HAWK INLET MONITORING PROGRAM 2016 ANNUAL REPORT

Hecla Greens Creek Mining Company

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HAWK INLET MONITORING PROGRAM 2016 ANNUAL REPORT

1. INTRODUCTION

1.1 Site Description

The Greens Creek Mine on Admiralty Island is located 18 miles southwest of the city of Juneau, Alaska. Dense forests cover the mountain slopes up to an elevation of 2,500 feet, above which the vegetation is alpine. The climate is maritime, with precipitation similar to that in Juneau, averaging 60 to 70 inches per year at the mine site, and 45 to 55 inches per year near the port facilities. The mine and mill facilities (920 area) are located over 6 miles from Hawk Inlet tidewater.

Zinc, lead, silver, and gold are the target recovery metals. The Greens Creek Mine production of ore concentrate began in February 1989, and operated approximately four years before production was suspended in April 1993. The mine and mill were recommissioned and operations restarted in mid-1996. A 2,200 ton/day milling facility and appurtenant support facilities are in place at the 920 area. Filter pressed tailings from the milling process are backfilled in the mine and also deposited at a surface dry-stack tailings pile at the Tailings Basin. Ore concentrate (concentrate) is transported from the mill to the Hawk Inlet port facilities area (Port), where it is stored until it is shipped offsite. Support facilities to the mining and milling operation at the Port include rock core storage, concentrate storage, shipping port, and shift housing. A domestic waste water treatment plant is also located at the Port.

One wastewater discharge outfall and 10 stormwater discharge sites are authorized by the HGCMC Alaska Pollutant Discharge Elimination System (APDES) Permit Number AK-004320-6. Sewage effluent previously discharged through Outfall 001 is combined with area surface runoff, and pumped to Pond 7. At Pond 7, the water is combined with effluent streams from the 920 and the Tailings Basin, treated, and discharged through the submarine APDES Outfall 002 to the ocean at the mouth of Hawk Inlet. Authority over the federal permitting, compliance and enforcement of the NPDES program transferred to the State in November of 2010 for the mining industry. This report fulfills the requirements of APDES Permit Number AK-004320-6, reissued October 1st, 2015.

Hawk Inlet is a marine inlet formed during the late Holocene glaciation and is underlain by a series of late-Paleozoic to Mesozoic phyllitic-schist and greenstone formations. Hawk Inlet extends seven miles north from Chatham Strait to a tidal mudflat estuary about 0.6

miles in diameter. The narrow channel connecting the Inlet to Chatham Strait, located between the top of the Greens Creek delta and the western shore of Hawk Inlet, has a minimum low tide depth of 35 feet. The mid-channel depth ranges from 35 feet to 250 feet. The Inlet has regular, twice-daily tides, with a maximum tidal variation of 25 feet. On the flood tide, the surface 35-foot layer contains the bulk of the water transport entering the Inlet and is then flushed out on the ebb tide. Flushing describes the rate and extent to which a body of water is replenished by tidal or other currents. Flushing rates are also indicative of the length of time that mining effluent may remain in a water body and become incorporated into the physical and biological ecosystem through ingestion, adsorption or other means. In 1983, dispersion dye testing in Hawk Inlet determined that over each tidal cycle, an average of 13 billion gallons of water is flushed from the Inlet (SEA 1983). At that rate, it is estimated that the Inlet will completely flush at least once every five tidal cycles. Based on the average daily output in 2016, the input of effluent from the mining operations over a day represents approximately 0.007 percent of the total volume flushed daily.

Greens Creek geology exploration began in 1973, which led to predevelopment of mining operations in 1986. Prior to this the Hawk Inlet cannery was constructed in 1910 and operated until it burned in 1976. It is estimated the summer population at Hawk Inlet during cannery operation was 500. Additionally, up until 1946, gold was being mined near Hawk Inlet beginning in 1919 at the Alaska Empire Mine (Forest Service 2013). Factor in the historical and current use of Hawk Inlet's commercial fishing industry and there is a substantial amount of anthropogenic effects which cannot all be attributable to the Greens Creek mining operation.

1.2 Hawk Inlet Monitoring Program

In anticipation of the Greens Creek Mine development, government agencies, scientists and biological consultants carried out surveys of marine life and baseline studies of heavy metals in the environment beginning in the early 1980s. Several researchers have studied marine life in Hawk Inlet, and the on-going quarterly, semi-annual, and annual monitoring events have generated an extensive time-series data set of coincident metal levels in water, sediment, and marine tissue samples.

The primary objective of the Hawk Inlet monitoring program is to document the water quality, sediment chemistry, and biological conditions in receiving waters and marine environments that may be impacted by the mine's operations. Sea water is sampled quarterly at three locations in Hawk Inlet. Sediment and invertebrate samples are collected annually at three (five locations every three years) and seven locations, respectively (Figure 1-1). Table 1-1 summarizes the requirements of the permit for sample parameters, sample preservation and holding time, sampling frequency, analytical method and required method detection limits (MDL). Specific quality assurance/quality control (QA/QC) requirements (i.e., sampling procedures, documentation, chain of custody processes, calibration procedures and frequency, data validation, corrective actions, etc.) are outlined in the NPDES Quality Assurance Plan: Project Monitoring Manual (HGCMC 2015).

Table 1-1. Summary of Permit Sampling Requirements for Hawk Inlet

APDES Requirement	Parameter	Required Sampling Frequency	Sample Type	Sample Container	Sample Preservation	Laboratory	Holding Time	Analytical Method(s)	Minimum Required Method Detection Limit	Units	Comments
RECEIVING WATER COLUMN MONITORING											
1.6.1.1.3 Table 5	Dissolved Cadmium	Quarterly	Grab (1 sample for Cd, Cu, Pb, Zn)	1 ea. 500 ml Teflon bottle (1 bottle for Cd, Cu, Pb, Zn)	HNO_3 to pH <2 by lab	Battelle Marine Sciences	6 months	EPA 213.2/ 1638	0.10	µg/L	MDLs set by APDES permit Section 1.6.1.1.3, Table 5
1.6.1.1.3 Table 5	Dissolved Copper	Quarterly						EPA 220.2/ 1638	0.03	µg/L	
1.6.1.1.3 Table 5	Dissolved Lead	Quarterly						EPA 239.2/ 1638	0.05	µg/L	
1.6.1.1.3 Table 5	Dissolved Zinc	Quarterly					6 months	EPA 289.2/ 1638	0.200	µg/L	
1.6.1.1.3 Table 5	Total Mercury	Quarterly	Grab	1 ea. 250 ml Teflon bottle			28 days	EPA 245.1/ 1631	0.002	µg/L	
1.6.1.1.3 Table 5	Total Suspended Solids	Quarterly	Grab	1 ea. 1 liter plastic bottle	Cool to 4°C	ACZ Labs	7 days	EPA 160.2/ SM 2540D	--	mg/L	
1.6.1.1.3 Table 5	Turbidity	Quarterly	Grab	1 ea. 1 liter plastic bottle	Cool to 4°C	Field measurement	48 hours	EPA 180.1	--	NTU	
1.6.1.1.3 Table 5	WAD Cyanide	Quarterly	Grab	1 ea 1 liter plastic bottle	NaOH to pH >12, cool to 4°C	ACZ Labs	14 days	EPA 335.2/ SM 4500-CN-E	5.00	µg/L	Add 0.6g ascorbic acid, if chlorine is present.
1.6.1.1.3 Table 5	pH	Quarterly	Grab	NA	NA	Field measurement	15 min	EPA 150.1/ SM 4500-H, B	--	SU	
1.6.1.1.3 Table 5	Conductivity	Quarterly	Grab	NA	NA	Field measurement	20 days	EPA 120.1	--	µmhos/cm	
1.6.1.1.3 Table 5	Temperature	Quarterly	Grab	NA	NA	Field measurement	15 min	NA	--	°C	
BIOACCUMULATION WATER SEDIMENT MONITORING											
1.6.1.2.3 Table 6	Total Cadmium	Annual	Grab	6 ea. 8 oz. plastic or glass jar	Chill and ice sample (not frozen)	ALS Environmental		PSEP/GFAA	0.30	mg/Kg	MDLs set by APDES permit Section 1.6.1.2.3, Table 6
1.6.1.2.3 Table 6	Total Copper	Annual	Grab			ALS		PSEP/ICP	15.00	mg/Kg	
1.6.1.2.3 Table 6	Total Lead	Annual	Grab			ALS		PSEP/ICP	0.50	mg/Kg	NMFS request dupilicate sampling
1.6.1.2.3 Table 6	Total Mercury	Annual	Grab			ALS		PSEP/ EPA 7471A	0.02	mg/Kg	
1.6.1.2.3 Table 6	Total Zinc	Annual	Grab			ALS		PSEP/ICP	15.00	mg/Kg	
BIOACCUMULATION WATER IN-SITU BIOASSAY MONITORING											
1.6.1.3.2 Table 7	Total Cadmium	Annual	Grab	6 ea. 8 oz. plastic or glass jar	Chill and ice sample (not frozen)	ALS		EPA 200.8/ 6020	not specified	mg/Kg	NMFS request dupilicate sampling since Fall 2004
1.6.1.3.2 Table 7	Total Copper	Annual	Grab			ALS		EPA 200.8/ 6020	not specified	mg/Kg	
1.6.1.3.2 Table 7	Total Lead	Annual	Grab			ALS		EPA 200.8/ 6020	not specified	mg/Kg	
1.6.1.3.2 Table 7	Total Mercury	Annual	Grab			ALS		EPA 7471A	not specified	mg/Kg	
1.6.1.3.2 Table 7	Total Zinc	Annual	Grab			ALS		EPA 200.8/ 6020	not specified	mg/Kg	

In May 2016, Marine Taxonomic Services surveyed the 002 Outfall pipeline for corrosion and damage. A CD of the survey footage can be found as Appendix B. The following points summarize the major findings of the inspection (Marine Taxonomic Services, 2016):

- The outfall pipe is in good overall condition. No cracks or leaks were found, and all diffusers have full flow.
- All diffuser ports were found to have moderate to considerable biofouling that was completely removed with the use of scrapers and brushes.
- The zinc anode end caps installed to protect the stainless hardware show considerable corrosion in some cases. Those caps are being maintained through replacement of approximately 1/3rd of the caps per annual inspection event.
- The minimal sediment accretion inside the diffuser is not a threat to discharge flow rates and requires no maintenance or removal at the present time.
- The pipeline hardware is in good overall condition.

This report presents information on each of the three media sampled in Hawk Inlet: water column, sediment, and in-situ bioassay. All results for the samples collected in 2016 are presented, along with the associated QA/QC data. Statistical evaluation of the data showing averages, variations, and changes over time are also included. The next section describes any deviations from the monitoring program that occurred in 2016, and the reasons for the deviations.

1.3 Deviation(s) from Monitoring Program and Incidents in 2016

There were no reportable deviations in the 2016 receiving water column monitoring program.

2. WATER COLUMN MONITORING

The receiving water column monitoring requirements originate from Section 1.6.1.1 and Table 5 of the APDES permit. The objective of the receiving water column monitoring element of the sampling program is to provide scientifically valid data on specific physical and chemical parameters for Hawk Inlet water quality. These data are used to evaluate potential changes in the Hawk Inlet marine environment.

In fulfillment of the first EPA issued NPDES permit in 1987, Greens Creek Mining Company sampled quarterly at five locations (104, 105, 106, 107, and 108) for ten total recoverable metals (Ag, As, Ni, Zn, Cd, Cr, Cu, Hg, Pb, and Se) at depths of five feet and 20 feet. In 1998 the NPDES permit was reissued, with the number of sample locations reduced to three (106, 107, and 108) and a reduction in the metals analyzed to five metals (Cd, Cu, Pb, Hg, and Zn), collected at a depth of five feet on a quarterly basis.

Currently three seawater sites in Hawk Inlet are sampled to monitor potential water quality effects from the mine. Seawater samples are collected quarterly from the sites on an outgoing tide, with the Chatham Strait sample (Site 106) collected just after low slack water. The two other sites are Station 107, located about mid-way east-west in Hawk Inlet and west of the ship loader facility, and Station 108, located proximal to the 002 diffuser in the mixing zone. Samples at all three locations are taken at a depth of five feet. Sample timing in each quarter is tide and weather dependent.

Water samples are sent to Battelle Marine Science Lab in Sequim, Washington, for low level dissolved trace metals analyses (Cd, Cu, Pb, and Zn), total mercury and ACZ Laboratories in Steamboat Springs, Colorado for WAD CN and total suspended solids analyses. Temperature, pH, turbidity and conductivity are measured in the field by the Environmental staff.

2.1 2016 Analytical Results

The tables in this section summarize the results for the quarterly water column monitoring conducted in 2016.

Table 2-1. Hawk Inlet Field Parameters 2016 (sample depth 5')

Site	Sample Date	Sample Time (24 hr)	Weather Conditions	Conductivity (µmhos/cm)	pH (SU)	Temp. (°C)	Turbidity (NTU)
106	Quarter 1 (12/29/16)	12:00	sunny	47,410	7.93	5.6	0.48
	Quarter 2 (06/07/16)	09:50	sunny	47,140	8.12	9.9	1.94
	Quarter 3 (08/09/16)	11:55	cloudy	32,420	8.18	14.3	0.76
	Quarter 4 (11/01/16)	09:15	cloudy	50,600	7.80	7.0	0.6
107	Quarter 1 (12/29/16)	12:20	sunny	46,630	7.95	5.2	0.66
	Quarter 2 (06/07/16)	09:27	sunny	45,970	8.06	10.0	1.77
	Quarter 3 (08/09/16)	11:20	cloudy	38,260	8.15	13.6	1.84
	Quarter 4 (11/01/16)	11:30	cloudy	51,000	7.79	6.9	0.55
108	Quarter 1 (12/29/16)	11:45	sunny	39,700	7.93	5.1	0.54
	Quarter 2 (06/07/16)	09:39	sunny	46,310	8.11	10.1	1.82
	Quarter 3 (08/09/16)	11:45	cloudy	39,400	8.18	13.5	1.37
	Quarter 4 (11/01/16)	08:45	cloudy	50,600	7.77	6.9	0.66

Table 2-2. Hawk Inlet Water Column Monitoring 2016: Nonmetal Parameters (ACZ Laboratories) (sample depth 5')

Site	Sample Quarter	TSS (mg/L)	WAD CN (µg/L)
	Lab MDL	*(5.0)*	*(3.0)*
	Req. MDL	--	*(5.0)*
106	1	<5	<3.0
	2	49	<3.0
	3	11	<3.0
	4	<5	<3.0
107	1	<5	<3.0
	2	24	<3.0
	3	11	<3.0
	4	<5	<3.0
108	1	<5	<3.0
	2	32	<3.0
	3	32	<3.0
	4	14	<3.0

Note: "<" denotes the sample was analyzed for, but was not detected above the level of the method detection limit.

Table 2-3. Hawk Inlet Water Column Monitoring Results 2016: Metals (Battelle Marine Sciences Laboratory) (sample depth 5')

Site	Sample Quarter	Cd (µg/L) Dissolved	Cu (µg/L) Dissolved	Pb (µg/L) Dissolved	Hg (µg/L) Total	Zn (µg/L) Dissolved
	Lab MDL	*(0.002)*	*(0.023)*	*(0.001)*	*(0.0001)*	*(0.042)*
	Req. MDL	*(0.10)*	*(0.03)*	*(0.05)*	*(0.002)*	*(0.20)*
106	1	0.0760	0.186	0.00204	0.000194	0.295
	2	0.0672	0.175	0.00322	0.000151	0.132
	3	0.0509	0.292	0.00176	0.000632	0.086
	4	0.0890	0.215	0.00395	0.000193	0.310
107	1	0.0796	0.236	0.00610	0.000278	0.569
	2	0.0613	0.200	0.00675	0.000300	0.236
	3	0.0594	0.267	0.00446	0.000514	0.202
	4	0.0862	0.197	0.00419	0.000230	0.311
108	1	0.0764	0.202	0.00929	0.000249	0.406
	2	0.0680	0.209	0.00678	0.000238	0.223
	3	0.0588	0.269	0.00426	0.000416	0.527
	4	0.0899	0.224	0.02800	0.000288	0.527

Table 2-4 Site 35 APDES Outfall 002 and Water Column Site 108 Results

Site	Analyte	Units	Quarter 1	*MDL*	Quarter 2	*MDL*	Quarter 3	*MDL*	Quarte r 4	*MDL*
Site 35 APDES Outfall 002	Cadmium Total	µg/L	0.4	0.2	<0.1	*0.1*	0.1	*0.1*	0.2	*0.1*
	Copper Total	µg/L	1.2	0.5	1.1	*0.5*	<0.5	*0.5*	1.7	*0.5*
	Mercury Total	µg/L	<0.2	0.2	<0.2	*0.2*	<0.2	*0.2*	<0.2	*0.2*
	Lead Total	µg/L	41.4	0.1	27.4	*0.1*	48.6	*0.1*	44.8	*0.1*
	Zinc Total	µg/L	53	2	30	*2*	23	*2*	52	*2*
	TSS	mg/L	<5	5	<5	*5*	<5	*5*	<5	*5*
	WAD CN	µg/L	<3	3	<3	*3*	<3	*3*	<3	*3*
	pH	s.u.	7.89	--	8.32	--	8.27	--	7.91	--
Water Column Site 108	Cadmium Dissolved	µg/L	0.08	0.001	0.068	*0.002*	0.0588	*0.002*	0.0899	*0.002*
	Copper Dissolved	µg/L	0.202	0.023	0.209	*0.023*	0.269	*0.023*	0.224	*0.023*
	Mercury Total	µg/L	0.00025	0.0001	0.00024	*0.0001*	0.00042	*0.0001*	0.00029	*0.0001*
	Lead Dissolved	µg/L	0.0093	0.001	0.0068	*0.001*	0.0043	*0.001*	0.028	*0.001*
	Zinc Dissolved	µg/L	0.406	0.042	0.223	*0.042*	0.527	*0.042*	0.527	*0.042*
	TSS	mg/L	<5	5	32	*5*	32	*5*	14	*5*
	WAD CN	µg/L	<3	3	<3	*3*	<3	*3*	<3	*3*
	pH	s.u.	7.93	--	8.11	--	8.18	--	7.77	--

Note: “<” denotes the sample was analyzed for, but was not detected above the level of the method detection limit

2.2 Data Evaluation

Figures 2-1a, b, c through 2-7a, b, c show the time series plots of field pH, conductivity, cadmium, copper, lead, mercury and zinc for stations 106 (2-1a through 2-7a), 107 (2-1b through 2-7b) and 108 (2-1c through 2-7c). The Alaska Water Quality Standards (AWQS) for marine aquatic life – chronic levels, are shown or noted on the graphs where applicable. The graphs show that Hawk Inlet water quality has remained within or below AWQS standards in all historical and 2016 samples.

WAD cyanide results were below the laboratory minimum detection limit (MDL) in 2016 (Table 2-2). In prior reports, it was noted that the laboratory failed to meet the required MDL of 1.0 µg/L. The WAD cyanide MDL was revised in the APDES Permit Number AK0043206 from 1.0 µg/L to 5.0 µg/L effective October 1st, 2015.

Table 2-4 summarizes the 2016 quarterly site 35 APDES outfall 002 and water column seawater station 108 results. The outfall 002 results remain significantly below the permitted effluent limits for total cadmium (100 µg/L daily max and 50 µg/L monthly average), total copper (99 µg/L daily max and 39 µg/L monthly average), total mercury (1.9 µg/L daily max and 1.0 µg/L monthly average), total lead (327 µg/L daily max and 123 µg/L monthly average), total zinc (1,000 µg/L daily max and 500 µg/L monthly average), and pH (not less than 6.0 or greater than 9.0 standard units). Outfall 002 results ranged from 8 to 500 times less than the daily effluent max limits for all five metals. Similarly station 108 data remain significantly below AWQS for marine life for dissolved cadmium (8.8 µg/L), dissolved copper (3.1 µg/L), dissolved mercury (0.9401 µg/L), dissolved lead (8.054 µg/L), and dissolved zinc (81.488 µg/L). Station 108 results ranged from 3 to 3000 times less than the AWQS for all five metals. The sampling requirements for outfall 002 and station 108 differ in multiple respects. Comparison requires looking at the above permit effluent limits and AWQS while factoring in dissolved metals concentrations (lower MDLs) vs. total metals concentrations (higher MDLs).

Table 2-5 is a comparison of metal values averaged from 2011 through 2015 (n=20) and the 2016 (n=4) results. With the exception of dissolved cadmium values at site 106, all 2016 results remain below the previous five year average. The dissolved cadmium concentration at site 106 remains within historical range and was 0.0001 µg/L above the 2011 through 2015 average, well below the 8.8 µg/L chronic dissolved cadmium AWQS for marine life.

Table 2-5. Hawk Inlet Water Column Average Dissolved Metal Concentrations

	Cd (µg/L)		**Cu** (µg/L)		**Pb** (µg/L)		**Hg** (TOTAL - µg/L)		**Zn** (µg/L)	
Site	**2011 through 2015**	**2016**	**2011 through 2015**	**2016**	**2011 through 2015**	**2016**	**2011 through 2015**	**2016**	**2011 through 2015**	**2016**
106	0.0707	0.0708	0.289	0.217	0.0193	0.003	0.0004	0.0003	0.88	0.21
107	0.0739	0.0716	0.458	0.225	0.0349	0.005	0.0005	0.0003	1.02	0.33
108	0.0740	0.0733	0.352	0.226	0.0265	0.012	0.0004	0.0003	1.12	0.42

2.3 QA/QC Results

Battelle Marine Sciences Laboratory, ACZ Laboratories, and Admiralty Environmental analyzed the required parameters (refer to Table 1-1) in the sea water samples. Complete QA plans and reports are kept on file in each lab's office and are available upon request. The remainder of this section summarizes the relevant QA/QC results from each laboratory for the quarterly 2016 sea water samples. Elevated levels of zinc in the field blanks, often at levels higher than all the other sea water samples, have been noted consistently by Battelle for this sampling program. The 4Q16 field blank results contained zinc levels higher than those contained at sample locations 106, 107, and 108 respectively.

Battelle Marine Science (low level dissolved trace metals analyses in salt water matrices):
1Q16: Target detection limits were met for all metals. Method blank results were less than the MDL for all metals. The field blank concentrations were less than the MDL for all metals. Standard reference material (SRM), matrix spike and duplicate results were within the default criteria of ±25%.

2Q16: Target detection limits were met for all metals. Method blank results were less than the MDL for all metals. The field blank concentrations were less than the MDL for all metals. Standard reference material (SRM), matrix spike and duplicate results were within the default criteria of ±25%.

3Q16: Target detection limits were met for all metals. Method blank results were less than the MDL for all metals. The field blank concentrations were less than the MDL for all metals. Standard reference material (SRM), matrix spike and duplicate results were within the default criteria of ±25%.

4Q16: Target detection limits were met for all metals. Method blank results were less than the MDL for all metals. With the exception of zinc, concentrations in the field blank were less than the MDL for all metals. Zinc was detected substantially above the MDL in the field blank; however the sample concentrations were typical for these samples, so it appears the contamination was confined to the field blank. Standard reference material (SRM), matrix spike and duplicate results were within the default criteria of ±25%.

ACZ Laboratories (WAD cyanide analyses):
1Q16: No certification qualifiers associated with this analysis.
2Q16: No certification qualifiers associated with this analysis.
3Q16: No certification qualifiers associated with this analysis.
4Q16: No certification qualifiers associated with this analysis.

3. SEDIMENT MONITORING

The requirements for the sediment monitoring originate from Section I.D.2, Sediment Monitoring, and Table 5 of the APDES permit. The objective of this element of the monitoring program is to provide scientifically valid data on five specific trace metal parameters analyzed at dry weight (dw) from sediments at four locations in Hawk Inlet (see Figure 1-1 for locations). These data are used to evaluate potential changes in the Hawk Inlet marine environment over time.

Sediment samples were collected semi-annually through 2015, with the reissuance of the permit the sampling frequency was changed to annual. Samples are collected at the Greens Creek delta (Site S-1), Pile Driver Cove near the mouth of the inlet (Site S-2), ~400 feet south of the concentrate loading facility (Site S-4), and under the loading facility (Sites S-5N and S-5S which bracket the area where concentrate was spilled in 1989). Samples are analyzed at ALS Environmental (formerly Columbia Analytical Services, Inc.) in Kelso, Washington for total concentrations of five trace metals (cadmium [Cd], copper [Cu], lead [Pb], mercury [Hg], and zinc [Zn]).

An additional station S-3 located near the head of Hawk Inlet, established as a background site, has also been sampled for sediment and biota since the 1980s. Though dropped from the official sampling program in the early 2000s HGCMC continued to monitor the site yearly, and has included the data in this report.

3.1 2016 Sediment Analytical Results

All sediment samples were collected by Marine Taxonomic Services, LTD. The sample locations, dates, times, weather conditions, and tides are shown in Table 3-1. Tables 3-2 and 3-3 in this section summarize the total metals results for the semi-annual sediment monitoring events. Sample repetitions (reps) 1 through 6 denote duplicate samples taken at each sample site.

Table 3-1. Hawk Inlet Sediment Monitoring Field Parameters 2016

Locations	Date Sampled	Time Sampled (24 hour)	Weather Conditions	Tide (ft)
S-1	5/9/16	09:00	Partly Cloudy	-2.5
S-2	5/9/16	09:40	Partly Cloudy	-3.0
S-4	5/8/16	08:40	Partly Cloudy	-2.5
S-5S	5/11/16	13:00	Sunny	+1.2
S-5N	5/11/16	13:30	Sunny	+1.5

Table 3-2. 2016 Hawk Inlet Sediment Results (ALS Environmental)

Site	Rep	Sample date	Cd (mg/kg dw)	Cu (mg/kg dw)	Pb (mg/kg dw)	Hg (mg/kg dw)	Zn (mg/kg dw)
		Required MDL	*(0.3)*	*(15.0)*	*(0.05)*	*(0.02)*	*(15.0)*
S-1 Sediments	1	5/9/2016	0.119	14.5	5.85	0.020	110
	2		0.141	15.6	6.54	0.023	132
	3		0.156	15.2	5.92	0.020	115
	4		0.120	17.2	5.83	0.022	120
	5		0.119	15.8	5.83	0.023	120
	6		0.120	15.5	5.89	0.021	116
S-2 Sediments	1	5/9/2016	0.206	10.2	2.05	<0.018	43.5
	2		0.109	8.82	1.59	<0.018	38.9
	3		0.122	10.4	1.90	<0.019	41.3
	4		0.115	11.3	1.58	<0.019	39.4
	5		0.112	9.17	1.50	<0.018	36.1
	6		0.134	9.34	1.97	<0.018	44.7
S-4 Sediments	1	5/8/2016	0.261	16.8	11.9	0.028	54.6
	2		0.286	16.6	12.7	0.028	62.4
	3		0.296	15.4	9.56	0.138	55.4
	4		0.327	18.2	17.8	0.032	65.3
	5		0.298	12.7	58.1	0.030	50.7
	6		0.270	15.5	14.8	<0.019	57.6
S-5N Sediments	1	5/11/2016	1.87	85.3	337	0.094	734
	2		1.63	108	1,230	0.134	321
	3		1.65	63.3	166	0.638	340
	4		1.28	51.4	112	0.224	257
	5		4.20	111	243	0.231	849
	6		1.18	38.5	116	0.101	405
S-5S Sediments	1	5/11/2016	4.56	128	259	0.244	848
	2		101[a]	176	907	0.246	19,500[a]
	3		3.95	98.7	349	0.212	740
	4		2.85	78.4	163	0.244	559
	5		0.976	161	104	0.166	233
	6		2.64	130	260	0.153	500

Notes: Method Reporting Limit (MRL) – Define by ALS Environmental as being times the MDL (or greater).
Method Reporting Limit (MRL) – Listed in the Appendix.
"<" denotes the sample was analyzed for, but was not detected above the MRL/MDL.

[a] These cadmium and zinc results are outliers (> 3 standard deviation). The average cadmium (n=91) and zinc (n=91) values since sampling began, excluding the outliers, are 3.94 µg/L +/- 3.57 and 822.8 µg/L +/- 713.1 respectively. These values were excluded from further analysis.

3.2 Data Evaluation

Prior to opening the Greens Creek mine for full production in 1989, sediment and biota tissues were sampled for heavy metal concentrations. Sampling sites S-1, S-2, and S-3 were chosen to represent natural conditions; therefore, results from these sites from September of 1984 until January of 1989 were used to calculate baseline, pre-production values. These data are useful as baseline values against which to compare metal values after mining began, and the results for the current year's sampling. Sampling sites S-4, and S-5 are thought to have been influenced by the old industrial cannery operation and are not suitable for background comparisons.

Table 3-3. Sediment Data: Pre-Production Baseline, Production Period and Current Year Comparison using a compilation of results from Stations S-1, S-2, (and S-3 for Pre-Production only)

Metal	Pre-Production (9/1984-1/1989)			Production (2/1989-9/2015)			Current Year 2016		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Cd	0.37	0.03	1.1	0.18	0.06	0.9	0.13	0.11	0.21
Cu	24.6	11.9	55.2	13.7	6	39.5	12.8	8.8	17.2
Pb	7.7	2.2	15.1	5.1	1.3	23.7	3.9	1.5	6.5
Hg	0.05	0.01	0.06	0.02	0.002	0.14	0.02	0.01	0.02
Zn	104.2	11	200	71.8	26.1	188	79.7	36.1	132
Note: non-detects are averaged using half of the MRL value.									

The comparison of pre-production and production sediment metal values in Table 3-3 shows that across Stations S-1 and S-2, the average metal levels are lower during the production/mining period than they were during pre-production. The current year's results show the average metals levels to be equal or below the production period's average values for all metals except zinc. The average concentration of zinc at S-1 in 2016 was slightly above the average calculated for the production period. Based on these data, it appears that heavy metals in sediment continue to vary from year to year, and there are no apparent trends in metals concentrations when concentrations from production years are compared to pre-production concentrations.

Figures 3-1 through 3-5 show the time series plots for cadmium, copper, lead, mercury and zinc including replicate samples for sample site S-1. Figures 3-6 through 3-10 show the time series plots for cadmium, copper, lead, mercury and zinc including replicate samples for sample site S-2. .Replicate samples are plotted with a single point, representing the mean value of the data, and error bars represent the overall distribution of the data.

Sampling sites S-4 and S-5N and S-5S are located near the ore concentrate loading facility. In May 1989, the first attempt to load a barge with bulk ore concentrate resulted in a spill of approximately 1,000 pounds of bulk ore concentrate into Hawk Inlet. During the re-commissioning of the mine (mid-nineties) State and Federal agencies provided oversight as Greens Creek Mine cleaned up the spilled concentrate. A suction dredge contractor removed approximately 550 cubic yards of concentrate and sediment from the spill site in 1994. This effort was confounded by the residual debris from the 1974 cannery facility fire. Metal scrap was removed from the area along with inert debris. Although clean-up efforts were extensive, annual sediment monitoring indicates that there may still be some concentrate present at the spill site.

Following the 1994 clean-up effort at the concentrate spill site, the sampling methodology at S-5 was expanded. The site was sub-divided into two separate locations. Sampling site S-5S was added on the south side of the spill area. This station complements S-5N located on the north side of the spill area (site S-5N is a continuation of the original site 5). Average concentrations of heavy metals at S-4 and S5-N remain below or equal to average concentrations reported since production began. However, following the spill, metal concentrations in the sediment as S-5S have been elevated and variable. This year all heavy metals, except cadmium and zinc, reported averages at or below those reported post spill cleanup. The average cadmium and zinc concentrations at site S-5S ranged between 101 mg/kg dw and 0.976 mg/kg dw for cadmium and zinc ranged between 19,500 mg/kg dw and 233 mg/kg dw. The elevated cadmium and zinc concentrations in the S-5S Rep II result are outliers (> 3 standard deviations), as they are by far the largest concentrations since sampling began in 1994 at site S-5S as the next closest result for cadmium was 17.8 mg/kg and 3,770 mg/kg for zinc which both occurred in June 2007. These two values are not included in the Table 3-4 results. Figures 3-11 through 3-15 show the metal time series graphs for site S-4. Figures 3-16 through 3-20 show the metal time series graphs for site S-5N. Figures 3-21 through 3-25 show the metal time series graphs for site S-5S. Since 2004 replicate samples have been taken at each site and all replicates were included; plotted by the mean and include the standard error bars, unless otherwise noted.

Table 3-4 shows the average metal concentrations and the associated standard deviations for each sediment sampling site during pre-production, production, and the current year. Pre-production sediment metals average values show some consistency across stations, but the standard deviations for these data indicate high variability, representative of typical natural distributions. Beginning in the fall of 2004 replicate sampling of these sites was initiated.

Table 3-4. Sediment Data Comparison of Pre-Production, Production, Post Cleanup, and Current Year Values for Sites S-1, S-2, S-4, S-5N, and S-5S

Metal (mg/kg dw)	S-1					S-2				
	pre-production (9/1984-1/1989) (n = 9)		production (2/1989 - 9/2015) (n = 106)		Current Year 2016	pre-production (9/1984-1/1989) (n = 9)		production (2/1989 - 9/2015) (n = 102)		Current Year 2016
	avg	stdev	avg	stdev	avg	avg	stdev	avg	stdev	avg
Cd	0.22	0.12	0.20	0.16	0.13	0.27	0.12	0.16	0.10	0.13
Cu	21.8	4.1	16.5	6.3	15.6	14.9	2.7	10.8	4.1	9.9
Pb	7.8	2.3	7.6	3.5	6.0	5.3	2.5	2.4	1.4	1.8
Hg	0.04	0.01	0.04	0.02	0.02	0.03	0.01	0.01	0.01	0.01
Zn	125.0	8.1	98.8	28.7	118.8	60.5	5.7	43.7	13.0	40.7

Metal (mg/kg dw)	S-3					S-4				
	pre-production (9/1984-1/1989) (n = 9)		production (2/1989 - 9/2015) (n = 105)		Current Year 2016	pre-production (9/1984-1/1989) (n = 6)		production (2/1989 - 9/2015) (n = 105)		Current Year 2016
	avg	stdev	avg	stdev	avg	avg	stdev	avg	stdev	avg
Cd	0.6	0.3	0.7	0.3	1.0	0.3	0.2	0.6	0.7	0.3
Cu	37.0	9.7	34.2	12.0	47.1	46.2	13.3	34.7	40.5	15.9
Pb	10.0	3.5	13.5	4.9	18.0	53.8	22.1	64.4	105.2	20.8
Hg	0.1	0.02	0.07	0.03	0.08	0.1	0.06	0.1	0.4	0.04
Zn	127.0	52.9	125.8	38.7	181.3	0.3	0.2	0.6	0.7	0.3

Metal (mg/kg dw)	S-5N			S-5S		
	post spill clean up (6/1995–9/2015 (n = 103)		Current Year 2016	post spill clean up (6/1995 – 9/2015 (n = 88)		Current Year 2016
	avg	stdev	avg	avg	stdev	avg
Cd	2.6	2.4	2.0	3.8	3.5	3.0
Cu	143.5	128.1	76.3	105	81.3	128.7
Pb	434.9	591.9	367.3	342	367.8	340.3
Hg	0.6	2.8	0.2	0.3	0.3	0.2
Zn	583.1	506.4	484.3	825.6	732.3	576

Note: Non-detects are averaged using half of the MRL value; underlined average values higher than baseline.

3.3 QA/QC Results

ALS Environmental analyzed the required parameters (see Table 1-1) in the sediment samples. Complete QA plans and reports are kept on file at the ALS Environmental office and are available upon request. The remainder of this section summarizes any relevant QA/QC results that were exceptions for the 2016 sampling event.

The matrix spike recovery of copper for sample S-5S Sediment Rep I was outside the ALS control criteria as a result of the heterogeneous character of the sample. The Relative Percent Difference

(RPD) for the replicate analysis supported this. Since the unspiked samples contained high analyte concentrations relative to the amount spiked, the variability between replicates was sufficient to bias the percent recoveries outside normal ALS control criteria. The associated QA/QC results (e.g. control sample, calibration standards, etc.) indicated the analysis was in control. No further corrective action was appropriate. The control criteria for matrix spike recovery of zinc for sample S-5S Sediment Rep I were not applicable. The analyte concentration in the sample was significantly higher than the added spike concentration, preventing accurate evaluation of the spike recovery.

The Relative Percent Difference (RPD) for the replicate analysis of copper in sample S-2 Sediment Rep V, and copper and zinc in sample S-5S Sediment Rep I was outside the normal ALS control limits. The percent RPD is calculated as follows:

$$RPD = \frac{(\text{sample result} - \text{duplicate result}) * 100}{(\text{sample result} + \text{duplicate result}) / 2}$$

The variability in the results was attributed to the heterogeneous character of the sample. Standard mixing techniques were used, but were not sufficient for complete homogenization of these samples.

No other anomalies associated with the analysis of these samples were observed.

Beginning in the fall of 2004, duplicate samples have been collected from each site, where possible, to address a National Marine Fisheries Service request. Precision can be calculated from the results of duplicate samples. In this case, the Relative Standard Deviation (RSD) is calculated as follows:

$$RSD = \frac{\text{standard deviation} * 100}{\text{sample mean}}$$

The RSD is shown for the duplicate samples from 2016 in Table 3-5.

The data quality objective for the RSD is that it is less than or equal to 30 percent, when the values are at least four times the detection limit. Ten out of the 24 (42%) RSDs calculated for the 2016 dataset were not within this data quality objective. All of the samples that were above this RSD were from sample sites S-4, S-5S, and S-5N, which are in the vicinity of the 1989 concentrate spill. Sampling at these sites continues to have the greatest variability and therefore higher RSDs that are typical of mixed population samples.

Table 3-5. Relative Standard Deviation for Replicate Sediment Samples

Sample ID	Rep	Date	Cadmium	Copper	Lead	Mercury	Zinc
			(mg/kg dw)	(mg/kg dw)	(mg/kg dw)	(mg/kg dw)	(mg/kg dw)
S-1 Sediments	1	5/9/16	0.119	14.5	5.85	0.02	110
	2		0.141	15.6	6.54	0.023	132
	3		0.156	15.2	5.92	0.02	115
	4		0.12	17.2	5.83	0.022	120
	5		0.119	15.8	5.83	0.023	120
	6		0.12	15.5	5.89	0.021	116
		RSD (%)	**12.17**	**5.7**	**4.66**	**6.41**	**6.3**
S-2 Sediments	1	5/9/16	0.206	10.2	2.05	<0.018	43.5
	2		0.109	8.82	1.59	<0.018	38.9
	3		0.122	10.4	1.9	<0.019	41.3
	4		0.115	11.3	1.58	<0.019	39.4
	5		0.112	9.17	1.5	<0.018	36.1
	6		0.134	9.34	1.97	<0.018	44.7
		RSD (%)	**27.7**	**9.4**	**13.3**	**--**	**7.8**
S-4 Sediments	1	5/8/16	0.261	16.8	11.9	0.028	54.6
	2		0.286	16.6	12.7	0.028	62.4
	3		0.296	15.4	9.56	0.138	55.4
	4		0.327	18.2	17.8	0.032	65.3
	5		0.298	12.7	58.1	0.03	50.7
	6		0.27	15.5	14.8	<0.019	57.6
		RSD (%)	**8.1**	**11.7**	**88.8**	**94.8**	**9.3**
S-5N Sediments	1	5/11/16	1.87	85.3	337	0.094	734
	2		1.63	108	1230	0.134	321
	3		1.65	63.3	166	0.638	340
	4		1.28	51.4	112	0.224	257
	5		4.2	111	243	0.231	849
	6		1.18	38.5	116	0.101	405
		RSD (%)	**57.3**	**39.4**	**117.4**	**86.6**	**50.6**
S-5S Sediments	1	5/11/16	4.56	128	259	0.244	848
	2		NA	176	907	0.246	NA
	3		3.95	98.7	349	0.212	740
	4		2.85	78.4	163	0.244	559
	5		0.976	161	104	0.166	233
	6		2.64	130	260	0.153	500
		RSD (%)	**46.0**	**28.5**	**85.3**	**19.9**	**41.1**

"--" indicates RSD was not calculated because one or more of the values was less than 4 times the MRL.
"<" denotes the sample was analyzed for, but was not detected above the MRL/MDL.
"NA" These cadmium and zinc results are outliers (> 3 standard deviation). These values were excluded from further analysis.

4. IN-SITU BIOASSAYS

The requirements for the bioassay monitoring originate from Section 1.6.1.3, In-situ Bioassays, and Table 7 of the APDES permit. The objective of this monitoring element is to provide scientifically valid data on five specific trace metal parameters analyzed at dry weight from the tissues of polychaete worms (*Nephtys*) and bay mussels (*Mytilus edulis*) at seven locations in Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment.

Bioaccumulation in-situ bioassay sampling in Hawk Inlet consists of annual testing of trace metal tissue burdens of selected species of invertebrate organisms with different feeding guilds. In the Hawk Inlet sill area, where no fine grained sediments occur, four sites (Stations STN-1, STN-2, STN-3 and East Shoal Light (ESL)) are used for in-situ bioassay monitoring of trace metals in bay mussels. Data gathered from this area measures the response in organisms in the immediate vicinity of the 002 Outfall discharge. In most other areas of Hawk Inlet, the bottom is covered with sediment. Consequently, samples of sediment dwelling polychaete worms (*Nephtys procera and Nereis sp.*) are collected at three additional sites (S-1, S-2, and S-4). *Nereis sp*. were not encountered in sufficient numbers for analysis in 2016 and so only *Nephtys* were collected.

4.1 2016 Analytical Results

All tissue samples were collected by Marine Taxonomic Services, LTD. The sample locations, types, dates, times, weather conditions, and tides are shown in Table 4-1. Table 4-2 summarizes the total metals results for the annual bioassays. Sample repetitions (reps) 1 through 6 denote replicate samples taken at each site.

Table 4-1. Hawk Inlet Tissue Sampling Field Data 2016

Locations	Sample Type	Date	Time	Weather Conditions	Tide (ft MLLW)
S-1	*Nephtys*	5/9/16	09:20	Partly Cloudy	-2.8
S-2	*Nephtys*	5/9/16	10:00	Partly Cloudy	-3.5
S-4	*Nephtys*	5/8/16	09:00	Partly Cloudy	-3.0
STN-1	Mussels	5/12/16	13:20	Sunny	+1.5
STN-2	Mussels	5/12/16	14:00	Sunny	+1.8
STN-3	Mussels	5/10/16	13:30	Sunny	+2.1
ESL	Mussels	5/10/16	13:55	Sunny	+2.7

Table 4-2. Hawk Inlet Tissue Bioassay Results for 2016 (ALS Environmental)

Sample No.	Rep	Date	Cd (mg/kg dw)	Cu (mg/kg dw)	Pb (mg/kg dw)	Hg (mg/kg dw)	Zn (mg/kg dw)
S-1 *Nephtys*	1	5/9/16	1.70	13.1	0.679	0.030	182
	2		1.86	11.5	0.626	0.030	183
	3		1.79	12.2	0.609	0.026	182
	4		1.81	12.8	0.640	0.022	194
	5		1.61	19.1	0.828	0.044	173
	6		1.73	11.7	0.640	0.028	176
S-2 *Nephtys*	1	5/9/16	0.972	6.89	0.561	<0.02	176
	2		0.990	7.21	0.541	<0.02	170
	3		0.930	6.18	0.544	<0.02	170
	4		0.986	6.21	0.512	<0.02	169
	5		0.975	6.13	0.515	<0.02	167
	6		0.973	6.34	0.539	<0.02	177
S-4 *Nephtys*	1	5/8/16	0.507	9.8	3.06	<0.02	183
	2		0.502	10.2	2.99	<0.02	179
	3		0.494	9.5	2.84	<0.02	173
	4		0.488	10.1	2.93	<0.02	174
	5		0.517	9.7	2.95	<0.02	183
	6		0.488	9.02	2.94	<0.02	177
STN-1 Mussels	1	5/12/16	10.5	7.46	2.97	0.056	167
	2		10.1	6.94	2.40	0.064	153
	3		10.1	7.65	2.59	0.044	166
	4		9.99	7.14	2.42	0.066	152
	5		10.3	7.27	2.33	0.056	156
	6		10.3	7.65	3.78	0.048	162
STN-2 Mussels	1	5/12/16	11.7	6.70	1.88	0.067	166
	2		11.7	6.12	1.87	0.072	157
	3		11.7	6.66	1.97	0.068	160
	4		11.7	6.39	1.75	0.072	157
	5		11.9	6.41	1.75	0.075	160
	6		11.6	6.68	1.94	0.062	158
STN-3 Mussels	1	5/10/16	10.9	6.79	0.695	0.078	126
	2		11.0	6.58	0.696	0.058	129
	3		10.9	6.59	0.681	0.048	125
	4		10.9	6.56	0.742	0.059	124
	5		11.3	6.82	0.697	0.066	127
	6		11.1	6.35	1.160	0.066	117
ESL Mussels	1	5/10/16	8.02	7.01	1.020	0.060	121
	2		8.04	6.96	0.892	0.046	114
	3		8.46	7.21	0.852	0.054	119
	4		8.28	6.91	0.859	0.056	115
	5		8.20	7.48	0.846	0.042	119
	6		7.93	7.42	0.825	0.053	112

"<" denotes the sample was analyzed for, but was not detected above the MRL/MDL

4.2 Data Evaluation

Prior to opening the Greens Creek mine for full production in 1989, sediment and biota tissues were sampled for heavy metal concentrations. Results for mussels from sites STN-1, STN-2, STN-3 and ESL, and for *Nephtys* from sites S-1, S-2, and S-3 from September of 1984 until January of 1989 were used to calculate baseline, pre-production values. These data are useful as baseline values against which to compare metal values after mining began and the results for the current year's sampling.

As noted by Oceanographic Institute of Oregon in the 1998 Kennecott Greens Creek Mine Risk Assessment (p 4-3),

> "Sampling stations were selected to demonstrate a range of potential exposures including "worst case" exposure to Outfall discharges. Some of the test organisms placed in cages directly on the Outfall diffuser ports lived for six months. These results indicate that even maximum exposure to the Outfall discharge result in no acute effects."

Average lead concentrations in mussel tissues were approximately five times higher during the production period than the pre-production period (Table 4-3). Average lead values in 2016 were over 1 mg/kg higher than the pre-production (0.50 mg/kg dw) and 0.79 mg/kg lower than production average values (2.36 mg/kg dw). Average zinc values in 2016 (140.13 mg/kg dw) were greater in concentration to pre-production values (91.1 mg/kg dw) and production values (85.3 mg/kg dw). Average cadmium values in 2016 (10.28 mg/kg dw) were higher than pre-production values (7.99 mg/kg dw) and production values (8.07 mg/kg). Average copper concentration in 2016 (6.91 mg/kg dw) was less than both pre-production concentration (8.08 mg/kg dw) and production concentration (8.19 mg/kg dw). Average concentration for mercury in 2016 is comparable to pre-production average concentration. Figures 4-1 through 4-20 show the time series plots for cadmium, copper, lead, mercury and zinc in mussel samples for sample sites STN-1, STN-2, STN-3, and ESL. Error bars are included where necessary on 2016 values only. Prior to the reissued 2015 APDES permit, replicate mussel tissue samples were not collected.

Table 4-3. Hawk Inlet Mussels Tissue Data: Pre-Production, Production, and Current Year for Sites STN-1, STN-2, STN-3, and ESL.

Metal (mg/kg dw)	Pre-Production (9/1984-1/1989) (n = 36)			Production (2/1989-9/2015) (n = 224)			Current Year 2016		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Cd	7.99	3.25	15.76	**8.07**	0.13	15.9	**10.28**	7.93	11.9
Cu	8.08	5.5	12.2	**8.19**	0.25	110.0	6.91	6.12	7.65
Pb	0.50	0.15	1.73	**2.36**	0.05	126.0	**1.57**	0.68	3.78
Hg	0.05	0.01	0.34	0.04	0.01	0.56	**0.06**	0.04	0.08
Zn	91.1	71.9	142	85.3	1.3	126	**140.1**	112.0	167.0

Notes: Non-detects are averaged using half of the MDL value; underlined average values higher than baseline.

When compared to the "Mussel Watch" averages for Alaska, cadmium and zinc exceeded these averages (2.87 mg/kg and 87.95 mg/kg, respectively) during pre-production. Cadmium and lead exceeded these averages (2.87 mg/kg and 1.17 mg/kg, respectively) during production. These levels were similarly noted in the 2003 Review of the Status of Essential Fish Habitat in Hawk Inlet Subsequent to Mining Operations (p 57):

> "…the average mining production period metal levels are generally below Mussel Watch averages for Alaska. The exception to this is Cd, which was above Mussel Watch Alaska averages prior to and subsequent to mining operations. Because the USFWS Hawk Inlet-

wide levels of Pb increased similarly to the outfall monitoring site levels of Pb, these increases over time may be due to natural increases in Pb in the environment."

Trace metal concentrations averaged for *Nephtys* sampled in 2016 are varied when compared to pre-production and production stages of monitoring (Table 4-4). Cadmium (1.36 mg/kg dw) and zinc (177.0 mg/kg dw) are the only trace metals where reported concentrations are below both the pre-production and production stages of monitoring. Average copper concentration for 2016 (9.95 mg/kg dw) is below pre-production, but above production averages. Average concentration for lead in 2016 (0.60 mg/kg dw) is less than pre-production and less than production monitoring periods. Average concentrations for mercury are relatively consistent among all sampling time frames. Average concentration for mercury in 2016 and less than pre-production and production.

Table 4-4. Hawk Inlet *Nephtys* Tissue Data: Pre-Production Baseline, Production Period and Current Year Comparison using a compilation of results from Stations S-1, S-2 (and S-3 for Pre-Production only)

Metal (mg/kg dw)	Pre-Production (9/1984-1/1989) (n = 26)			Production (2/1989-9/2015) (n = 310)			Current Year 2016		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Cd	3.23	0.53	8.45	2.07	0.24	8.33	1.36	0.93	1.86
Cu	12.47	6.24	22.6	9.27	4.30	42.10	9.95	6.13	19.10
Pb	0.62	0.28	1.64	<u>0.84</u>	0.10	4.76	0.60	0.51	0.83
Hg	0.07	0.01	0.73	0.03	0.01	0.10	0.02	0.01	0.04
Zn	221	71	305	194	62.6	357	177	167	194

Notes: Non-detects are averaged using half of the MDL value; underlined average values higher than baseline.

The average and standard deviation results for pre-production, production and current year periods for the individual sites for mussels is provided in Table 4-5. Table 4-5 shows larger standard deviations in production levels of zinc concentrations in mussels at all sites. Larger standard deviations were also noticed for lead at STN-2 and STN-3, as well as copper at ESL. In 2016, STN-1, STN-2, and STN-3 had zinc concentrations higher than the production period. ESL also had elevated zinc levels, just below that reported in early 2009. Average concentrations of mercury at STN-2 was the highest since 1999 and STN-3 results were slightly above the production average.

Table 4-5. Average and Standard Deviation Values for Pre-Production, Production, and Current Year Mussel Data – Sites STN-1, STN-2, STN-3, and ESL.

Metal (mg/kg dw)	ESL					STN-1				
	pre-production (9/1984-1/1989) (n = 9)		Production (2/1989 - 9/2015) (n = 56)		Current Year 2016	pre-production (9/1984-1/1989) (n = 9)		Production (2/1989 - 9/2015) (n = 56)		Current Year 2016
	avg	stdev	avg	stdev	avg	avg	stdev	avg	stdev	avg
Cd	6.67	1.70	6.52	1.89	8.16	7.41	1.91	8.31	2.16	10.22
Cu	8.16	0.72	10.19	14.47	7.17	7.96	1.27	7.35	1.76	7.35
Pb	0.42	0.12	1.34	0.78	0.88	0.62	0.44	1.30	0.79	2.75
Hg	0.03	0.01	0.03	0.01	0.05	0.07	0.10	0.05	0.06	0.06
Zn	91.4	8.9	82.5	17.8	116.7	94.9	11.9	85.6	15.1	159.3

Metal (mg/kg dw)	STN-2					STN-3				
	pre-production (9/1984-1/1989) (n = 9)		Production (2/1989 - 9/2015) (n = 56)		Current Year 2016	pre-production (9/1984-1/1989) (n = 9)		Production (2/1989 - 9/2015) (n = 56)		Current Year 2016
	avg	stdev	avg	stdev	avg	avg	stdev	avg	stdev	avg
Cd	8.60	3.29	8.92	2.55	11.72	9.27	3.24	8.55	1.89	11.02
Cu	7.71	1.12	7.82	3.63	6.49	8.50	1.79	7.41	2.05	6.62
Pb	0.37	0.20	3.72	16.70	1.86	0.59	0.22	3.07	12.24	0.78
Hg	0.04	0.01	0.04	0.02	0.07	0.04	0.01	0.05	0.07	0.06
Zn	82.4	11.9	85.5	17.3	159.7	95.7	18.9	87.7	15.6	124.7

Notes: Underlined concentrations are higher than pre-production averages. Non-detects are averaged using half of the MRL/MDL value.

The historical and year 2016 metals concentration in *Nephtys* is shown in Table 4-6. Concentrations of cadmium and mercury in *Nephtys* show general decline over time. Cadmium and mercury average concentrations were lower at all four sampled stations for both production relative to pre-production and 2016 relative to pre-production. Moreover, cadmium and mercury levels were lower in 2016 than the production average. This same trend has been observed for zinc at S-1 and S-4. Zinc concentrations in 2016 were in between the pre-production and production levels at S-2. Various trends in copper were reported at all three stations; increase at S-1, almost no change at S-2, and a decrease at S-4. Lead concentrations at S-1 and S-2 have been higher on average since production began relative to pre-production; however, 2016 concentrations were lower than the average for the other production years. At S-4, lead concentrations were much lower in 2016 than the production average and lower than pre-production average concentration. Beginning in the fall of 2004 replicate sampling of *Nephtys* was initiated. The replicate samples are reflected averaged in Table 4-6. Figures 4-21 through 4-35 show the time series plots for cadmium, copper, lead, mercury and zinc including replicate samples in *Nephtys* for sample sites S-1, S-2, and S-4. Replicate samples are plotted by the mean and include standard error bars.

Table 4-6. Average and Standard Deviation Values for Pre-Production, Production, and Current Year *Nephtys* Data – Sites S-1, S-2, S-3, and S-4

Metal (mg/kg dw)	S-1 *Nephtys* pre-production (9/1984-1/1989) (n = 9)		S-1 Production (2/1989 - 9/2015) (n = 104)		S-1 Current Year 2016	S-2 *Nephtys* pre-production (9/1984-1/1989) (n = 9)		S-2 Production (2/1989 - 9/2015) (n = 104)		S-2 Current Year 2016
	avg	stdev	avg	stdev	avg	avg	stdev	avg	stdev	avg
Cd	4.0	1.7	3.1	1.0	1.8	1.7	0.7	1.1	0.5	0.97
Cu	9.0	1.2	<u>9.8</u>	5.5	<u>13.4</u>	12.4	3.3	8.8	4.9	6.5
Pb	0.5	0.2	<u>0.97</u>	0.8	<u>0.7</u>	0.6	0.2	<u>0.7</u>	0.4	0.5
Hg	0.05	0.01	0.05	0.02	0.03	0.02	0.01	0.02	0.01	0.01
Zn	243.6	42.5	213.9	34.9	181.7	181.1	29.4	174.4	34.8	171.5

Metal (mg/kg dw)	S-3 *Nephtys* pre-production (9/1984-1/1989) (n = 8)		S-3 Production (2/1989 - 9/2015) (n = 102)		S-3 Current Year 2016	S-4 *Nephtys* pre-production (9/1984-1/1989) (n =2)		S-4 Production (2/1989 - 9/2015) (n = 104)		S-4 Current Year 2016
	avg	stdev	avg	stdev	avg	avg	stdev	avg	stdev	avg
Cd	4.1	2.6	2.1	1.2	1.7	1.2	0.98	0.8	0.6	0.5
Cu	16.5	5.3	13.96	15.7	12.3	16.8	9.5	<u>20.1</u>	16.7	9.7
Pb	0.8	0.5	<u>0.9</u>	0.7	0.6	4.2	1.8	<u>7.7</u>	9.4	2.95
Hg	0.14	0.24	0.04	0.02	0.05	0.12	0.09	0.03	0.02	0.01
Zn	241.4	75.6	239.9	45.0	216.7	193.5	14.8	<u>199.8</u>	43.1	178.2

Notes: Underlined concentrations are higher than pre-production averages. Non-detects are averaged using half of the MDL value.

Effluent toxicity testing, conducted since the mining operations began, was discontinued in 2005 with reissuance of the NPDES Permit (AK-004320-6). Between February 1989 and October 1998, acute toxicity testing was performed using treated effluent. Between November 1998 and June 2005, chronic toxicity testing was performed. The previously performed toxicity testing showed no lethal or sub-lethal deleterious effects to tested marine aquatic organisms from prolonged exposure to the treated effluent;

> "The data show that the effluent from Outfall 002 has no reasonable potential to contribute to an exceedance of the (Alaska) WQS for toxicity." (USEPA Fact Sheet dated October 28, 2004; page 14, Section VI.B Whole Effluent Toxicity Testing).

4.3 QA/QC Results

ALS Environmental analyzed the required parameters (see Table 1-1) for the bioassay samples. Complete QA plans and reports are kept on file at the ALS Environmental office and are available upon request. The remainder of this section summarizes the relevant QA/QC results for 2016 sampling.

The RPD for the replicate analysis of Lead in sample STN-3 Mussel Rep V was outside the normal ALS control limits (33% RPD versus a control limit of 20%). The samples were homogenized, freeze dried, then ground prior to digestion, however this was not sufficient to achieve a completely uniform distribution of Lead in the tissue.

No other anomalies associated with the analysis of these samples were observed.

Beginning in the fall of 2004, replicate samples have been collected from each site, where possible, to address a National Marine Fisheries Service request. Precision can be calculated from the results of duplicate samples. In this case, RSD is shown for the duplicate samples in Table 4-7. The data quality objective for the RSD is that it is less than or equal to 30 percent, when the values are at least four times the detection limit. All of the RSDs calculated for the 2016 duplicate samples were within this data quality objective.

Table 4-7. Relative Standard Deviation for Replicate Tissue Samples

Sample ID	Rep	Date	Cadmium	Copper	Lead	Mercury	Zinc
			(mg/kg dw)	(mg/kg dw)	(mg/kg dw)	(mg/kg dw)	(mg/kg dw)
S-1 *Nephtys*	1	5/9/2016	1.7	13.1	0.679	0.03	182
	2		1.86	11.5	0.626	0.03	183
	3		1.79	12.2	0.609	0.026	182
	4		1.81	12.8	0.64	0.022	194
	5		1.61	19.1	0.828	0.044	173
	6		1.73	11.7	0.64	0.028	176
		RSD (%)	**5.1**	**21.3**	**12.0**	**24.9**	**4.0**
S-2 *Nephtys*	1	5/9/2016	0.972	6.89	0.561	<0.02	176
	2		0.99	7.21	0.541	<0.02	170
	3		0.93	6.18	0.544	<0.02	170
	4		0.986	6.21	0.512	<0.02	169
	5		0.975	6.13	0.515	<0.02	167
	6		0.973	6.34	0.539	<0.02	177
		RSD (%)	**2.2**	**6.9**	**3.5**	**--**	**2.4**
S-4 *Nephtys*	1	5/8/2016	0.507	9.8	3.06	<0.02	183
	2		0.502	10.2	2.99	<0.02	179
	3		0.494	9.5	2.84	<0.02	173
	4		0.488	10.1	2.93	<0.02	174
	5		0.517	9.7	2.95	<0.02	183
	6		0.488	9.02	2.94	<0.02	177
		RSD (%)	**2.3**	**4.4**	**2.5**	**--**	**2.4**

"--" indicates RSD was not calculated because one or more of the values was less than 4 times the MRL.
"<" denotes the sample was analyzed for, but was not detected above the MRL/MDL

5. CONCLUSIONS

Water quality, sediments, and invertebrate tissue monitoring began in Hawk Inlet prior to production to establish a baseline against which future monitoring (during production) could be evaluated within the context of potential natural changes over time. Greens Creek Mine has established a 30+ year monitoring database for many of the sites used to establish the original baseline. This monitoring program has been modified as needed (e.g. splitting of S-5 into S-5N and S-5S and dropping of S-3) to account for changes at the site and to facilitate compliances with the APDES permit.

