More than 100 Years of Background-Level Sedimentary Metals, Nisqually River Delta, South Puget Sound, Washington

By Renee K. Takesue and Peter W. Swarzenski

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Area	
square kilometer (km^2)	247.1	acre
	Volume	
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	2.113	pint (pt)
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
liter (L)	61.02	cubic inch (in^3)
	Flow rate	
meter per second (m/s)	3.281	foot per second (ft/s)
millimeter per year (cm/yr)	0.3937	inch per year (in/yr)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
	Density	
kilogram per cubic meter (kg/m^3)	0.06242	pound per cubic foot (lb/ft^3)
gram per cubic centimeter (g/cm^3)	62.4220	pound per cubic foot (lb/ft^3)
	Radioactivity	
becquerel per liter (Bq/L)	27.027	picocurie per liter (pCi/L)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8 x °C)+32
Horizontal coordinate information is referenced to the insert datum name (and abbreviation) here, for instance, “North American Datum of 1983 (NAD 83)”

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Introduction

The Nisqually River Delta is located about 25 km south of the Tacoma Narrows in the southern reach of Puget Sound (fig. 1). Delta evolution is controlled by sedimentation from the Nisqually River and erosion by strong tidal currents that may reach 0.95 m/s in the Nisqually Reach (Barnhardt and Sherrod, 2006). The Nisqually River flows 116 km from the Cascade Range, including the slopes of Mount Rainier, through glacially carved valleys to Puget Sound (Williams, Pearson, and Wilson, 1985). Extensive tidal flats on the delta consist of late-Holocene silty and sandy strata from normal river streamflow and seasonal floods and possibly from distal sediment-rich debris flows associated with volcanic and seismic events (Barnhardt and Sherrod, 2006).

In the early 1900s, dikes and levees were constructed around Nisqually Delta salt marshes, and the reclaimed land was used for agriculture and pasture. In 1974, U.S. Fish and Wildlife Service established the Nisqually National Wildlife Refuge on the reclaimed land to protect migratory birds; its creation has prevented further human alteration of the Delta and estuary. In October 2009, original dikes and levees were removed to restore tidal exchange to almost 3 km^2 of man-made freshwater marsh on the Nisqually Delta.

