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CHEMICAL ANALYSIS OF AUGUST 1988 PORT TOWNSEND BAY SEAWATER SAMPLES

by
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ABSTRACT

Seawater samples collected from Port Townsend Bay during August 16-17, 1988, were analyzed for EPA priority pollutants, 61 trace elements, herbicides, and nitrogen- and phosphorus-containing compounds in an effort to identify the water-borne toxicant thought responsible for liver disease of pen-reared Atlantic salmon. Concentrations of EPA priority pollutant metals were low and consistent with those reported for the main basin of Puget Sound and coastal seawater. The elemental composition of the water compared closely to that in samples collected concurrently in nearby Admiralty Inlet. Organic compounds were not detected. These results support conclusions from an earlier October-December 1987 survey of Port Townsend Bay that indicated the level of chemical contamination to be generally low. It is recommended that further investigation into the cause of the liver disease be focused on the occurrence of natural toxins.

INTRODUCTION

During August 16-17, 1988, a series of seawater samples were collected from Port Townsend Bay in connection with the ongoing investigation into liver disease of pen-reared Atlantic salmon. The objective, as in Ecology's October-December, 1987, survey of the bay (Johnson, 1988), was to screen for the presence of toxic chemicals--a water-borne toxicant believed responsible for the disease (Kent, 1988). The 1987 survey, which included analysis of seawater, salmon tissues, bottom sediments, and effluents, found no basis for a chemical etiology of the disease and generally indicated Port Townsend Bay to have a low level of chemical contamination relative to other parts of Puget Sound. The present survey was conducted because 1) the disease appeared to be primarily a spring-summer phenomenon and existing data had been obtained during winter, and 2) the Environmental Services Division of EPA Region 10 had preliminary data from samples collected on April 4, 1988, suggesting elevated concentrations of several metals in the Port Townsend Bay water column. The EPA data were ultimately rejected based on an internal quality assurance review by Raleigh Farlow (Farlow, personal communication).

Ecology's August 1988 seawater samples were collected on the west side of Port Townsend Bay at salmon rearing pens maintained by Blue Water Farm (Figure 1). This site was selected rather than Crane Point in the southeast corner of the bay (site of Ecology's 1987 water samples and site where the disease had been documented to occur in past years) based on results of ongoing field studies being

