4.0
SAMPLE COLLECTION METHODS

Animals were popped off the rocks with a clean stainless steel blade using a quick twisting motion to minimize the amount of substrate scraped up with the animal. Animals were transferred to personnel for shucking. The animals were handled with Nitrile gloves, and the whole body tissue samples were scraped into clean glass jars using a clean knife for each sample. Any opihi in which a foot contacted the shell of another opihi, was not used for the sample. The 30-gram sample size required for the PAH analysis was estimated as approximately 30 cubic centimeters. Samples were placed on ice in a cooler immediately upon collection. Samples collected in September were placed in a freezer upon return to the command center on Kauai at the Outrigger Hotel, and were shipped on dry ice to Arthur D. Little (ADL) laboratory in Cambridge, Massachusetts.

Samples were collected in November in a similar way, according to the "Sampling and Analysis Plan, Opihi Samples," October 2, 1998, prepared by ENTRIX, Inc. The opihi were placed, shell side down, on clean aluminum trays and the animals were carried to a central area for processing as described above.

To prevent the misidentification of samples collected, each jar was labeled after collection with a unique sample identification number. The shells were placed in ZipLok™ bags for later measuring. In September, shells were segregated according to opihi species. In November, shells were segregated according to respective samples/jars. The shells were sent to John Cubit at NOAA, where they were measured.

A chain of custody record was completed to accompany each shipment of samples to the laboratory. The chain of custody form was used to establish the documentation necessary to trace sample possession from the time of collection until laboratory analysis. The samples collected during the November sampling event were stored in a cooler with frozen ice packs and dry ice under custody of Clayton Environmental Consultants until shipment to the laboratory. The samples and the chain of custody form were then shipped to ADL laboratory in Cambridge, Massachusetts, by overnight delivery on 3 November 1998. The laboratory received the samples frozen and intact on 4 November 1998.

4.1 DECONTAMINATION PROCEDURES

Nitrile gloves were used for handling the opihi and were changed between samples to prevent cross-contamination. The stainless steel knives that were reused were decontaminated after the collection of each sample by washing with water, rinsing with distilled water, and wiping with isopropyl alcohol. The sampling equipment was then air dried or wiped with paper towels.

5.1 LABORATORY ANALYSES

ADL laboratory analyzed four of the eight opihi samples collected on 23 September 1998 and all 14 samples collected on 2 and 3 November 1998 for alkylated PAHs according to modified EPA Method 8270 using gas chromatography/mass spectrometry in the selective ion monitoring mode (GC/MS-SIM). The laboratory was requested to retain all tissue residues. ADL laboratory analyzed a sample of the oil released in the SPM Hose Spill with the tissue batch for comparison. Quality control samples analyzed and reported by the laboratory included a procedural blank, matrix spike, matrix spike duplicate, and standard reference material, as well as surrogate spike results for each sample. A copy of the laboratory data report is included in Appendix B.

5.2 DATA QUALITY REVIEW

An ENTRIX chemist (Judy Nedoff) reviewed the laboratory results for compliance with quality criteria. Data validation includes but is not limited to a review of sample integrity (information from chain of custody form), review of detection and reporting limits, appropriate significant figures, and completeness of report. In addition, quality control data reported by the laboratory are reviewed to determine whether precision and accuracy criteria were achieved. In this opihi data report, results for the procedural blank, surrogate spikes, matrix spike samples, and standard reference material samples were reviewed as indicators of the laboratory's ability to measure sample concentrations accurately. Results for the matrix spike duplicate pair were compared to precision criteria and indicate the laboratory's ability to produce consistent results.

Results of the data quality review indicate that the data can be accepted for use with some qualifications. Naphthalene was detected in the procedural blank at 25 µg/kg (parts per billion - ppb) on a dry weight basis, which is higher than the concentration of naphthalene detected in many of the opihi samples. Benzo(ghi)perylene was detected in the blank at 14 µg/kg. This indicates the analytical system (e.g., reagents) contains interferences that may impact the accuracy of some sample results. In the data validation process, when a constituent is detected in a sample that is also detected in the associated procedural blank, qualification of the sample result is necessary unless the concentration in the sample is five times greater than the level in the blank (USEPA 1994). In this data set, naphthalene was detected in all the opihi samples at levels less than five times the level in the blank. One opihi sample contained benzo(ghi)perylene at a level less than five times that in the blank. A "U" qualifier was added to these results during validation, indicating that the constituent concentrations are equivalent to not detected.

Results for surrogate spike, matrix spike and duplicate matrix spike analyses met acceptance criteria for accuracy in all samples. However, as the report narrative explains, results for the tissue standard reference material (SRM) did not meet acceptance criteria. ADL analyzed the SRM a second time and obtained similar results. During the same period, the SRM was analyzed in triplicate for an interlaboratory study, and these analyses met the acceptance criteria. The SRM failed because six of the thirteen PAHs were detected at elevated concentrations relative to expected levels, indicating that levels of these compounds measured in opihi samples may be biased high. Of the six PAHs that failed the criteria, one was detected in two opihi samples, and four were detected in only one opihi sample. Five were detected in a sample from Ahukini which had an anomalous PAH distribution compared to the other opihi samples, as described in Section 6.2.2. A Standard Reference Material is prepared by an independent source and used by the laboratory to check the accuracy of its measurements. Generally, accuracy of analytical data is not considered questionable based on results of the SRM alone when sufficient other accuracy measurements have been made and meet acceptance criteria, such as in this case.