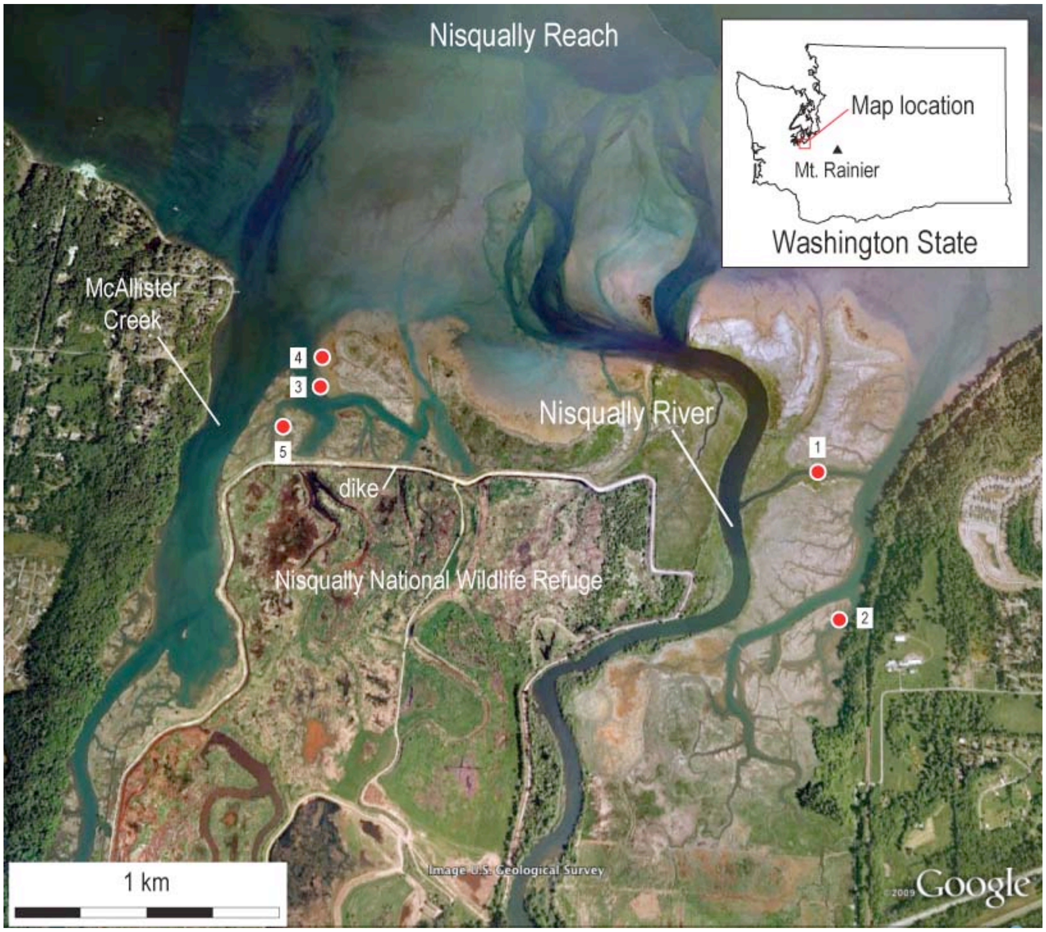

Figure 1. Satellite image of the Nisqually River Delta, South Puget Sound, Washington, with an intact outer dike around the Nisqually National Wildife Refuge, as was the case when sediment cores were collected. Numbers indicate sediment core sites.

Potential Contaminants of the Nisqually System

Industrial activity has left a legacy of contamination in Puget Sound. Between 1890 and 1985, lead (Pb) and copper (Cu) smelting operations at the ASARCO Smelter in Tacoma released these and co-occurring metals such as antimony (Sb), arsenic (As), cadmium (Cd), mercury (Hg), and zinc (Zn) to the atmosphere (Bloom and Crecelius, 1987; Crecelius, Bothner, and Carpenter, 1975; Lefkovitz, Cullinan, and Crecelius, 1997), where they subsequently were deposited on land and water, adsorbed to terrestrial and marine particles, and deposited on the seabed (Crecelius, Bothner, and Carpenter, 1975) in a northeast to southwest-trending region stretching from Seattle to Olympia (Washington Department of Ecology, 2005). Nearshore transport of marine water and particles dispersed contaminants southward through the Narrows and into South Puget Sound where the sediment and contaminants accumulated on the seabed (Cannon, 1978; Crecelius, Bothner, and Carpenter, 1975). Contemporary sources of pollutants in Puget Sound include industrial and municipal discharges, surface runoff, groundwater seepage, and oil spills (Puget Sound Action Team, 2003). For example, increasing automobile use around Puget Sound has resulted in increasing concentrations of toxic, combustion-sourced polycyclic aromatic hydrocarbons (PAHs) in sediment during the past 40 years (Van Metre, Mahler, and Furlong, 2000).

Study Goals and Approach

The goal of this study was to determine whether there were historical trends in contaminant metals in Nisqually Delta sediment. Five shallow sediment cores were collected at low tide from the Nisqually tidal flats in August 2009 (fig. 1; table 1). Total metal contents of sediment were examined in the core that had the best-preserved sediment record, as derived from downcore excess ^{210}Pb profiles.

Table 1. Sediment-core locations, Nisqually River Delta, South Puget Sound, Washington.

Site	Date	Length (cm)	Latitude (N)	Longitude (W)
1	20-Aug-2010	45	47.09423	122.69247
2	19-Aug-2010	24	47.08874	122.69152
3	19-Aug-2010	43	47.09628	122.70656
4	19-Aug-2010	31	47.09765	122.71297
5	20-Aug-2010	29	47.09486	122.72298

Methods

^{210}Pb Dating

Sedimentary geochronology is useful for evaluating the timing and duration of watershed sediment and comtaminant perturbations. For this study, the period of interest spans the past 100 years, a time heavily influenced by anthropogenic activities. The naturally-occurring radionuclide ^{210}Pb ($t_{1/2}$ = 22.3 yr) is the most appropriate geochronological tracer. Goldberg (1963) first proposed ^{210}Pb-based sediment chronologies and the technique has since been used widely in the evaluation of marine and lacustrine systems (Appleby and Oldfield, 1978, 1992; Krishnaswami, Lal, and others, 1971; Robbins and Edgington, 1975; Robbins, Edgington, and Kemp, 1978; Robbins and Herche, 1993). There are several models that can be applied to calculate sediment ages from the downcore excess ^{210}Pb distribution. The Constant Rate of Supply (CRS) model is the most appropriate model for calculating sediment ages when the sediment accumulation rate, influenced by deposition and subsequent resuspension, may vary over time. A basic assumption of this model is that excess ^{210}Pb was supplied to the sediment at a given site at a constant rate (Appleby and Oldfield, 1992). The CRS model uses ^{210}Pb inventories to calculate an age.