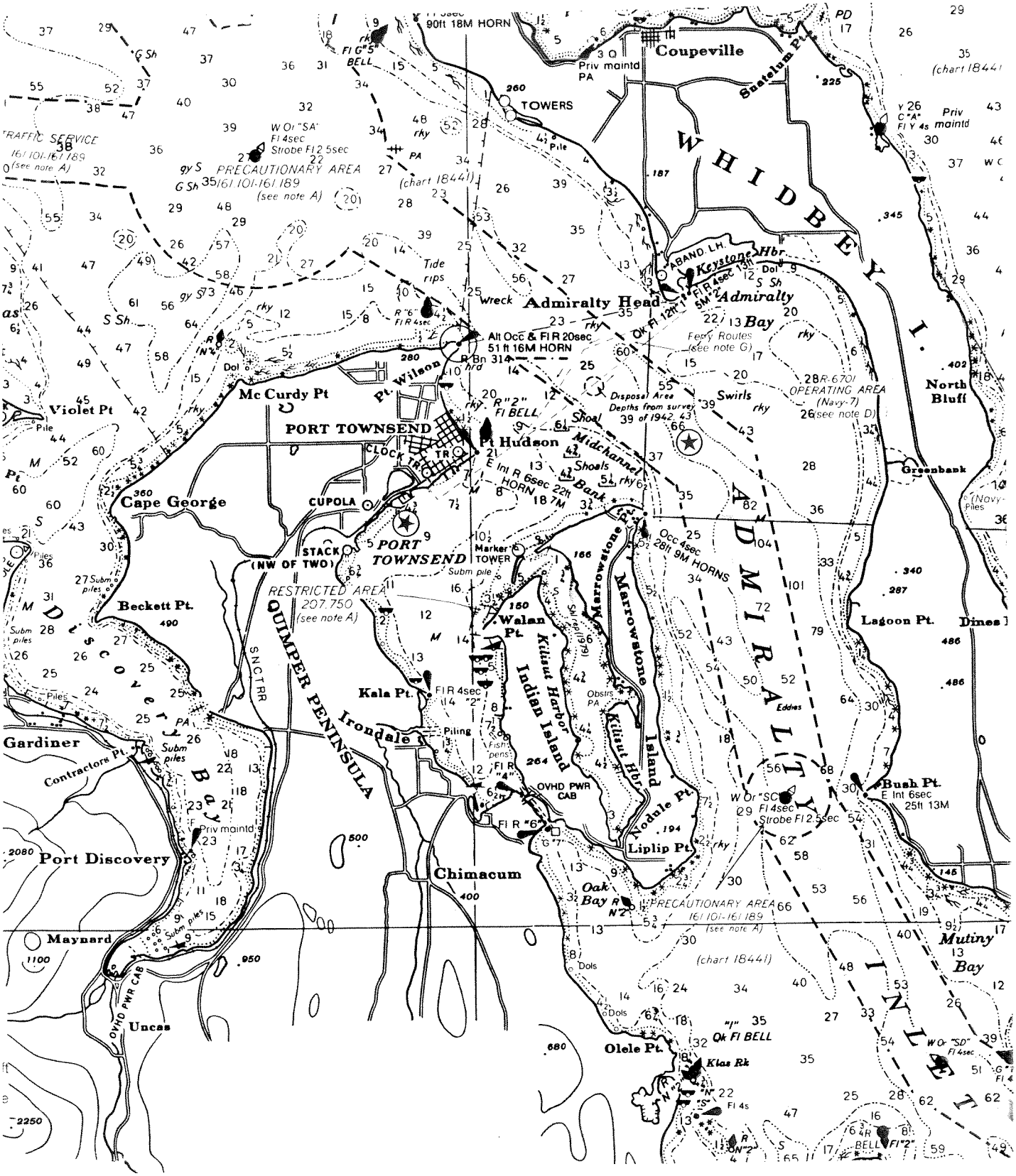

Figure 1. Sampling Locations [★] in Port Townsend Bay and Admiralty Inlet, August 16-17, 1988

conducted for Ecology by the Battelle Marine Research Laboratory. The status of Battelle's work just prior to the present survey was that onset of the liver disease had been detected in Atlantic salmon held at Blue Water (their first attempt to raise this species), but due to failure of an experimental pen being monitored by Battelle, recurrence of the disease at Crane Point was not to be documented until later in the year (Kent, 1989).

METHODS

Timing of the water sample collections is summarized in Table 1. Tidal exchange over the course of the two-day survey was minimal; low and high water extremes ranged from 0.5 to 2.4 meters (1.8 to 7.8 feet). All samples were surface grabs collected at a depth of approximately 0.5 meter. Sample handling is described in Table 2.

Table 3 shows the chemical analyses conducted. These included the EPA priority pollutant metals, volatiles, acid/base/neutral compounds and cyanide, selected herbicides, a screen for organo-nitrogen/organo-phosphorus compounds, and a multi-element scan. A complete list of target organic compounds, including detection limits, is in Appendix A. Temperature, salinity, pH, and dissolved oxygen data were also obtained at Blue Water using a Hydrolab Model 8000; these data are in Appendix B.

The priority pollutant analyses and screen for organo-nitrogen compounds (as well as analysis for specific nitrogen-containing munitions chemicals) mentioned above had been done on the water samples collected in 1987; results were unremarkable. Analysis for the other priority pollutants (i.e., chlorinated pesticides, PCBs, and dioxin [2,3,7,8-TCDD]) in tissue samples from diseased Atlantic salmon collected in 1987 showed low levels of DDT compounds and PCBs typical of Puget Sound salmonids. TCDD was not detected in salmon tissue. Therefore, these analyses were not repeated in 1988. Herbicides, organophosphorus compounds, and trace elements (other than priority pollutant metals) had not been previously analyzed in Port Townsend Bay. The multi-element scan was extended to seawater samples collected concurrently from Admiralty Inlet (see Figure 1) to help put these data in perspective.

The accuracy of the data was assessed using standard reference materials, surrogate compound spikes, matrix spikes, replicate field samples, field blanks, and method blanks. The Ecology/EPA Environmental Laboratory in Manchester, Washington reviewed the results for organic priority pollutants and herbicides and concluded the data were of acceptable quality; this review is in Appendix C.

Table 1. Timing of seawater sample collections in Port Townsend Bay, August 1988.

