes	3	15.2333	0.39299	13.542	16.924	
Letharia vulpina	1	7.2	0.68069	4.271	10.129	

One-way Analysis of DDTs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	13722.803	13722.8	541.6896	**0.0018**	9.8
Error	2	50.667	25.3			
C. Total	3	13773.47				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia physodes	3	150.667	2.9059	138.2	163.17	
Letharia vulpina	1	15.4	5.0332	-6.3	37.06	

One-way Analysis of PCBs ng/g Lipid by Species

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	25.172033	25.172	49.315	**0.0197**	1.8
Error	2	1.020867	0.5104			
C. Total	3	26.1929				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia physodes	3	12.7533	0.41249	10.979	14.528	
Letharia vulpina	1	6.96	0.71445	3.886	10.034	

One-way Analysis of PAHs ng/g Lipid by Species

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	
Species	1	387129488	387129488	91.4526	0.0108	3.1
Error	2	8466232	4233116.1			
C. Total	3	395595720				

Level	Number	Mean	Std Error	Lower 95%	Upper 95%	
Hypogymnia physodes	3	33464.3	1187.9	28353	38575	
Letharia vulpina	1	10744.9	2057.5	1892	19597	

Appendix 4A.2. Mean Total Pesticide Burdens (ng/g lipid) in WACAP Parks by Lichen Genus. Parks not connected by the same letter are significantly different. Levels not connected by same letter are significantly different.

Park Within Genus		Total Pesticides (ng/g lipid)	Notes
Alectoria			
Park		*Mean*	
MORA	A	168.23	**MORA > STLE**
OLYM	A B	139.68	OLYM = NOCA = GLBA = STLE
NOCA	A B	102.88	
GLBA	A B	74.98	
STLE	B	23.97	
Flavocetraria			
Park		*Mean*	
KATM	A	37.30	KATM = WRST= DENA
WRST	A	25.80	
DENA	A	18.94	
Hypogymnia			
Park		*Mean*	
GLAC	A	1378.33	**GLAC > WRST , KATM**
WRST	B	108.44	WRST = KATM
KATM	B	82.97	
Letharia			
Park		*Mean*	
GLAC	A	947.20	**GLAC, SEKI > CRLA, LAVO**
SEKI	A	899.59	GLAC = SEKI = YOSE = GRTE
YOSE	A B	615.57	CRLA = LAVO = GRTE = YOSE
CRLA	B	306.51	
GRTE	A B	264.44	
LAVO	B	218.42	
Lobaria			
Park		*Mean*	
OLYM	A	58.33	OLYM = STLE
STLE	A	46.33	
Masonhalea			
Park		*Mean*	
NOAT	A	3.88	**GAAR > NOAT**
DENA	A B	3.08	DENA = NOAT
GAAR	B	1.96	DENA = GAAR
Platismatia			
Park		*Mean*	
GLAC	A	1504.40	**GLAC > STLE**
NOCA	A B	485.10	GLAC =NOCA = WRST= GLBA
STLE	B	327.78	
WRST	A B	277.85	
GLBA	A B	258.80	
Usnea			
Park		*Mean*	
BAND	A	257.95	BAND = BIBE = GRTE
BIBE	A	222.89	
GRTE	A	212.61	
Xanthoparmelia			
Park		*Mean*	
GRSA	A	899.95	**GRSA > ROMO**
BAND	A B	179.29	BAND = YOSE = ROMO
YOSE	A B	173.04	
ROMO	B	28.45	

Appendix 4A.3. Comparisons of SOC Concentrations in the Epiphytic Lichen, *Hypogymnia physodes*, and the Tundra Lichen, *Flavocetraria cucullata*, from Three Sites Each in Katmai National Park. Comparisons provide evidence that concentrations of endosulfans, HCB, HCHs, PCBs and PAHs were 1.5- to 4.6-fold higher in *H. physodes* than in *F. cucullata* (t-tests, assuming equal variances, $p < 0.05$).

SOC	*H. physodes* Park Mean (ng/g lipid)	*F. cucullata* Park Mean (ng/g lipid)	*H. ph./F. cu.* Ratio	Significant? ($p < 0.05$)
Endosulfan	32.30	7.10	4.55	Y
HCB	30.30	20.00	1.52	Y
a-HCH	12.30	6.70	1.84	Y
g-HCH	3.50	1.72	2.03	Y
PCBs	2.91	0.67	4.34	Y
PAHs	406.00	118.00	3.44	Y
Chlordanes	3.75	1.08	3.47	N
Dacthal	0.72	0.44	1.64	N

Appendix 4A.4. Comparisons of SOC Concentrations in the Epiphytic Lichens, *Platismatia glauca* and *Alectoria sarmentosa*, from Three Sites Each in the Stikine LeConte Wilderness. Comparisons provide evidence that concentrations of dacthal, endosulfans, HCB, HCHs, PCBs and PAHs were 3.8 to 22.2 fold higher in *P. glauca* than *A. sarmentosa* (t-tests, assuming equal variances, $p < 0.05$).

SOC	*P. glauca* Park Mean (ng/g lipid)	*A. sarmentosa* Park Mean (ng/g lipid)	P. gl./A. sa. Ratio	Significant? ($p < 0.05$)
Endosulfan	12.67	0.70	18.10	Y
HCB	156.16	7.03	22.21	Y
a-HCH	81.50	6.32	12.90	Y
g-HCH	58.75	7.20	8.16	Y
PCBs	14.07	2.01	7.00	Y
PAHs	4.62	0.71	6.51	N
Chlordanes	4.45	1.15	3.87	Y
Dacthal	1648.00	156.00	10.56	Y

Appendix 4A.5. Mean Total Pesticide Burdens (ng/g lipid) in WACAP Parks by Conifer Genus. Parks not connected by the same letter are significantly different. Levels not connected by same letter are significantly different

Park within Genus	Total Pesticides (ng/g lipid)				Notes
True fir *(Abies)*					
Park				*Mean*	
SEKI	A			472.46	SEKI > CRLA, MORA, GLAC, NOCA, ROMO, OLYM
LAVO	A	B		270.61	
CRLA		B		180.19	
MORA		B		173.29	
GLAC		B		136.23	
NOCA		B		118.82	
GRTE	A	B		86.12	
ROMO		B		73.70	
OLYM		B		67.93	
Spruce *(Picea)*					
Park				*Mean*	
GLAC	A			103.67	GLAC > GLBA, ROMO, STLE, WRST, KATM, DENA
GLBA		B		48.88	GLBA > KATM, DENA
ROMO		B	C	42.52	
STLE		B	C D	35.97	
WRST		B	C D	19.46	
KATM			C D	15.17	
DENA			D	11.18	
Pine *(Pinus)*					
Park				*Mean*	
YOSE	A			118.64	YOSE > GRSA, BAND
SEKI	A	B		94.27	
GRTE	A	B		25.19	
BIBE	A	B		23.88	
CRLA	A	B		21.94	
GRSA		B		15.01	
BAND		B		12.60	
Douglas-fir *(Pseudotsuga)*					
Park				*Mean*	
GLAC	A			155.59	GLAC > NOCA
NOCA		B		70.52	
Western hemlock *(Tsuga)*					
Park				*Mean*	
GLAC	A			550.92	GLAC > MORA, OLYM
MORA		B		193.50	MORA = NOCA = OLYM
NOCA	A	B		178.94	
OLYM		B		119.19	

Appendix 4A.6. Comparison of Inter-generic Differences among Conifer SOC Concentrations (ng SOC/g conifer needle lipid) within WACAP Parks Where More than One Genus of Conifer Was Sampled. Within park and contaminant, genera sharing a common letter do not have different mean concentrations (Tukey-Kramer multiple means comparison test, α = 0.05). Results show that: (1) concentrations of many SOCs in pine (*Pinus*) were significantly lower than concentrations in true fir (*Abies*) from the same parks, (2) western hemlock (*Tsuga*) SOC concentrations were similar to or higher than true firs, Douglas fir (*Pseudotsuga*), and spruce (*Picea*), and (3) spruce (*Picea*) and true firs were similar*.

		Trifluralin		Triallate		Chlorpyrifos		Endosulfans		Dacthal		Current Use		g-HCH		a-HCH		HCB		Historic Use		PCBs		PAHs	
	Genus	Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean	
GRTE	*Abies*	5.80	A			1.10	A	30.3	A	20.0	A	57.2	A			14.0	A	14.0	A	28.9	A	0.56	A	870	A
	Pinus	4.13	A			1.12	A	3.4	B	7.9	B	16.5	B			3.50	B	4.9	B	8.7	B	0.60	A	16	B
SEKI	*Abies*					2.63	A	309.6	A	75.8	A	388.0	A	8.36	A	16.6	A	15.7	A	84.5	A	4.66	A	3960	A
	Pinus					2.00	A	29.9	B	38.3	A	70.3	B	2.90	A	5.3	A	5.8	A	24.0	A	0.38	B	1140	B
CRLA	*Abies*	0.34	A					77.7	A	33.7	A	111.8	A	5.80	A	26.2	A	33.8	A	68.4	A	1.39	A	1825	A
	Pinus	0.18	B					4.3	A	6.1	A	10.5	A	0.63	B	4.20	B	6.40	A	11.4	B	0.06	B	48	A
OLYM	*Tsuga*					5.33	A	21.6	A	2.9	A	29.3	A	8.3	A	47.5	A	29.0	A	89.9	A	2.76	A	5787	A
	Abies					0.39	B	18.9	A	3.7	A	23.0	B	3.4	B	25.3	B	15.3	B	45.0	B	1.12	A	245	B
MORA	*Tsuga*							96.2	A	12.7	A	110.6	A	8.0	A	39.7	A	24.2	A	83.0	A	2.54	A	4129	A
	Abies							91.8	A	6.7	B	98.6	A	5.8	A	31.7	A	23.3	A	74.7	A	3.44	A	506	B
NOCA	*Tsuga*							62.0	A	13.0	A	75.0	A	11.0	A	49.0	A	35.0	A	103.9	A	2.27	A	4265	A
	Abies							42.1	B	9.5	B	51.6	B	5.2	B	31.0	B	25.3	A	67.2	A	1.30	A	2542	A
	Pseud.							24.4	C	5.2	C	29.6	C	2.0	B	17.0	B	19.0	A	40.9	A	0.50	A	241	A
GLACE	*Abies*			5.1	B	0.77	B	84.8	A	18.7	B	109.3	A	6.0	A	11.7	A	7.1	A	26.9	A	0.87	A	2345	A
	Pseud.			17.3	A	3.50	A	83.9	A	25.3	A	130.0	A	5.9	A	8.7	A	8.2	A	25.6	A	0.79	A	2209	A
ROMO	*Abies*					0.31	A	29.8	A	20.5	A	50.4	A	3.4	A	9.2	A	8.2	A	23.4	A	1.09	A	382	A
	Picea					1.05	A	5.6	B	12.7	A	19.4	A	16.2	A	2.8	A	2.1	A	23.2	A	0.49	A	88	A
GLACW	*Tsuga*			22.7	A	3.70	A	231.8	A	112.3	A	370.6	A	41.2	A	67.7	A	50.5	A	180.4	A	3.23	B	47312	A
	Picea			0.7	A	0.29	A	28.3	B	22.3	A	51.4	B	43.0	A	3.2	A	4.3	A	52.3	A	6.90	A	1043	B

Notes: The analysis ignores site effects within parks but sites on different sides of the continental divide (GLACeast, GLACwest) were not compared and sites influenced by local sources (OLYM1) were excluded.

* Contaminant concentrations in *Abies* was generally substantially higher than *Pinus*: especially in endosulfans ~ 10 x higher, dacthal 2-5X higher, historic use g- and a-HCH, and HCB ~ 3-5x higher: *Tsuga* was usually somewhat higher than Abies by 1/3 to 3x. *Pseudotsuga* was similar to *Abies* but could be 2-3x lower in endosulfans and dacthal. *Picea* was similar to *Abies* and *Tsuga* but 5 (*Abies*) to 10 (*Tsuga*) x lower in endosulfans.

Appendix 4A.7. Comparison of Lichen and Conifer SOC Concentrations. Results are given of paired t-tests from sites within the 20 WACAP parks at which both vegetation types were collected. Lichen concentrations were 2- to 9-fold higher, or not different than, conifer needle concentrations. N, number of sites, varies with detection frequency among sites. Bold-faced SOCs indicate lichen and conifer concentrations were significantly different (Prob > t < 0.05).

SOC	Statistic	ng/g lipid	T-test Parameter	T-test result	Notes
Trifluralin	Lichen mean		t-Ratio		No difference, but only one pair
	Conifer mean		DF	0	
	Mean Difference	-0.25	Prob > |t|	-2.0000	
	% Difference		Prob > t	2.0000	
	Std Error		Prob < t	-1.0000	
	Upper95%		N	1	
	Lower95%		Correlation		
Triallate	Lichen mean	6.24	t-Ratio	-1.1972	No difference; but only 7 pairs
	Conifer mean	11.46	DF	6	
	Mean Difference	-5.22	Prob > |t|	0.2764	
	% Difference	*54*	Prob > t	0.8618	
	Std Error	4.36	Prob < t	0.1382	
	Upper95%	5.45	N	7	
	Lower95%	-15.90	Correlation	0.33	
Chlorpyrifos	Lichen mean	8.47	t-Ratio	3.6789	Lichens 3x higher
	Conifer mean	2.80	DF	15	
	Mean Difference	5.67	Prob > |t|	0.0022	
	% Difference	*302*	Prob > t	0.0011	
	Std Error	1.54	Prob < t	0.9989	
	Upper95%	8.96	N	16	
	Lower95%	2.39	Correlation	0.67	
Dacthal	Lichen mean	63.73	t-Ratio	4.0682	Lichens 3x higher
	Conifer mean	22.38	DF	59	
	Mean Difference	41.35	Prob > |t|	0.0001	