Sediment cores were collected by hand on intertidal mud flats during low tide. Core sites were selected based on visual observation of the benthic faunal population and sediment grain size. Clear, acrylic 15-cm-diameter core tubes were used to minimize sediment compaction during core collection. Cores were extruded immediately upon retrieval, sliced into sequential 1-cm-thick intervals, and stored chilled for transport. Upon return to the U.S. Geological Survey laboratory in Santa Cruz, California, sediment was dried at 60 degrees Celsius for 3-4 days, homogenized using a mortar and pestle, and packed into 10 ml vials for gamma-counting.

Sealed sediment gamma vials were stored for 3 weeks to allow for radioactive equilibrium between ^{226}Ra ($t_{1/2}$ = 1620yr) and ^{214}Pb ($t_{1/2}$ = 26.9min). Sediment vials were counted on an ultra-low-background germanium well detector, which provides low noise and excellent energy resolution at low- to moderate-energies. Gamma ray analyses were performed inside a large-diameter, low-background shield consisting of copper-lined lead that was flushed continuously with nitrogen gas to remove any residual radon (Rn) buildup. ^{210}Pb was measured by its gamma peak at 46.5 keV, ^{226}Ra was measured by its indirect peaks at 351.87 (^{214}Pb) and 609.31 (^{214}Bi), and ^{137}Cs was measured by its peak at 661 keV. An average measurement lasted for 24 hr. Unsupported, or excess, ^{210}Pb ($^{210}Pb_{ex}$) was calculated by subtracting supported ^{210}Pb from total ^{210}Pb. Absolute activities were determined by using calibrated (RGU-1, RGTh-, and IAEA) sediment samples in the same geometry (1-10 ml). Typical counting errors were less than 12 percent.

Sediment Digestion and ICP-MS Analysis

After gamma-counting, 3-5 g of dry sediment was size-fractioned in stainless-steel sieves (500-µm, 250-µm, 125-µm, and 63-µm mesh diameters) to obtain a rough estimate of the grain-size distribution and to isolate the fine fraction (silt and clay; grain diameter <63 µm). Around 14-15 mg of fine sediment were digested in 10 ml of a 1:3 mixture of concentrated TraceMetal™-grade hydrofluoric and nitric acids by using a microwave-assisted digestion system (MARS X, CEM Corp.) according to U.S. Environmental Protection Agency Method 3052. Sediment digestates were evaporated to dryness in Teflon® vials on a hot plate set to 185 degrees Celsius and then were reconstituted with 2-percent Optima™-grade nitric acid containing 100 parts per billion germanium (Ge) as an internal standard. Volatile elements, such as As and Sb, may have been lost during evaporation, so values for these elements should be considered minimum values. Estuarine- (NIST 1646a), marine- (NIST 2702), and stream- (STDS-2, STDS-3) sediment reference materials were processed in the same manner and used as external standards. Twenty-nine major-, minor-, and trace-element contents were determined by quadrupole inductively-coupled plasma mass spectrometry (ICP-MS; X Series 2, Thermo Scientific) at the University of California at Santa Cruz (UCSC) Institute of Marine Science Marine Analytical Laboratories. Element contents of standard STDS-2, analyzed six times during the course of the ICP-MS run, were within 3 percent of certified values. Detection limits were less than 0.01 parts per million for all elements. All total-element contents are reported per dry weight of sediment (appendixes A and B).