Long-term water column monitoring for cadmium, copper, lead, mercury, and zinc indicates no impairment (exceedance of marine water quality standards) of the Hawk Inlet water column.

Sediment monitoring at S-1, S-2, and S-3 has been occurring annually for 30+ years. When comparing S-1 which is located in the vicinity of the 002 outfall to S-2, a background site located over 1.5 miles to the south, it is evident that some metal concentrations at the two sites exhibit similar concentration ranges. This year, average concentrations of copper, lead, and zinc were noticeably higher at S-1 than S-2. However, these values remain within close range of average values reported during pre-production and production. Given the spatial distance but similar concentrations between the sites, the sediment metal concentrations for most metals at S-1 appear within the range of natural conditions.

Observations by fishermen and researchers suggest that the physical features and biotic communities of Hawk Inlet remain intact following over two decades of mine operation and they remain similar to adjacent inlets. Ridgeway (2003) made a similar statement following the first decade of operation. Halibut and crab numbers are reported to have declined significantly with the closing of the fish processing facilities which previously operated at the Hawk Inlet Cannery, which is now the HGCMC port facility.

Marine species which live within sediments or filter water are susceptible to incorporating metals within their tissues. Moreover, when these organisms are also sedentary or otherwise unable to move appreciable distances, they become potential indicators of local sediment and water quality conditions. The Hawk Inlet Monitoring Program was designed to monitor the potential impact of the mine's discharge on such indicator species. Based on the suite of species listed as having Essential Fish Habitat in Hawk Inlet, the species most likely to encounter these elevated metal levels through their diet and habitat uses would include the flatfishes (e.g. yellowfin sole, arrowtooth flounder, flathead sole, and rock sole), pacific cod, sculpin and crab species. These species are extremely mobile predators, by comparison the mussels and polychaetes monitored in the mine-associated areas (i.e. diffuser and port facility) that are constantly exposed to the water and sediment of interest.

Cadmium and zinc levels from tissue monitoring of *Nephtys* are reported at higher concentrations than that reported for sediment at sites S-1 and S-2. All other metal concentrations observed for *Nephtys* tissue are approximately equal or far less than the average concentrations reported for sediment. Average concentrations of heavy metals decrease from S-1 to S-2. If the temporal variation in the sediment load at S-1 was a result of discharge from the 002 Outfall, the similar variation observed at S-2 would not be expected. This similarity in temporal variation and with spatial distances occurs with the other metals as well. HGCMC believes that the variation in concentration monitored in organisms near the 002 outfall is natural and that the monitoring program is sufficient for detecting changes.

The effectiveness of the sediment monitoring system for detecting change can be evaluated by examining metal concentrations at sites near the ship loader (S-4 and S-5 (N and S)). These sites are influenced from the original activities of the cannery, the burning down of the cannery in 1974, and concentrate spillage associated with the ship loader spill in 1989. For example, prior to the spill, pre-production lead levels at S-4 were approximately 50 mg/kg dw. Post concentrate spillage, between 1989-1994, resulted in drastic increase of lead concentration (around 200 mg/kg dw) at S-4. During re-commissioning (mid 1990s) sediments were dredged in the vicinity of the ship loader. Following dredging, the average lead level returned to pre-productions levels. Since the early 2000’s lead levels at S-4 have routinely been less than 30 mg/kg, attributed to natural process (e.g. sedimentation) and repeated debris cleanup efforts of dive crews that have removed contaminated materials associated with pre-mine site users (e.g. batteries). For several decades the dive crew has been removing lead acid batteries on an annual basis from Hawk Inlet, discarded during the operations of the Cannery. In addition, sediment monitoring has provided useful information by showcasing the significant discrepancies in high trace metal concentrations at S-5S vs. the lower concentrations observed at S-5N. The differences in values at all three of these sites indicates where heavy and low concentrations of metals are currently and provides insight about anthropogenic processes and/or environmental conditions effecting trace metal concentrations in this area.

As discussed in the report, there have been some elevated metal concentrations in the invertebrate and sediment samples. Particularly, regarding elevated concentrations of cadmium and zinc in sampled mussel tissue. However, the recent tissue for *Nephtys* samples are similar to pre-mining levels and the sediments exhibit similar variation despite their spatial distances. The difference in trace metal concentration in the tissues of these two types of organisms may relate to the difference in location of the organisms being sampled. Distinctions in life history regarding where they feed, how they feed, what they feed on, and how their metabolic processes react to various analytes may influence reported concentrations. Lastly, the older an organism is the more time it has been subjected to trace metals in question. Assuming the organism cannot metabolize the trace metal efficiently, bioaccumulation will result. These results indicate that there is natural variability, the relatively low trophic level organisms studied are not greatly impacted, and that the APDES monitoring program is effective for measuring potential impacts associated with the Greens Creek Mine.

6. REFERENCES

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USDA Forest Service (2013). *Greens Creek Mine Tailings Disposal Facility Expansion: Final Environmental Impact Statement and Record of Decision*.

FIGURES

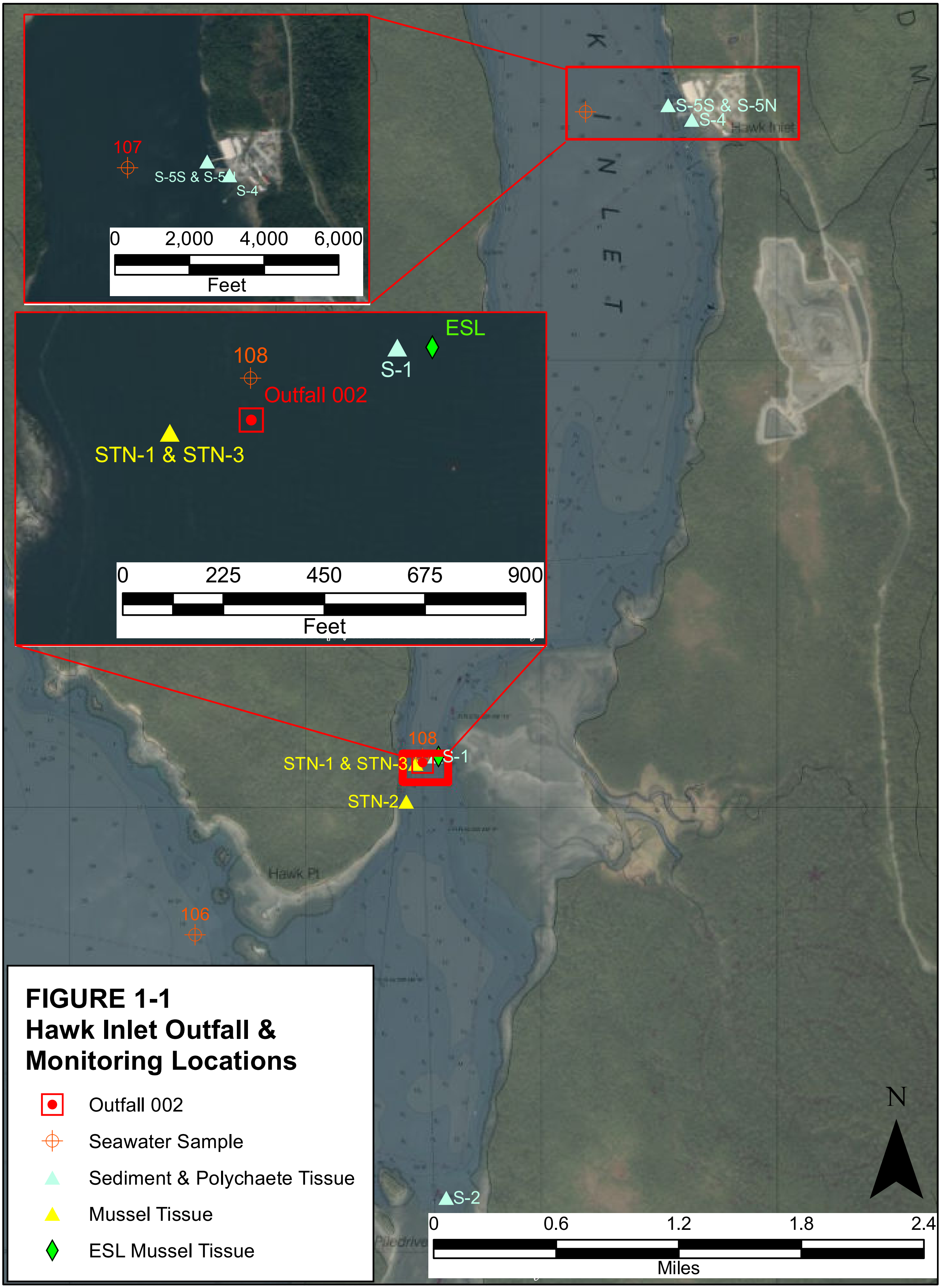

107
S-5S & S-5N
S-4
0
2,000
4,000
6,000
Feet
ESL
108
S-1
Outfall 002
STN-1 & STN-3
0
225
450
675
900
Feet
S-5S & S-5N
S-4
Hawk Inlet
STN-2
Hawk Pt
106
S-2
N
0
0.6
1.2
1.8
2.4
Miles
FIGURE 1-1
Hawk Inlet Outfall & Monitoring Locations
Outfall 002
Seawater Sample
Sediment & Polychaete Tissue
Mussel Tissue
ESL Mussel Tissue

Figure 2-1a

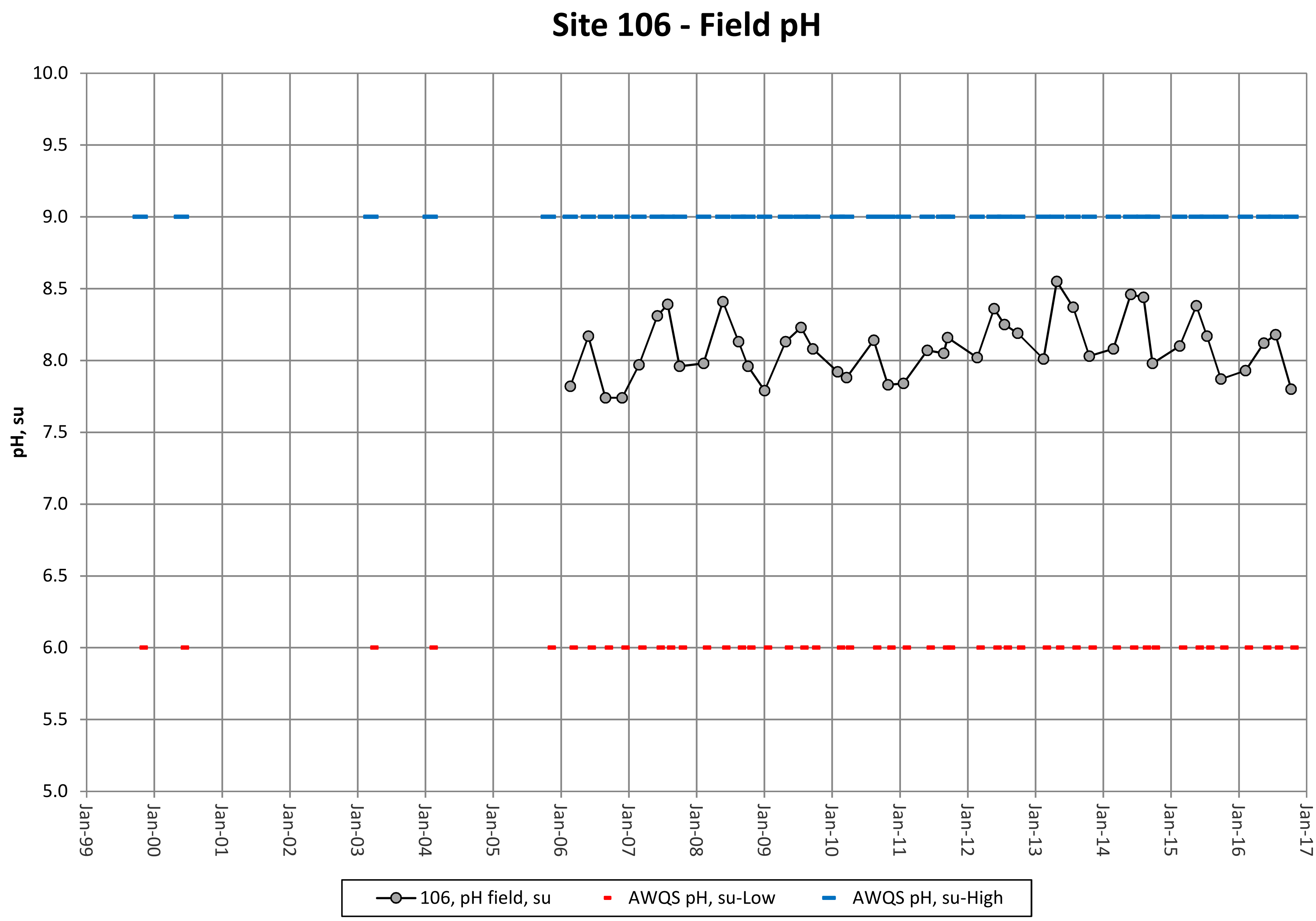

Site 106 - Field pH
pH, su
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, pH field, su
AWQS pH, su-Low
AWQS pH, su-High

Figure 2-1b

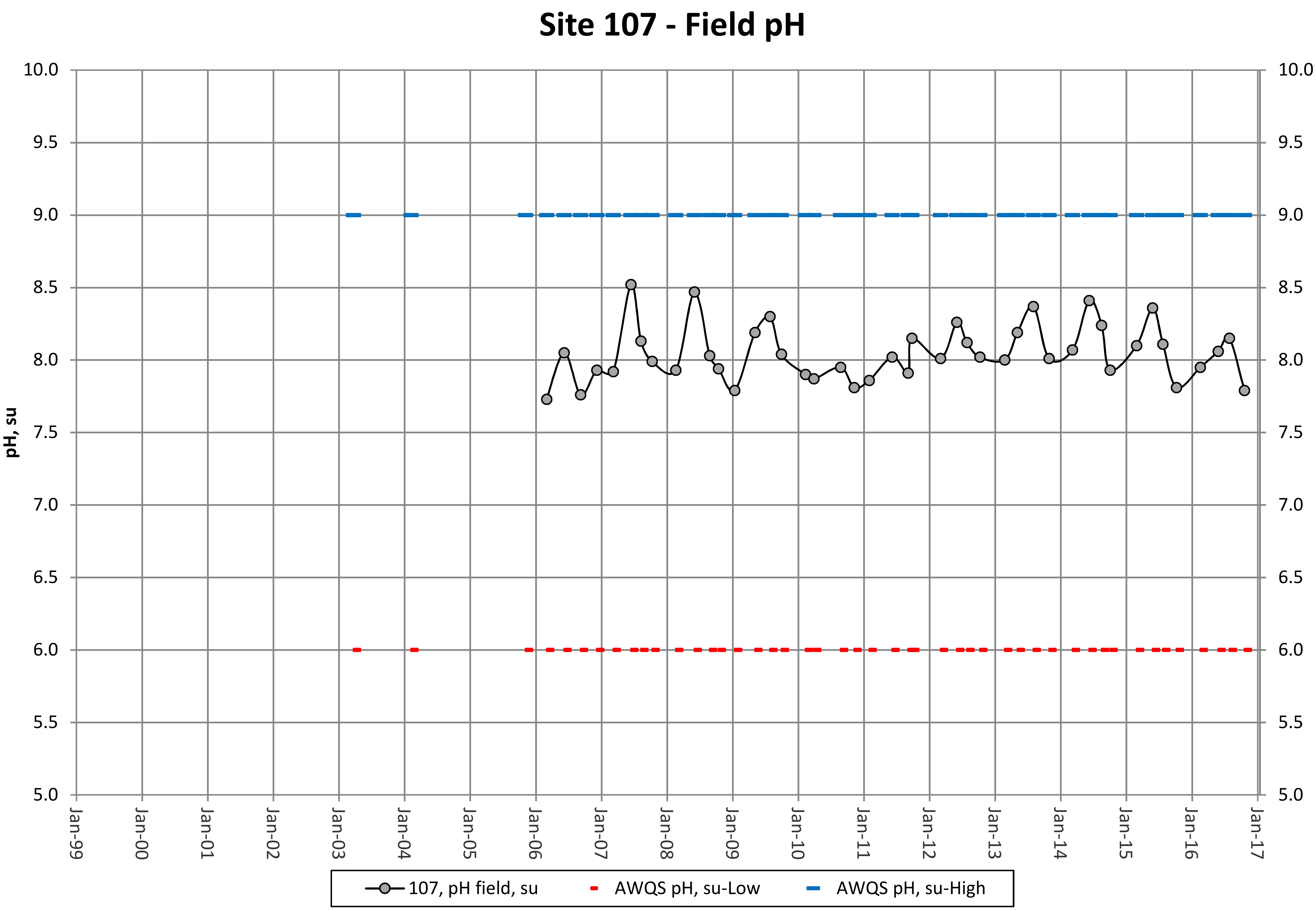
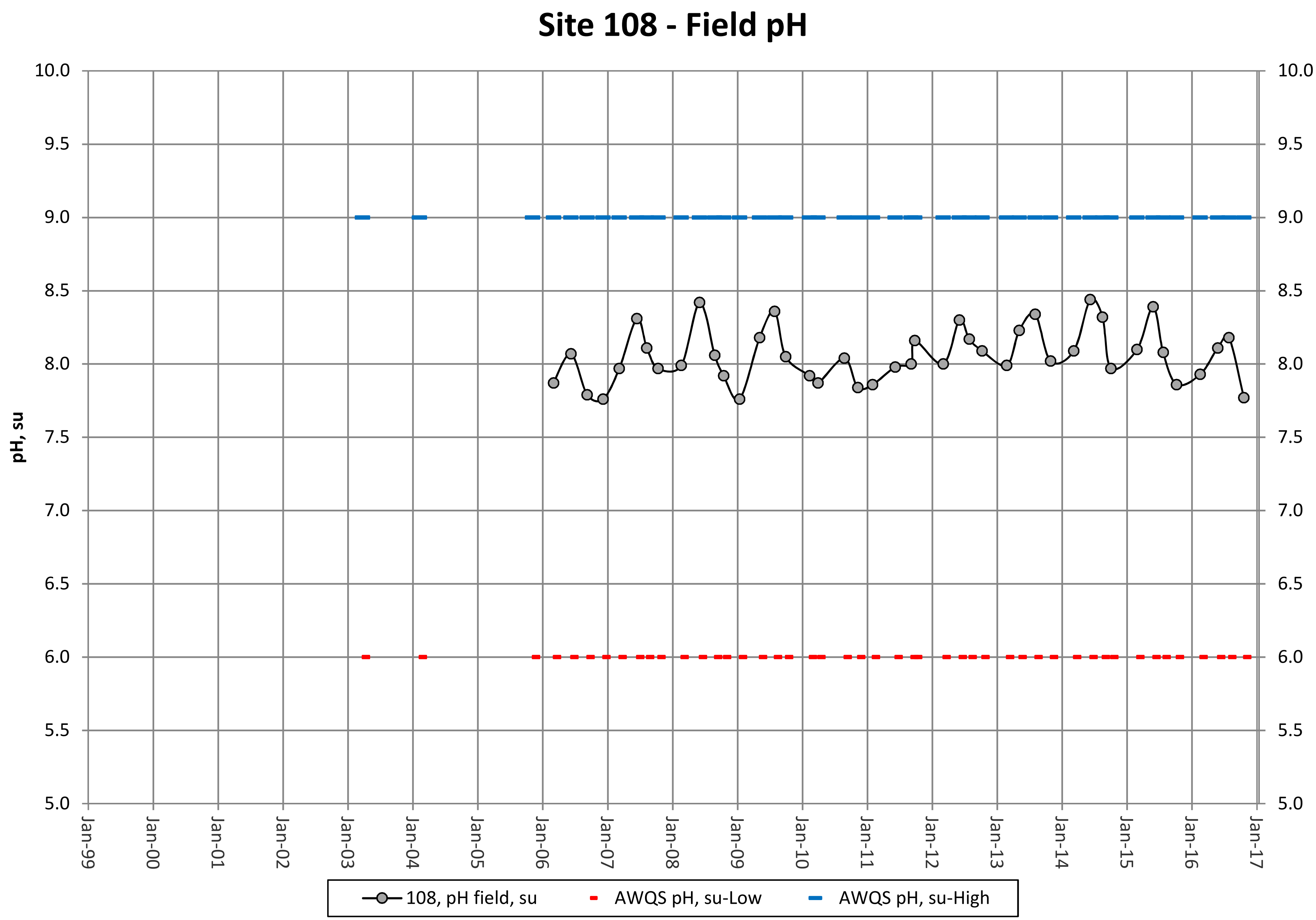

Site 107 - Field pH
pH, su
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, pH field, su
AWQS pH, su-Low
AWQS pH, su-High

Figure 2-1c



Site 108 - Field pH
pH, su
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, pH field, su
AWQS pH, su-Low
AWQS pH, su-High

Figure 2-2a

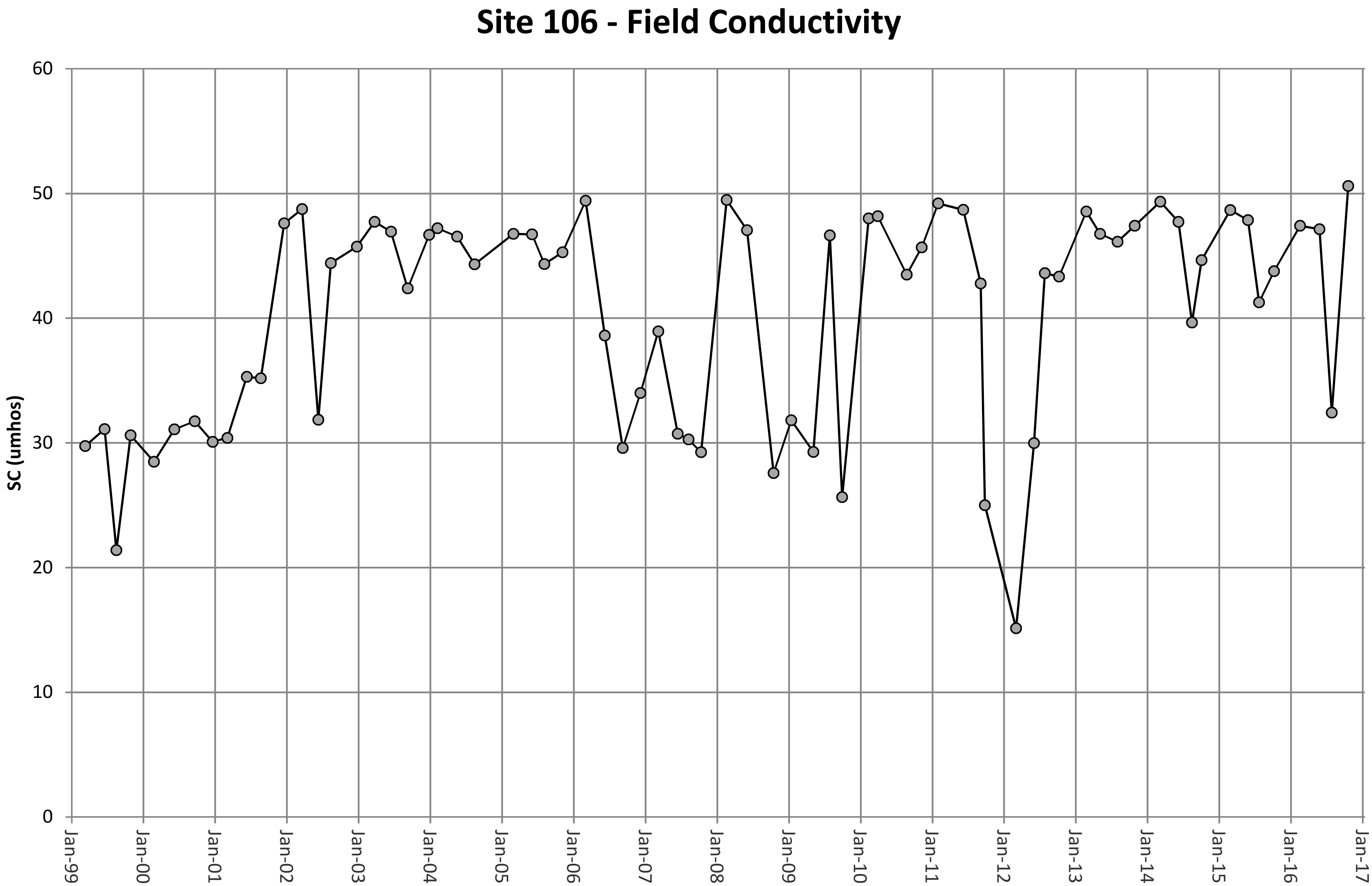

Site 106 - Field Conductivity
SC (umhos)
0
10
20
30
40
50
60
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17

Figure 2-2b

Site 107 - Field Conductivity

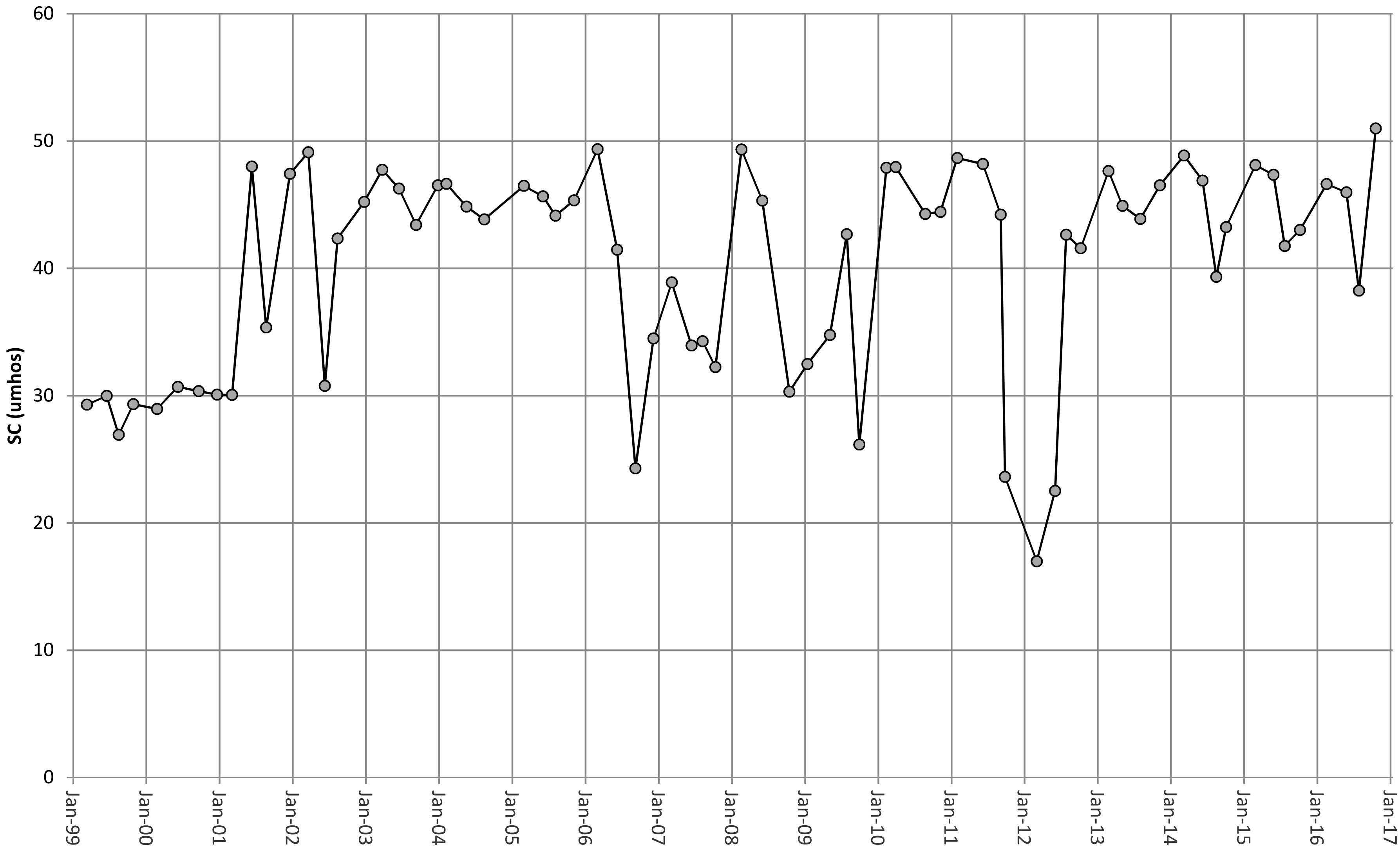


Figure 2-2c

Site 108 - Field Conductivity

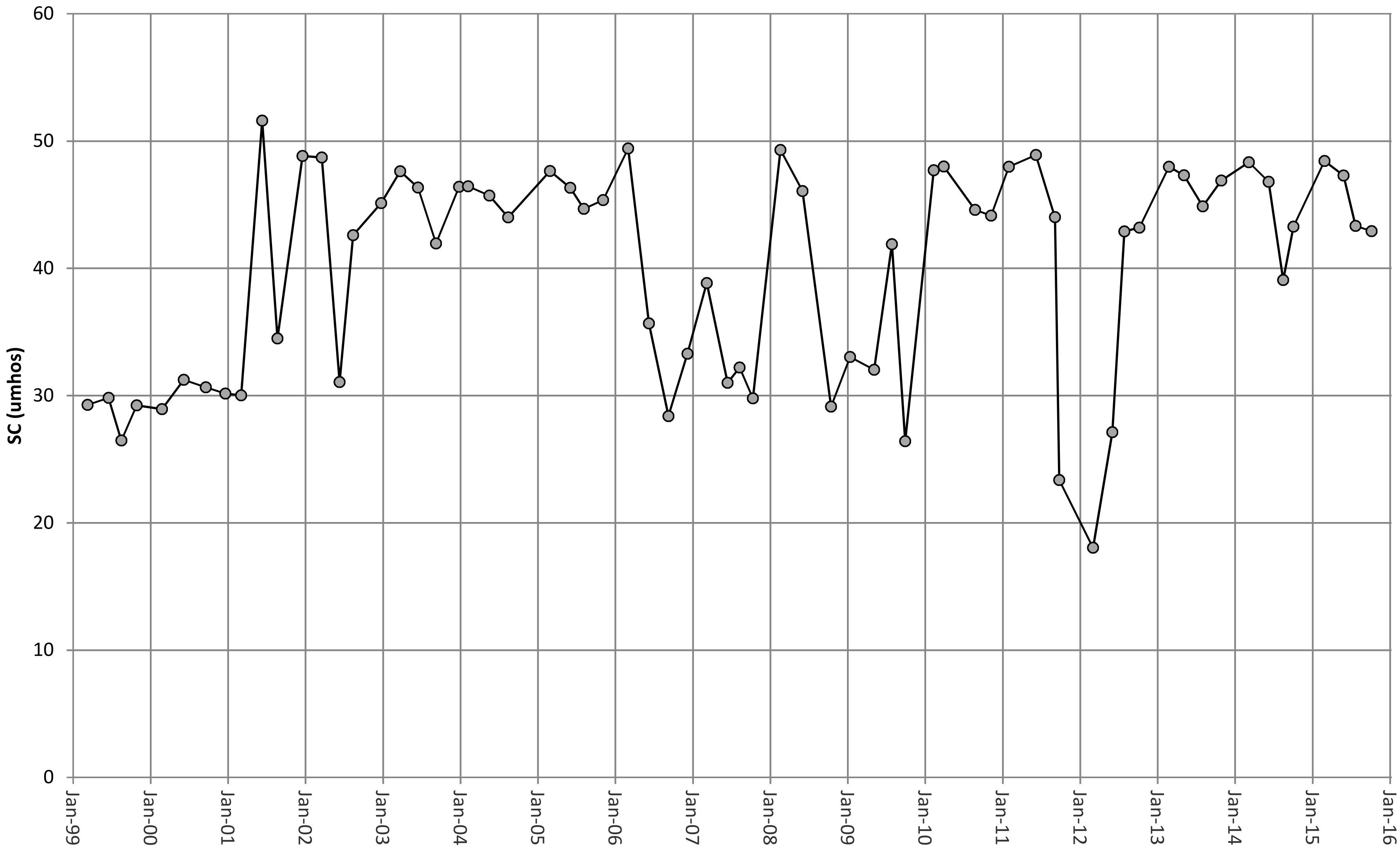


Figure 2-3a

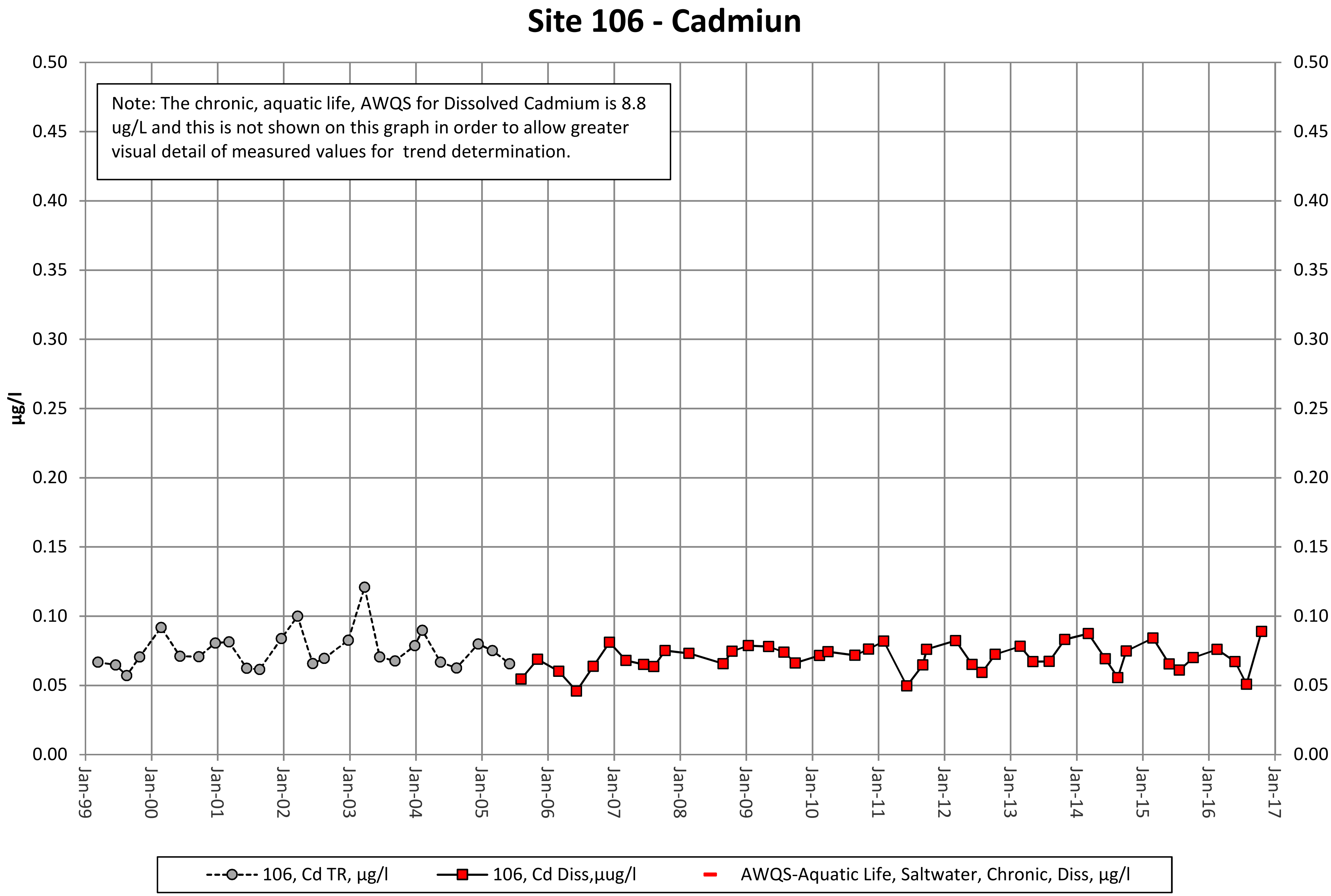
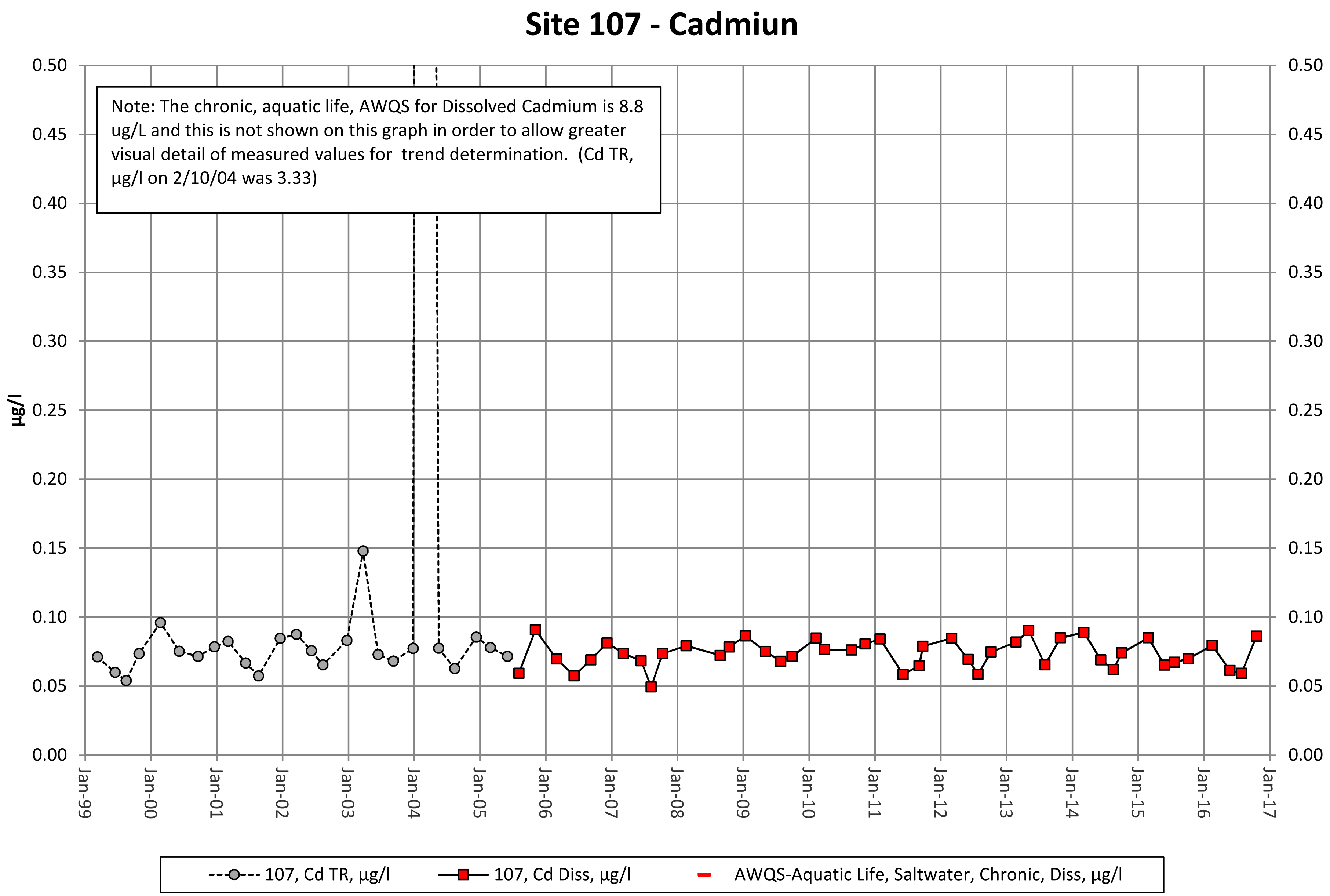

Site 106 - Cadmiun
Note: The chronic, aquatic life, AWQS for Dissolved Cadmium is 8.8 ug/L and this is not shown on this graph in order to allow greater visual detail of measured values for trend determination.
µg/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Cd TR, µg/l
106, Cd Diss,µug/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-3b



Site 107 - Cadmiun
Note: The chronic, aquatic life, AWQS for Dissolved Cadmium is 8.8 ug/L and this is not shown on this graph in order to allow greater visual detail of measured values for trend determination. (Cd TR, µg/l on 2/10/04 was 3.33)
µg/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Cd TR, µg/l
107, Cd Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-3c

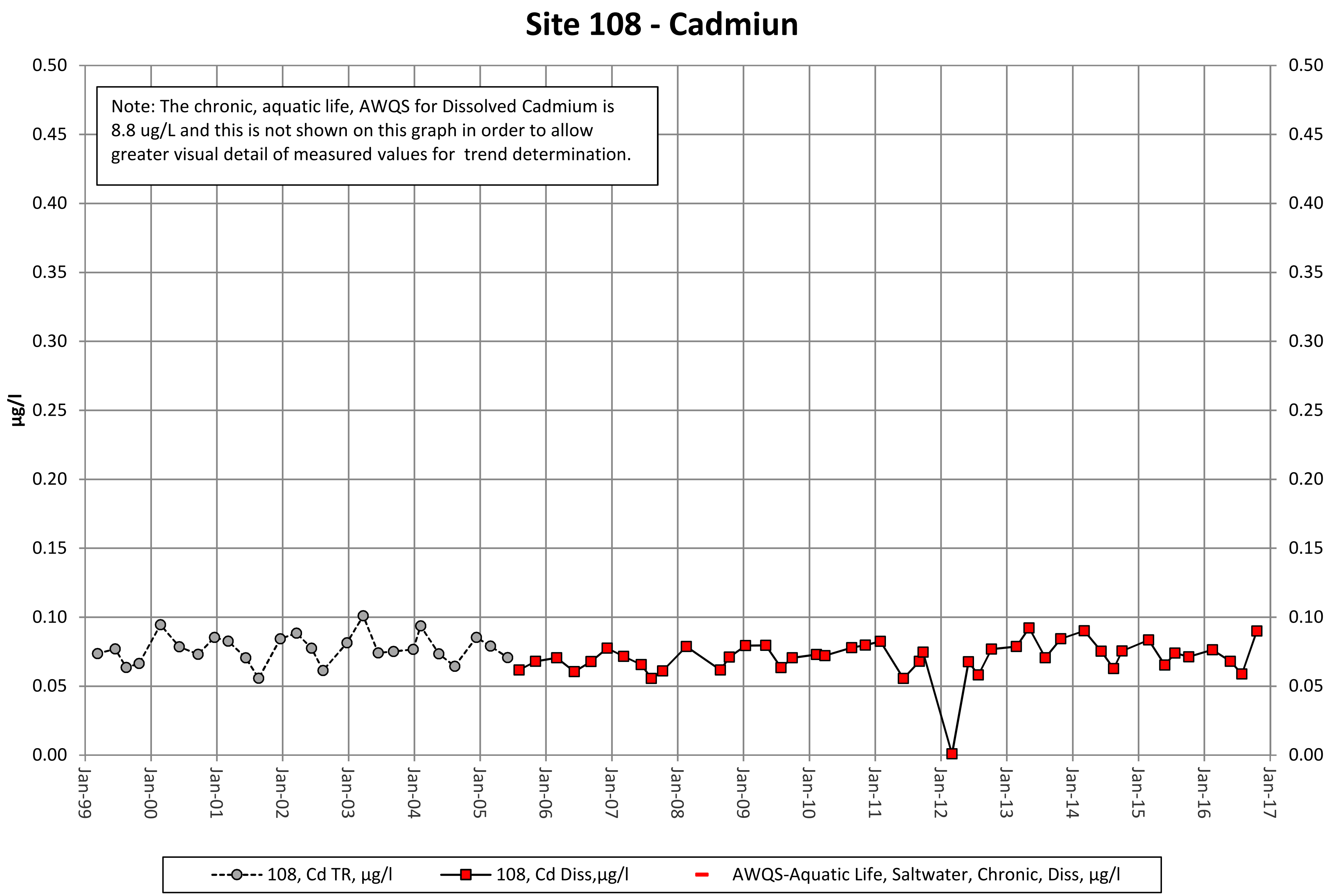
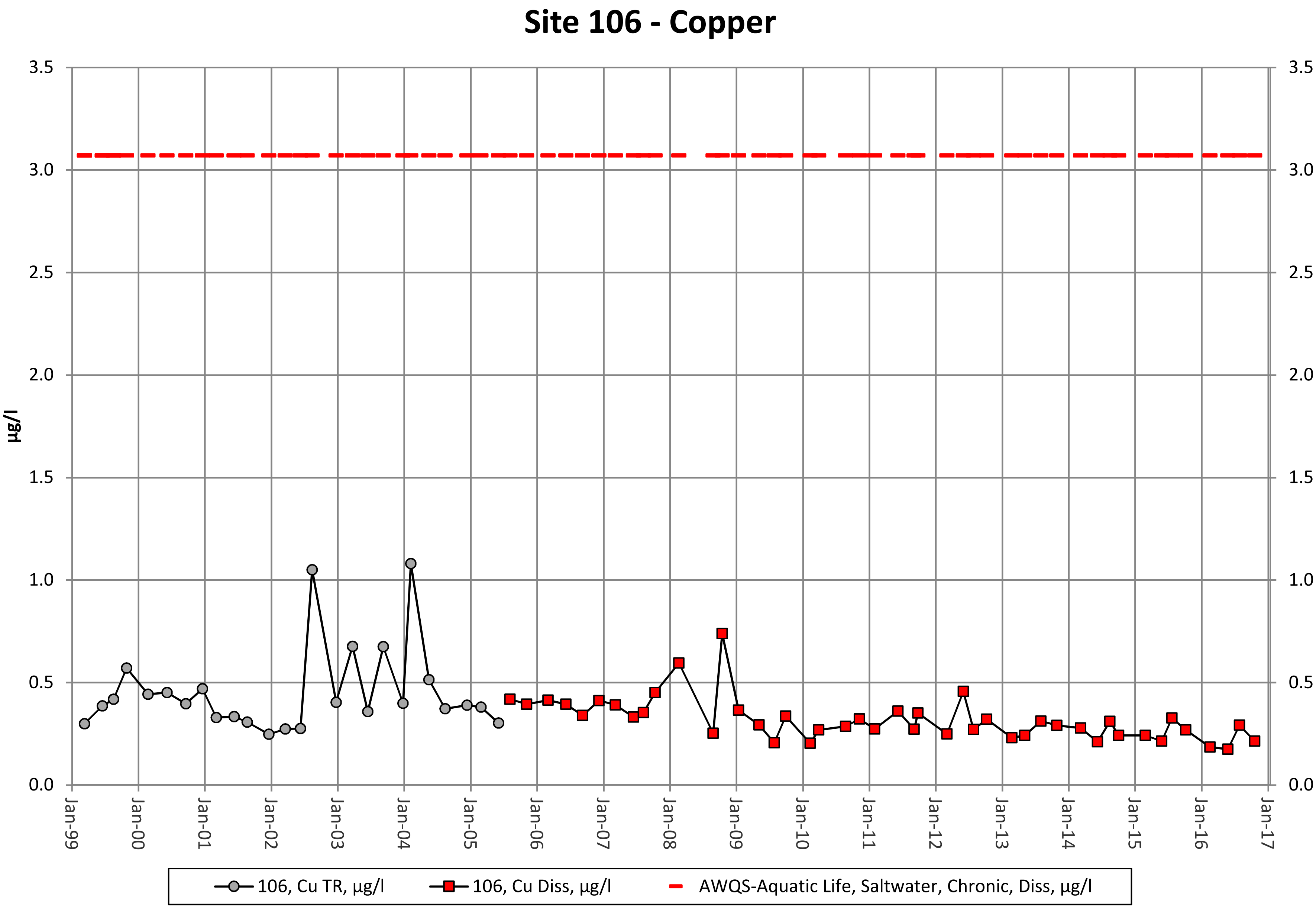

Site 108 - Cadmiun
Note: The chronic, aquatic life, AWQS for Dissolved Cadmium is 8.8 ug/L and this is not shown on this graph in order to allow greater visual detail of measured values for trend determination.
µg/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Cd TR, µg/l
108, Cd Diss,µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-4a



Site 106 - Copper
µg/l
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Cu TR, µg/l
106, Cu Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-4b

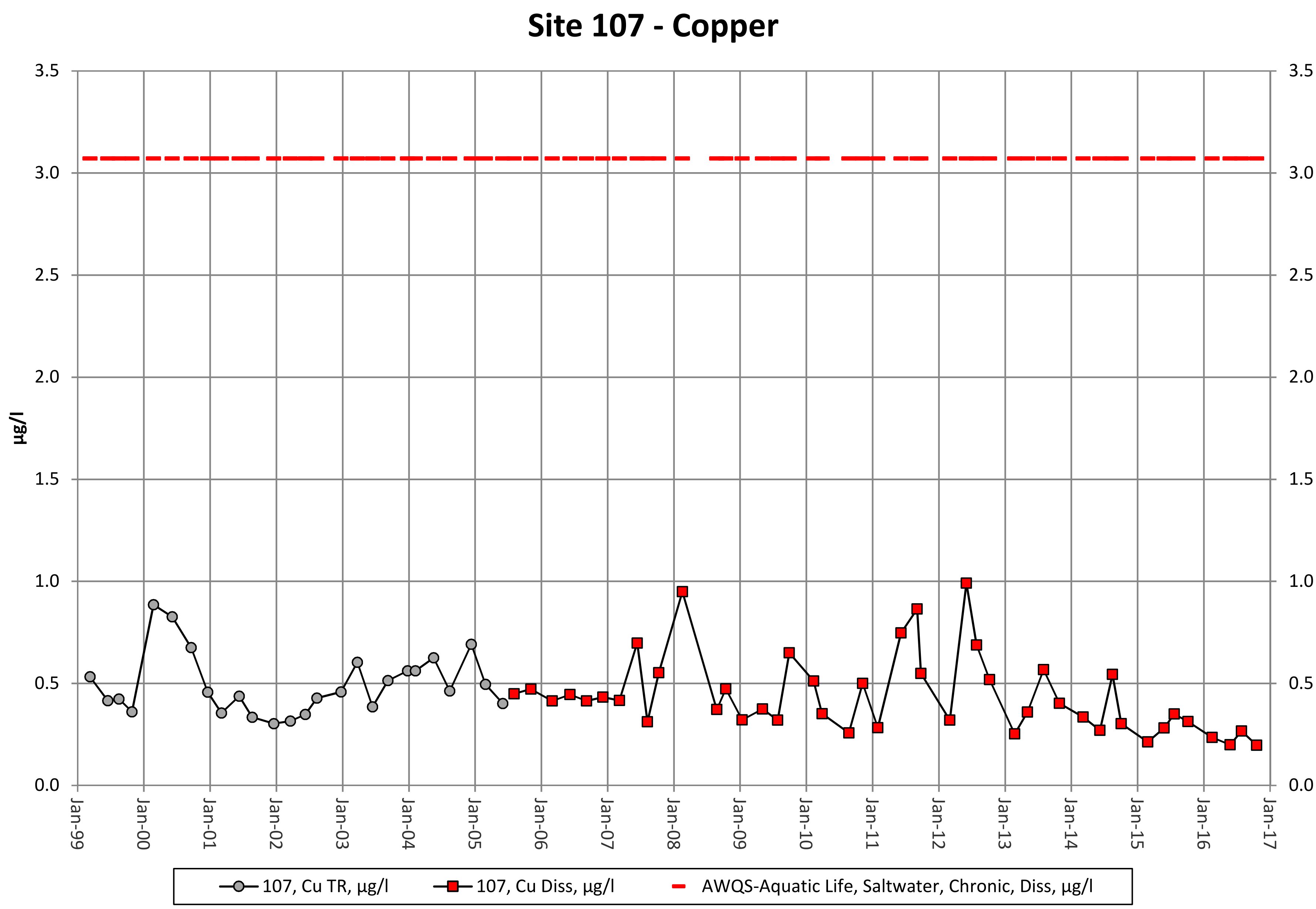

Site 107 - Copper
µg/l
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Cu TR, µg/l
107, Cu Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-4c

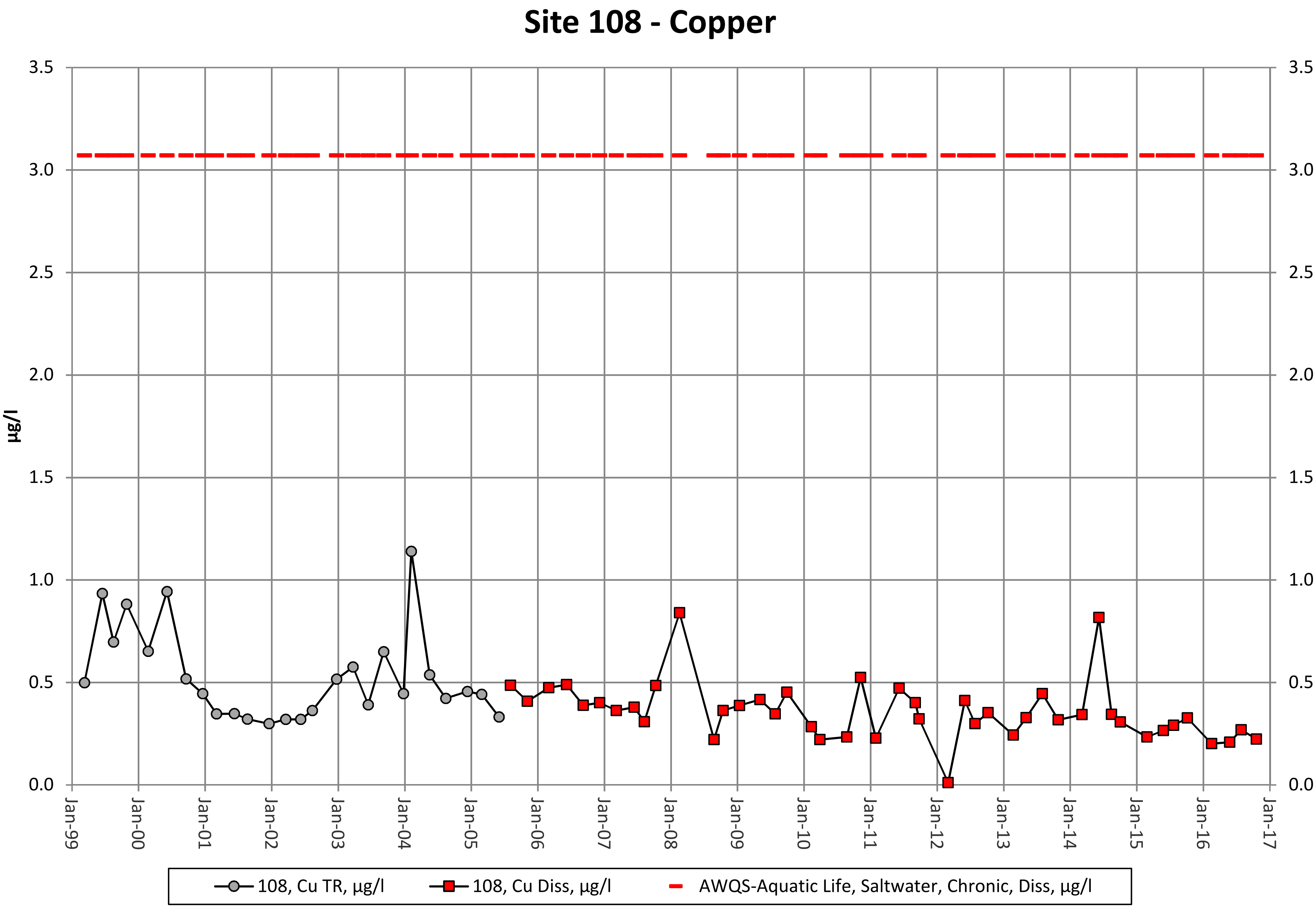
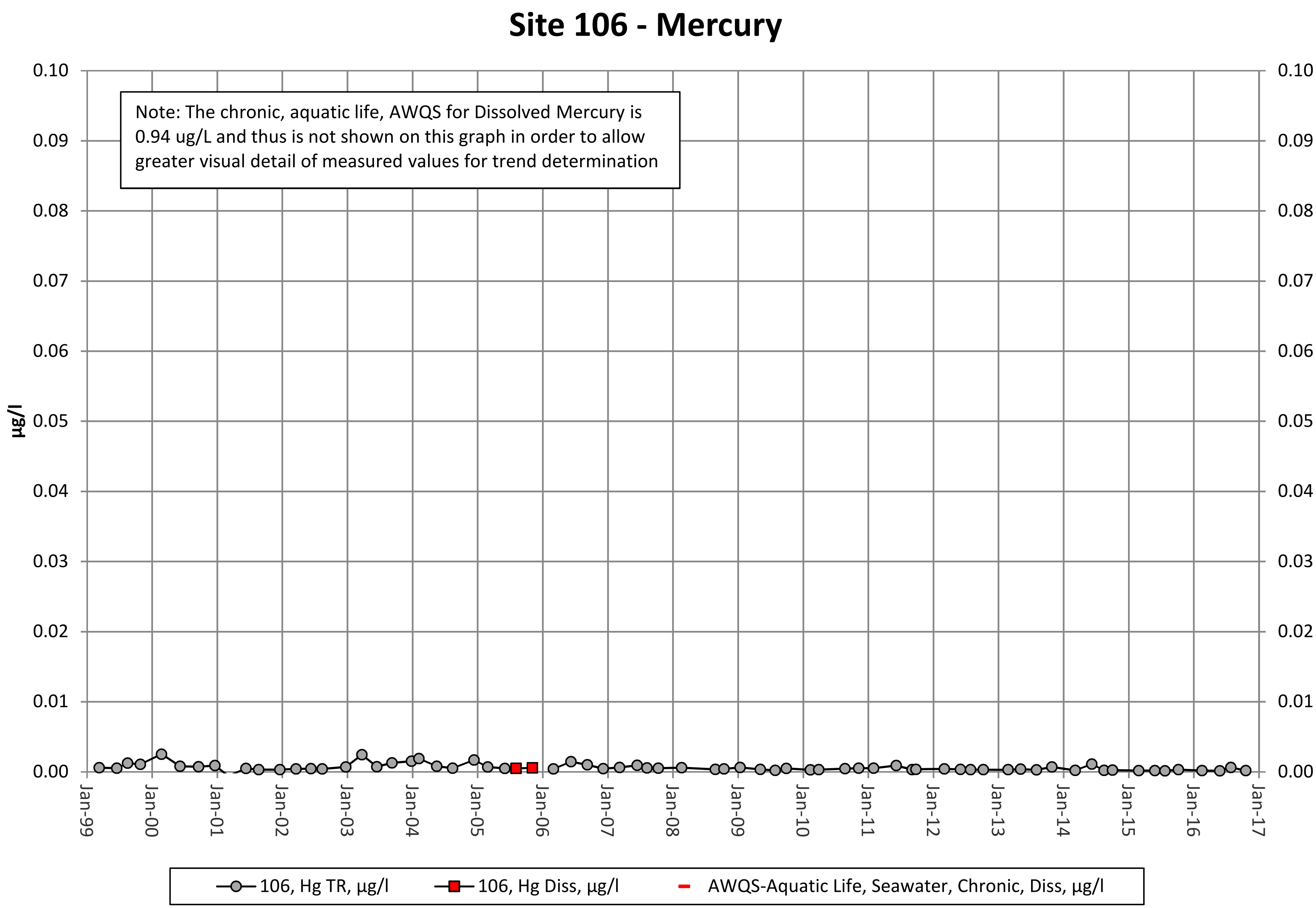
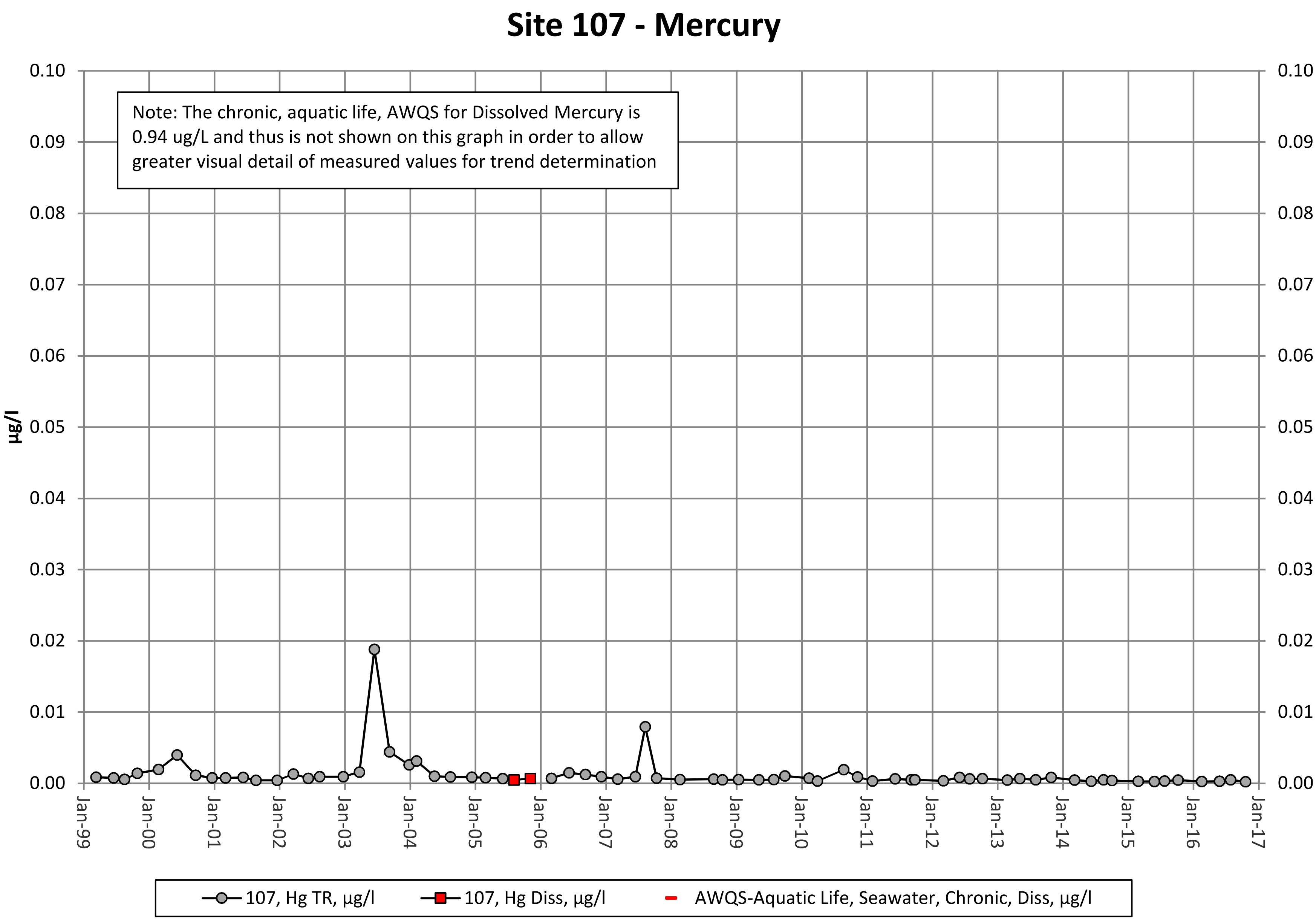

