2012 San Juan Islands Marine Sediment Monitoring

Sediment Toxicity Data Summary

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Results and Statistical Summaries

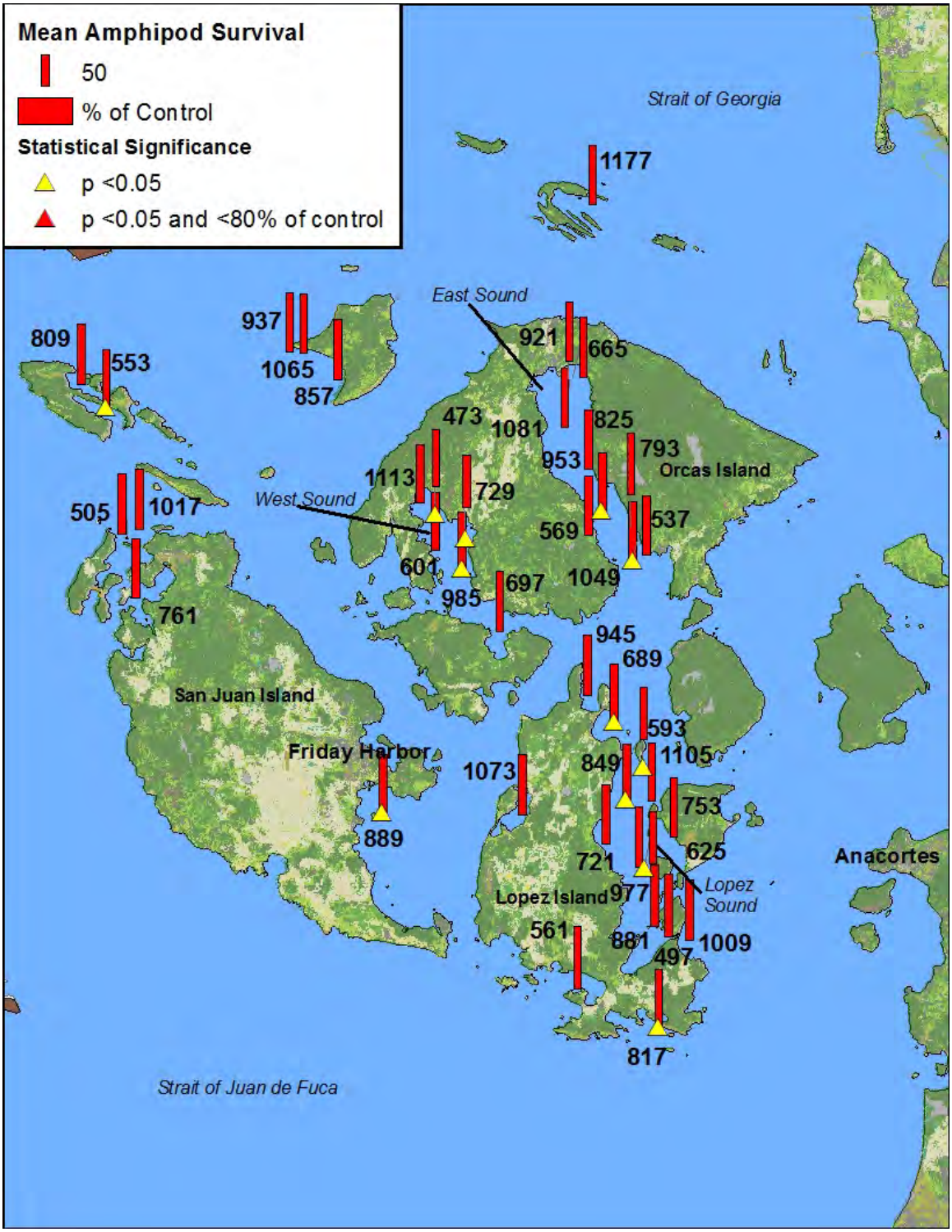
Amphipod Survival

Results of amphipod survival tests for 40 sediment samples from the 2012 San Juan Islands monitoring region.

