Exxon Valdez Oil Spill State/Federal
Natural Resource Damage Assessment
Final Report

Hydrocarbon Residues in Tissues of Sea Otters (*Enhydra lutris*) Collected from Southeast Alaska

Marine Mammal Study 6-2
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Study History: Marine Mammal Study 6 (MM6), titled *Assessment of the Magnitude, Extent and Duration of Oil Spill Impacts on Sea Otter Populations in Alaska*, was initiated in 1989 as part of the Natural Resource Damage Assessment (NRDA). The study had a broad scope, involving more than 20 scientists over a three year period. Final results are presented in a series of 19 reports that address the various project components. Earlier versions of this report were included in NRDA Draft Preliminary Status Reports for MM6.

Abstract: Samples of kidney, liver and muscle were taken from 12 sea otters from southeast Alaska, an area considered to be relatively free of petroleum contaminants, and analyzed for hydrocarbon content. Concentrations of aliphatic and aromatic hydrocarbons detected in the samples were low, and similar in all three tissue types. These data provide comparative data for the analysis of hydrocarbon concentrations in samples from sea otters that died following the T/V *Exxon Valdez* oil spill in Prince William Sound, Alaska.

Key Words: carcasses, *Enhydra lutris*, *Exxon Valdez*, hydrocarbons, mortality, oil spill, sea otter.

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EXECUTIVE SUMMARY

Samples of kidney, liver and muscle were taken from 12 sea otters from Khaz Bay in southeast Alaska, an area considered to be relatively free of petroleum contaminants, and analyzed for hydrocarbon content. Concentrations of aliphatic and aromatic hydrocarbons in the samples were low, and similar in all three tissue types. No one analyte exceeded 200 ng/g in any tissue sample and many were below the method detection limit. These data provide comparative data for the analysis of hydrocarbon concentrations in samples from sea otters that died following the T/V *Exxon Valdez* oil spill in Prince William Sound, Alaska.

INTRODUCTION

The *Exxon Valdez* oil spill in Prince William Sound, Alaska, in March 1989 was the first spill in North America to involve very large numbers of marine mammals. Several thousand sea otters (*Enhydra lutris*) died as a result of the spill, with more than 800 carcasses recovered (Ballachey et al. 1994, DeGange et al. 1994, Estes 1991). We have analyzed hydrocarbons in tissues from sea otters found dead following the spill (Ballachey and Kloecker 1997a,b; Mulcahy and Ballachey 1994). Prince William Sound is also an area of regular vessel traffic, including oil transport and other shipping, commercial and sport fishing, and recreational boating activities. These activities may provide additional sources of petroleum hydrocarbon residues in tissues of the resident sea otter populations. The presence of petroleum hydrocarbons from sources other than the *Exxon Valdez* oil spill complicates attributing hydrocarbon loads in sea otter tissues to the spill. There are no data on the concentrations of petroleum hydrocarbons expected in tissues from sea otters not known to have been exposed to a spill.

We report the concentrations of aliphatic and aromatic hydrocarbons present in kidney, liver, and muscle from 12 sea otters from southeast Alaska. These animals had no known history of exposure to a specific petroleum accident such as an oil spill. There was no evidence in the hydrocarbon data from these animals of recent, acute exposure to crude oil. This data set provides a baseline for comparison of similar analyses done on tissues from sea otters that were exposed to oil from the T/V *Exxon Valdez*.

METHODS AND MATERIALS

Sea Otters

Twelve sea otter carcasses were collected in southeast Alaska from Khaz Bay on the western side of Chichagof Island, approximately 50 miles northwest of Sitka, in May 1991. Eleven were skinned carcasses of adult males, shot by a native hunter for subsistence purposes. One adult female sea otter that drowned in a gill net in the same area also was included in the study.

Tissue Samples

Carcasses were opened with care to prevent contamination of the abdominal cavity. About 0.5 kg each of muscle and liver, and an entire kidney, were removed from each animal, wrapped separately in aluminum foil, and frozen. In the laboratory, tissues were thawed and a sample was taken from the interior of each tissue piece, avoiding possible surface contamination and using instruments rinsed with acetone and n-hexane. The samples were

placed in contaminant-free glass jars (Eagle Picher Environmental Services, Miami, Oklahoma) and frozen at -20°C in the dark. All samples were analyzed within 9 months of collection. Because of potential contamination, no sample of kidney or liver was taken from otter #4 and no sample of kidney was taken from otter #7. An upper first premolar was taken for sectioning to obtain the age of each animal by counting dental annuli (Garshelis 1984).