Site 108 - Copper
µg/l
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Cu TR, µg/l
108, Cu Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-5a



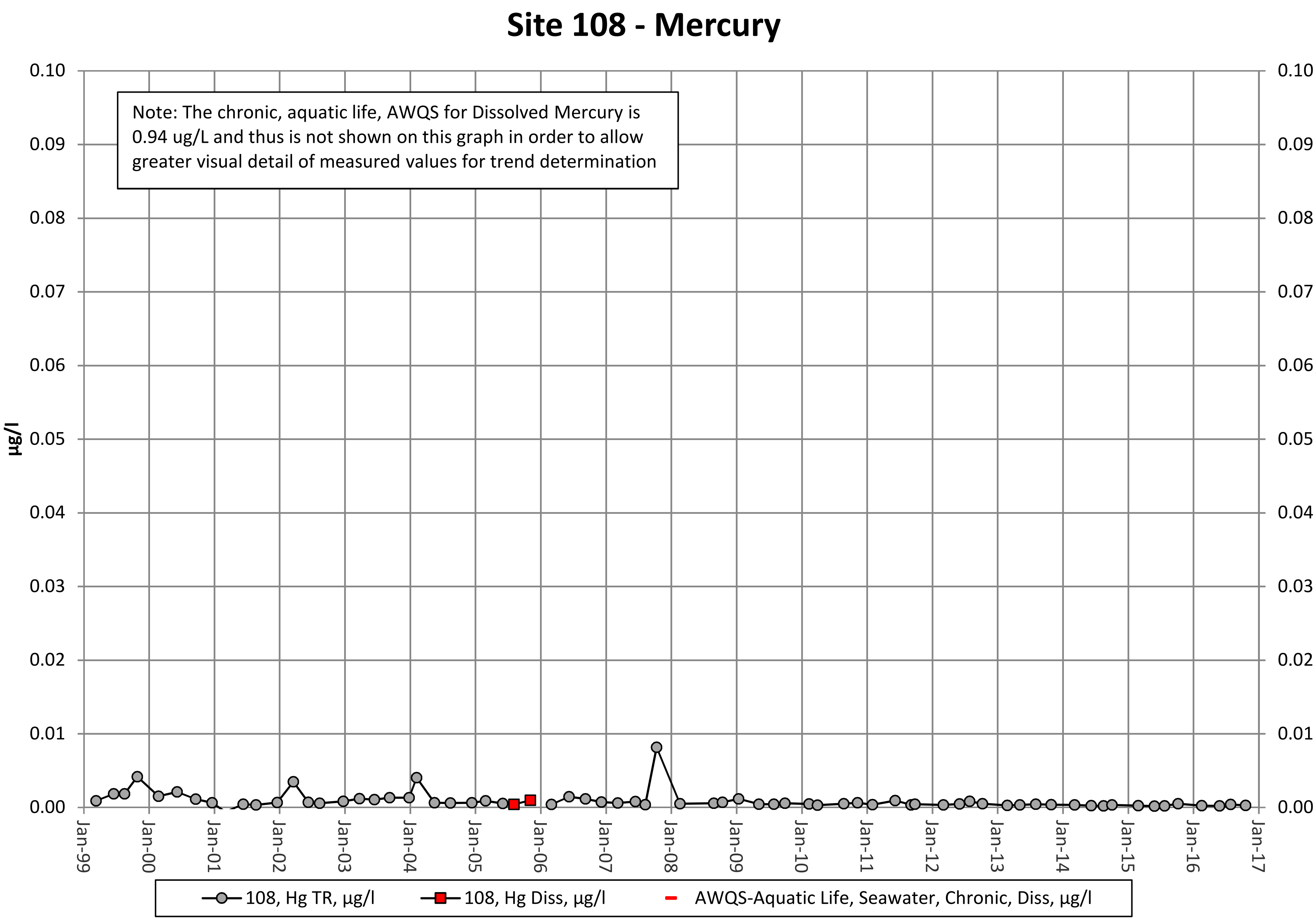
Site 106 - Mercury
Note: The chronic, aquatic life, AWQS for Dissolved Mercury is 0.94 ug/L and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Hg TR, µg/l
106, Hg Diss, µg/l
AWQS-Aquatic Life, Seawater, Chronic, Diss, µg/l

Figure 2-5b



Site 107 - Mercury
Note: The chronic, aquatic life, AWQS for Dissolved Mercury is 0.94 ug/L and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Hg TR, µg/l
107, Hg Diss, µg/l
AWQS-Aquatic Life, Seawater, Chronic, Diss, µg/l

Figure 2-5c



Site 108 - Mercury
Note: The chronic, aquatic life, AWQS for Dissolved Mercury is 0.94 ug/L and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Hg TR, µg/l
108, Hg Diss, µg/l
AWQS-Aquatic Life, Seawater, Chronic, Diss, µg/l

Figure 2-6a

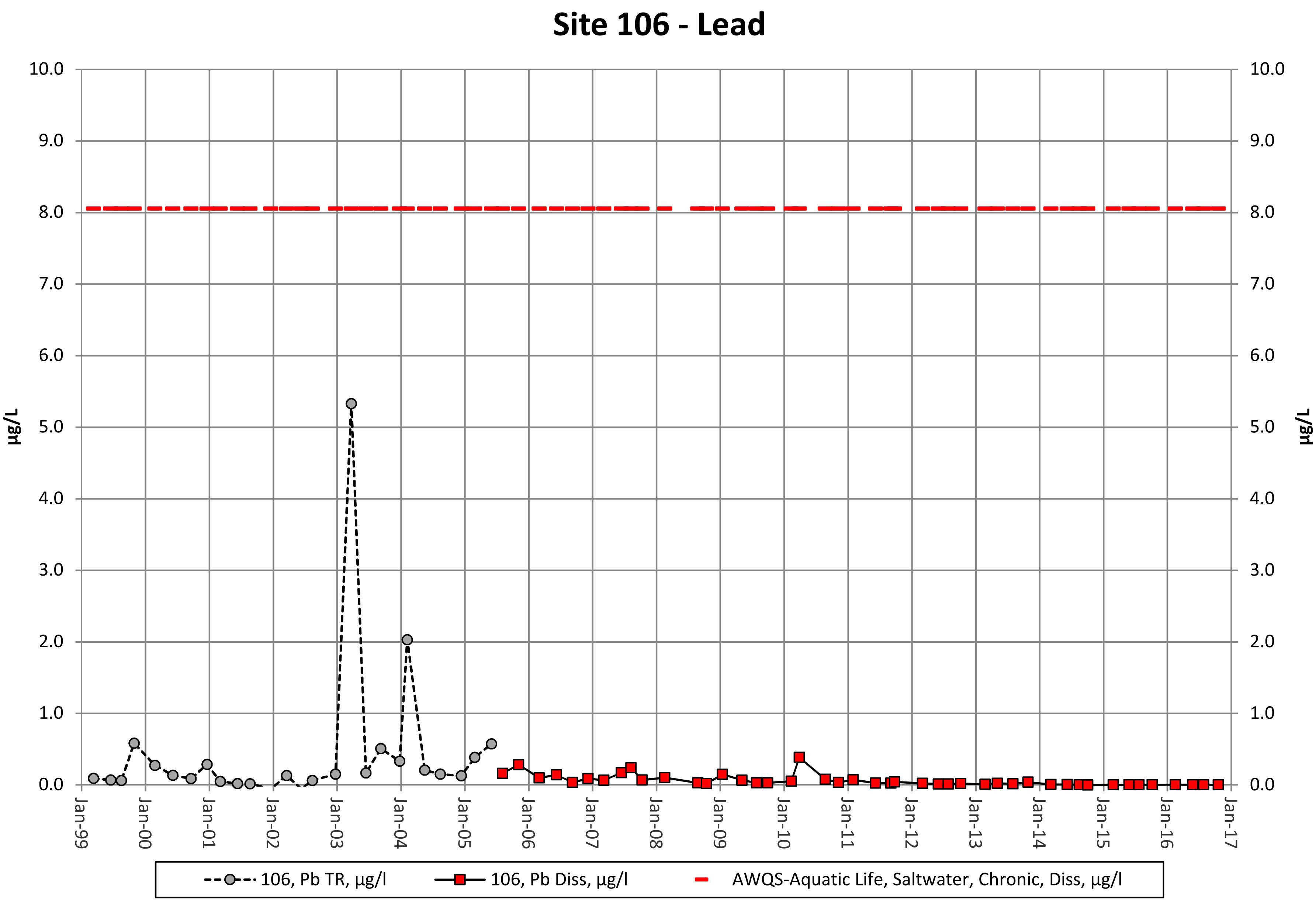

Site 106 - Lead
µg/L
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Pb TR, µg/l
106, Pb Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-6b

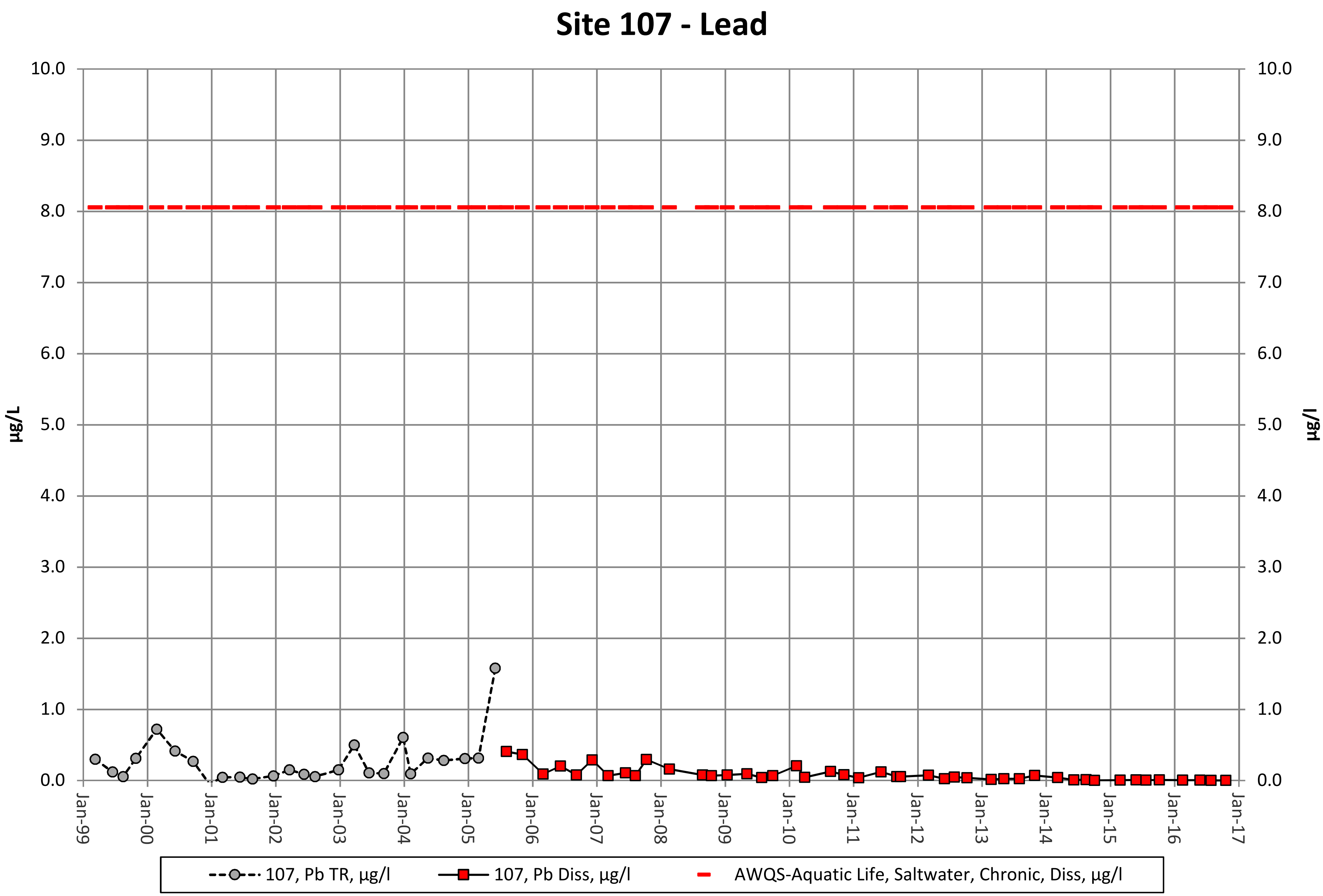
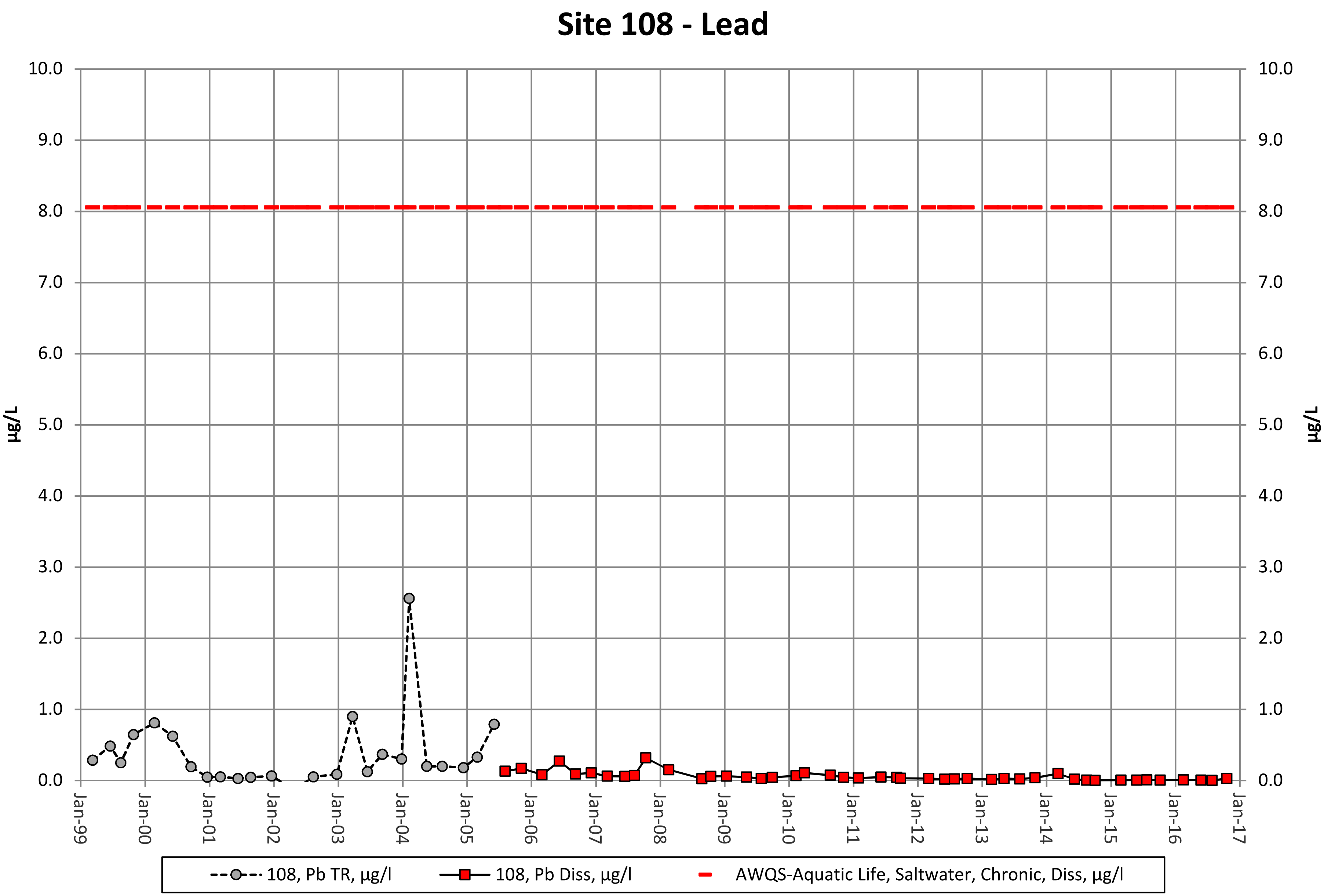
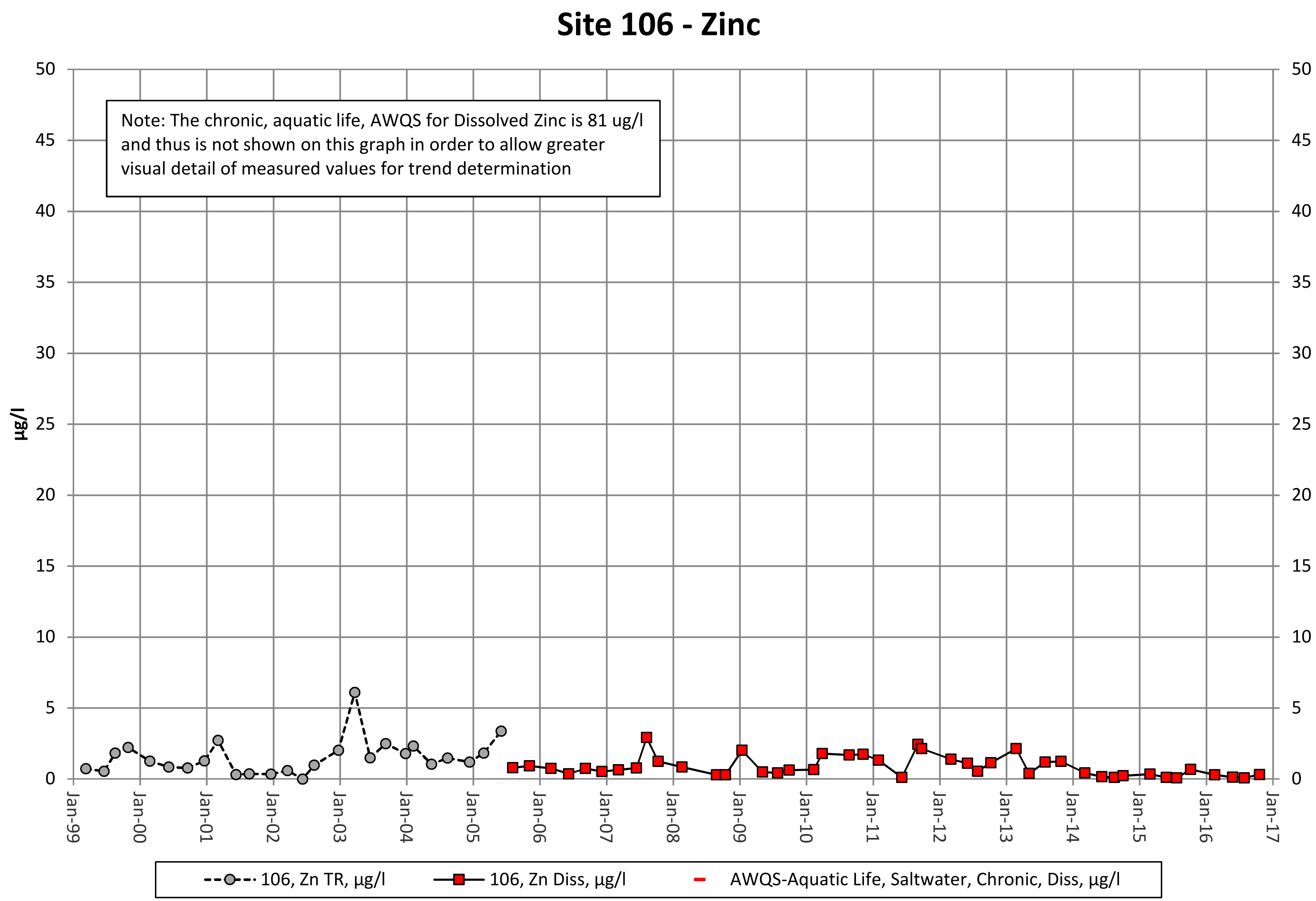

Site 107 - Lead
µg/L
µg/l
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Pb TR, µg/l
107, Pb Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-6c



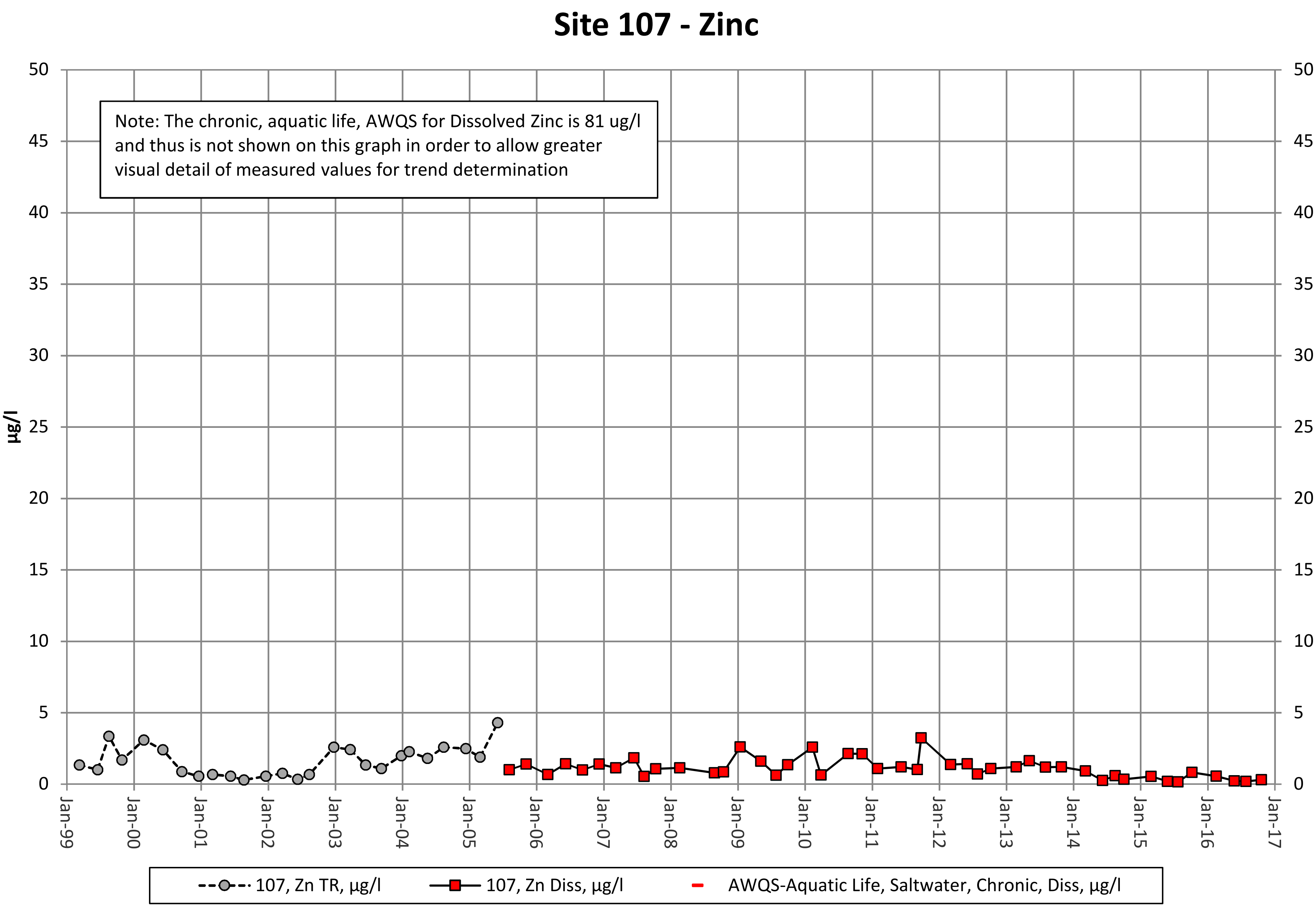
Site 108 - Lead
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
µg/L
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Pb TR, µg/l
108, Pb Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-7a



Site 106 - Zinc
Note: The chronic, aquatic life, AWQS for Dissolved Zinc is 81 ug/l and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
50
45
40
35
30
25
20
15
10
5
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Zn TR, µg/l
106, Zn Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-7b



Site 107 - Zinc
Note: The chronic, aquatic life, AWQS for Dissolved Zinc is 81 ug/l and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0
5
10
15
20
25
30
35
40
45
50
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Zn TR, µg/l
107, Zn Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-7c

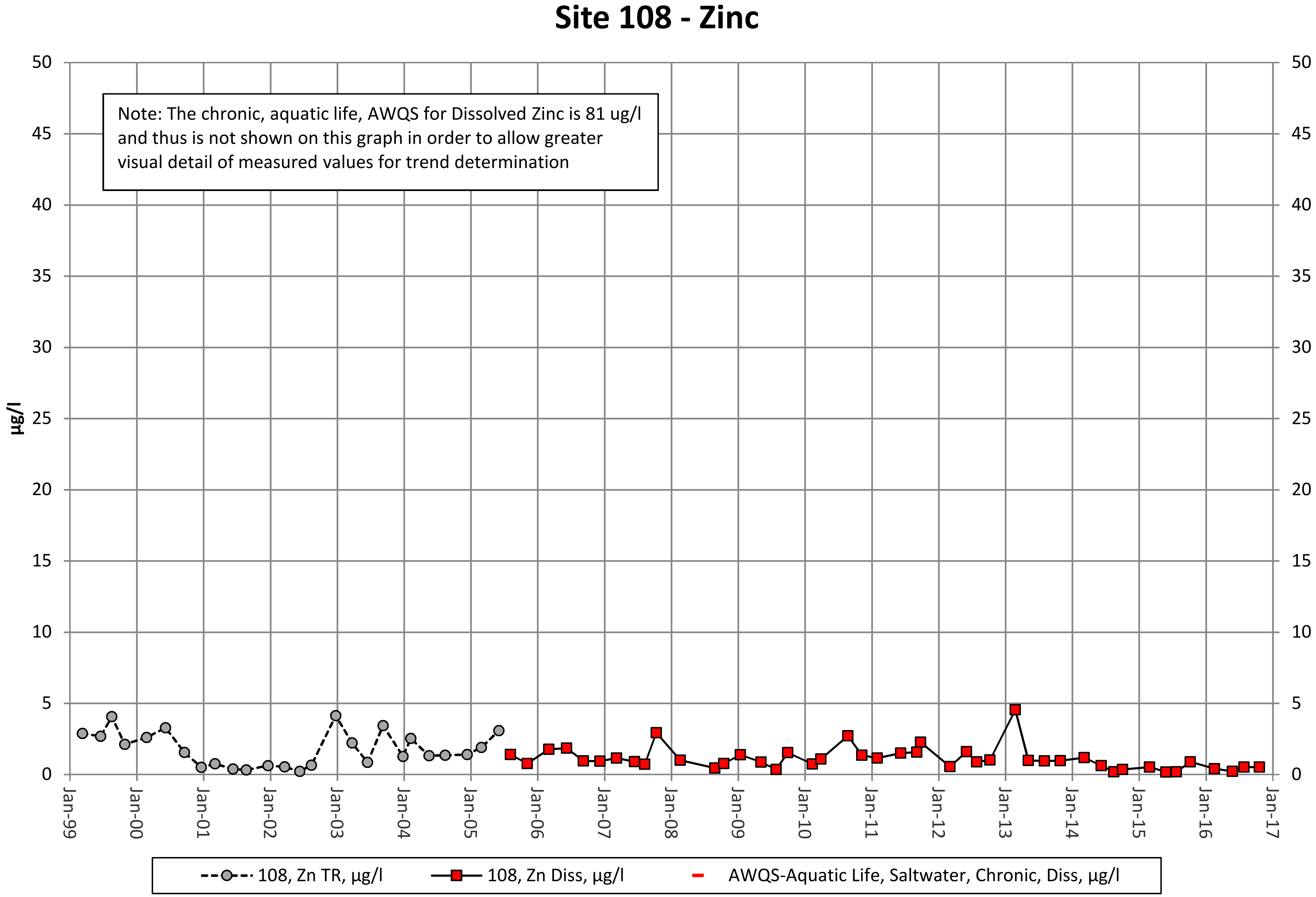

Site 108 - Zinc
Note: The chronic, aquatic life, AWQS for Dissolved Zinc is 81 ug/l and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0
5
10
15
20
25
30
35
40
45
50
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Zn TR, µg/l
108, Zn Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-1a

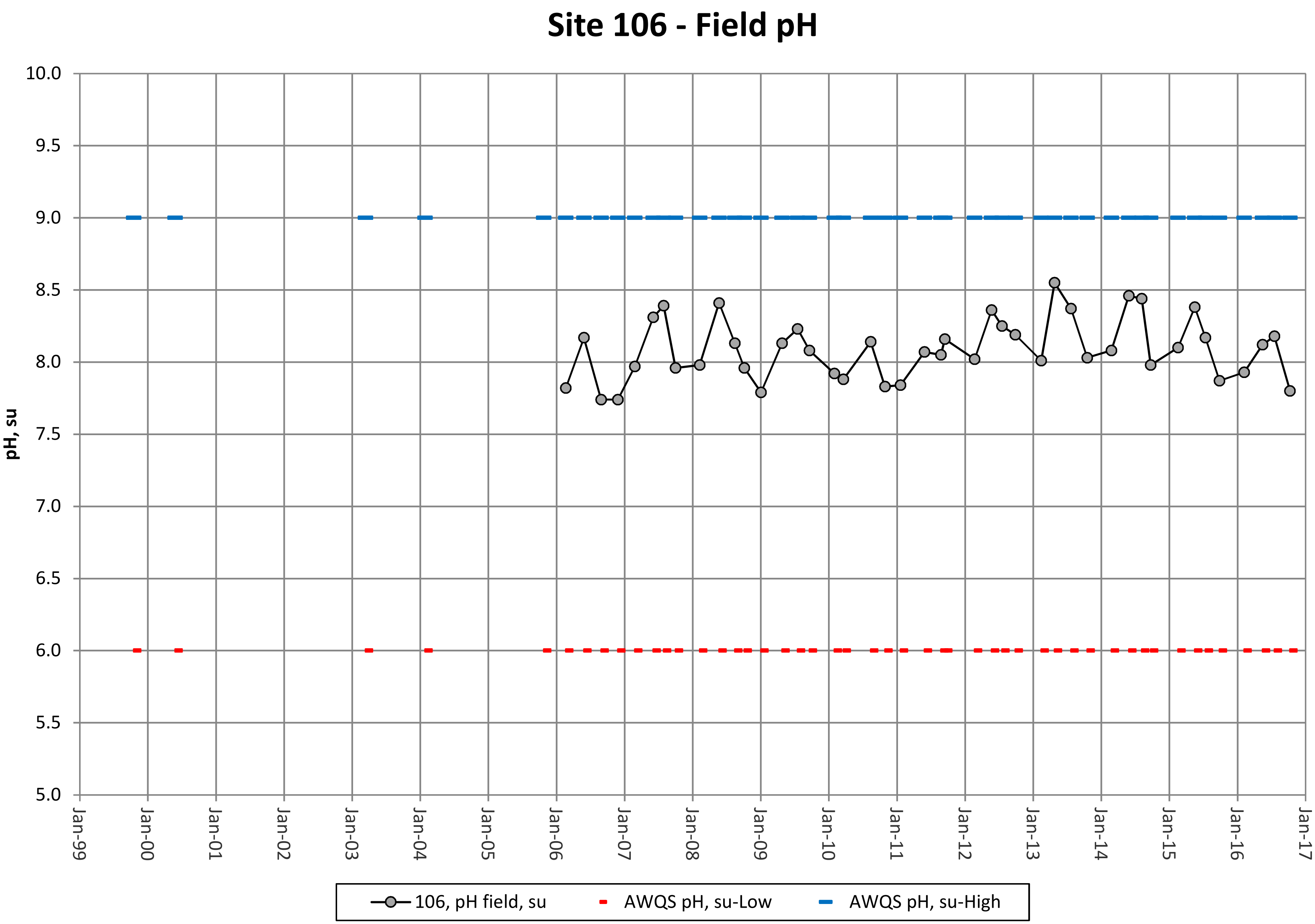
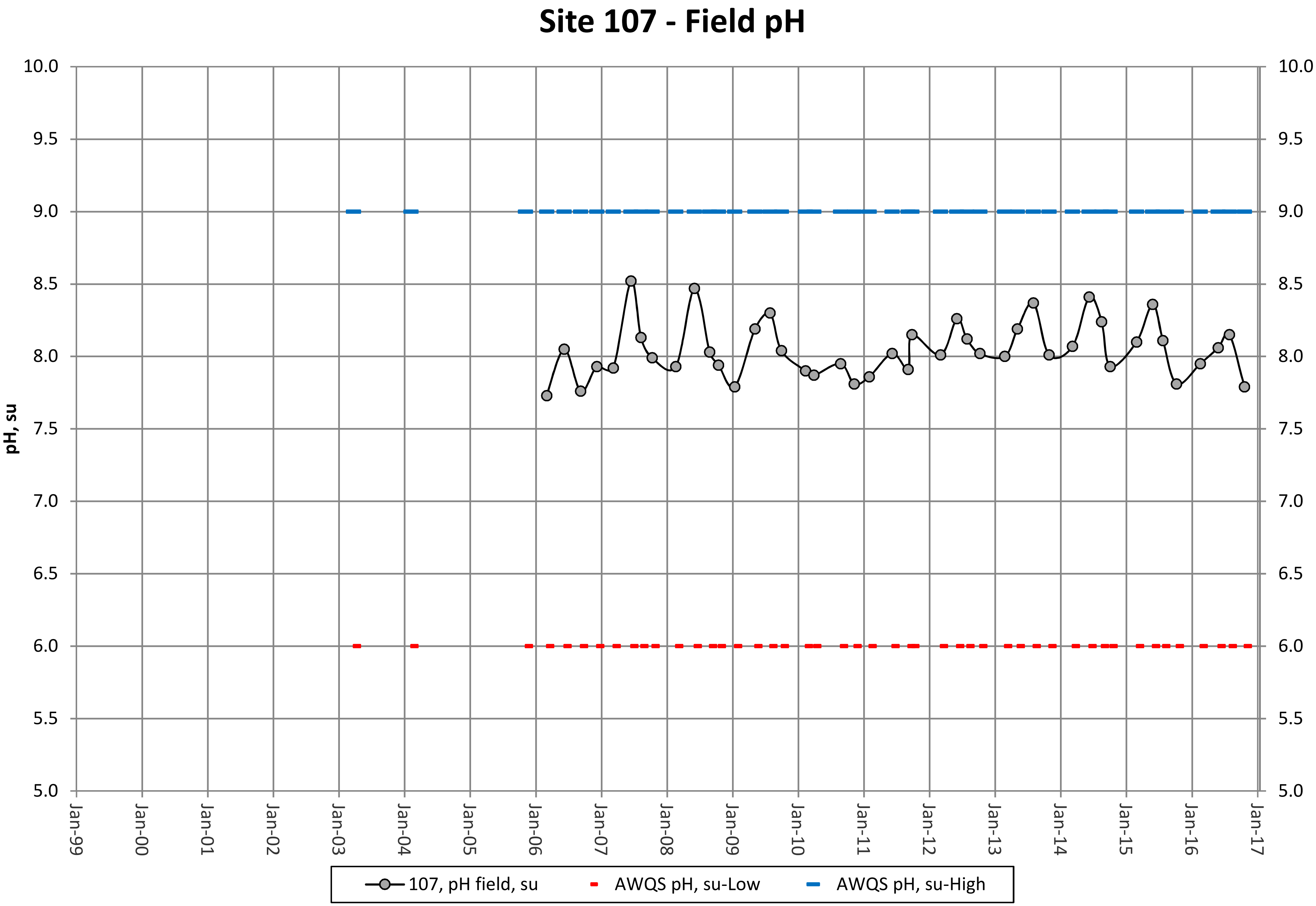
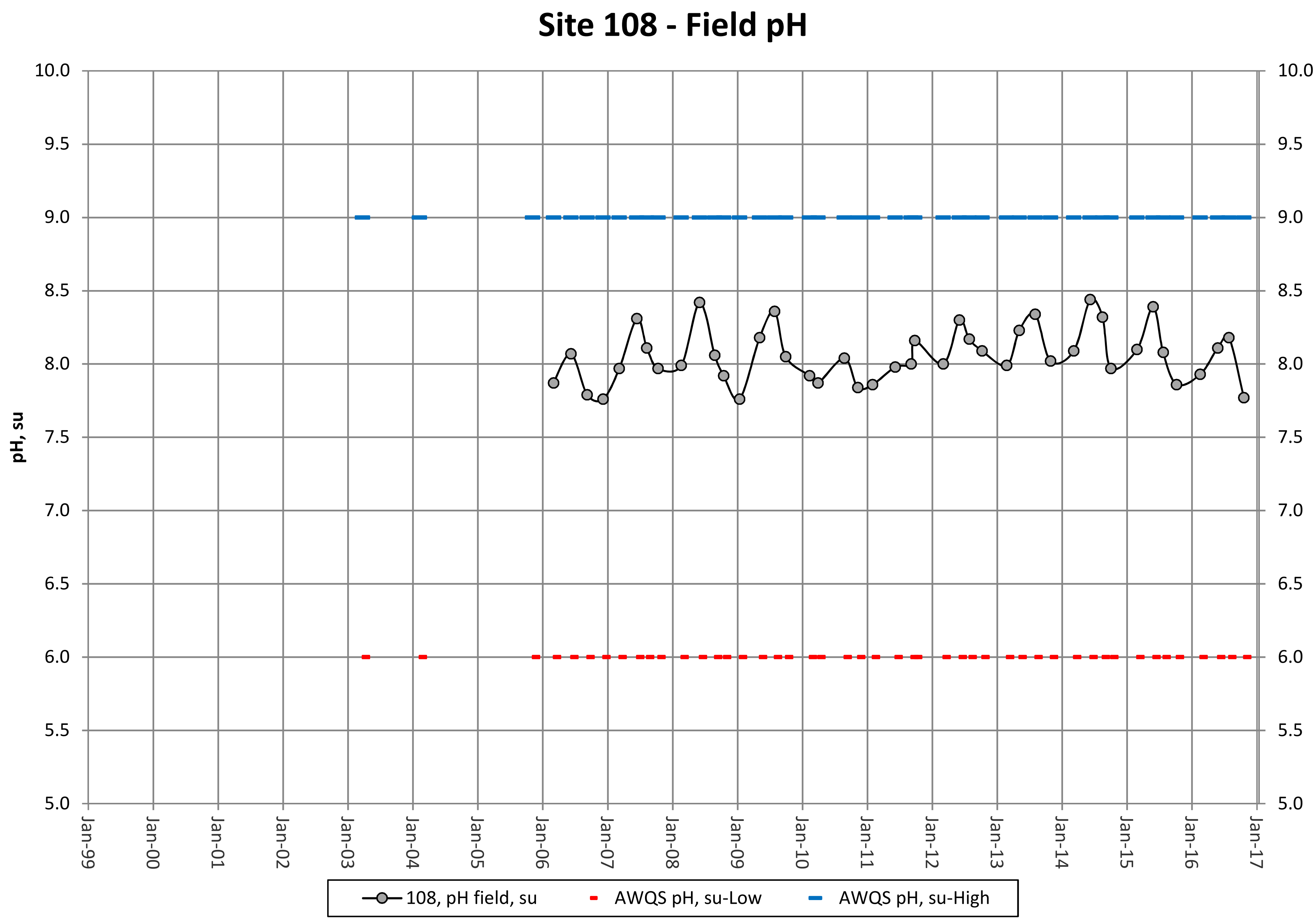

Site 106 - Field pH
pH, su
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, pH field, su
AWQS pH, su-Low
AWQS pH, su-High

Figure 2-1b



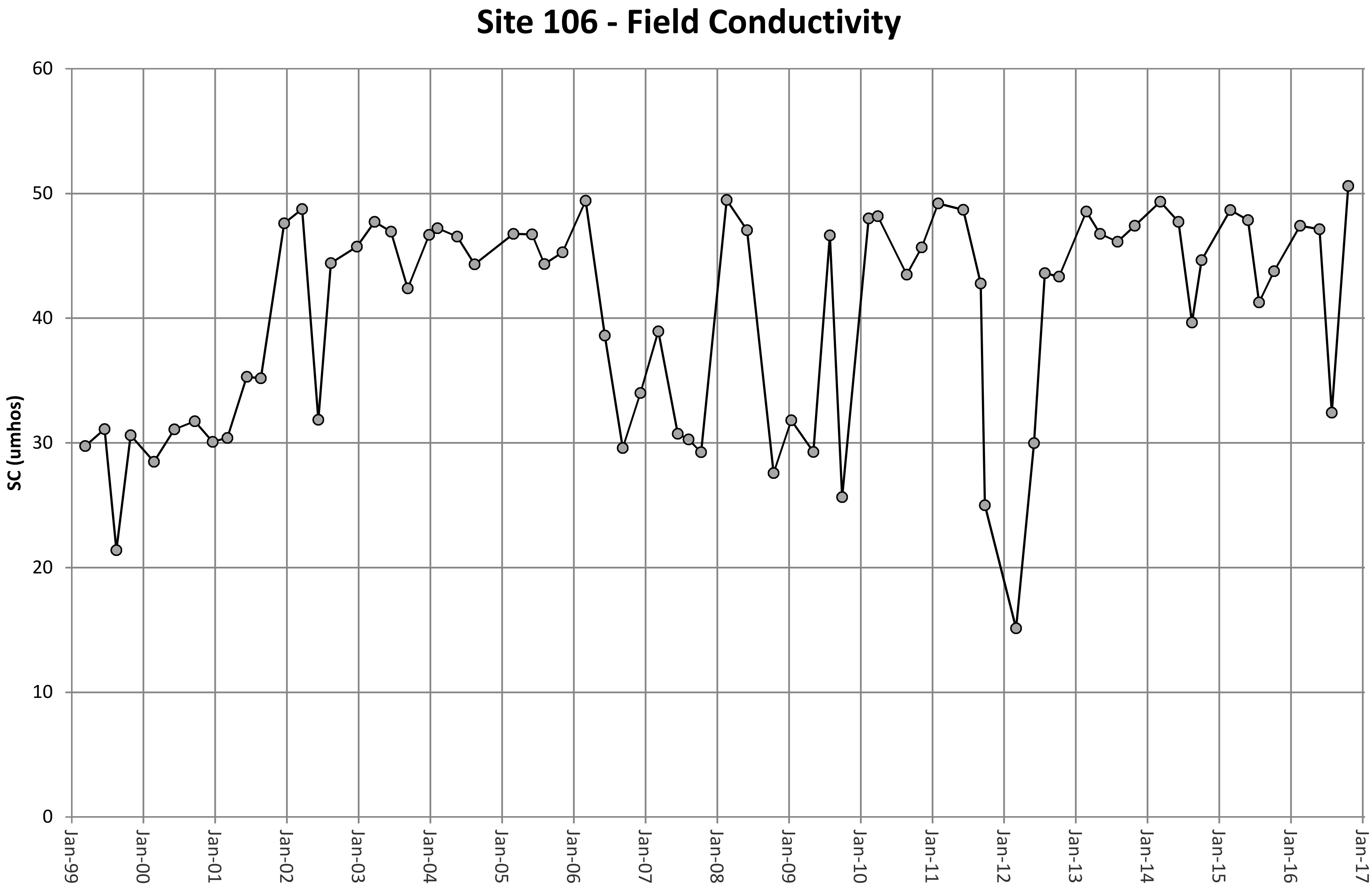
Site 107 - Field pH
pH, su
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, pH field, su
AWQS pH, su-Low
AWQS pH, su-High

Figure 2-1c



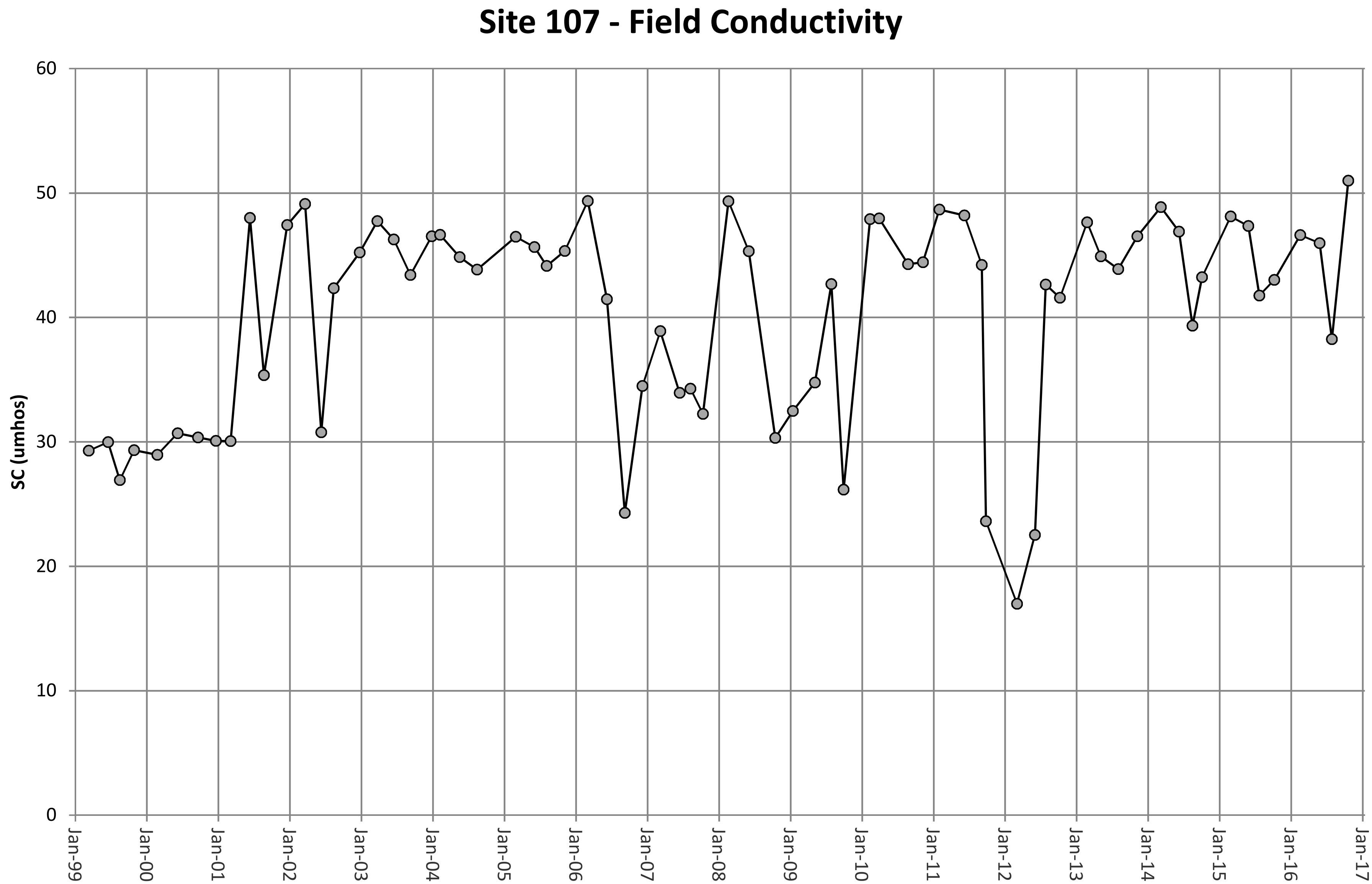
Site 108 - Field pH
pH, su
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, pH field, su
AWQS pH, su-Low
AWQS pH, su-High

Figure 2-2a



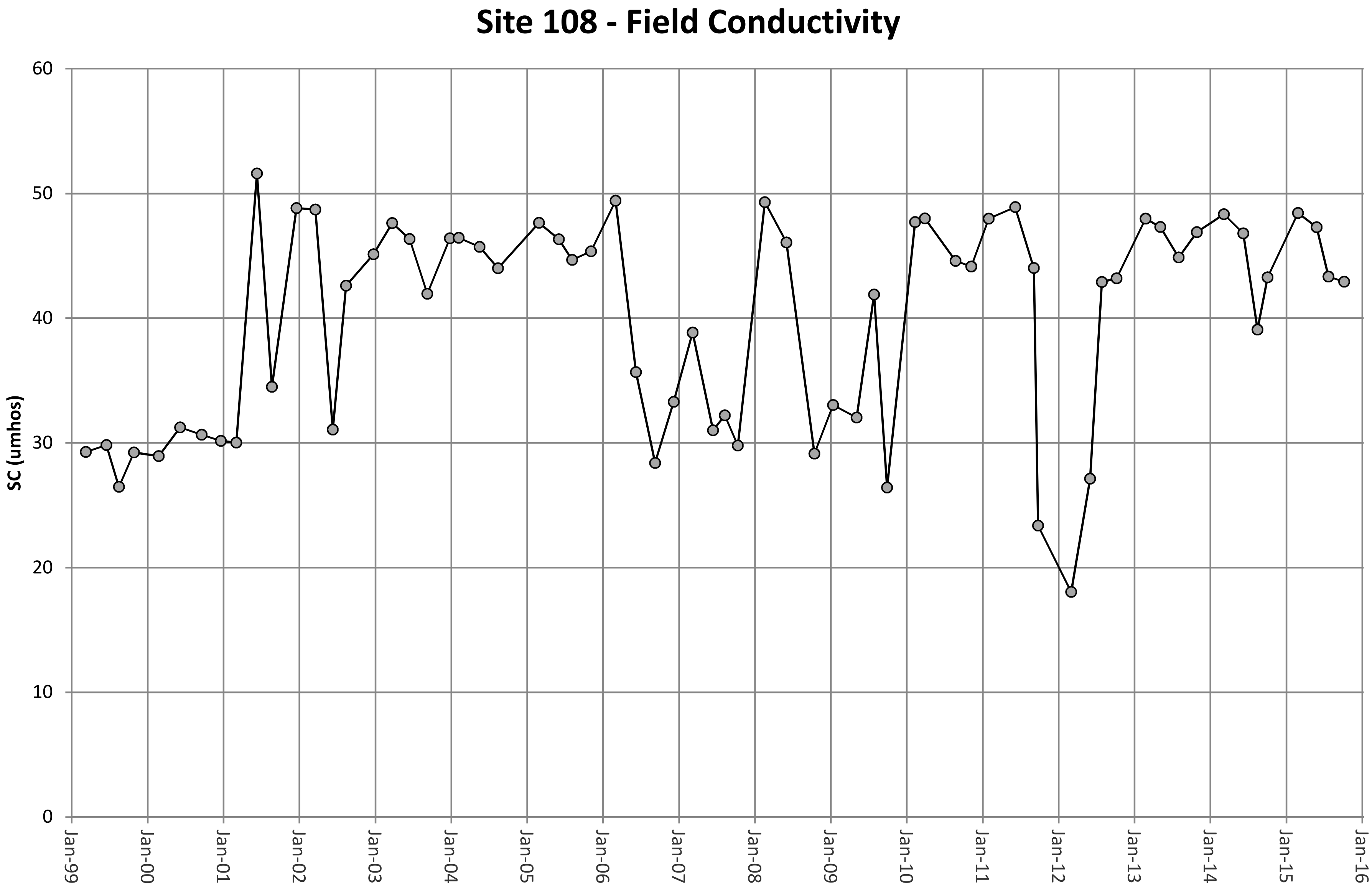
Site 106 - Field Conductivity
SC (umhos)
0
10
20
30
40
50
60
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17

Figure 2-2b



Site 107 - Field Conductivity
SC (umhos)
60
50
40
30
20
10
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17

Figure 2-2c



Site 108 - Field Conductivity
SC (umhos)
0
10
20
30
40
50
60
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16

Figure 2-3a

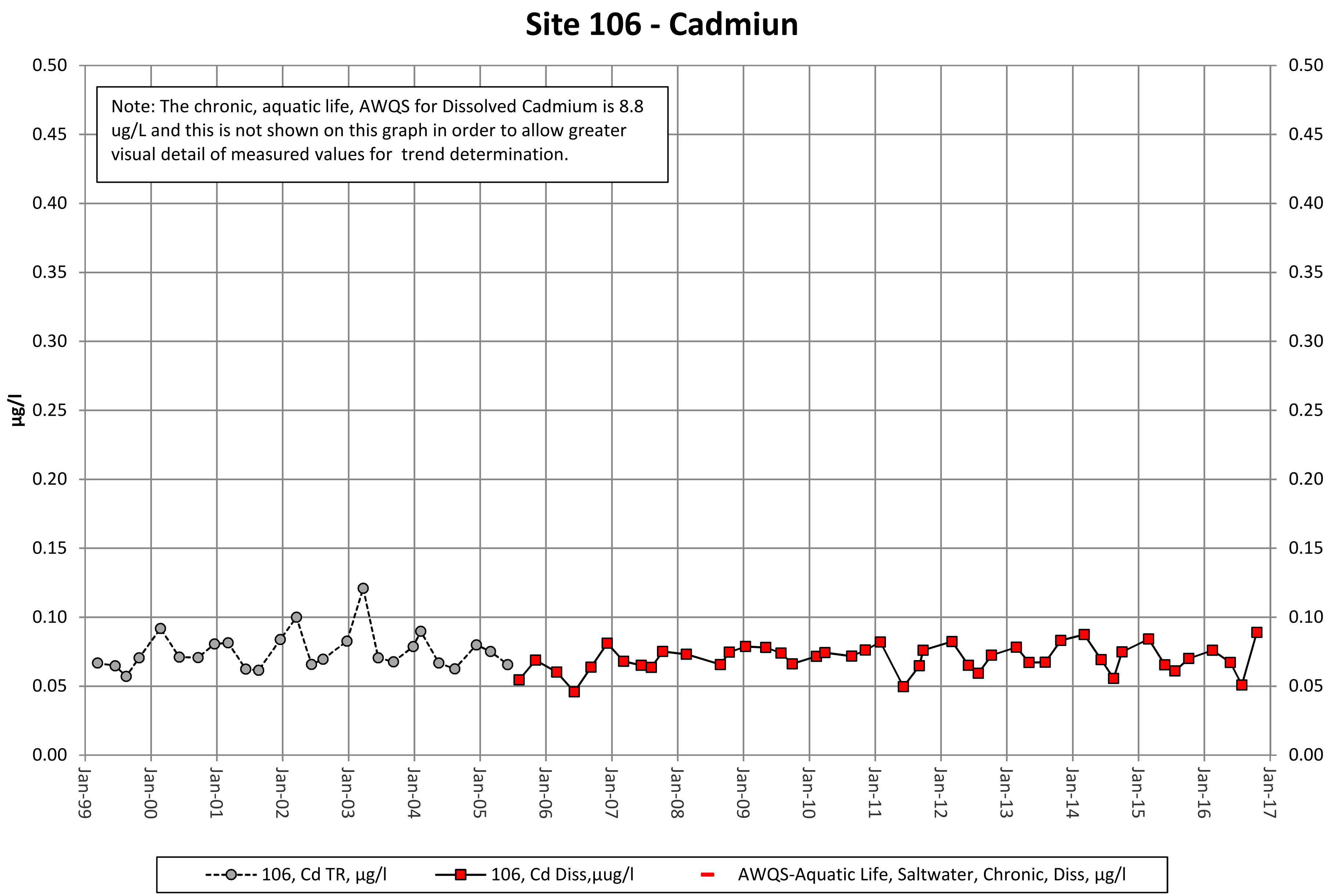

Site 106 - Cadmiun
Note: The chronic, aquatic life, AWQS for Dissolved Cadmium is 8.8 ug/L and this is not shown on this graph in order to allow greater visual detail of measured values for trend determination.
µg/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Cd TR, µg/l
106, Cd Diss,µug/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-3b