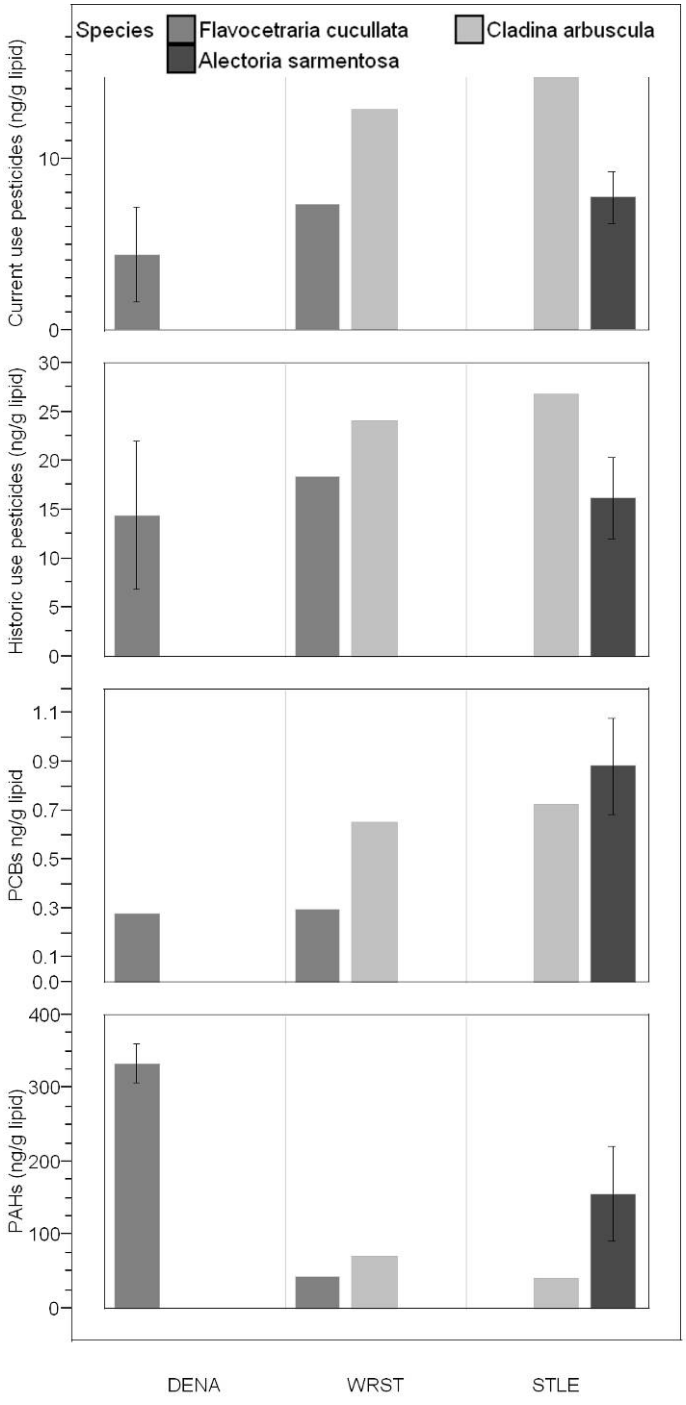
	% Difference	*285*	Prob > t	0.0001	
	Std Error	10.16	Prob < t	0.9999	
	Upper95%	61.69	N	60	
	Lower95%	21.01	Correlation	0.59	
Endosulfans	Lichen mean	188.36	t-Ratio	5.2249	Lichens 4x higher
	Conifer mean	51.38	DF	65	
	Mean Difference	136.98	Prob > |t|	0.0000	
	% Difference	*367*	Prob > t	0.0000	
	Std Error	26.22	Prob < t	1.0000	
	Upper95%	189.34	N	66	
	Lower95%	84.62	Correlation	0.45	
HCB	Lichen mean	24.66	t-Ratio	2.9045	Lichens 2x higher; no correlation between veg types
	Conifer mean	14.40	DF	62	
	Mean Difference	10.26	Prob > |t|	0.0051	
	% Difference	*171*	Prob > t	0.0025	
	Std Error	3.53	Prob < t	0.9975	
	Upper95%	17.33	N	63	
	Lower95%	3.20	Correlation	0.01	
a-HCH	Lichen mean	18.60	t-Ratio	1.0468	Many pairs, no difference; poor correlation between veg types
	Conifer mean	15.45	DF	63	
	Mean Difference	3.15	Prob > |t|	0.2992	
	% Difference	*120*	Prob > t	0.1496	
	Std Error	3.00	Prob < t	0.8504	
	Upper95%	9.15	N	64	
	Lower95%	-2.86	Correlation	0.10	
g-HCH	Lichen mean	13.21	t-Ratio	0.4303	Many pairs, no difference; poor correlation between veg types
	Conifer mean	11.86	DF	46	
	Mean Difference	1.35	Prob > |t|	0.6690	

	% Difference	*111*	Prob > t	0.3345	
	Std Error	3.13	Prob < t	0.6655	
	Upper95%	7.64	N	47	
	Lower95%	-4.95	Correlation	0.27	
Chlordanes	Lichen mean	6.59	t-Ratio	5.0010	Lichens 2x higher
	Conifer mean	2.69	DF	57	
	Mean Difference	3.90	Prob > |t|	0.0000	
	% Difference	*245*	Prob > t	0.0000	
	Std Error	0.78	Prob < t	1.0000	
	Upper95%	5.46	N	58	
	Lower95%	2.34	Correlation	0.46	
Dieldrin	Lichen mean	7.27	t-Ratio	2.1543	No difference, but only 3 pairs
	Conifer mean	4.51	DF	2	
	Mean Difference	2.76	Prob > |t|	0.1640	
	% Difference	*161*	Prob > t	0.0820	
	Std Error	1.28	Prob < t	0.9180	
	Upper95%	8.26	N	3	
	Lower95%	-2.75	Correlation	0.85	
DDTs	Lichen mean	77.73	t-Ratio	3.6962	Lichens 9X higher
	Conifer mean	8.60	DF	15	
	Mean Difference	69.13	Prob > |t|	0.0022	
	% Difference	*904*	Prob > t	0.0011	
	Std Error	18.70	Prob < t	0.9989	
	Upper95%	108.99	N	16	
	Lower95%	29.26	Correlation	0.33	
PCBs	Lichen mean	4.92	t-Ratio	6.8672	Lichens 3X higher
	Conifer mean	1.75	DF	46	

	Mean Difference	3.17	Prob > |t|	0.0000	
	% Difference	*281*	Prob > t	0.0000	
	Std Error	0.46	Prob < t	1.0000	
	Upper95%	4.10	N	47	
	Lower95%	2.24	Correlation	0.44	
PAHs	Lichen mean	7294.10	t-Ratio	1.7279	Lichens 3X higher, strong correlation between veg types
	Conifer mean	2711.62	DF	63	
	Mean Difference	4582.48	Prob > |t|	0.0889	
	% Difference	*269*	Prob > t	0.0444	
	Std Error	2651.98	Prob < t	0.9556	
	Upper95%	9882.05	N	64	
	Lower95%	-717.09	Correlation	0.87	

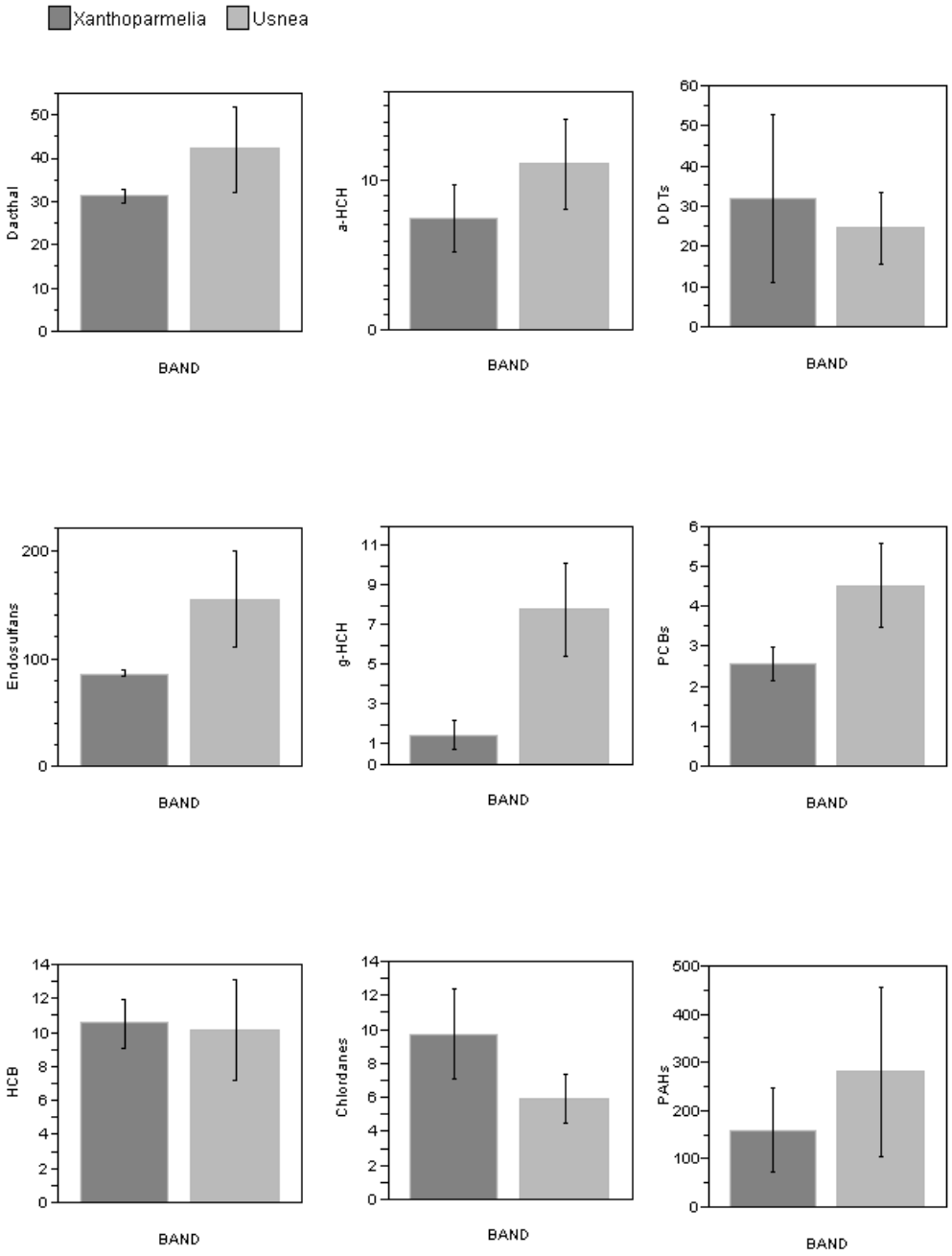
Appendix 4A.8. SOC Concentrations in Lichens

In general, lichens growing on trees accumulated higher concentrations of SOCs than lichens growing on the ground, but there was much variability among species. For example, pesticide concentrations in the best accumulators among the tundra lichens, *F. cucullata* and *C. arbuscula* (grays), were comparable to or higher than those of the poorest epiphytic accumulator, *A. sarmentosa* (black). Smoke from a forest fire in DENA during sampling could have boosted PAHs at this park. Bars indicate one standard error.



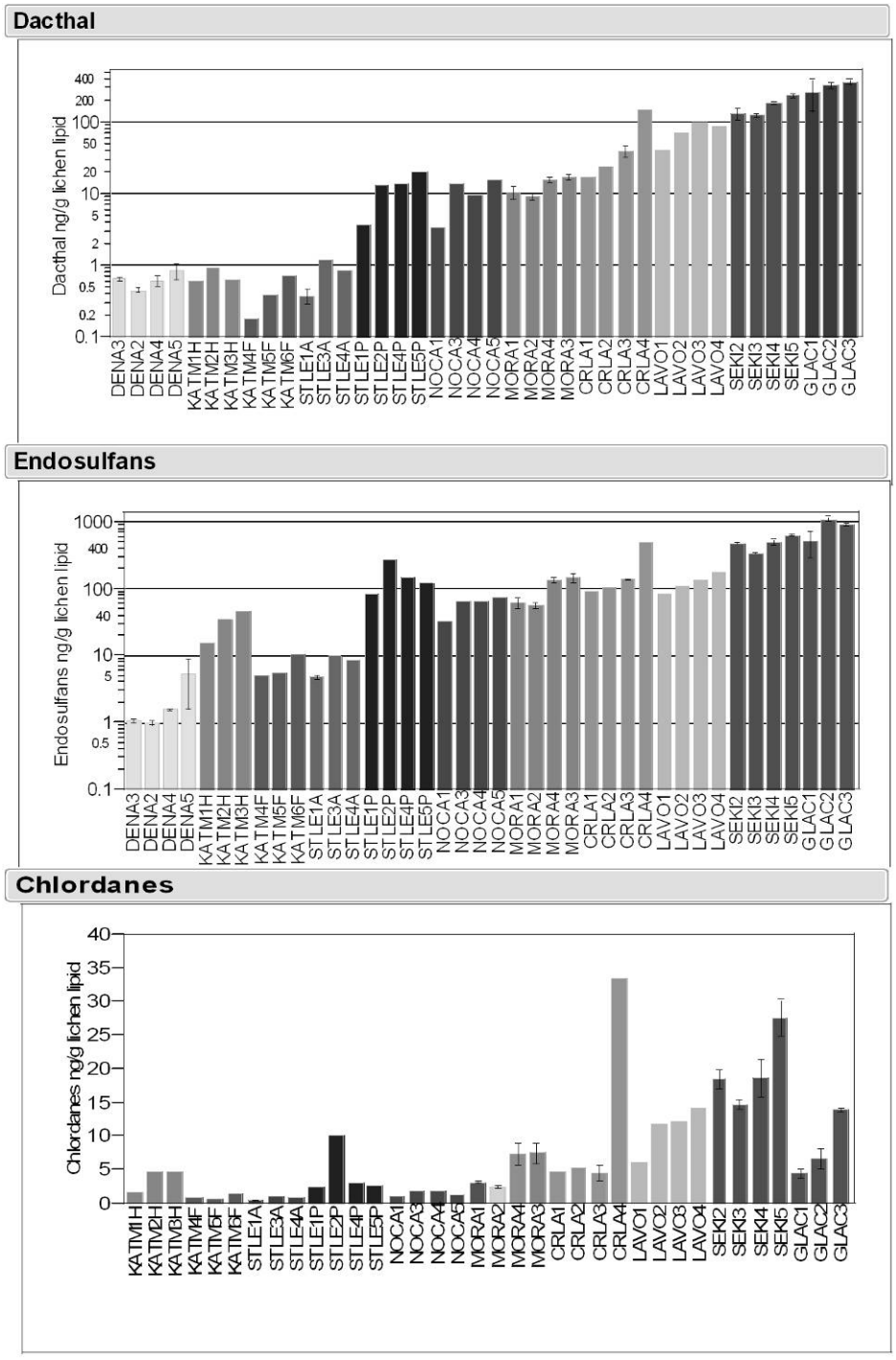
Appendix 4A.9. SOC Concentrations in Lichens *Xanthoparmelia* and *Usnea* from BAND

Despite major differences in growth habit and form, the lichens *Xanthoparmelia* and *Usnea* from BAND accumulated similar concentrations of many SOCs. *Xanthoparelia* is a flat, leafy lichen that adheres closely to its rock substrates; *Usnea* is a hair-like or filamentous lichen that hangs from trees; they were sampled at the two lowest and three highest elevations, respectively. Snow burial was not expected to limit exposure period at any of the sites. Bars indicate one standard error.