Total PAH concentrations for opihi samples are summarized in Table 6-1. Total PAH as reported by the laboratory and total PAH adjusted for blank contamination (values qualified with a U subtracted) are shown.

Opihi samples collected on 23 September in the oiled boulder area at Kipu Kai showed total PAH (adjusted) concentrations ranging from 140 to 340 µg/kg (parts per billion) dry weight for the three blackfoot opihi samples, and 14 µg/kg for the one yellowfoot opihi sample. Three blackfoot opihi samples collected on 2 November from the same area contained 13 to 67 µg/kg total PAH (adjusted). Two blackfoot opihi samples collected on 2 November from the limestone outcropping area of Kipu Kai (formerly lightly oiled) contained 7.6 and 14 µg/kg total PAH (adjusted). Two blackfoot opihi samples were collected from each of two non-oiled areas of Kipu Kai on 2 November. Total PAH (adjusted) concentrations in these four samples ranged from 15 to 40 µg/kg.

Two blackfoot opihi samples were collected from an area at Ahukini that had been oiled in September. Total PAH (adjusted) concentrations in these samples were 13 and 180 µg/kg. Two opihi samples collected from Ninini Point (a non-oiled area near Ahukini) contained 6.3 and 8 µg/kg total PAH (adjusted).

In addition, one opihi sample was collected from Haena, which was outside the area of Kauai coastline known to have been oiled as a result of the SPM Hose Spill. Only one sample could be collected due to dangerous surf conditions at the time of sampling. This sample contained 10 µg/kg total PAH (adjusted).

6.1 INTERPRETATION OF PAH RESULTS

6.1.1 SEPTEMBER 1998 OPIHI RESULTS

Based on the samples collected in September 1998 and on a comparison of the PAH tissue concentrations measured in opihi from reference sites in November (Table 6-1), a qualitative case can be made for exposure of the blackfoot species (*C. exarata*) to petroleum. This conclusion is based on two points of evidence:

- The total adjusted PAH concentration measured in these samples (140 to 410 µg/kg dry wt.) is approximately 10 times greater than total adjusted PAH concentrations measured six weeks later in the Kipu Kai reference areas (15 to 40 µg/kg dry wt.);

Table 6-1. Summary of Total PAH Results in Opihi Samples Collected September 23 and November 2 and 3 1998

Location	Sample Name	Minimum Reporting Limit	Total PAH	Total PAH adjusted*
		ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.
Kipu Kai, oiled boulders	Blackfoot 1	35	150	140
September 23, 1998	Blackfoot 4A/4B	35	440	410
	Blackfoot 6	29	350	340
	Yellow Foot 1	34	38	14
	Average Value			**226**
Kipu Kai, oiled boulders	SITE2S-KIPU	29	80	67
November 2, 1998	SITE 2S KIPU - Jar 2	23	47	29
	SITE 2S KIPU - Jar 3	24	25	13
	Average Value			**36**
Kipu Kai,	SITE2N-KIPU	25	26	14
oiled limestone	SITE 2N KIPU - Jar 2	20	25	7.6
November 2, 1998	**Average Value**			**11**
Kipu Kai,	SITE3-KIPU	35	38	21
reference areas	SITE 3 KIPU - Jar 2	28	39	19
November 2, 1998	SITE4-KIPU	34	32	15
	SITE 4 KIPU - Jar 2	34	81	40
	Average Value			**24**
Ahukini, oiled boulders	SITE1-AHU	31	220	180
November 2, 1998	SITE 1 AHU - Jar 2	28	29	13
	Average Value			**97**
Ahukini, reference	SITE5-NINI	23	17	8
November 3, 1998	SITE 5 NINI - Jar 2	21	20	6.3
	Average Value			7.2
Haena, control November 3, 1998	SITE 6-KEE	28	25	10

- The distribution of PAHs measured in the blackfoot samples (Table 6-2, Figure 6-1) indicates that the PAHs in these samples are dominated by phenanthrenes and dibenzothiophenes (all samples also contained naphthalene, however, not at levels above those found in the method blanks). Within these homologous families, most of the blackfoot samples are characterized by higher concentrations of the more highly alkylated PAHs. While there is not enough information in the PAH suite to make defensible conclusions regarding the specific source of these PAHs, the distribution is consistent with exposure to weathered oil. A probable source of the weathered oil is the SPM Hose Spill. If the PAH concentrations found in these samples were derived from non-petroleum sources (e.g., PAHs associated with post-combustion air-borne particulates, creosote, etc.), one would expect to see PAH distributions dominated by detectable levels of higher molecular weight PAHs (e.g., chrysenes, benzo[a]pyrene, etc.) and low levels of the alkylated homologues.

Total PAH concentration (14 µg/kg dry wt.) and the PAH distribution (see Table 6-2) measured in the yellowfoot sample from Kipu Kai in September 1998 are similar to those measurements in the blackfoot opihi collected from the Kipu Kai reference areas in November 1998. This observation is consistent with the hypothesis that the intertidal animals collected and analyzed as part of the Yellowfoot 1 sample were exposed to little if any petroleum from the Tesoro release.