Date:	August 16	August 17	August 17
Time:	1800	0830	1245
Approx. Tide Stage[a]	higher high water	lower high water	higher low water
Metals	X	X	X
Multi-element scan[b]	X	X	X
Volatiles	X		X
Acid/base/neutrals	X		X
Cyanide	X		X
Herbicides	X		X
N/P Compounds	X		X

[a]Time and height of tides - August 16: LLW, 1249, 1.8'; HHW, 1950, 7.8'
August 17: LLW, 0155, 2.2'; LHW, 0805, 5.8';
HLW, 1321, 2.9'

[b]Samples also collected in Admiralty Inlet on August 16 at 1720, and August 17 at 0855 and 1330.

Table 2. Sample handling for Port Townsend Bay seawater samples collected August 16-17, 1988.

Analysis	Sample Container[a]	Preservation	Maximum Allowable Holding Time
Metals	1 liter teflon	HNO_3 to pH <2 (field); cool to 4°C	6 months 28 days for mercury
Multi-element scan	1 quart polyethylene cubitainer w/teflon lid liner	cool to 4°C	not established
Volatiles	40 mL vial w/teflon septum	cool to 4°C	14 days
Acid/base/neutrals	1 gallon glass w/teflon lid liner	cool to 4°C	7 days to extraction 14 days after extraction
Cyanide	250 mL polyethylene	NaOH to pH >12 (field); cool to 4°C	14 days
Herbicides	1/2 gallon glass w/teflon lid liner	cool to 4°C	7 days
N/P screen	1/2 gallon glass w/teflon lid liner	cool to 4°C	not established

[a] I-Chem Series 300 or equivalent

Table 3. Analytical methods for Port Townsend seawater samples collected August 16-17, 1988.

Analysis	Method	Laboratory
Metals (t.recoverable)	AAS	Battelle, Sequim, WA
Multi-element scan	ICP/MS	Elemental Research Inc. Vancouver, B.C.
Volatiles	purge and trap GC/MS (method 624)	ARI, Seattle, WA
Acid/base/neutrals	GC/MS (method 625)	ARI, Seattle, WA
Cyanide	titrimetric, spectrophotometric (method 335.2-1)	Ecology, Manchester, WA
Herbicides	GC (method 8150)	ARI, Seattle, WA
N/P	GC/FID (method 614)	Ecology, Manchester, WA

AAS = atomic absorption spectrometry
GC/MS = gas chromatography/mass spectrometry
GC = gas chromatography
GC/FID = gas chromatography/flame ionization detector
ICP/MS = inductively coupled plasma/mass spectrometry

RESULTS

Metals (Table 4). This analysis included the 13 priority pollutant metals and tin. Analysis of National Research Council Canada and National Bureau of Standards reference materials demonstrated the data reported for silver, cadmium, chromium, copper, mercury, nickel, lead, and zinc are accurate. A field blank of distilled, de-ionized water carried through the survey and preserved in the field in the same manner as the seawater samples had metals concentrations below method detection limits, except for trace amounts of copper (0.037 ug/L[1]), mercury (0.0012 ug/L), lead (0.027 ug/L), and zinc (0.831 ug/L).

Metals concentrations were low (at or below approximately 1 ug/L) in all Port Townsend Bay seawater samples. Beryllium, antimony, selenium, thallium, and tin were below detection limits. The concentrations observed for those metals detected (silver, arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc) ranged from 0.0006-0.0008 ug/L for mercury to 1.08-1.24 ug/L for arsenic. These results are consistent with metals concentrations reported for the main basin of Puget Sound and coastal seawater (Bloom and Crecelius, 1983; Bruland et al., 1979; Hardy et al., 1985; Paulson and Feeley, 1985; Yeats et al., 1978) and are one or more orders of magnitude below concentrations considered toxic to marine life (EPA, 1986).

Multi-element Scan (Table 5). This analysis furnished data on concentrations of 61 elements. For purposes of the present survey, evaluation of the significance of the concentrations observed in Port Townsend Bay seawater was limited to a comparison with concentrations measured in the samples collected in Admiralty Inlet.

Results showed close agreement between trace element concentrations in Port Townsend Bay and Admiralty Inlet. With the exception of beryllium, antimony, and tin, this analysis corroborated the low concentrations of priority pollutant metals found through conventional atomic absorbtion methods of seawater analysis, as described above.

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1 ug/L = micrograms per liter (parts per billion)

Table 4. Metals concentrations in Port Townsend Bay seawater samples collected August 16-17, 1988 (µg/L; ppb).