Results

Sedimentation Rates

The 43-cm-long core collected near the western edge of the delta (Core 3) had the best-preserved sediment record. The downcore $^{210}Pb_{ex}$ profile suggests two distinct sedimentation rates. From the surface to 5 cm, the sedimentation rate was 0.103 cm/yr (fig. 2). From 5 to 21 cm, the sedimentation rate was 0.347 cm/yr (fig. 2). The higher rate is similar to sedimentation rates measured in 70 m of water in the Nisqually Reach (Carpenter, Peterson, and Bennett, 1985). Below 21 cm there was no unsupported ^{210}Pb. In combination, the two sedimentation rates and extrapolation of the rate at 21 cm to the bottom of the core yield a sediment record beginning in 1851. The accuracy of this date is uncertain due to the extrapolation of the sedimentation rate over the bottom half of the core, so the length of the sediment record is better approximated as 100 to 150 years long. It is certain that sediment below 21 cm in Core 3 is more than 100 years old since it contained no detectable $^{210}Pb_{ex}$.

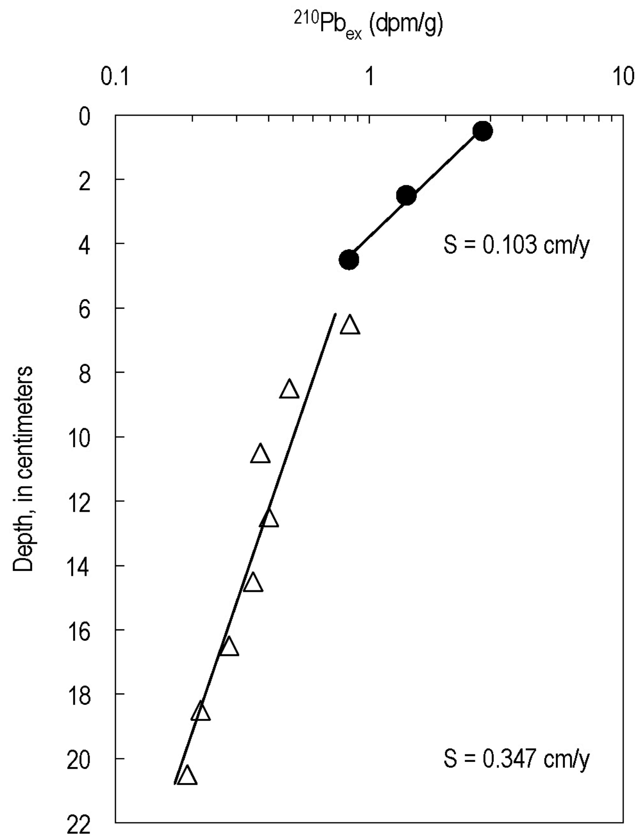

Figure 2. Excess ^{210}Pb profile and sedimentation rates in Core 3, Nisqually River Delta, South Puget Sound, Washington.

Contaminant Metal Contents

Trace-metal contents in Nisqually River Delta sediment were well below levels of concern for marine sediment as defined by Washington State (table 2). Washington State does not have a marine sediment quality standard for nickel (Ni), so the median value at which adverse biological impacts occur (Long and Morgan, 1990) is shown for reference (table 2). Nisqually sedimentary-metal contents were similar to background (preanthropogenic) levels in Commencement Bay near Tacoma and in the main basin of Puget Sound (Bloom and Crecelius, 1987; Crecelius, Bothner, and Carpenter, 1975; Lefkovitz, Cullinan, and Crecelius, 1997).

Table 2. Total sedimentary-metal contents, Nisqually River Delta, South Puget Sound, Washington, and marine-sediment quality standards.

[Units are in parts per million dry weight. RSD, relative standard deviation; NOAA, National Oceanographic and Atmospheric Administration; nd, not defined]

	As	Cd	Cr	Cu	Ni	Pb	Zn
Nisqually Delta, 0-43 cm							
Maximum	6	0.3	60	43	27	11	152
Minimum	3	0.1	46	22	19	8	56
Mean	4	0.2	50	31	22	9	65
RSD	20%	18%	12%	23%	16%	13%	29%
Marine-Sediment Quality Standards							
Washington	57	5.1	260	390	nd	450	410
NOAA	70	9.6	370	270	52	218	410

With the exception of Ni, metals did not show long-term historical trends during the 100 to 150 year-long sediment record (fig. 3). When normalized by aluminum (Al) content to account for differences in the amount of clay in the fine fraction (Windom, Schropp, and others, 1989), the Ni content of Nisqually sediment decreased 25 percent from the bottom to the top of the core. The content of Cu increased 15 percent from the bottom of the core to the present day, but this difference is not statistically significant relative to the degree of noise in the data (the standard deviation of sedimentary Cu content is 18 percent of the mean). Sedimentary Zn contents were elevated at three depths in the sediment column (fig. 3), but were not correlated with other contaminants or redox-sensitive elements. Therefore elevated Zn does not appear to have been caused by contaminant inputs or reducing sediment. The slight increase in sedimentary As content in the upper 3 cm corresponds to a similar increase in sodium (Na) and likely originates from seawater. The pore-water content of the sediment column was higher near the sediment-water interface, and As concentrations are higher in seawater than in freshwater and sediment derived from common rock types, excluding shale (Drever, 1988).