Analytical Methods

Hydrocarbon analyses were done by the Geochemical and Environmental Research Group at Texas A & M University (GERG), College Station, Texas. The concentrations of a total of 28 aliphatic and 39 aromatic hydrocarbon primary analytes were measured. The tissue extraction and analytical methods used were those initially developed by MacLeod et al. (1985) as modified by Wade et al. (1988, 1993) and Jackson et al. (1994).

Briefly, a tissue sample weighing approximately 1 g was used for the analysis. After the addition of internal standards (surrogates) and 50 g of anhydrous sodium sulfate, the tissue was extracted three times with dichloromethane using a tissuemizer. The extract was fractionated by alumina:silica open column chromatography. The extract was sequentially eluted from the column with pentane (aliphatic fraction) and pentane-dichloromethane (aromatic fraction). The aromatic fraction was further purified by HPLC to remove lipids.

Quality assurance for each set of 10 samples included a procedural blank and a sample spiked with all calibration analytes (matrix spike) which were carried through the entire analytical scheme. In addition, a laboratory reference oil from the T/V *Exxon Valdez* was used to confirm the identity of alkylated polyaromatic hydrocarbons when no standards were available, and act as a reference oil. All internal standards (surrogates) were added to the samples prior to extraction and were used for quantification.

Aliphatic hydrocarbons (n-C_{10} to n-C_{34} including pristane and phytane) were separated by gas chromatography in the split-less mode using a flame ionization detector. Analyte amounts were calculated using the surrogate standards.

Aromatic hydrocarbons were separated and quantified by gas chromatography-mass spectrometry (GC-MS). The mass spectral data were acquired using selected ions for each of the polyaromatic hydrocarbon analytes. The GC-MS was calibrated by injection of a standard component mixture at five concentrations ranging from 0.01 ng/μl to 1 ng/μl. Sample component concentrations were calculated from the average response factor for each analyte. Analyte identifications were based on correct retention time of the quantitation ion (molecular ion) for the specific analyte and confirmed by the ratio of the confirmation ion.

A calibration check standard was run three times during the sample runs (beginning, middle and end), with no more than 6 h between calibration checks. The calibration check was confirmed to maintain an average response factor within 10% for all analytes, with no one analyte greater than 25% of the known concentration. With each set of samples, a laboratory reference sample (oil spiked solution) was analyzed to confirm GC-MS system performance.

Analytical data are always estimates of the concentrations of the compounds being measured; however, the uncertainties of the estimated concentrations can be assessed. The minimum concentration of a substance that can be measured and reported with a specified statistical confidence that the analyte concentration is greater than zero can be determined and is sometimes termed the method detection limit (MDL). Using spiked oyster (*Crassostrea virginica*) tissue samples (n=7) obtained from the Gulf of Mexico, GERG estimated the MDLs of the hydrocarbon analytes at the 99% confidence level; these MDL estimates are listed in Appendix Table A-1. Concentrations of individual hydrocarbons lower than the computed MDL were reported by GERG and are given with the data results (Appendix Tables A-2, A-3).

Data Handling

GERG reported hydrocarbon analytes in units of nanogram analyte per gram (ng/g) tissue (wet weight). These reported values were multiplied by the sample wet weight to obtain the results in nanograms (ng) of analyte. All comparisons to MDL were done using data in ng. Results in ng/g (wet weight) as reported by GERG are presented in Appendix Tables A-2, A-3.

RESULTS

All but one (otter #3) of the animals in this study were males. Ages ranged from 2 to 9 years (Table 1).