Sample Number	Description	Date and Time of Collection	Silver	Arsenic	Beryllium	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Antimony	Selenium	Tin	Thallium	Zinc
Field Samples:																
348080	Port Townsend Bay	Aug 6, 1800	0.001	1.18	<0.01	0.082	0.146	0.305	0.0008	0.356	0.054	<1.07	<0.51	<0.01	<1.55	0.831
348080	(duplicate analysis)		NA[a]	NA	NA	NA	NA	NA	0.0007	NA	NA	NA	NA	NA	NA	NA
348083	Port Townsend Bay	Aug 17, 1830	0.001	1.24	<0.01	<0.105	0.160	0.366	0.0007	0.243	0.063	<1.07	<0.51	<0.01	<1.55	1.200
348085	Port Townsend Bay	Aug 17, 1245	0.001	1.08	<0.01	0.097	0.173	0.317	0.0006	0.227	0.050	<1.07	<0.51	<0.01	<1.55	0.185
348085	(duplicate analysis)		0.001	1.08	<0.01	0.090	0.173	0.329	NA	0.227	0.050	<1.07	<0.51	<0.01	<1.55	0.185
348086	Blank	-- --	<0.001	<0.04	<0.01	<0.001	<0.013	0.037	0.0012	<0.028	0.027	<1.07	<0.51	<0.01	<1.55	0.831
Standard Reference Materials:																
CASS-1	NRCC[b] Coastal Atlantic Seawater		0.002		<0.01	0.027	0.133	0.317		0.292	0.281	<1.07	<0.51	<0.01	<1.55	1.200
CASS-1	(duplicate analysis)		0.002		<0.01	0.029	0.133	0.317		0.292	0.308	<1.07	<0.51	<0.01	<1.55	1.110
	Certified value =		NC[c]		NC	0.026± 0.005	0.118 ±0.021	0.291 ±0.027		0.290 ±0.031	0.251 ±0.027	NC	NC	NC	NC	0.980 ±0.099
NASS-1	NRCC North Atlantic Seawater			1.60												
NASS-1	(duplicate analysis)			1.48												
	Certified value =			1.65± 0.19												
1641b	NBS[d] Mercury in Water								1.50							
1641b	(duplicate analysis)								1.79							
	Certified value =								1.52± 0.04							

[a] Not analyzed

[b] National Research Council Canada, Ottawa

[c] Not certified

[d] National Bureau of Standards, Washington, D.C.

Table 5. Concentrations of 61 elements in Port Townsend Bay seawater samples collected August 16-17, 1988 (µg/L; ppb).