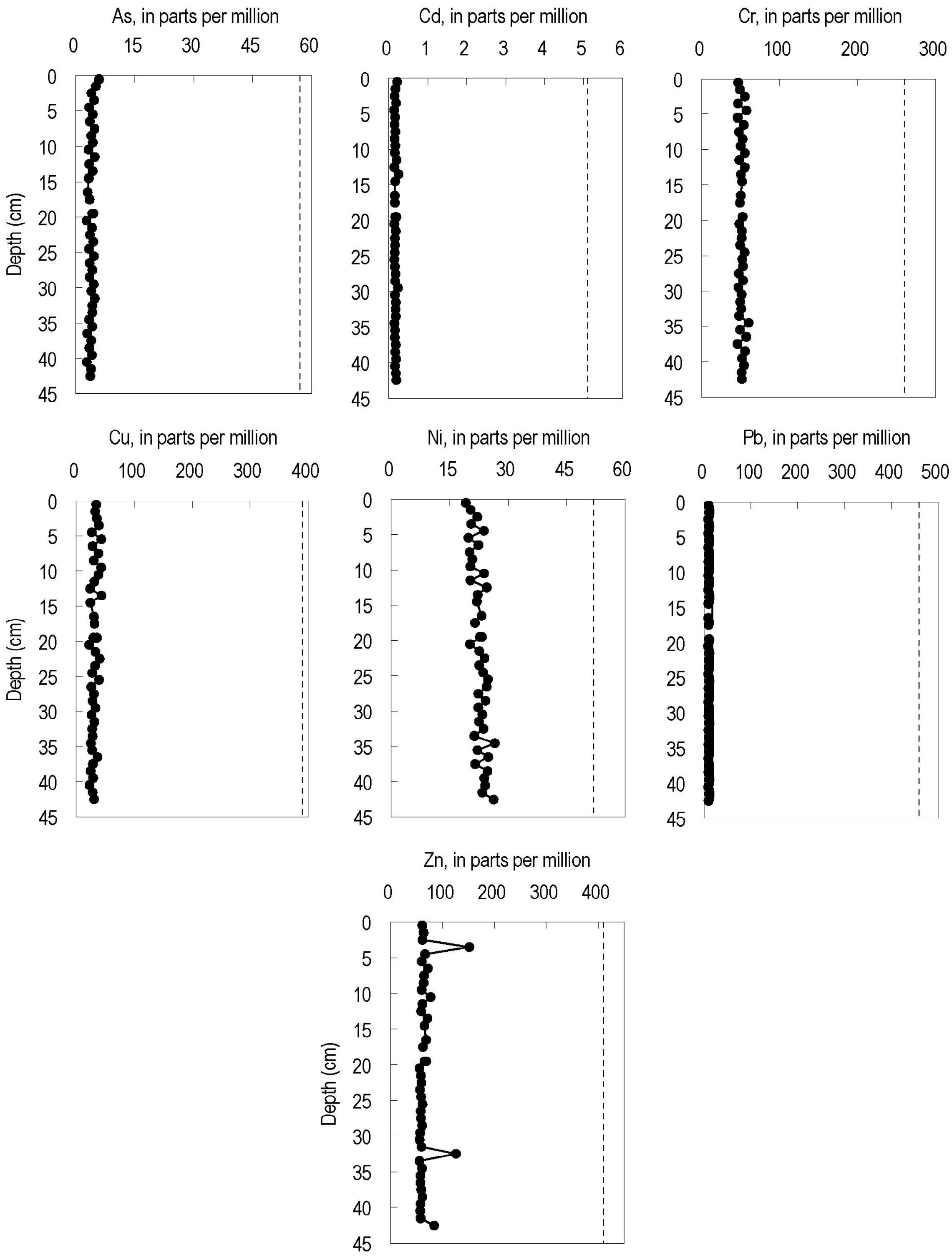

Figure 3. Depth-profiles of total sedimentary-metal contents in the Nisqually Delta, South Puget Sound, Washington. Vertical dashed lines show levels of concern given in table 2.

