

2004-2014 Puget Sound Marine Sediment Monitoring

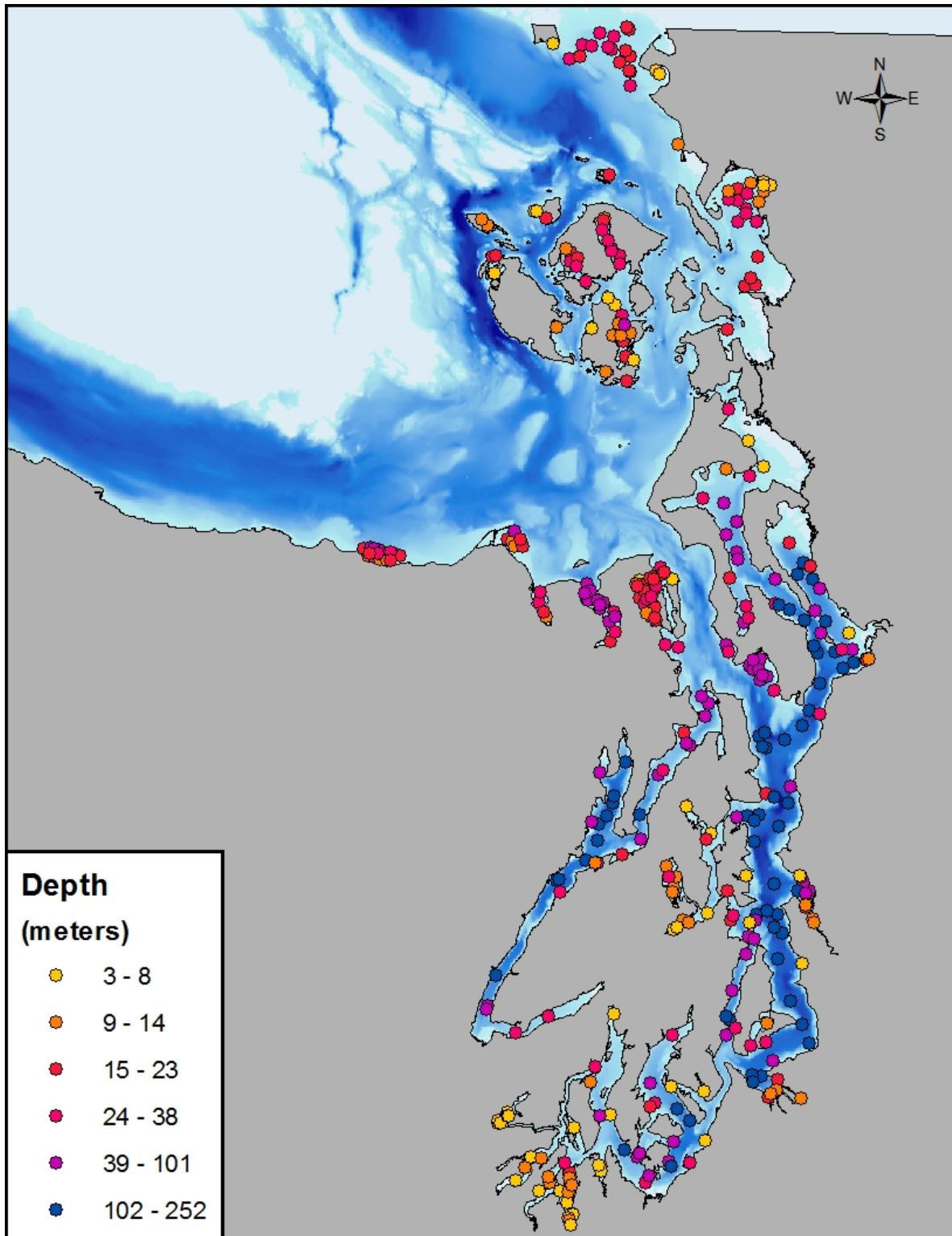


Physical Sediment Characteristics Data Summary

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Depth



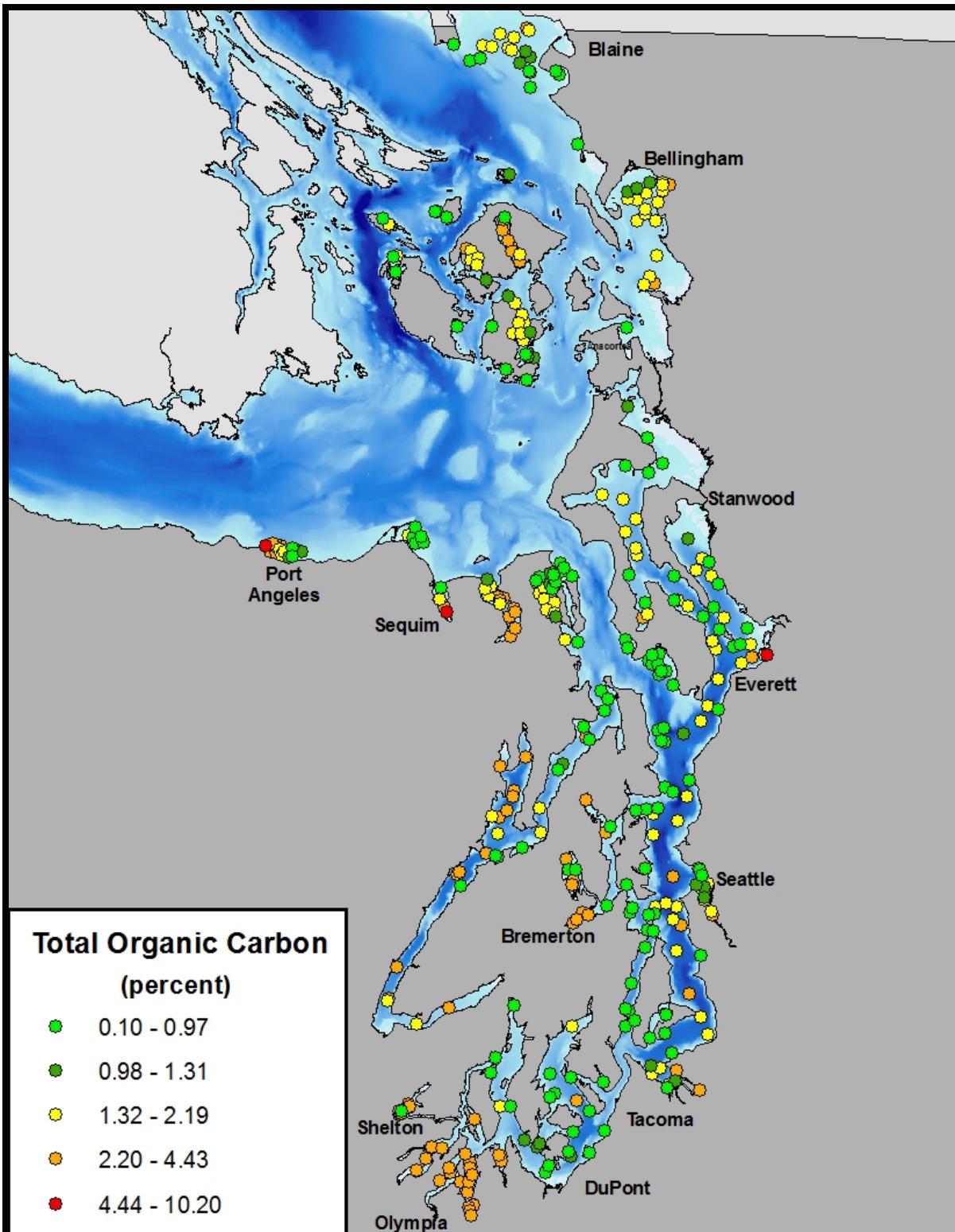
Water depths at sediment stations sampled for the 2004-2014 survey of Puget Sound.