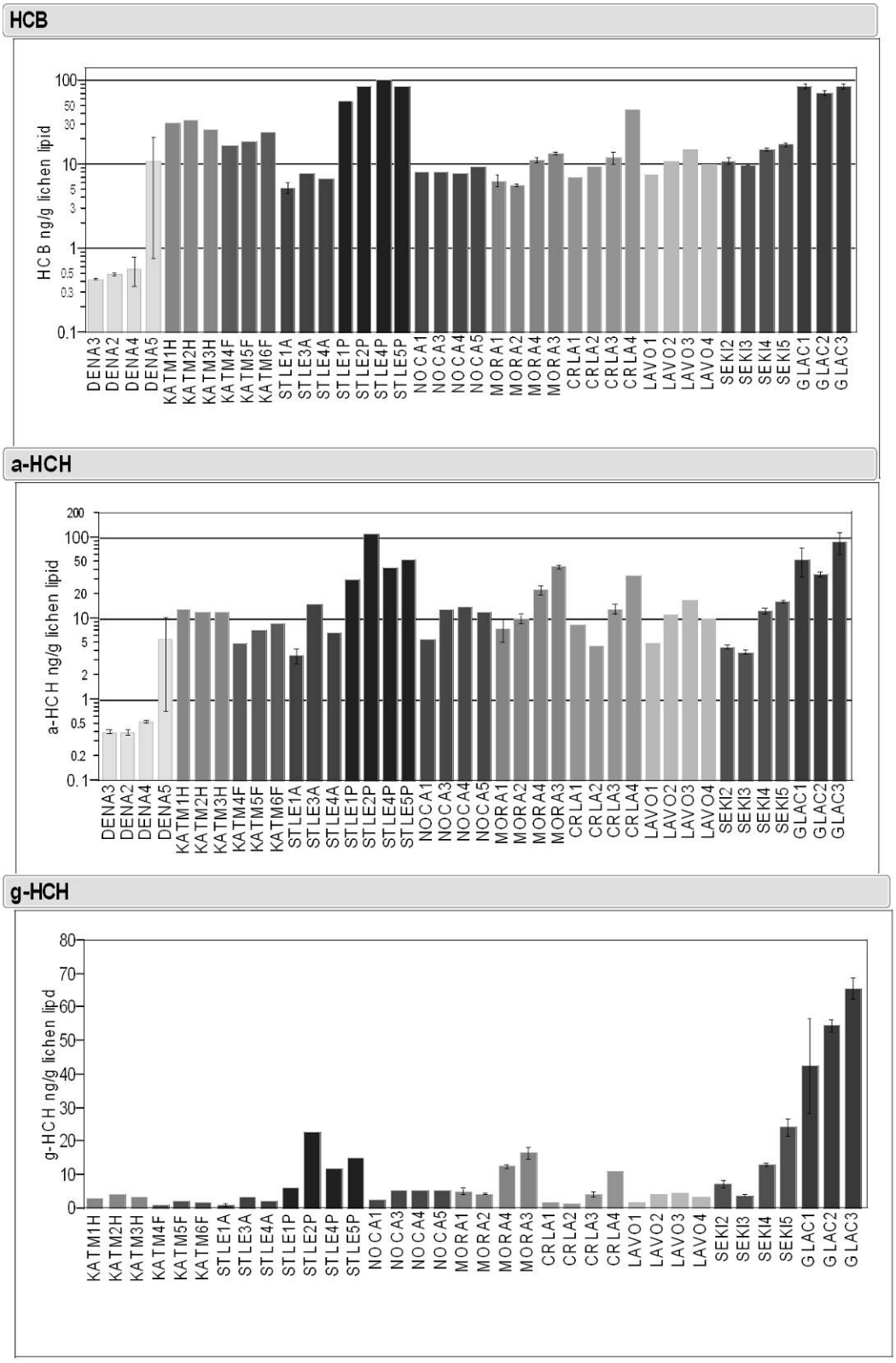


Appendix 4A.10. Relationship between Elevation and SOC Concentrations in Lichens Showing Significant Elevational Trends.

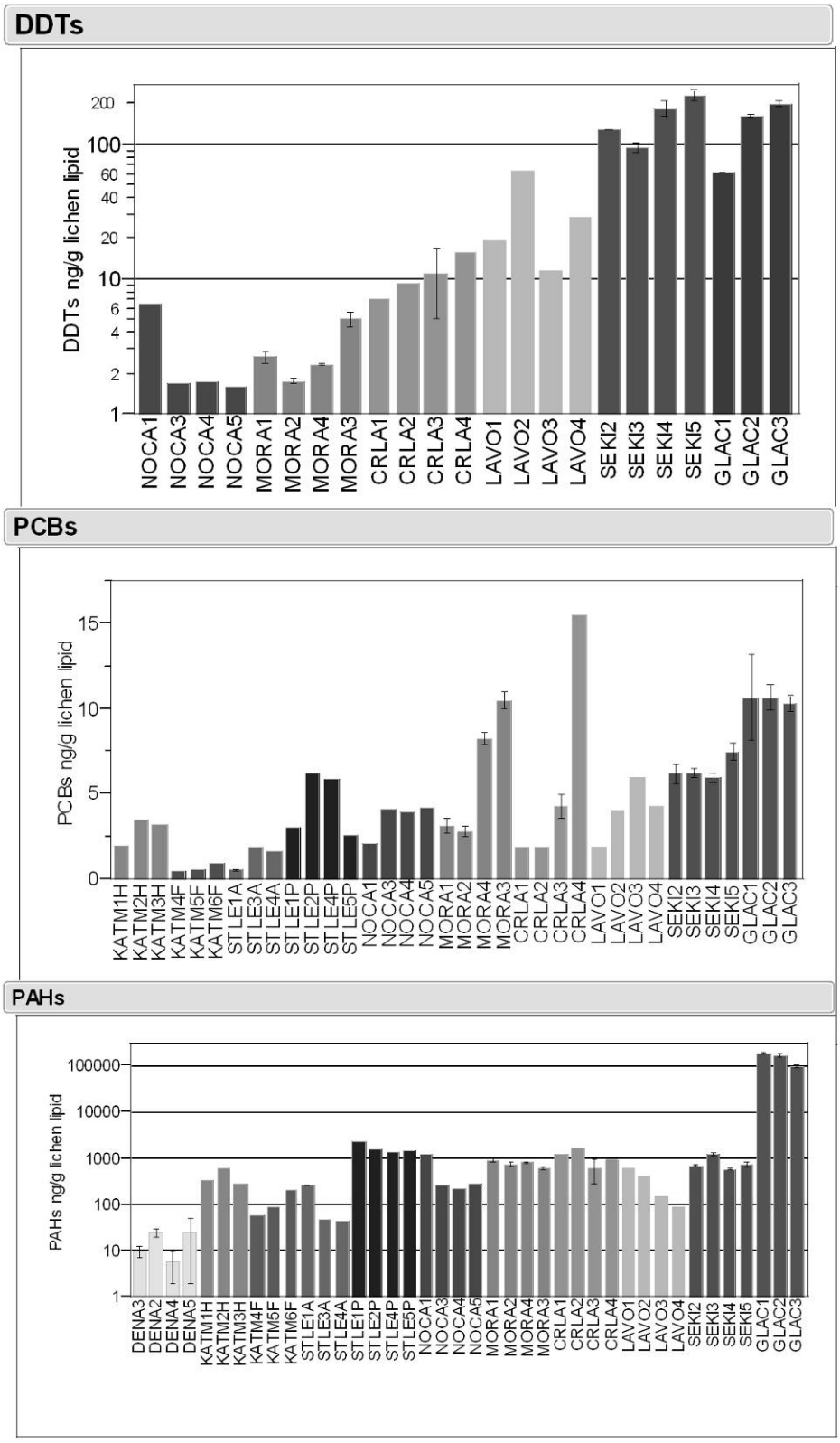
Pesticides and PCBs increase with elevation as predicted by the cold condensation hypothesis: PAHs decrease with elevation. See Chapter 3 for data selection criteria for elevational trends analyses. See Appendix 4A.11 for park name acronyms, lichen species, and evidence of significant trends. Sites within parks are listed in order of increasing elevation. Bars represent one standard error.



Appendix 4A.10. (continued).



Appendix 4A.10. (continued).



Appendix 4A.11. Analysis of Elevation Trends. June 06, 2007.

Notes:

Parks and lichen species used in analyses:

BAND = Bandolier National Monument, *Usnea* (all other parks were compared to BAND)
CRLA = Crater Lake National Park, *Letharia vulpina*
GLAC = Glacier National Park, *Platismatia glauca*
KATMF = Katmai National Park, *Flavocetraria cucullata*
KATMH = Katmai National Park, *Hypogymnia physodes*
LAVO = Lassen Volcanic National Park, *Letharia vulpina*
MORA = Mt. Rainier National Park, *Alectoria sarmentosa*
NOCA = North Cascades National Park, *Alectoria sarmentosa*
SEKI = Sequoia-Kings Canyon National Park, *Letharia vulpina*
STLEA = Stikine LeConte Wilderness, *Alectoria sarmentosa* samples
STLEP = Stikine LeConte Wilderness, *Platismatia glauca*

See Methods chapter for detailed description of multiple linear regression modeling used in this analysis. Best fit models are reported here. All SOC concentrations in ng/g lipid.

Chlorpyrifos

formula = Chlorpyrifos ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-3.0289	2.9688	-1.0202	0.3187
ParkGLAC	0.6053	1.8372	0.3295	0.7449
ParkMORA	5.1879	1.9115	2.7140	0.0127
ParkNOCA	5.2466	2.1913	2.3943	0.0256
Elevm	0.0035	0.0013	2.7512	0.0117

Residual standard error: 2.182 on 22 degrees of freedom
Multiple R-Squared: 0.5338
F-statistic: 6.297 on 4 and 22 degrees of freedom, the p-value is 0.001554
Residuals plot range between -2 and +4. Outliers cases 3, 8, 7.

Dacthal

formula = log(Dacthal) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	1.3079	0.4548	2.8756	0.0055
ParkCRLA	0.4283	0.3229	1.3266	0.1895
ParkDENA	-2.6363	0.3684	-7.1561	0.0000
ParkGLAC	2.9540	0.3446	8.5730	0.0000
ParkKATMF	-3.0502	0.4448	-6.8582	0.0000
ParkKATMH	-1.8507	0.5066	-3.6535	0.0005
ParkLAVO	0.9066	0.3368	2.6919	0.0091
ParkMORA	0.1803	0.3457	0.5216	0.6038
ParkNOCA	-0.0177	0.4050	-0.0437	0.9653
ParkSEKI	1.6882	0.2750	6.1383	0.0000
ParkSTLEA	-2.1385	0.4717	-4.5336	0.0000
ParkSTLEP	0.5618	0.4509	1.2460	0.2174
Elevm	0.0010	0.0002	5.9044	0.0000

Residual standard error: 0.4726 on 62 degrees of freedom
Multiple R-Squared: 0.9654
F-statistic: 144.2 on 12 and 62 degrees of freedom, the p-value is 0
Residuals plot range between -1 and +1. Case 23 still very low outlier? Cases 2 and 9 outliers.

Endosulfan I

formula = log(EndosulfanI) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	1.0719	0.4124	2.5994	0.0117
ParkCRLA	0.3379	0.2927	1.1545	0.2527
ParkDENA	-2.3074	0.3340	-6.9082	0.0000
ParkGLAC	1.0709	0.3124	3.4278	0.0011
ParkKATMF	-0.8374	0.4032	-2.0767	0.0420
ParkKATMH	-0.1960	0.4593	-0.4267	0.6711
ParkLAVO	0.0536	0.3053	0.1754	0.8613
ParkMORA	0.7714	0.3134	2.4610	0.0167
ParkNOCA	0.3777	0.3672	1.0286	0.3077
ParkSEKI	1.2972	0.2494	5.2023	0.0000
ParkSTLEA	-0.7928	0.4277	-1.8538	0.0685
ParkSTLEP	0.4945	0.4088	1.2095	0.2311
Elevm	0.0009	0.0001	6.4791	0.0000

Residual standard error: 0.4285 on 62 degrees of freedom
Multiple R-Squared: 0.9454
F-statistic: 89.46 on 12 and 62 degrees of freedom, the p-value is 0
Residuals plot range between -1 and +1.5. Outliers 23 (low) and 9 and 19.

Endosulfan II

formula = log(EndosulfanII) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.8008	0.6029	1.3283	0.1905
ParkCRLA	0.7646	0.4062	1.8824	0.0660
ParkGLAC	2.6674	0.4423	6.0307	0.0000
ParkLAVO	0.2030	0.4230	0.4799	0.6335
ParkMORA	1.0557	0.4466	2.3641	0.0223
ParkNOCA	0.7703	0.5208	1.4790	0.1458
ParkSEKI	2.2890	0.3455	6.6257	0.0000
ParkSTLEA	-3.5596	0.6148	-5.7897	0.0000
ParkSTLEP	-1.2996	0.5856	-2.2192	0.0313
Elevm	0.0008	0.0002	3.4741	0.0011

Residual standard error: 0.5928 on 47 degrees of freedom
Multiple R-Squared: 0.9297
F-statistic: 69.02 on 9 and 47 degrees of freedom, the p-value is 0
Residual plot range between -1 and +1. Case 11 very low, case 2 low, case 9 high outliers.

Endosulfan Sulfate

formula = log(Endosulfansulfate) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	2.3087	0.4924	4.6883	0.0000
ParkCRLA	0.5475	0.3496	1.5664	0.1224
ParkDENA	-3.2553	0.3988	-8.1618	0.0000
ParkGLAC	2.9316	0.3730	7.8584	0.0000
ParkKATMF	-1.6192	0.4815	-3.3626	0.0013
ParkKATMH	0.7742	0.5484	1.4117	0.1630
ParkLAVO	0.2440	0.3646	0.6693	0.5058
ParkMORA	0.7754	0.3743	2.0717	0.0425

ParkNOCA	0.4146	0.4384	0.9457	0.3480
ParkSEKI	1.3638	0.2978	4.5803	0.0000
ParkSTLEA	-1.0649	0.5107	-2.0853	0.0412

Residual standard error: 0.5116 on 62 degrees of freedom
Multiple R-Squared: 0.9541
F-statistic: 107.3 on 12 and 62 degrees of freedom, the p-value is 0
Residual plot range between -1 and +1. Case 23 very low, case 2 low and 19 high outliers.

Sum Endosulfans

formula = log(SumEndosulfans) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	2.7285	0.4776	5.7130	0.0000
ParkCRLA	0.5354	0.3390	1.5792	0.1194
ParkDENA	-3.0838	0.3868	-7.9718	0.0000
ParkGLAC	2.7030	0.3618	7.4708	0.0000
ParkKATMF	-1.5187	0.4670	-3.2520	0.0019
ParkKATMH	0.4639	0.5319	0.8721	0.3865
ParkLAVO	0.1960	0.3536	0.5541	0.5815
ParkMORA	0.8161	0.3630	2.2482	0.0281
ParkNOCA	0.4569	0.4252	1.0745	0.2867
ParkSEKI	1.5097	0.2888	5.2277	0.0000
ParkSTLEA	-1.1371	0.4953	-2.2959	0.0251
ParkSTLEP	1.7579	0.4735	3.7129	0.0004
Elevm	0.0009	0.0002	5.1807	0.0000

Residual standard error: 0.4962 on 62 degrees of freedom
Multiple R-Squared: 0.9541
F-statistic: 107.3 on 12 and 62 degrees of freedom, the p-value is 0
Residual plot range between -1 and +1. Case 23 very low, 73 and 19 high outliers.

HCB

formula = sqrt(HCB) ~ Park + Elevm, data = HCB
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.1100	0.6700	0.1641	0.8702
ParkCRLA	1.2685	0.4715	2.6906	0.0092
ParkDENA	-0.0181	0.5564	-0.0325	0.9741
ParkGLAC	7.1881	0.5048	14.2398	0.0000
ParkKATMF	3.3725	0.6519	5.1730	0.0000
ParkKATMH	5.1370	0.7439	6.9051	0.0000
ParkLAVO	0.5347	0.4916	1.0876	0.2811
ParkMORA	1.5388	0.5070	3.0351	0.0036
ParkNOCA	1.5773	0.5935	2.6579	0.0101
ParkSEKI	0.8270	0.4015	2.0598	0.0438
ParkSTLEA	1.9689	0.6928	2.8419	0.0061
ParkSTLEP	8.2182	0.6619	12.4167	0.0000
Elevm	0.0012	0.0002	5.1381	0.0000

Residual standard error: 0.6897 on 60 degrees of freedom
Multiple R-Squared: 0.9368
F-statistic: 74.15 on 12 and 60 degrees of freedom, the p-value is 0
Residual plot range between -1 and +2. Cases 2 (low) and 9 and 18 high.