6.1.2 NOVEMBER 1998 OPIHI RESULTS

6.1.2.1 Reference and Control Site Samples

A total of six reference and one control site samples were collected and analyzed for alkylated PAHs. At Kipu Kai, the total adjusted PAH concentrations for the four reference samples ranged from 15 to 40 µg/kg dry wt. (Table 6-1). PAH distributions for these samples (presented in Table 6-2) indicate that minor amounts of phenanthrene are present in the these tissue samples. As discussed above, the naphthalene concentrations are below those found in the method blanks. The Ahukini reference and the Haena control samples (see Tables 6-1 and 6-2) have total adjusted PAH concentrations in the range 10 to 6.3 µg/kg dry wt., and distributions similar to those seen in the reference samples from Kipu Kai. Based on the similarities in total adjusted PAH concentrations (6.3 to 40 µg/kg dry wt.; mean 17±11 µg/kg dry wt.) and on the relative similarity in distributions of PAH homologues within these samples, it appears that these results represent background levels of PAHs in the local environment.

6.1.2.2 Kipu Kai Samples

A review of Table 6-1 shows that the total adjusted PAH concentrations measured in opihi samples collected from the possibly oiled limestone area (14 and 7.6 µg/kg dry wt.) and in most samples collected from the oiled boulder area (13 to 67 µg/kg dry wt.; mean 36±28 µg/kg dry wt.) largely overlap the results from the Kipu Kai reference sites and indicate a close approach to background levels of tissue PAHs measured in the local

Table 6-2. PAH Distribution in Opihi Samples Collected September and November 1998

Field ID			Blackfoot 1	Blackfoot 4A/4B	Blackfoot 6	Yellow Foot 1	SITE2S-KIPU	SITE 2S KIPU - JAR 2	SITE 2S KIPU - JAR 3
Field Date			09/23/98	09/23/98	09/23/98	09/23/98	11/02/98	11/02/98	11/02/98
Min Reporting Limit			35	35	29	34	29	23	24
Units			ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.
PAH Compounds	# Rings	Abbr.							
Naphthalene	2	N	13 JB U	32 JB U	16 JB U	24 JB U	13 JB U	18 JB U	12 JB U
C1-Naphthalenes	2	N1	ND	ND	ND	ND	14 J	16 J	ND
C2-Naphthalenes	2	N2	ND	ND	ND	ND	ND	ND	ND
C3-Naphthalenes	2	N3	ND	ND	ND	ND	ND	ND	ND
C4-Naphthalenes	2	N4	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	2	ACY	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	3	ACE	ND	ND	ND	ND	ND	ND	ND
Biphenyl	3	B	ND	ND	ND	ND	ND	ND	ND
Fluorene	3	F	ND	ND	ND	ND	ND	ND	ND
C1-Fluorenes	3	F1	ND	ND	ND	ND	ND	ND	ND
C2-Fluorenes	3	F2	ND	ND	ND	ND	ND	ND	ND
C3-Fluorenes	3	F3	ND	ND	ND	ND	ND	ND	ND
Anthracene	3	A	ND	50	ND	ND	ND	ND	ND
Phenanthrene	3	P	29 J	43	39	14 J	20 J	13 J	13 J
C1-Phenanthrenes/Anthracenes	3	PA1	42	97	95	ND	19 J	ND	ND
C2-Phenanthrenes/Anthracenes	3	PA2	65	91	80	ND	ND	ND	ND
C3-Phenanthrenes/Anthracenes	3	PA3	ND	ND	ND	ND	ND	ND	ND
C4-Phenanthrenes/Anthracenes	3	PA4	ND	ND	ND	ND	ND	ND	ND
Dibenzothiophene	3	DBT	ND	ND	11 J	ND	ND	ND	ND
C1-Dibenzothiophenes	3	DBT1	ND	55	55	ND	ND	ND	ND
C2-Dibenzothiophenes	3	DBT2	ND	76	56	ND	ND	ND	ND
C3-Dibenzothiophenes	3	DBT3	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	4	FL	ND	ND	ND	ND	7 J	ND	ND
Pyrene	4	PY	ND	ND	ND	ND	6.9 J	ND	ND
C1-Fluoranthenes/Pyrenes	4	FLPY1	ND	ND	ND	ND	ND	ND	ND
C2-Fluoranthenes/Pyrenes	4	FLPY2	ND	ND	ND	ND	ND	ND	ND
C3-Fluoranthenes/Pyrenes	4	FLPY3	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	4	BaA	ND	ND	ND	ND	ND	ND	ND
Chrysene	4	C	ND	ND	ND	ND	ND	ND	ND
C1-Chrysenes	4	C1	ND	ND	ND	ND	ND	ND	ND
C2-Chrysenes	4	C2	ND	ND	ND	ND	ND	ND	ND
C3-Chrysenes	4	C3	ND	ND	ND	ND	ND	ND	ND
C4-Chrysenes	4	C4	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	5	BbF	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	5	BkF	ND	ND	ND	ND	ND	ND	ND
Benzo(e)pyrene	5	BeP	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	5	BaP	ND	ND	ND	ND	ND	ND	ND
Perylene	5	Per	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	6	Ind	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	5	DahA	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	6	BghiP	ND	ND	ND	ND	ND	ND	ND
Sum PAHs			150	440	350	38	80	47	25
Adjusted Sum PAHs*			140	410	340	14	67	29	13

* These values do not include values for those PAHs (primarily naphthalene) which are less than 5 times the level in the blank.
Only 2 significant figures used.