Sample Description	Blue Water Farm				Admiralty Inlet			Field Blank	NRCC Reference Material NASS-2 North Atlantic Seawater		
Sample No. (34-)	8080	8083	8085	8085(rep)	8081	8082	8084	8086			
Date of Collection	8/16	8/17	8/17	8/17	8/16	8/17	8/17	--			
Time of Collection	1800	0830	1245	1245	1720	0855	1330		Analysis 1	Analysis 2	Certified Value
Magnesium	65100	800000	878000	922000	925000	920000	870000	839	985000	1230000	
Calcium	559000	596000	572000	613000	584000	632000	589000	2120	757000	780000	
Titanium	1660	1810	1880	2010	1620	1780	1860	177	1680	2750	
Chromium	0.18	0.22	0.24	0.26	0.21	0.23	0.24	0.01	0.17	0.43	0.175±0.09
Iron	0.22	0.30	0.30	0.34	0.29	0.31	0.31	0.24	0.22	0.47	0.224±0.039
Nickel	0.20	0.24	0.26	0.28	0.22	0.25	0.26	<0.01	0.26	0.39	0.257±0.027
Zinc	0.10	0.12	0.12	0.16	0.11	0.30	0.11	0.04	0.18	0.16	0.178±0.025
Germanium	25.6	27.4	31.0	30.7	29.8	33.8	28	0.46	32.1	45.3	
Bromine	76000	84300	90200	91400	83200	85000	84400	1000	91700	123000	
Rubidium	190	187	195	213	194	199	206	0.45	218	281	
Yttrium	0.48	0.40	0.37	0.39	0.58	0.50	0.34	<0.08	0.61	0.84	
Niobium	0.15	0.88	0.78	0.93	0.70	0.47	0.21	0.11	0.25	1.13	
Ruthenium	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	
Palladium	<0.14	<0.14	0.91	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	<0.14	
Cadmium	0.03	0.04	0.03	0.03	<0.01	0.02	<0.01	<0.01	0.03	0.03	0.029±0.004
Tin	3.61	2.19	2.29	1.92	2.51	2.58	2.68	0.60	3.55	2.46	
Iodine	89.4	108	108	109	106	118	115	28.6	111	152	
Cesium	0.74	0.60	0.72	0.74	0.53	0.70	0.62	<0.08	0.77	1.07	
Lanthanum	0.08	0.17	0.09	<0.08	0.12	<0.08	0.19	<0.08	0.16	0.19	
Praeseodynium	0.12	0.12	<0.08	0.25	0.12	0.13	0.12	<0.08	<0.08	0.22	
Samarium	<0.09	<0.09	0.47	0.43	0.57	0.48	<0.09	<0.09	<0.09	<0.09	
Gadolinium	<0.10	0.42	<0.10	<0.10	<0.10	<0.10	<0.10	0.16	<0.10	<0.10	
Dysprosium	0.26	0.26	0.30	0.48	0.31	<0.08	0.26	0.16	<0.08	0.39	
Erbium	<0.09	0.30	<0.09	0.42	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	
Ytterbium	<0.09	<0.09	<0.09	<0.09	<0.09	0.48	<0.09	<0.09	<0.09	<0.09	
Hafnium	0.10	<0.08	0.17	0.14	<0.08	0.25	0.17	<0.08	<0.08	0.22	
Tungsten	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	
Osmium	0.35	<0.10	<0.10	<0.10	1.18	<0.10	0.43	<0.10	<0.10	<0.10	
Platinum	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	0.23	<0.13	1.46	
Mercury	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	
Lead	0.02	<0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.04	0.03	0.039±0.006
Thorium	<0.08	<0.08	0.08	<0.08	<0.08	<0.08	0.08	<0.08	0.08	<0.08	
Beryllium	<0.11	<0.88	0.85	0.92	<0.11	1.35	1.14	0.12	<0.11	<0.11	
Sodium	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	
Aluminum	254	315	312	311	343	353	335	14.6	461	<2.54	

Table 5. Continued.

Sample Description	Blue Water Farm				Admiralty Inlet			Field Blank	NRCC Reference Material NASS-2 North Atlantic Seawater		
Sample No. (34-)	8080	8083	8085	8085(rep)	8081	8082	8084	8086			
Date of Collection	8/16	8/17	8/17	8/17	8/16	8/17	8/17	--			
Time of Collection	1800	0830	1245	1245	1720	0855	1330		Analysis 1	Analysis 2	Certified Value
Scandium	192	205	199	219	209	212	215	35.0	343	233	
Vanadium	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	
Manganese	0.02	0.03	0.03	0.03	0.03	0.03	0.03	<0.01	0.02	0.04	0.022±0.007
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.004±0.001
Copper	0.14	0.18	0.20	0.23	0.16	0.18	0.19	0.03	0.11	0.30	0.109±0.011
Gallium	10.5	15.9	17.5	16.3	16.4	16.1	15.4	4.09	<0.57	26.43	
Arsenic	1.16	1.91	2.13	2.37	1.93	2.16	2.10	0.07	1.65	3.79	1.65±.19
Selenium	0.02	0.02	0.03	0.02	0.02	0.02	0.02	<0.01	0.02	0.03	0.024±0.004
Strontium	10800	10900	17800	11700	11300	11500	11200	6.11	13100	16100	
Zirconium	0.83	1.24	1.18	1.08	1.23	0.98	4.22	<0.15	1.41	1.74	
Molybdenum	8.47	10.8	11.4	12.1	9.94	11.0	11.0	0.55	11.5	15.6	11.5±1.9
Rhodium	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	
Silver	<0.10	<0.51	<0.10	<0.10	<0.10	0.48	<0.10	<0.10	<0.10	<0.10	
Indium	IS	IS	IS	IS	IS	IS	IS	IS	IS	IS	
Antimony	1.17	2.07	2.45	2.33	1.86	1.68	2.07	0.10	2.27	2.91	
Tellurium	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	
Barium	7.90	6.24	6.65	6.73	7.40	9.00	7.95	<0.17	7.11	7.52	
Cerium	0.13	<0.08	0.33	0.40	0.17	0.25	0.28	<0.08	<0.08	0.50	
Neodymium	<0.08	0.28	0.45	0.42	0.34	0.83	0.49	<0.08	0.44	0.74	
Europium	0.09	0.15	0.12	0.19	0.22	0.22	<0.08	<0.08	0.13	0.20	
Terbium	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.10	<0.08	<0.08	0.20	
Holmium	0.36	0.32	0.38	0.47	0.37	0.45	0.49	<0.08	0.39	0.73	
Thulium	0.09	<0.08	<0.08	<0.08	<0.08	<0.08	0.10	<0.08	<0.08	<0.08	
Lutetium	IS	IS	IS	IS	IS	IS	IS	IS	IS	IS	
Tantalum	<0.08	<0.08	<0.08	<0.08	0.09	<0.08	<0.08	<0.08	<0.08	<0.08	
Rhenium	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	
Iridium	<0.08	<0.08	0.28	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	
Gold	<1.58	<1.29	<0.98	<2.50	<1.75	<1.36	<0.71	<1.56	<2.16	<3.98	
Thallium	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.39	<0.08	
Bismuth	<0.08	<0.08	0.27	<0.08	<0.08	0.15	<0.08	<0.08	<0.08	<0.08	
Uranium	1.97	2.17	1.92	1.61	2.06	1.84	1.80	0.01	3.00	1.89	3.00±0.15