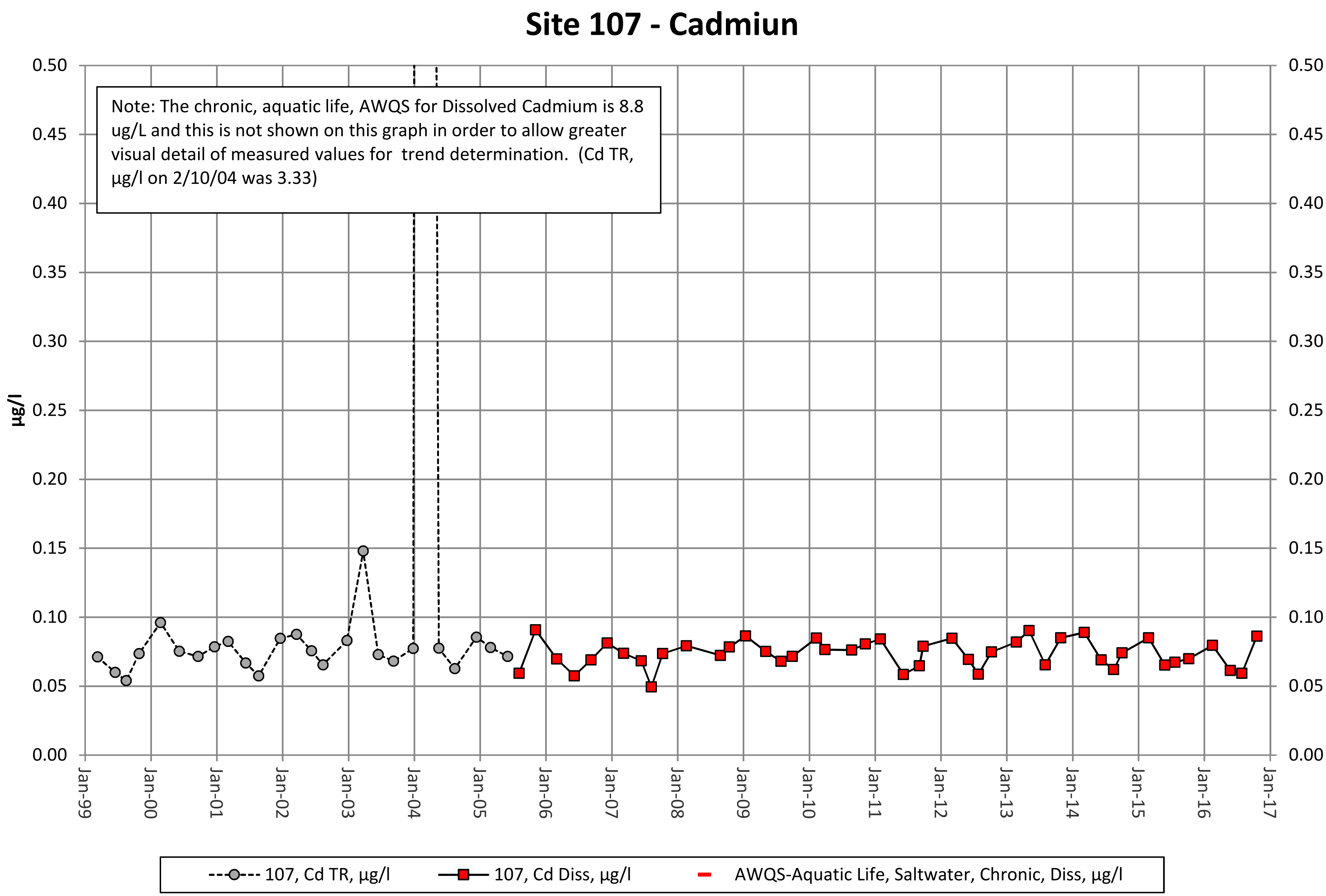

Site 107 - Cadmiun
Note: The chronic, aquatic life, AWQS for Dissolved Cadmium is 8.8 ug/L and this is not shown on this graph in order to allow greater visual detail of measured values for trend determination. (Cd TR, µg/l on 2/10/04 was 3.33)
µg/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Cd TR, µg/l
107, Cd Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-3c

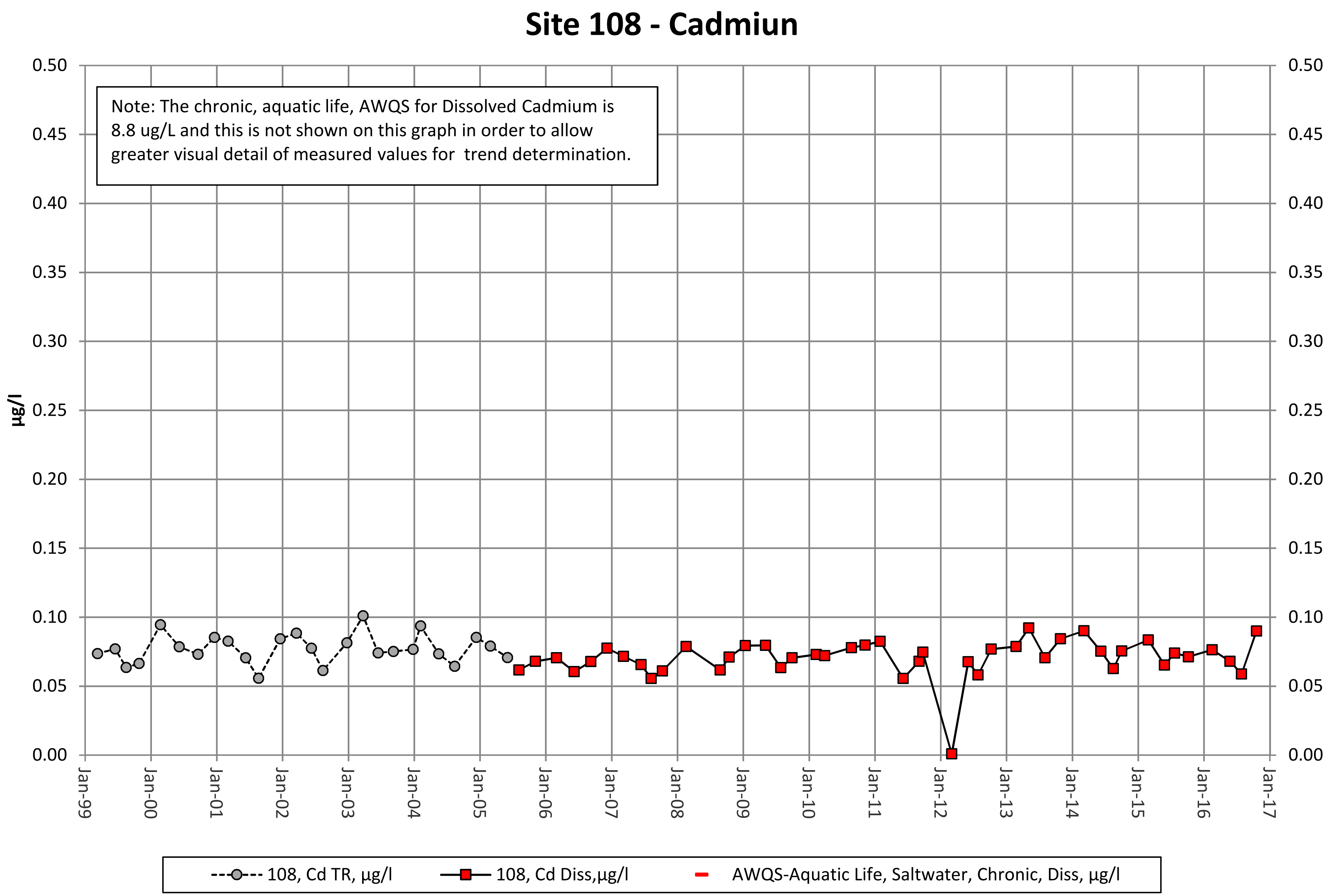
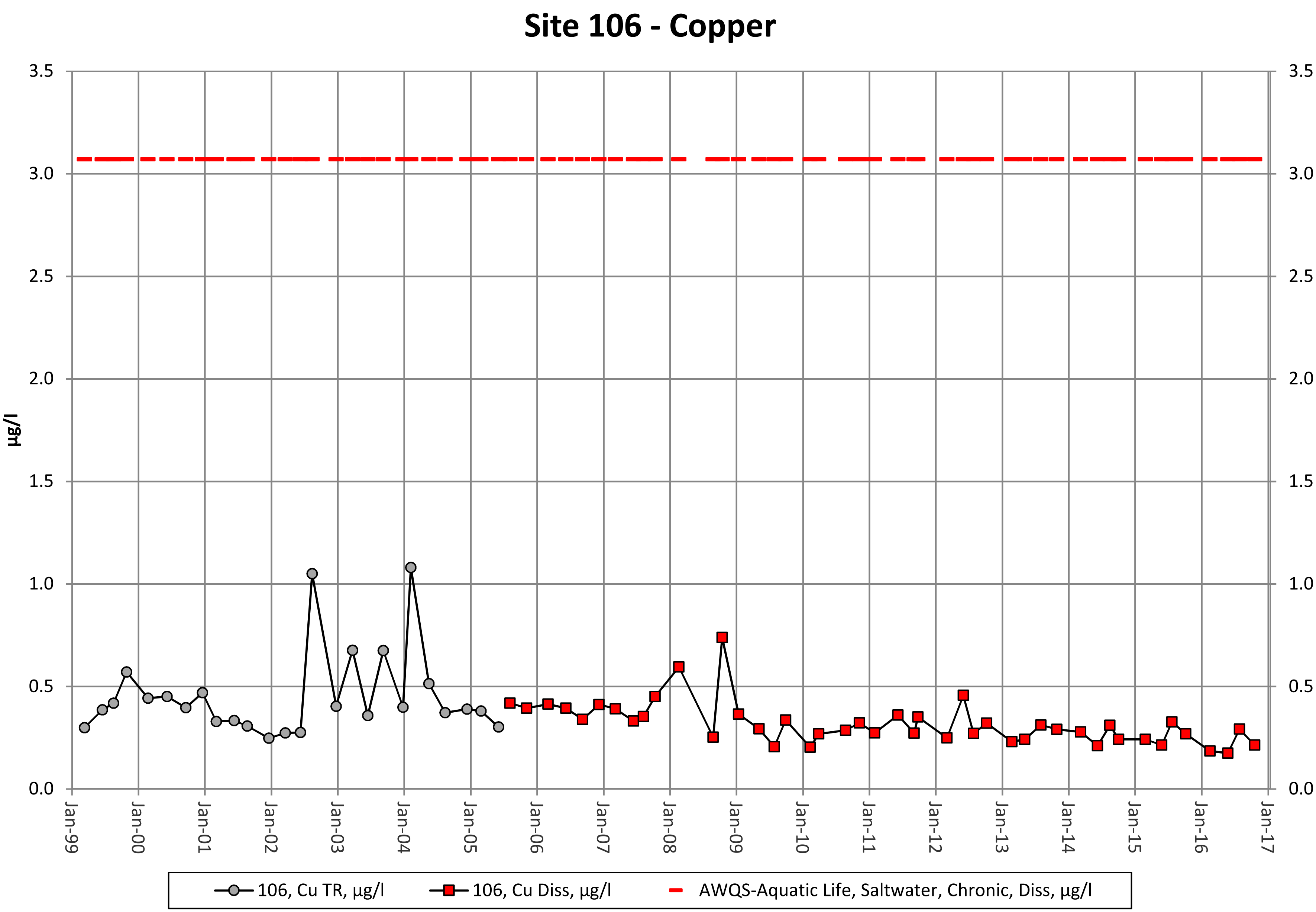
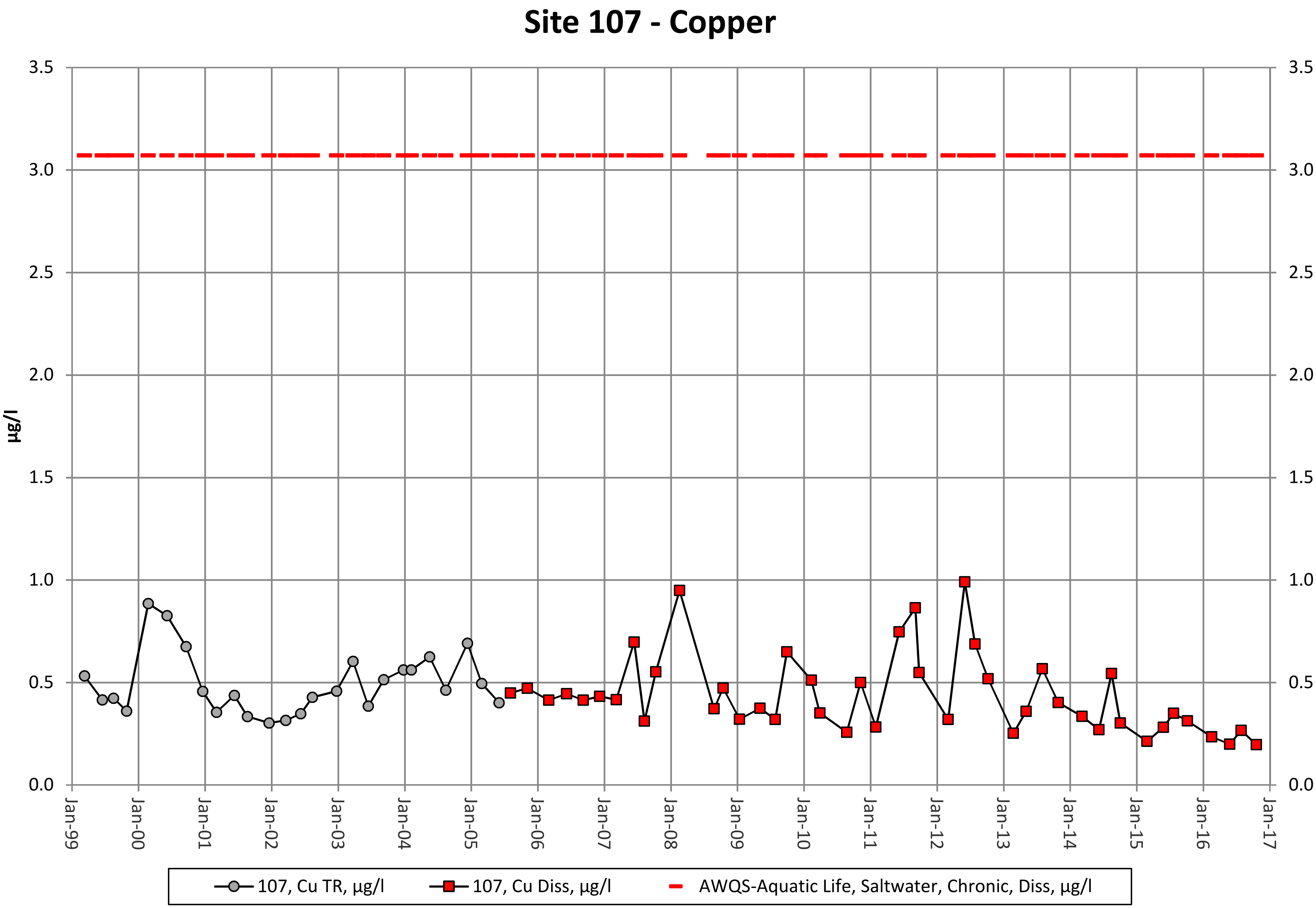

Site 108 - Cadmiun
Note: The chronic, aquatic life, AWQS for Dissolved Cadmium is 8.8 ug/L and this is not shown on this graph in order to allow greater visual detail of measured values for trend determination.
µg/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Cd TR, µg/l
108, Cd Diss,µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-4a



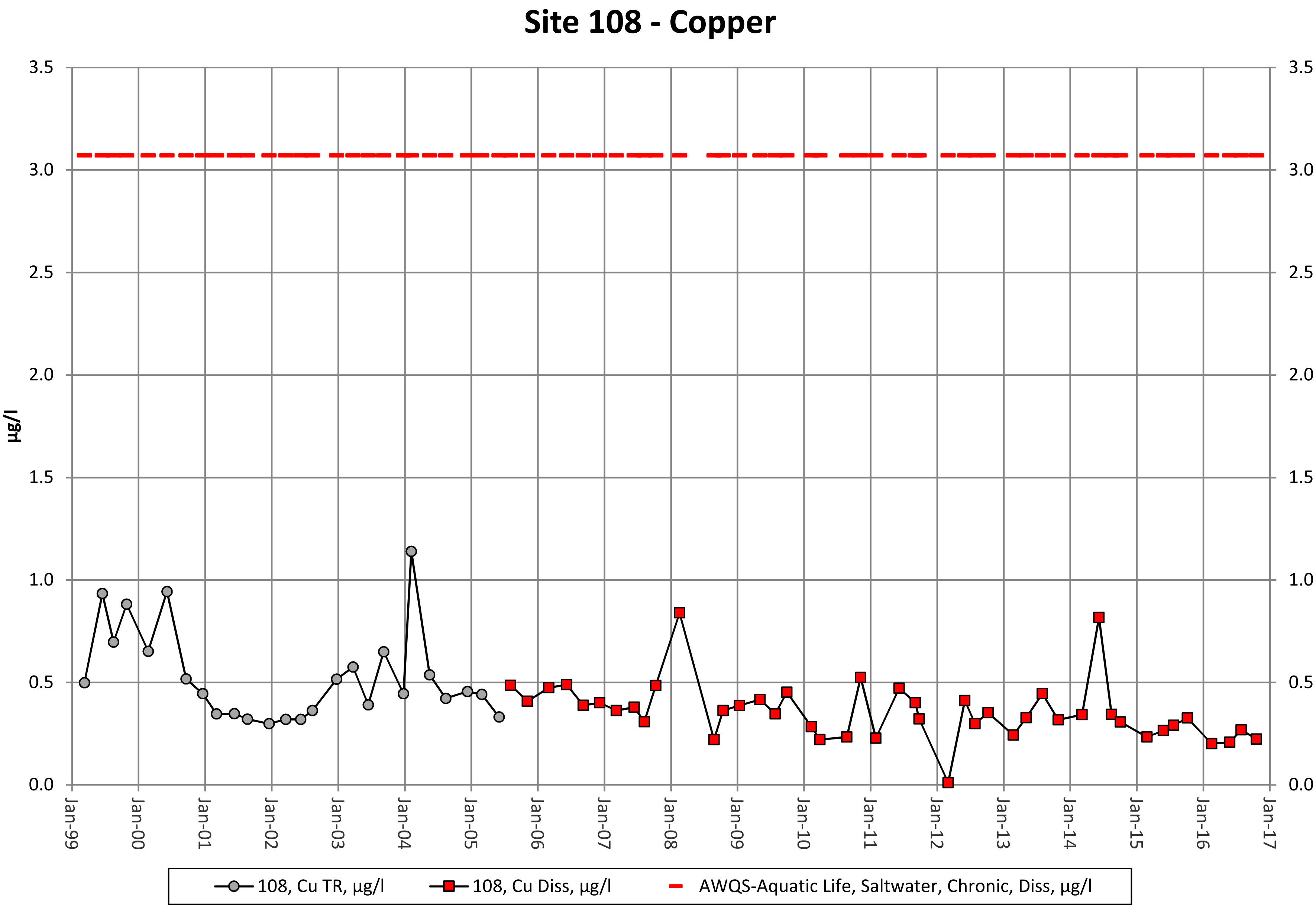
Site 106 - Copper
µg/l
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Cu TR, µg/l
106, Cu Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-4b



Site 107 - Copper
µg/l
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Cu TR, µg/l
107, Cu Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-4c



Site 108 - Copper
µg/l
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Cu TR, µg/l
108, Cu Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-5a

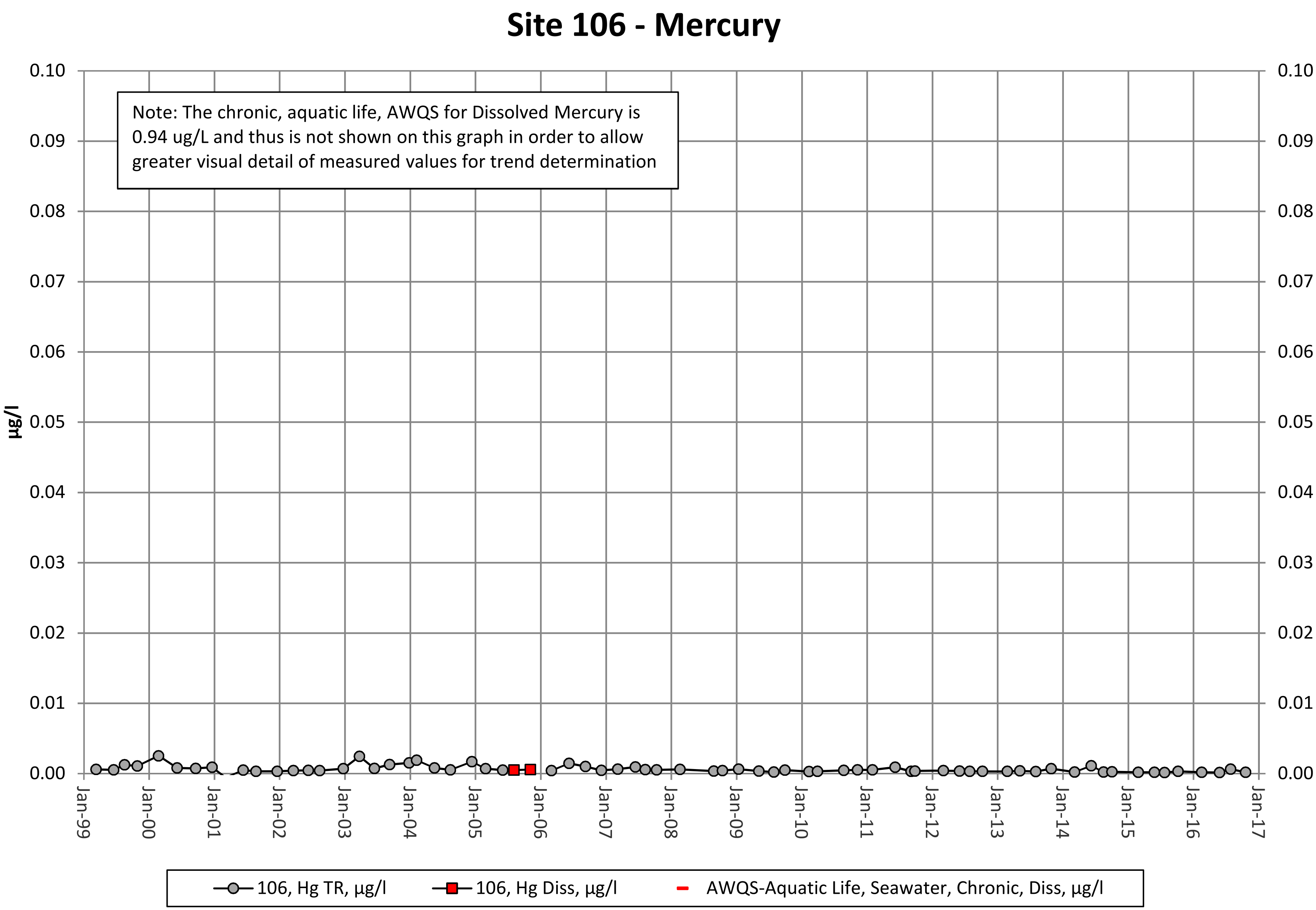
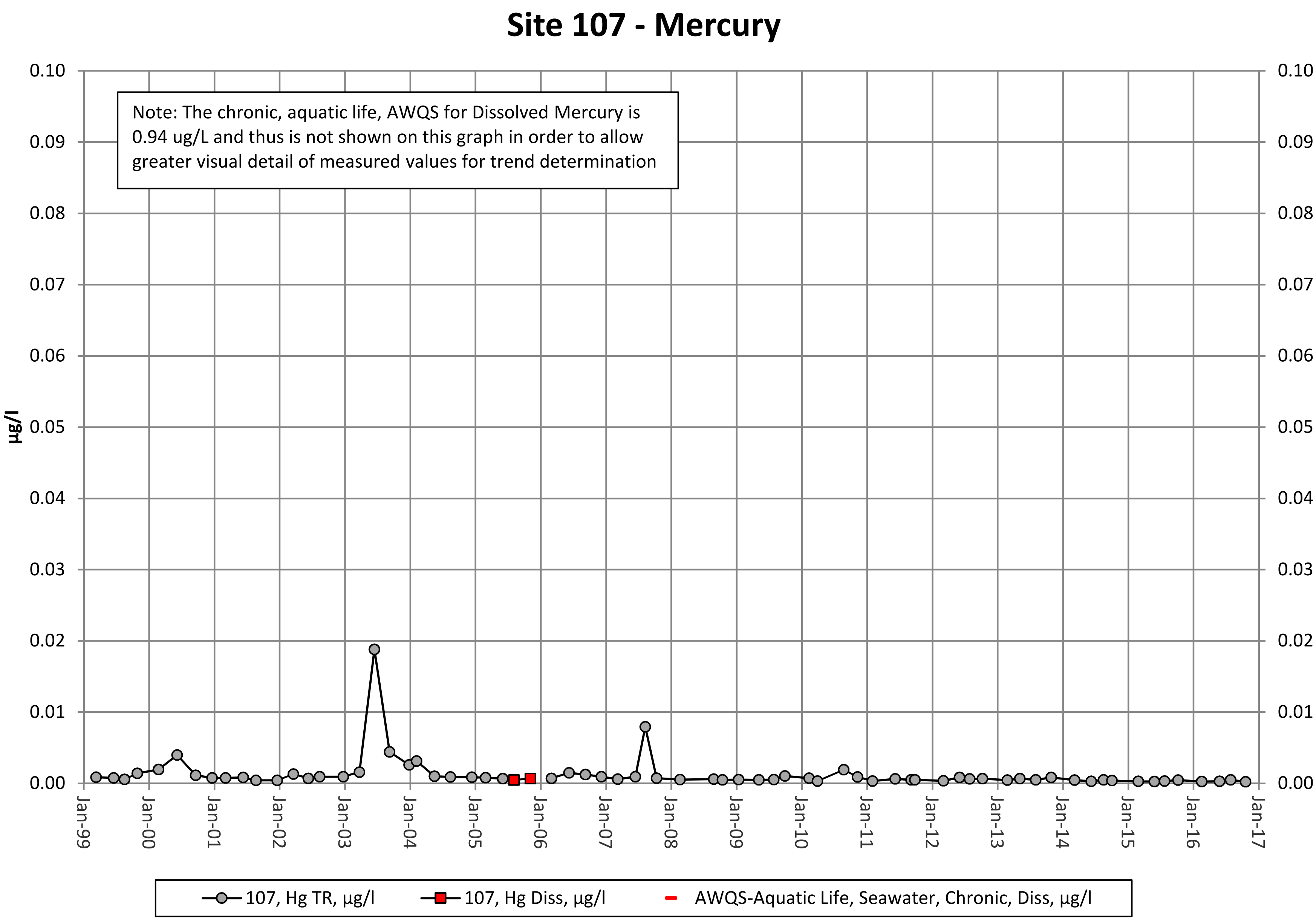
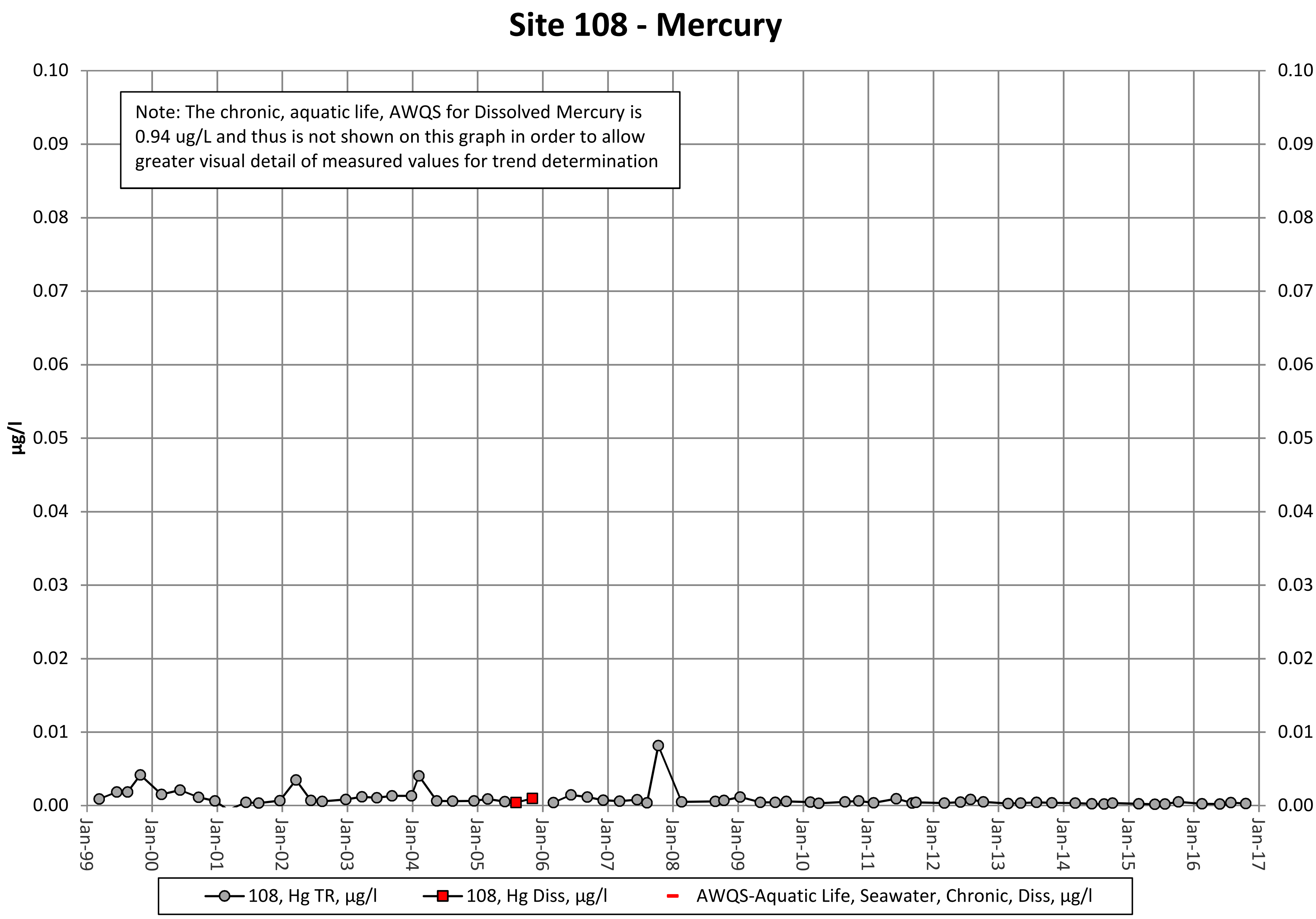

Site 106 - Mercury
Note: The chronic, aquatic life, AWQS for Dissolved Mercury is 0.94 ug/L and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Hg TR, µg/l
106, Hg Diss, µg/l
AWQS-Aquatic Life, Seawater, Chronic, Diss, µg/l

Figure 2-5b



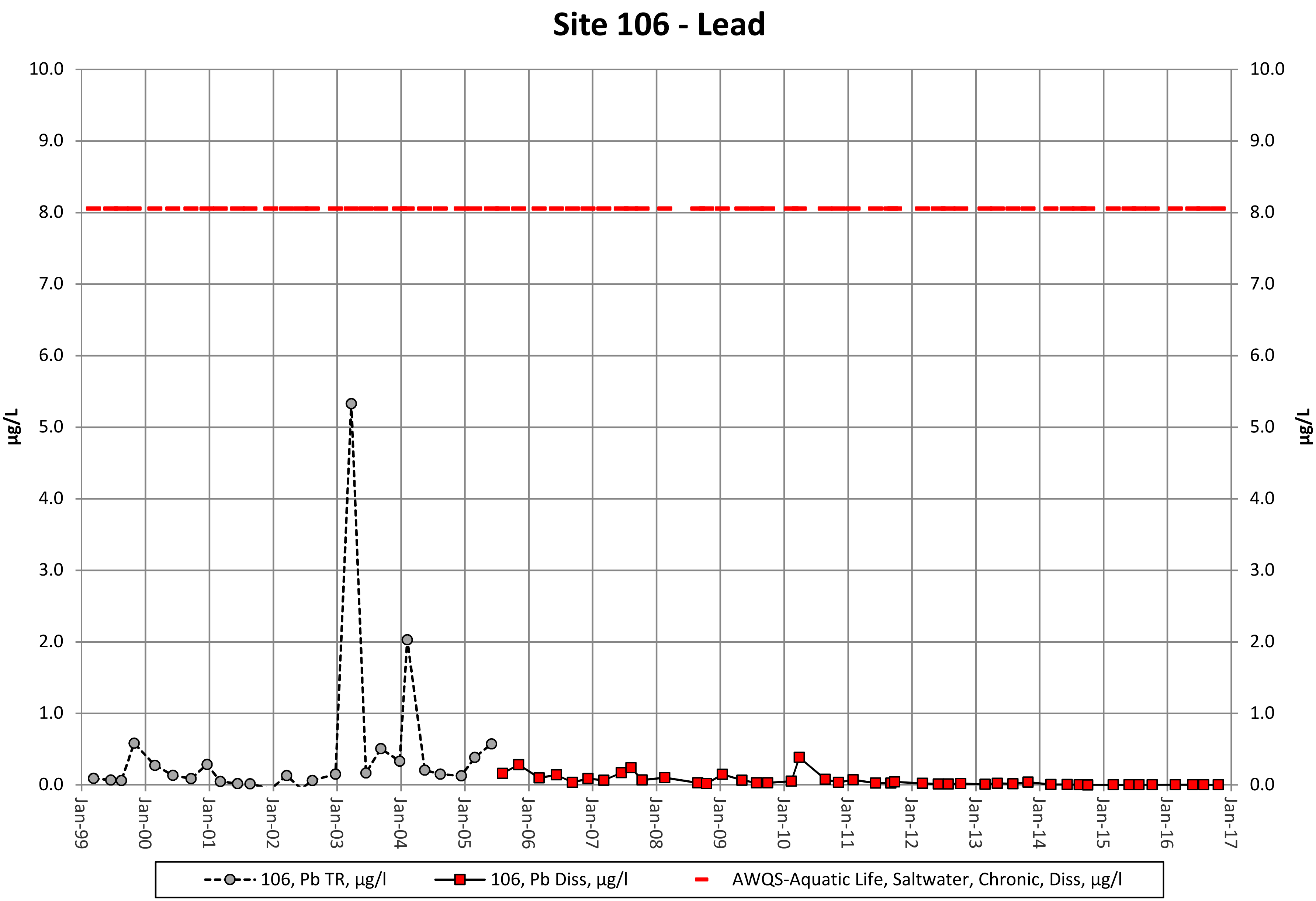
Site 107 - Mercury
Note: The chronic, aquatic life, AWQS for Dissolved Mercury is 0.94 ug/L and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Hg TR, µg/l
107, Hg Diss, µg/l
AWQS-Aquatic Life, Seawater, Chronic, Diss, µg/l

Figure 2-5c



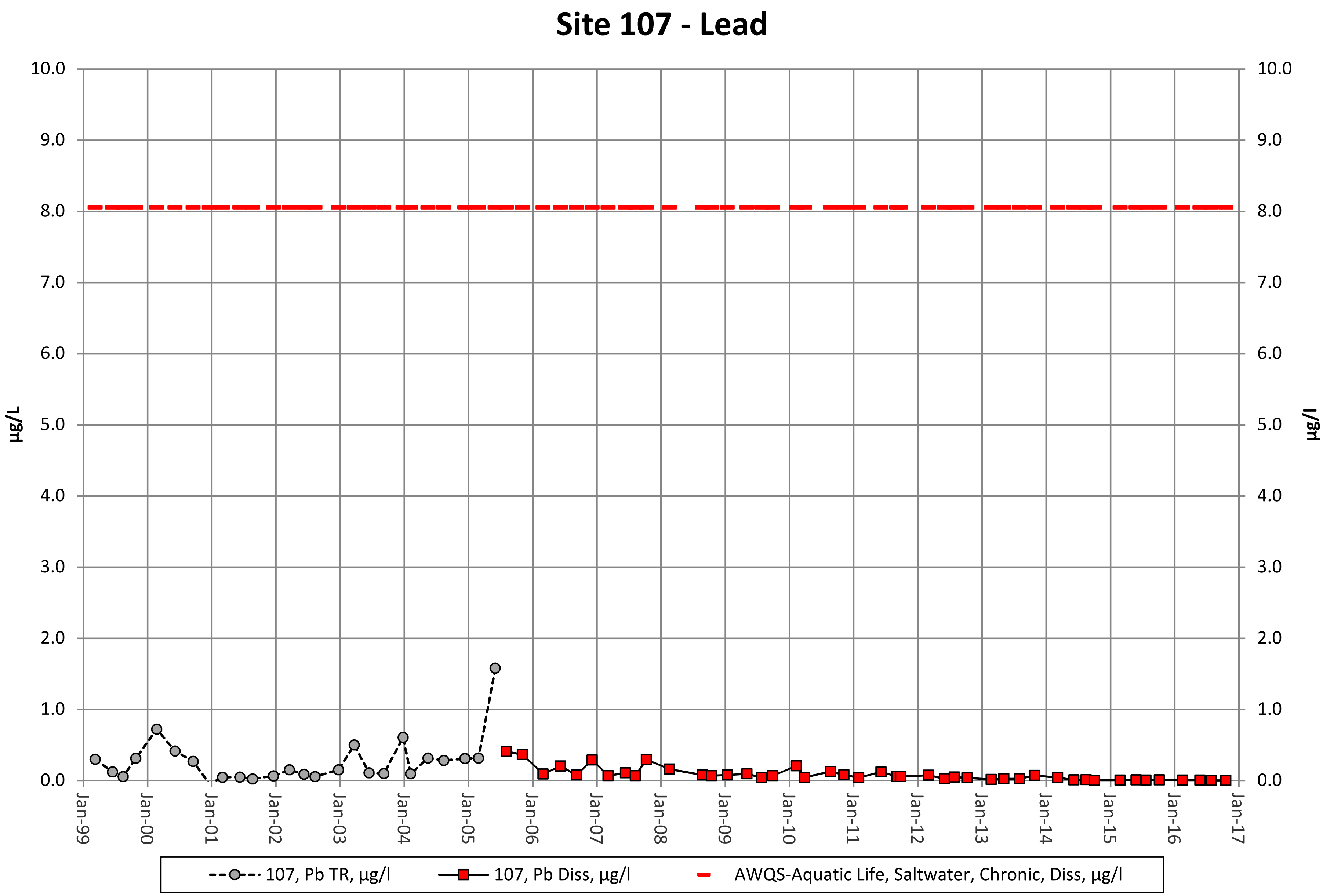
Site 108 - Mercury
Note: The chronic, aquatic life, AWQS for Dissolved Mercury is 0.94 ug/L and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Hg TR, µg/l
108, Hg Diss, µg/l
AWQS-Aquatic Life, Seawater, Chronic, Diss, µg/l

Figure 2-6a



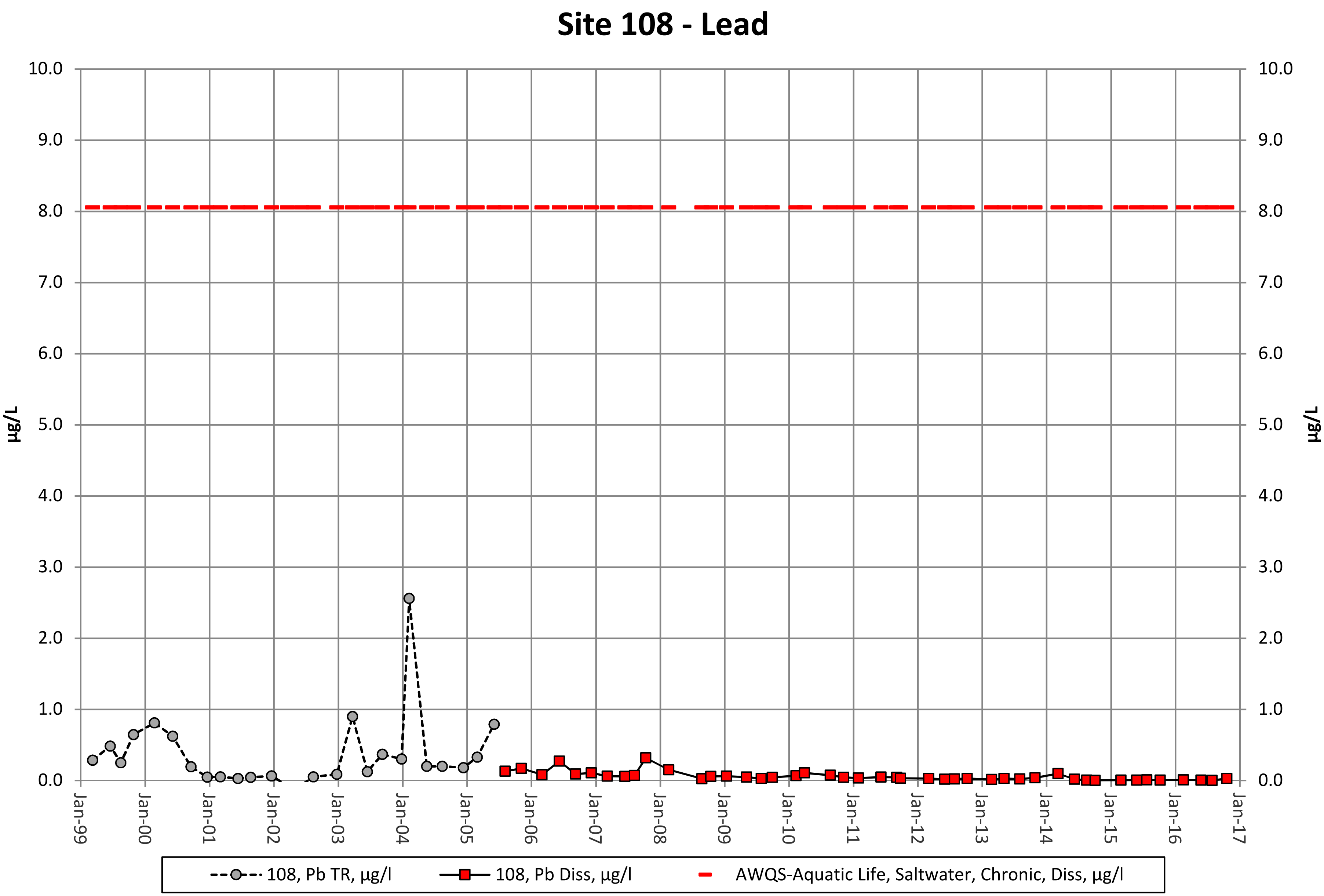
Site 106 - Lead
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
µg/L
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Pb TR, µg/l
106, Pb Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-6b



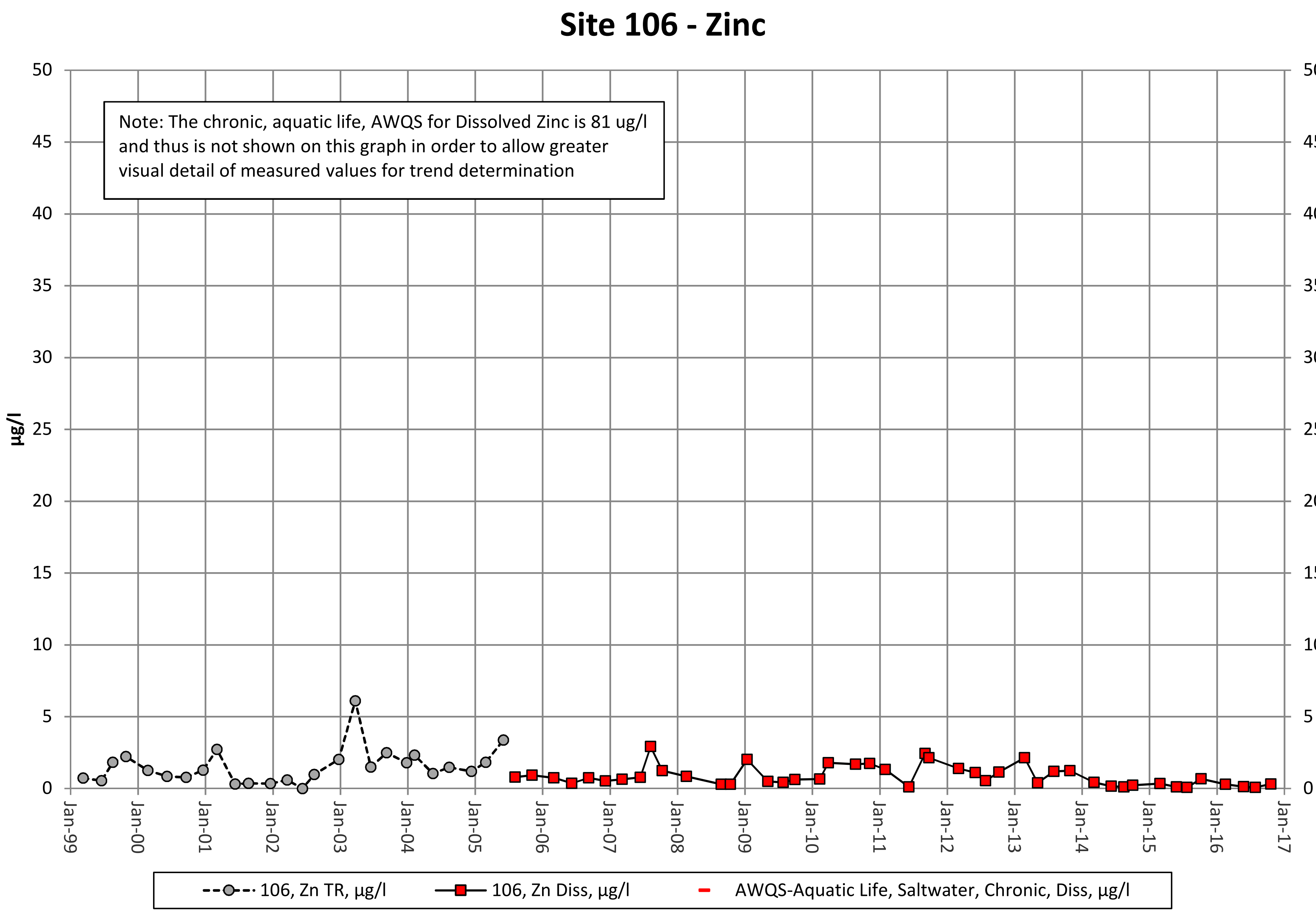
Site 107 - Lead
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
µg/L
µg/l
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Pb TR, µg/l
107, Pb Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-6c



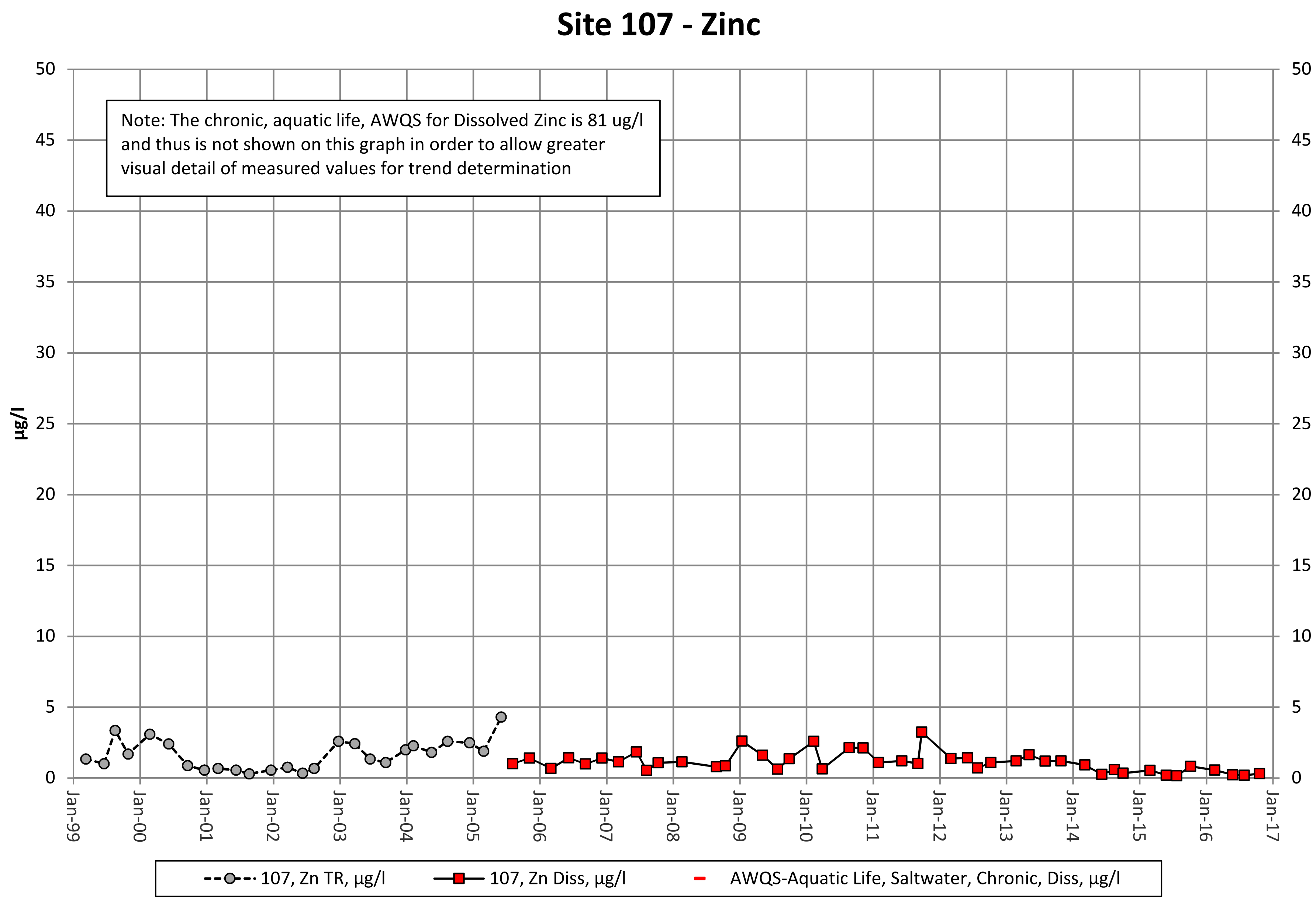
Site 108 - Lead
µg/L
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Pb TR, µg/l
108, Pb Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-7a



Site 106 - Zinc
Note: The chronic, aquatic life, AWQS for Dissolved Zinc is 81 ug/l and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
50
45
40
35
30
25
20
15
10
5
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
106, Zn TR, µg/l
106, Zn Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-7b



Site 107 - Zinc
Note: The chronic, aquatic life, AWQS for Dissolved Zinc is 81 ug/l and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0
5
10
15
20
25
30
35
40
45
50
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
107, Zn TR, µg/l
107, Zn Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 2-7c

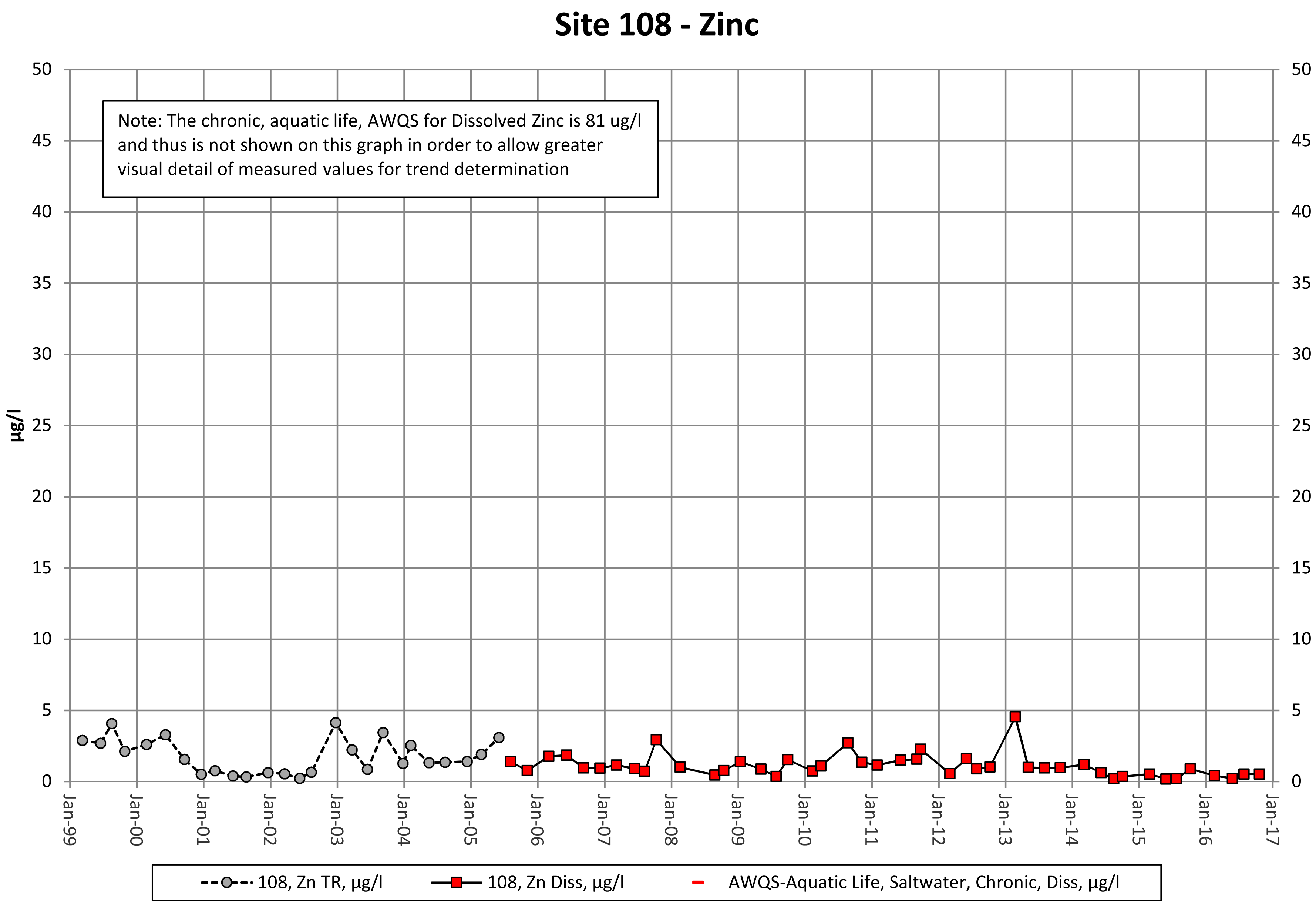
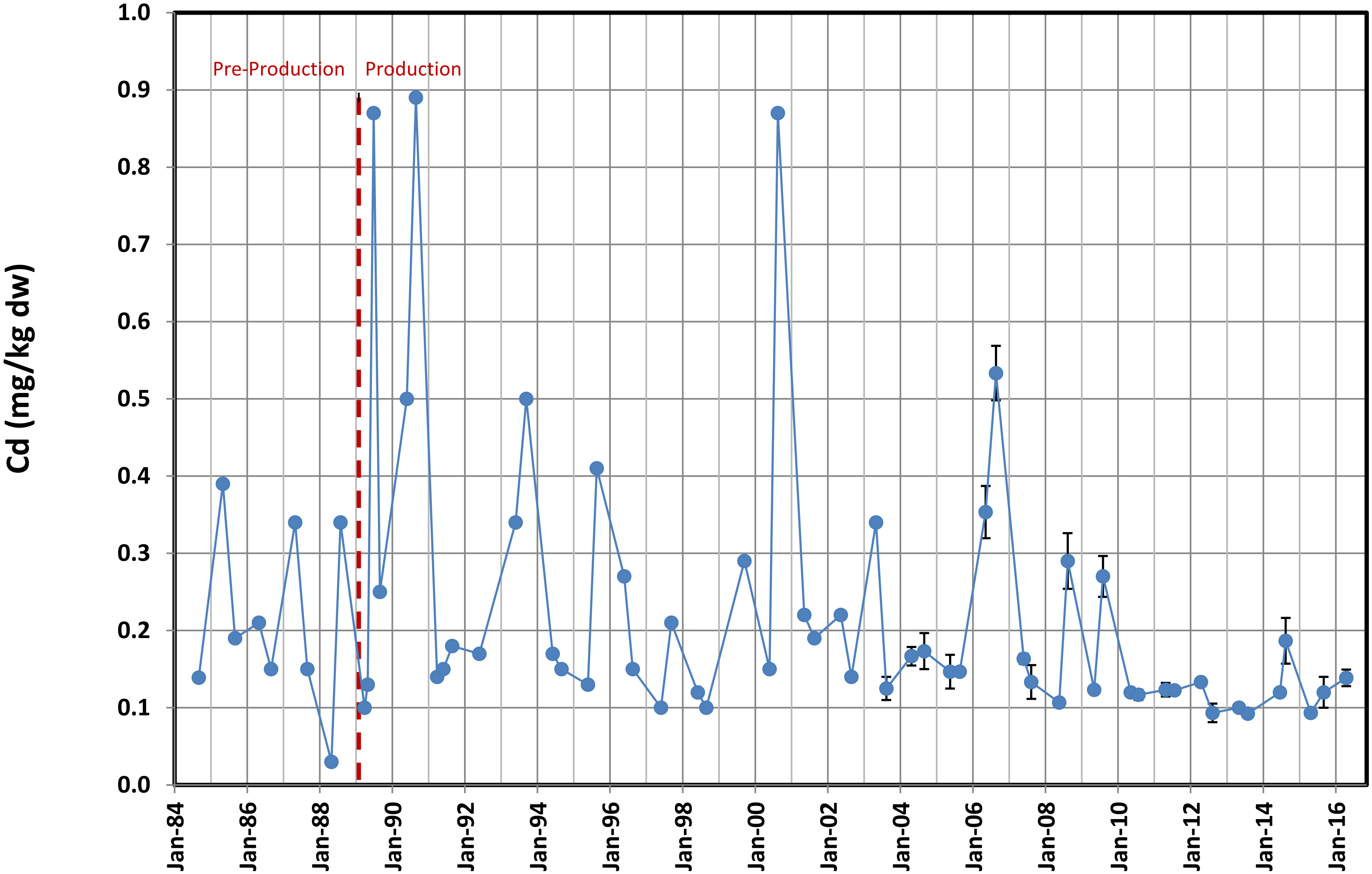

Site 108 - Zinc
Note: The chronic, aquatic life, AWQS for Dissolved Zinc is 81 ug/l and thus is not shown on this graph in order to allow greater visual detail of measured values for trend determination
µg/l
0
5
10
15
20
25
30
35
40
45
50
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
108, Zn TR, µg/l
108, Zn Diss, µg/l
AWQS-Aquatic Life, Saltwater, Chronic, Diss, µg/l

Figure 3-1. Cadmium in Sediments at Site S-1



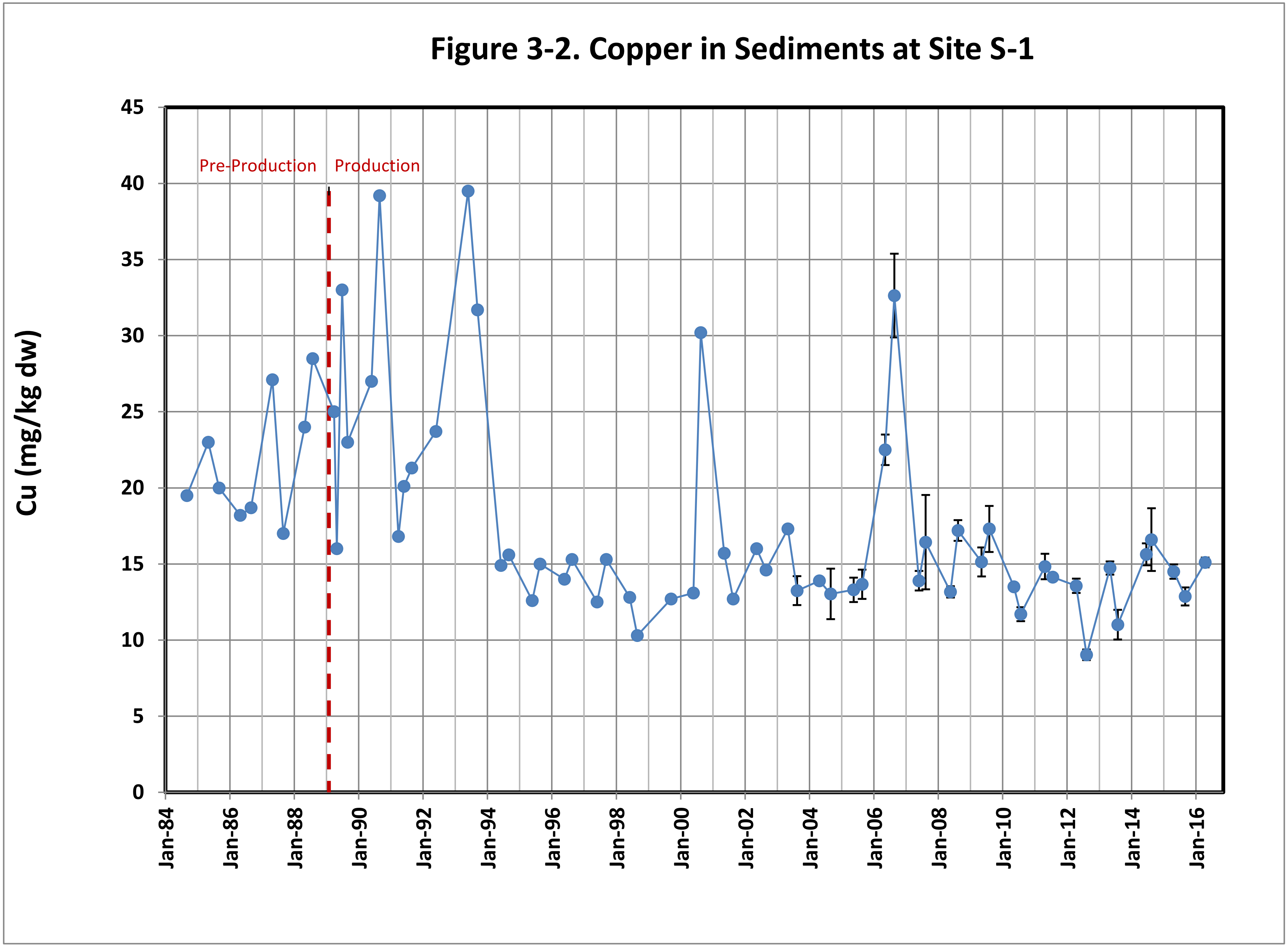


Figure 3-2. Copper in Sediments at Site S-1
Cu (mg/kg dw)
Pre-Production
Production
0
5
10
15
20
25
30
35
40
45
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