Total Organic Carbon

Summary statistics for percent total organic carbon in sediments collected for the 2004-2014 Survey of Puget Sound.

Region Stratum	N	Minimum	Maximum	Mean	Standard Deviation	No. of Un- detected	% Un- detected
Strait of Georgia	40	0.15	3.58	1.42	0.72	0	0
Basin	13	0.21	1.75	0.97	0.56	0	0
Harbor	3	1.47	3.58	2.25	1.15	0	0
Passage	8	1.37	2.38	1.93	0.31	0	0
Rural	7	0.15	2.27	1.4	0.84	0	0
Urban	9	0.19	2.06	1.38	0.54	0	0
San Juan Archipelago	40	0.14	3.3	1.43	0.8	0	0
Rural	40	0.14	3.3	1.43	0.8	0	0
Eastern Strait of Juan de Fuca	40	0.16	7.19	2.13	1.39	0	0
Harbor	5	1.44	7.19	3.91	2.14	0	0
Rural	24	0.16	4.47	1.92	1.19	0	0
Urban	11	0.91	2.83	1.78	0.75	0	0
Admiralty Inlet	43	0.1	2.72	0.99	0.9	6	13.95
Passage	13	0.1	1.53	0.32	0.37	6	46.15
Urban	30	0.1	2.72	1.29	0.91	0	0
Whidbey Basin	40	0.1	5.92	1.38	1.07	1	2.5
Harbor	3	1.38	5.92	3.58	2.27	0	0
Passage	15	0.1	2.02	1.24	0.68	1	6.67
Rural	22	0.13	2.77	1.17	0.76	0	0
Central	80	0.1	4.06	1.29	1.03	4	5
Basin	30	0.11	2.21	1.27	0.8	0	0
Harbor	13	0.52	4.06	2.35	1.15	0	0
Passage	10	0.1	2.32	0.37	0.69	4	40
Rural	10	0.16	0.89	0.38	0.23	0	0
Urban	17	0.2	3.53	1.56	0.87	0	0
Hood Canal	30	0.13	2.94	1.58	0.95	0	0
Basin	21	0.13	2.5	1.26	0.96	0	0
Rural	9	1.68	2.94	2.32	0.35	0	0
South Sound	55	0.1	4.41	1.96	1.24	3	5.45

Region Stratum	N	Minimum	Maximum	Mean	Standard Deviation	No. of Un- detected	% Un- detected
Basin	8	0.1	1.2	0.51	0.43	3	37.5
Harbor	9	0.3	4.41	2.89	1.15	0	0
Passage	7	0.26	2.95	0.96	0.99	0	0
Rural	23	0.11	3.99	2.11	1.08	0	0
Urban	8	2.28	3.27	2.81	0.38	0	0
Puget Sound	368	0.1	7.19	1.51	1.09	14	3.8
Basin	72	0.1	2.5	1.13	0.81	3	4.17
Harbor	33	0.3	7.19	2.84	1.47	0	0
Passage	53	0.1	2.95	0.92	0.84	8	15.09
Rural	135	0.11	4.47	1.57	1	0	0
Urban	75	0.1	3.53	1.6	0.9	3	4



Spatial patterns in percent total organic carbon for the 2004-2014 survey of Puget Sound.

Grain Size

Summary statistics for grain size classes of sediments collected for the 2004-2014 survey of Puget Sound.

Region Stratum	Gravel			Sand			Silt			Clay			Fines		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Strait of Georgia	0.1	30.8	1.5	3.9	96.7	27	2.2	72.6	49.7	0.9	66.1	869.9	3.2	96.2	71.4
Basin	0.1	30.8	3.8	11.1	96.7	43.6	2.2	67.4	40.3	1	21.4	161.2	3.2	88.8	52.7
Harbor	0.1	0.3	0.2	3.9	18	9.7	54.4	65.5	59.7	27.6	33.1	91.4	82.9	96.2	90.6
Passage	0.1	0.8	0.2	6.1	13.7	9.7	51	70.4	63.9	20.3	34.6	209.9	85.6	93.7	90.1
Rural	0.1	4.5	0.7	5.9	95.8	33.1	3.2	69.9	44.4	0.9	66.1	145.2	4.1	94.1	65.1
Urban	0.1	0.7	0.3	4.7	93.9	19.2	3.8	72.6	51.5	1.9	42.5	262.2	5.7	95.4	80.6
San Juan Archipelago	0.1	28.3	1.1	0.8	93.9	37.7	4.7	73.2	44.8	1	46.4	656.8	6.1	99.1	61.2
Rural	0.1	28.3	1.1	0.8	93.9	37.7	4.7	73.2	44.8	1	46.4	656.8	6.1	99.1	61.2
E. Strait of Juan de Fuca	0.1	14.9	1.9	4.5	93.2	39.2	3.2	77.9	44.9	1.1	29.1	561.1	4.3	95.3	59
Harbor	0.2	3.3	1.9	20.1	68.7	31.8	25.9	63.6	50.7	2.9	21.7	77.5	28.8	79.7	66.2
Rural	0.1	14.9	2.2	4.5	93.2	37.7	3.2	77.9	45.6	1.1	29.1	350.1	4.3	95.3	60.1
Urban	0.1	9.2	1.1	17.2	69.3	45.8	22.5	58.5	41	4.9	21.4	133.5	30.2	79.9	53.1
Whidbey Basin	0.1	21.4	1.8	1	97.8	44.4	1.2	64.5	31.4	0	57.1	896	2.1	98.9	53.8
Harbor	3	21.4	11.7	30.2	60.6	47.8	14.5	54	32.7	3.6	12.8	23.5	16.4	66.8	40.4
Passage	0.1	4.8	0.5	2.8	97.8	38.5	1.2	59.2	33.4	0.9	53	415.8	2.1	97	60.9
Rural	0.1	13	1.3	1	97.3	48	2	64.5	29.9	0	57.1	456.7	2.6	98.9	50.7
Admiralty Inlet	0.1	49.2	4.2	11.9	99.2	64.7	0.6	61.6	21.9	0.1	27.7	396.7	0.7	85.5	31.1
Passage	0.1	6	1.2	28.1	99.2	87.8	0.6	56.7	8.1	0.1	15	38.8	0.7	71.7	11.1
Urban	0.1	49.2	5.4	11.9	98.5	54.8	0.6	61.6	27.9	0.2	27.7	357.9	0.9	85.5	39.8