Data are expressed as mean percent survival and as percentage of control response.
Tests were performed with *Eohaustorius estuarius*.
* = Results statistically significant (t-test, α = 0.05).
** = Results statistically significant and mean survival <80% of control.

Station	Location	Mean amphipod survival (%)	Mean amphipod survival as % of control	Statistical significance
473	West Sound, S. Massacre Bay	87	92	*
497	Northern Mud Bay	97	100	
505	Roche Harbor, Posey Island	98	98	
537	Southern East Sound	91	96	
553	Stuart Is., Reid Harbor	94	94	*
561	Mackaye Hbr., South Lopez	99	100	
569	East Sound, Rosario	94	96	
593	North Lopez Sound	83	85	*
601	West Sound, N. of Victim Island	89	94	
625	Central Lopez Sound	80	84	*
665	Northern East Sound	94	99	
689	Lopez Island, Swifts Bay	93	93	*
697	N. of Blind Bay, Shaw Island	92	97	
721	Lopez Sound, Small Island	92	97	
729	West Sound, White Beach Bay	80	84	*
753	Decatur	90	95	
761	Westcott Bay	97	97	
793	East Sound	94	99	
809	Stuart Is., Prevost Harbor	98	98	
817	McArdle Bay, South Lopez	92	94	*
825	East Sound	91	93	*
849	North Lopez Sound	89	91	*
857	Waldron Is., Waldron	98	98	
881	Lopez Sound, Fortress Island	100	100	
889	Griffin Bay	92	94	*

Station	Location	Mean amphipod survival (%)	Mean amphipod survival as % of control	Statistical significance
921	Northern East Sound	92	97	
937	Waldron Is., Sandy Pt.	96	96	
945	Lopez Island, Swifts Bay	97	97	
953	Central East Sound	94	96	
977	Lopez Sound	93	98	
985	Southern West Sound	87	92	*
1009	Shoal Bight, South Lopez	96	98	
1017	Roche Harbor, Barren Island	97	97	
1049	South East Sound	92	94	*
1065	Waldron Is., Cowlitz Bay	97	97	
1073	Lopez Island, Fisherman Bay	97	97	
1081	Northern East Sound	93	95	
1105	North Lopez Sound	92	94	
1113	West Sound, Massacre Bay	89	94	
1177	Sucia Is. Echo Bay	96	96	



Spatial patterns in sediment toxicity determined with the amphipod *Eohaustorius estuarius* (control-corrected % survival) in the 2012 San Juan Islands monitoring region.

The numbers on the map are the station identifications.