Table 6-2. PAH Distribution in Opihi Samples Collected September and November 1998

Field ID			SITE2N-KIPU	SITE 2N KIPU-JAR 2	SITE3-KIPU	SITE 3 KIPU-JAR 2	SITE4-KIPU	SITE 4 KIPU-JAR 2	SITE1-AHU
Field Date			11/02/98	11/02/98	11/02/98	11/02/98	11/02/98	11/02/98	11/02/98
Min Reporting Limit			25	20	35	28	34	34	31
Units			ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.
PAH Compounds	#Rings	Abbr.							
Naphthalene	2	N	2 JB U	17 JB U	17 JB U	20 JB U	17 JB U	41 B U	31 B U
C1-Naphthalenes	2	N1	ND	ND	ND	10 J	ND	25 J	ND
C2-Naphthalenes	2	N2	ND	ND	ND	ND	ND	ND	ND
C3-Naphthalenes	2	N3	ND	ND	ND	ND	ND	ND	ND
C4-Naphthalenes	2	N4	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	2	ACY	ND	ND	ND	ND	ND	ND	14 J
Acenaphthene	3	ACE	ND	ND	ND	ND	ND	ND	18 J
Biphenyl	3	B	ND	ND	ND	ND	ND	ND	ND
Fluorene	3	F	ND	ND	ND	ND	ND	ND	ND
C1-Fluorenes	3	F1	ND	ND	ND	ND	ND	ND	ND
C2-Fluorenes	3	F2	ND	ND	ND	ND	ND	ND	ND
C3-Fluorenes	3	F3	ND	ND	ND	ND	ND	ND	ND
Anthracene	3	A	ND	ND	ND	ND	ND	ND	8.1 J
Phenanthrene	3	P	4 J	7.6 J	21 J	8.7 J	15 J	15 J	26 J
C1-Phenanthrenes/Anthracenes	3	PA1	ND	ND	ND	ND	ND	ND	ND
C2-Phenanthrenes/Anthracenes	3	PA2	ND	ND	ND	ND	ND	ND	ND
C3-Phenanthrenes/Anthracenes	3	PA3	ND	ND	ND	ND	ND	ND	ND
C4-Phenanthrenes/Anthracenes	3	PA4	ND	ND	ND	ND	ND	ND	ND
Dibenzothiophene	3	DBT	ND	ND	ND	ND	ND	ND	ND
C1-Dibenzothiophenes	3	DBT1	ND	ND	ND	ND	ND	ND	ND
C2-Dibenzothiophenes	3	DBT2	ND	ND	ND	ND	ND	ND	ND
C3-Dibenzothiophenes	3	DBT3	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	4	FL	ND	ND	ND	ND	ND	ND	15 J
Pyrene	4	PY	ND	ND	ND	ND	ND	ND	14 J
C1-Fluoranthenes/Pyrenes	4	FLPY1	ND	ND	ND	ND	ND	ND	ND
C2-Fluoranthenes/Pyrenes	4	FLPY2	ND	ND	ND	ND	ND	ND	ND
C3-Fluoranthenes/Pyrenes	4	FLPY3	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	4	BaA	ND	ND	ND	ND	ND	ND	ND
Chrysene	4	C	ND	ND	ND	ND	ND	ND	15 J
C1-Chrysenes	4	C1	ND	ND	ND	ND	ND	ND	ND
C2-Chrysenes	4	C2	ND	ND	ND	ND	ND	ND	ND
C3-Chrysenes	4	C3	ND	ND	ND	ND	ND	ND	ND
C4-Chrysenes	4	C4	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	5	BbF	ND	ND	ND	ND	ND	ND	16 J
Benzo(k)fluoranthene	5	BkF	ND	ND	ND	ND	ND	ND	14 J
Benzo(e)pyrene	5	BeP	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	5	BaP	ND	ND	ND	ND	ND	ND	13 J
Perylene	5	Per	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	6	Ind	ND	ND	ND	ND	ND	ND	16 J
Dibenzo(a,h)anthracene	5	DahA	ND	ND	ND	ND	ND	ND	10 J
Benzo(g,h,i)perylene	6	BghiP	ND	ND	ND	ND	ND	ND	15 JB U
Sum PAHs			26	25	38	39	32	81	220
Adjusted Sum PAHs*			14	7.6	21	19	15	40	180

* These values do not include values for those PAHs (primarily naphthalene) which are less than 5 times the level in the blank
Only 2 significant figures used.

Table 6-2. PAH Distribution in Opihi Samples Collected September and November 1998