Region Stratum	Gravel			Sand			Silt			Clay			Fines		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Central	0.1	28.6	1.7	1.1	97.5	48.5	0.8	72.2	32.1	0.5	51.9	1421.8	1.6	99	49.9
Basin	0.1	28.6	1.9	1.1	96.2	41.3	1.4	63	32.8	0.5	51.9	721.9	1.9	99	56.9
Harbor	0.1	14.1	1.3	1.3	84.1	29.6	5.2	66.6	46	1.1	35.3	300.3	6.3	98.7	69.1
Passage	0.1	10.5	1.9	14.3	97.4	86.3	1.3	63.8	8.5	0.6	21.6	33.5	1.9	85.4	11.9
Rural	0.1	3.3	0.8	59.9	97.5	87	1	24.2	8	0.6	12.5	42.5	1.6	36.7	12.3
Urban	0.1	15.9	2	3.7	81.8	30.7	0.8	72.2	48.3	1.4	37	323.6	2.2	96.3	67.3
Hood Canal	0.1	3.7	0.6	10.5	96.4	47.1	0.5	69.6	35.4	1.7	40.3	510.5	3.6	89.6	52.4
Basin	0.1	2	0.2	10.9	96.4	56.2	0.5	69.6	29.8	1.7	40.3	290.5	3.6	87.5	43.6
Rural	0.1	3.7	1.5	10.5	63.4	25.8	25.3	63.1	48.3	9.6	40.3	220	34.9	89.6	72.9
South Sound	0.1	71	3.3	3.4	98.5	44.7	0.3	73.6	34.8	0.1	39.2	943.8	0.4	96.6	52
Basin	0.1	5	1	58	98.5	84.2	0.3	25.7	9.5	0.1	16.2	42.9	0.4	41.9	14.9
Harbor	0.1	34	5.7	6.3	91.5	46.8	2.9	62	32.9	1.3	30.9	131.7	4.2	92.9	47.5
Passage	0.1	0.1	0.1	17	96.6	63	2.2	55.8	25.5	1	30.2	80.1	3.2	83	37
Rural	0.1	71	5	3.4	96.9	34.5	2.1	73.6	40.7	0.8	37.7	458	2.9	96.6	60.6
Urban	0.1	3.7	0.8	8.1	56.1	16.7	22.9	63.9	53.7	17.4	39.2	231.1	40.3	91.4	82.6
Puget Sound	0.1	71	2.1	0.8	99.2	44.7	0.3	77.9	36.2	0	66.1	6256.6	0.4	99.1	53.2
Basin	0.1	30.8	1.7	1.1	98.5	50.8	0.3	69.6	30.7	0	51.9	1216.5	0.4	99	47.6
Harbor	0.1	34	3.4	1.3	91.5	34.5	2.9	66.6	43.2	1.1	35.3	624.4	4.2	98.7	62.1
Passage	0.1	10.5	0.8	2.8	99.2	58.5	0.6	70.4	26.1	0.1	53	778.1	0.7	97	40.7
Rural	0.1	71	2	0.8	97.5	41.5	1	77.9	39.3	0	66.1	2329.3	1.6	99.1	56.6
Urban	0.1	49.2	2.9	3.7	98.5	39.7	0.6	72.6	40	0.2	42.5	1308.3	0.9	96.3	57.4

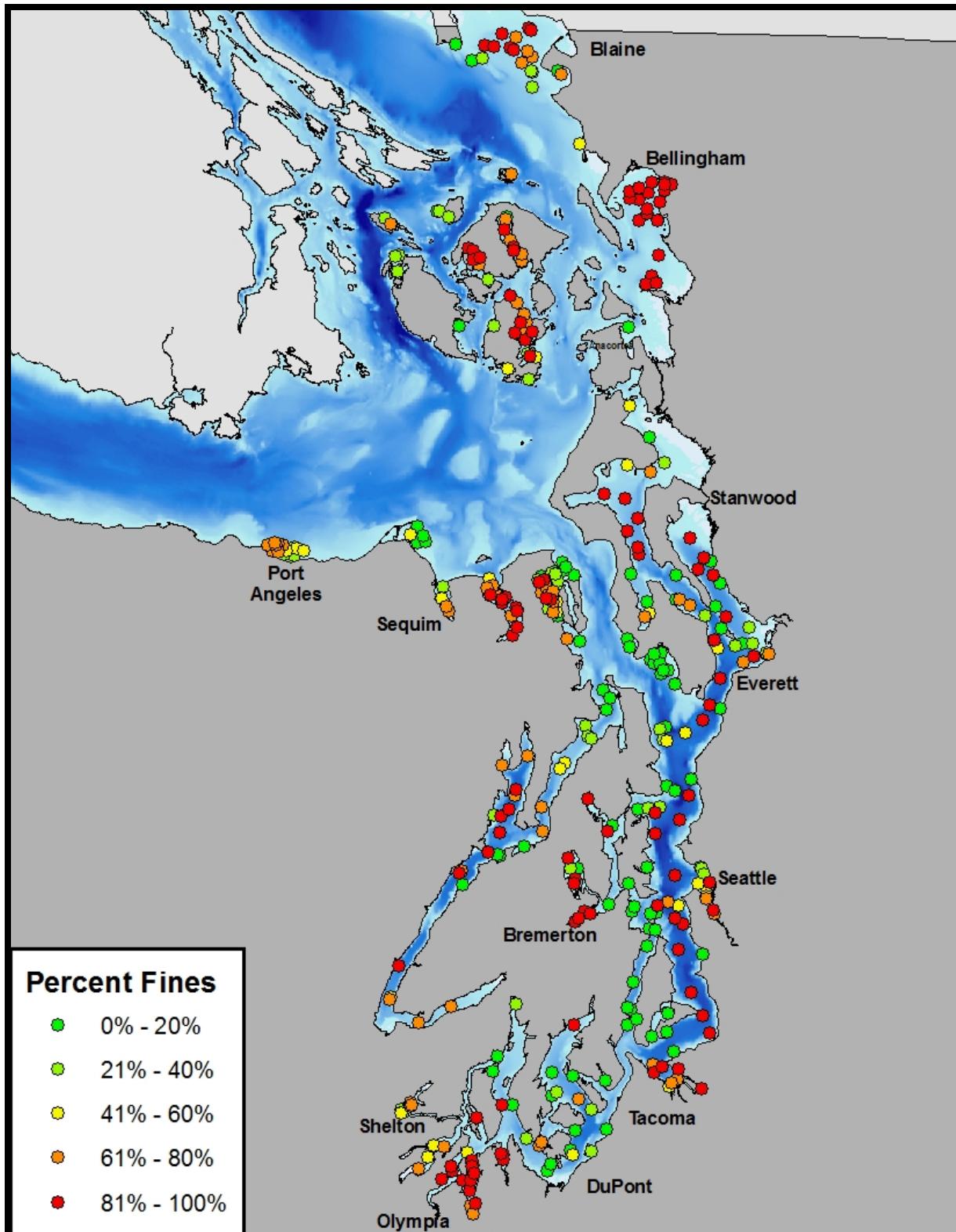
Sediment types characterizing 368 samples in 8 monitoring regions and all of Puget Sound collected for the 2004-2014 survey of Puget Sound.