Urchin Fertilization

All data rejected due to laboratory errors

Toxicity

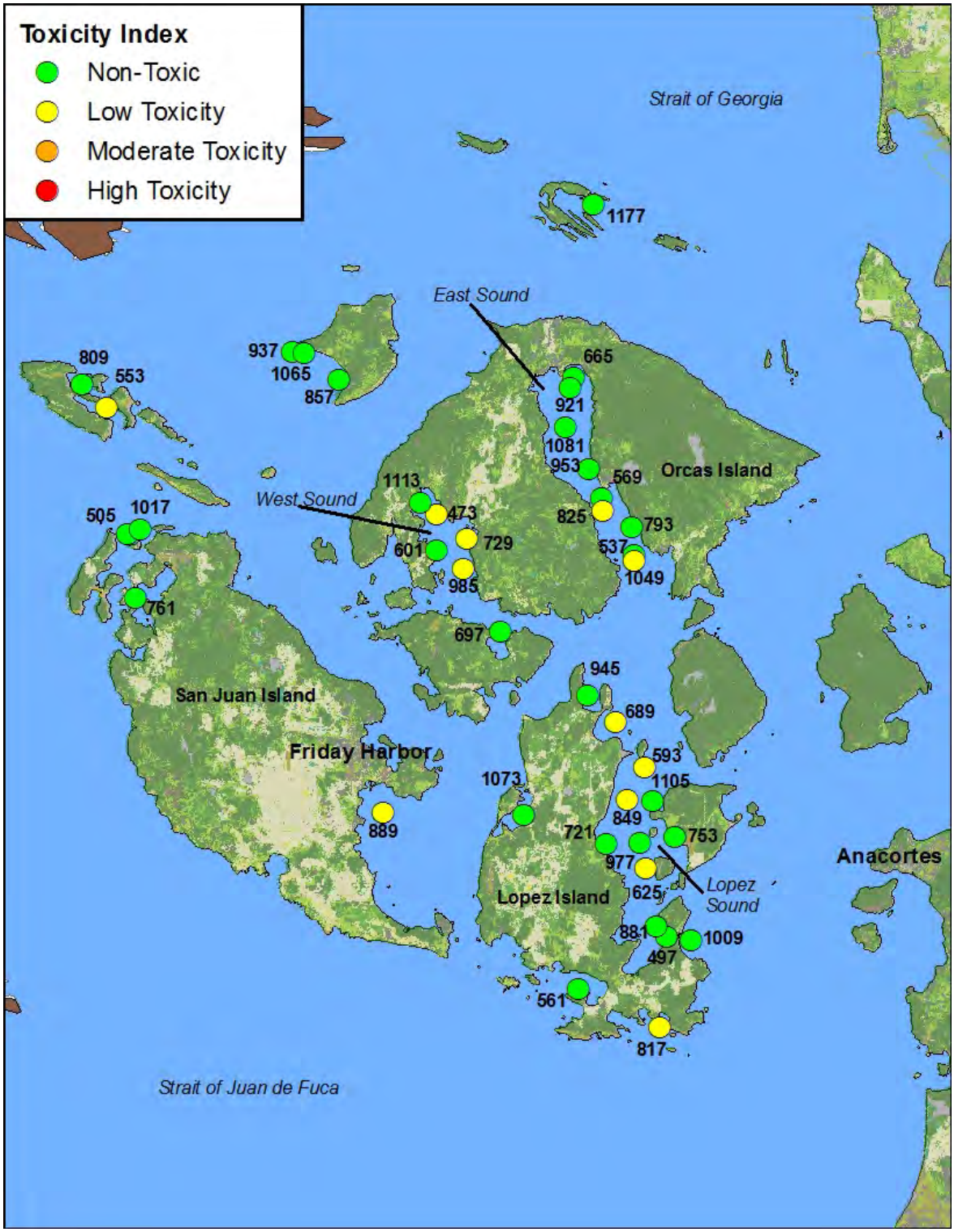
Estimated incidence and spatial extent of moderate or high toxicity in the 2012 San Juan Islands monitoring region.

Critical Value Exceeded	Stations		Area	
	No.	(%)	km^2	(%)
Total Study Area	40	(100.0)	79.5	(100.0)
Amphipod survival (10-day)[1]	0	(0.0)	0	(0.0)

[1] Results statistically significant and mean percent survival <80% of control

Incidence and spatial extent of chemical toxicity in the 2012 San Juan Islands monitoring region as measured with the Sediment Toxicity Index.

Sediment Toxicity Index Category	Stations		Area	
	No.	(%)	km^2	(%)
San Juan Islands	40	(100.0)	79.5	(100.0)
Non-Toxic	37	(92.5)	73.5	(92.5)
Low Toxicity	3	(7.5)	6.0	(7.5)
Moderate Toxicity	0	(0.0)	0.0	(0.0)
High Toxicity	0	(0.0)	0.0	(0.0)



Spatial patterns in Sediment Toxicity Index in the 2012 San Juan Islands monitoring region.

The numbers on the map are the station identifications.

Comparisons with Baseline

Changes in sediment toxicity from 2002-2003 to 2012 in the San Juan Islands sediment monitoring region.