Field ID			SITE 1 ALIU - JAR 2	SITE5-NINI	SITE 5 NINI - JAR 2	SITE6-KEE	SPM HOSE001
Field Date			11/02/98	11/03/98	11/03/98	11/03/98	10.1
Min Reporting Limit			28	23	21	28	5
Units			ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	mg/Kg
PAH Compounds	#Rings	Abbr					
Naphthalene	2	N	16 JB U	9.1 JB U	14 JB U	15 JB U	300
C1-Naphthalenes	2	N1	ND	ND	ND	ND	820
C2-Naphthalenes	2	N2	ND	ND	ND	ND	1300
C3-Naphthalenes	2	N3	ND	ND	ND	ND	1400
C4-Naphthalenes	2	N4	ND	ND	ND	ND	950
Acenaphthylene	2	ACY	ND	ND	ND	ND	ND
Acenaphthene	3	ACE	ND	ND	ND	ND	26
Biphenyl	3	B	ND	ND	ND	ND	66
Fluorene	3	F	ND	ND	ND	ND	110
C1-Fluorenes	3	F1	ND	ND	ND	ND	300
C2-Fluorenes	3	F2	ND	ND	ND	ND	380
C3-Fluorenes	3	F3	ND	ND	ND	ND	330
Anthracene	3	A	ND	ND	ND	ND	27
Phenanthrene	3	P	13 J	8 J	6.3 J	10 J	300
C1-Phenanthrenes/Anthracenes	3	PA1	ND	ND	ND	ND	570
C2-Phenanthrenes/Anthracenes	3	PA2	ND	ND	ND	ND	540
C3-Phenanthrenes/Anthracenes	3	PA3	ND	ND	ND	ND	300
C4-Phenanthrenes/Anthracenes	3	PA4	ND	ND	ND	ND	160
Dibenzothiophene	3	DBT	ND	ND	ND	ND	120
C1-Dibenzothiophenes	3	DBT1	ND	ND	ND	ND	250
C2-Dibenzothiophenes	3	DBT2	ND	ND	ND	ND	300
C3-Dibenzothiophenes	3	DBT3	ND	ND	ND	ND	250
Fluoranthene	4	FL	ND	ND	ND	ND	5.2
Pyrene	4	PY	ND	ND	ND	ND	15
C1-Fluoranthenes/Pyrenes	4	FLPY	ND	ND	ND	ND	51
C2-Fluoranthenes/Pyrenes	4	FLPY	ND	ND	ND	ND	69
C3-Fluoranthenes/Pyrenes	4	FLPY	ND	ND	ND	ND	67
Benzo(a)anthracene	4	BaA	ND	ND	ND	ND	ND
Chrysene	4	C	ND	ND	ND	ND	12
C1-Chrysenes	4	C1	ND	ND	ND	ND	29
C2-Chrysenes	4	C2	ND	ND	ND	ND	49
C3-Chrysenes	4	C3	ND	ND	ND	ND	58
C4-Chrysenes	4	C4	ND	ND	ND	ND	56
Benzo(b)fluoranthene	5	BbF	ND	ND	ND	ND	2.9 J
Benzo(k)fluoranthene	5	BkF	ND	ND	ND	ND	ND
Benzo(e)pyrene	5	BeP	ND	ND	ND	ND	6.7
Benzo(a)pyrene	5	BaP	ND	ND	ND	ND	2.3 J
Perylene	5	Per	ND	ND	ND	ND	2.2 J
Indeno(1,2,3-c,d)pyrene	6	Ind	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	5	DahA	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	6	BghiP	ND	ND	ND	ND	3.5 J
Sum PAHs			29	17	20	25	9200
Adjusted Sum PAHs*			13	8	6.3	10	

* These values do not include values for those PAHs (primarily naphthalene) which are less than 5 times the level in the blank.
Only 2 significant figures used.