Region Sediment type	Percent sand	Range of Percent gravel for sediment type	No. of stations with this sediment type	Area (km ²)	Percent of total study area
Strait of Georgia					
Sand	> 80	0.1 - 15.6	3	26.9	7.4
Silty sand	60 - 80	0.1 - 30.8	4	26.5	7.4
Mixed	20 - < 60	0.1 - 4.5	6	59.6	16.5
Silt + clay	< 20	0.1 - 0.95	27	247.7	68.7
San Juan Archipelago					
Sand	> 80	0.1 - 5.2	2	4.0	5.0
Silty sand	60 - 80	0.1 - 28.3	10	19.9	25.0
Mixed	20 - < 60	0.1 - 0.8	15	29.8	37.5
Silt + clay	< 20	0.1 - 2.3	13	25.8	32.5
Eastern Strait of Juan de Fuca					
Sand	> 80	9.1 - 0.2	5	11.4	16.8
Silty sand	60 - 80	2.4 - 0.1	5	5.6	8.2
Mixed	20 - < 60	3.3 - 0.1	18	24.9	36.7
Silt + clay	< 20	14.9 - 0.1	12	26.0	38.3
Admiralty Inlet					
Sand	> 80	0.1 - 6.5	21	42.8	64.3
Silty sand	60 - 80	0.1 - 0.4	4	4.0	6.0
Mixed	20 - < 60	0.2 - 49.2	11	12.8	19.2
Silt + clay	< 20	0.1 - 15.7	7	7.0	10.5
Whidbey Basin					
Sand	> 80	0.1 - 21.4	10	91.8	26.0
Silty sand	60 - 80	0.1 - 13.0	6	47.8	13.5
Mixed	20 - < 60	0.1 - 8.5	9	67.7	19.2
Silt + clay	< 20	0.1 - 1.1	15	146.0	41.3
Central					
Sand	> 80	0.1 - 28.6	26	234.0	35.1
Silty sand	60 to 80	0.1 - 11.8	8	72.4	10.8

Region Sediment type	Percent sand	Range of Percent gravel for sediment type	No. of stations with this sediment type	Area (km ²)	Percent of total study area
Mixed	20 to < 60	0.1 - 2.9	15	90.0	13.5
Silt + clay	< 20	0.1 - 0.7	31	271.0	40.6
Hood Canal					
Sand	> 80	0.1 – 0.2	7	64.6	21.9
Silty sand	60 to 80	0.1 – 1.8	4	38.9	13.2
Mixed	20 to 60	0.1 – 1.6	11	109.5	37.1
Silt + clay	< 20	0.1 – 3.7	8	81.8	27.7
South Sound					
Sand	> 80	0.1 – 5.0	12	89.9	28.3
Silty sand	60 - 80	0.1 – 2.3	9	50.0	15.7
Mixed	20 - <60	0.1 – 71.0	13	79.2	24.9
Silt + clay	< 20	0.1 – 34.0	21	98.6	31.0
Puget Sound					
Sand	> 80	0.1 – 28.6	86	565.20	25.6
Silty sand	60 - 80	0.1 – 30.8	50	265.14	12.0
Mixed	20 - <60	0.1 – 71.0	98	473.56	21.5
Silt + clay	< 20	0.1 – 34.0	134	903.82	40.9

Sediment types characterizing 368 samples in five sediment monitoring strata and all of Puget Sound collected for the 2004-2014 survey of Puget Sound.

Region Sediment type	Percent sand	Range of Percent gravel for sediment type	No. of stations with this sediment type	Area (km ²)	Percent of total study area
Basin					
Sand	> 80	0.1 - 15.6	20	227.2	27.6
Silty sand	60 - 80	0.1 - 30.8	13	135.3	16.5
Mixed	20 - < 60	0.1 - 4.5	16	162.8	19.8
Silt + clay	< 20	0.1 - 0.95	23	296.7	36.1
Harbor					
Sand	> 80	0.1 - 5.2	2	1.1	5.7
Silty sand	60 - 80	0.1 - 28.3	7	3.3	16.8
Mixed	20 - <60	0.1 - 0.8	11	6.6	33.2
Silt + clay	< 20	0.1 - 2.3	13	8.7	44.3
Passage					
Sand	> 80	9.1 - 0.2	28	173.3	37.1
Silty sand	60 - 80	2.4 - 0.1	2	23.0	4.9
Mixed	20 - <60	3.3 - 0.1	6	51.0	10.9
Silt + clay	< 20	14.9 - 0.1	17	220.2	47.1
Rural					
Sand	> 80	0.1 - 6.5	25	148.2	19.4
Silty sand	60 - 80	0.1 - 0.4	20	94.1	12.3
Mixed	20 - <60	0.2 - 49.2	40	215.7	28.3
Silt + clay	< 20	0.1 - 15.7	50	304.2	39.9
Urban					
Sand	> 80	0.0 - 21.4	11	15.4	11.3
Silty sand	60 - 80	0.0 - 13.0	8	9.4	6.9
Mixed	20 - <60	0.0 - 8.5	25	37.5	27.5
Silt + clay	< 20	0.0 - 1.1	31	74.0	54.3
Puget Sound					
Sand	> 80	0.1 - 28.6	86	565.2	25.6
Silty sand	60 to 80	0.1 - 11.8	50	265.1	12.0
Mixed	20 to < 60	0.1 - 10.7	98	473.5	21.4
Silt + clay	< 20	0.1 - 0.7	134	903.8	40.9



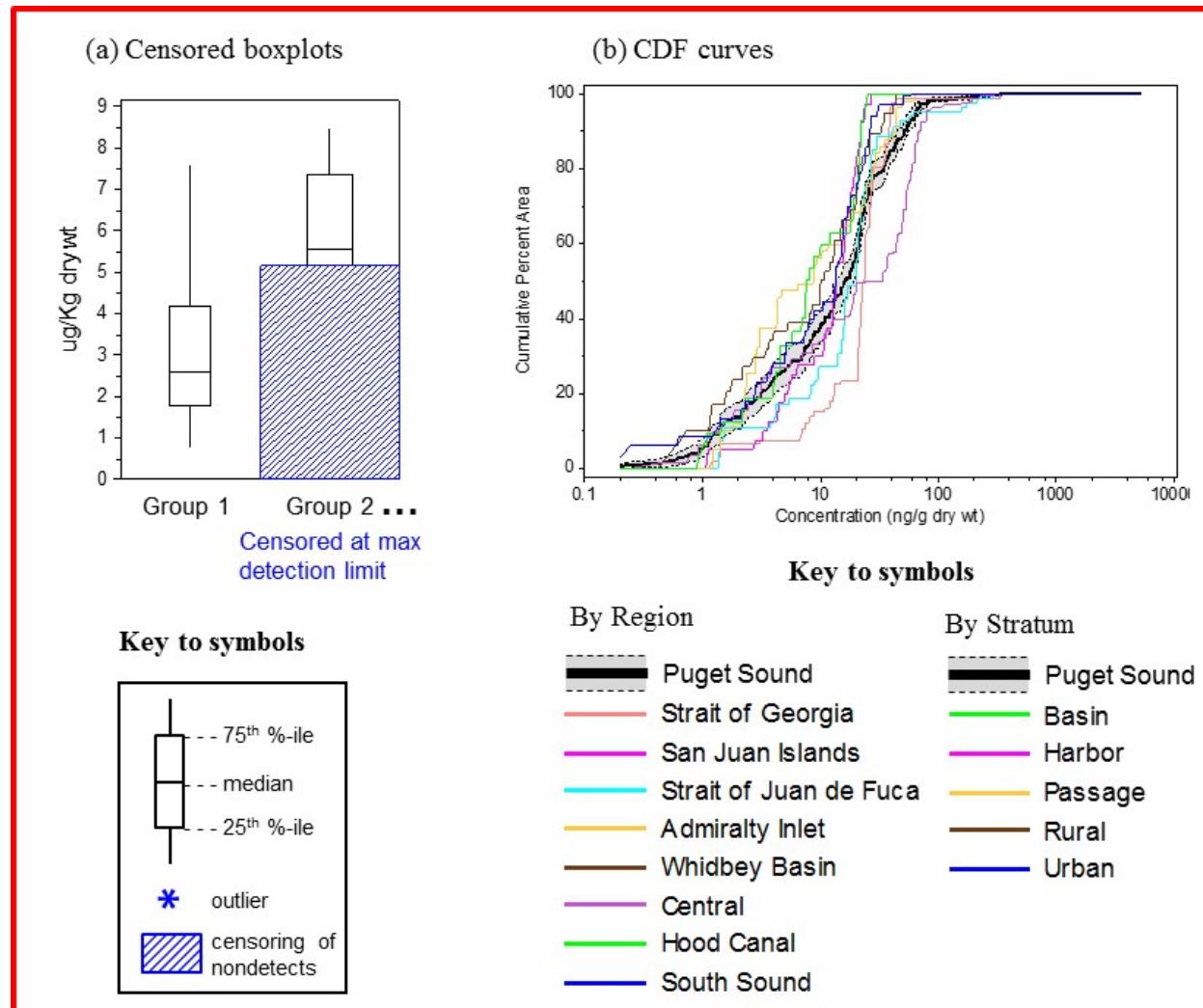
Spatial patterns in percent fines for the 2004-2014 survey of Puget Sound.