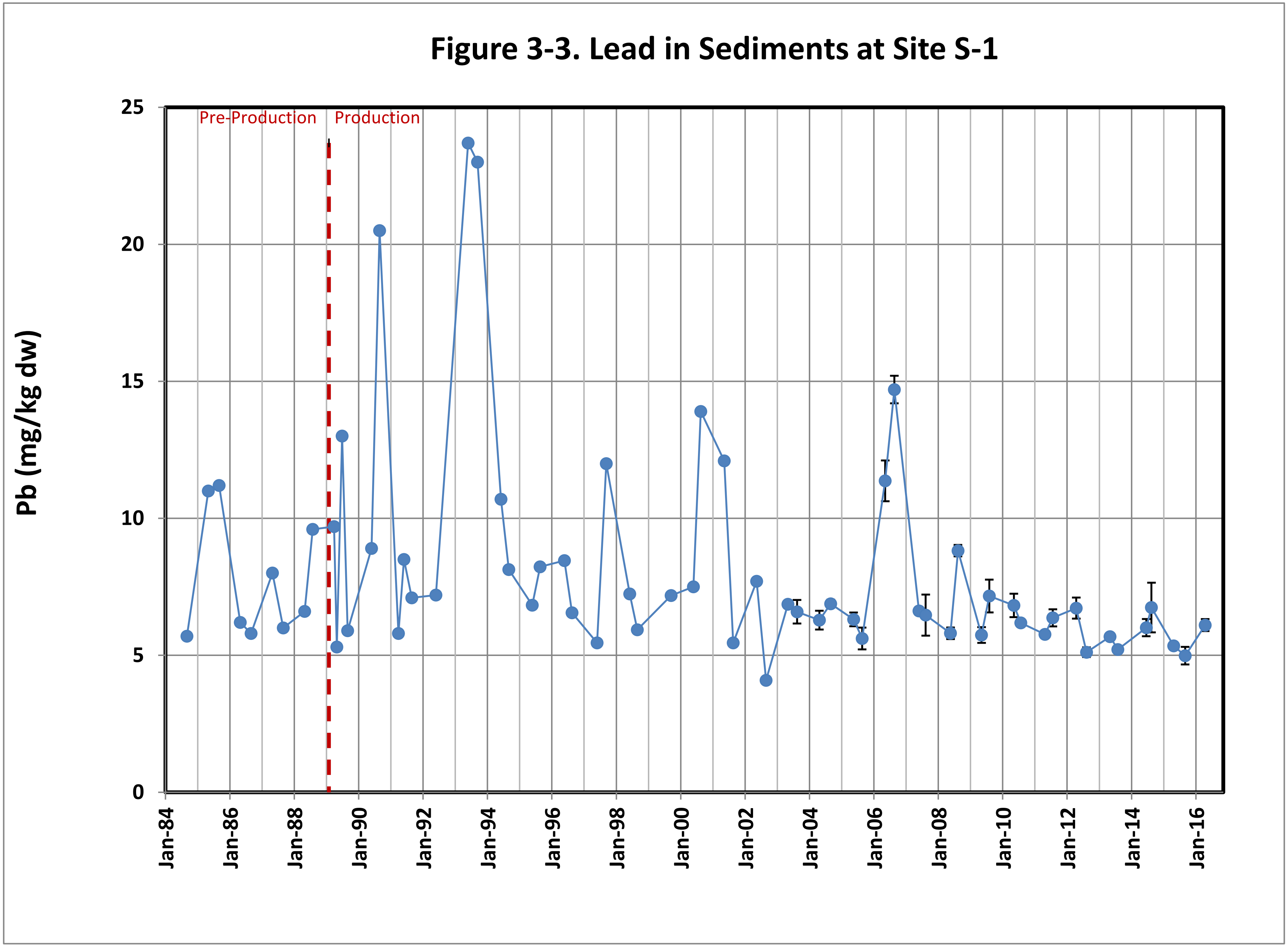
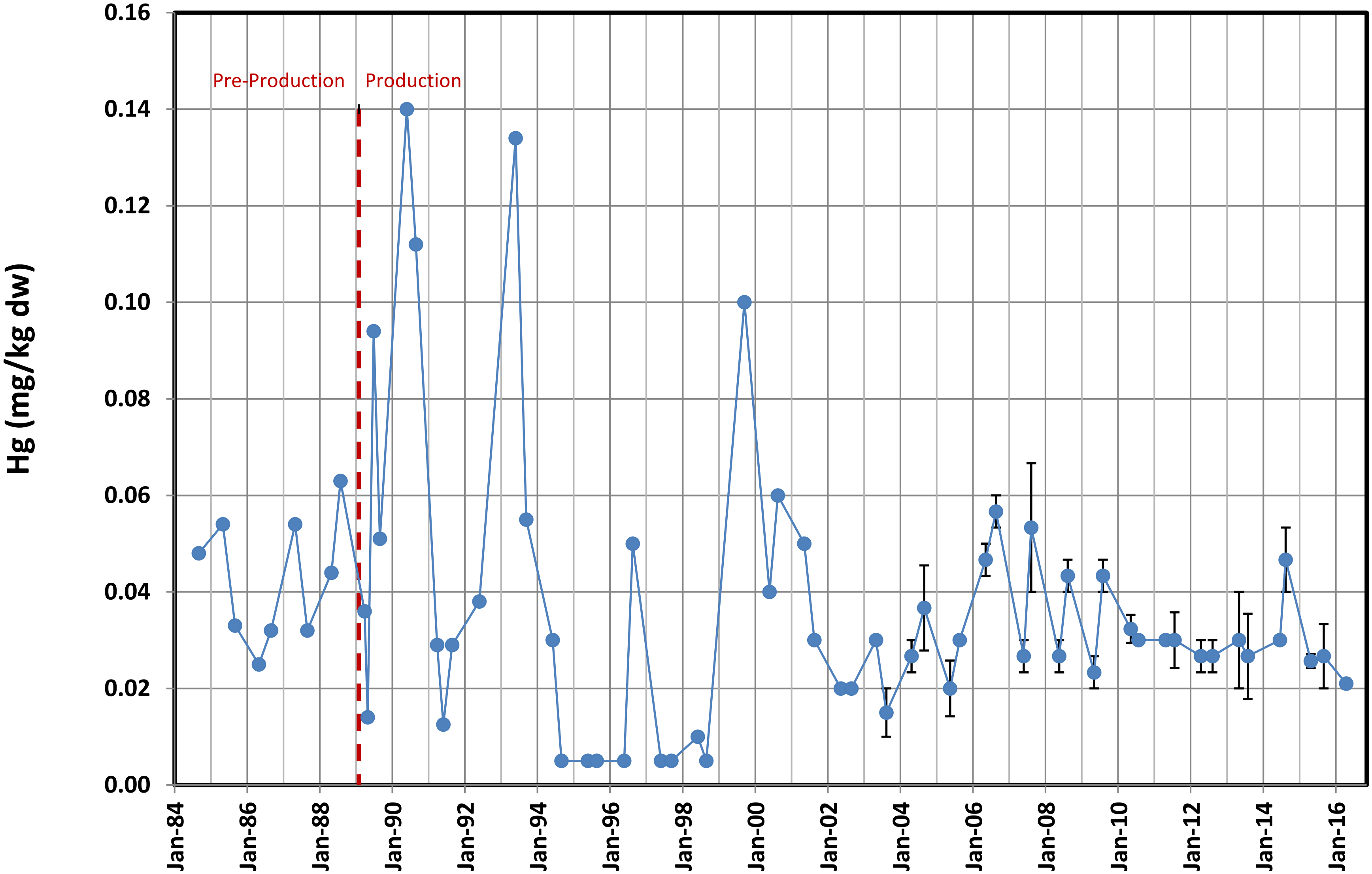


Figure 3-3. Lead in Sediments at Site S-1
Pb (mg/kg dw)
25
20
15
10
5
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-4. Mercury in Sediments at Site S-1



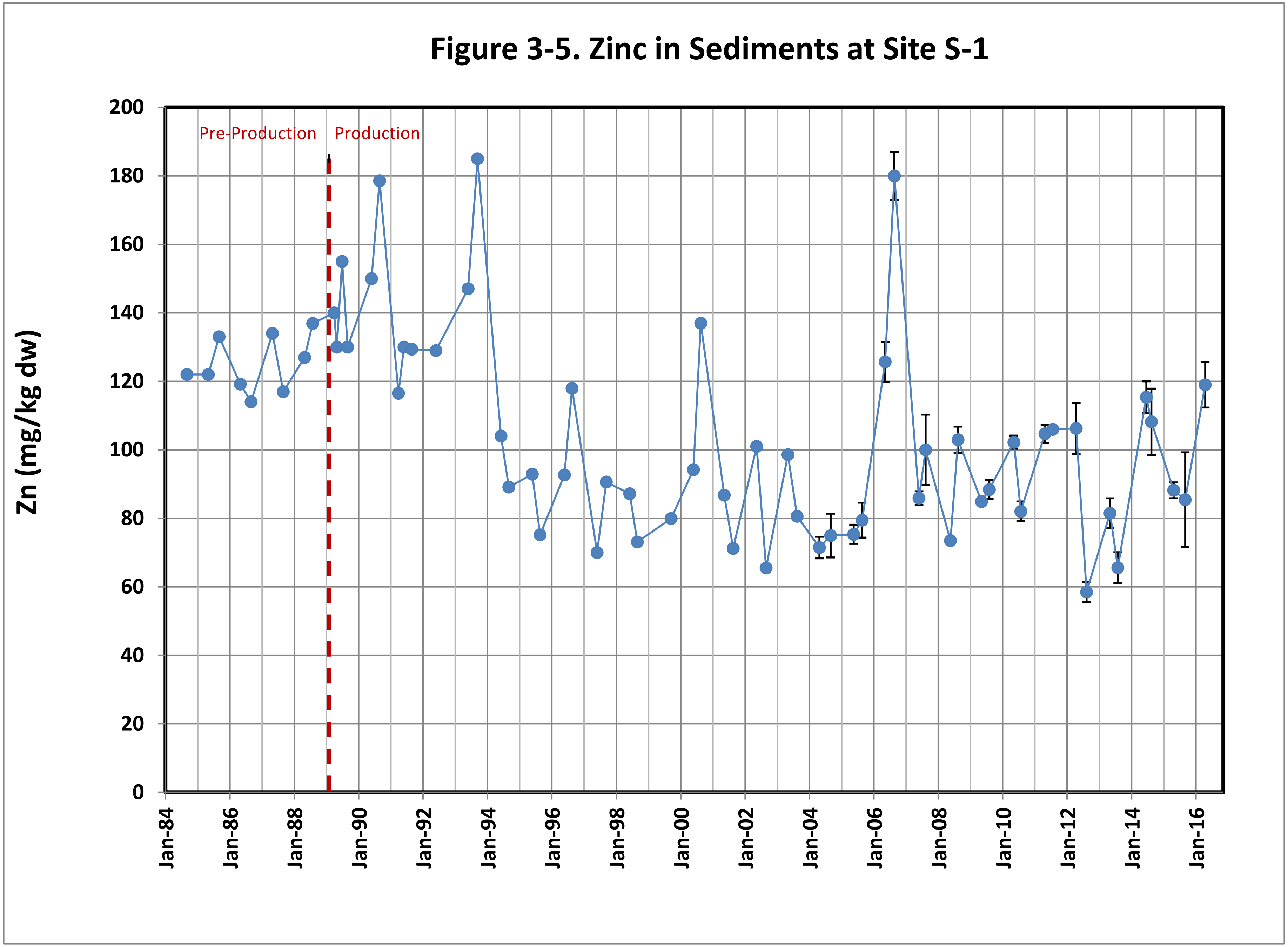
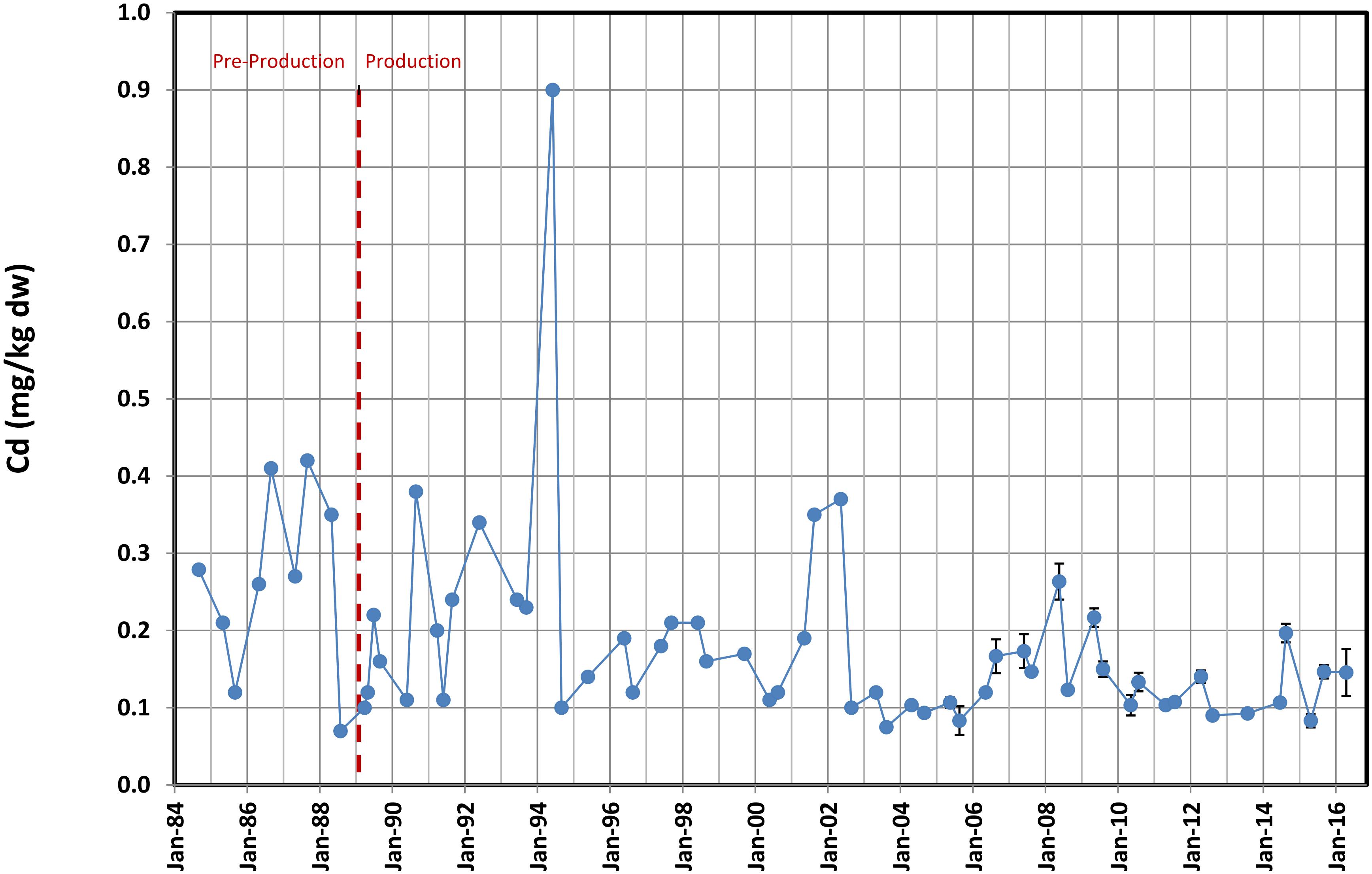


Figure 3-5. Zinc in Sediments at Site S-1
Pre-Production
Production
Zn (mg/kg dw)
200
180
160
140
120
100
80
60
40
20
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-6. Cadmium in Sediments at Site S-2



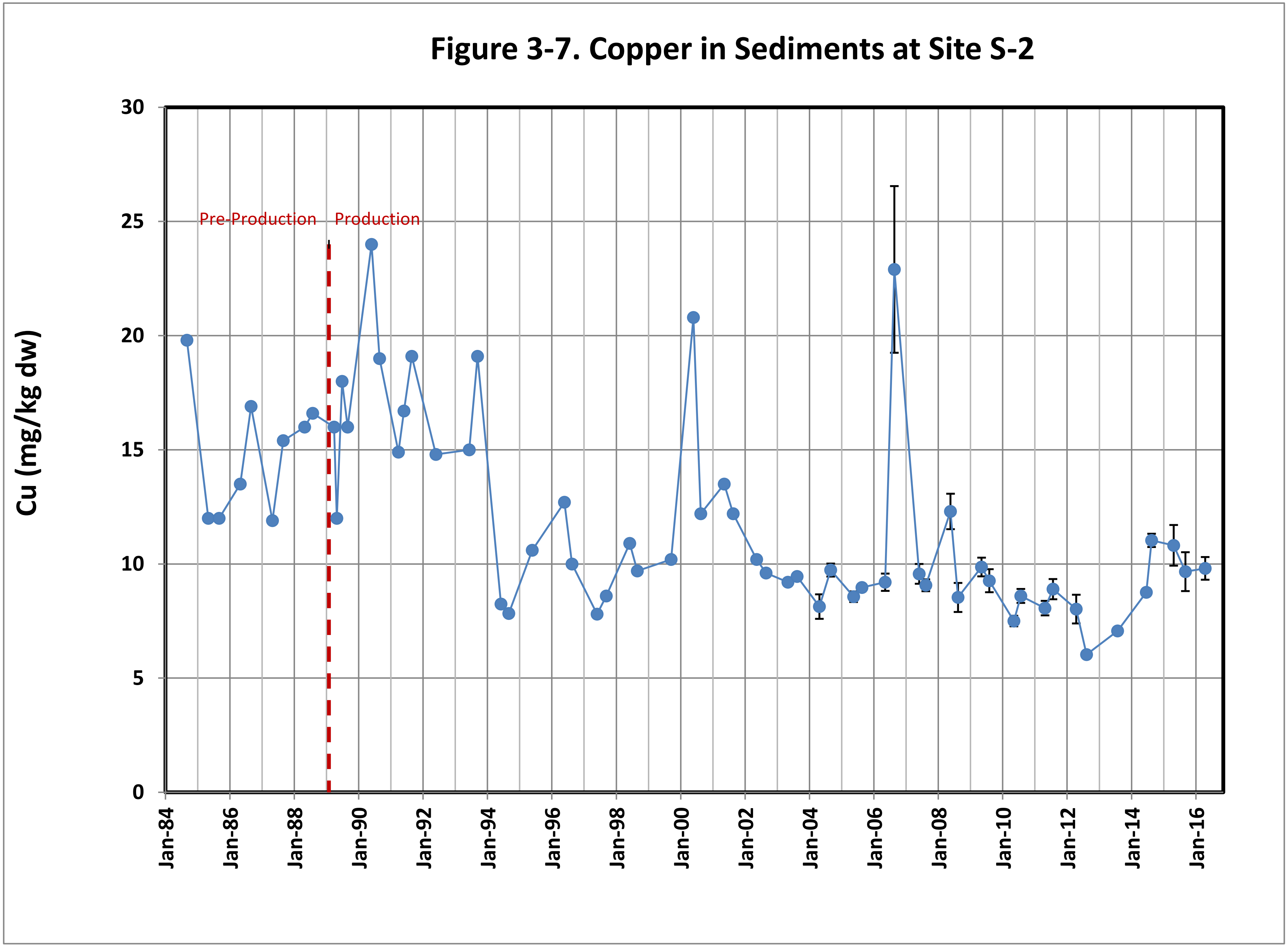
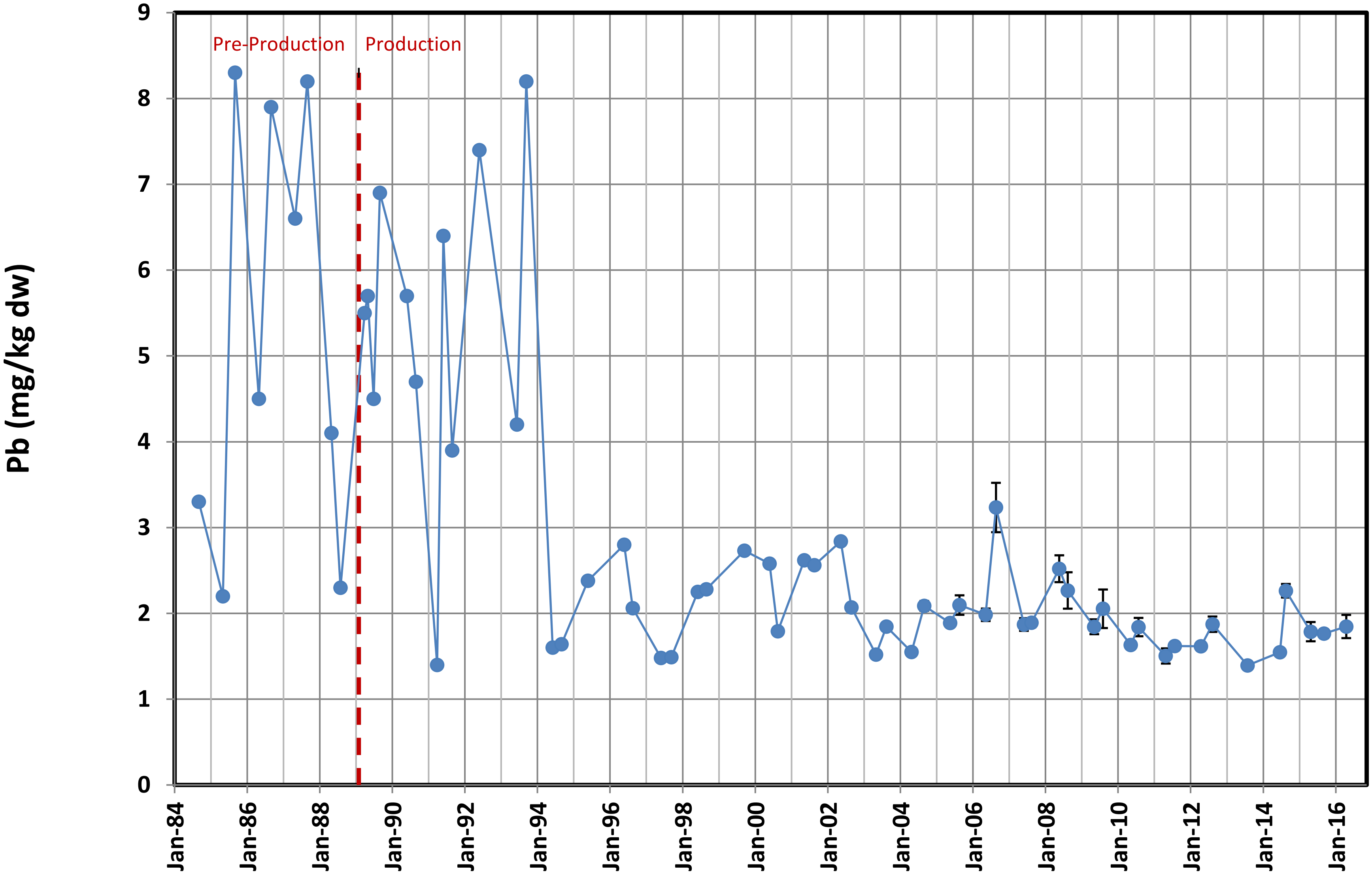


Figure 3-7. Copper in Sediments at Site S-2
Cu (mg/kg dw)
Pre-Production
Production
30
25
20
15
10
5
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-8. Lead in Sediments at Site S-2



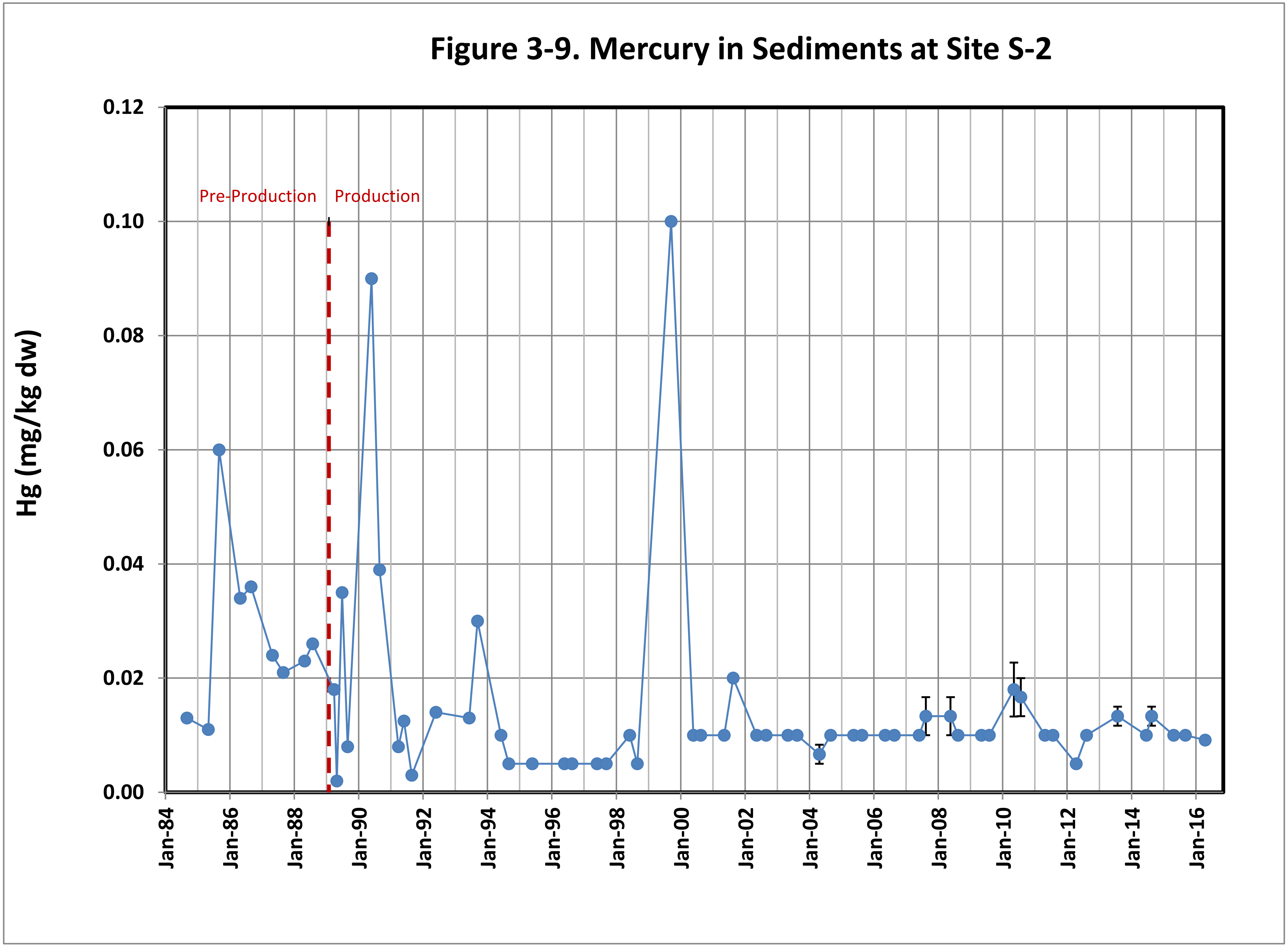


Figure 3-9. Mercury in Sediments at Site S-2
Hg (mg/kg dw)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

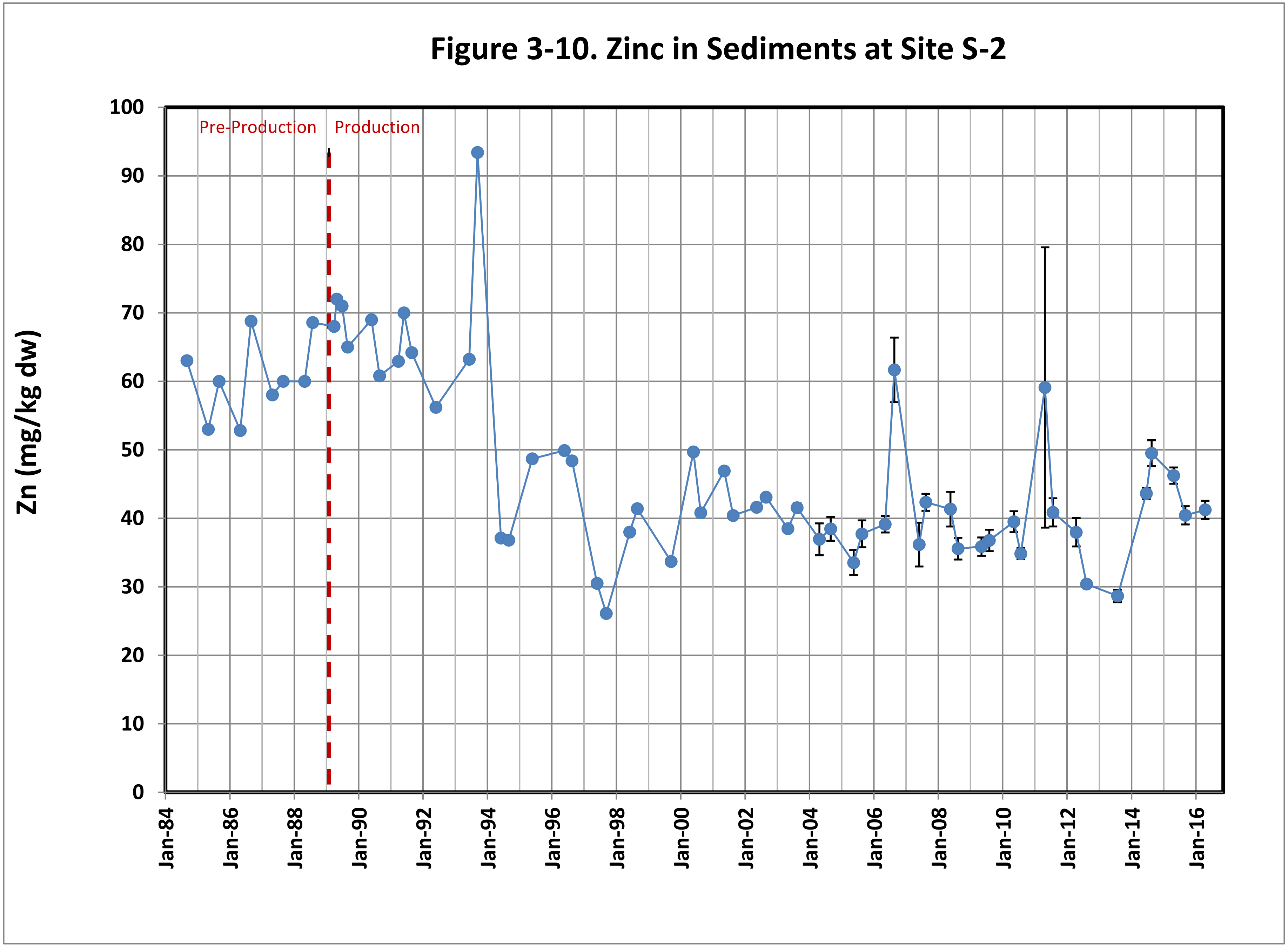


Figure 3-10. Zinc in Sediments at Site S-2
Zn (mg/kg dw)
Pre-Production
Production
100
90
80
70
60
50
40
30
20
10
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

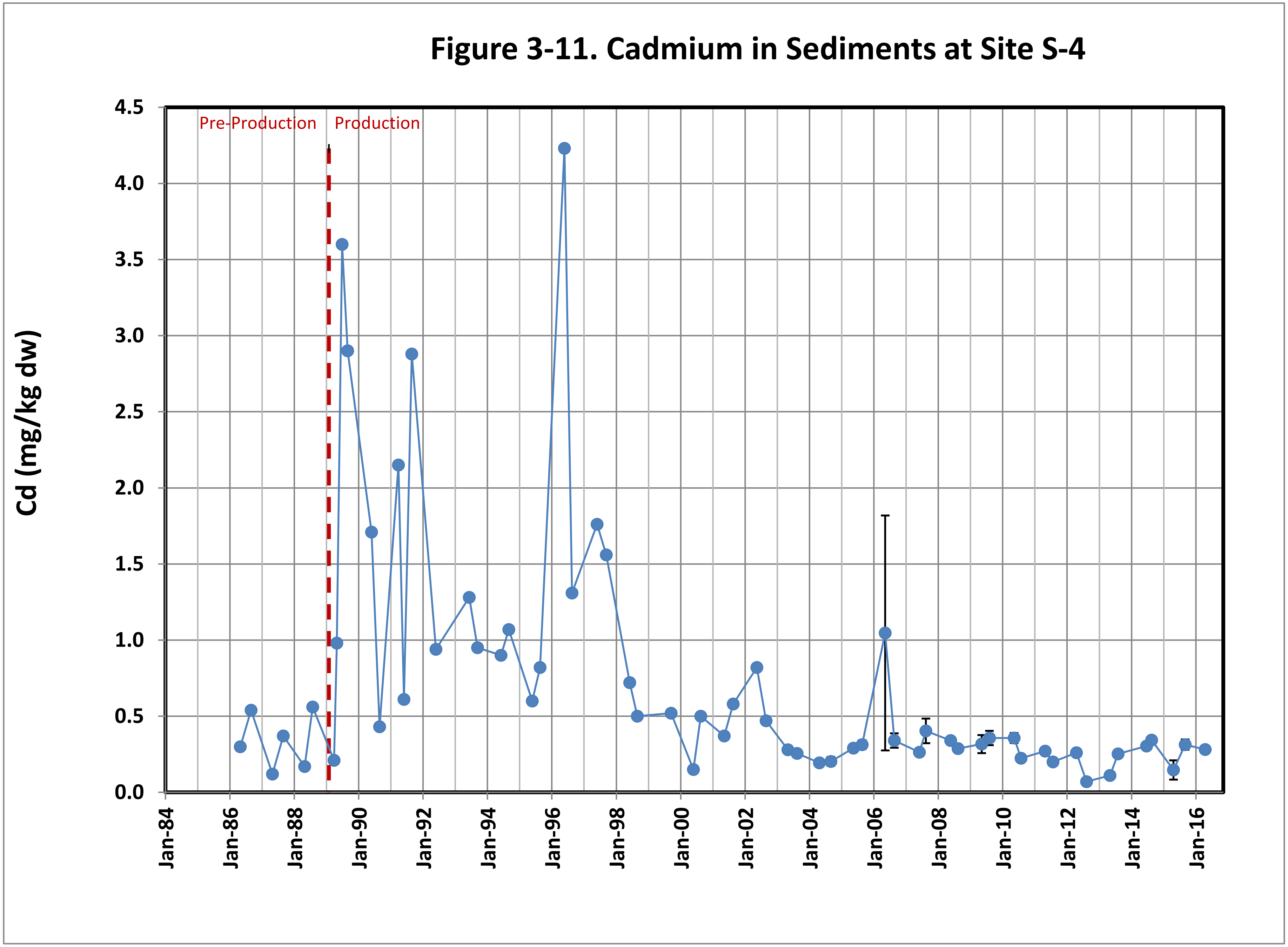


Figure 3-11. Cadmium in Sediments at Site S-4
Cd (mg/kg dw)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

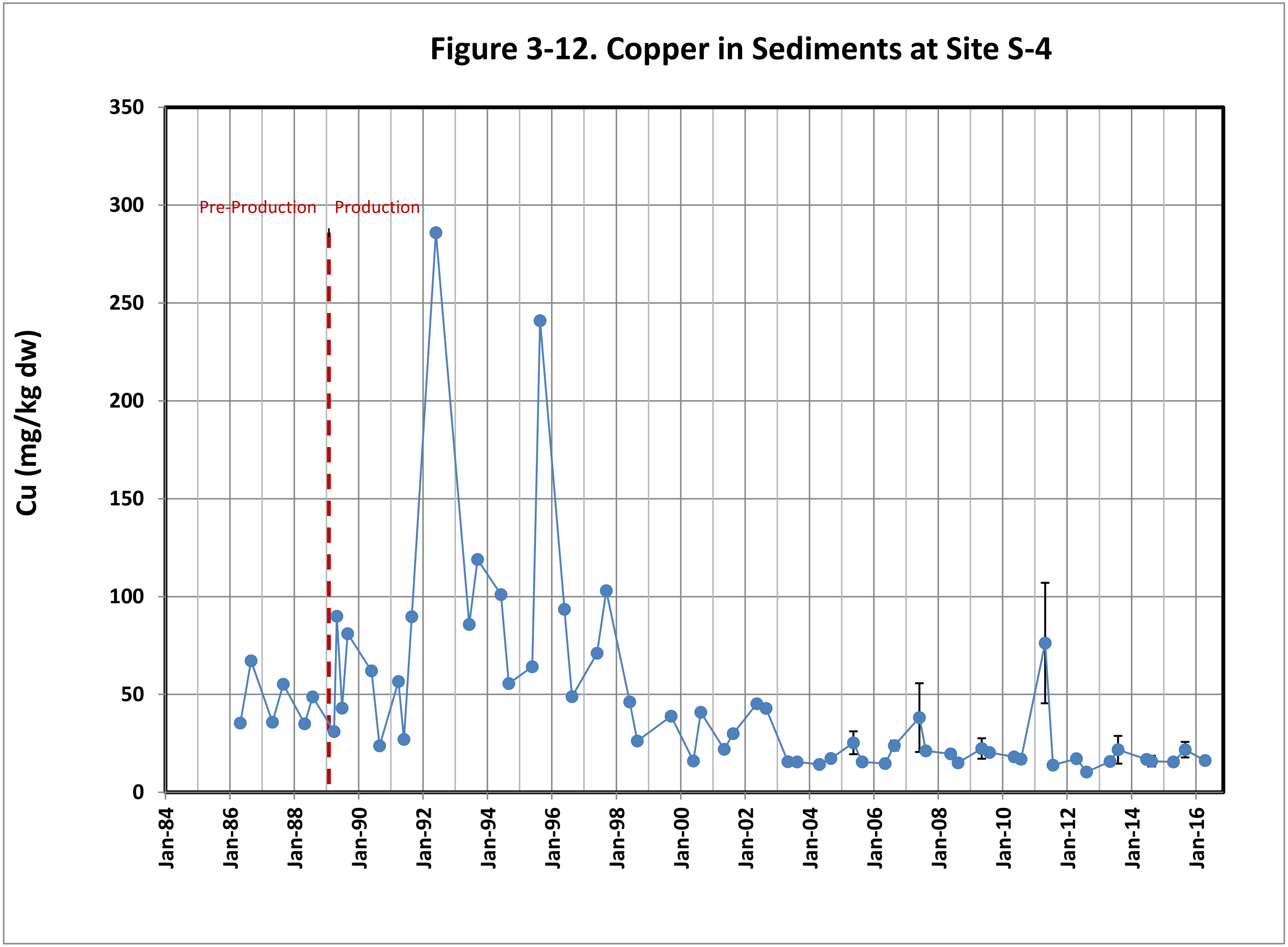


Figure 3-12. Copper in Sediments at Site S-4
Cu (mg/kg dw)
350
300
250
200
150
100
50
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

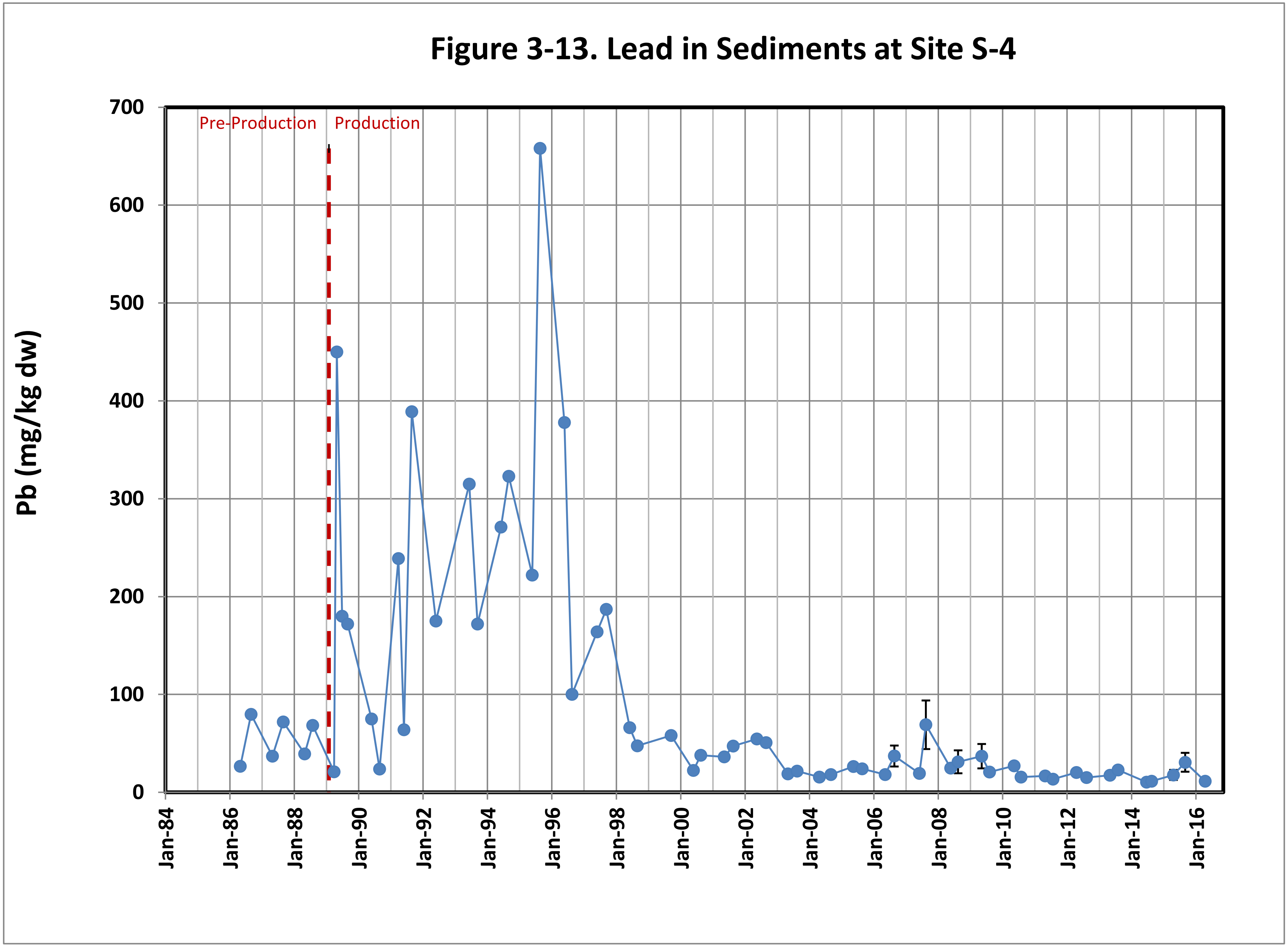


Figure 3-13. Lead in Sediments at Site S-4
Pre-Production
Production
Pb (mg/kg dw)
0
100
200
300
400
500
600
700
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

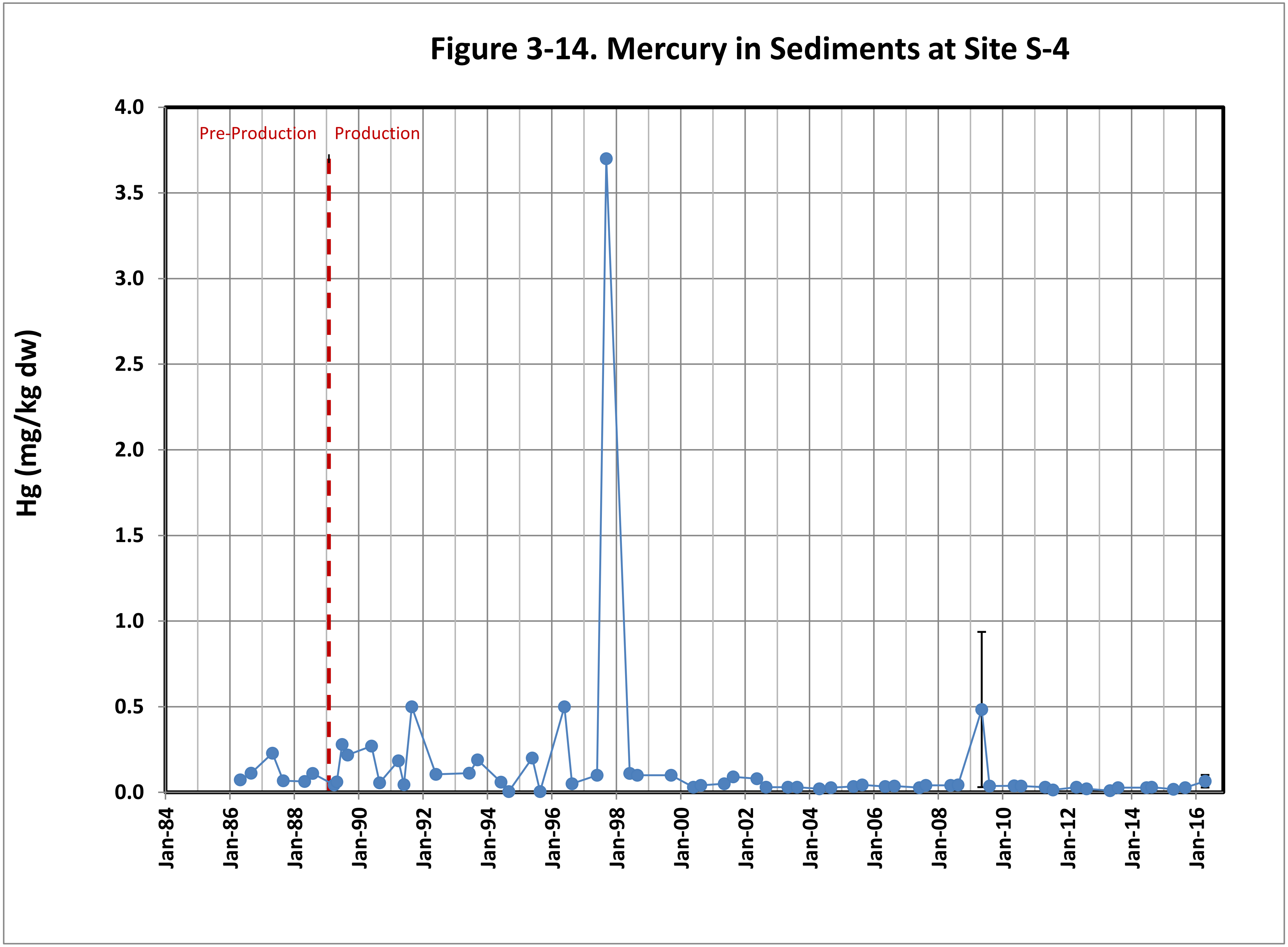


Figure 3-14. Mercury in Sediments at Site S-4
Hg (mg/kg dw)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

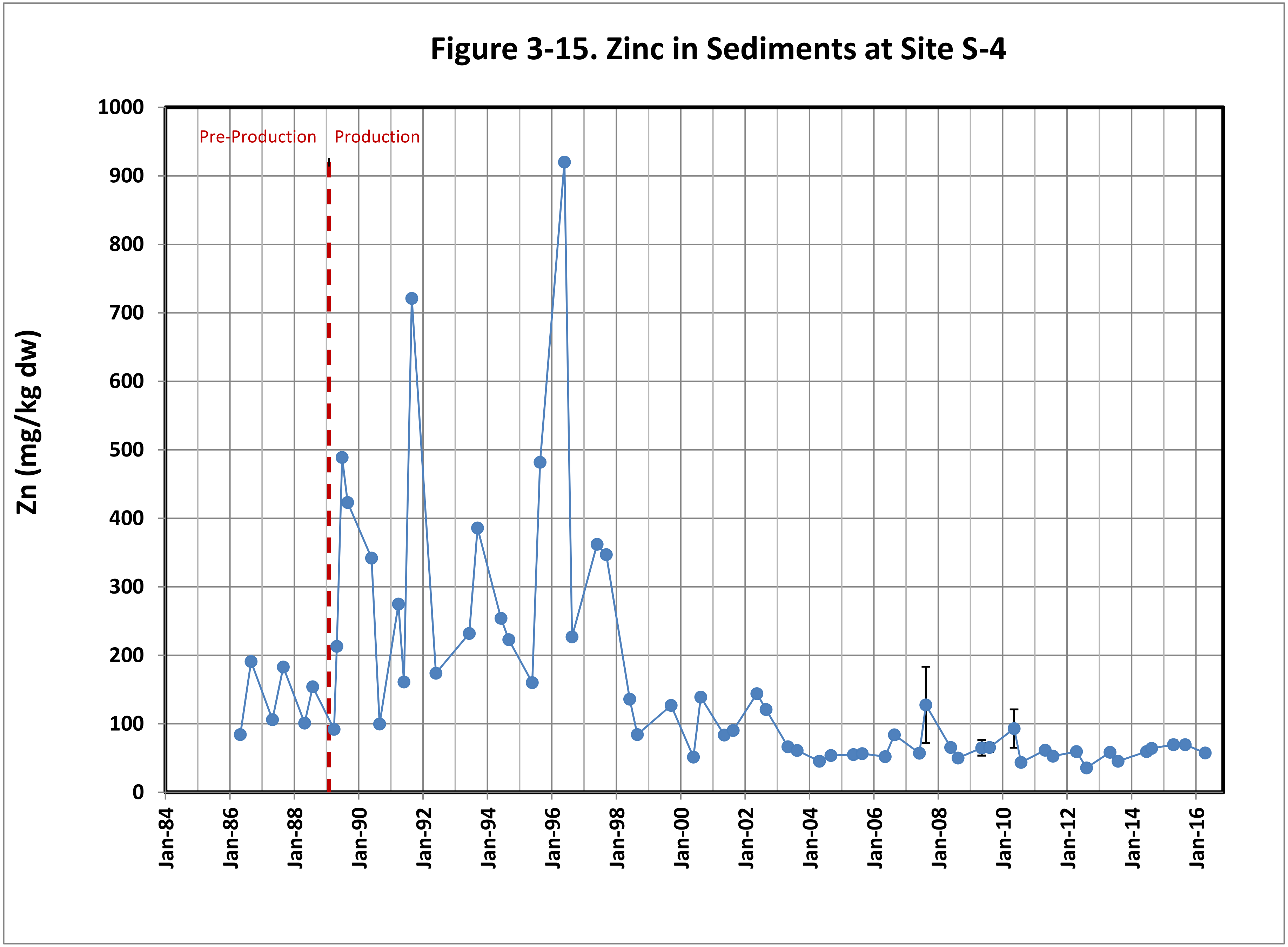


Figure 3-15. Zinc in Sediments at Site S-4
Zn (mg/kg dw)
1000
900
800
700
600
500
400
300
200
100
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

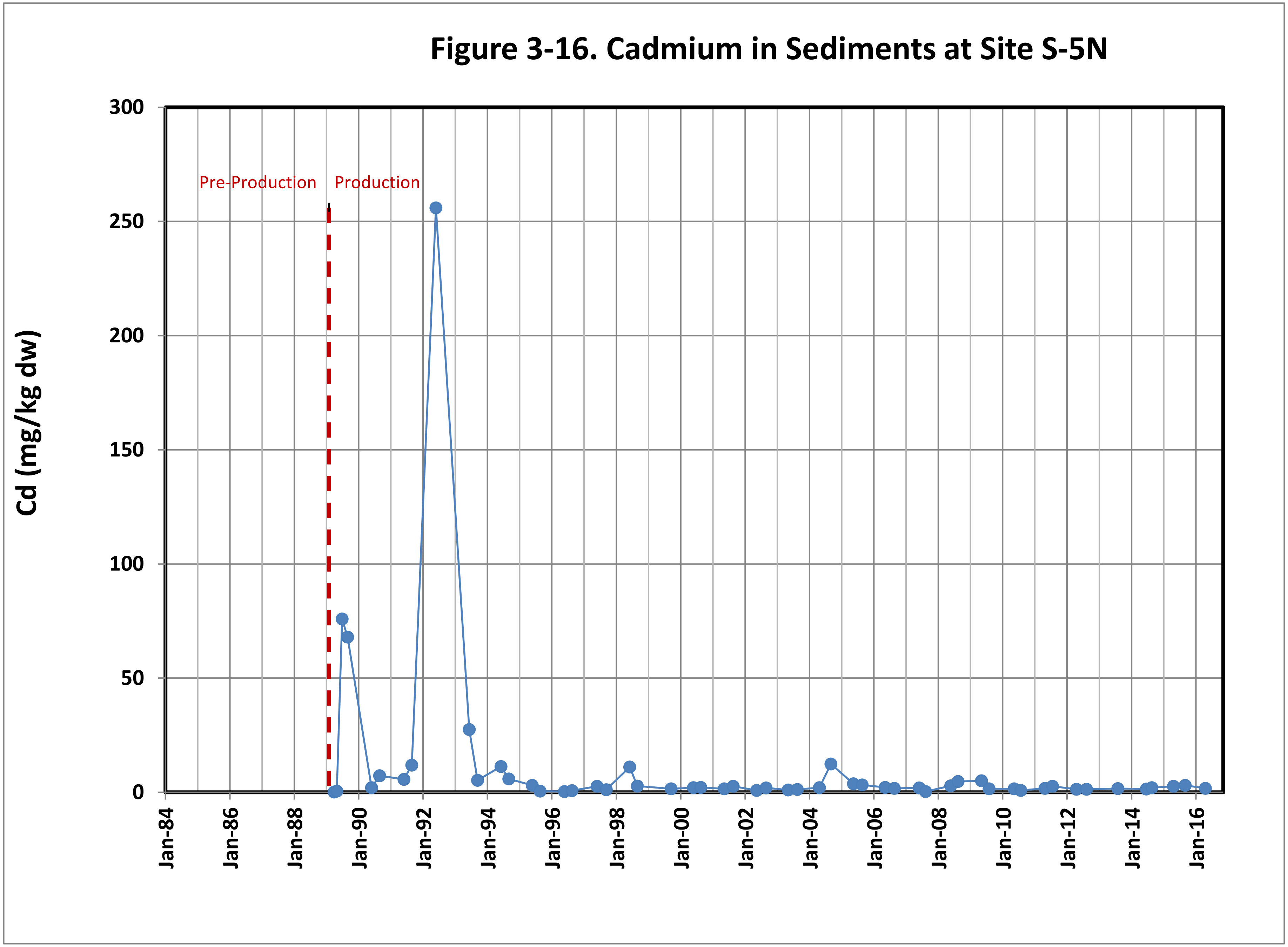
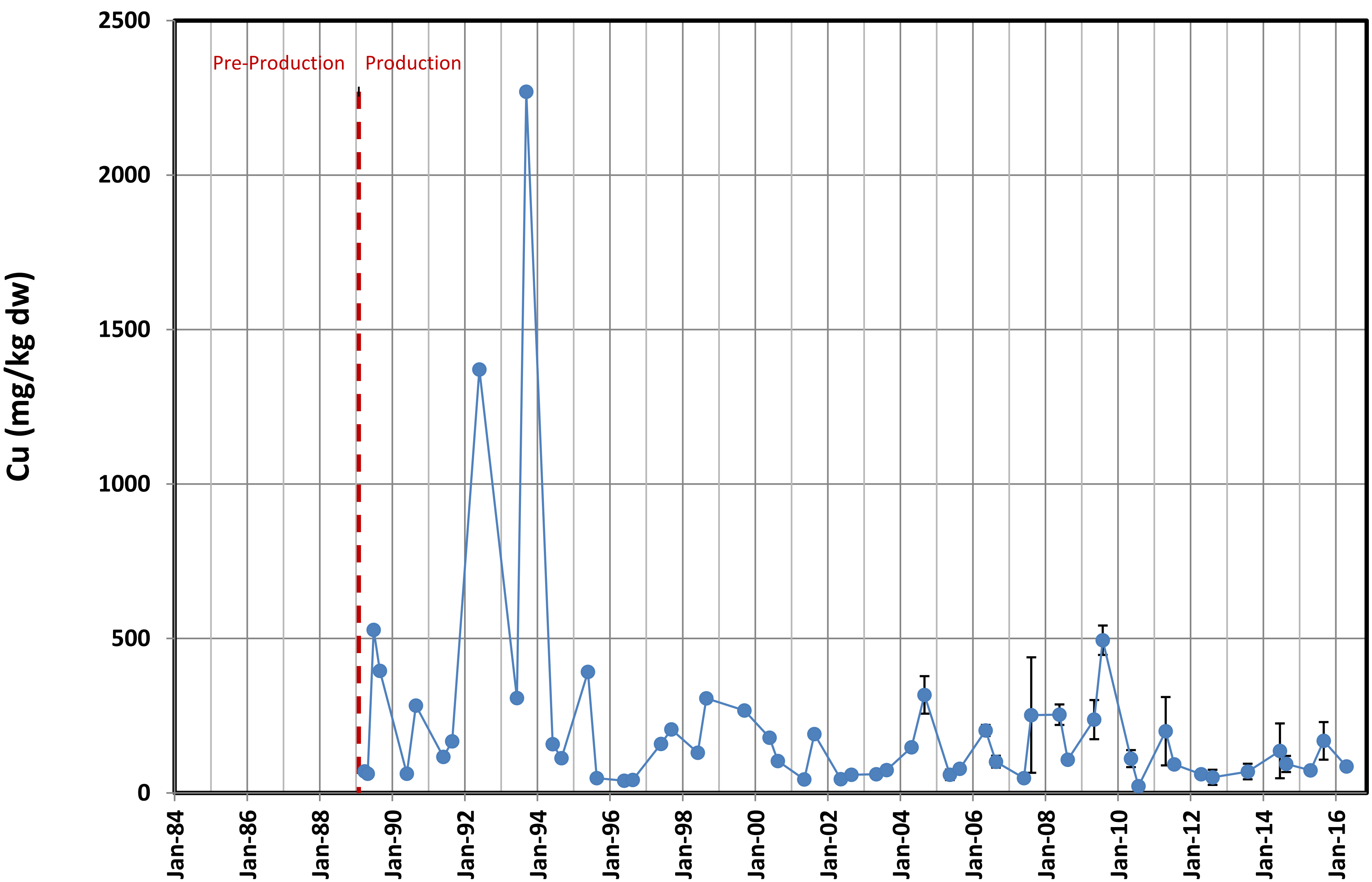