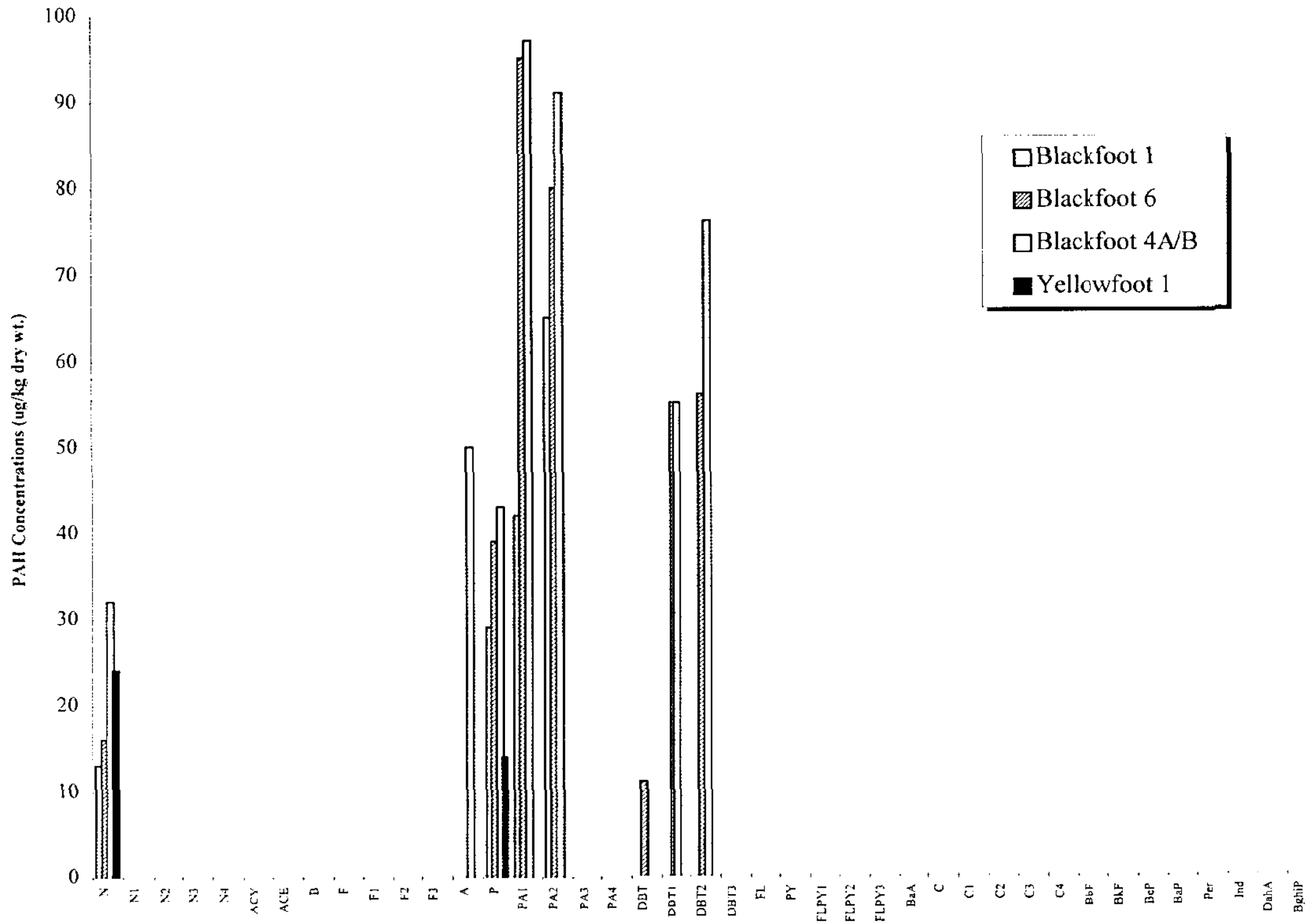

Figure 6-1. PAHs in Opihi Tissue Collected on September 23, 1998 from Oiled Boulders at Kipu Kai, Kauai

environment. The PAH distributions measured in the opihi from the oiled locations are also similar to those measured from the reference locations. The implications of these distributions have been discussed above (Section 6.2.1). While the degree of replication was not sufficient for powerful statistical tests, these results support the conclusion that either: (1) the opihi sampled in November from this location were much less exposed to petroleum from the Tesoro spill than those sampled in September; or (2) depuration diminished or removed any measurable effect of petroleum exposure. The latter explanation, if correct, suggests that above-background petroleum exposure in these intertidal animals was temporally restricted to a period of **approximately** two months.

6.1.2.3 Ahukini Samples

As noted above and in Table 6-1, replicate samples of opihi tissue were collected from oiled boulders in the Ahukini area. These two replicates have very different total adjusted PAH concentrations (13 and 180 μg/kg dry wt.) and PAH distributions (Table 6-2 and Figure 6-2). A review of the PAH distributions presented in Figure 6-2 shows that the Site 1 Jar 2 sample distribution is characterized by high molecular weight PAHs and an absence of alkylated homologues. As discussed above, exposure of biological tissues to petroleum would tend to result in a relative dominance of lower molecular weight compounds and in the uptake of alkylated compounds. This is due to the higher relative concentrations of these compounds in petroleum products (see SPM Hose oil PAH distribution in Figure 6-3) and their ability to more easily move through the environment and be available for uptake. Conversely, PAHs derived from pyrogenic sources such as combustion of petroleum products or creosote, have a PAH distribution dominated by the more stable non-alkylated PAHs (i.e., parent PAHs) and by the larger molecular weight PAHs (Burns 1997 #4).

The PAH distribution measured in the Ahukini Site 1 Jar 2 sample appears to be indicative of a pyrogenic source. The discrepancy between this sample and the other Ahukini Site 1 sample suggests that the pyrogenic source may be derived from a localized input (or from sample contamination). A review of the PAH concentration and distribution in the Ahukini Site 1 sample compared with the total adjusted PAH concentrations measured at the Ahukini reference site (8 and 6.3 μg/kg dry wt., respectively) indicates that there is no current exposure of these intertidal animals to either petroleum or pyrogenic PAH sources.

6.1.3 Interpretation Summary

Total adjusted PAH concentrations for all Kipu Kai opihi samples are comparatively illustrated in Figure 6.4. This presentation emphasizes the differences between the PAH tissue concentrations measured in the September 1998 blackfoot samples, the November samples from both the oiled boulder area and oiled limestone area, and the samples collected from the reference locations. As discussed above, the difference noted between the September and November samples collected from the oiled boulder area clearly suggests that continued exposure to petroleum from the SPM Hose spill is no longer present at levels sufficient to elevate tissue concentrations over background levels.

Further, based on review of all results presented in Tables 6-1 and 6-2, exposure to petroleum from the SPM Hose spill is not indicated in the November 1998 opihi samples collected and analyzed from Ahukini.