Comparisons between Regions and between Strata

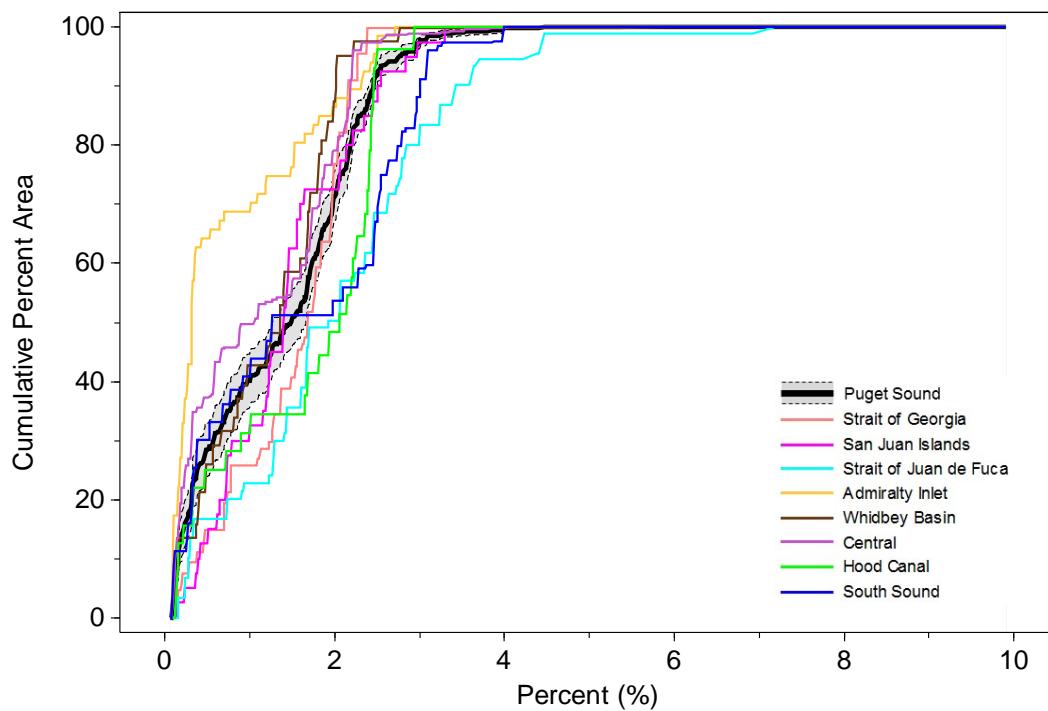
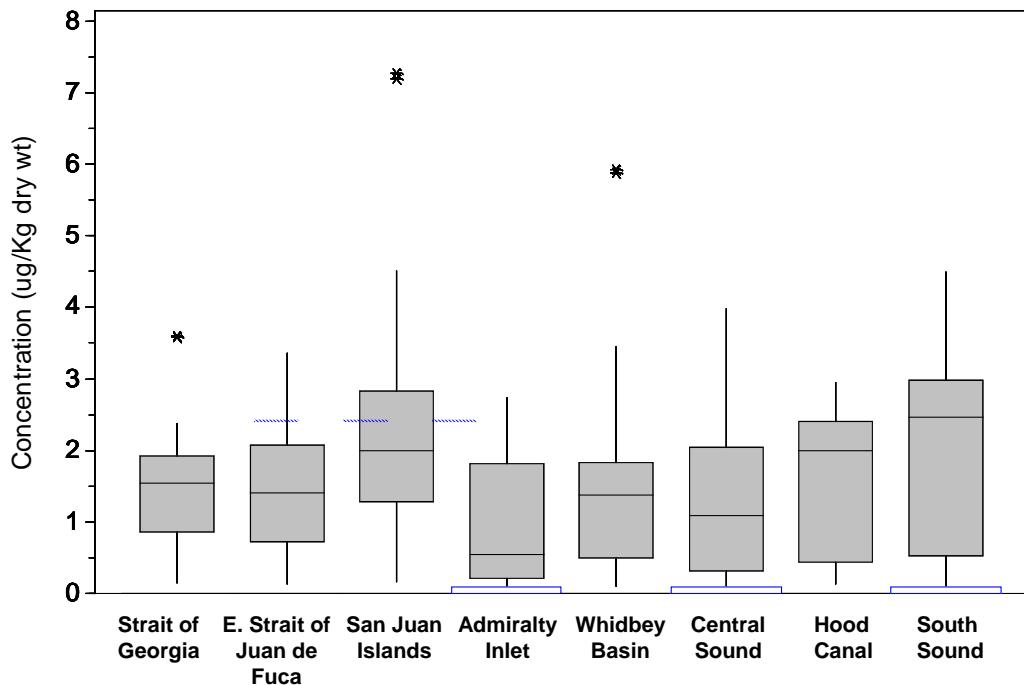
Comparison of total organic carbon and fines (silt-clay) in sediments sampled, by Puget Sound sampling regions and strata.