Figure 3-16. Cadmium in Sediments at Site S-5N
Cd (mg/kg dw)
300
250
200
150
100
50
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-17. Copper in Sediments at Site S-5N



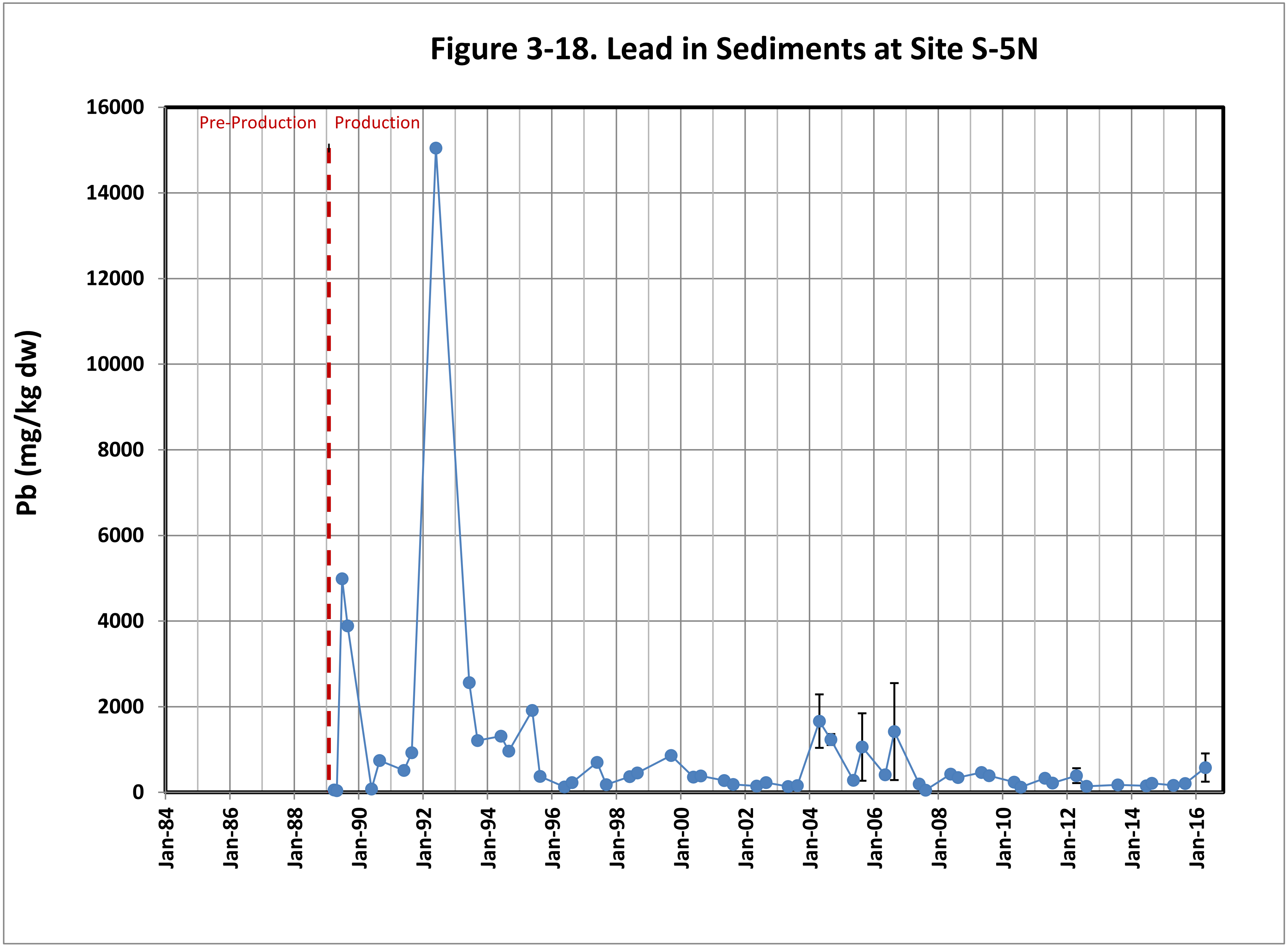
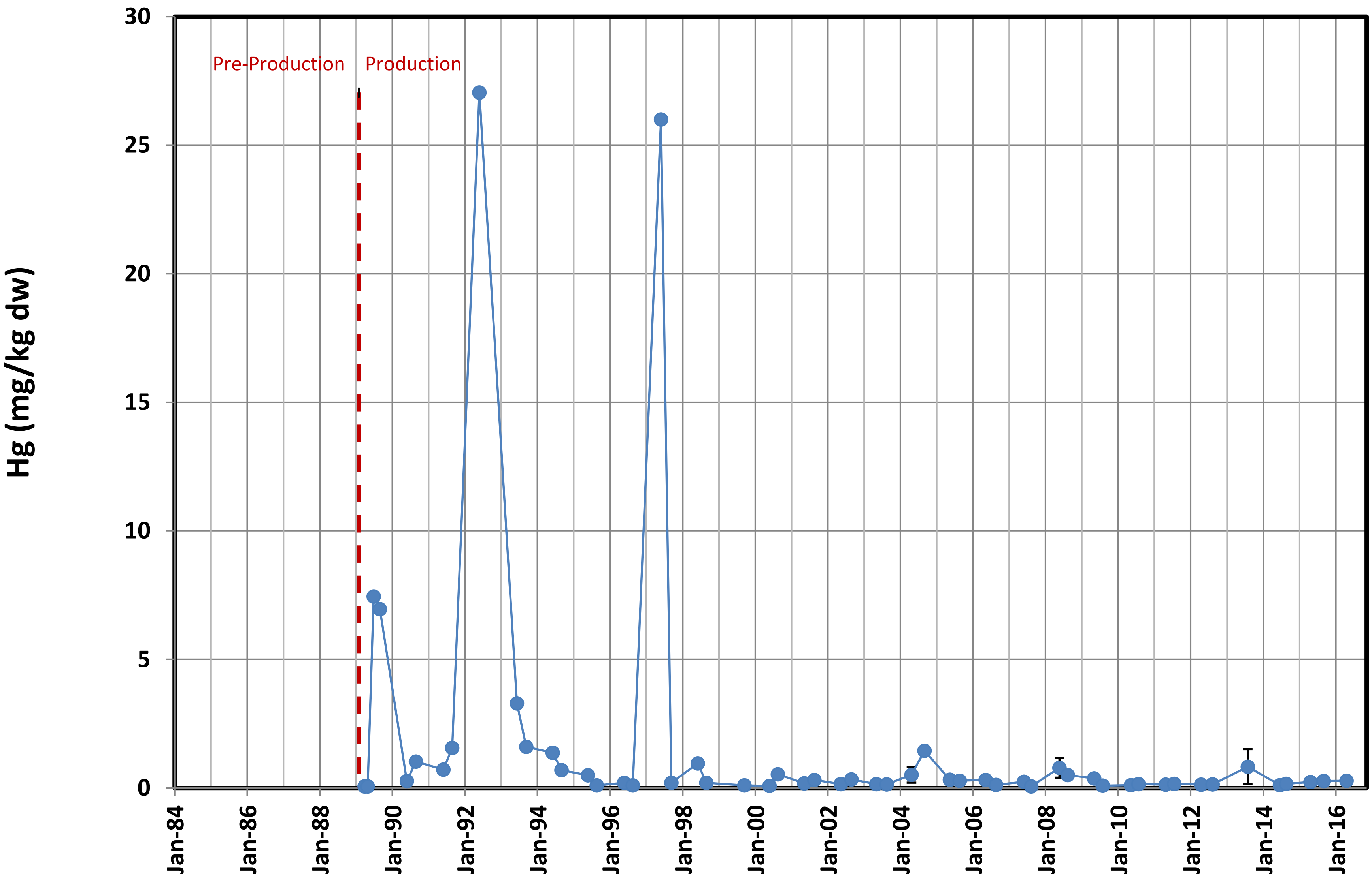


Figure 3-18. Lead in Sediments at Site S-5N
Pre-Production
Production
Pb (mg/kg dw)
16000
14000
12000
10000
8000
6000
4000
2000
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-19. Mercury in Sediments at Site S-5N



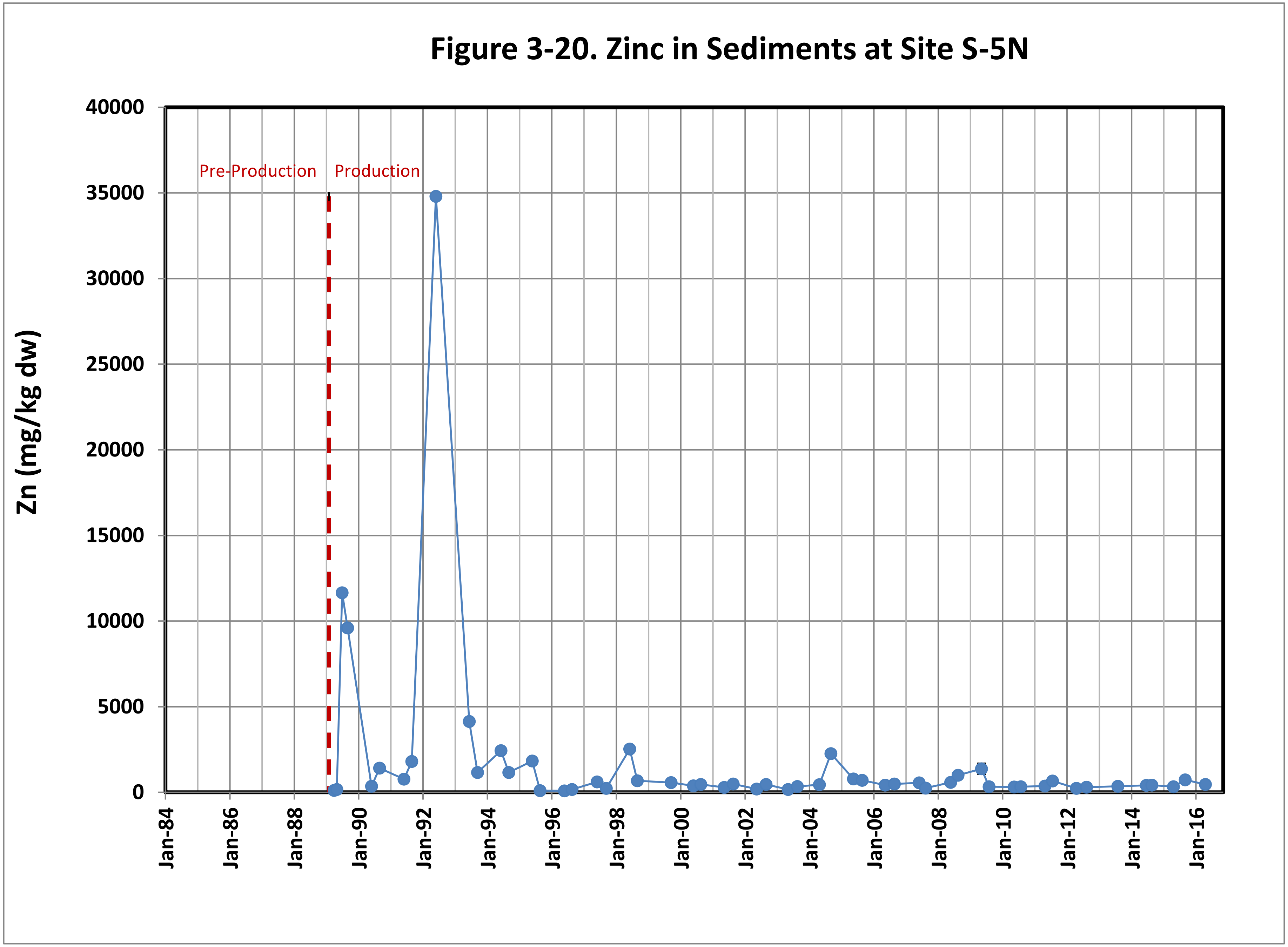
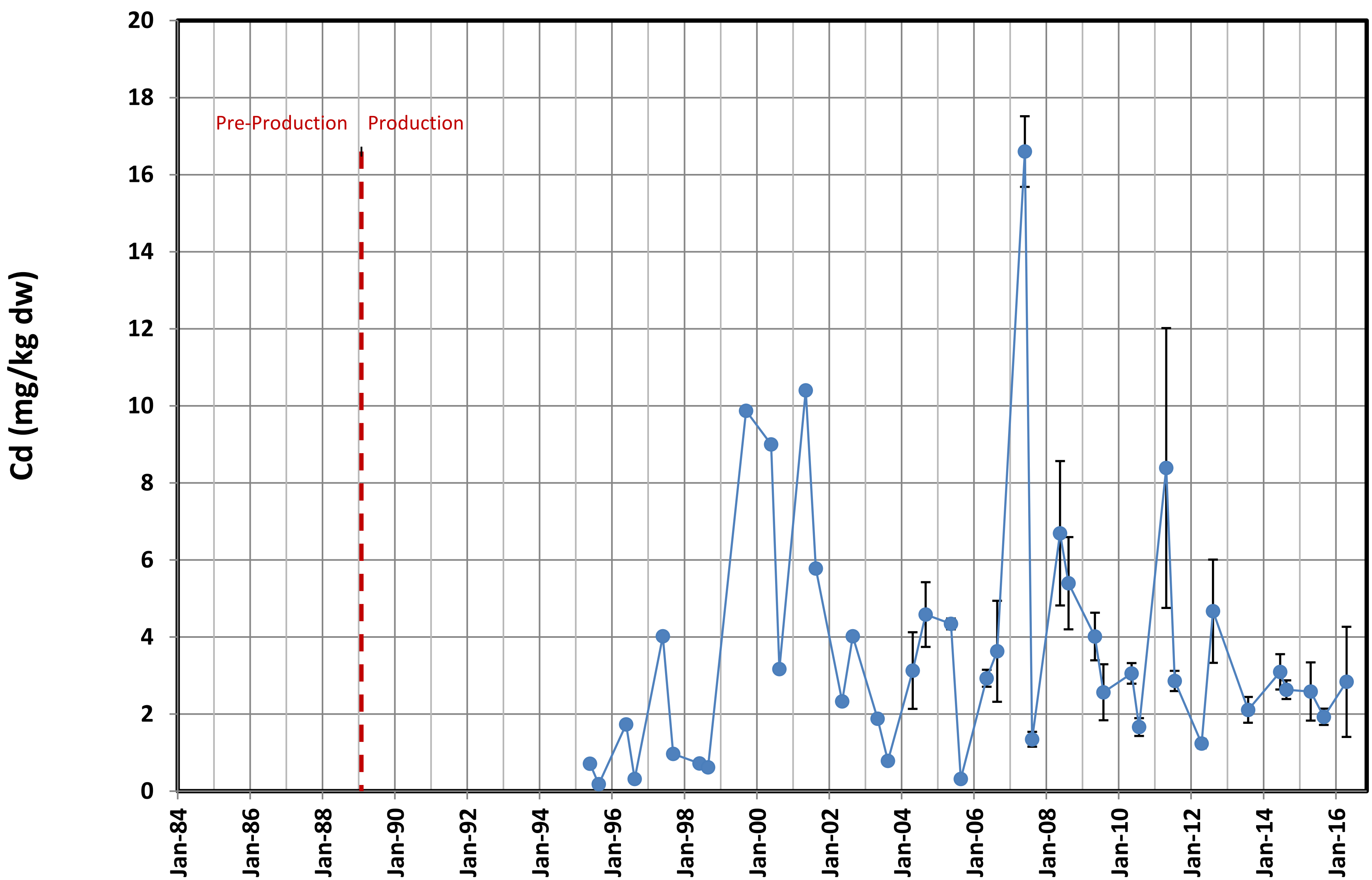


Figure 3-20. Zinc in Sediments at Site S-5N
Zn (mg/kg dw)
Pre-Production
Production
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-21. Cadmium in Sediments at Site S-5S



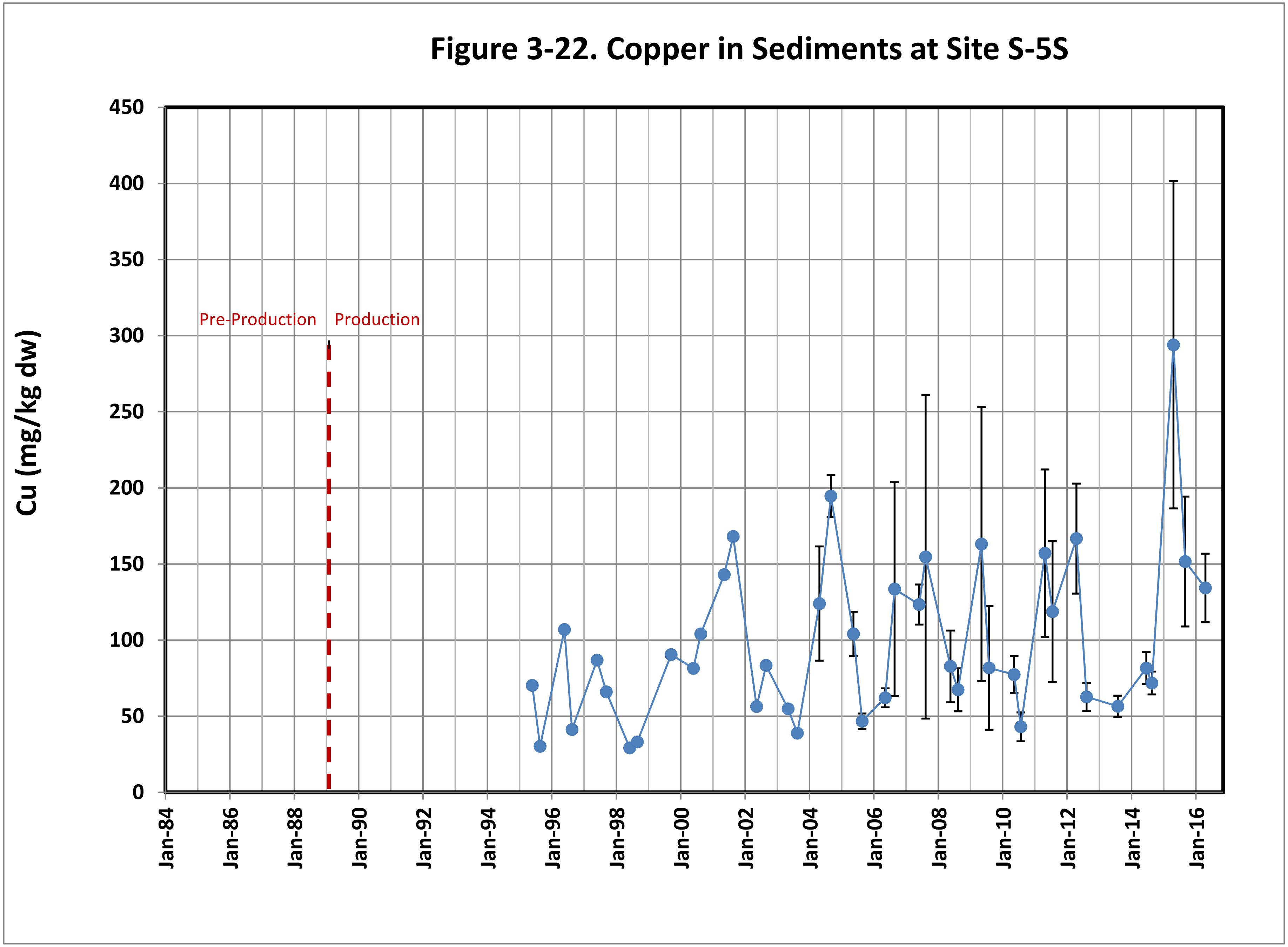


Figure 3-22. Copper in Sediments at Site S-5S
Cu (mg/kg dw)
450
400
350
300
250
200
150
100
50
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

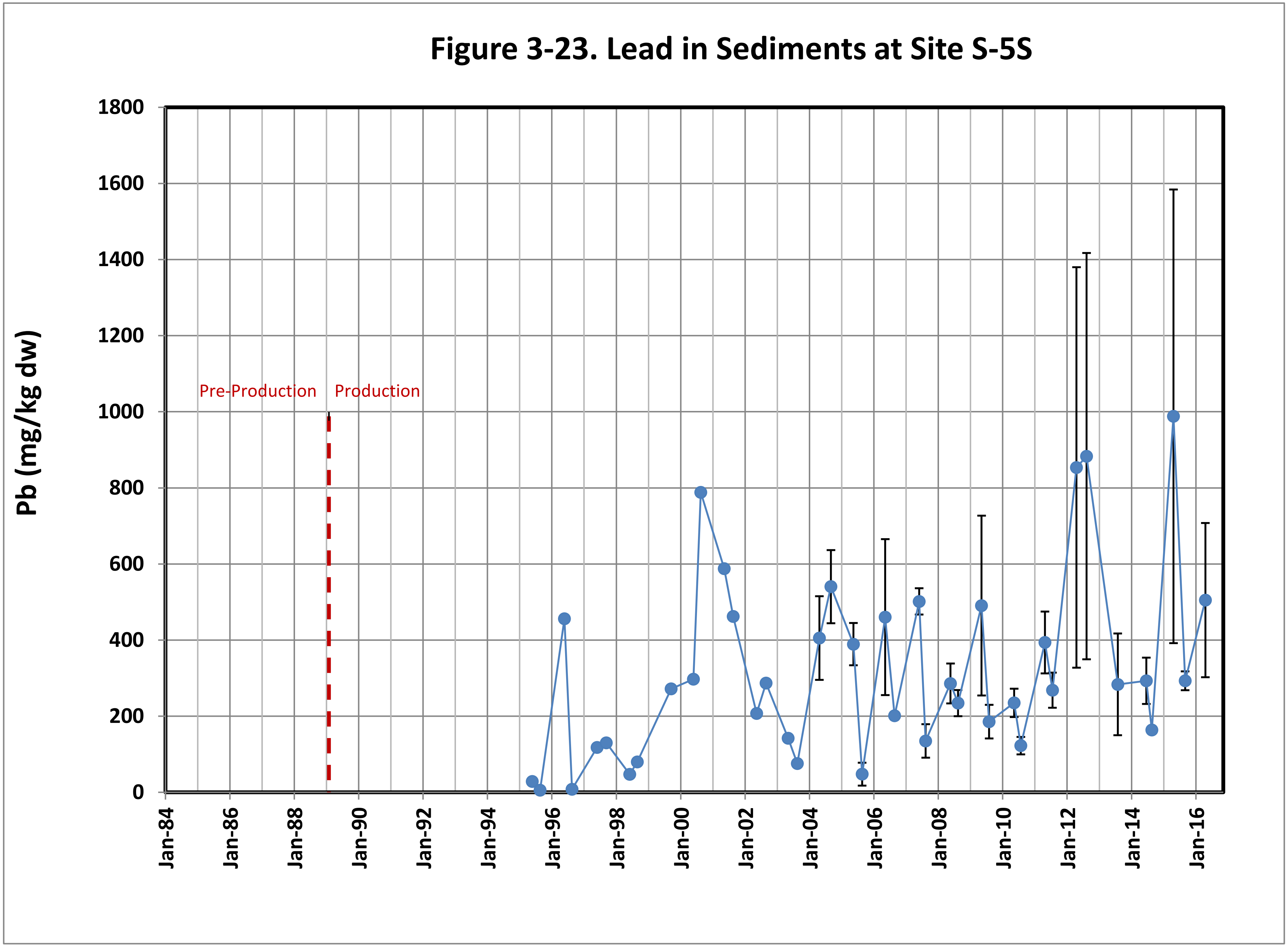


Figure 3-23. Lead in Sediments at Site S-5S
Pb (mg/kg dw)
1800
1600
1400
1200
1000
800
600
400
200
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

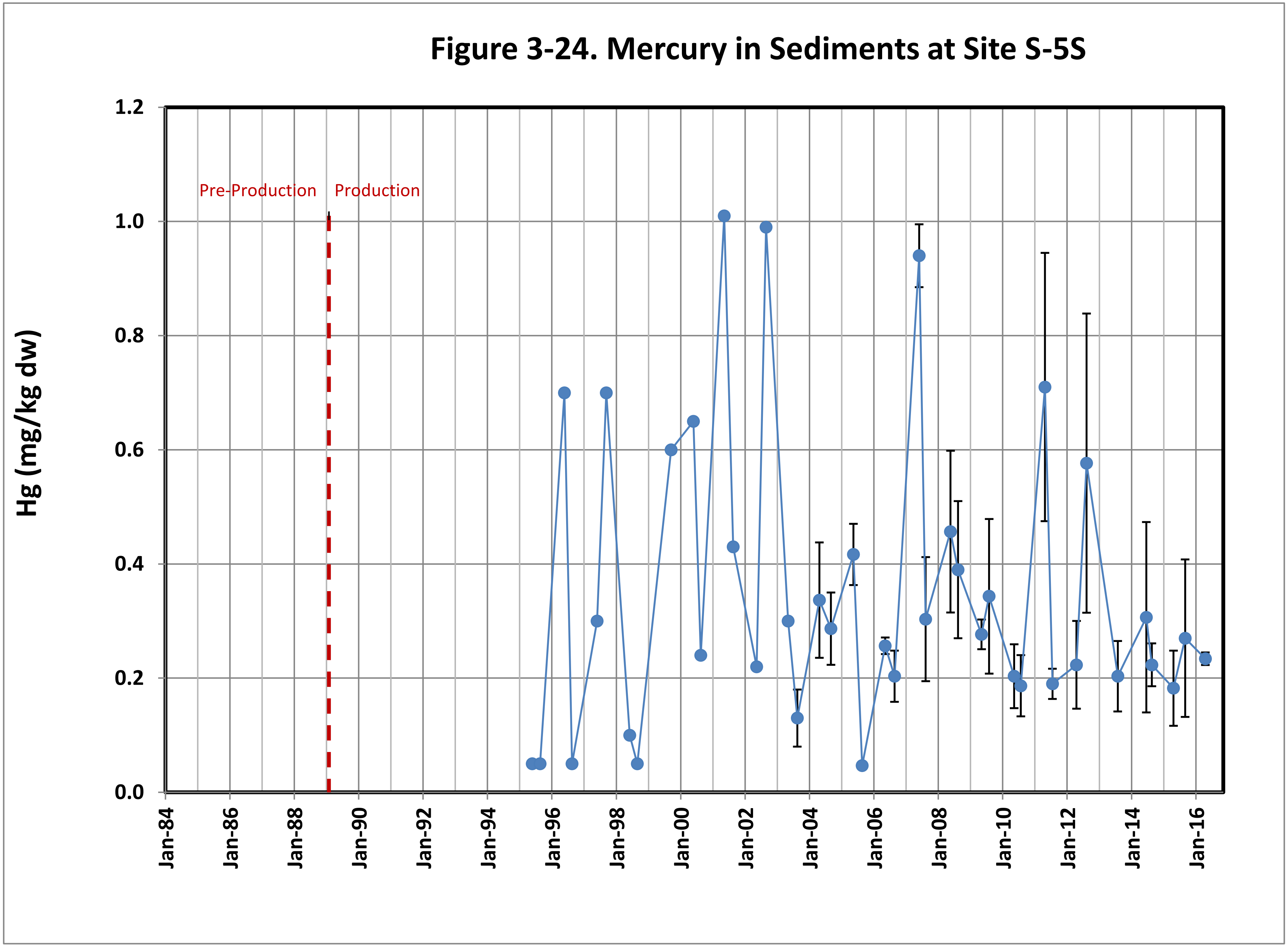


Figure 3-24. Mercury in Sediments at Site S-5S
Hg (mg/kg dw)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 3-25. Zinc in Sediments at Site S-5S

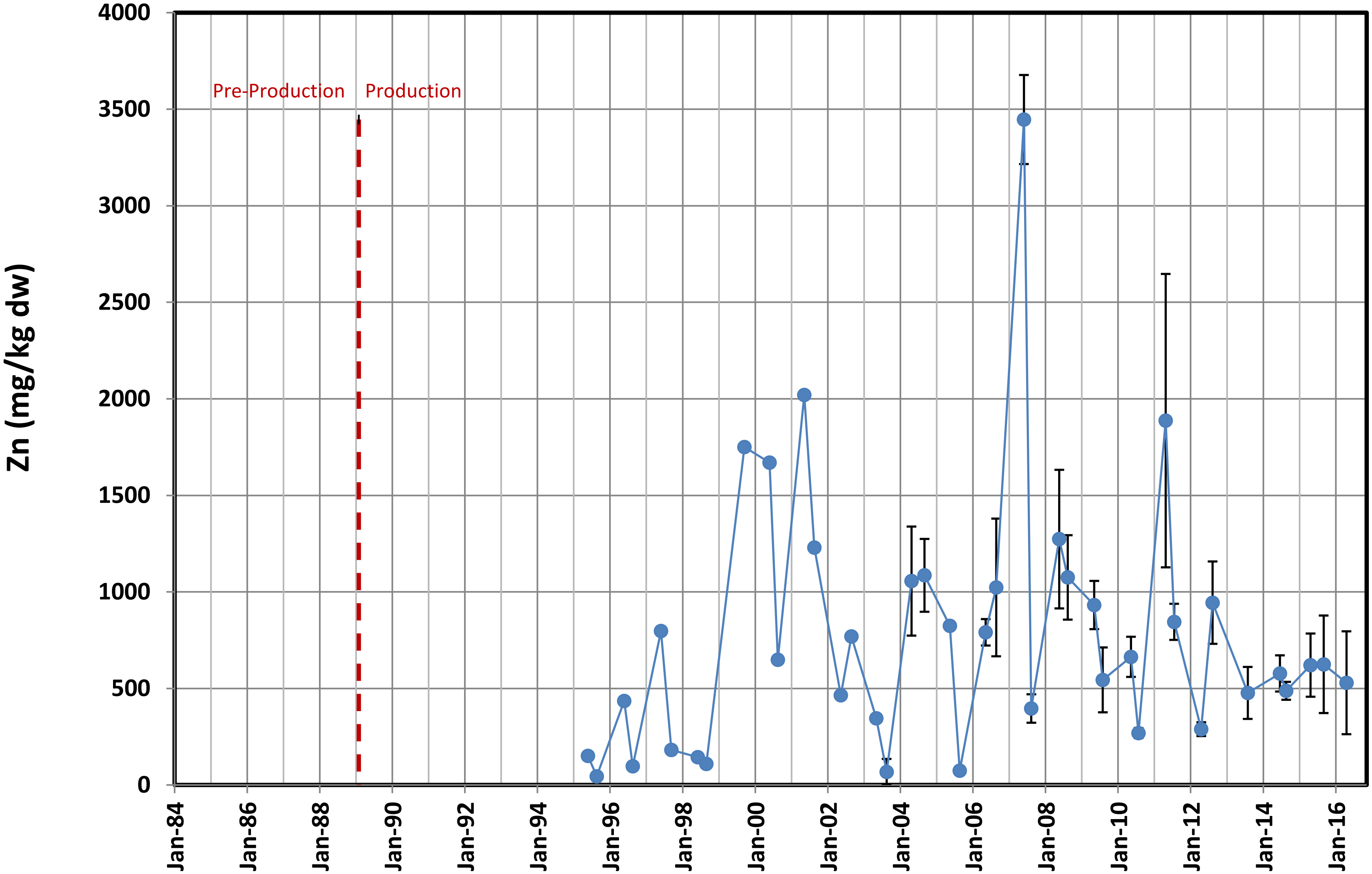


Figure 4-1. Cadmium in Mussels at Site STN-1

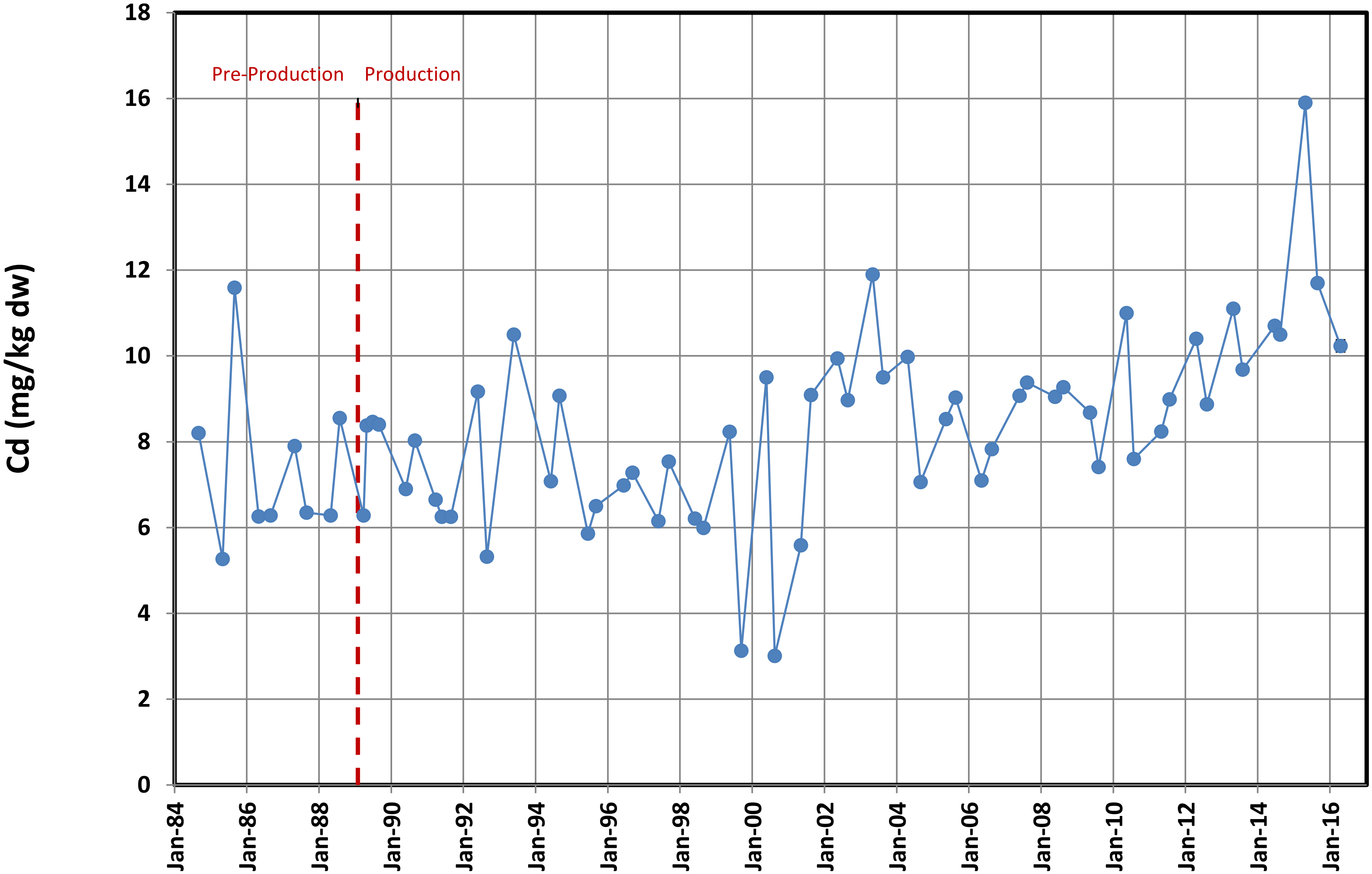


Figure 4-2. Copper in Mussels at Site STN-1

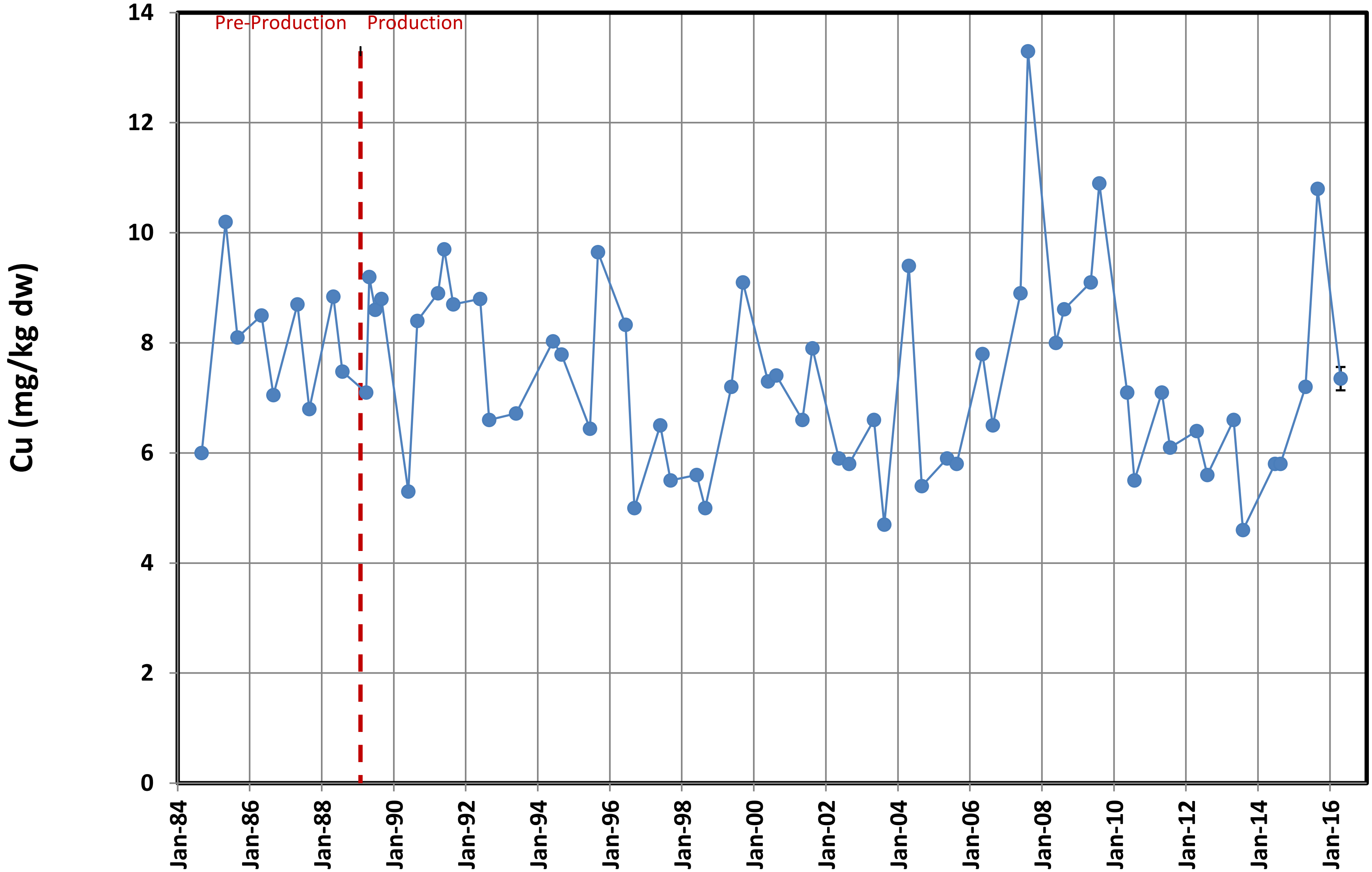
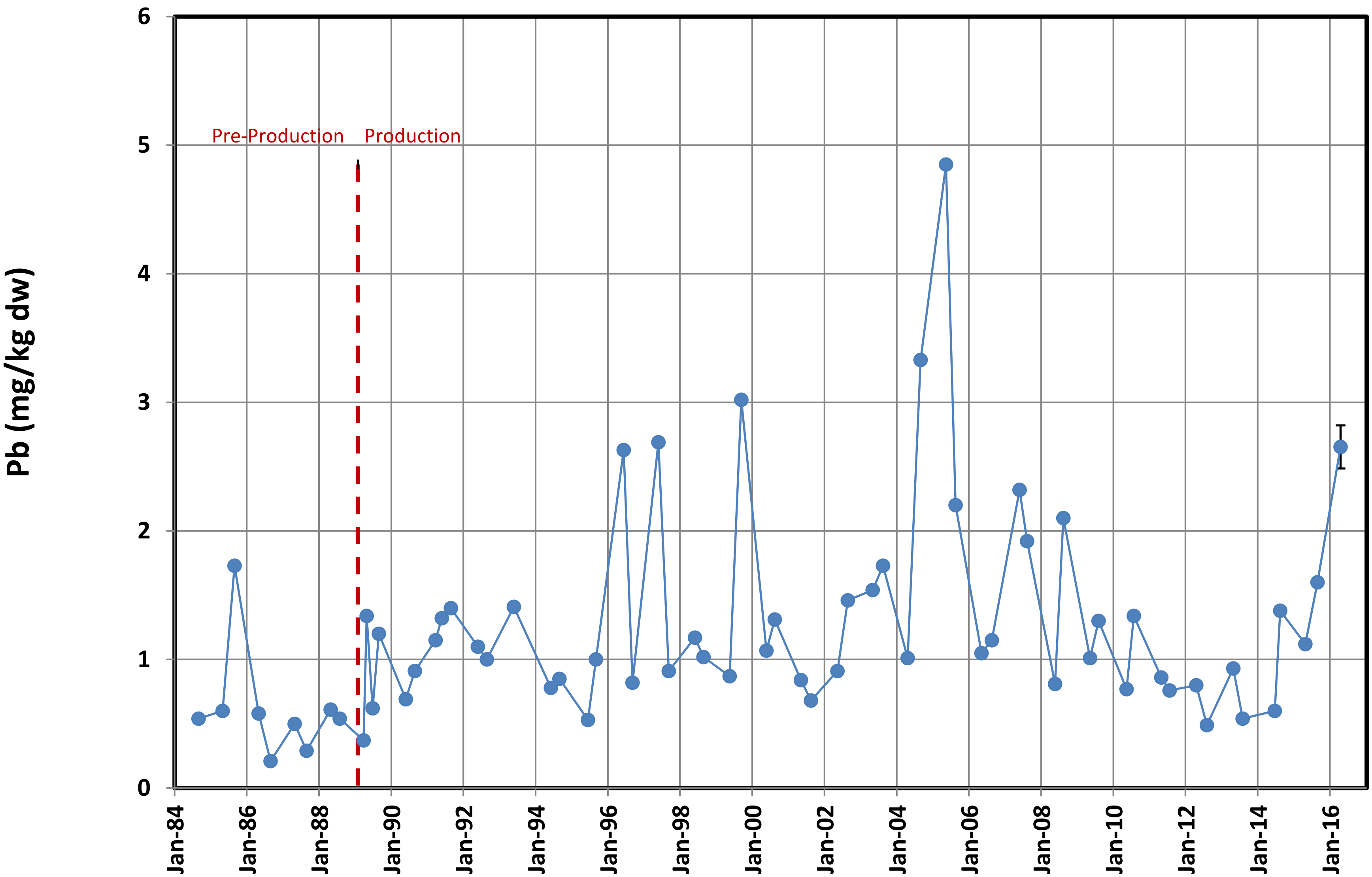


Figure 4-3. Lead in Mussels at Site STN-1



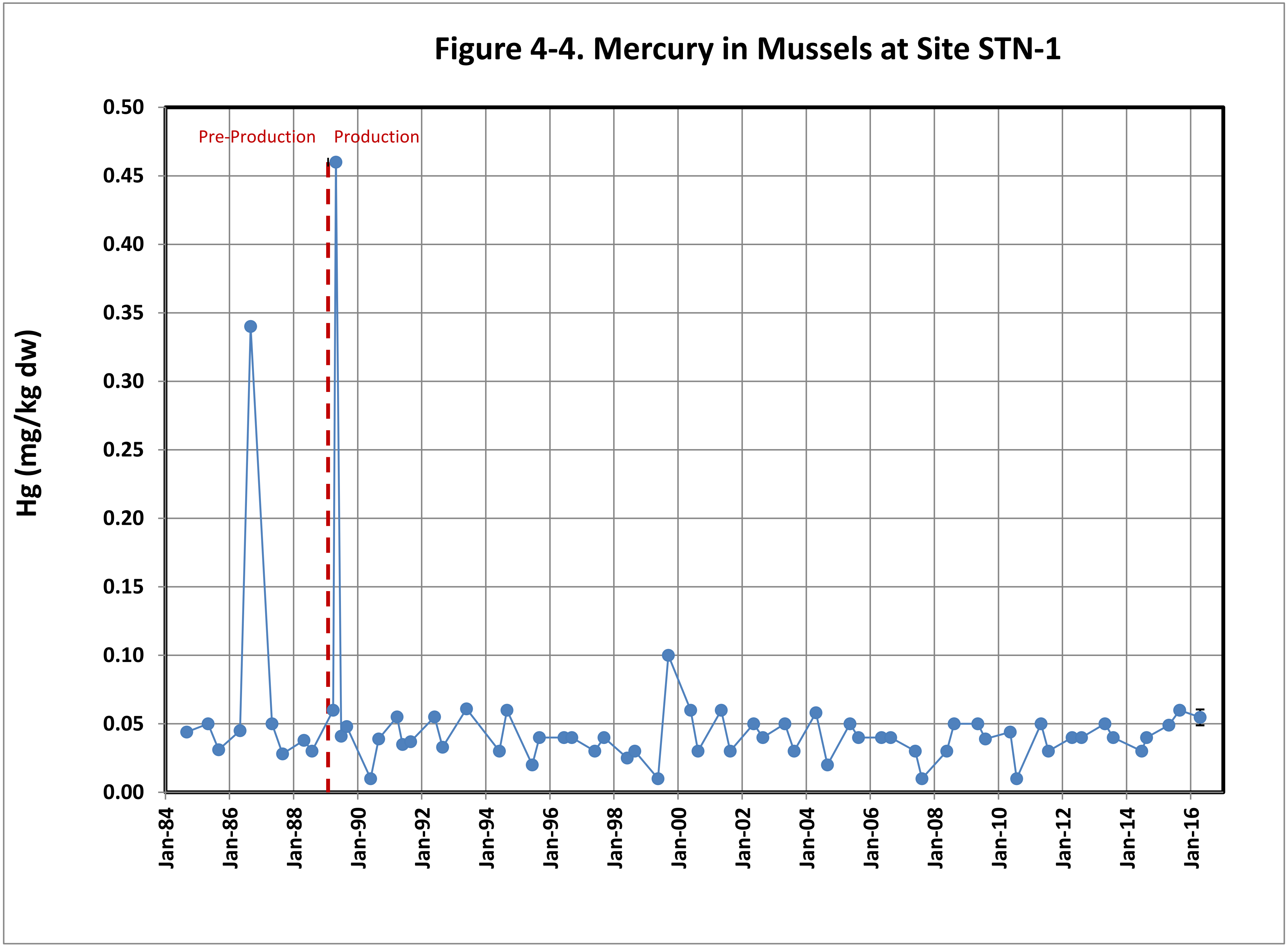
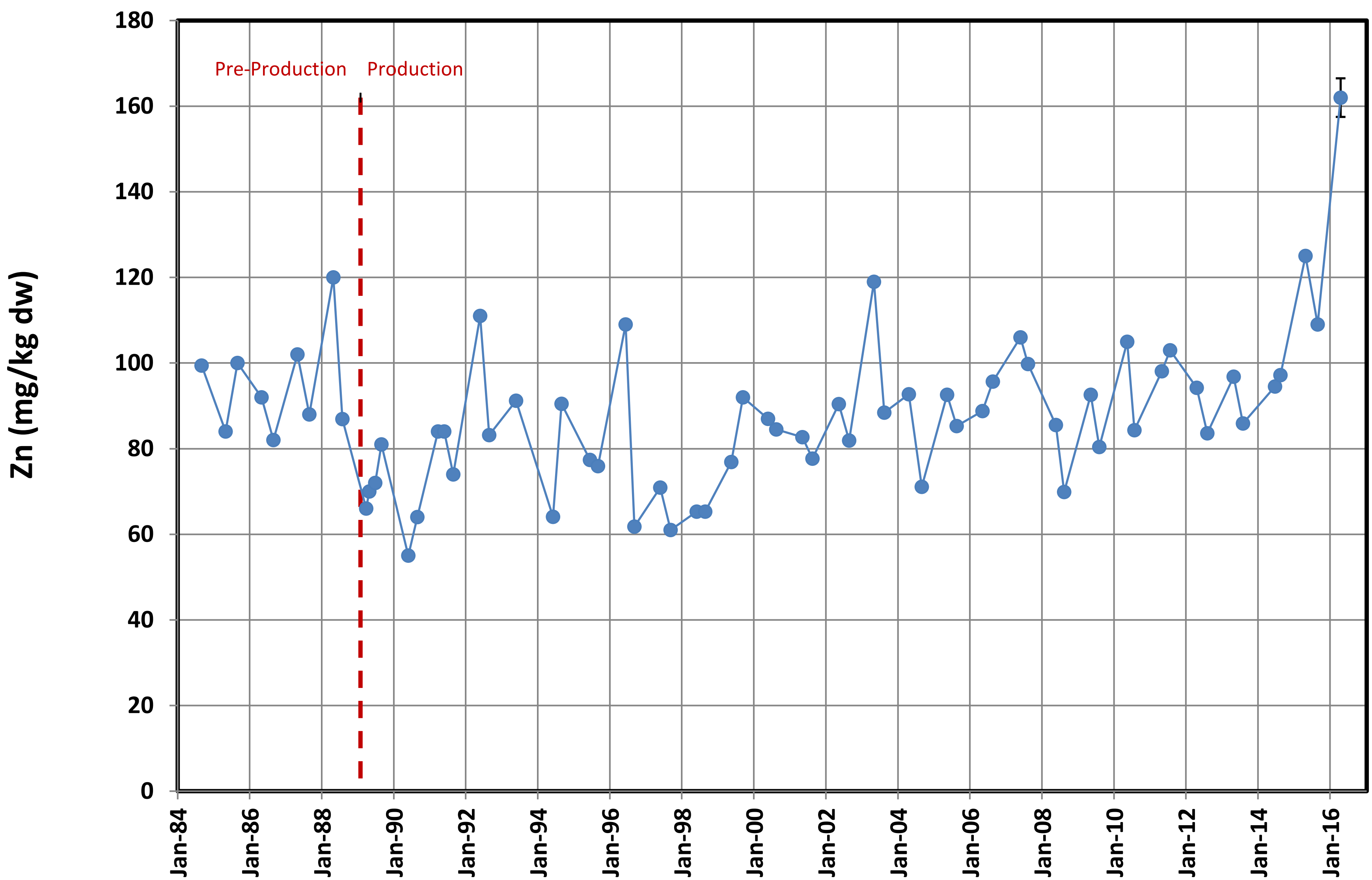


Figure 4-4. Mercury in Mussels at Site STN-1
Hg (mg/kg dw)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-5. Zinc in Mussels at Site STN-1



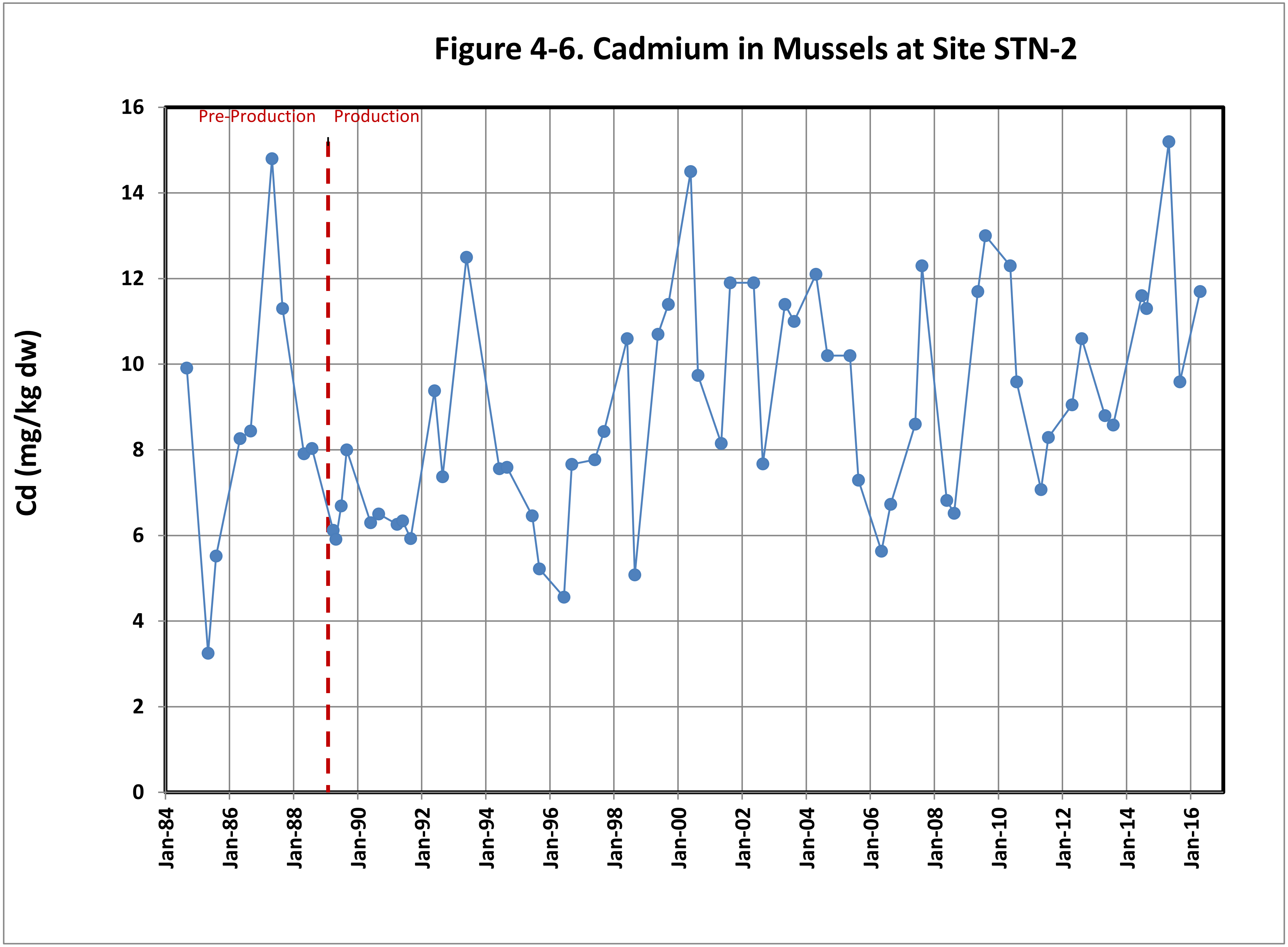


Figure 4-6. Cadmium in Mussels at Site STN-2
Pre-Production
Production
Cd (mg/kg dw)
16
14
12
10
8
6
4
2
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

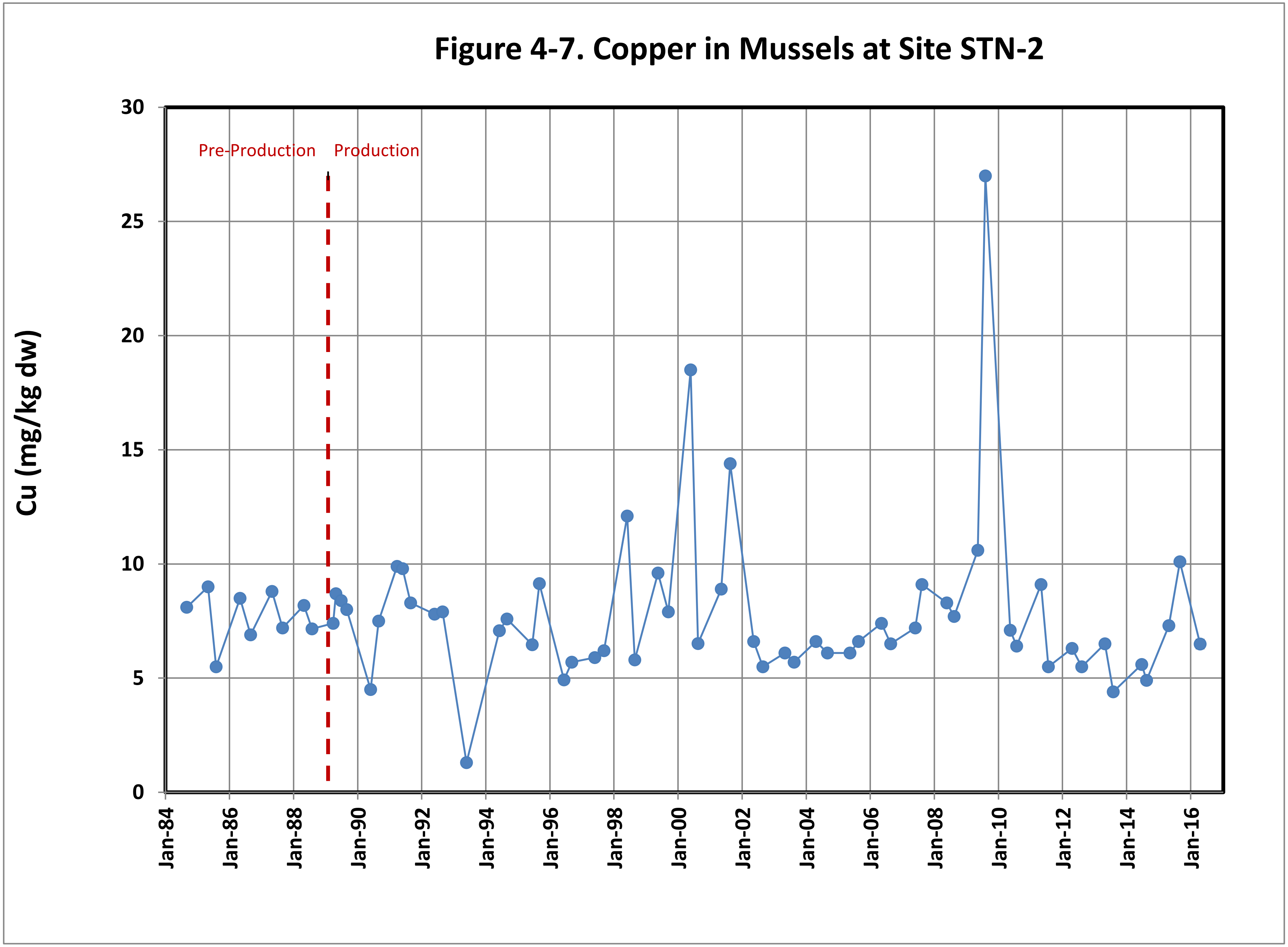


Figure 4-7. Copper in Mussels at Site STN-2
Cu (mg/kg dw)
Pre-Production
Production
30
25
20
15
10
5
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