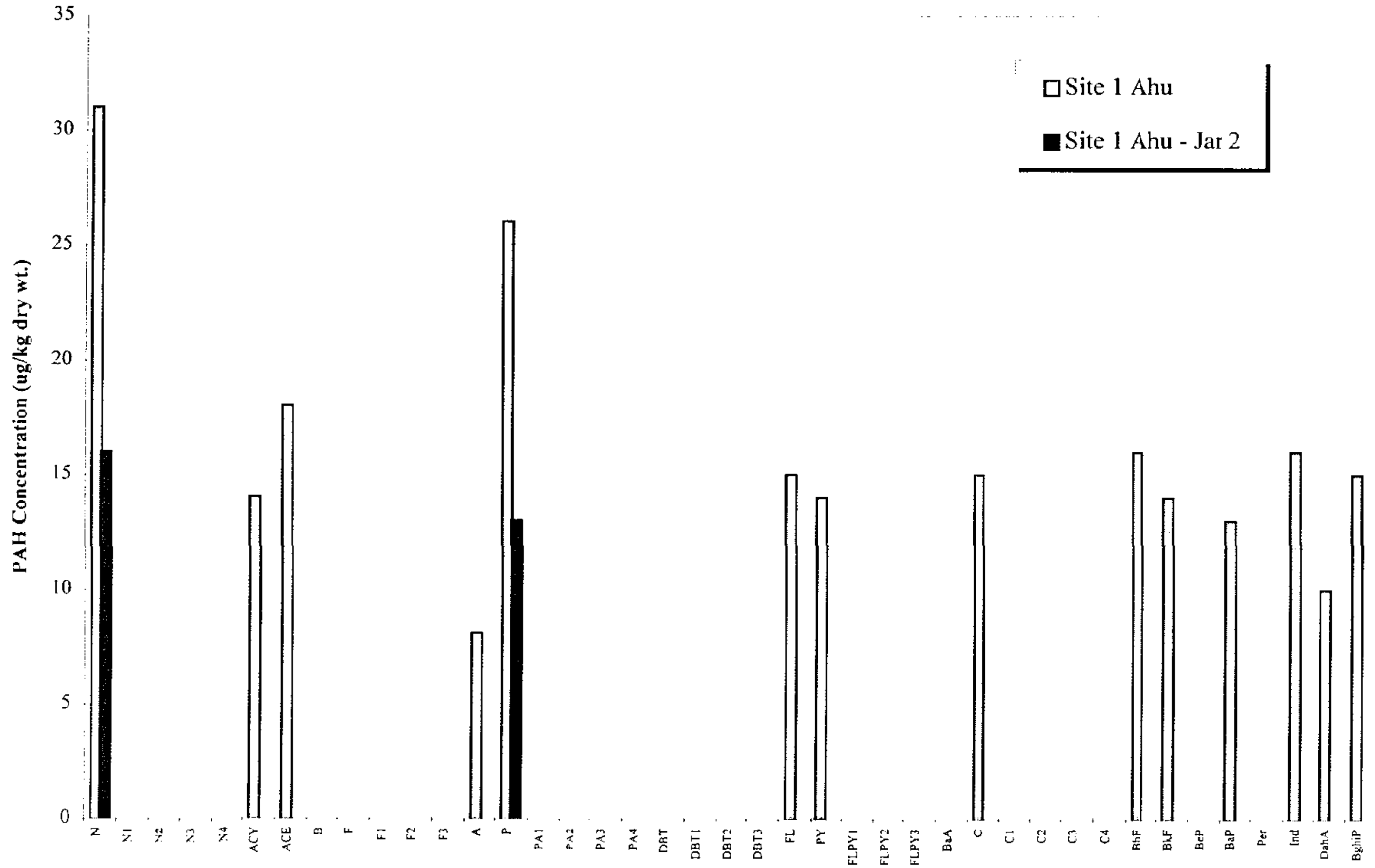

Figure 6-2. Comparison of PAH Concentrations Measured in Site 1 Ahukini Opihi Replicates Collected on November 2, 1998