α-HCH

formula = log(aHCH) ~ Park + Elevm

Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.8944	0.5394	-1.6580	0.1024
ParkCRLA	0.7264	0.3829	1.8971	0.0625
ParkDENA	-0.6901	0.4369	-1.5795	0.1193
ParkGLAC	3.2538	0.4087	7.9623	0.0000
ParkKATMF	1.7755	0.5275	3.3660	0.0013
ParkKATMH	3.1398	0.6008	5.2263	0.0000
ParkLAVO	0.3980	0.3994	0.9965	0.3229
ParkMORA	2.2500	0.4100	5.4876	0.0000
ParkNOCA	1.9666	0.4803	4.0947	0.0001
ParkSEKI	0.0906	0.3262	0.2778	0.7821
ParkSTLEA	2.2205	0.5594	3.9691	0.0002
ParkSTLEP	4.1586	0.5348	7.7764	0.0000
Elevm	0.0013	0.0002	6.7546	0.0000

Residual standard error: 0.5605 on 62 degrees of freedom

Multiple R-Squared: 0.8793

F-statistic: 37.65 on 12 and 62 degrees of freedom, the p-value is 0

Residual plot range between -1 and +1. Cases 23, 73, and 19 high.

γ-HCH

formula = sqrt(gHCH) ~ Park + Elevm

Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.0997	0.6836	-1.6087	0.1128
ParkCRLA	-0.0675	0.4853	-0.1392	0.8898
ParkDENA	0.2013	0.5537	0.3635	0.7175
ParkGLAC	6.3376	0.5179	12.2379	0.0000
ParkKATMF	1.1518	0.6684	1.7231	0.0899
ParkKATMH	2.6427	0.7613	3.4712	0.0009
ParkLAVO	-0.3969	0.5062	-0.7841	0.4360
ParkMORA	2.3683	0.5196	4.5580	0.0000
ParkNOCA	1.7265	0.6087	2.8365	0.0062
ParkSEKI	0.9654	0.4134	2.3354	0.0228
ParkSTLEA	1.9234	0.7089	2.7131	0.0086
ParkSTLEP	3.9268	0.6777	5.7945	0.0000
Elevm	0.0016	0.0002	6.4561	0.0000

Residual standard error: 0.7102 on 62 degrees of freedom

Multiple R-Squared: 0.897

F-statistic: 45.01 on 12 and 62 degrees of freedom, the p-value is 0

Residual plot range between -1 and +1. Cases 23 (very low) and 19 and 73 high outliers.

trans-Chlordane

formula = transChlordane ~ Park + Elevm

Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-2.3755	1.3069	-1.8176	0.0750
ParkCRLA	1.7337	0.8895	1.9490	0.0568
ParkGLAC	3.9573	0.9647	4.1020	0.0001
ParkKATMF	1.1313	1.2488	0.9060	0.3692
ParkKATMH	2.7274	1.4353	1.9003	0.0631

ParkLAVO	1.8793	0.9267	2.0280	0.0478
ParkMORA	2.0931	0.9728	2.1516	0.0362
ParkNOCA	1.3339	1.1355	1.1747	0.2456
ParkSEKI	4.8500	0.7568	6.4087	0.0000
ParkSTLEA	1.9919	1.3370	1.4898	0.1424
ParkSTLEP	2.9709	1.2744	2.3312	0.0237
Elevm	0.0018	0.0005	3.7280	0.0005

Residual standard error: 1.299 on 51 degrees of freedom
Multiple R-Squared: 0.7684
F-statistic: 15.38 on 11 and 51 degrees of freedom, the p-value is 1.306e-012
Residual plot range between -2 and +2. Cases 51 (low) and 61 and 9 high outliers.

cis-Nonachlor

formula = cisNonachlor ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.3992	0.5406	-2.5884	0.0125
ParkCRLA	0.7191	0.3679	1.9546	0.0561
ParkGLAC	1.7262	0.3990	4.3263	0.0001
ParkKATMF	0.8340	0.5165	1.6148	0.1125
ParkKATMH	1.7377	0.5936	2.9271	0.0051
ParkLAVO	0.5762	0.3833	1.5034	0.1389
ParkMORA	0.8960	0.4024	2.2268	0.0304
ParkNOCA	0.7204	0.4697	1.5339	0.1312
ParkSEKI	1.8485	0.3130	5.9055	0.0000
ParkSTLEA	1.2299	0.5530	2.2241	0.0306
ParkSTLEP	2.0254	0.5271	3.8424	0.0003
Elevm	0.0009	0.0002	4.8589	0.0000

Residual standard error: 0.5373 on 51 degrees of freedom
Multiple R-Squared: 0.7595
F-statistic: 14.64 on 11 and 51 degrees of freedom, the p-value is 3.254e-012
Residuals plot range between -1 and +1. Cases 11 (low) and 61 and 9 high outliers.

trans-Nonachlor

formula = transNonachlor ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-2.5202	1.3352	-1.8875	0.0648
ParkCRLA	1.8376	0.9088	2.0221	0.0484
ParkGLAC	3.7946	0.9856	3.8502	0.0003
ParkKATMF	1.3459	1.2757	1.0550	0.2964
ParkKATMH	3.3647	1.4663	2.2947	0.0259
ParkLAVO	1.7117	0.9467	1.8081	0.0765
ParkMORA	1.8813	0.9938	1.8930	0.0640
ParkNOCA	1.3925	1.1601	1.2004	0.2355
ParkSEKI	4.1004	0.7731	5.3036	0.0000
ParkSTLEA	2.2491	1.3659	1.6466	0.1058
ParkSTLEP	3.5636	1.3020	2.7371	0.0085
Elevm	0.0017	0.0005	3.5885	0.0007

Residual standard error: 1.327 on 51 degrees of freedom
Multiple R-Squared: 0.6971
F-statistic: 10.67 on 11 and 51 degrees of freedom, the p-value is 8.093e-010
Residuals plot range between -2 and +2. Cases 17, 61 and 9 high outliers.

Sum of Chlordanes

formula = sqrt(SumChlordane) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.1250	0.6599	0.1894	0.8505
ParkCRLA	0.8772	0.4492	1.9530	0.0563
ParkGLAC	1.5560	0.4871	3.1943	0.0024
ParkKATMF	0.1564	0.6305	0.2480	0.8051
ParkKATMH	1.5729	0.7247	2.1704	0.0347
ParkLAVO	1.1679	0.4679	2.4959	0.0158
ParkMORA	1.0416	0.4912	2.1206	0.0388
ParkNOCA	0.1812	0.5734	0.3161	0.7532
ParkSEKI	2.2368	0.3821	5.8537	0.0000
ParkSTLEA	0.3788	0.6751	0.5612	0.5771
ParkSTLEP	1.4204	0.6435	2.2074	0.0318
Elevm	0.0009	0.0002	3.9338	0.0003

Residual standard error: 0.6559 on 51 degrees of freedom
Multiple R-Squared: 0.7878
F-statistic: 17.22 on 11 and 51 degrees of freedom, the p-value is 1.558e-013
Residuals plot range between -1 and +1. Cases 61 and 9 high outliers.

Sum of DDTs

formula = log(DDTSum) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	2.0223	0.5692	3.5531	0.0010
ParkCRLA	-0.4842	0.3569	-1.3567	0.1825
ParkGLAC	2.5460	0.4011	6.3469	0.0000
ParkLAVO	0.4262	0.3707	1.1497	0.2571
ParkMORA	-1.4277	0.4077	-3.5015	0.0012
ParkNOCA	-1.5304	0.4727	-3.2379	0.0024
ParkSEKI	2.1791	0.3028	7.1970	0.0000
Elevm	0.0004	0.0002	1.7519	0.0875

Residual standard error: 0.5186 on 40 degrees of freedom
Multiple R-Squared: 0.9321
F-statistic: 78.46 on 7 and 40 degrees of freedom, the p-value is 0
Residual plot range between -1 an +1. Cases 2 (low) and 18 and 33 high outliers.

PCB 118

formula = log(PCB118) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.1580	0.6202	-1.8671	0.0694
ParkCRLA	0.3751	0.4939	0.7594	0.4522
ParkGLAC	1.2140	0.4376	2.7739	0.0085
ParkKATMH	0.6093	0.6653	0.9159	0.3654
ParkLAVO	0.3561	0.6363	0.5596	0.5789
ParkMORA	0.8471	0.4454	1.9018	0.0646
ParkNOCA	0.7244	0.5166	1.4024	0.1687
ParkSEKI	0.1868	0.3318	0.5628	0.5768
ParkSTLEA	0.1196	0.6301	0.1899	0.8504
ParkSTLEP	1.3307	0.6724	1.9790	0.0549
Elevm	0.0006	0.0002	2.5688	0.0141

Residual standard error: 0.5684 on 39 degrees of freedom
Multiple R-Squared: 0.3786
F-statistic: 2.376 on 10 and 39 degrees of freedom, the p-value is 0.02623
Residuals range between -1 and +1. Case 8 very low outlier.

PCB 153

formula = PCB153 ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.1434	0.6019	-0.2383	0.8126
ParkCRLA	0.2482	0.4096	0.6060	0.5472
ParkGLAC	1.5311	0.4443	3.4464	0.0011
ParkKATMF	-0.0854	0.5751	-0.1485	0.8825
ParkKATMH	0.7329	0.6610	1.1088	0.2727
ParkLAVO	-0.1258	0.4267	-0.2948	0.7693
ParkMORA	1.0255	0.4480	2.2891	0.0262
ParkNOCA	0.1088	0.5229	0.2081	0.8360
ParkSEKI	0.1757	0.3485	0.5040	0.6164
ParkSTLEA	0.2515	0.6157	0.4084	0.6847
ParkSTLEP	1.0623	0.5869	1.8101	0.0762
Elevm	0.0006	0.0002	2.9983	0.0042

Residual standard error: 0.5982 on 51 degrees of freedom
Multiple R-Squared: 0.5345
F-statistic: 5.324 on 11 and 51 degrees of freedom, the p-value is 0.00001521
Residual plot range between -1 and +1. Cases 11 (low) and 9 and 61 high outliers.

PCB 183

formula = PCB183 ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.0418	0.1495	-0.2798	0.7807
ParkCRLA	0.0133	0.1064	0.1247	0.9012
ParkGLAC	0.0769	0.1103	0.6974	0.4888
ParkKATMF	-0.0353	0.1427	-0.2476	0.8055
ParkKATMH	0.2192	0.1641	1.3356	0.1877
ParkLAVO	-0.0787	0.1058	-0.7441	0.4603
ParkMORA	0.1935	0.1112	1.7402	0.0880
ParkNOCA	0.0463	0.1298	0.3566	0.7229
ParkSEKI	0.1099	0.0864	1.2719	0.2093
ParkSTLEA	0.0446	0.1529	0.2918	0.7717
ParkSTLEP	0.1799	0.1457	1.2349	0.2226
Elevm	0.0002	0.0001	2.9410	0.0049

Residual standard error: 0.1483 on 50 degrees of freedom
Multiple R-Squared: 0.4552
F-statistic: 3.798 on 11 and 50 degrees of freedom, the p-value is 0.0005441
Residual plot range between -.2 and +.2. Outliers 60, 47 and 48 high.

Sum of PCBs

formula = PCBSum ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.3328	2.3896	-0.5577	0.5795
ParkCRLA	0.7753	1.6264	0.4767	0.6356
ParkGLAC	7.8398	1.7639	4.4446	0.0000

ParkKATMF	-0.4112	2.2832	-0.1801	0.8578
ParkKATMH	3.6197	2.6243	1.3793	0.1738
ParkLAVO	-1.1251	1.6943	-0.6641	0.5096
ParkMORA	4.2087	1.7787	2.3662	0.0218
ParkNOCA	1.9161	2.0762	0.9229	0.3604
ParkSEKI	1.1741	1.3837	0.8485	0.4001
ParkSTLEA	1.4407	2.4446	0.5894	0.5582
ParkSTLEP	4.1668	2.3301	1.7882	0.0797
Elevm	0.0030	0.0009	3.5145	0.0009

Residual standard error: 2.375 on 51 degrees of freedom
Multiple R-Squared: 0.6174
F-statistic: 7.481 on 11 and 51 degrees of freedom, the p-value is 1.879e-007
Residual plot range between -4 and +4. Cases 38, 9 and 10 high outliers.

FLO

formula = log(FLO) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	2.3852	0.6061	3.9355	0.0003
ParkCRLA	2.1241	0.5901	3.5996	0.0008
ParkDENA	-1.3529	0.5818	-2.3254	0.0248
ParkGLAC	4.8701	0.4977	9.7859	0.0000
ParkKATMF	-0.6778	0.6617	-1.0242	0.3115
ParkKATMH	0.9093	0.6266	1.4512	0.1540
ParkLAVO	1.1731	0.4635	2.5307	0.0151
ParkMORA	1.4319	0.5047	2.8370	0.0069
ParkNOCA	0.8034	0.5392	1.4899	0.1435
ParkSEKI	2.3795	0.4319	5.5098	0.0000
ParkSTLEA	-0.4440	0.6011	-0.7387	0.4641
ParkSTLEP	2.1383	0.5821	3.6736	0.0007
Elevm	-0.0007	0.0002	-4.1979	0.0001

Residual standard error: 0.4004 on 43 degrees of freedom
Multiple R-Squared: 0.9479
F-statistic: 65.24 on 12 and 43 degrees of freedom, the p-value is 0
Residual plot range between -.5 and +1. Cases 16 (low) and 18 and 33 high outliers.

PHE

formula = log(PHE) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	6.5184	0.3276	19.8970	0.0000
ParkDENA	-3.5566	0.3037	-11.7123	0.0000
ParkGLAC	4.6367	0.2378	19.4966	0.0000
ParkKATMF	-3.0210	0.3624	-8.3357	0.0000
ParkKATMH	-0.9352	0.3694	-2.5319	0.0146
ParkLAVO	-1.0698	0.2674	-4.0000	0.0002
ParkMORA	-0.6393	0.2347	-2.7238	0.0089
ParkNOCA	-1.2356	0.2852	-4.3325	0.0001
ParkSEKI	0.2895	0.1961	1.4764	0.1462
ParkSTLEA	-3.0623	0.3402	-9.0024	0.0000
ParkSTLEP	0.6759	0.3226	2.0951	0.0413
Elevm	-0.0006	0.0001	-4.2772	0.0001

Residual standard error: 0.3659 on 49 degrees of freedom
Multiple R-Squared: 0.9754

F-statistic: 176.4 on 11 and 49 degrees of freedom, the p-value is 0
Residual plot range between -.5 and +.5. Cases 25 and 3 low and 8 high outliers.