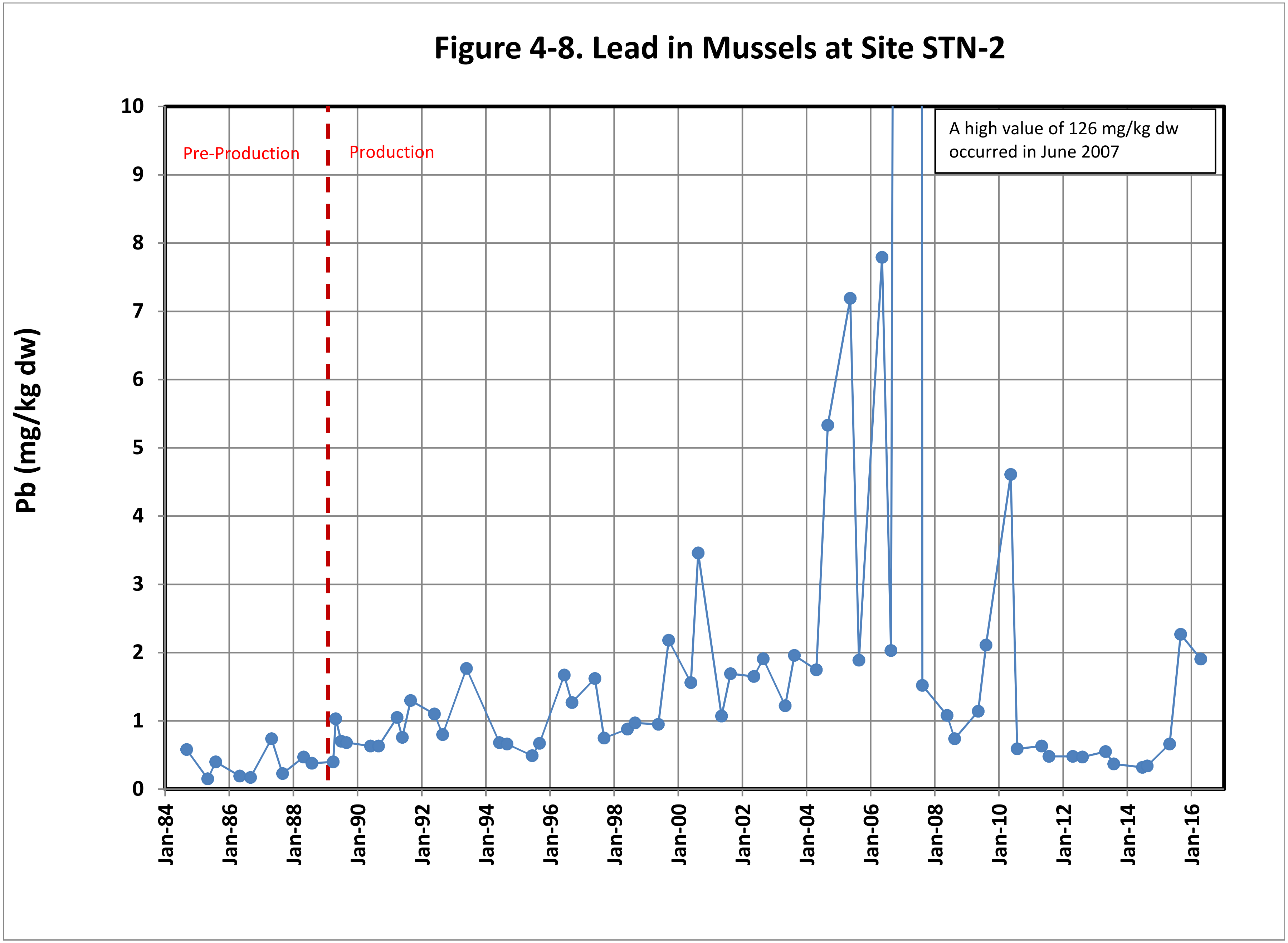


Figure 4-8. Lead in Mussels at Site STN-2
Pb (mg/kg dw)
10
9
8
7
6
5
4
3
2
1
0
Pre-Production
Production
A high value of 126 mg/kg dw occurred in June 2007
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

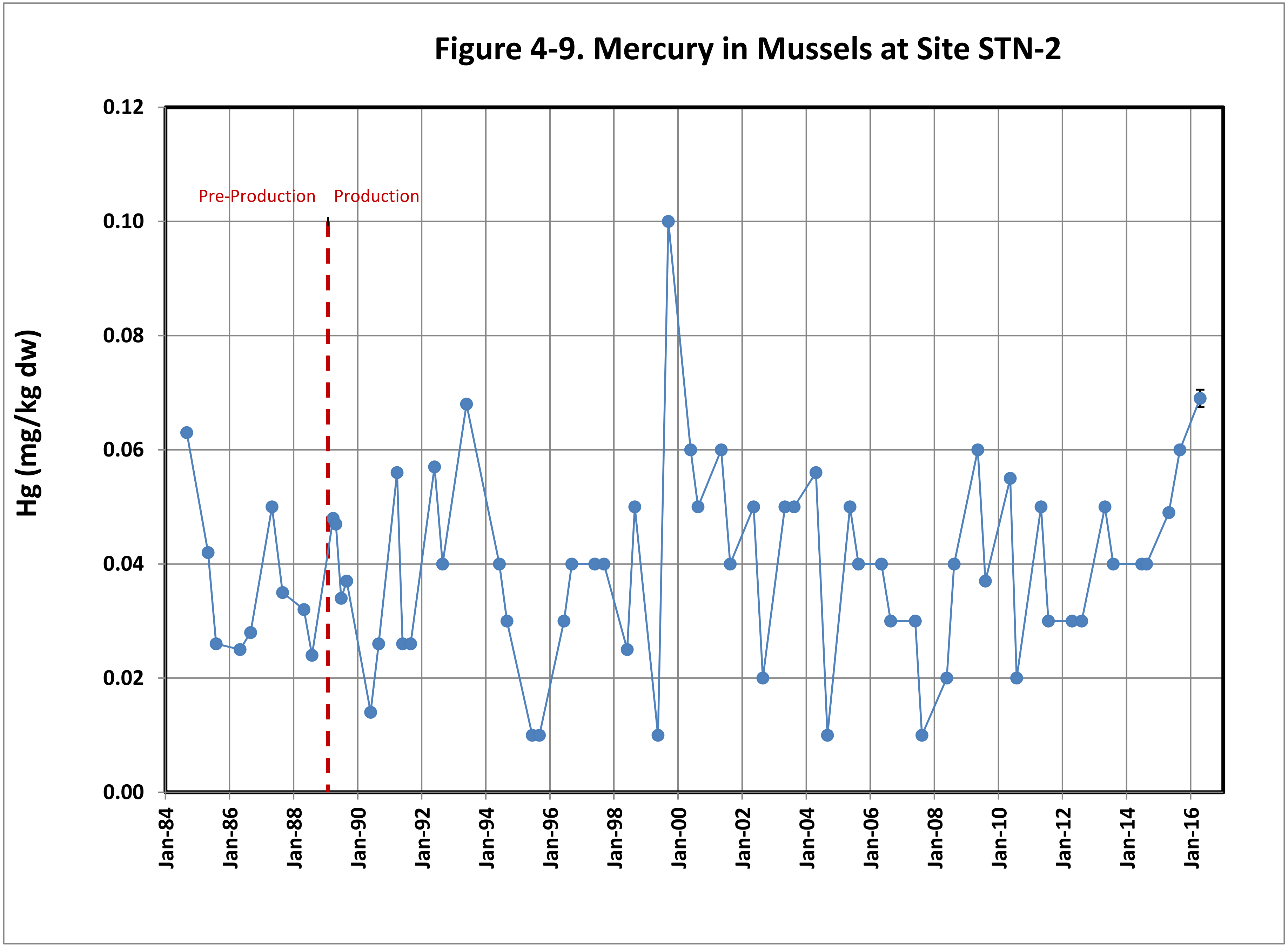
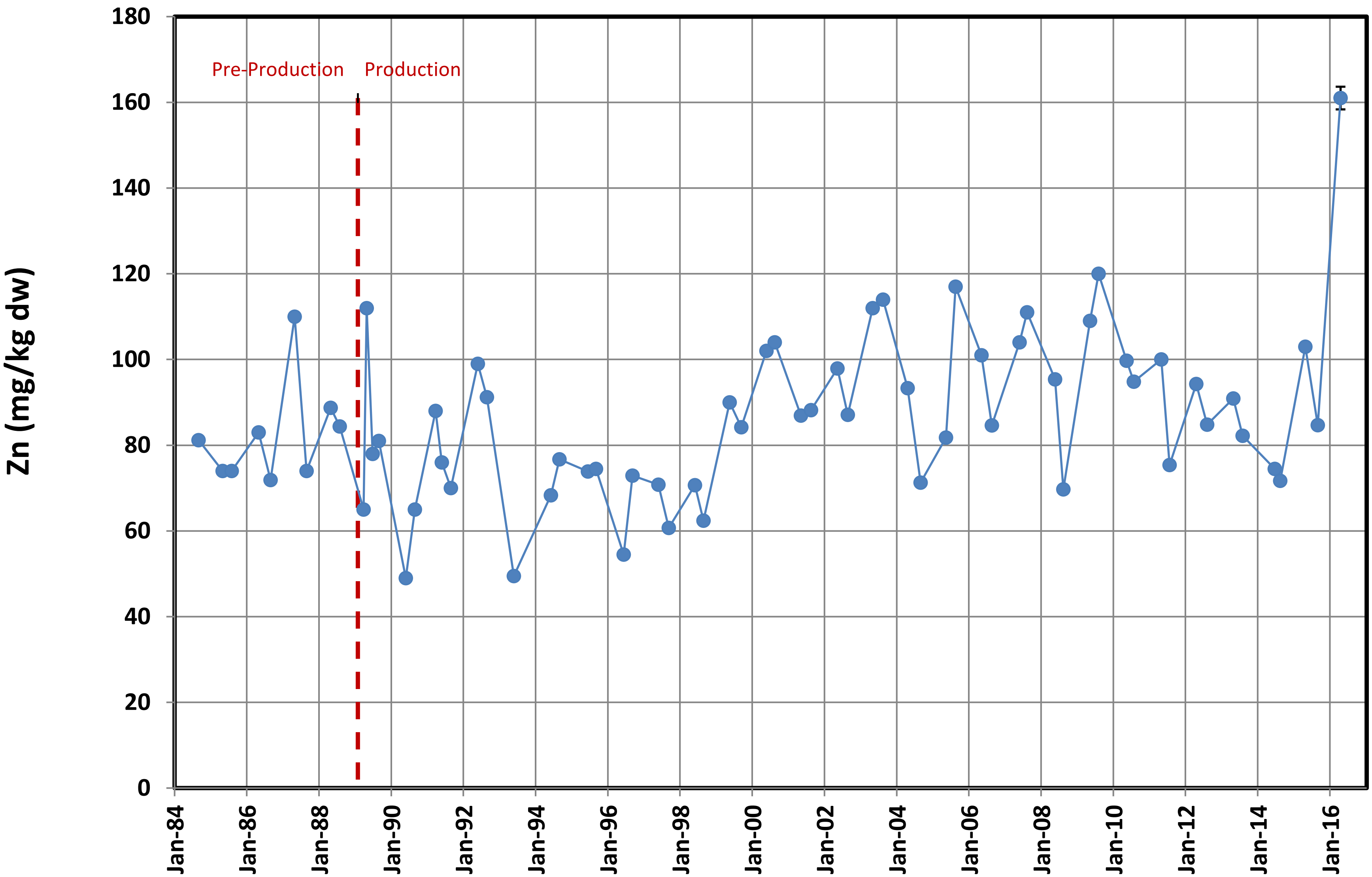


Figure 4-9. Mercury in Mussels at Site STN-2
Hg (mg/kg dw)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-10. Zinc in Mussels at Site STN-2



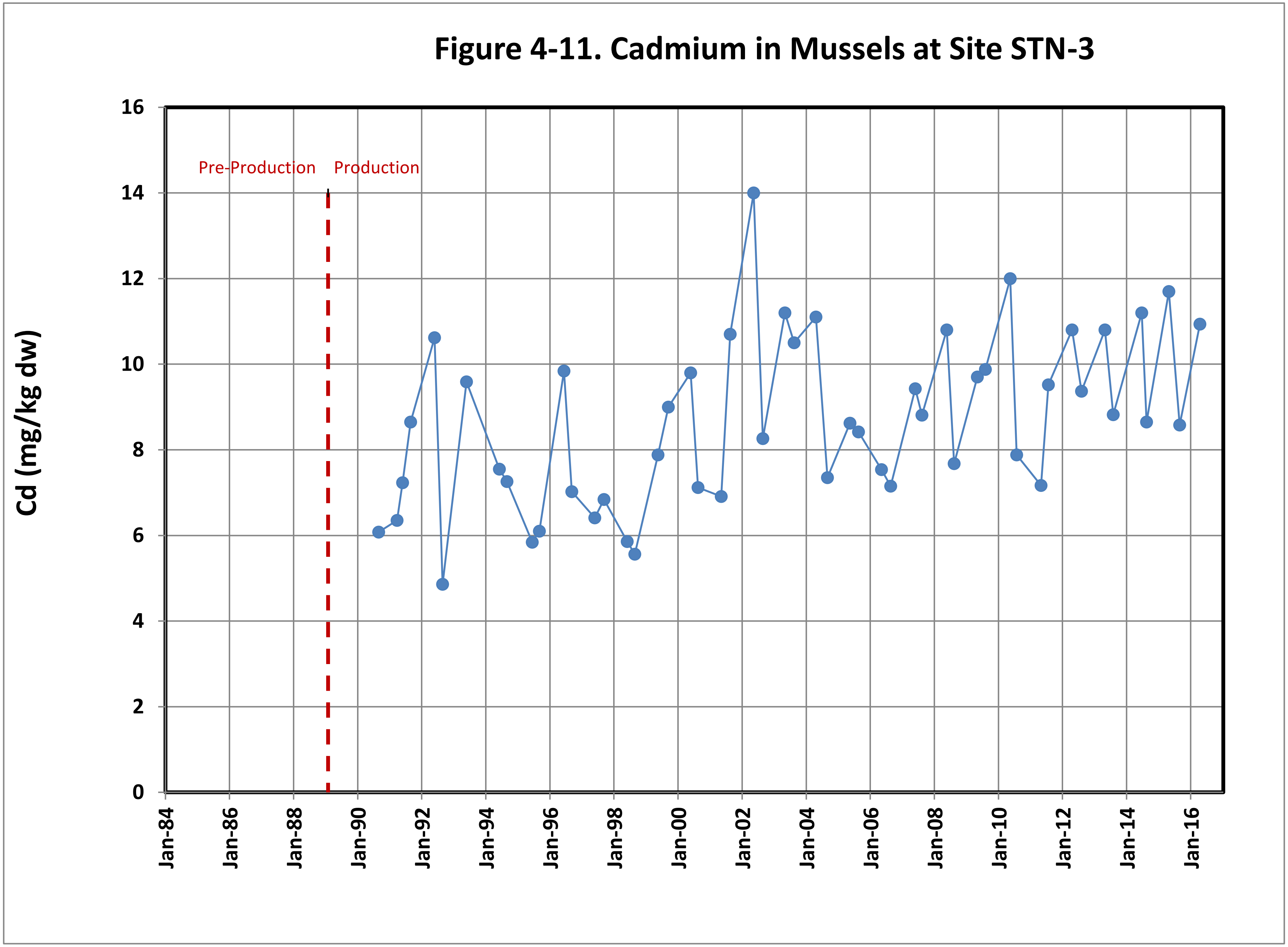


Figure 4-11. Cadmium in Mussels at Site STN-3
Cd (mg/kg dw)
Pre-Production
Production
0
2
4
6
8
10
12
14
16
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-12. Copper in Mussels at Site STN-3

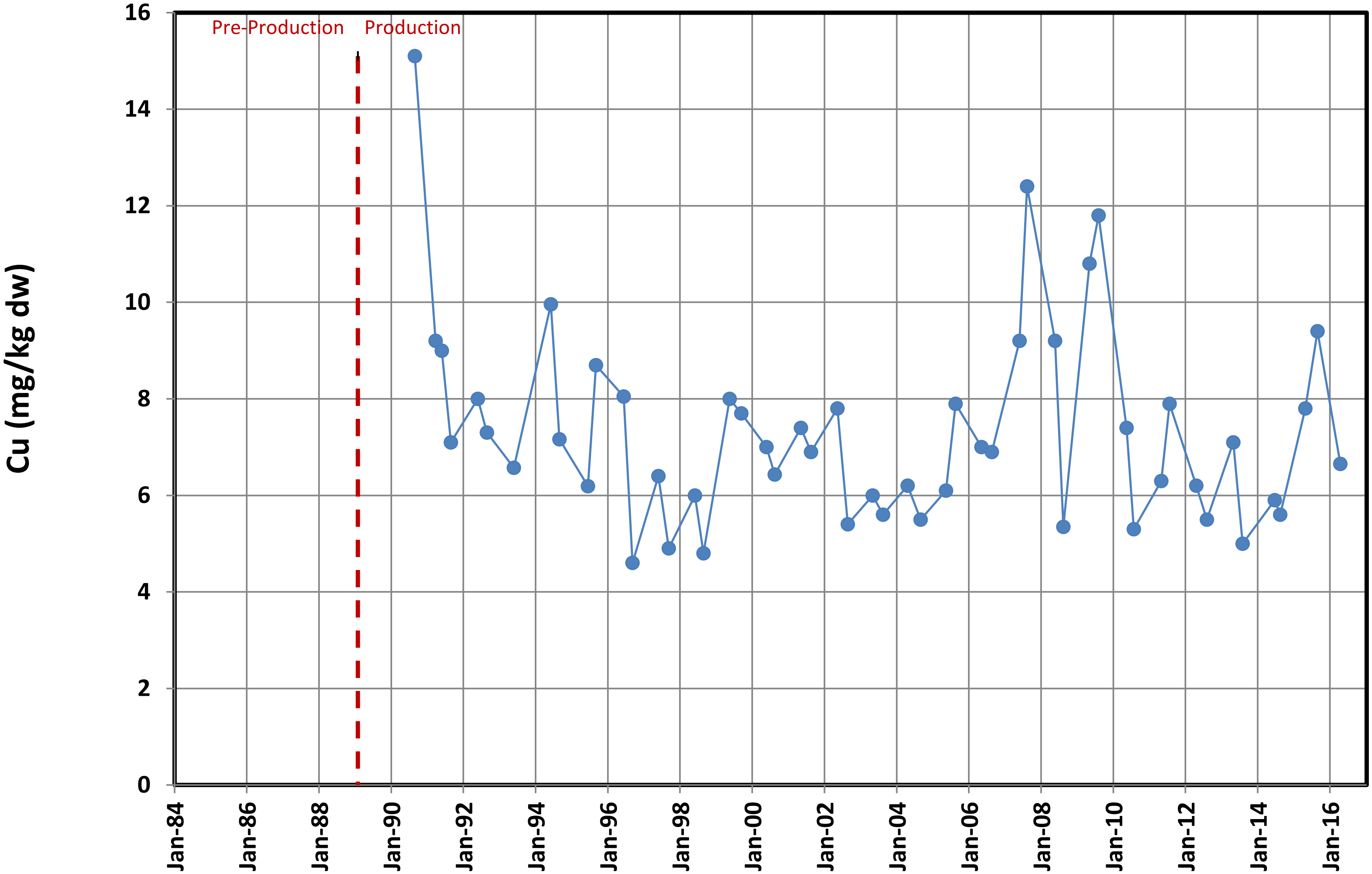
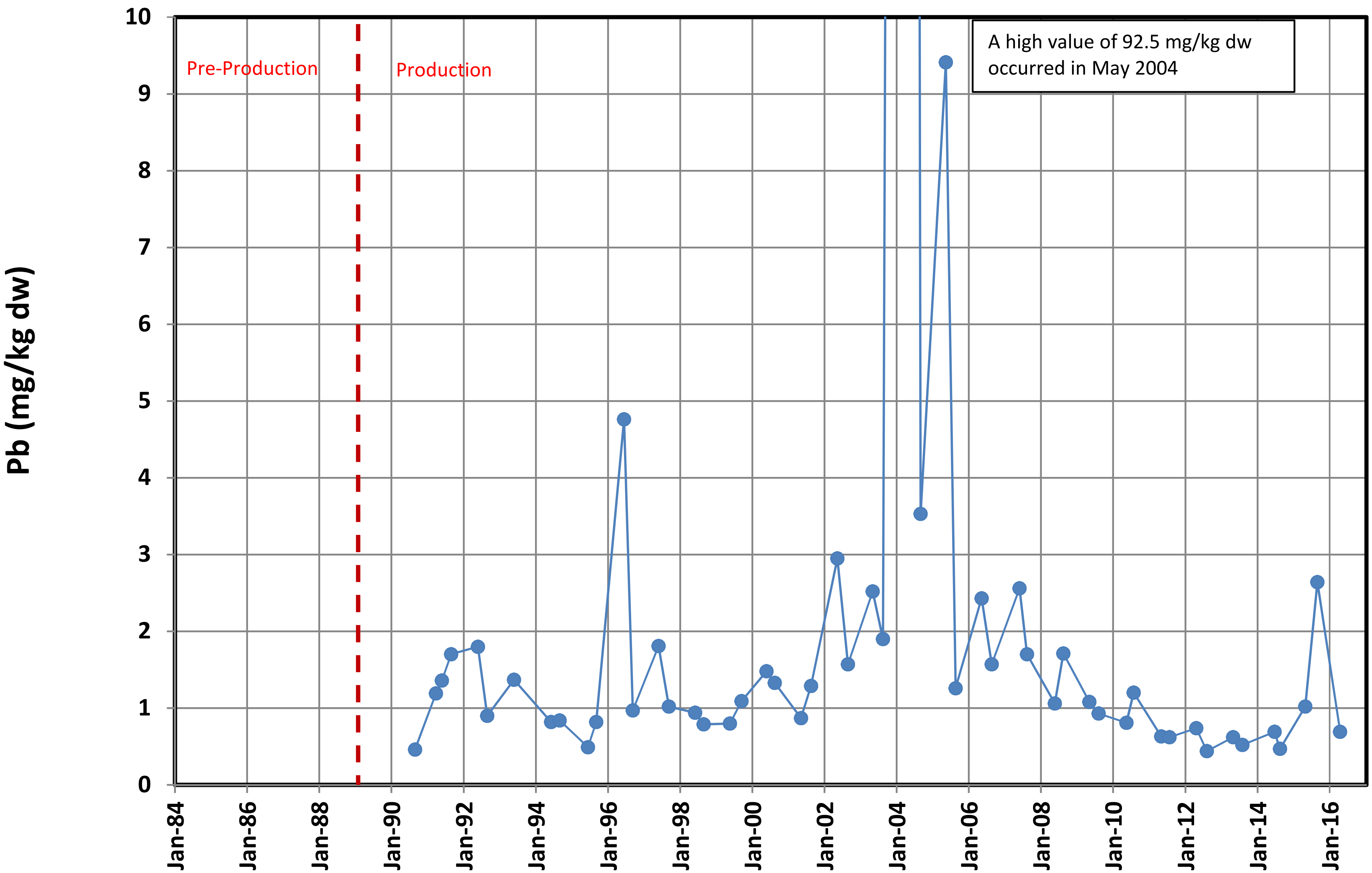


Figure 4-13. Zinc in Mussels at Site STN-3



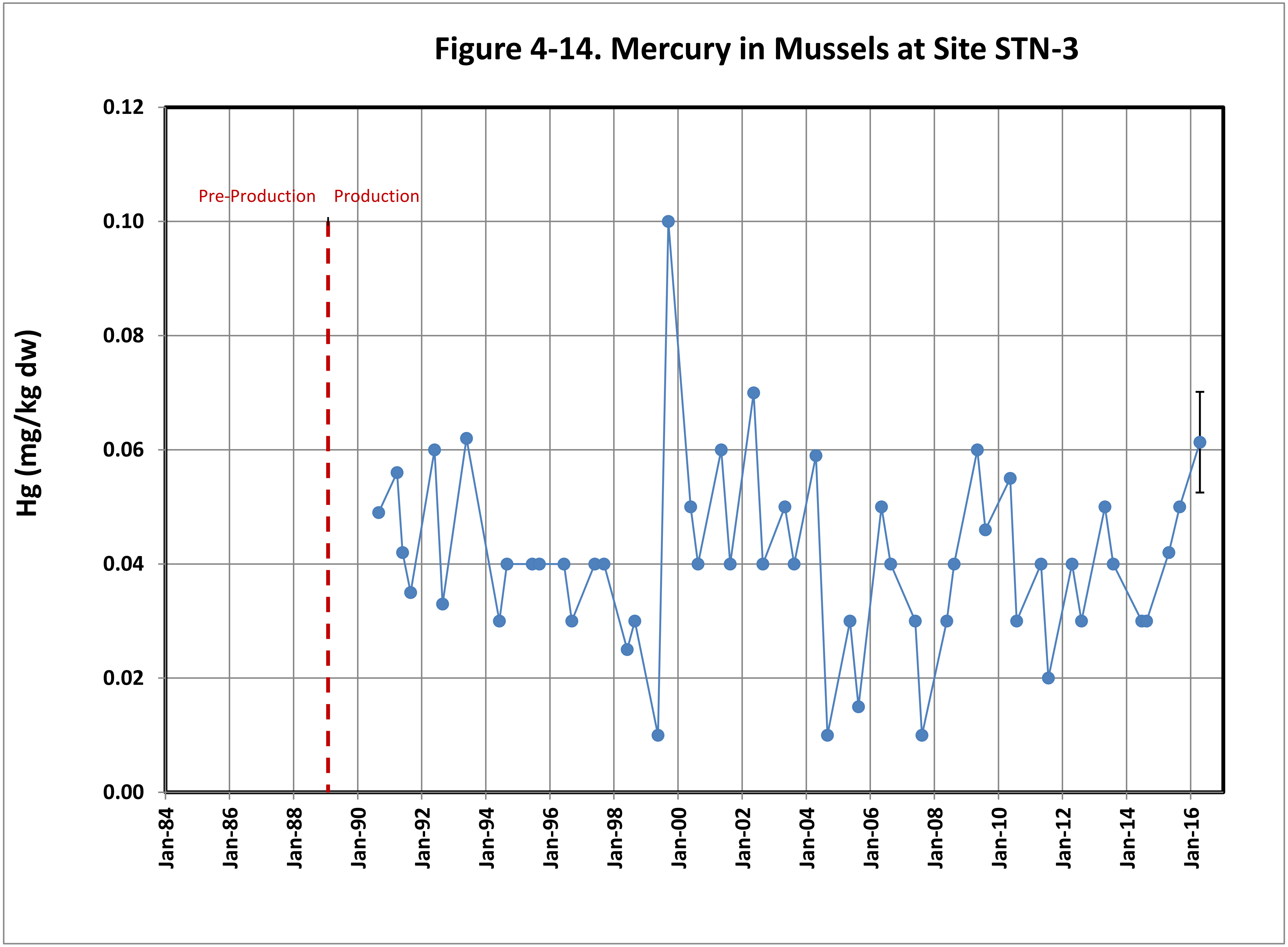


Figure 4-14. Mercury in Mussels at Site STN-3
Hg (mg/kg dw)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

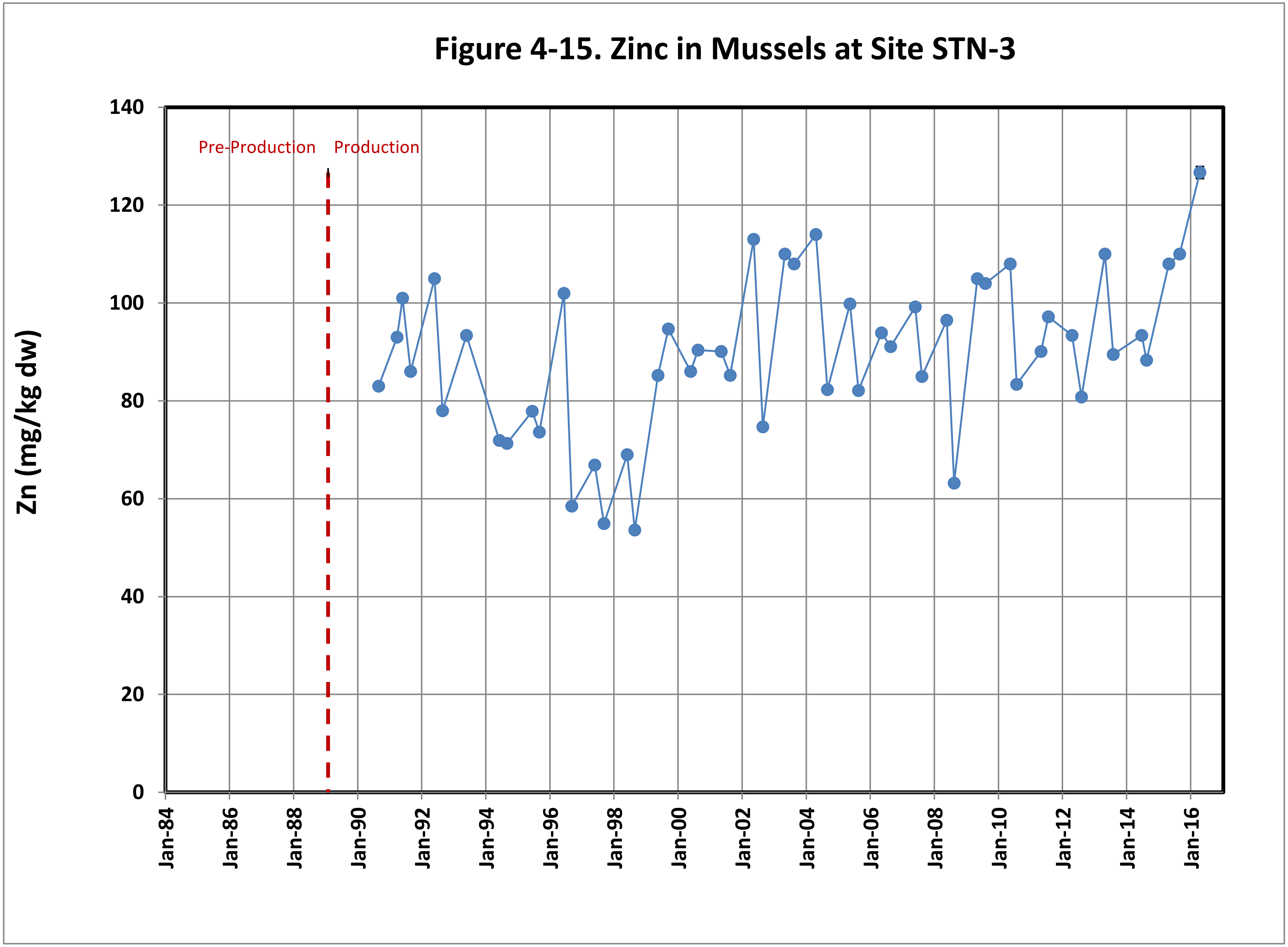
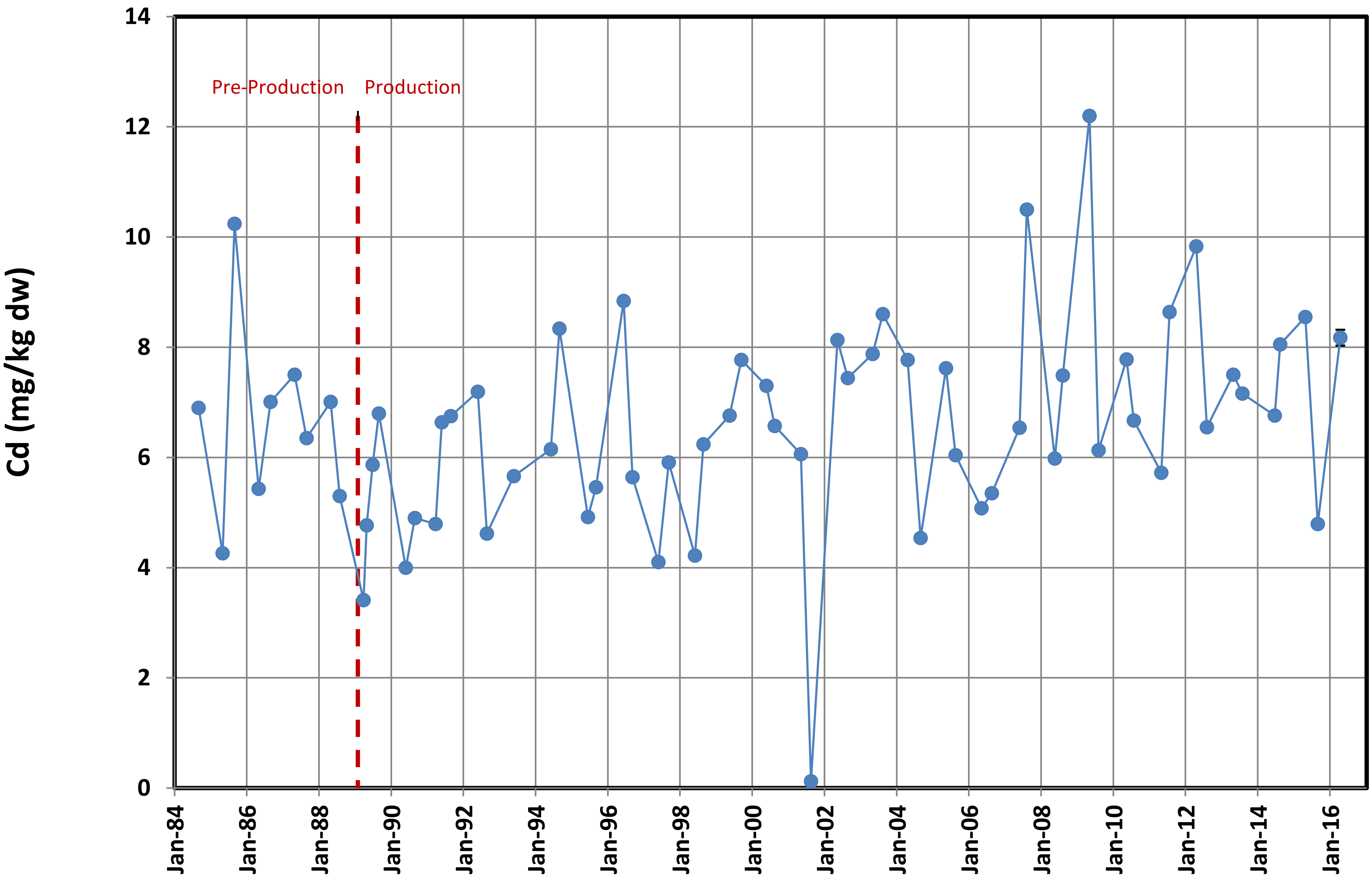


Figure 4-15. Zinc in Mussels at Site STN-3
Zn (mg/kg dw)
140
120
100
80
60
40
20
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-16. Cadmium in Mussels at Site ESL



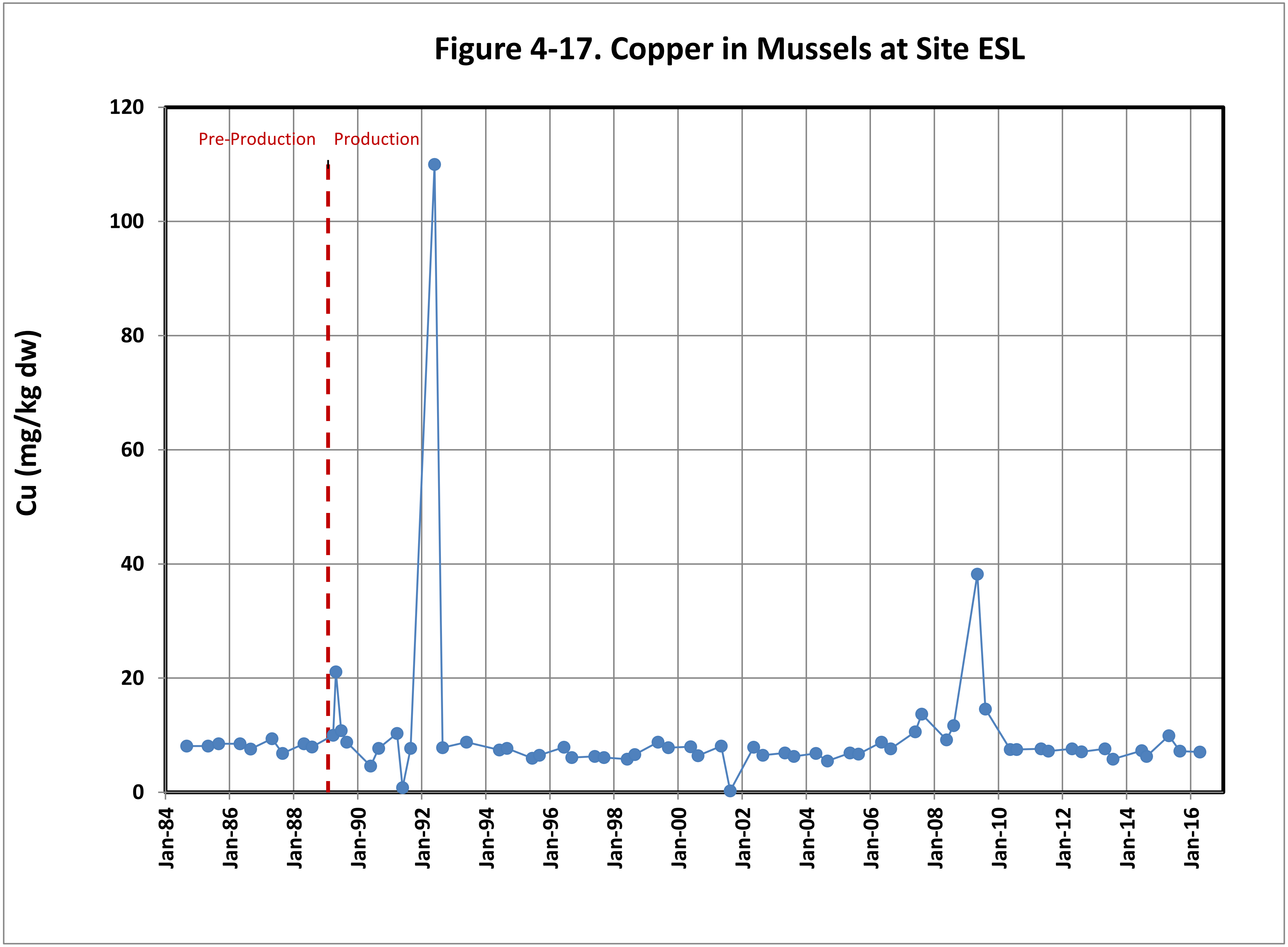


Figure 4-17. Copper in Mussels at Site ESL
Cu (mg/kg dw)
120
100
80
60
40
20
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

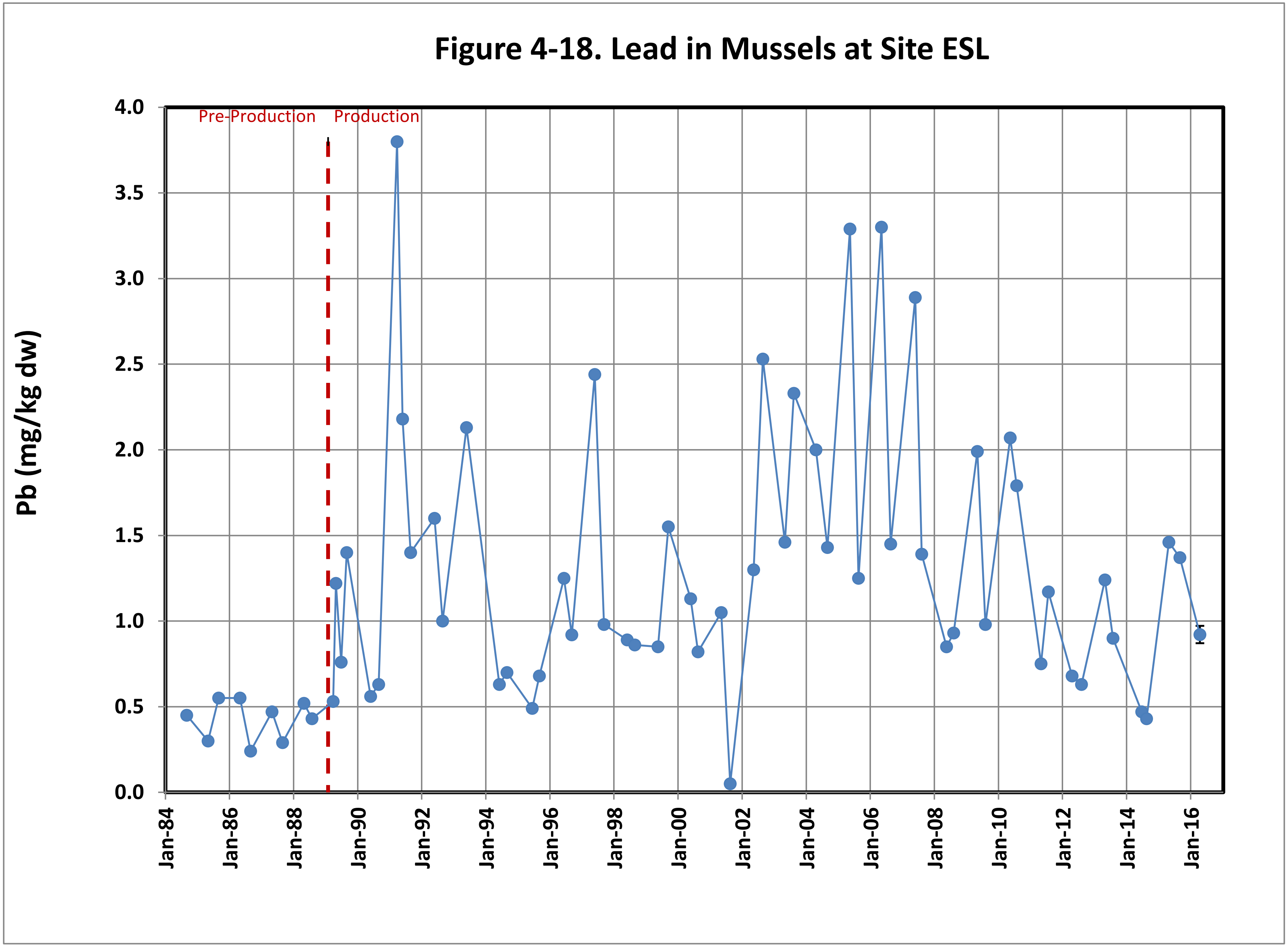


Figure 4-18. Lead in Mussels at Site ESL
Pb (mg/kg dw)
Pre-Production
Production
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-19. Mercury in Mussels at Site ESL

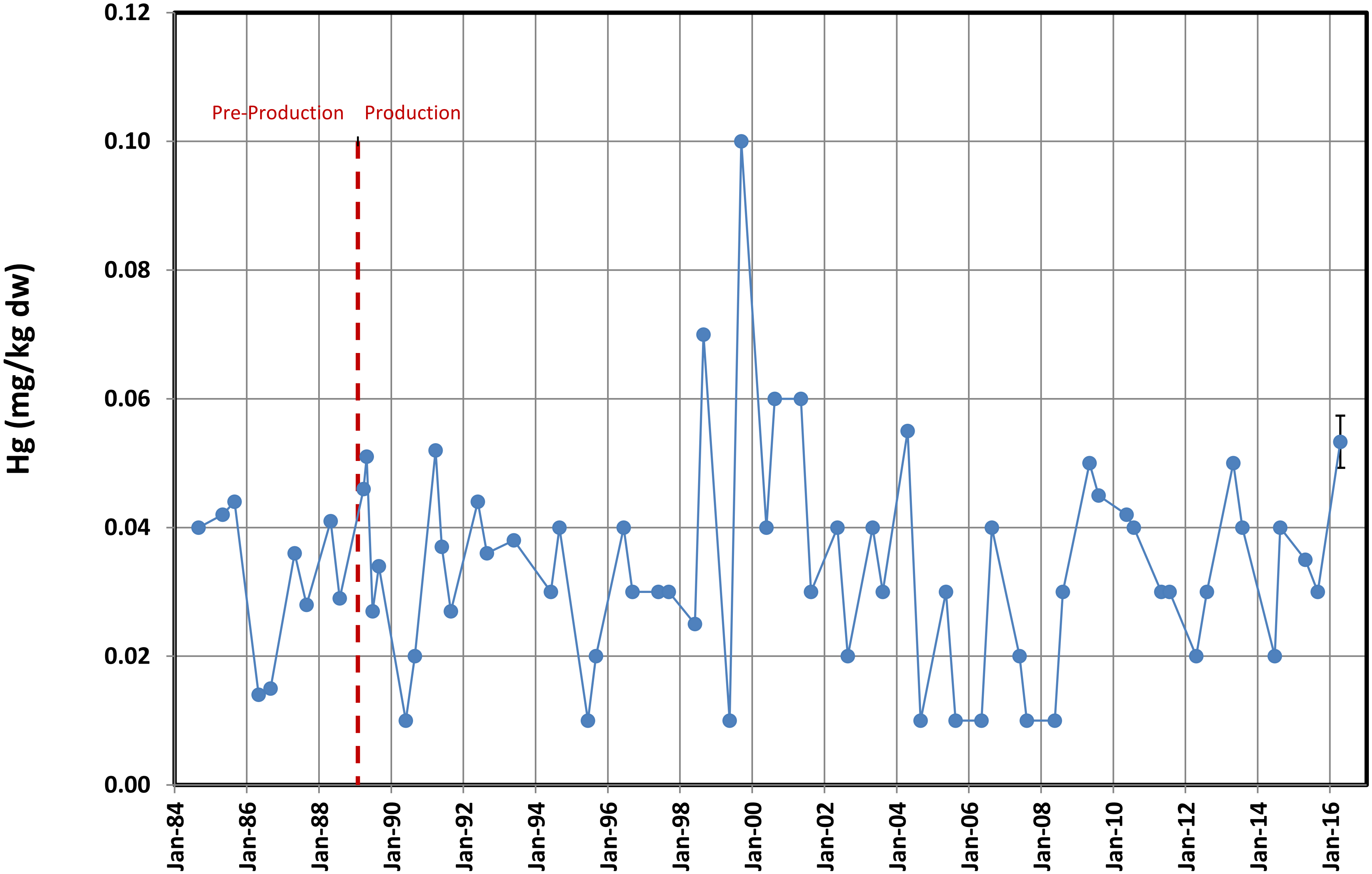


Figure 4-20. Zinc in Mussels at Site ESL

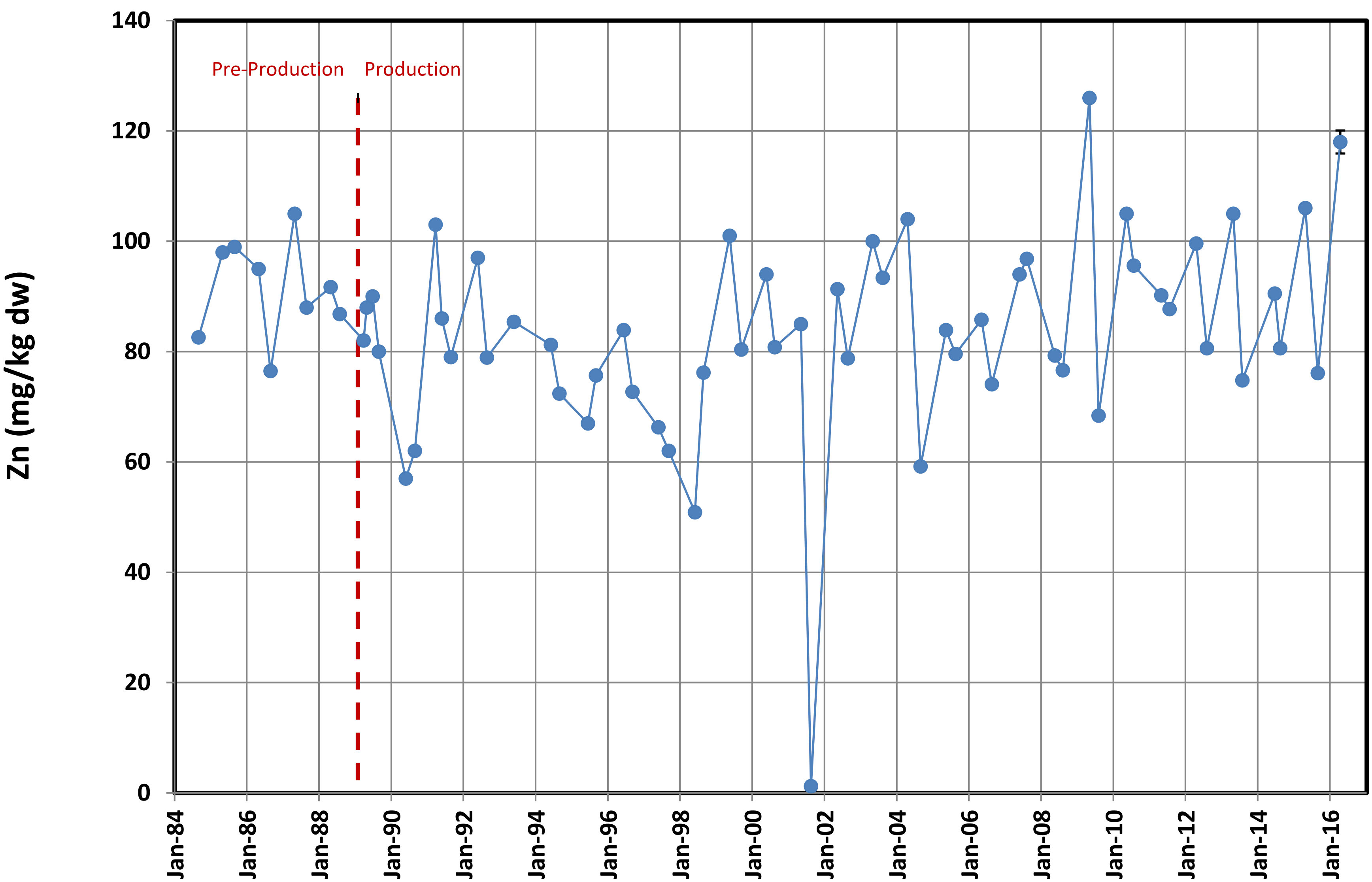
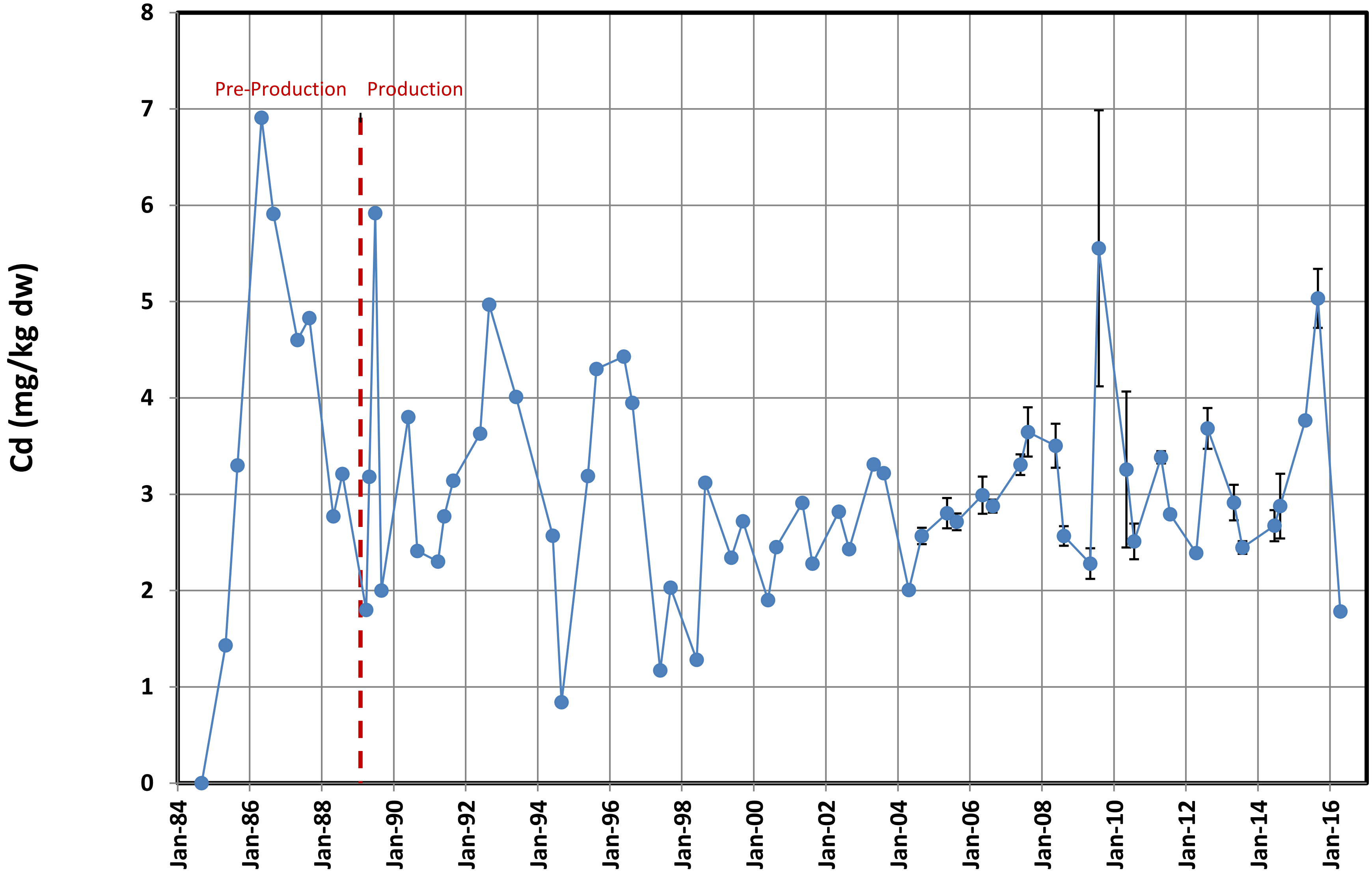


Figure 4-21. Cadmium in Nephtys at Site S-1



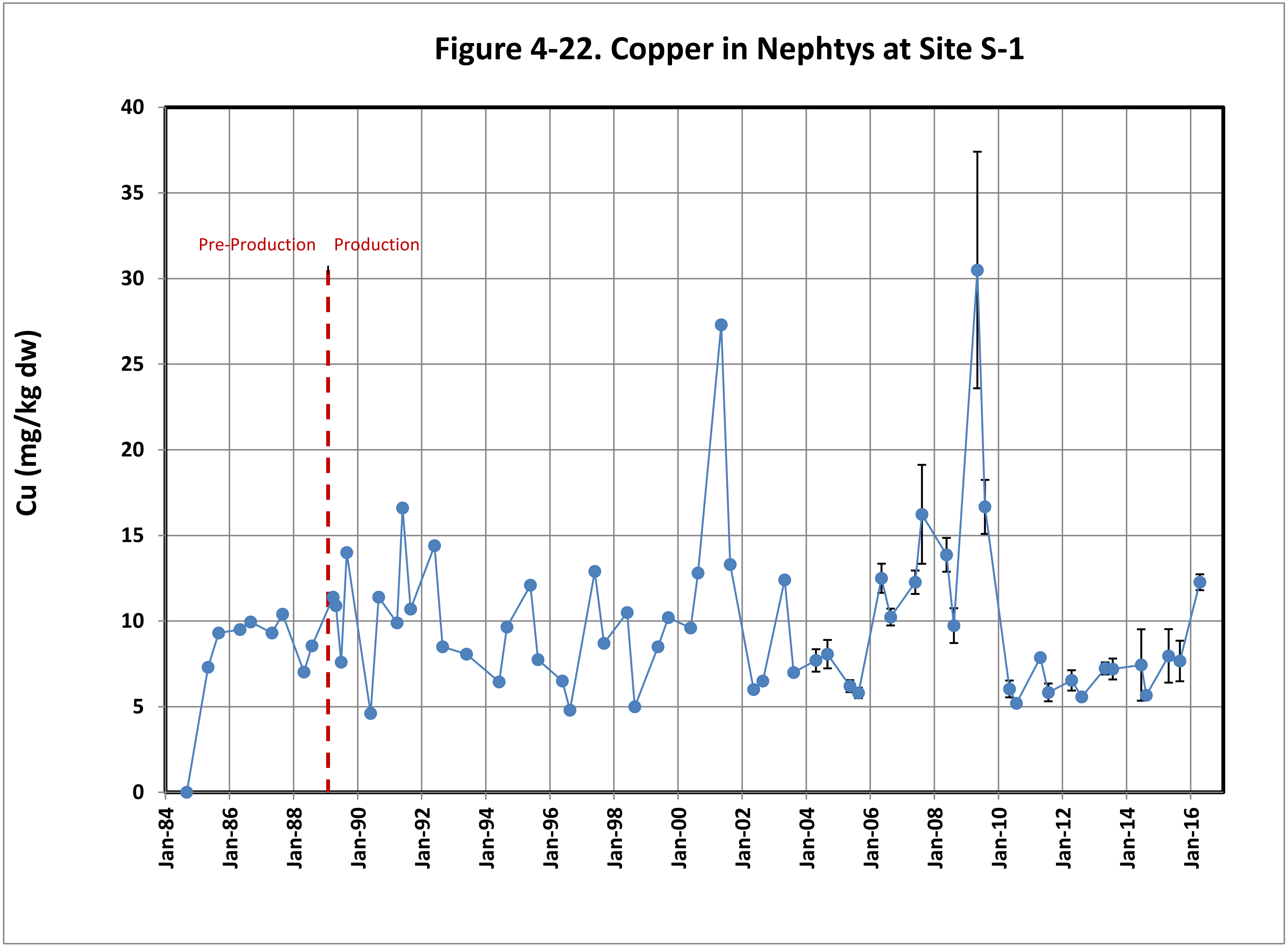


Figure 4-22. Copper in Nephtys at Site S-1
Cu (mg/kg dw)
Pre-Production
Production
0
5
10
15
20
25
30
35
40
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

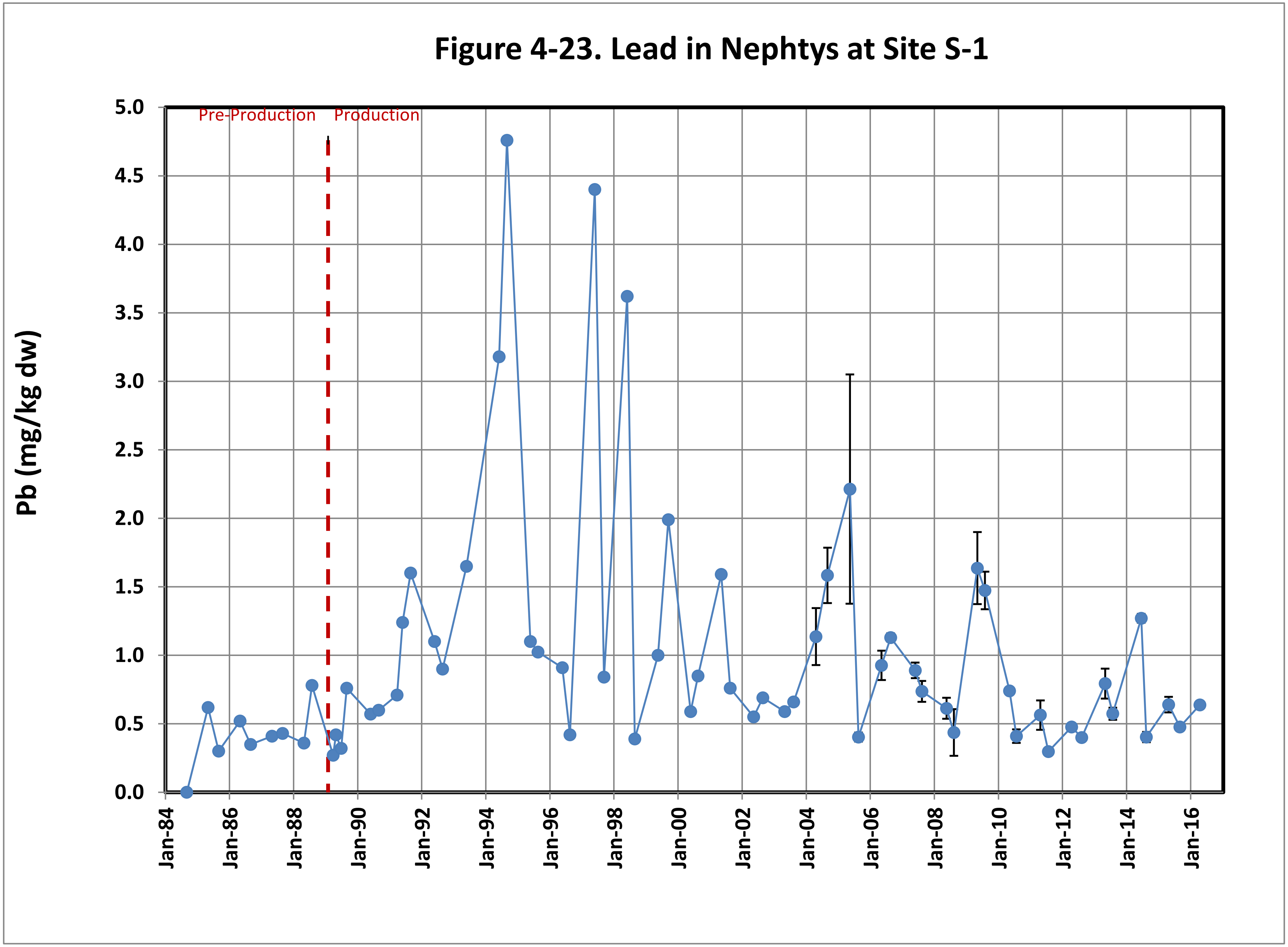


Figure 4-23. Lead in Nephtys at Site S-1
Pb (mg/kg dw)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