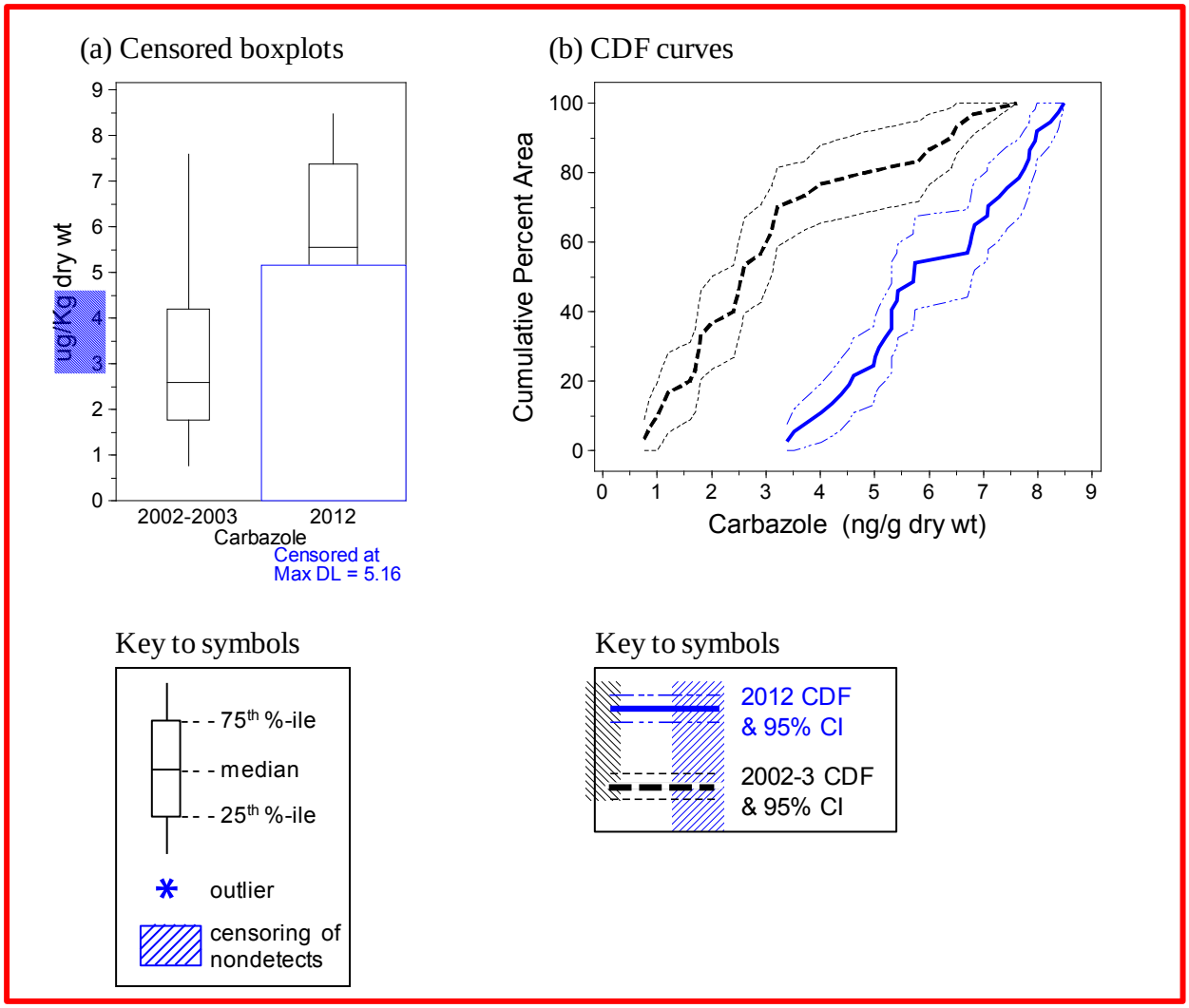
Year sampled	Numbers of Samples	Sea Urchin Fertilization Test		Amphipod Survival Test		
		Incidence (# of stations)	Spatial Extent (% of area)	Test Species	Incidence (# of stations)	Spatial Extent (% of area)
2002-2003	30	1	3.3	*Ampelisca abdita*	1	3.3
2012	40	Not Available		*Eohaustorius estuarius*	0	0.0
Statistically significant change						