Summary

This study investigated the sedimentary record of contaminant-metal accumulation on an inner tidal flat of the Nisqually River Delta. A 43-cm-long sediment core collected on the west side of the delta near McAllister Creek had a well-preserved sedimentation record. Based on ^{210}Pb dating, sediment in the core accumulated during a 100 to 150 year-long period. Metal contents throughout the core were similar to background levels at other Puget Sound sites (Bloom and Crecelius, 1987; Crecelius, Bothner, and Carpenter, 1975; Lefkovitz, Cullinan, and Crecelius, 1997; Schell and Nevissi, 1977), indicating that earlier periods of industrialization in Puget Sound did not contribute legacy contaminants to sediment in the Nisqually River Delta. The establishment of the Nisqually National Wildife Refuge in 1974 may account for low levels of contemporary metals associated with urbanization, such as Cu and Pb (Schell and Nevissi, 1977). The 25-percent decrease in total Ni content between preindustrial and modern sediment is likely of geologic origin. Sediment carried by the Nisqually River includes glacial deposits from lowland valleys and volcanic erosion products from the Cascade Range (Barnhardt and Sherrod, 2006). The geochemical composition (Ni, Pb, Rb, Sr, and Th) of Nisqually River Delta sediment is consistent with that of andesitic tephra from Mt. Rainier (Donoghue, Vallance, and others, 2007). The two tephra flows (Layers H and L) to which Nisqually sediment are the most compositionally similar have Ni contents of 12 to 37 ppm (Donoghue, Vallance, and others, 2007), that bracket the range observed in the Nisqually River Delta for more than 100 years. All other elements vary 2-fold or less in Rainier tephra flows (Donoghue, Vallance, and others, 2007), which may explain their lower variability compared to Ni in the Nisqually Delta. The pristine quality of Nisqually River Delta sediment suggests that mobilization, transport, and deposition of tidal-flat sediment arising from restoration activities will not have an adverse chemical impact on benthic organisms.

Acknowledgments

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Appendixes

Appendix A. Total major- and minor-element contents of Core 3 sediment, Nisqually Delta, South Puget Sound, Washington.

[Depth in centimeters. Units are in percent (%)]

Depth	Al	Ca	Fe	Mg	Na	P	Ti
0-1	9.5	3.7	3.6	1.5	3.4	0.1	0.5
1-2	9.6	3.8	3.6	1.5	3.2	0.1	0.5
2-3	9.5	4.1	3.6	1.7	3.0	0.1	0.6
3-4	9.5	3.8	3.4	1.5	3.1	0.1	0.5
4-5	9.7	4.2	3.8	1.8	3.0	0.1	0.6
5-6	9.5	3.8	3.4	1.5	3.0	0.1	0.5
6-7	9.6	4.1	3.7	1.7	3.0	0.1	0.6
7-8	9.7	3.9	3.5	1.5	3.1	0.1	0.5
8-9	9.8	4.1	3.6	1.7	3.0	0.1	0.5
9-10	9.6	3.8	3.4	1.5	3.0	0.1	0.5
10-11	9.7	4.2	3.7	1.7	3.0	0.1	0.6
11-12	9.5	3.8	3.5	1.5	3.1	0.1	0.5
12-13	9.7	4.1	3.4	1.5	3.0	0.1	0.5
13-14	9.7	3.9	3.4	1.5	3.1	0.1	0.5
14-15	9.6	4.1	3.6	1.6	3.0	0.1	0.5
15-16	9.5	4.1	3.5	1.6	2.9	0.1	0.5
16-17	9.7	4.0	3.5	1.5	3.0	0.1	0.5
18-19	9.8	3.9	3.5	1.5	3.1	0.1	0.5
19-20	9.7	3.9	3.4	1.5	3.0	0.1	0.5
20-21	9.2	3.9	3.4	1.5	2.8	0.1	0.5
21-22	9.8	3.8	3.5	1.5	3.0	0.1	0.5
22-23	9.8	4.1	3.8	1.6	2.9	0.1	0.6
23-24	9.7	3.7	3.7	1.4	3.0	0.1	0.5
24-25	9.9	4.1	3.8	1.7	2.9	0.1	0.6
25-26	9.9	3.6	3.7	1.5	2.9	0.1	0.5
26-27	9.6	4.1	3.8	1.7	2.9	0.1	0.6
27-28	9.8	3.8	3.5	1.4	3.1	0.1	0.5
28-29	9.8	4.1	3.7	1.6	2.9	0.1	0.6
29-30	9.5	3.7	3.4	1.4	3.3	0.1	0.5
30-31	9.9	4.1	3.7	1.6	3.0	0.1	0.5
31-32	9.8	3.9	3.5	1.5	3.0	0.1	0.5
32-33	8.8	3.2	3.3	1.2	3.0	0.1	0.5
33-34	9.7	3.8	3.4	1.4	3.0	0.1	0.5
34-35	9.8	4.3	3.9	1.8	2.9	0.1	0.6
35-36	9.8	4.0	3.5	1.5	3.0	0.1	0.5
36-37	9.8	4.3	3.6	1.7	2.9	0.1	0.6
37-38	9.4	3.7	3.3	1.4	2.9	0.1	0.5
38-39	9.8	4.2	3.7	1.7	2.9	0.1	0.6
39-40	9.8	4.0	3.5	1.5	3.0	0.1	0.5
40-41	9.8	4.2	3.5	1.6	2.9	0.1	0.5
41-42	9.8	4.0	3.5	1.5	3.0	0.1	0.5
42-43	9.8	4.2	3.4	1.5	2.9	0.1	0.5