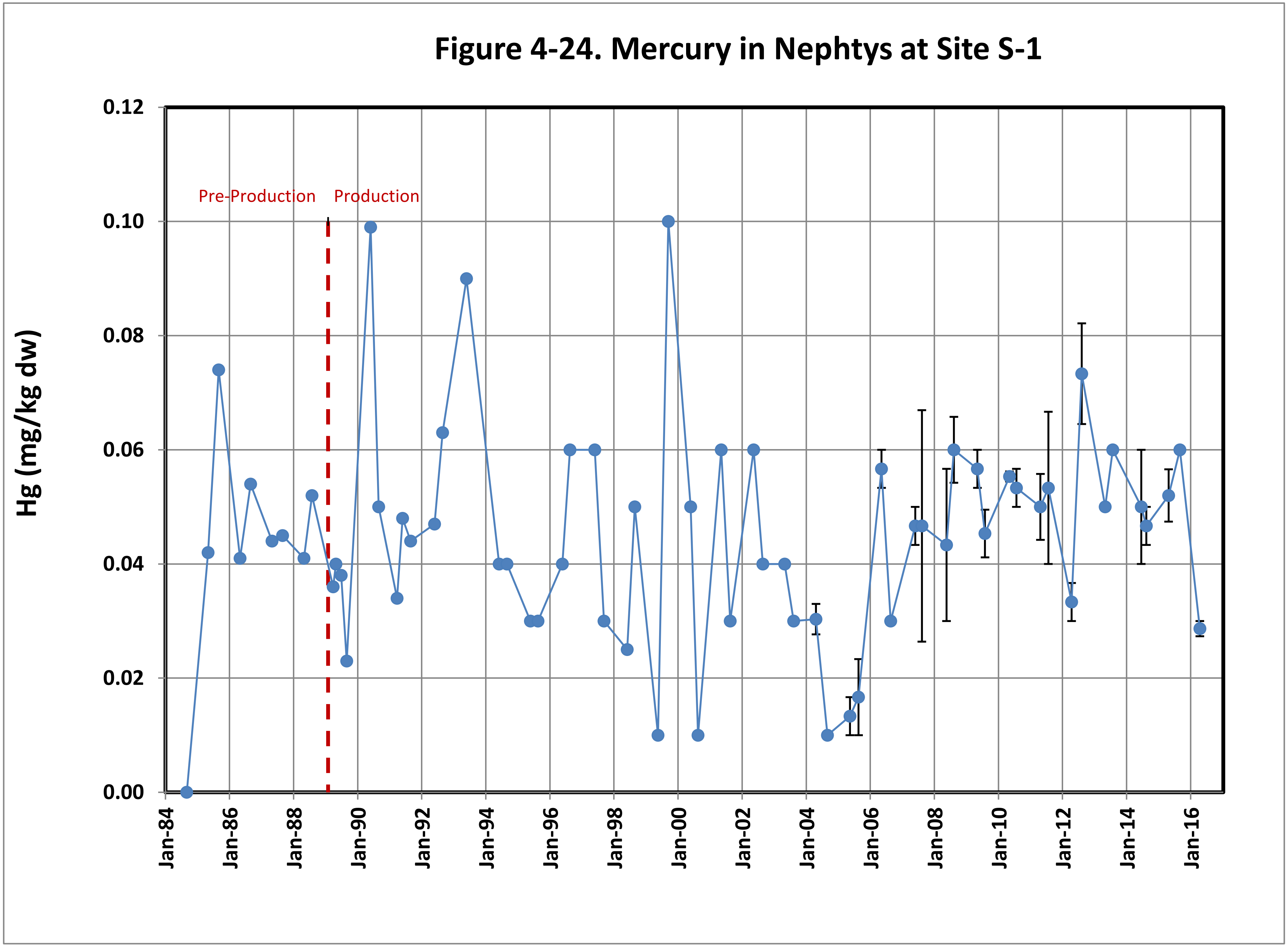


Figure 4-24. Mercury in Nephtys at Site S-1
Hg (mg/kg dw)
Pre-Production
Production
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

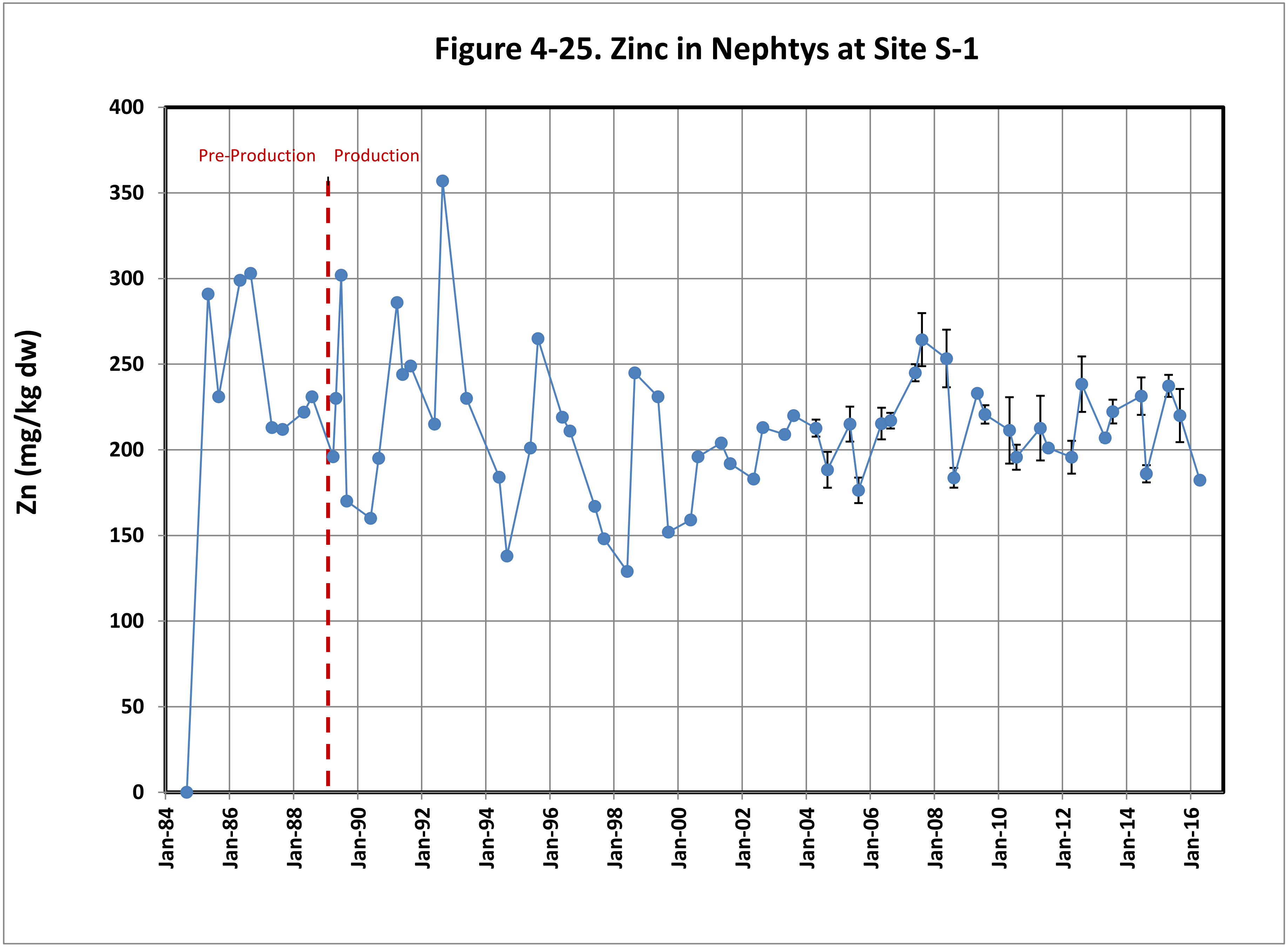


Figure 4-25. Zinc in Nephtys at Site S-1
Zn (mg/kg dw)
400
350
300
250
200
150
100
50
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-26. Cadmium in Nephtys at Site S-2

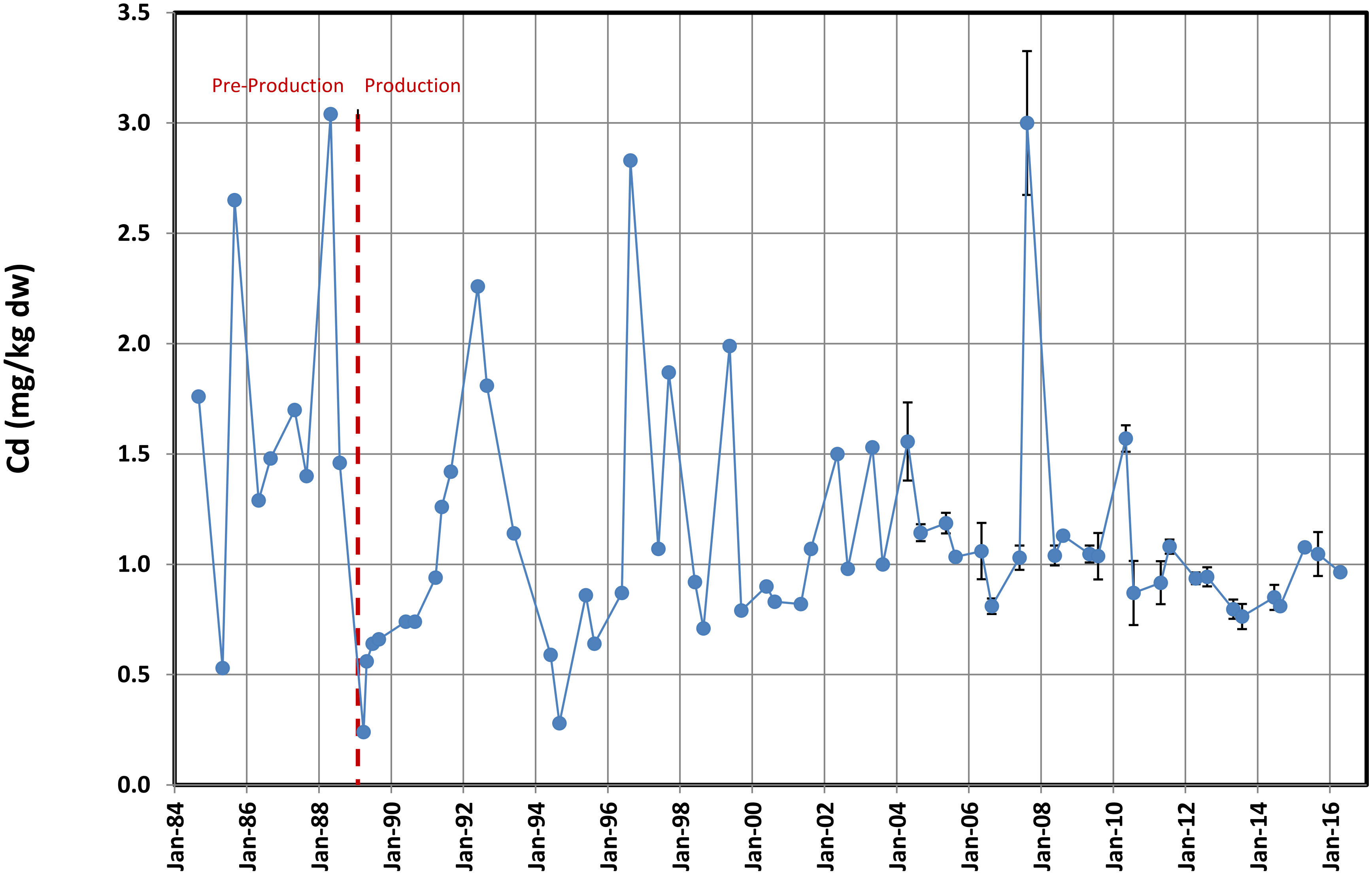
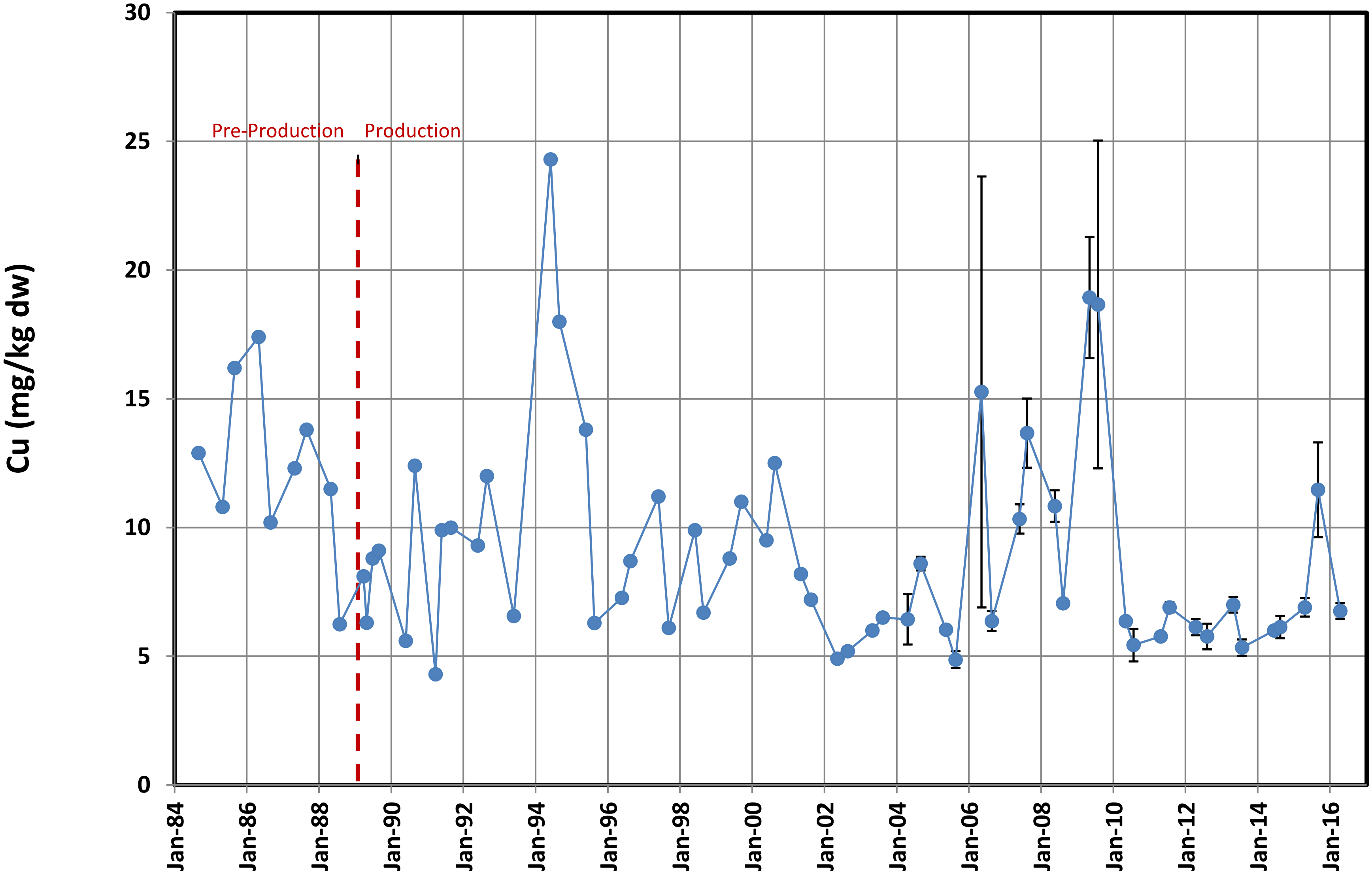


Figure 4-27. Copper in Nephtys at Site S-2



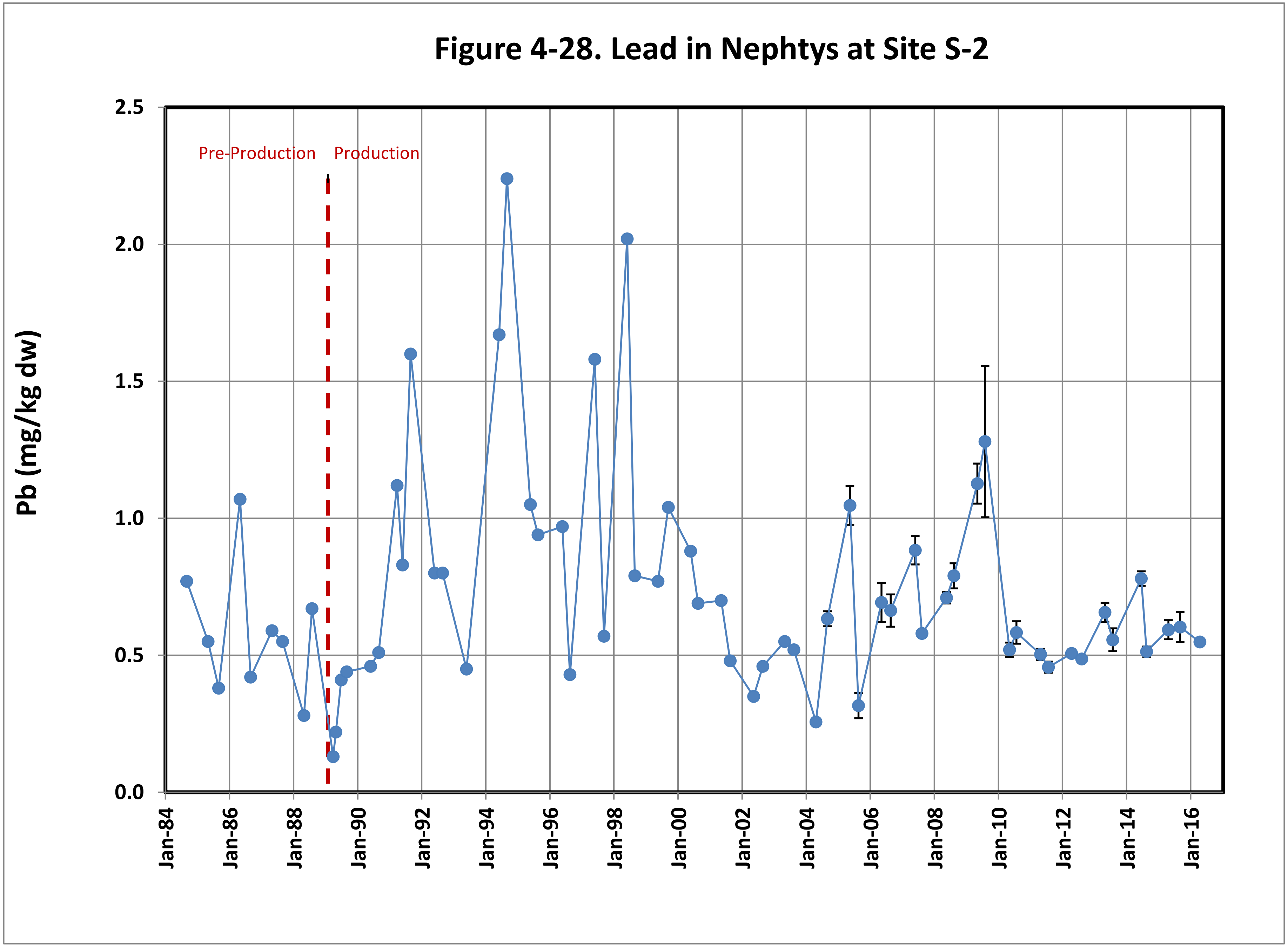


Figure 4-28. Lead in Nephtys at Site S-2
Pb (mg/kg dw)
2.5
2.0
1.5
1.0
0.5
0.0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

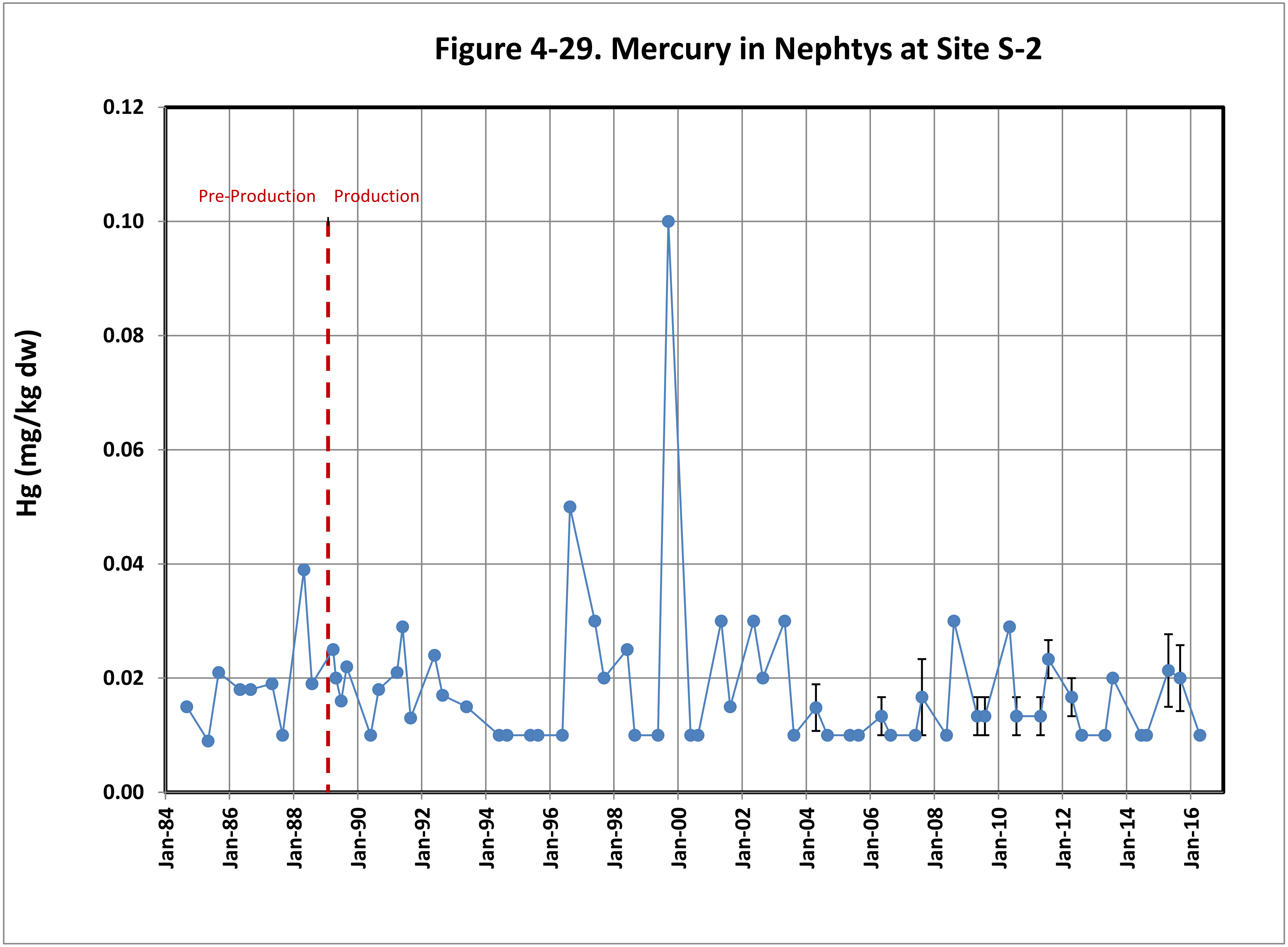


Figure 4-29. Mercury in Nephtys at Site S-2
Hg (mg/kg dw)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

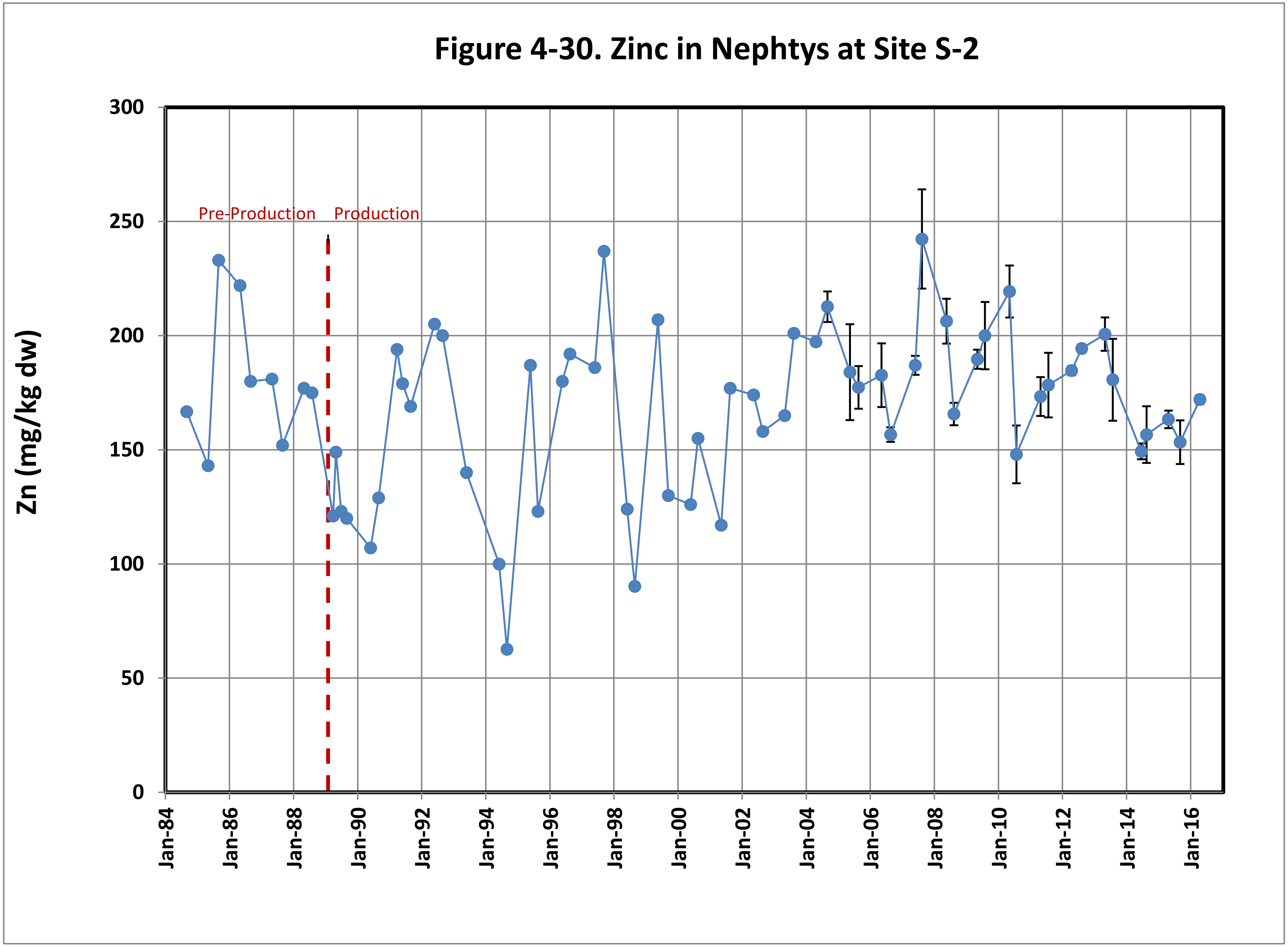


Figure 4-30. Zinc in Nephtys at Site S-2
Zn (mg/kg dw)
300
250
200
150
100
50
0
Pre-Production
Production
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-31. Cadmium in Nephtys at Site S-4

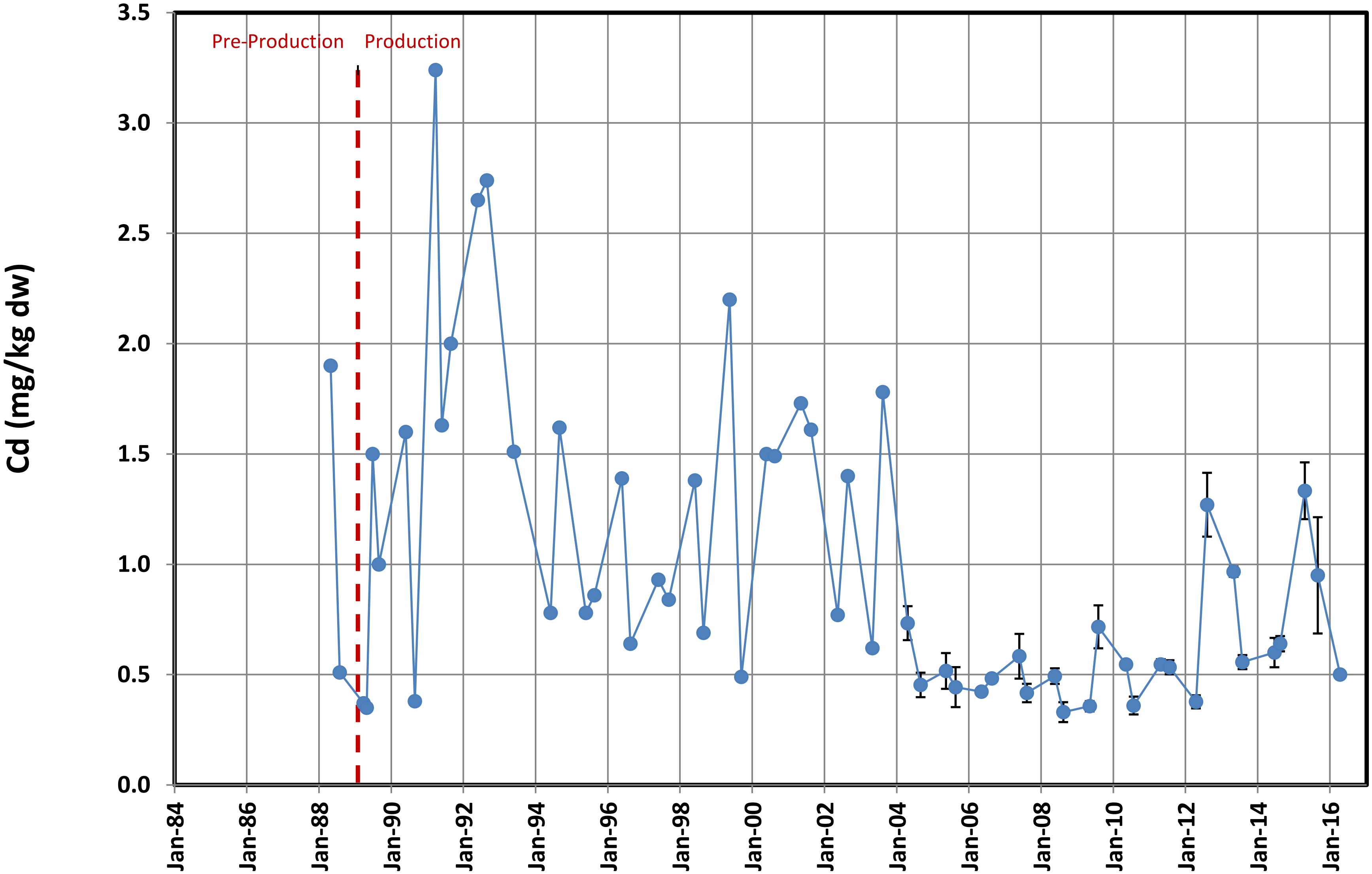
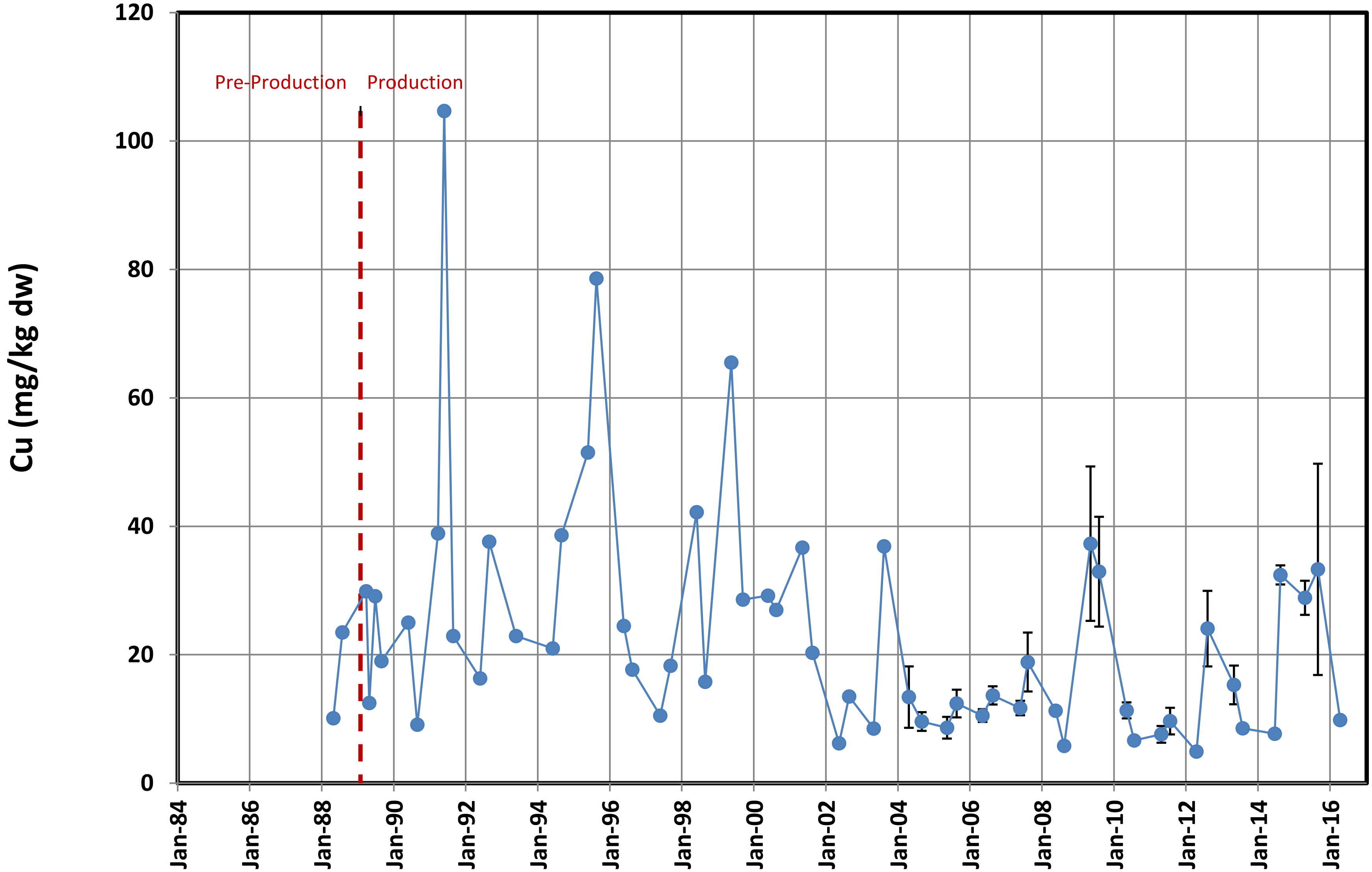


Figure 4-32. Copper in Nephtys at Site S-4



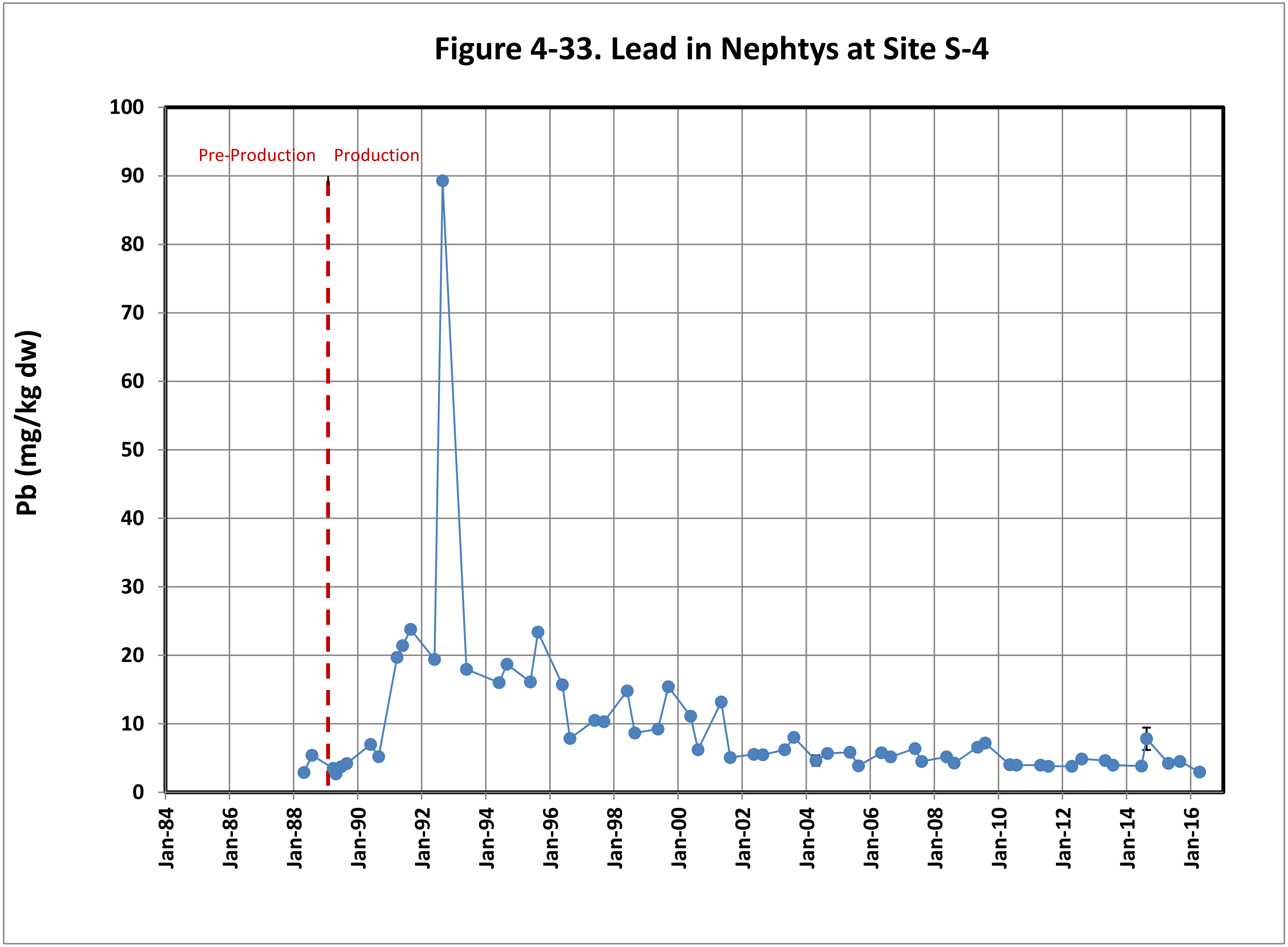


Figure 4-33. Lead in Nephtys at Site S-4
Pb (mg/kg dw)
Pre-Production
Production
100
90
80
70
60
50
40
30
20
10
0
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16

Figure 4-34. Mercury in Nephtys at Site S-4

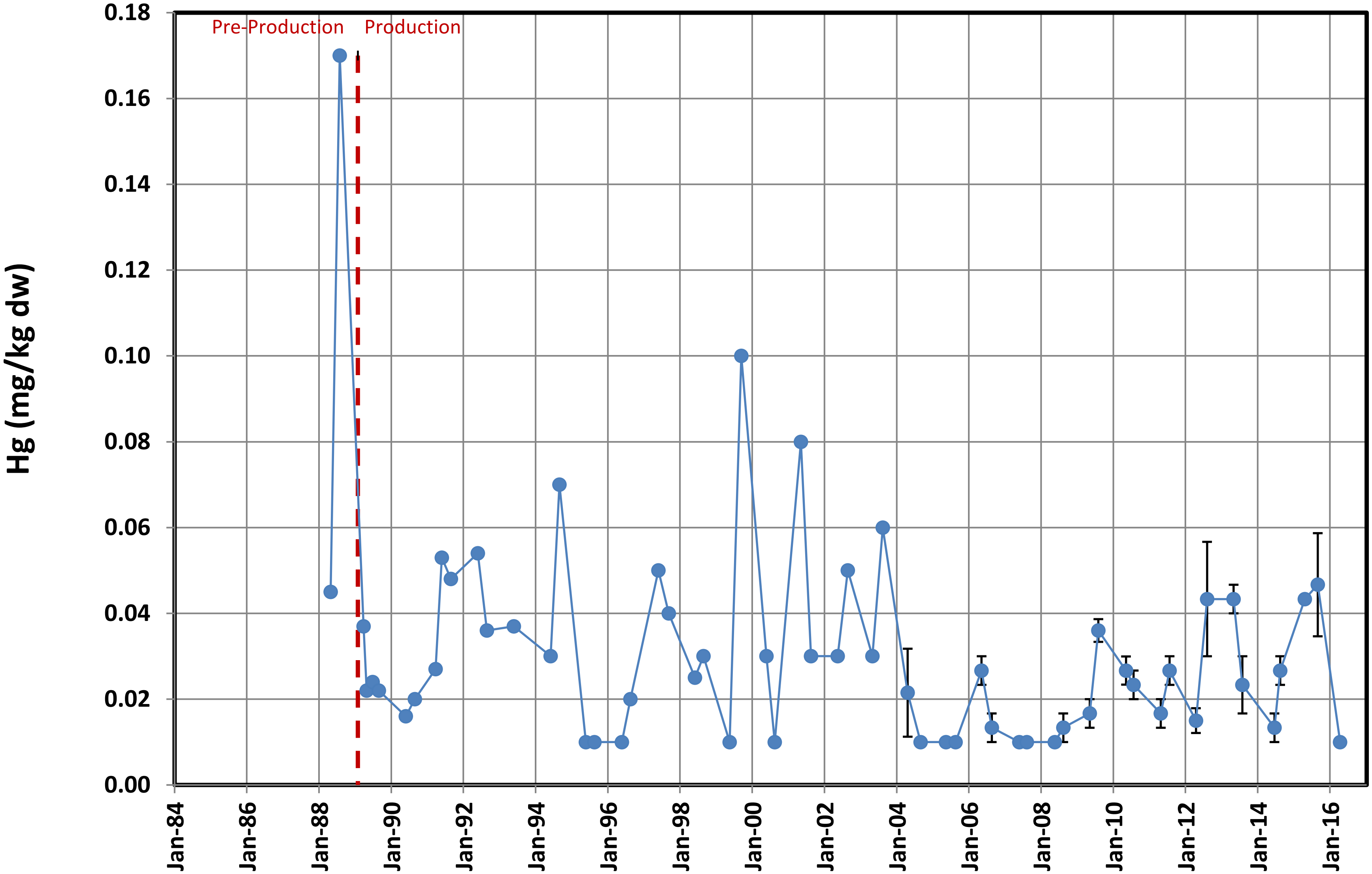
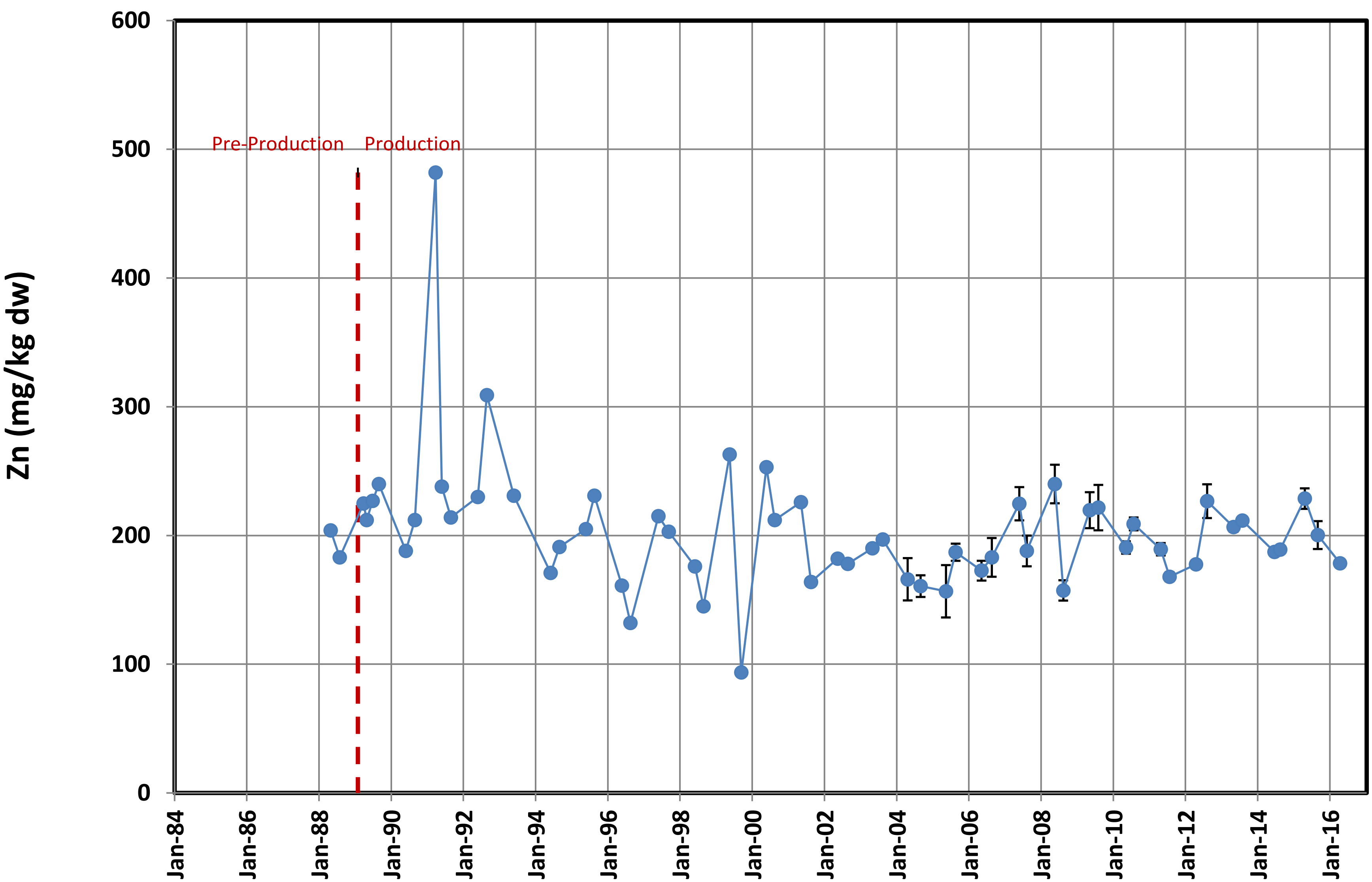


Figure 4-35. Zinc in Nephtys at Site S-4



APPENDIX A

Sediment Method Reporting Limit

2016 Laboratory Detection Limits for Sediment Analysis		
Sample ID	**Metal**	**2016**
	mg/Kg/dw	MRL
S-1 Sediment Rep I	Cadmium, Total	0.018
	Copper, Total	0.091
	Lead, Total	0.046
	Mercury, Total	0.020
	Zinc, Total	0.46
S-1 Sediment Rep II	Cadmium, Total	0.021
	Copper, Total	0.10
	Lead, Total	0.052
	Mercury, Total	0.019
	Zinc, Total	0.52
S-1 Sediment Rep III	Cadmium, Total	0.017
	Copper, Total	0.087
	Lead, Total	0.043
	Mercury, Total	0.019
	Zinc, Total	0.43
S-1 Sediment Rep IV	Cadmium, Total	0.020
	Copper, Total	0.098
	Lead, Total	0.049
	Mercury, Total	0.019
	Zinc, Total	0.49
S-1 Sediment Rep V	Cadmium, Total	0.017
	Copper, Total	0.085
	Lead, Total	0.042
	Mercury, Total	0.020
	Zinc, Total	0.42
S-1 Sediment Rep VI	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.049
	Mercury, Total	0.018
	Zinc, Total	0.49
S-2 Sediment Rep I	Cadmium, Total	0.012
	Copper, Total	0.061
	Lead, Total	0.031
	Mercury, Total	0.018
	Zinc, Total	0.31
S-2 Sediment Rep II	Cadmium, Total	0.012
	Copper, Total	0.058
	Lead, Total	0.029
	Mercury, Total	0.018
	Zinc, Total	0.29
S-2 Sediment Rep III	Cadmium, Total	0.012
	Copper, Total	0.058
	Lead, Total	0.029
	Mercury, Total	0.019
	Zinc, Total	0.29
S-2 Sediment Rep IV	Cadmium, Total	0.012
	Copper, Total	0.060
	Lead, Total	0.030
	Mercury, Total	0.019

2016 Laboratory Detection Limits for Sediment Analysis		
Sample ID	**Metal**	**2016**
	mg/Kg/dw	MRL
S-2 Sediment Rep IV	Zinc, Total	0.30
S-2 Sediment Rep V	Cadmium, Total	0.011
	Copper, Total	0.057
	Lead, Total	0.029
	Mercury, Total	0.018
	Zinc, Total	0.29
S-2 Sediment Rep VI	Cadmium, Total	0.012
	Copper, Total	0.060
	Lead, Total	0.030
	Mercury, Total	0.018
	Zinc, Total	0.30
S-3 Sediment Rep I	Cadmium, Total	0.024
	Copper, Total	0.12
	Lead, Total	0.059
	Mercury, Total	0.021
	Zinc, Total	0.59
S-3 Sediment Rep II	Cadmium, Total	0.022
	Copper, Total	0.11
	Lead, Total	0.055
	Mercury, Total	0.020
	Zinc, Total	0.55
S-3 Sediment Rep III	Cadmium, Total	0.020
	Copper, Total	0.10
	Lead, Total	0.051
	Mercury, Total	0.021
	Zinc, Total	0.51
S-3 Sediment Rep IV	Mercury, Total	0.021
	Cadmium, Total	0.023
	Copper, Total	0.11
	Lead, Total	0.057
	Zinc, Total	0.57
S-3 Sediment Rep V	Mercury, Total	0.021
	Cadmium, Total	0.023
	Copper, Total	0.11
	Lead, Total	0.057
	Zinc, Total	0.57
S-3 Sediment Rep VI	Cadmium, Total	0.016
	Copper, Total	0.082
	Mercury, Total	0.020
	Zinc, Total	0.41
	Lead, Total	0.041
S-4 Sediment Rep I	Cadmium, Total	0.012
	Copper, Total	0.061
	Lead, Total	0.031
	Mercury, Total	0.019
	Zinc, Total	0.31

Method Reporting Limit (MRL) – Defined by ALS Environmental as being 3 times the MDL (or greater).

2016 Laboratory Detection Limits for Sediment Analysis				2016 Laboratory Detection Limits for Sediment Analysis		
Sample ID	**Metal**	**2016**		**Sample ID**	**Metal**	**2016**
	mg/Kg/dw	MRL			mg/Kg/dw	MRL
S-4 Sediment Rep II	Cadmium, Total	0.011		S-5N Sediment Rep VI	Zinc, Total	0.88
	Copper, Total	0.053			Mercury, Total	0.019
	Lead, Total	0.026			Cadmium, Total	0.015
	Mercury, Total	0.018			Copper, Total	0.074
	Zinc, Total	0.26			Lead, Total	0.037
S-4 Sediment Rep III	Cadmium, Total	0.012		S-5S Sediment Rep I	Lead, Total	0.038
	Copper, Total	0.062			Mercury, Total	0.019
	Lead, Total	0.031			Cadmium, Total	0.015
	Mercury, Total	0.020			Copper, Total	0.076
	Zinc, Total	0.31			Zinc, Total	0.76
S-4 Sediment Rep IV	Cadmium, Total	0.013		S-5S Sediment Rep II	Lead, Total	0.036
	Copper, Total	0.064			Mercury, Total	0.019
	Mercury, Total	0.018			Cadmium, Total	0.014
	Zinc, Total	0.32			Copper, Total	0.072
	Lead, Total	0.032			Zinc, Total	140
S-4 Sediment Rep V	Cadmium, Total	0.013		S-5S Sediment Rep III	Lead, Total	0.034
	Copper, Total	0.066			Mercury, Total	0.020
	Mercury, Total	0.018			Cadmium, Total	0.013
	Zinc, Total	0.33			Copper, Total	0.067
	Lead, Total	0.033			Zinc, Total	0.67
S-4 Sediment Rep VI	Cadmium, Total	0.012		S-5S Sediment Rep IV	Mercury, Total	0.018
	Copper, Total	0.061			Cadmium, Total	0.019
	Mercury, Total	0.019			Copper, Total	0.094
	Zinc, Total	0.30			Lead, Total	0.047
	Lead, Total	0.030			Zinc, Total	0.94
S-5N Sediment Rep I	Cadmium, Total	0.013		S-5S Sediment Rep V	Cadmium, Total	0.013
	Copper, Total	0.063			Copper, Total	0.065
	Lead, Total	0.032			Mercury, Total	0.019
	Mercury, Total	0.018			Zinc, Total	0.65
	Zinc, Total	0.32			Lead, Total	0.033
S-5N Sediment Rep II	Cadmium, Total	0.013		S-5S Sediment Rep VI	Cadmium, Total	0.014
	Copper, Total	0.065			Copper, Total	0.068
	Lead, Total	1.6			Mercury, Total	0.018
	Mercury, Total	0.018			Zinc, Total	0.68
	Zinc, Total	0.32			Lead, Total	0.034
S-5N Sediment Rep III	Cadmium, Total	0.013				
	Copper, Total	0.065				
	Lead, Total	0.032				
	Mercury, Total	0.019				
	Zinc, Total	0.65				
S-5N Sediment Rep IV	Cadmium, Total	0.013				
	Copper, Total	0.066				
	Mercury, Total	0.019				
	Zinc, Total	0.66				
	Lead, Total	0.033				
S-5N Sediment Rep V	Mercury, Total	0.019				
	Cadmium, Total	0.018				
	Copper, Total	0.088				
	Lead, Total	0.044				
	Zinc, Total	0.88				

2016 Laboratory Detection Limits for Mussels Analysis				2016 Laboratory Detection Limits for Mussels Analysis		
Sample ID	**Metal**	**2016**		**Sample ID**	**Metal**	**2016**
	mg/Kg/dw	MRL			mg/Kg/dw	MRL
STN-1 Mussel Rep I	Cadmium, Total	0.019		STN-2 Mussel Rep V	Cadmium, Total	0.019
	Copper, Total	0.095			Copper, Total	0.097
	Lead, Total	0.019			Lead, Total	0.019
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.48			Zinc, Total	0.49
STN-1 Mussel Rep II	Cadmium, Total	0.020		STN-2 Mussel Rep VI	Cadmium, Total	0.020
	Copper, Total	0.099			Copper, Total	0.098
	Lead, Total	0.020			Lead, Total	0.020
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.49			Zinc, Total	0.49
STN-1 Mussel Rep III	Cadmium, Total	0.020		STN-3 Mussel Rep I	Cadmium, Total	0.019
	Copper, Total	0.100			Copper, Total	0.097
	Lead, Total	0.020			Lead, Total	0.019
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.50			Zinc, Total	0.48
STN-1 Mussel Rep IV	Cadmium, Total	0.020		STN-3 Mussel Rep II	Cadmium, Total	0.020
	Copper, Total	0.099			Copper, Total	0.099
	Lead, Total	0.020			Lead, Total	0.020
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.49			Zinc, Total	0.50
STN-1 Mussel Rep V	Cadmium, Total	0.019		STN-3 Mussel Rep III	Cadmium, Total	0.020
	Copper, Total	0.096			Copper, Total	0.099
	Lead, Total	0.019			Lead, Total	0.020
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.48			Zinc, Total	0.50
STN-1 Mussel Rep VI	Cadmium, Total	0.019		STN-3 Mussel Rep IV	Cadmium, Total	0.020
	Copper, Total	0.097			Copper, Total	0.099
	Lead, Total	0.019			Lead, Total	0.020
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.49			Zinc, Total	0.50
STN-2 Mussel Rep I	Cadmium, Total	0.020		STN-3 Mussel Rep V	Cadmium, Total	0.019
	Copper, Total	0.099			Copper, Total	0.096
	Lead, Total	0.020			Lead, Total	0.019
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.50			Zinc, Total	0.48
STN-2 Mussel Rep II	Cadmium, Total	0.020		STN-3 Mussel Rep VI	Cadmium, Total	0.019
	Copper, Total	0.100			Copper, Total	0.094
	Lead, Total	0.020			Lead, Total	0.019
	Mercury, Total	0.020			Mercury, Total	0.020
	Zinc, Total	0.50			Zinc, Total	0.47
STN-2 Mussel Rep III	Cadmium, Total	0.020				
	Copper, Total	0.098				
	Lead, Total	0.020				
	Mercury, Total	0.020				
	Zinc, Total	0.49				
STN-2 Mussel Rep IV	Cadmium, Total	0.020				
	Copper, Total	0.099				
	Lead, Total	0.020				
	Mercury, Total	0.020				
	Zinc, Total	0.50				

2016 Laboratory Detection Limits for Mussels Analysis		
Sample ID	**Metal**	**2016**
	mg/Kg/dw	MRL
ESL Mussel Rep I	Cadmium, Total	0.019
	Copper, Total	0.097
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.48
ESL Mussel Rep II	Cadmium, Total	0.019
	Copper, Total	0.094
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.47
ESL Mussel Rep III	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50
ESL Mussel Rep IV	Cadmium, Total	0.019
	Copper, Total	0.093
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.46
ESL Mussel Rep V	Cadmium, Total	0.019
	Copper, Total	0.096
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.48
ESL Mussel Rep VI	Cadmium, Total	0.020
	Copper, Total	0.098
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.49

2016 Laboratory Detection Limits for *Nephtys* Analysis		
Sample ID	**Metal**	**2016**
	mg/Kg/dw	DL
S-1 Nephtys Rep I	Cadmium, Total	0.019
	Copper, Total	0.097
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.48
S-1 Nephtys Rep II	Cadmium, Total	0.019
	Copper, Total	0.093
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.46
S-1 Nephtys Rep III	Cadmium, Total	0.019
	Copper, Total	0.094
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.47
S-1 Nephtys Rep IV	Cadmium, Total	0.019
	Copper, Total	0.096
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.48
S-1 Nephtys Rep V	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50
S-1 Nephtys Rep VI	Cadmium, Total	0.019
	Copper, Total	0.096
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.48
S-2 Nephtys Rep I	Cadmium, Total	0.020
	Copper, Total	0.098
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.49
S-2 Nephtys Rep II	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50
S-2 Nephtys Rep III	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.49
S-2 Nephtys Rep IV	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50

2016 Laboratory Detection Limits for *Nephtys* Analysis		
Sample ID	**Metal**	**2016**
	mg/Kg/dw	DL
S-2 Nephtys Rep V	Cadmium, Total	0.019
	Copper, Total	0.094
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.47
S-2 Nephtys Rep VI	Cadmium, Total	0.020
	Copper, Total	0.098
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.49
S-4 Nephtys Rep I	Cadmium, Total	0.019
	Copper, Total	0.096
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.48
S-4 Nephtys Rep II	Cadmium, Total	0.019
	Copper, Total	0.094
	Lead, Total	0.019
	Mercury, Total	0.020
	Zinc, Total	0.47
S-4 Nephtys Rep III	Cadmium, Total	0.020
	Copper, Total	0.099
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50
S-4 Nephtys Rep IV	Cadmium, Total	0.020
	Copper, Total	0.10
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50
S-4 Nephtys Rep V	Cadmium, Total	0.020
	Copper, Total	0.100
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.50
S-4 Nephtys Rep VI	Cadmium, Total	0.020
	Copper, Total	0.098
	Lead, Total	0.020
	Mercury, Total	0.020
	Zinc, Total	0.49

Method Reporting Limit (MRL) – Define by ALS Environmental as being times the MDL (or greater).

APPENDIX B

Outfall Survey Footage

Provided electronically to the Alaska Department of Environmental Conservation