Comparison of sea urchin fertilization results and Sediment Toxicity Index values for 2002-2003 to 2012, in the San Juan Islands sediment monitoring region.

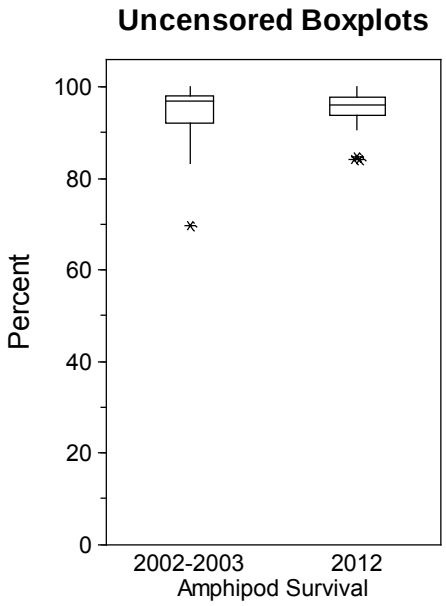
(a) Boxplots display the distributions of the data unweighted by sample area.

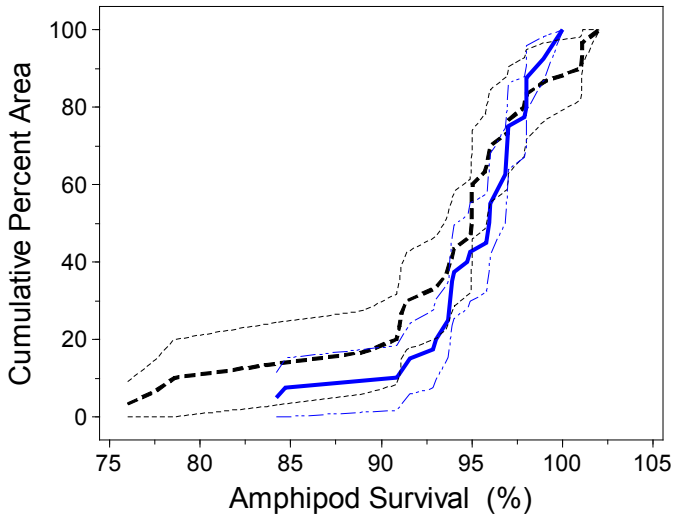
(b) Cumulative distribution function (CDF) curves display the cumulative distributions of the data weighted by sample area.

Note: 95% confidence intervals (CI) are shown in both graph types. Non-overlapping confidence intervals indicate statistically significant differences.