Retene

formula = log(Retene + 1e-006) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	4.3334	2.9265	1.4807	0.1442
ParkCRLA	4.7735	2.0253	2.3570	0.0219
ParkDENA	-3.5747	2.5152	-1.4212	0.1607
ParkGLAC	6.8797	2.1943	3.1352	0.0027
ParkKATMF	0.9801	2.8216	0.3474	0.7296
ParkKATMH	0.1757	3.2315	0.0544	0.9568
ParkLAVO	3.9156	2.1109	1.8549	0.0688
ParkMORA	2.4660	2.1962	1.1229	0.2662
ParkNOCA	1.5408	2.5672	0.6002	0.5508
ParkSEKI	4.9443	1.7239	2.8681	0.0058
ParkSTLEA	-0.7905	3.0098	-0.2626	0.7938
ParkSTLEP	1.4773	2.8721	0.5144	0.6090
Elevm	-0.0015	0.0010	-1.4802	0.1443

Residual standard error: 2.96 on 57 degrees of freedom
Multiple R-Squared: 0.4881
F-statistic: 4.529 on 12 and 57 degrees of freedom, the p-value is 0.00004422
Residual plot better, but messy, range -5 and +5. Many very low outliers, especially low cases 4 and 14.

CHR/TRI

formula = log(CHR.TRI) ~ Park + Elevm,
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	3.7637	0.6259	6.0133	0.0000
ParkCRLA	1.3432	0.4425	3.0351	0.0035
ParkDENA	-2.7154	0.5061	-5.3647	0.0000
ParkGLAC	5.5466	0.4760	11.6536	0.0000
ParkKATMF	-1.2986	0.6107	-2.1264	0.0375
ParkKATMH	-1.7043	0.6961	-2.4483	0.0172
ParkLAVO	-0.6584	0.4616	-1.4265	0.1588
ParkMORA	0.7754	0.4748	1.6331	0.1076
ParkNOCA	0.1692	0.5560	0.3043	0.7619
ParkSEKI	0.8921	0.3769	2.3667	0.0211
ParkSTLEA	-1.6393	0.6483	-2.5289	0.0140
ParkSTLEP	-0.3516	0.6195	-0.5676	0.5724
Elevm	-0.0005	0.0002	-2.3518	0.0219

Residual standard error: 0.6476 on 61 degrees of freedom
Multiple R-Squared: 0.9271
F-statistic: 64.65 on 12 and 61 degrees of freedom, the p-value is 0
Residual plot range between -1 and +1. Cases 7 (low) and 8 and 19 high outliers.

B(a)A

formula = log(BaA) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	4.3467	0.8383	5.1850	0.0000
ParkCRLA	-0.1428	0.5875	-0.2431	0.8088
ParkDENA	-4.5253	0.6755	-6.6989	0.0000

ParkGLAC	4.7703	0.6338	7.5271	0.0000
ParkLAVO	-1.1255	0.6126	-1.8373	0.0714
ParkMORA	-1.2420	0.6331	-1.9618	0.0547
ParkNOCA	-3.2363	0.7408	-4.3688	0.0001
ParkSEKI	0.6786	0.5002	1.3565	0.1803
ParkSTLEA	-3.0583	0.8657	-3.5327	0.0008
ParkSTLEP	-2.1140	0.8268	-2.5568	0.0133
Elevm	-0.0014	0.0003	-4.6703	0.0000

Residual standard error: 0.8593 on 57 degrees of freedom
Multiple R-Squared: 0.8998
F-statistic: 51.21 on 10 and 57 degrees of freedom, the p-value is 0
Residual plot better, range between -1 and +1. Cases 57 (low) and 58 and 19 high outliers.

SUM OF PAHs

formula = log(PAHSum) ~ Park + Elevm
Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	7.0345	0.6864	10.2479	0.0000
ParkCRLA	1.5044	0.4853	3.0996	0.0029
ParkDENA	-4.1538	0.5551	-7.4830	0.0000
ParkGLAC	5.8868	0.5220	11.2776	0.0000
ParkKATMF	-1.7076	0.6697	-2.5496	0.0133
ParkKATMH	-0.8984	0.7634	-1.1768	0.2439
ParkLAVO	0.3340	0.5062	0.6597	0.5119
ParkMORA	0.5403	0.5207	1.0377	0.3035
ParkNOCA	-0.2387	0.6098	-0.3915	0.6968
ParkSEKI	1.5335	0.4134	3.7094	0.0005
ParkSTLEA	-2.0292	0.7109	-2.8542	0.0059
ParkSTLEP	0.8172	0.6794	1.2029	0.2337
Elevm	-0.0009	0.0002	-3.5744	0.0007

Residual standard error: 0.7102 on 61 degrees of freedom
Multiple R-Squared: 0.9374
F-statistic: 76.11 on 12 and 61 degrees of freedom, the p-value is 0
Residual plot range between -1 and +1. Case 19 is high outlier. Several other outliers. Cases 17 and others low.

Appendix 4A.12. Summary Statistics of Element Concentrations (ppm) in Lichen Samples from the Core WACAP Parks.

		GAAR		NOAT		DENA		OLYM		MORA	SEKI	GLAC			ROMO
		Flcu	Mari	Flcu	Mari	Flcu	Mari	Alsa	Plgl	Alsa	Levu	Alsa	Levu	Plgl	Xant
	N	3	2	2	4	6	6	6	2	6	3	3	3	3	3
Al	**Mean**	**675.5**	**90.5**	**133.0**	**48.2**	**237.9**	**47.0**	**34.0**	**422.5**	**60.3**	**283.3**	**99.7**	**383.3**	**897.6**	**3066.7**
	s.d.	131.5	5.0	1.9	13.5	29.5	9.0	8.9	116.7	16.3	55.1	12.4	79.3	184.8	957.1
	s.e.	75.9	3.5	1.3	6.7	12.0	3.7	3.6	82.5	6.6	31.8	7.2	45.8	106.7	552.6
As	**Mean**	**0.66**	**0.19**	**0.20**	**0.07**	**0.39**	**0.16**	**0.06**	**0.31**	**0.10**	**0.30**	**0.18**	**0.58**	**0.60**	
	s.d.	0.06	0.02	0.05	0.03	0.09	0.04	0.02	0.03	0.04	0.05	0.04	0.09	0.03	
	s.e.	0.03	0.01	0.04	0.01	0.04	0.02	0.01	0.02	0.02	0.03	0.02	0.05	0.02	
Ba	**Mean**	**9.49**	**3.31**	**70.00**	**41.02**	**9.59**	**3.38**	**9.94**	**56.17**	**1.66**	**5.72**	**17.49**	**11.22**	**71.38**	**31.24**
	s.d.	1.98	0.05	3.34	26.72	1.57	1.08	2.43	16.34	0.59	0.84	3.51	1.94	4.64	12.64
	s.e.	1.14	0.03	2.36	13.36	0.64	0.44	0.99	11.56	0.24	0.49	2.02	1.12	2.68	7.30
Bi	**Mean**	**0.023**	**0.023**	**0.056**	**0.026**	**0.017**	**0.013**	**0.007**	**0.028**	**0.016**	**0.017**	**0.021**	**0.051**	**0.071**	
	s.d.	0.003	0.008	0.003	0.025	0.010	0.006	0.001	0.006	0.009	0.002	0.007	0.007	0.018	
	s.e.	0.002	0.006	0.002	0.013	0.004	0.002	0.000	0.004	0.004	0.001	0.004	0.004	0.010	
Ca	**Mean**	**21956**	**18090**	**4139**	**2517**	**1341**	**1252**	**3000**	**2514**	**4234**	**1564**	**1754**	**2729**	**2913**	**17062**
	s.d.	1506	857	158	1410	42	378	1358	414	1128	235	251	737	92	4870
	s.e.	870	606	112	705	17	154	554	293	460	136	145	425	53	2812
Cd	**Mean**	**0.220**	**0.202**	**0.194**	**0.136**	**0.101**	**0.064**	**0.077**	**0.084**	**0.068**	**0.072**	**0.100**	**0.337**	**0.379**	**0.663**
	s.d.	0.050	0.003	0.021	0.053	0.027	0.013	0.034	0.036	0.020	0.006	0.012	0.077	0.043	0.137
	s.e.	0.029	0.002	0.015	0.026	0.011	0.005	0.014	0.026	0.008	0.003	0.007	0.044	0.025	0.079
Ce	**Mean**	**2.38**	**0.44**	**0.18**	**0.12**	**0.39**	**0.13**	**0.08**	**0.36**	**0.20**	**0.55**	**0.24**	**1.44**	**1.78**	
	s.d.	0.25	0.05	0.01	0.05	0.04	0.05	0.02	0.00	0.03	0.12	0.04	0.22	0.11	
	s.e.	0.15	0.03	0.01	0.02	0.02	0.02	0.01	0.00	0.01	0.07	0.02	0.13	0.06	
Co	**Mean**	**0.47**	**0.12**	**0.16**	**0.11**	**0.28**	**0.12**	**0.11**	**0.25**	**0.07**	**0.15**	**0.10**	**0.27**	**0.36**	**0.24**
	s.d.	0.08	0.02	0.01	0.03	0.06	0.02	0.06	0.08	0.03	0.03	0.00	0.03	0.03	0.00
	s.e.	0.05	0.01	0.01	0.02	0.02	0.01	0.02	0.06	0.01	0.02	0.00	0.02	0.02	0.00
Cu	**Mean**	**2.51**	**1.04**	**1.70**	**0.75**	**1.55**	**0.80**	**0.72**	**2.50**	**1.06**	**2.93**	**1.22**	**1.97**	**3.40**	**10.43**
	s.d.	0.27	0.01	0.06	0.09	0.12	0.08	0.14	0.08	0.30	0.31	0.03	0.35	0.26	4.51
	s.e.	0.15	0.01	0.04	0.05	0.05	0.03	0.06	0.06	0.12	0.18	0.01	0.20	0.15	2.60
Dy	**Mean**	**0.118**	**0.041**	**0.021**	**0.013**	**0.027**	**0.017**	**0.008**	**0.023**	**0.015**	**0.031**	**0.019**	**0.115**	**0.106**	
	s.d.	0.034	0.000	0.002	0.005	0.004	0.007	0.002	0.004	0.003	0.007	0.005	0.019	0.008	
	s.e.	0.019	0.000	0.001	0.003	0.002	0.003	0.001	0.003	0.001	0.004	0.003	0.011	0.005	
Er	**Mean**	**0.049**	**0.019**	**0.011**	**0.005**	**0.015**	**0.008**	**0.003**	**0.011**	**0.009**	**0.016**	**0.012**	**0.064**	**0.056**	
	s.d.	0.013	0.001	0.001	0.002	0.002	0.004	0.002	0.000	0.003	0.004	0.004	0.011	0.003	
	s.e.	0.008	0.001	0.001	0.001	0.001	0.002	0.001	0.000	0.001	0.002	0.002	0.006	0.002	
Eu	**Mean**	**0.045**	**0.010**	**0.005**	**0.004**	**0.009**	**0.004**	**0.002**	**0.007**	**0.004**	**0.008**	**0.005**	**0.028**	**0.029**	
	s.d.	0.007	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.004	0.002	
	s.e.	0.004	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.002	0.001	
Fe	**Mean**	**1656.7**	**245.8**	**272.0**	**98.9**	**405.4**	**101.2**	**50.7**	**525.0**	**64.7**	**363.3**	**132.3**	**562.7**	**1325.6**	**2905.8**
	s.d.	119.3	3.2	2.7	19.1	92.1	24.6	15.8	91.9	19.0	51.3	9.2	106.3	172.1	891.1
	s.e.	68.9	2.3	1.9	9.5	37.6	10.0	6.5	65.0	7.8	29.6	5.3	61.4	99.4	514.5
Ga	**Mean**	**0.211**	**0.033**	**0.054**	**0.015**	**0.080**	**0.018**	**0.014**	**0.128**	**0.022**	**0.087**	**0.043**	**0.137**	**0.370**	
	s.d.	0.032	0.002	0.002	0.003	0.012	0.004	0.003	0.028	0.007	0.013	0.001	0.024	0.057	
	s.e.	0.019	0.001	0.002	0.001	0.005	0.002	0.001	0.020	0.003	0.008	0.001	0.014	0.033	