Concentrations of individual aliphatic and aromatic hydrocarbons were uniformly low and similar in all samples of kidney, liver and muscle (Figures 1-6; Appendix Tables A-2, A-3). Generally, several of the lowest (n-C_{10}-C_{12}) and the highest (n-C_{32} to C_{34}) molecular weight n-alkanes were present at concentrations below MDL or not at all (Figures 1-3). The even number carbon chains in the n-C_{13}-C_{21} range were also below MDL in most samples. The odd number carbon chains in the n-C_{13}-C_{19} range were present at concentrations above MDL in many of the samples. Some of the highest concentrations of aliphatic hydrocarbons in southeast sea otters were of n-C_{15}. Both odd and even number carbon chains in the n-C_{22}-C_{31} range were present in concentrations above MDL in many of the samples, with the highest measured value less than 130 ng/g. Of the isoprenoid hydrocarbons, pristane was present in concentrations well above MDL (values ranged to 190 ng/g) in kidney and liver but not muscle, while phytane was never measured above MDL in any of the tissue types.

The unresolved complex mixture (UCM) was present at concentrations <25 μg/g in several samples of each of the three types of tissues. However, the presence of the UCM was not necessarily consistent in all tissues from an individual otter. It was found in only the kidney samples of otters #8 and #10, kidney and liver of otter #9, liver and muscle of otters #1 and #7, and muscle from otter #4 (the only tissue sampled from this sea otter). The UCM

fraction was found in all three tissue types from otters #2, #3, #5, and #6, and was not found in any tissues analyzed from otters #11 and #12.

The concentrations of the individual aromatic hydrocarbons were low and, in all cases, below estimated MDLs (Figures 4-6; Appendix Table A-3). Except for C-1 naphthalene, none of the alkylated naphthalenes and no alkylated derivatives of fluorene, phenanthrene, dibenzothiophene, or chrysene were detected in any of the samples. Several other aromatic compounds were detected, but were well below MDLs (Figures 4-6).

DISCUSSION

There was no evidence in our data of recent, acute exposure of these animals to crude oil. This conclusion was based on the uniformity and low concentrations of all the hydrocarbon analytes, especially the aromatic hydrocarbons, the low concentrations or absence of the UCM, and the complete absence of the alkylated derivatives of naphthalene, fluorene, phenanthrene, dibenzothiophene, and chrysene. These compounds are of petrogenic origins and do not have biogenic sources.

The presentation and discussion of hydrocarbon data which are quantitatively less than the calculated MDL for each hydrocarbon are controversial (Rhodes 1981, Berthouex 1993). The MDL is a statistical value obtained from replicate analyses of samples with known quantities of the compound of interest. In the literature, hydrocarbon concentrations which fall below the MDL are presented in various ways: as "trace", "not detected (ND)", "$<$MDL", zero, or some incremental number between zero and the MDL. Alternate strategies, which include simply presenting the measured concentration regardless of its relationship to the MDL, presentation of both the measured concentration and the MDL (our choice), or giving the measured concentration followed by a statistical estimate of its precision, are considered superior (Berthouex 1993, Gilbert 1987). These methods prevent the discarding of useful information which occurs with the former methods, all of which censor some of the data.

In the sea otters in this study, concentrations of the aromatic hydrocarbons were lower than the aliphatic hydrocarbons. Similar low concentrations of aromatic hydrocarbons were described in muscle tissue of seals, whales and porpoises in the Atlantic Ocean (Hellou et al. 1990, Law and Whinnett 1992). The difference between the two classes of hydrocarbons may be attributed to more natural, biogenic sources of aliphatic than of aromatic compounds. Marine organisms and terrestrial plants are known to produce aliphatic hydrocarbons, especially odd number carbon chains and pristane (NRC 1985, Blumer et al. 1971, Clark and Blumer 1967). However, they contain no or very few aromatic hydrocarbons (NRC 1985, Clark and Brown 1977). Brown algae such as laminaria, alaria, fucus, macrocystis and nereocystis are common in southeast Alaska, and it is probable that the hydrocarbons measured in the sea otter tissues originated in algae, phytoplankton, and copepods. These may be ingested either directly by sea otter prey species, or become part of the detrital material which

may then be ingested. The aliphatic profiles for the sea otter tissues in this study closely match the hydrocarbon profiles for several brown algaes from the northeast United States (Clark and Blumer 1967), with peaks at n-C_{15}, lesser peaks at n-C_{17}, minimums at n-C_{21}, and relatively flat profiles above n-C_{23}. In addition, calanoid copepods are known producers of pristane (Karinen et al. 1993), and it has been hypothesized that pristane may become incorporated in tissues of grazers and filter feeders through the uptake of detrital material, which could account for the relatively high concentrations of pristane in kidney and liver. The relatively high levels of n-C_{13} and n-C_{22} were somewhat confusing; however, examination of the procedural blanks for these samples reveals peaks at n-C_{13}, n-C_{22}, and also at n-C_{15} (Figure 7). It may be that the high levels of these aliphatics can be attributed in part to procedural artifact.