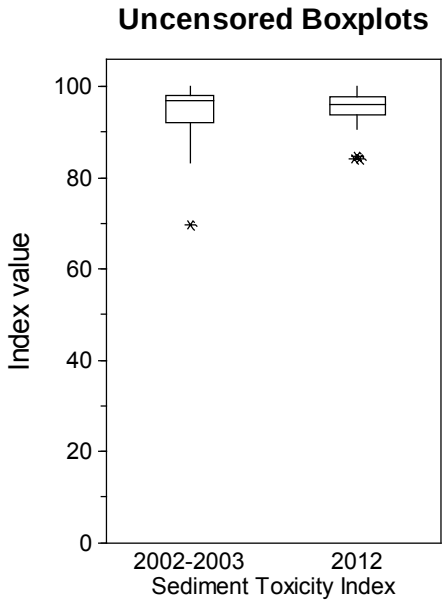


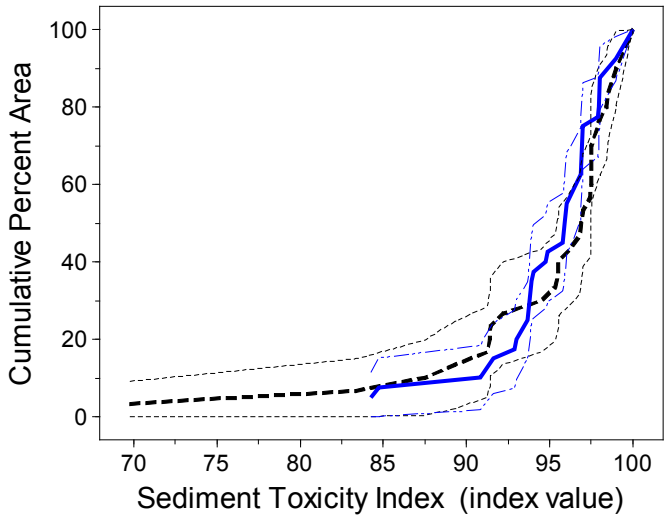
Amphipod Survival (%)





Sediment Toxicity Index

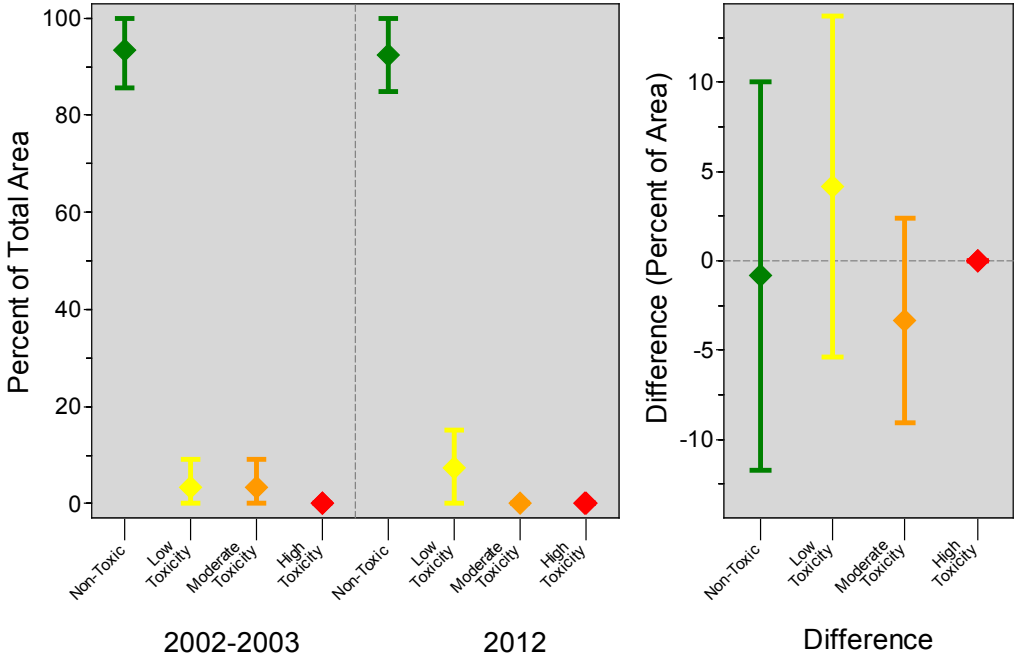




Comparison of Sediment Toxicity Index Categories by Year

Estimated spatial extent (percent of area) and 95% confidence intervals for each of the STI categories for the 2012 San Juan Islands monitoring region, compared to 2002-2003. The differences between the years are *not* statistically significant, as indicated by the difference confidence intervals containing the value zero.