Appendix B. Total trace-element contents of Core 3 sediment, Nisqually Delta, South Puget Sound, Washington.

[Depth in centimeters. Units are in parts per million (ppm)]

Depth	As	Ba	Cd	Co	Cr	Cu	La	Li
0-1	6	398	0.2	11	47	34	21	25
1-2	5	396	0.2	12	49	32	23	25
2-3	4	385	0.1	13	55	35	22	24
3-4	5	393	0.2	11	46	39	22	25
4-5	3	392	0.1	13	57	27	23	24
5-6	4	396	0.2	11	46	43	22	24
6-7	4	388	0.1	13	54	28	23	24
7-8	5	401	0.2	11	48	38	22	25
8-9	4	399	0.1	12	52	30	24	24
9-10	4	395	0.2	11	50	43	22	24
10-11	3	389	0.2	13	55	38	23	23
11-12	5	393	0.2	11	48	31	22	24
12-13	3	388	0.1	12	55	24	22	23
13-14	4	400	0.3	11	50	43	22	24
14-15	3	386	0.2	12	52	24	22	23
15-16	3	385	0.2	12	50	30	22	23
16-17	4	403	0.2	12	49	31	22	24
18-19	4	406	0.2	12	52	36	22	25
19-20	4	399	0.2	11	52	29	23	24
20-21	3	369	0.1	11	48	22	21	22
21-22	4	403	0.2	12	51	33	23	25
22-23	4	397	0.2	12	51	40	24	24
23-24	4	392	0.2	12	49	32	24	25
24-25	3	396	0.2	13	55	27	24	25
25-26	5	394	0.1	13	52	39	23	27
26-27	4	390	0.2	13	53	26	24	24
27-28	4	404	0.2	12	47	30	22	25
28-29	4	400	0.2	12	53	28	23	25
29-30	5	391	0.2	12	47	33	22	25
30-31	4	402	0.2	13	51	26	23	25
31-32	5	405	0.2	12	49	31	23	26
32-33	4	356	0.2	12	51	27	19	23
33-34	4	402	0.2	11	48	28	23	25
34-35	3	392	0.1	14	60	25	23	24
35-36	4	401	0.2	12	49	27	23	25
36-37	3	393	0.2	13	57	37	24	24
37-38	4	387	0.2	11	46	28	21	24
38-39	3	398	0.2	13	55	25	23	25
39-40	4	406	0.2	12	52	29	23	25
40-41	3	399	0.2	13	54	23	25	24
41-42	4	403	0.2	12	51	28	22	25
42-43	4	401	0.2	12	51	31	23	25

Appendix B (cont'd). Total major- and minor-element contents of Core 3 sediment, Nisqually Delta, South Puget Sound, Washington.