The aliphatic hydrocarbon array measured in the samples from southeast sea otters could be attributed to a diesel source or to combustion of fossil fuels. Hydrocarbons from diesel show a range of aliphatics from n-C_{10}-C_{25}, with a maximum around n-C_{15}-C_{17} (Bence and Burns 1995). In hydrocarbons originating from pyrolytic sources, the parent forms of aromatic compounds predominate over their alkylated forms, and the PAH fraction is dominated by 4, 5, and 6 ring compounds such as phenanthrenes, anthracenes, benz[a]anthracene, and benzo[a]pyrene (NRC 1983, Neff 1990, Hellou 1996, Bence and Burns 1995). The aliphatics and the naphthalenes measured in the sea otters resemble those from diesel or pyrolytic sources. However, given the lack of all other PAH, and the apparently pristine area inhabited by the otters, it is unlikely that diesel or combustion are the sources for hydrocarbons present at concentrations greater than MDL in these samples.

An additional factor that may affect tissue hydrocarbon levels is the capability of higher level organisms such as fish, birds and mammals to rapidly metabolize many hydrocarbon compounds (Krahn et al. 1986a, 1986b, 1987, Le Bon et al. 1988, Perdu-Durand and Tulliez 1985, Tarshis and Rattner 1982, Varanasi 1989, Watanabe et al. 1989). The resulting metabolites are not readily identified by routine analytical techniques such as those used in the present study. Metabolites of parent hydrocarbons may be excreted or they may be stored in the body. They may be either more or less toxic to the body than their parent compounds. The enzyme systems that detoxify hydrocarbons are not uniformly distributed among organs, and petroleum hydrocarbons found in tissues may have escaped or overwhelmed metabolism and may be retained for long periods (Hellou et al. 1990).

The concentrations of the aliphatic hydrocarbons present in blood from five heavily oiled sea otters admitted to a rehabilitation center following the spill ranged from 20 to 800 mg/l (Williams et al. 1990). These concentrations were 40- to 1,000-fold higher than the concentrations measured in the visceral tissues in our study. Williams et al. (1990) inversely correlated the hydrocarbon concentrations with length of survival, although all five of their animals eventually died. They concluded that concentrations above 80 to 120 mg/l of aliphatic hydrocarbons were strongly associated with mortality. Sea otters which were captured during the spill and held in aquaria for a year had undetectable levels of aliphatic hydrocarbons in their blood (Williams 1990). The minimum detectable limit of the analytical method used in that study was not mentioned, but the absence of remarkable concentrations of hydrocarbons

after one year in animals known to have suffered oiling indicates the capability of sea otters to metabolize and excrete petroleum hydrocarbons.

In conclusion, hydrocarbon compounds in tissue samples from southeast Alaska were generally low, with a high proportion of aliphatic and all aromatic compounds measured at levels below the MDL. Aliphatic compounds present in tissues at detectable levels were consistent with biogenic sources. These samples appear representative of tissue contaminant levels in sea otters inhabiting a clean area with little or no petroleum contamination, and thus provide suitable baseline data for comparison with tissues from otters potentially exposed to petroleum hydrocarbons.

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Table 1. Genders, ages, and lengths of 12 sea otters killed in southeast Alaska in May, 1991. ND=Not determined.

Otter number	Gender	Age[1] (years)	Length (cm)
1	Male	ND	ND
2	Male	ND	ND
3	Female	ND	120
4	Male	2	131
5	Male	2	165
6	Male	6	138
7	Male	5	133
8	Male	5	141
9	Male	9	141
10	Male	7	130
11	Male	3	124
12	Male	7	143

[1] Ages were determined from dental annuli.