MC = major component
MI = molecular interference
IS = internal standard

Volatiles. Except for trace amounts (5.3 - 11 ug/L) of methylene chloride, a common laboratory contaminant also detected in both field and method blanks, purgeable organic priority pollutants were not detected in Port Townsend Bay seawater. Detection limits were 0.2 - 2.9 ug/L.

Acid/Base/Neutrals. No acid/base/neutral compounds were detected. Detection limits were 1 - 5 ug/L, except for benzoic acid and dinitrophenols, where a detection limit of 10 ug/L was achieved.

Cyanide. A trace of cyanide (2 ug/L total cyanide) was detected in one of the two samples collected for this analysis. This concentration is at the detection limit of the method. Water quality criteria for protection of marine life from the toxic effects of cyanide are in the range of 1 - 10 ug/L (EPA, 1986; CCREM, 1987; Thurston et al., 1979; NAS, 1973).

Herbicides. No samples contained detectable concentrations of herbicides at detection limits ranging from 0.02 - 8.0 ug/L.

Nitrogen/Phosphorus Compounds. The screen for organo-nitrogen and organo-phosphorus compounds failed to detect the presence of these types of compounds at a detection limit of 0.02 ug/L.

CONCLUSIONS

Analysis of Port Townsend Bay seawater samples collected during August 16-17, 1988, showed no evidence of chemical contamination. These results lend further support to the conclusions reached in Ecology's October-December 1987 survey of the bay, namely that "the level of chemical contamination in Port Townsend Bay appeared to be generally low [and] no evidence was found of the unusual occurrence of toxic chemicals." Subsequent investigations into the cause of this liver disease in pen-reared salmon should focus on natural toxins, perhaps an algal toxin as suggested by results of Battelle's 1988 studies (Kent, 1989).

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Appendix A. Organic compounds analyzed in Port Townsend Bay, August 16-17, 1988 (detection limits in µg/L; ppb).