Gd	**Mean**	**0.192**	**0.051**	**0.027**	**0.019**	**0.039**	**0.020**	**0.008**	**0.028**	**0.022**	**0.041**	**0.026**	**0.143**	**0.143**	
	s.d.	0.038	0.003	0.001	0.007	0.010	0.008	0.004	0.005	0.005	0.009	0.002	0.029	0.009	
	s.e.	0.022	0.002	0.001	0.004	0.004	0.003	0.002	0.003	0.002	0.005	0.001	0.017	0.005	
Hg	**Mean**	**0.017**	**0.023**	**0.022**	**0.026**	**0.012**	**0.021**	**0.232**	**0.268**	**0.154**	**0.301**	**0.136**	**0.388**	**0.266**	
	s.d.	0.002	0.003	0.003	0.003	0.002	0.006	0.036	0.025	0.023	0.017	0.017	0.067	0.020	
	s.e.	0.001	0.002	0.002	0.002	0.001	0.003	0.015	0.018	0.009	0.010	0.010	0.039	0.012	
Ho	**Mean**	**0.020**	**0.007**	**0.004**	**0.003**	**0.005**	**0.003**	**0.002**	**0.005**	**0.004**	**0.006**	**0.003**	**0.022**	**0.021**	
	s.d.	0.005	0.001	0.000	0.001	0.001	0.002	0.000	0.000	0.001	0.001	0.001	0.005	0.003	
	s.e.	0.003	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.003	0.002	
K	**Mean**	**1840**	**1418**	**2611**	**1476**	**2603**	**1462**	**1583**	**1494**	**1821**	**2319**	**1917**	**2246**	**2047**	**2963**
	s.d.	159	33	264	88	270	234	183	114	130	64	166	190	27	195
	s.e.	92	23	187	44	110	95	75	80	53	37	96	110	16	113
La	**Mean**	**1.133**	**0.212**	**0.084**	**0.054**	**0.182**	**0.057**	**0.036**	**0.178**	**0.089**	**0.285**	**0.113**	**0.684**	**0.864**	
	s.d.	0.139	0.013	0.000	0.022	0.024	0.022	0.009	0.000	0.014	0.053	0.016	0.113	0.070	
	s.e.	0.080	0.009	0.000	0.011	0.010	0.009	0.004	0.000	0.006	0.031	0.009	0.065	0.041	
Li	**Mean**	**0.837**	**0.096**	**0.135**	**0.022**	**0.224**	**0.038**	**0.028**	**0.204**	**0.027**	**0.238**	**0.125**	**0.311**	**0.557**	**2.067**
	s.d.	0.135	0.069	0.002	0.000	0.051	0.026	0.012	0.051	0.018	0.072	0.050	0.031	0.155	0.505
	s.e.	0.078	0.049	0.001	0.000	0.021	0.010	0.005	0.036	0.007	0.042	0.029	0.018	0.089	0.292
Lu	**Mean**	**0.007**	**0.003**	**0.001**	**0.001**	**0.002**	**0.001**	**0.000**	**0.001**	**0.001**	**0.002**	**0.001**	**0.008**	**0.007**	
	s.d.	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.001	
	s.e.	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	
Mg	**Mean**	**793.2**	**192.6**	**686.2**	**186.9**	**383.5**	**116.7**	**346.6**	**386.0**	**261.4**	**453.9**	**325.3**	**600.2**	**639.4**	**932.0**
	s.d.	10.9	7.1	21.0	27.0	57.7	25.5	42.8	29.5	16.2	33.8	9.6	51.7	37.8	171.0
	s.e.	6.3	5.0	14.8	13.5	23.6	10.4	17.5	20.9	6.6	19.5	5.6	29.8	21.8	98.7
Mn	**Mean**	**58.0**	**21.3**	**385.3**	**97.2**	**208.8**	**31.1**	**100.1**	**164.0**	**153.7**	**97.3**	**160.6**	**262.2**	**126.3**	**77.0**
	s.d.	4.2	0.2	30.9	28.9	52.8	13.7	48.0	118.2	67.9	2.4	23.7	113.4	5.1	42.2
	s.e.	2.4	0.2	21.8	14.4	21.5	5.6	19.6	83.6	27.7	1.4	13.7	65.5	2.9	24.3
Mo	**Mean**	**626.94**	**0.61**	**0.51**	**0.34**		**0.29**	**0.30**	**0.86**	**166.33**		**0.58**	**0.35**	**0.42**	**1.82**
	s.d.	58.67	0.22	.	0.08		.	0.11	.	190.53		0.39	.	.	0.31
	s.e.	33.87	0.16	.	0.06		.	0.08	.	77.78		0.28	.	.	0.18
Na	**Mean**	**1.2**	**94.3**	**718.3**	**226.6**	**144.7**	**150.3**	**137.0**	**104.6**	**0.1**	**67.2**	**137.1**	**95.5**	**105.6**	**92.1**
	s.d.	0.1	4.9	23.8	192.5	38.8	162.0	35.8	56.2	0.0	54.2	173.2	33.7	35.1	11.8
	s.e.	0.1	3.5	16.9	96.2	15.8	66.1	14.6	39.7	0.0	31.3	100.0	19.5	20.2	6.8
Nd	**Mean**	**1.274**	**0.230**	**0.107**	**0.073**	**0.197**	**0.083**	**0.042**	**0.187**	**0.323**	**0.230**	**0.125**	**0.746**	**0.873**	
	s.d.	0.229	0.029	0.001	0.027	0.015	0.033	0.013	0.004	0.262	0.047	0.024	0.124	0.060	
	s.e.	0.132	0.020	0.001	0.013	0.006	0.013	0.005	0.003	0.107	0.027	0.014	0.071	0.035	
Ni	**Mean**	**544.378**	**0.225**	**0.802**	**0.413**	**0.717**	**0.325**	**0.446**	**2.124**	**674.208**	**0.916**	**0.810**	**0.594**	**2.128**	**4.330**
	s.d.	45.214	0.033	0.300	0.063	0.198	0.228	0.114	0.810	117.317	0.229	0.393	0.102	0.077	0.410
	s.e.	26.104	0.023	0.212	0.032	0.081	0.093	0.047	0.573	47.894	0.132	0.227	0.059	0.054	0.237
P	**Mean**	**1**	**330**	**763**	**491**	**538**	**327**	**433**	**740**	**1**	**738**	**648**	**583**	**705**	**1112**
	s.d.	0	23	16	116	143	113	98	142	0	73	96	110	56	165
	s.e.	0	16	11	58	59	46	40	101	0	42	55	63	32	95
Pb	**Mean**	**0.30**	**0.86**	**0.25**	**0.42**	**0.53**	**0.48**	**1.09**	**4.22**	**0.03**	**1.39**	**0.96**	**3.90**	**6.59**	**21.16**
	s.d.	0.03	0.02	0.02	0.13	0.04	0.17	0.23	0.44	0.01	0.18	0.23	.	.	1.65
	s.e.	0.02	0.01	0.01	0.07	0.01	0.07	0.09	0.31	0.00	0.10	0.13	.	.	0.95
Pr	**Mean**	**3.924**	**0.055**	**0.024**	**0.016**	**0.049**	**0.018**	**0.010**	**0.046**	**3.623**	**0.062**	**0.030**	**0.182**	**0.223**	
	s.d.	0.325	0.004	0.001	0.006	0.006	0.007	0.002	0.000	0.875	0.015	0.005	0.029	0.016	
	s.e.	0.188	0.003	0.001	0.003	0.002	0.003	0.001	0.000	0.357	0.009	0.003	0.017	0.009	

Rb	**Mean**	**330.93**	**2.46**	**3.38**	**2.42**	**8.05**	**4.72**	**1.70**	**2.50**	**409.43**	**8.10**	**1.51**	**1.80**	**3.11**	
	s.d.	39.88	0.05	0.24	0.26	1.44	1.52	0.79	0.45	88.62	0.20	0.28	0.03	0.29	
	s.e.	23.03	0.03	0.17	0.13	0.59	0.62	0.32	0.32	36.18	0.11	0.16	0.02	0.16	
S	**Mean**	**0**	**227**	**296**	**244**	**244**	**240**	**353**	**585**	**0**	**1017**	**568**	**1073**	**985**	**1227**
	s.d.	0	47	6	29	32	60	75	83	0	64	22	107	46	154
	s.e.	0	33	4	15	13	25	31	59	0	37	13	62	27	89
Sb	**Mean**	**0.237**	**0.032**	**0.101**	**0.016**	**0.070**	**0.021**	**0.012**	**0.017**	**0.023**	**0.016**	**0.052**	**0.124**	**0.140**	
	s.d.	0.027	0.005	0.008	0.008	0.016	0.010	0.008	0.005	0.007	0.006	0.005	0.008	0.014	
	s.e.	0.016	0.004	0.006	0.004	0.007	0.004	0.003	0.003	0.003	0.004	0.003	0.005	0.008	
Sm	**Mean**	**15.941**	**0.052**	**0.023**	**0.016**	**0.040**	**0.018**	**0.010**	**0.037**	**5.753**	**0.044**	**0.025**	**0.144**	**0.165**	
	s.d.	1.211	0.010	0.007	0.005	0.002	0.007	0.004	0.002	1.728	0.009	0.002	0.023	0.005	
	s.e.	0.699	0.007	0.005	0.003	0.001	0.003	0.002	0.001	0.705	0.005	0.001	0.013	0.003	
Sr	**Mean**	**0.03**	**8.68**	**6.46**	**2.60**	**3.17**	**1.59**	**12.18**	**15.81**	**0.00**	**6.14**	**5.92**	**3.88**	**19.55**	**21.75**
	s.d.	0.00	0.77	0.06	0.85	0.23	0.22	2.53	6.73	0.00	0.92	0.96	0.58	0.08	4.11
	s.e.	0.00	0.55	0.04	0.42	0.10	0.09	1.03	4.76	0.00	0.53	0.55	0.34	0.05	2.37
Tb	**Mean**	**0.414**	**0.007**	**0.004**	**0.002**	**0.005**	**0.003**	**0.001**	**0.005**	**0.021**	**0.005**	**0.003**	**0.019**	**0.021**	
	s.d.	0.004	0.000	0.001	0.001	0.000	0.001	0.000	0.001	0.022	0.001	0.000	0.002	0.001	
	s.e.	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.001	0.000	0.001	0.001	
Th	**Mean**	**0.007**	**0.030**	**0.031**	**0.023**	**0.041**	**0.028**	**0.007**	**0.061**	**0.001**	**0.115**	**0.024**	**0.205**	**0.384**	
	s.d.	0.000	0.008	0.013	0.026	0.018	0.029	0.000	0.016	0.000	0.022	0.012	0.115	0.149	
	s.e.	0.000	0.006	0.009	0.013	0.007	0.012	0.000	0.012	0.000	0.013	0.007	0.066	0.086	
Tm	**Mean**	**0.064**	**0.003**	**0.001**	**0.001**	**0.002**	**0.001**	**0.000**	**0.002**	**0.001**	**0.002**	**0.002**	**0.009**	**0.008**	
	s.d.	0.010	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.002	0.001	
	s.e.	0.006	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	
U	**Mean**	**1.341**	**0.041**	**0.007**	**0.006**	**0.024**	**0.011**	**0.003**	**0.021**	**0.108**	**0.059**	**0.011**	**0.022**	**0.059**	
	s.d.	0.191	0.008	0.002	0.004	0.009	0.004	0.005	0.006	0.103	0.004	0.009	0.003	0.005	
	s.e.	0.110	0.006	0.002	0.002	0.004	0.002	0.002	0.004	0.042	0.002	0.005	0.002	0.003	
V	**Mean**	**0.01**	**0.34**	**0.48**	**0.12**	**0.50**	**0.14**	**0.10**	**0.97**	**0.01**	**0.50**	**0.22**	**0.89**	**1.94**	**5.30**
	s.d.	.	0.16	0.02	0.03	0.07	0.02	0.05	0.14	0.00	0.11	0.06	0.20	0.04	1.76
	s.e.	.	0.11	0.01	0.01	0.03	0.01	0.02	0.10	0.00	0.07	0.03	0.12	0.03	1.02
W	**Mean**						**0.017**		**0.016**		**0.022**	**0.018**	**0.020**	**0.026**	
	s.d.						0.006		0.005		0.004	0.004	0.002	0.009	
	s.e.						0.004		0.003		0.002	0.003	0.001	0.005	
Y	**Mean**	**0.52**	**0.23**	**0.13**	**0.09**	**0.16**	**0.09**	**0.05**	**0.12**	**0.10**	**0.16**	**0.11**	**0.65**	**0.55**	
	s.d.	0.10	0.00	0.00	0.03	0.02	0.04	0.01	0.01	0.02	0.03	0.02	0.13	0.02	
	s.e.	0.06	0.00	0.00	0.02	0.01	0.02	0.00	0.01	0.01	0.02	0.01	0.07	0.01	
Yb	**Mean**	**0.042**	**0.021**	**0.008**	**0.006**	**0.012**	**0.009**	**0.004**	**0.011**	**0.007**	**0.015**	**0.010**	**0.054**	**0.052**	
	s.d.	0.010	0.000	0.001	0.002	0.002	0.003	0.001	0.001	0.002	0.003	0.002	0.011	0.004	
	s.e.	0.005	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.002	0.001	0.006	0.002	
Zn	**Mean**	**27.4**	**20.7**	**0.5**	**25.0**	**23.3**	**13.8**	**17.3**	**23.7**	**22.7**	**27.0**	**20.0**	**38.7**	**24.9**	**54.9**
	s.d.	2.4	0.8	0.3	2.2	1.4	1.3	0.8	0.8	4.3	4.4	0.6	2.3	1.5	2.8
	s.e.	1.4	0.6	0.2	1.1	0.6	0.5	0.3	0.6	1.8	2.5	0.3	1.3	0.9	1.6
Zr	**Mean**	**0.86**	**0.28**		**0.35**	**0.30**	**0.29**	**0.30**	**0.65**	**0.35**	**0.46**	**0.26**	**0.82**	**1.77**	
	s.d.	0.06	0.06		0.25	0.06	0.20	0.16	0.42	0.09	0.21	0.03	0.24	0.34	
	s.e.	0.03	0.04		0.13	0.02	0.08	0.06	0.30	0.04	0.12	0.02	0.14	0.20	

Notes: Flcu= *Flavocetraria cucullata*, Mari = *Masonhalea richardsonii*, Alsa = *Alectoria sarmentosa*, Plgl = *Platismatia glauca*, Levu = *Letharia vulpina*, Xant = *Xanthoparmelia sp.*
s.d.= standard deviation; s.e. = mean standard error; N = number of samples. Laboratory replicates were averaged before calculating means, field replicates were treated as independent measurements.

Appendix 4A.13. Summary Statistics for Nitrogen Concentrations (ppm) in Lichens from the 20 WACAP Parks.

		Alaska							Pacific Northwest				California			N Rockies			S Rockies		
		GAAR	NOAT	DENA	KATM	WRST	GLBA	STLE	NOCA	OLYM	MORA	CRLA	LAVO	YOSE	SEKI	GLAC	GRTE	ROMO	GRSA	BAND	BIBE
Alsa	**Ave**						**3890**	**3183**	**4223**	**4094**	**5141**					**8197**					
	s.d.							640	763	505	909					451					
	s.e.							320	382	191	262					260					
	N						1	4	4	7	12					3					
Bryo	**Ave**									**7778**											
	s.d.									299											
	s.e.									172											
	N									3											
Clar	**Ave**					**5360**		**3380**													
	s.d.																				
	s.e.																				
	N					1		1													
Flcu	**Ave**	**4800**	**5318**	**4074**	**4335**	**4370**															
	s.d.	144	364	370	303	.															
	s.e.	83	258	117	175	.															
	N	3	2	10	3	1															
Hyph	**Ave**				**7347**	**7133**								**9265**		**10300**					
	s.d.				2288	1895										3162					
	s.e.				1321	1094										1826					
	N				3	3								1		3					
Levu	**Mean**											**5759**	**7508**	**10800**	**17555**	**10498**	**8768**				
	s.d.											1111	1877	580	3531	1706					
	s.e.											497	840	410	1117	853					
	N											5	5	2	10	4	-1				
Loor	**Ave**							**18860**		**22050**											
	s.d.									501											
	s.e.									289											
	N							1		3											
Mari	**Ave**	**4150**	**3618**	**3985**					**5200**	**5115**							**9883**				

	s.d.	141	536	853					559				698					
	s.e.	100	169	246					395				493					
	N	2	10	12				1	2				0					
Plgl	**Ave**				**2920**	**7860**	**5498**					**10557**						
	s.d.						793					1557						
	s.e.						397					519						
	N				1	1	2					9						
Spgl	**Ave**					**5425**												
	s.d.					403												
	s.e.					285												
	N					2												
Tham	**Ave**			**2920**														
	s.d.																	
	s.e.																	
	N			1														
Usne	**Ave**															**16093**	**14755**	
	s.d.															735	1138	
	s.e.															367	805	
	N															4	2	
Xant	**Ave**									**13460**		**15667**		**11120**	**15280**			
	s.d.											2050		4851	3748			
	s.e.											1184		3430	2650			
	N									1		3		2	2			

Notes: Alsa= *Alectoria sarmentosa*, Bryo = *Bryoria* spp., Clar = *Cladina arbuscula*, Flcu= *Flavocetraria cucullata*, Hypphy = *Hypogymnia physodes*, Levu = *Letharia vulpina*, Loor = *Lobaria oregana*, Mari = *Masonhalea richardsonii*, Plgl = *Platismatia glauca*, Spgl = Sphaerophorus *globosus*, Tham = *Thamnolia* sp., Usne = *Usnea* spp., Xant = *Xanthoparmelia* spp.; s.d.= standard deviation; s.e. = mean standard error; N = number of samples. Laboratory replicates were averaged before calculating means, field replicates were treated as independent measurements.

Appendix 4A.14. Distribution of Cadmium, Mercury, Nitrogen, Lead, and Sulfur Concentrations in Lichen Genera in National Parks and Forests of the United States, 1977-2005. Ninety percent quantiles (yellow highlight) were used as thresholds for background ranges to assess enhancement in WACAP lichen samples. Data were obtained from the NPS national database NPElement (Bennett, 2007), the NPS Arctic Parks database courtesy of P. Neitlich (all *Masonhalea* and some *Flavocetraria* data), and the USFS National Lichens and Air Quality database (US Forest Service 2007). For a list of public lands from which distributions were calculated, see Appendix 3.15.