The graphical displays include two types of graphs:

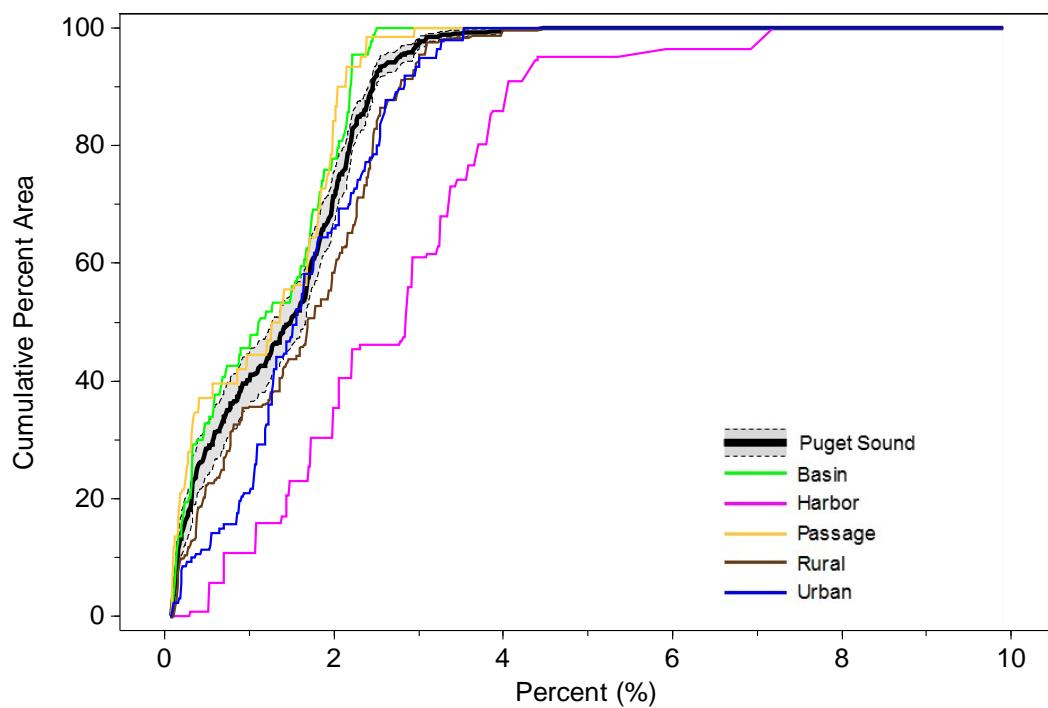
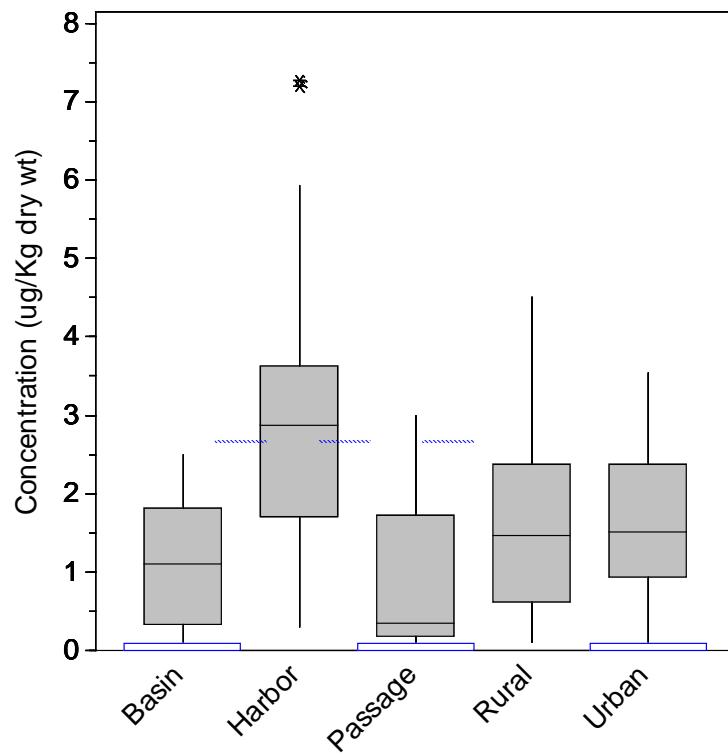
- Censored boxplots display the distributions of the data unweighted by sample area.
- Cumulative distribution function (CDF) curves display the cumulative distributions of the data weighted by sample area. A 95% confidence interval is given for the whole-Sound CDF. CDFs are not given when there were too few detected values.



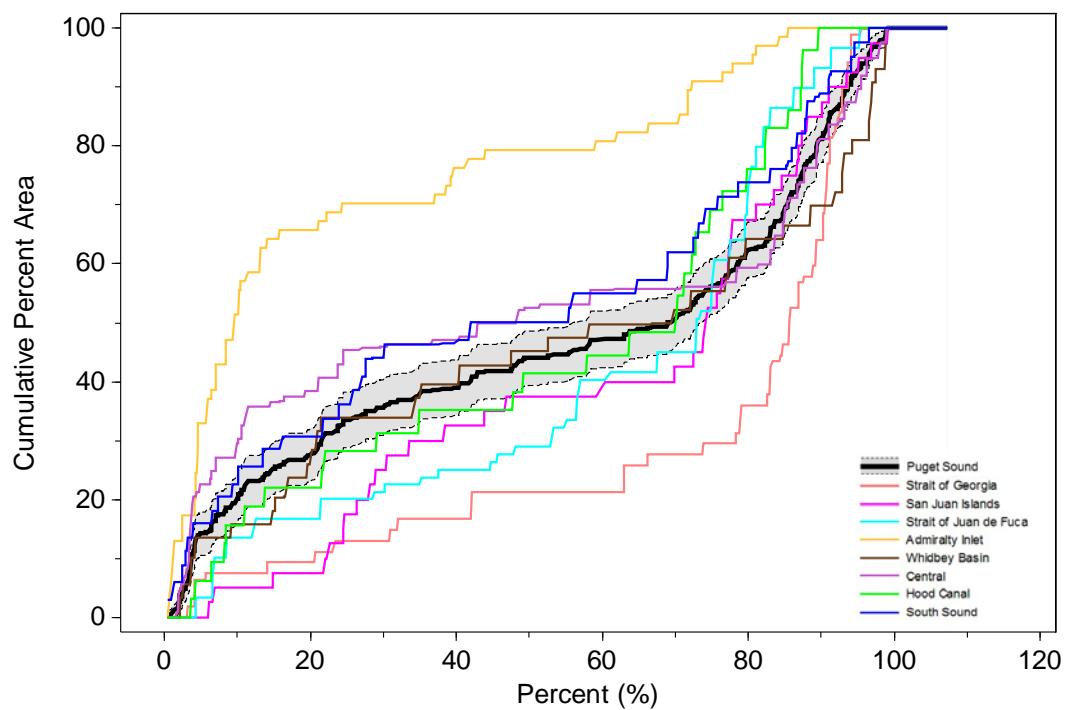
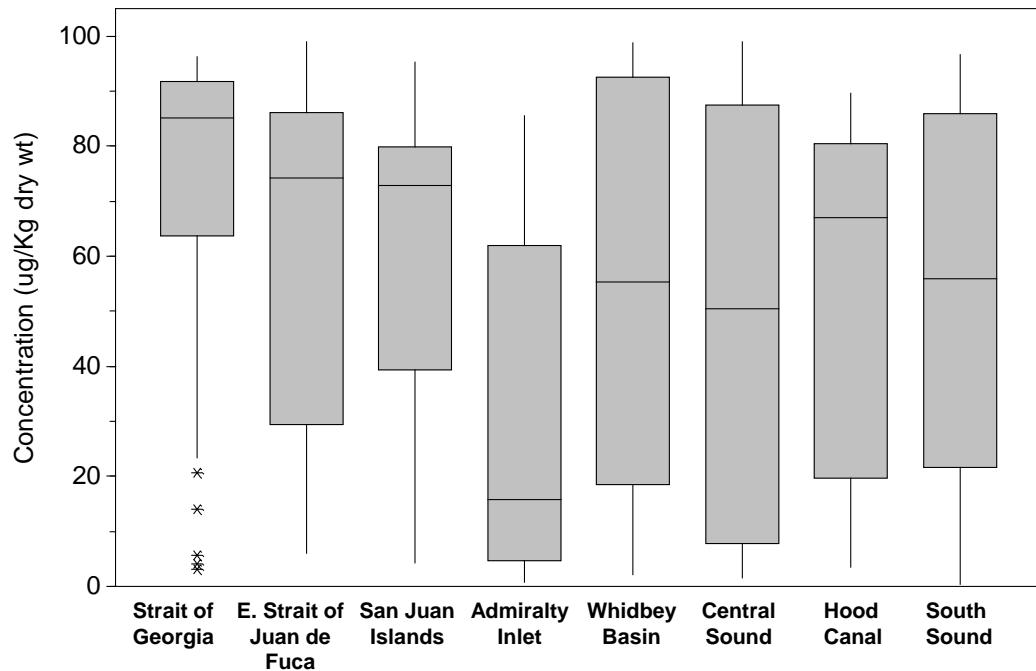
Total Organic Carbon by Region