Sediment Toxicity Index Category	Baseline (2002-2003)			2012			Difference (2012-Baseline)			* = significantly different (alpha=0.05)
		Confidence Limit			Confidence Limit			Confidence Limit		
	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	
Non-Toxic	93.33	85.61	100.00	92.50	84.87	100.00	-0.83	-11.69	10.02	
Low Toxicity	3.33	0.00	9.07	7.50	0.00	15.13	4.17	-5.38	13.72	
Moderate Toxicity	3.33	0.00	9.08	0.00	n.a.	n.a.	-3.33	n.a.	n.a.	
High Toxicity	0.00	n.a.	n.a.	0.00	n.a.	n.a.	0.00	n.a.	n.a.	



Comparisons with Other Regions

Incidence and spatial extent of toxicity from eight PSEMP Sediment Component regions and all of Puget Sound.

Monitoring Region	Year(s) sampled	Numbers of Samples	Sea Urchin Fertilization Test		Amphipod Survival Test		
			Incidence (% of stations)	Spatial Extent (% of area)	Test Species	Incidence (% of stations)	Spatial Extent (% of area)
Strait of Georgia	1997	61	8.2	2.47	*Ampelisca abdita*	0.0	0.0
	2006	40	0.0	0.0	*Eohaustorius estuarius*	7.5	5.5
Whidbey Basin	1997	39	25.6	6.0	*Ampelisca abdita*	0.0	0.0
	2007	40	5.0	3.3	No amphipod test results for 2007		
Central Puget Sound	1998-1999	128	7.8	0.6	*Ampelisca abdita*	0.8	0.2
	2008-2009	80	10	4.6	*Eohaustorius estuarius*	5.0	3.0
South Puget Sound	1999	42	9.5	3.0	*Ampelisca abdita*	0.0	0.0
	2011	55	16.4	12	*Eohaustorius estuarius*	5.5	3.1
Hood Canal	1999	21	14.3	11.7	*Ampelisca abdita*	0.0	0.0
	2004	30	16.7	17.7	No amphipod test results for 2004		
San Juan Islands	2002-2003	30	3.3	3.3	*Eohaustorius estuarius*	3.3	3.3
	2012	Not Available			*Eohaustorius estuarius*	0.0	0.0
Eastern Strait of Juan de Fuca	2002-2003	30	17.7	13.3	*Eohaustorius estuarius*	0.0	0.0
	2013	40	Results in preparation		*Eohaustorius estuarius*	Results in preparation	
Admiralty Inlet	1998-2003	30	6.7	11.1	*Ampelisca abdita, Eohaustorius estuarius*	0.0	0.0
	2014	43	Available after 2014		*Eohaustorius estuarius*	Available after 2014	
All of Puget Sound	1997-2003	381	10.2	4.5	*Ampelisca abdita, Eohaustorius estuarius*	0.3	0.05
	2004-2014	368	Available after 2014		*Eohaustorius estuarius*	Available after 2014	

Incidence and spatial extent of toxicity in eight sediment monitoring regions and all of Puget Sound as measured with the Sediment Toxicity Index.