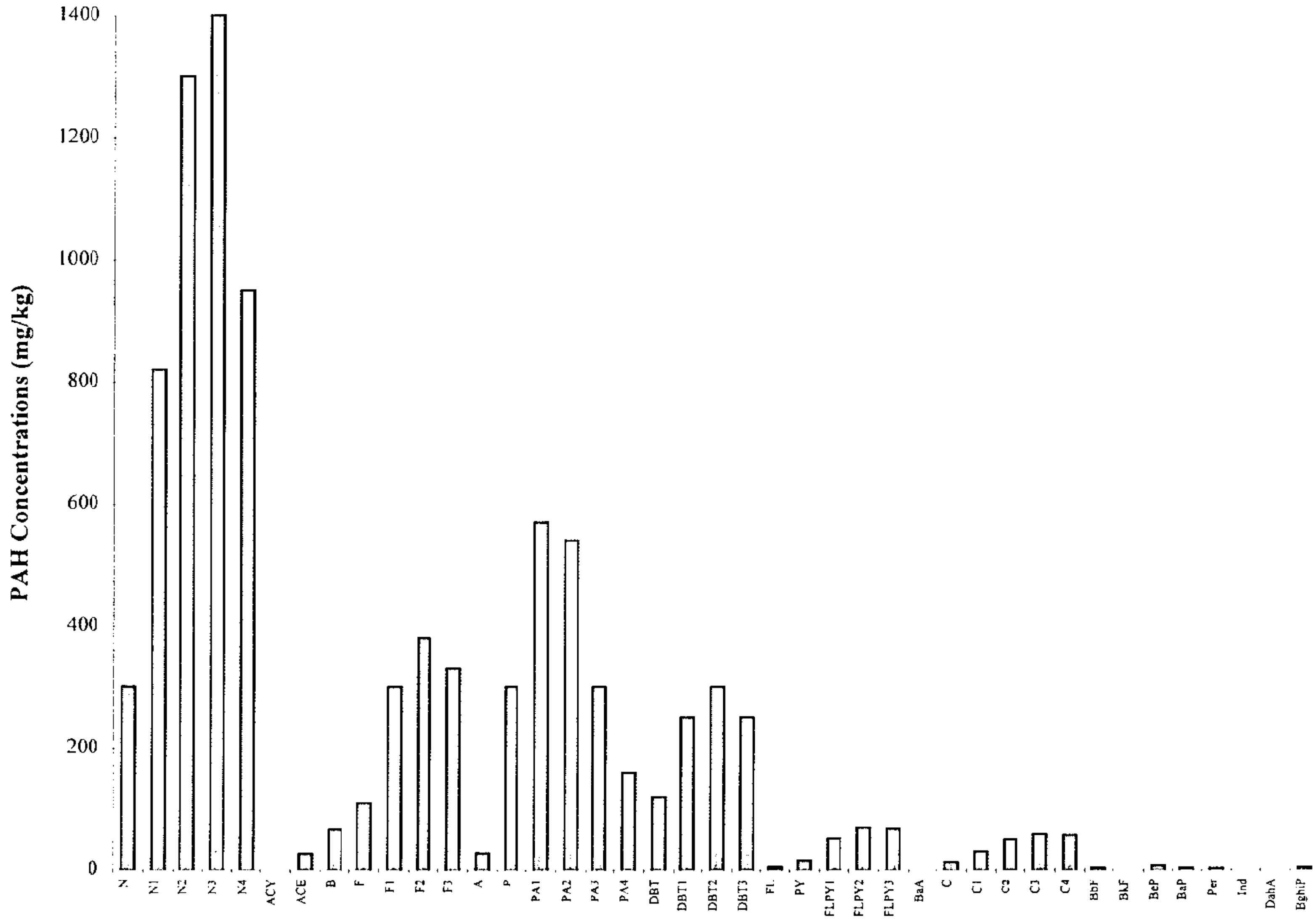

Figure 6-3. PAH Concentrations in the SPM Hose Oil

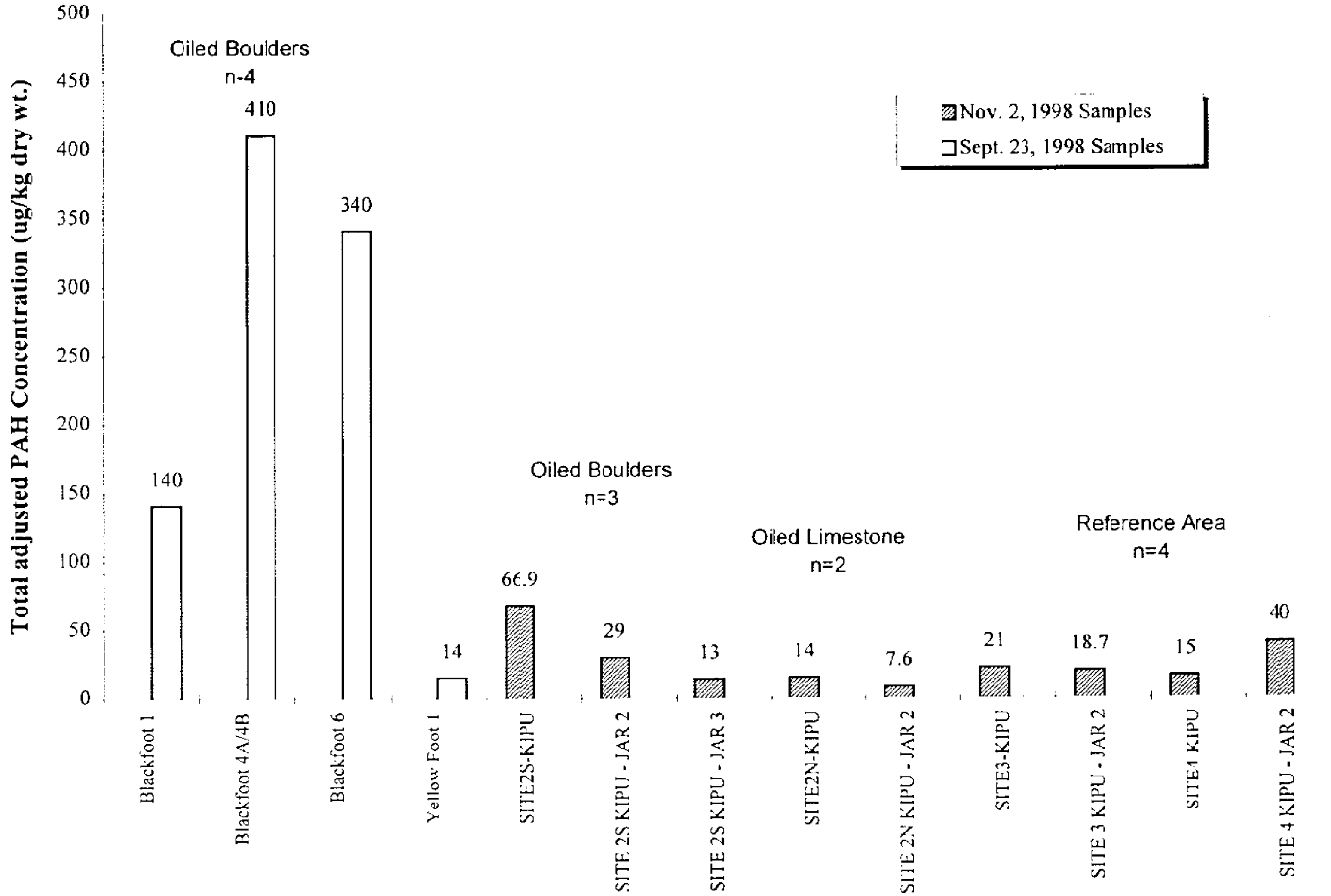

Figure 6-4. Comparison of Total PAHs in Kipu Kai Opihi Samples, September and November 1998

7.0
REFERENCES

Burns, WA, Mankiewiez, PJ, Bence, AE, Page, DS, and Parker, KR. 1997. A Principal Component and Least-Squares Method for Allocating Polycyclic Aromatic Hydrocarbons in Sediment to Multiple Sources. Environ. Tox. & Chem. 16:1119-1131.

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APPENDIX A

PHOTOGRAPHS

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking east	Photo 1
	Project	Opihi Tissue Sampling, Kauai, Hawaii	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking east	Photo 2
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking northeast	Photo 3
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking south	Photo 4
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking west	Photo 5
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	View of debris on rocks at Ahukini	Photo 6
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998