Volatiles			
Chloromethane	(2.9)	1,2-Dichloropropane	(0.6)
Bromomethane	(0.9)	Trans-1,3-Dichloropropene	(0.5)
Vinyl Chloride	(1.1)	Trichloroethene	(0.8)
Chloroethane	(0.9)	Dibromochloromethane	(0.9)
Methylene Chloride	*	1,1,2-Trichloroethane	(0.3)
Acetone	(0.6)	Benzene	(0.4)
Carbon Disulfide	(2.0)	Cis-1,3-Dichloropropene	(0.6)
1,1-Dichloroethene	(1.3)	2-Chloroethylvinylether	(1.5)
1,1-Dichloroethane	(1.1)	Bromoform	(0.3)
Trans-1,2-Dichloroethene	(1.1)	4-Methyl-2-Pentanone	(1.8)
Cis-1,2-Dichloroethene	(1.2)	2-Hexanone	(1.3)
Chloroform	(0.9)	Tetrachloroethene	(0.6)
1,2-Dichloroethane	(0.6)	1,1,2,2-Tetrachloroethane	(0.6)
2-Butanone	(1.0)	Toluene	(0.6)
1,1,1-Trichloroethane	(1.0)	Chlorobenzene	(0.6)
Carbon Tetrachloride	(0.5)	Ethylbenzene	(0.6)
Vinyl Acetate	(1.7)	Styrene	(0.5)
Bromodichloromethane	(0.2)	Total Xylenes	(1.5)
Acid/Base/Neutrals			
Phenol	(1)	Acenaphthlene	(1)
Bis(2-Chloroethyl)Ether	(1)	2,4-Dinitrophenol	(10)
2-Chlorophenol	(1)	4-Nitrophenol	(5)
1,3-Dichlorobenzene	(1)	Dibenzofuran	(1)
1,4-Dichlorobenzene	(1)	2,4-Dinitrotoluene	(5)
Benzyl Alcohol	(5)	2,6-Dinitrotoluene	(5)
1,2-Dichlorobenzene	(1)	Diethylphthalate	(1)
2-Methylphenol	(1)	4-Chlorophenyl-phenylether	(1)
bis(2-chloroisopropyl)Ether	(1)	Fluorene	(1)
4-Methylphenol	(1)	4-Nitroaniline	(5)
N-Nitroso-Di-n-Propylamine	(1)	4,6-Dinitro-2-Methylphenol	(10)
Hexachloroethane	(2)	N-Nitrosodiphenylamine	(1)
Nitrobenzene	(1)	4-Bromophenyl-phenylether	(1)
Isophorone	(1)	Hexachlorobenzene	(1)
2-Nitrophenol	(5)	Pentachlorophenol	(5)
2,4-Dimethylphenol	(2)	Phenanthrene	(1)
Benzoic Acid	(10)	Anthracene	(1)
bis(2-Chloroethoxy)Methane	(1)	Di-n-Butylphthalate	(1)
2,4-Dichlorophenol	(3)	Fluoranthene	(1)
1,2,4-Trichlorobenzene	(1)	Pyrene	(1)
Naphthalene	(1)	Buthylbenzylphthalate	(1)
4-Chloroaniline	(3)	3,3'-Dichlorobenzidine	(5)
Hexachlorobutadiene	(2)	Benzo(a)Anthracene	(1)
4-Chloro-3-Methylphenol	(2)	Bis(2-Ethylhexyl)Phthalate	(1)
2-Methylnaphthalene	(1)	Chrysene	(1)
Hexachlorocyclopentadiene	(5)	Di-n-Octyl Phthalate	(1)
2,4,6-Trichlorophenol	(5)	Benzo(b)Fluoranthene	(1)
2,4,5-Trichlorophenol	(5)	Benzo(k)Fluoranthene	(1)
2-Chloronaphthalene	(1)	Benzo(a)Pyrene	(1)
2-Nitroaniline	(5)	Indeno(1,2,3-cd)Pyrene	(1)
Dimethyl Phthalate	(1)	Dibenz(a,h)Anthracene	(1)
Acenaphthylene	(1)	Benzo(ghi)Perylene	(1)
3-Nitroaniline	(5)		
Herbicides			
Silvex (2,4,5-TP)	(0.02)		
2,4,5-T	(0.02)		
Dinoseb	(0.02)		
Dicamba	(0.02)		
Dichlorprop	(0.04)		
2,4-D	(0.04)		
2,4-DB	(0.2)		
Dalapon	(2.0)		
MCPP	(8.0)		
MCPA	(4.0)		

* detected in blanks

Appendix B. Hydrolab profiles in Port Townsend Bay, August 16-17, 1988.

Depth (meters)	Temperature (^{o}C)	Salinity (%)	pH (S.U.)	Dissolved Oxygen (mg/L)
		8/16/88	1745-1800 hours	
Surface	11.8	30.1	7.3	7.5
1	11.9	30.1	7.4	8.6
2	11.9	30.3	7.4	8.9
4	11.8	30.4	7.5	9.3
6	11.7	30.5	7.5	9.0
8	11.6	30.5	7.5	8.7
10	11.5	30.4	7.5	8.3
15	11.4	30.4	7.4	7.9
16	11.0	30.6	7.3	6.6
17	Bottom			
		8/17/88	1300-1315 hours	
Surface	14.1	30.1	7.6	10.1
1	12.3	30.0	7.6	8.5
2	11.5	30.3	7.4	6.7
4	11.3	30.4	7.4	6.2
6	11.2	30.5	7.3	5.8
8	11.1	30.5	7.3	5.5
10	11.0	30.6	7.3	5.3
15	Bottom			