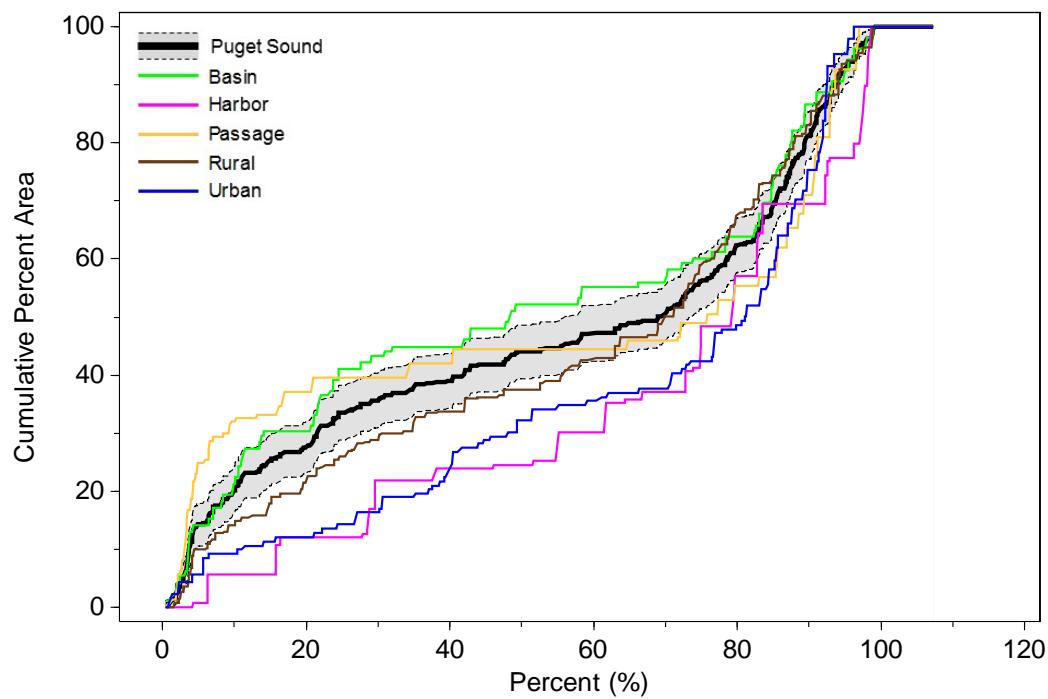
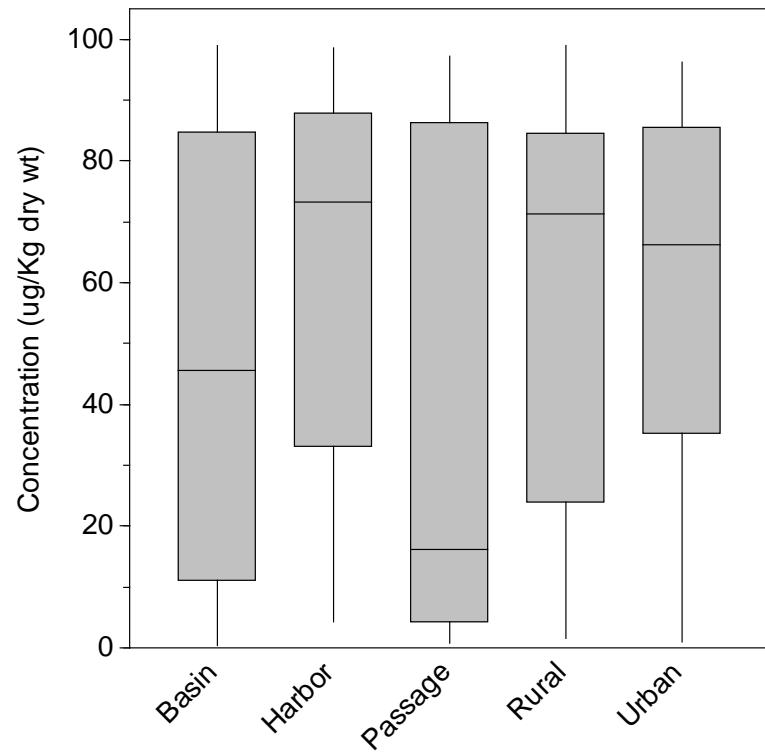
Total Organic Carbon by Stratum