[Depth in centimeters. Units are in parts per million (ppm)]

Depth	Mn	Mo	Nb	Ni	Pb	Rb	Sb	Sc
0-1	495	2	9	19	9	40	0.4	14
1-2	522	2	9	20	11	40	0.5	15
2-3	598	2	9	22	8	37	0.4	16
3-4	508	2	8	20	10	40	0.5	14
4-5	645	2	9	24	9	37	0.4	16
5-6	514	2	9	20	10	40	0.5	14
6-7	611	2	9	22	9	38	0.4	16
7-8	534	2	9	20	10	41	0.5	14
8-9	588	2	9	21	9	39	0.4	15
9-10	529	2	9	20	9	40	0.6	14
10-11	609	2	9	24	9	37	0.9	16
11-12	514	2	9	20	10	40	0.4	14
12-13	560	2	9	25	8	38	0.5	15
13-14	517	2	8	22	11	40	0.4	14
14-15	591	2	9	22	9	37	0.4	16
15-16	580	2	9	23	9	37	0.4	15
16-17	555	2	9	21	9	40	0.4	15
18-19	535	2	9	23	10	41	0.4	15
19-20	532	2	9	23	10	40	0.6	14
20-21	559	3	8	20	8	36	0.3	15
21-22	524	2	9	23	10	42	0.6	15
22-23	596	2	9	24	9	39	0.5	16
23-24	531	2	9	23	9	41	0.6	15
24-25	619	2	9	24	9	39	0.5	17
25-26	541	2	9	25	10	42	0.6	16
26-27	617	2	9	24	9	38	0.5	16
27-28	542	2	9	22	10	42	0.4	14
28-29	602	2	9	24	9	39	0.4	16
29-30	544	2	9	22	9	41	0.8	14
30-31	597	2	9	23	9	40	0.4	16
31-32	539	2	9	23	10	42	0.4	15
32-33	576	2	9	24	9	39	0.7	12
33-34	530	2	9	21	10	41	0.4	14
34-35	683	2	10	27	9	38	0.3	18
35-36	555	2	9	22	10	41	0.4	15
36-37	626	2	9	25	8	39	0.3	16
37-38	525	2	9	21	9	40	0.3	14
38-39	617	2	9	25	9	39	0.3	16
39-40	560	2	9	24	10	41	0.4	15
40-41	609	2	9	24	9	39	0.3	16
41-42	559	2	9	23	11	41	0.4	15
42-43	578	2	9	26	9	41	0.4	15

Appendix B (cont'd). Total major- and minor-element contents of Core 3 sediment, Nisqually Delta, South Puget Sound, Washington.

[Depth in centimeters. Units are in parts per million (ppm)]

Depth	Sr	Th	U	V	Y	Zn
0-1	468	6	2	80	17	61
1-2	474	6	2	82	18	64
2-3	492	5	2	85	18	62
3-4	466	6	2	78	17	152
4-5	502	5	2	89	18	66
5-6	474	6	2	78	17	60
6-7	489	6	2	87	18	72
7-8	481	6	2	80	17	65
8-9	495	6	2	82	18	64
9-10	475	6	2	79	18	60
10-11	502	6	2	84	18	77
11-12	473	7	2	79	17	61
12-13	497	6	2	78	17	59
13-14	491	6	2	77	17	71
14-15	495	6	2	83	18	65
15-16	497	6	2	79	17	68
16-17	498	6	2	80	18	62
18-19	495	6	2	81	18	69
19-20	490	6	2	79	18	65
20-21	477	5	2	77	16	56
21-22	488	6	2	81	18	59
22-23	505	7	2	86	18	59
23-24	477	7	2	84	18	57
24-25	508	6	2	89	19	59
25-26	465	6	2	95	19	62
26-27	501	6	2	89	18	58
27-28	497	6	2	81	18	58
28-29	509	6	2	85	18	61
29-30	488	8	2	80	17	57
30-31	517	6	2	85	18	56
31-32	501	6	3	81	18	60
32-33	446	5	2	83	15	126
33-34	496	6	2	79	18	56
34-35	524	6	2	92	19	61
35-36	506	7	2	81	18	58
36-37	523	5	2	86	18	58
37-38	487	5	2	76	17	59
38-39	520	6	2	87	18	61
39-40	516	6	2	81	18	58
40-41	528	6	2	84	18	57
41-42	516	6	2	81	18	58
42-43	524	6	2	81	18	84