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<u>Data Review</u>
October 7, 1988

Project:	Port Townsend
Sample No.:	348080, 348085, and 348086
Laboratory:	Analytical Resources Inc.
By:	Roy Araki, Chemist

VOA

<u>Holding Time:</u> The following is a time summary for this analysis:

Sam. #	Collect	To Manche	To Contr	VOA	VOA Frm Rcpt	VOA Frm Coll
34 8080	8/16	8/18	8/18	8/19	1 days	3 days
34 8085	8/17	8/18	8/18	8/19	1 days	2 days
34 8086	8/17	8/18	8/18	8/19	1 days	2 days

These times are within the U.S. EPA CLP limits of ten (10) days for analysis from the date of receipt and fourteen (14) days for analysis from the date of collection.

<u>Surrogates:</u> Recoveries are acceptable and within the U.S. EPA CLP limits.

<u>Matrix Spike & Matrix Spike Duplicate:</u> Toluene was recovered in the matrix spike duplicate at slightly higher (127%) than the CLP limit (125%). All other recoveries are acceptable and within the CLP limits. The Toluene recovery can be considered an anomaly and should not affect the data.

Precision data is acceptable and within the CLP limits.

<u>Sample Data:</u> Methylene chloride is a common laboratory contaminant in VOA analysis. It was found in the laboratory blank and therefore subsequent positives for this analyte received a "B" qualifier if it was quantitated at less than ten (10) times the level of the blank.

The data is considered acceptable for use without additional qualifications.

BNA

<u>Holding Times:</u> The following is a time summary for this analysis:

Sam. #	Collect	To Manche	To Contr	Ext BNA	Analysis BNA	Ext BNA Frm Rcpt	Ext BNA Frm Coll	BNA anal Frm Ext
34 8080	8/16	8/18	8/18	8/23	8/25	5 days	7 days	2 days
34 8085	8/17	8/18	8/18	8/23	8/25	5 days	6 days	2 days
34 8086	8/17	8/18	8/18	8/23	8/25	5 days	6 days	2 days

These times are within the U.S. EPA CLP limits of five (5) days for extraction from the date of receipt and seven (7) days for extraction from the date of collection. The CLP limit for analysis is forty (40) days from the date of extraction.

Surrogates: Recoveries are acceptable and within the U.S. EPA CLP limits.

Matrix Spike & Matrix Spike Duplicate: The recovery for Pyrene from the matrix spike duplicate (162%) was outside the CLP limit (127%). Two bases, 2,4-Dinitrotoluene and N-nitroso-di-n-propylamine were recovered form the matrix spike duplicate at a lower level than the matrix spike but within the CLP limits. The precision for N-nitroso-di-n-propylamine was affected severely enough to be outside the CLP limits.

Other QA/QC information appear to be acceptable and the recoveries mentioned above can be considered isolated to the analysis of the matrix spike duplicate and not to the rest of the sample set. The data should not be affected and additional data qualification is not needed.

Other recoveries and precision data are acceptable and within the CLP limts.

Sample Data: The data is considered acceptable without additional data qualification.

Chlorinated Herbicides:

Holding Times: The following is a time summary for this analysis:

Sam. #	Collect	To Manche	To Contr	Ext Herb	Cl Herb	Herb Ext Frm Rcpt	Herb Ext Frm Coll	Herb Ana Frm Ext
34 8080	8/16	8/18	8/18	8/24	9/1	6 days	8 days	8 days
34 8085	8/17	8/18	8/18	8/24	9/1	6 days	7 days	8 days
34 8086	8/17	8/18	8/18	8/24	9/1	6 days	7 days	8 days

There are no CLP limits on holding times for this analysis. Recommended holding times for chlorinated pesticides are five (5) days for extraction from the date of receipt and seven (7) days for extraction from the date of collection. The CLP limit for analysis is forty (40) days from the date of extraction. If these limits are applied then some of the times are in slight excess but not grossly so. This should have no affect of the subsequent data.

Surrogates: Recoveries are acceptable.

Matrix Spike & Matrix Spike Duplicate: Dinoseb was recovered at a low level in the matrix spike duplicate. Compared to the matrix spike the precision of recovery is poor for this analyte. It is highly possible that quantitation for this analyte is