Cd ppm

Quantiles	*Alectoria*	*Bryoria*	*Cladina*	*Flavocetraria*	*Hypogymnia*	*Letharia*	*Lobaria*	*Masonhalea*	*Platismatia*	*Sphaerophorus*	*Usnea*	*Xanthoparmelia*
100.00%	9.95	3.45	17.80	0.48	3.76	5.13	9.81	0.52	17.30	0.32	3.43	3.40
99.50%	1.07	3.35	17.80	0.48	1.55	4.06	8.75	0.52	1.65	0.32	3.43	3.40
97.50%	0.50	0.50	1.54	0.46	0.90	2.01	0.87	0.52	0.64	0.22	3.24	3.14
90.00%	**0.24**	**0.30**	**0.47**	**0.24**	**0.40**	**0.34**	**0.20**	**0.28**	**0.40**	**0.18**	**3.04**	**0.79**
75.00%	0.18	0.20	0.30	0.21	0.30	0.22	0.12	0.24	0.27	0.12	0.32	0.60
50.00%	0.12	0.15	0.15	0.14	0.22	0.16	0.10	0.17	0.19	0.12	0.18	0.50
25.00%	0.10	0.12	0.12	0.10	0.18	0.12	0.10	0.06	0.14	0.10	0.10	0.40
10.00%	0.02	0.10	0.10	0.07	0.10	0.10	0.10	0.05	0.12	0.10	0.06	0.31
2.50%	0.01	0.10	0.06	0.06	0.04	0.00	0.07	0.05	0.10	0.10	0.03	0.20
0.50%	0.00	0.01	0.06	0.06	0.00	0.00	0.01	0.05	0.00	0.08	0.01	0.10
0.00%	0.00	0.00	0.06	0.06	0.00	0.00	0.01	0.05	0.00	0.08	0.01	0.10
Mean	0.15	0.20	0.41	0.16	0.27	0.28	0.21	0.17	0.25	0.12	0.72	0.64
Std Dev	0.33	0.29	1.69	0.08	0.25	0.54	0.72	0.11	0.54	0.04	1.15	0.60
Std Err	0.01	0.02	0.16	0.01	0.01	0.02	0.05	0.02	0.02	0.00	0.08	0.05
Upper 95%	0.17	0.24	0.73	0.18	0.29	0.32	0.30	0.22	0.28	0.13	0.87	0.75
Lower 95%	0.14	0.17	0.09	0.14	0.26	0.24	0.12	0.12	0.22	0.12	0.57	0.53
N	1491	262	111	48	1079	819	251	22	1192	110	230	122

Hg ppm

Quantiles	*Alectoria*	*Bryoria*	*Cladina*	*Flavocetraria*	*Hypogymnia*	*Letharia*	*Lobaria*	*Masonhalea*	*Platismatia*	*Sphaerophorus*	*Usnea*	*Xanthoparmelia*
100.00%	0.518	0.290	0.070	0.090	0.330	7.195	0.120	0.033	0.287		0.960	0.470
99.50%	0.518	0.290	0.070	0.090	0.330	7.195	0.120	0.033	0.287		0.960	0.470
97.50%	0.518	0.290	0.070	0.090	0.330	4.675	0.120	0.033	0.287		0.810	0.470

90.00%	**0.399**	**0.208**	**0.070**	**0.048**	**0.264**	**0.717**	**0.120**	**0.032**	**0.287**	**0.630**	**0.405**
75.00%	0.270	0.170	0.063	0.033	0.200	0.418	0.105	0.026	0.287	0.403	0.285
50.00%	0.185	0.160	0.050	0.025	0.090	0.170	0.045	0.022	0.263	0.210	0.255
25.00%	0.137	0.120	0.040	0.018	0.060	0.070	0.013	0.018	0.249	0.050	0.173
10.00%	0.010	0.078	0.040	0.013	0.040	0.026	0.010	0.015	0.247	0.030	0.030
2.50%	0.010	0.060	0.040	0.010	0.030	0.010	0.010	0.014	0.247	0.020	0.030
0.50%	0.010	0.060	0.040	0.010	0.030	0.010	0.010	0.014	0.247	0.010	0.030
0.00%	0.010	0.060	0.040	0.010	0.030	0.010	0.010	0.014	0.247	0.010	0.030
Mean	0.204	0.149	0.052	0.029	0.128	0.379	0.056	0.023	0.267	0.254	0.230
Std Dev	0.118	0.050	0.012	0.017	0.086	0.964	0.045	0.005	0.019	0.237	0.121
Std Err	0.023	0.010	0.005	0.003	0.014	0.130	0.016	0.002	0.009	0.021	0.032
Upper 95%	0.250	0.170	0.064	0.034	0.156	0.640	0.094	0.026	0.290	0.296	0.300
Lower 95%	0.157	0.127	0.039	0.023	0.099	0.119	0.019	0.019	0.243	0.212	0.160
N	27	23	6	40	37	55	8	12	5	126	14

N ppm

Quantiles	*Alectoria*	*Bryoria*	*Cladina*	*Flavocetraria*	*Hypogymnia*	*Letharia*	*Lobaria*	*Masonhalea*	*Platismatia*	*Sphaerophorus*	*Usnea*	*Xanthoparmelia*
100.00%	10300	20000	5360	5630	25500	26100	27800	5430	17300	8800	16300	24400
99.50%	8371	19953	5360	5630	20214	23777	27800	5430	15200	8800	16300	24400
97.50%	7042	18300	5360	5609	15690	16220	25970	5430	12355	6974	15202	18980
90.00%	**5300**	**14700**	**5360**	**5355**	**10300**	**10940**	**24100**	**4964**	**7768**	**5027**	**13240**	**17520**
75.00%	4353	12200	5360	4943	7500	8800	22500	4200	5690	4400	10200	15500
50.00%	3600	9650	4370	4560	5800	6830	21100	3640	4500	3800	5960	13460
25.00%	3100	7095	3380	4263	4900	5430	19050	3120	3700	3225	4000	11500
10.00%	2603	5667	3380	3710	4180	4640	16660	2632	3176	2672	3418	10280
2.50%	2100	3829	3380	1244	3368	3818	14930	2440	2657	2265	2567	8592
0.50%	1500	1605	3380	1180	2112	3115	13500	2440	2000	1870	1200	0
0.00%	1400	1480	3380	1180	1700	2020	13500	2440	910	1870	1200	0
Mean	3825	9875	4370	4489	6684	7539	20756	3678	5116	3913	7308	13625
Std Dev	1182	3543	1400	820	2971	3228	2799	765	2271	1067	3817	3126

Std Err	39	226	990	112	101	122	218	129	66	93	285	242
Upper 95%	3901	10320	16949	4713	6883	7779	21187	3941	5245	4097	7869	14103
Lower 95%	3749	9430	-8209	4265	6485	7298	20326	3415	4987	3729	6747	13147
N	942	246	2	54	861	695	165	35	1195	132	180	167

Ni ppm

Quantiles	*Alectoria*	*Bryoria*	*Cladina*	*Flavocetraria*	*Hypogymnia*	*Letharia*	*Lobaria*	*Masonhalea*	*Platismatia*	*Sphaerophorus*	*Usnea*	*Xanthoparmelia*
100.00%	93.96	39.07	6.00	10.50	186.82	5153.00	19.00	5.38	94.00	48.24	15.00	549.00
99.50%	17.61	36.07	6.00	10.50	94.92	58.70	15.41	5.38	39.23	48.24	12.55	549.00
97.50%	13.42	9.91	4.00	9.00	52.85	26.70	4.00	5.38	18.61	38.60	7.00	148.00
90.00%	**9.00**	**4.00**	**3.00**	**3.37**	**19.00**	**9.20**	**2.88**	**4.06**	**8.00**	**26.40**	**5.00**	**80.45**
75.00%	5.50	2.99	1.77	1.76	10.00	5.00	2.00	3.36	6.00	20.00	2.79	48.67
50.00%	3.00	2.00	1.61	0.72	6.35	2.80	1.71	0.74	4.27	20.00	1.42	21.99
25.00%	2.00	1.68	1.00	0.64	4.57	1.80	1.00	0.45	3.08	16.80	0.90	8.29
10.00%	1.68	1.68	1.00	0.51	3.36	1.70	1.00	0.30	2.25	16.80	0.59	6.17
2.50%	1.00	1.18	0.84	0.24	1.58	1.70	0.23	0.28	1.75	11.51	0.39	5.38
0.50%	0.84	0.73	0.84	0.24	0.86	1.20	0.01	0.28	1.68	6.23	0.32	4.46
0.00%	0.61	0.68	0.84	0.24	0.42	0.80	0.00	0.28	1.68	6.23	0.31	4.46
Mean	4.34	2.88	1.65	1.52	10.60	10.59	1.85	1.77	5.45	20.27	2.12	36.65
Std Dev	4.18	3.43	0.79	1.70	15.13	170.91	1.34	1.66	6.01	5.38	1.90	54.08
Std Err	0.10	0.20	0.07	0.25	0.46	5.67	0.08	0.35	0.17	0.49	0.11	3.99
Upper 95%	4.54	3.28	1.79	2.01	11.49	21.71	2.02	2.49	5.78	21.24	2.34	44.51
Lower 95%	4.14	2.48	1.50	1.03	9.70	-0.54	1.69	1.05	5.11	19.29	1.91	28.78
N	1685	284	116	48	1102	909	255	23	1229	119	297	184

Pb ppm

Quantiles	*Alectoria*	*Bryoria*	*Cladina*	*Flavocetraria*	*Hypogymnia*	*Letharia*	*Lobaria*	*Masonhalea*	*Platismatia*	*Sphaerophorus*	*Usnea*	*Xanthoparmelia*
100.00%	93.96	39.07	6.00	10.50	186.82	5153.00	19.00	5.38	94.00	4.82	41.00	549.00
99.50%	17.62	36.07	6.00	10.50	94.92	59.10	15.41	5.38	39.58	4.82	39.69	549.00

97.50%	13.47	9.91	4.00	10.50	52.85	26.80	4.00	5.38	18.65	3.86	19.27	148.60
90.00%	**9.08**	**4.00**	**3.00**	**3.37**	**19.00**	**9.30**	**2.88**	**5.38**	**8.01**	**2.64**	**11.75**	**80.78**
75.00%	5.59	2.99	1.77	3.23	10.00	5.00	2.00	3.98	6.00	2.00	8.00	49.00
50.00%	3.00	2.00	1.61	1.05	6.35	2.80	1.71	3.36	4.24	2.00	3.73	22.00
25.00%	2.00	1.68	1.00	0.64	4.57	1.80	1.00	3.36	3.08	1.68	1.87	8.25
10.00%	1.68	1.68	1.00	0.64	3.36	1.70	1.00	3.35	2.24	1.68	0.80	6.16
2.50%	1.00	1.18	0.84	0.64	1.58	1.70	0.23	3.35	1.75	1.15	0.61	5.36
0.50%	0.91	0.73	0.84	0.64	0.86	1.20	0.01	3.35	1.68	0.62	0.44	4.46
0.00%	0.62	0.68	0.84	0.64	0.42	0.80	0.00	3.35	1.68	0.62	0.40	4.46
Mean	4.39	2.88	1.65	1.81	10.60	10.63	1.85	3.72	5.45	2.03	5.72	36.90
Std Dev	4.19	3.43	0.79	1.87	15.13	171.39	1.34	0.70	6.02	0.54	5.83	54.49
Std Err	0.10	0.20	0.07	0.31	0.46	5.70	0.08	0.23	0.17	0.05	0.36	4.05
Upper 95%	4.59	3.28	1.79	2.44	11.49	21.82	2.02	4.26	5.79	2.12	6.41	44.90
Lower 95%	4.18	2.48	1.50	1.17	9.70	-0.56	1.69	3.18	5.11	1.93	5.02	28.91
N	1663	284	116	36	1102	904	255	9	1223	119	270	181

S ppm

Quantiles	*Alectoria*	*Bryoria*	*Cladina*	*Flavocetraria*	*Hypogymnia*	*Letharia*	*Lobaria*	*Masonhalea*	*Platismatia*	*Sphaerophorus*	*Usnea*	*Xanthoparmelia*
100.00%	2430	1800		549	1970	2000	2010	525	3500	770	2800	2900
99.50%	820	1750		549	1830	1772	2010	525	1626	770	2800	2889
97.50%	673	1119		527	1532	1300	1740	525	1274	641	1948	2004
90.00%	**530**	**940**		**405**	**1100**	**901**	**1430**	**464**	**910**	**501**	**1410**	**1558**
75.00%	430	800		352	880	700	1160	339	690	460	973	1300
50.00%	350	720		310	690	600	970	255	560	410	723	1100
25.00%	290	630		251	560	520	810	216	470	340	558	950
10.00%	240	520		0	480	460	630	191	410	319	450	776
2.50%	200	330		0	380	390	495	191	360	240	380	504
0.50%	165	310		0	270	320	440	191	300	200	310	40
0.00%	140	310		0	200	87	440	191	200	200	310	0
Mean	376	732		283	748	651	1001		622	409	832	1156

Std Dev	144	193	127	271	221	295	255	91	404	366
Std Err	5	12	19	9	8	22	7	8	35	25
Upper 95%	386	756	320	767	666	1045	637	425	901	1205
Lower 95%	367	709	245	730	635	958	607	393	763	1108
N	949	262	46	832	777	179	1171	128	134	221

Notes: The 50% quantile is the median and the 100% and 0% quantiles are maximum and minimum values in the data sets. Std Dev and Std Error are the standard deviation and standard error of the mean. Upper 95% and lower 95% are the upper and lower 95% confidence intervals around the mean. N = number of measurements. Because most samples come from remote sites, field replicates were treated as independent measurements.

Appendix 4A.15. List of Public Lands in the Western United States from Which Background Distributions of Lichen Cadmium, Mercury, Nitrogen, Nickel, and Sulfur Concentrations in Table 4A.11 were calculated. N = number of measurements.