Percent Fines by Region



Percent Fines by Stratum



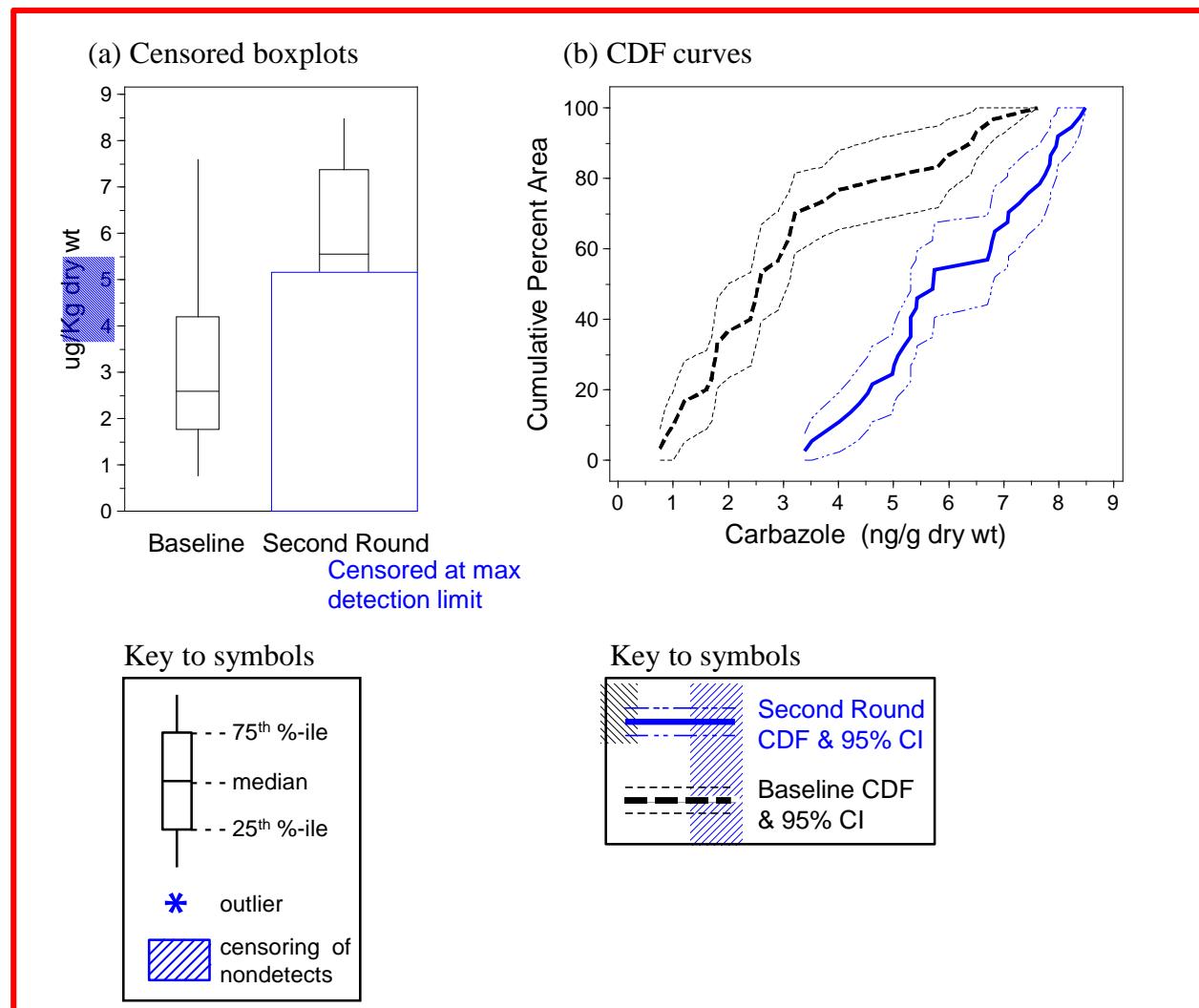
Comparisons of Surveys

Comparison of total organic carbon and fines (silt-clay) in sediments sampled in Puget Sound, Baseline (1997-2003) vs. Second Round (2004-2014).

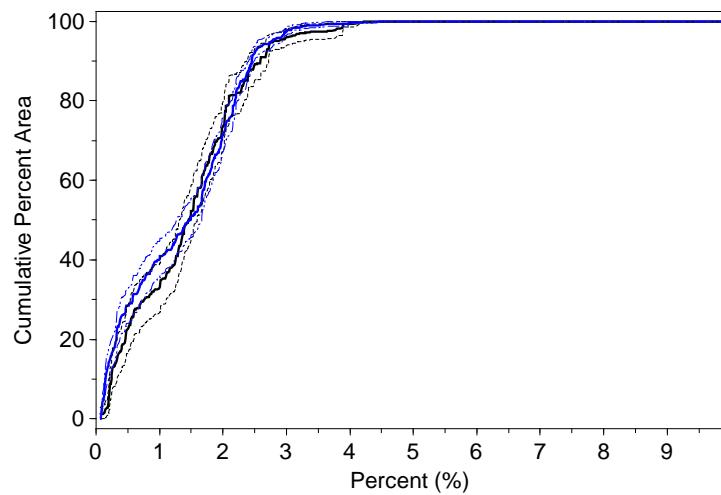
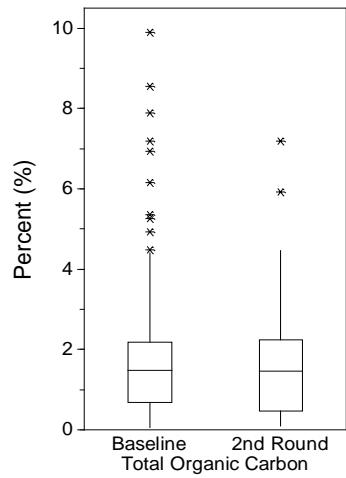
The graphical displays include two types of graphs:

- (c) Censored boxplots display the distributions of the data unweighted by sample area.
- (d) Cumulative distribution function (CDF) curves display the cumulative distributions of the data weighted by sample area. CDFs are not given when there were too few detected values.

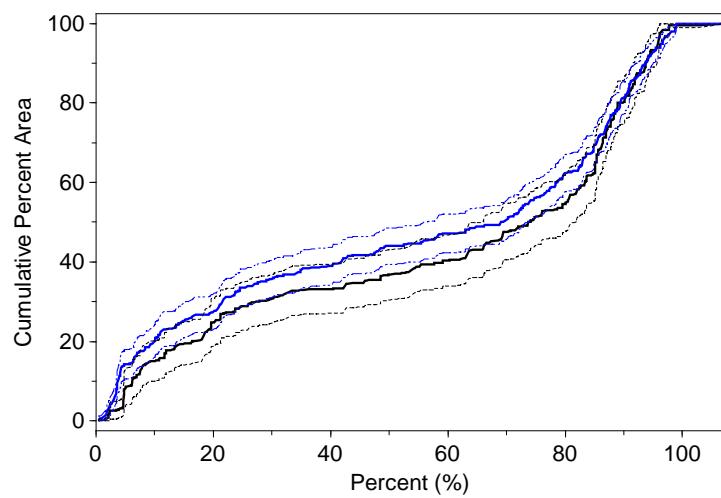
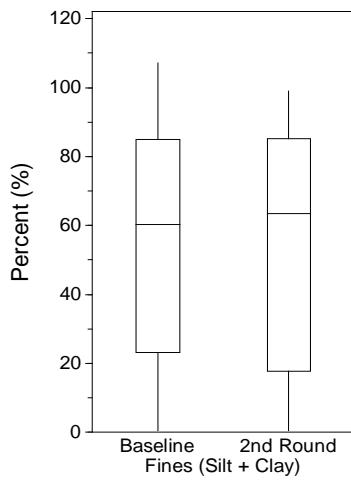
Note: 95% confidence intervals (CI) are shown for the CDFs. Non-overlapping confidence intervals indicate statistically significant differences.



Total Organic Carbon



Percent Fines



Changes^{1,2} in total organic carbon and percent fines from Baseline (1997-2003) to Second Round (2004-2014).

↑ = increase, ↓ = decrease, -- = no change, ? = significant only at $\alpha = 0.10$.

Parameter	Change from Baseline to Second Round
Total organic carbon	--
Percent fines	--

¹ Medians (unweighted) compared by Kruskal-Wallis test when all results detected, or by the Generalized Wilcoxon test when nondetects present ($\alpha = 0.05$).

² CDFs (weighted) compared by Wald F test ($\alpha = 0.05$).