Sediment Toxicity Index Category	Baseline				Second Baseline			
	Stations		Area		Stations		Area	
	No.	(%)	km^2	(%)	No.	(%)	km^2	(%)
San Juan Islands	30	(100.0)	80.7	(100.0)	40	(100.0)	79.5	(100.0)
Non-Toxic	28	(93.3)	75.4	(93.3)	37	(92.5)	73.5	(92.5)
Low Toxicity	1	(3.3)	2.7	(3.3)	3	(7.5)	6.0	(7.5)
Moderate Toxicity	1	(3.3)	2.7	(3.3)	0	(0.0)	0.0	(0.0)
High Toxicity	0	(0.0)	0.0	(0.0)	0	(0.0)	0.0	(0.0)
Hood Canal	21	(100.0)	331.7	(100.0)	30	(100.0)	294.8	(100.0)
Non-Toxic	18	(85.7)	293.0	(88.3)	24	(80.0)	233.5	(79.2)
Low Toxicity	1	(4.8)	1.4	(0.4)	1	(3.3)	9.2	(3.1)
Moderate Toxicity	2	(9.5)	37.4	(11.3)	1	(3.3)	9.2	(3.1)
High Toxicity	0	(0.0)	0.0	(0.0)	4	(13.3)	42.9	(14.5)
Strait of Georgia	61	(100.0)	386.9	(100.0)	40	(100.0)	360.6	(100.0)
Non-Toxic	56	(91.8)	377.4	(97.5)	24	(60.0)	237.3	(61.3)
Low Toxicity	0	(0.0)	0.0	(0.0)	16	(40.0)	123.3	(31.9)
Moderate Toxicity	5	(8.2)	9.6	(2.5)	0	(0.0)	0.0	(0.0)
High Toxicity	0	(0.0)	0.0	(0.0)	0	(0.0)	0.0	(0.0)
Whidbey Basin	39	(100.0)	338.1	(100.0)	40	(100.0)	353.3	(100.0)
Non-Toxic	29	(74.4)	317.8	(94.0)	37	(92.5)	333.4	(94.2)
Low Toxicity	2	(5.1)	19.7	(5.8)	1	(2.5)	8.2	(2.3)
Moderate Toxicity	2	(5.1)	0.1	(0.0)	1	(2.5)	11.5	(3.3)
High Toxicity	6	(15.4)	0.5	(0.1)	1	(2.5)	0.3	(0.1)
Central Sound	128	(100.0)	683.9	(100.0)	80	(100.0)	667.4	(100.0)
Non-Toxic	113	(88.3)	677.8	(99.1)	54	(67.5)	504.7	(75.6)
Low Toxicity	9	(7.0)	3.1	(0.5)	19	(23.8)	135.9	(20.4)
Moderate Toxicity	6	(4.7)	3.0	(0.4)	3	(3.8)	21.1	(3.2)
High Toxicity	0	(0.0)	0.0	(0.0)	4	(5.0)	5.7	(0.9)
South Sound	42	(100.0)	341.6	(100.0)	55	(100.0)	317.7	(100.0)
Non-Toxic	38	(90.5)	331.3	(97.0)	24	(43.6)	151.9	(47.8)
Low Toxicity	1	(2.4)	5.7	(1.7)	20	(36.4)	119.9	(37.7)
Moderate Toxicity	2	(4.8)	4.3	(1.3)	4	(7.3)	17.4	(5.5)
High Toxicity	1	(2.4)	0.3	(0.1)	7	(12.7)	28.5	(9.0)
E. Strait of Juan de Fuca	30	(100.0)	61.8	(100.0)	Results in preparation			
Non-Toxic	25	(83.3)	48.1	(77.9)				
Low Toxicity	1	(3.3)	2.7	(4.4)				
Moderate Toxicity	4	(13.3)	11.0	(17.7)				
High Toxicity	0	(0.0)	0.0	(0.0)				
Admiralty Inlet	30	(100.0)	69.2	(100.0)	Available after 2014			
Non-Toxic	28	(93.3)	61.5	(88.9)				
Low Toxicity	0	(0.0)	0.0	(0.0)				
Moderate Toxicity	2	(6.7)	7.9	(11.1)				

Sediment Toxicity Index Category	Baseline				Second Baseline			
	Stations		Area		Stations		Area	
	No.	(%)	km^2	(%)	No.	(%)	km^2	(%)
High Toxicity	0	(0.0)	0.0	(0.0)				
Total Study Area	381	(100.0)	2294.1	(100.0)	Available after 2014			
Non-Toxic	335	(87.9)	2182.3	(95.1)				
Low Toxicity	15	(3.9)	35.27	(1.5)				
Moderate Toxicity	24	(6.3)	75.73	(3.3)				
High Toxicity	7	(1.8)	0.78	(0.0)				

Laboratory Reports

Amphipod survival toxicity test lab report