Genus	Code	National Land	N	N(Cd)	N(Hg)	N(N)	N(Ni)	N(Pb)	N(S)
Alectoria	CHU	Chugach National Forest, AK	71	69	0	0	69	69	0
	CLE	Clearwater National Forest, ID	3	1	0	2	2	2	2
	COL	Colville National Forest, WA	1	1	0	1	1	1	1
	CRLA	Crater Lake National Park, OR	3	3	3	0	3	3	0
	DES	Deschutes National Forest, OR	121	82	9	107	98	90	102
	GIP	Gifford Pinchot National Forest, WA	198	169	0	167	170	176	176
	MBS	Mt Baker-Snoqualmie National Forest, WA	8	8	0	8	8	8	8
	WIL	Willamette National Forest, OR	1	1	0	1	1	1	1
	MORA	Mount Rainier National Park, WA	209	173	0	0	0	209	0
	MTH	Mt. Hood National Forest, OR	283	242	0	239	248	256	246
	NEP	Nez Perce National Forest, ID	2	0	0	0	2	2	2
	OLYM	Olympic National Park, WA	246	142	0	0	32	246	0
	BIT	Selway-Bitterroot Wilderness, ID	1	0	0	0	0	0	1
	SIU	Siuslaw National Forest, OR	3	2	0	2	2	2	3
	TON	Tongass National Forest, AK	273	246	0	0	245	245	0
	UMP	Umpqua National Forest, OR	135	102	0	110	119	105	115
	WAW	Wallowa-Whitman National Forest, OR	12	11	0	12	11	11	10
	WEN	Wenatchee National Forest, WA	3	3	0	3	3	3	3
	WIL	Willamette National Forest, OR	276	202	0	251	234	221	248
	WIN	Winema National Forest, OR	15	12	0	8	14	13	9
Bryoria	CLE	Clearwater National Forest, ID	1	0	0	0	1	1	1
	CRLA	Crater Lake National Park, OR	3	3	3	0	3	3	0
	DES	Deschutes National Forest, OR	120	111	0	113	114	107	110
	FRE	Fremont National Forest, OR	7	6	0	5	6	6	6
	WIN	Fremont National Forest, OR	1	1	0	1	1	1	1
	GIP	Gifford Pinchot National Forest, WA	12	10	0	10	10	10	10
	GRTE	Grand Tetons National Park, WY	5	5	0	5	5	5	0

	KLA	Klamath National Forest, CA	4	4	0	0	4	4	0
	MTH	Mt. Hood National Forest, OR	7	4	0	5	4	4	6
	NEP	Nez Perce National Forest, ID	3	0	0	0	3	3	3
	OLYM	Olympic National Park, WA	5	4	0	0	4	4	0
	PAY	Payette National Forest, ID	6	0	0	0	6	6	6
	ROMO	Rocky Mountain National Park, CO	2	2	2	0	2	2	0
	SAC	Salmon-Challis National Forest, ID	7	0	0	0	7	7	7
	SJR	San Juan-Rio Grande National Forest, CO	2	0	0	0	2	2	2
	BIT	Selway-Bitterroot Wilderness, ID	1	0	0	0	1	1	1
	UMP	Umpqua National Forest, OR	15	9	0	13	12	11	14
	WAW	Wallowa-Whitman National Forest, OR	31	25	0	25	25	25	26
	WIL	Willamette National Forest, OR	26	11	0	21	15	16	25
	WIN	Winema National Forest, OR	51	49	0	43	50	48	44
	YELL	Yellowstone National Park, WY	18	18	18	0	18	18	0
Cladina	CHU	Chugach National Forest, AK	63	57	0	0	57	57	0
	DENA	Denali National Park and Preserve, AK	6	3	6	0	6	6	0
	NOAT	Noatak National Preserve, AK	2	0	0	0	2	2	0
	TON	Tongass National Forest, AK	52	48	0	0	48	48	0
	YELL	Yellowstone National Park, WY	3	3	0	0	3	3	0
Flavocetraria	NOAT	Noatak National Preserve, AK	35	34	27	33	33	33	33
	ROMO	Rocky Mountain National Park, CO	2	2	2	0	2	2	0
	SJR	San Juan-Rio Grande National Forest, CO	1	0	0	0	1	1	1
Hypogymnia	ANG	Angeles National Forest, CA	6	6	0	0	6	6	0
	CRG	Columbia River Gorge National Scenic Area, OR & WA	137	115	0	106	115	115	116
	COL	Colville National Forest, WA	3	2	0	2	2	2	3
	DES	Deschutes National Forest, OR	66	61	0	54	61	61	56
	FINL	Finley National Wildlife Refuge, OR	2	2	0	2	2	2	2
	FRE	Fremont National Forest, OR	4	4	0	4	4	4	4
	GIP	Gifford Pinchot National Forest, WA	67	59	0	60	59	59	62
	MBS	Mt Baker-Snoqualmie National Forest, WA	7	6	0	6	6	6	7

	KLGO	Klondike Gold Rush National Historical Park, AK	24	24	0	24	24	15	0
	LOL	Lolo National Forest, MT	1	1	0	1	1	1	1
	MBS	Mount Baker-Snoqualmie National Forest, WA	35	33	0	30	33	33	31
	MTH	Mt. Hood National Forest, OR	239	217	0	193	217	216	197
	OKA	Okanogan National Forest, WA	7	7	0	6	7	7	6
	OLYM	Olympic National Park, WA	66	62	0	0	62	58	0
	ORCA	Oregon Caves National Monument, OR	3	3	2	0	3	3	0
	PORE	Point Reyes National Seashore, CA	14	14	14	14	14	14	0
	REDW	Redwood National Park, CA	50	27	21	0	49	49	0
	KICA	Sequoia and Kings Canyon National Park, CA	12	0	0	0	12	12	0
	SEKI	Sequoia and Kings Canyon National Park, CA	12	12	0	0	12	12	0
	SIU	Siuslaw National Forest, OR	122	106	0	106	107	107	106
	TON	Tongass National Forest, AK	72	65	0	0	65	65	0
	UMP	Umpqua National Forest, OR	44	38	0	36	38	38	35
	WAW	Wallowa-Whitman National Forest, OR	18	17	0	16	17	17	17
	WEN	Wenatchee National Forest, WA	5	5	0	4	5	5	4
	WIL	Willamette National Forest, OR	181	163	0	158	165	165	158
	WEN	Winema National Forest, OR	3	3	0	2	3	3	2
	WIN	Winema National Forest, OR	28	27	0	26	27	27	25
Letharia	ANG	Angeles National Forest, CA	18	18	0	0	18	18	0
	BEA	Beaverhead-Deer Lodge National Forest, MT	8	1	0	2	5	7	7
	BIT	Bitterroot National Forest, ID	4	0	0	0	3	2	4
	BRT	Bridger-Teton National Forest, WY	2	0	0	0	2	2	2
	CLE	Clearwater National Forest, ID	1	0	0	0	1	0	1
	CLV	Cleveland National Forest, CA	6	6	0	0	6	6	0
	CRG	Columbia River Gorge National Scenic Area, OR & WA	20	19	0	18	19	19	18
	COL	Colville National Forest, WA	11	9	0	9	9	9	11
	CODA	Coulee Dam National Recreation Area, WA	12	9	0	10	9	9	11
	CRLA	Crater Lake National Park, OR	12	12	12	0	12	12	0
	DES	Deschutes National Forest, OR	312	257	17	263	262	260	277

	ELD	Eldorado National Forest, CA	18	18	0	0	18	18	0
	FRE	Fremont National Forest, OR	28	25	0	24	25	25	23
	WIN	Fremont National Forest, OR	2	2	0	1	2	2	1
	GIP	Gifford Pinchot National Forest, WA	2	2	0	2	2	2	2
	HEL	Helena National Forest, MT	2	1	0	1	1	1	2
	KLA	Klamath National Forest, CA	12	12	0	0	12	12	0
	KOO	Kootenai National Forest, MT	2	0	0	0	0	2	2
	LABE	Lava Beds National Monument, CA	6	6	6	0	6	6	0
	LOL	Lolo National Forest, MT	2	2	0	2	2	2	2
	MTH	Mt. Hood National Forest, OR	35	28	0	24	28	28	31
	NEP	Nez Perce National Forest, ID	5	0	0	0	5	5	5
	OKA	Okanogan National Forest, WA	8	6	0	8	6	6	6
	PAY	Payette National Forest, ID	6	0	0	0	6	6	6
	SAC	Salmon-Challis National Forest, ID	46	0	0	0	41	45	46
	SAW	Sawtooth Wilderness, ID	4	0	0	0	0	3	4
	KICA	Sequoia and Kings Canyon National Park, CA	12	0	0	0	12	12	0
	SEKI	Sequoia and Kings Canyon National Park, CA	27	27	0	0	27	27	0
	STA	Stanislaus National Forest, CA	12	12	0	0	12	12	0
	TAR	Targhee National Forest, WY	3	0	0	0	3	3	3
	UMP	Umpqua National Forest, OR	2	2	0	2	2	2	2
	WAW	Wallowa-Whitman National Forest, OR	108	94	0	92	94	94	100
	WEN	Wenatchee National Forest, WA	5	5	0	5	5	5	5
	WIL	Willamette National Forest, OR	13	10	0	11	11	11	11
	WIN	Winema National Forest, OR	236	214	0	192	217	216	188
	YELL	Yellowstone National Park, WY	15	15	14	0	15	15	0
Lobaria	BIT	Bitterroot National Forest, ID	1	0	0	0	1	0	1
	CHU	Chugach National Forest, AK	26	24	0	0	24	24	0
	CLE	Clearwater National Forest, ID	3	0	0	0	3	1	3
	CRG	Columbia River Gorge National Scenic Area, OR & WA	10	10	0	10	10	10	10
	FINL	Finley National Wildlife Refuge, OR	4	2	0	2	2	2	4

	GIP	Gifford Pinchot National Forest, WA	29	21	0	25	25	22	26
	MBS	Mt Baker-Snoqualmie National Forest, WA	1	1	0	1	1	1	1
	KOO	Kootenai National Forest, MT	1	0	0	0	0	0	1
	MTH	Mt. Hood National Forest, OR	38	31	0	35	33	31	36
	NEP	Nez Perce National Forest, ID	2	0	0	0	2	1	2
	OLYM	Olympic National Park National Park, WA	6	5	0	5	5	5	5
	REDW	Redwood National Park, CA	8	6	8	0	8	8	0
	SIU	Siuslaw National Forest, OR	17	13	0	15	15	13	16
	TON	Tongass National Forest, AK	86	83	0	0	83	83	0
	UMP	Umpqua National Forest, OR	3	3	0	3	3	3	3
	WIL	Willamette National Forest, OR	79	52	0	65	66	51	71
Masonhalea	NOAT	Noatak National Preserve, AK	9	8	0	8	9	9	8
Platismatia	CLE	Clearwater National Forest, ID	2	1	0	1	1	1	2
	CRG	Columbia River Gorge National Scenic Area, OR & WA	179	171	0	153	171	171	150
	COL	Colville National Forest, WA	5	4	0	5	4	4	4
	CODA	Coulee Dam National Recreation Area, WA	8	6	0	6	6	6	8
	DES	Deschutes National Forest, OR	30	21	0	24	23	23	27
	FINL	Finley National Wildlife Refuge, OR	3	2	0	2	2	2	2
	GIP	Gifford Pinchot National Forest, WA	221	187	0	187	192	192	190
	MBS	Gifford Pinchot National Forest, WA	19	16	0	16	16	16	17
	KLGO	Klondike Gold Rush National Historical Park, AK	13	13	0	13	13	10	0
	MBS	Mount Baker-Snoqualmie National Forest, WA	49	44	0	43	44	44	41
	MTH	Mt. Hood National Forest, OR	291	262	0	257	263	263	258
	OLYM	Olympic National Park, WA	20	13	0	0	20	20	0
	SIU	Siuslaw National Forest, OR	30	23	0	28	23	23	30
	UMP	Umpqua National Forest, OR	141	120	0	114	125	125	116
	WAW	Wallowa-Whitman National Forest, OR	47	45	0	41	45	45	43
	WEN	Wenatchee National Forest, WA	3	3	0	2	3	3	2
	WIL	Willamette National Forest, OR	304	250	0	279	270	271	269
	WIN	Winema National Forest, OR	3	2	0	3	3	3	3

Sphaerophorus	CRG	Columbia River Gorge National Scenic Area, OR & WA	3	3	0	3	3	3	3
	GIP	Gifford Pinchot National Forest, WA	31	26	0	28	28	26	25
	MTH	Mt. Hood National Forest, OR	9	6	0	8	6	6	8
	OLYM	Olympic National Park, WA	13	2	0	0	13	9	0
	SIU	Siuslaw National Forest, OR	72	53	0	63	66	54	63
	UMP	Umpqua National Forest, OR	3	3	0	3	3	3	3
	WIL	Willamette National Forest, OR	28	17	0	25	25	18	26
Usnea	BIBE	Big Bend National Park, TX	44	44	44	44	44	44	0
	CHIR	Chiricahua National Monument, AZ	7	0	0	0	7	7	7
	CLE	Clearwater National Forest, ID	1	0	0	0	1	0	1
	CRG	Columbia River Gorge National Scenic Area, OR & WA	18	17	0	15	17	17	14
	DENA	Denali National Park and Preserve, AK	1	1	1	0	1	1	0
	ELMO	El Morro National Monument, NM	5	0	0	0	5	5	5
	FINL	Finley National Wildlife Refuge, OR	1	1	0	1	1	1	1
	GIP	Gifford Pinchot National Forest, WA	5	5	0	3	5	5	3
	GILA	Gila National Forest, NM	10	0	0	0	10	9	10
	GRTE	Grand Tetons National Park, WY	6	6	0	6	6	6	0
	OLYM	Olympic National Park, WA	1	1	0	0	1	1	0
	ORCA	Oregon Caves National Monument, OR	3	3	2	0	3	3	0
	PORE	Point Reyes National Seashore, CA	38	37	37	38	37	37	0
	REDW	Redwood National Park, CA	65	46	36	0	62	62	0
	ROMO	Rocky Mountain National Park, CO	6	6	6	0	4	6	0
	SAC	Salmon-Challis National Forest, ID	3	0	0	0	3	3	3
	SJR	San Juan-Rio Grande National Forest, CO	18	0	0	0	18	17	17
	SIU	Siuslaw National Forest, OR	50	37	0	46	43	38	45
	TAR	Targhee National Forest, WY	2	0	0	0	2	2	2
	UMP	Umpqua National Forest, OR	1	1	0	1	1	0	1
	WIL	Willamette National Forest, OR	6	6	0	6	6	6	6
Xanthoparmelia	ANG	Angeles National Forest, CA	3	3	0	0	3	3	0
	BIBE	Big Bend National Park, TX	4	4	4	4	4	4	0

BRT	Bridger-Teton National Forest, WY	4	0	0	0	2	4	2
CHCU	Chaco Culture National Historical Park, NM	5	0	5	0	0	5	0
CHIR	Chiricahua National Monument, AZ	11	0	0	0	11	10	11
CLE	Clearwater National Forest, ID	1	0	0	0	1	1	1
CRG	Columbia River Gorge National Scenic Area, OR & WA	86	62	0	63	62	62	65
DES	Deschutes National Forest, OR	3	2	0	2	2	2	3
DINO	Dinosaur National Monument, CO	2	0	0	0	2	2	2
GILA	Gila National Forest, NM	7	0	0	0	7	7	7
HUT	Humboldt-Toiyabe National Forest, NV	1	0	0	0	1	1	1
MAL	Manti-La Sal National Forest, UT	2	0	0	0	2	2	2
MEB	MedicineBow National Forest, WY	3	0	0	3	0	0	3
NEP	Nez Perce National Forest, ID	27	22	0	22	22	22	22
PAY	Payette National Forest, ID	2	0	0	0	2	2	2
ROMO	Rocky Mountain National Park, CO	9	2	2	7	0	0	7
ROO	Roosevelt National Forest, CO	2	0	0	2	0	0	2
ROU	Routt National Forest, CO	25	0	0	25	0	0	25
SAC	Salmon-Challis National Forest, ID	5	0	0	0	5	5	5
SJR	San Juan-Rio Grande National Forest, CO	26	0	0	0	26	22	26
MAL	Uinta National Forest, UT	2	0	0	0	2	2	2
WAW	Wallowa-Whitman National Forest, OR	27	21	0	23	21	21	21
WAC	Wasatch-Cache National Forest, UT	1	0	0	0	1	1	1
WHR	White River National Forest, CO	8	0	0	8	0	0	8
YELL	Yellowstone National Park, WY	3	3	3	0	3	3	0