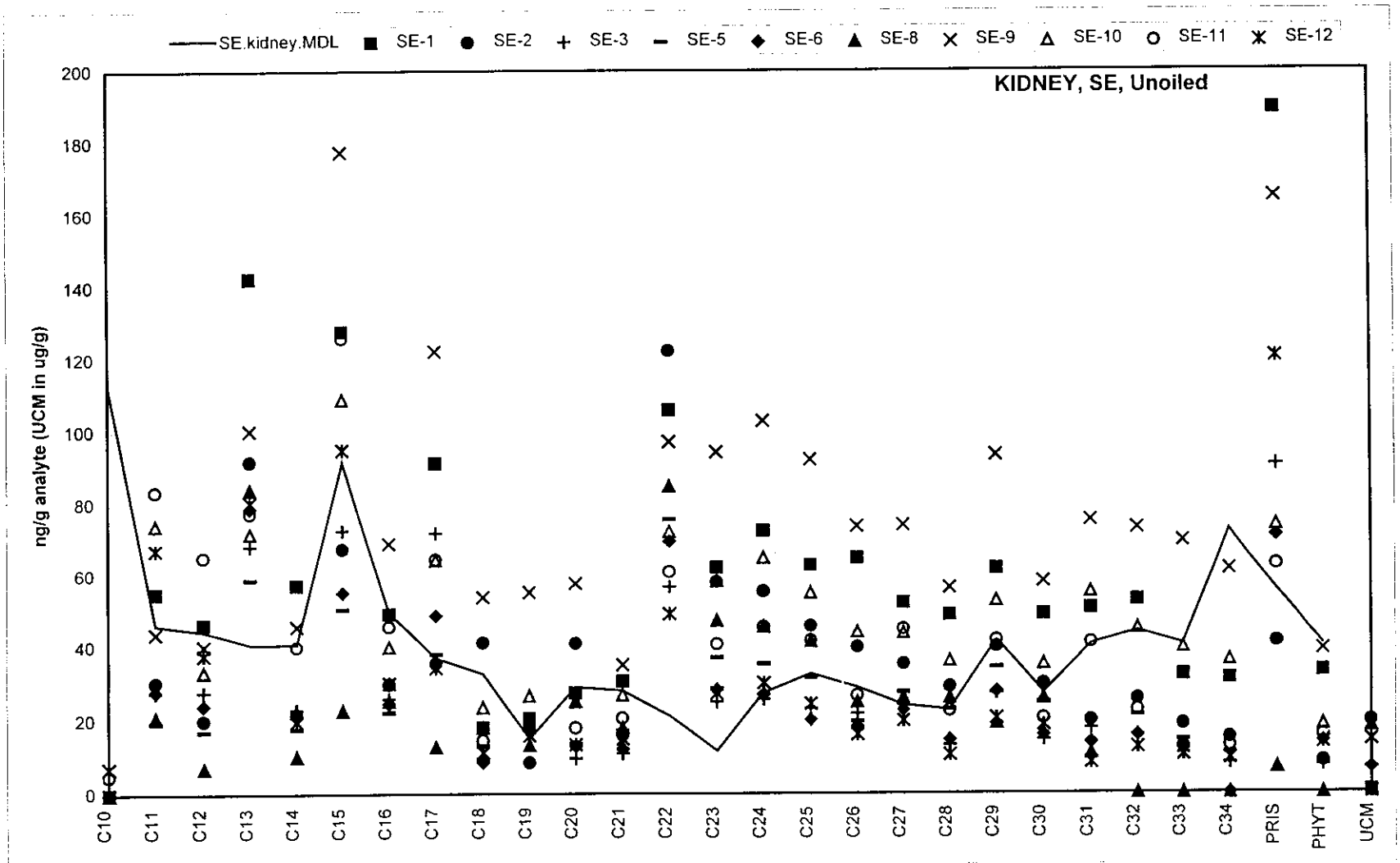

Figure 1. Aliphatic hydrocarbon concentrations in kidney samples from 12 unoiled sea otters killed in southeast Alaska. Units are in nanograms per gram except UCM which is in micrograms per gram. The solid line indicates the mean MDL for kidney samples from this group. The area under the MDL line is not a significant factor, rather the points are connected to aid in distinguishing MDLs from data points. Abbreviations: C10-C34: n-alkanes; PRIS: pristane; PHYT: phytane; UCM: unresolved complex mixture.

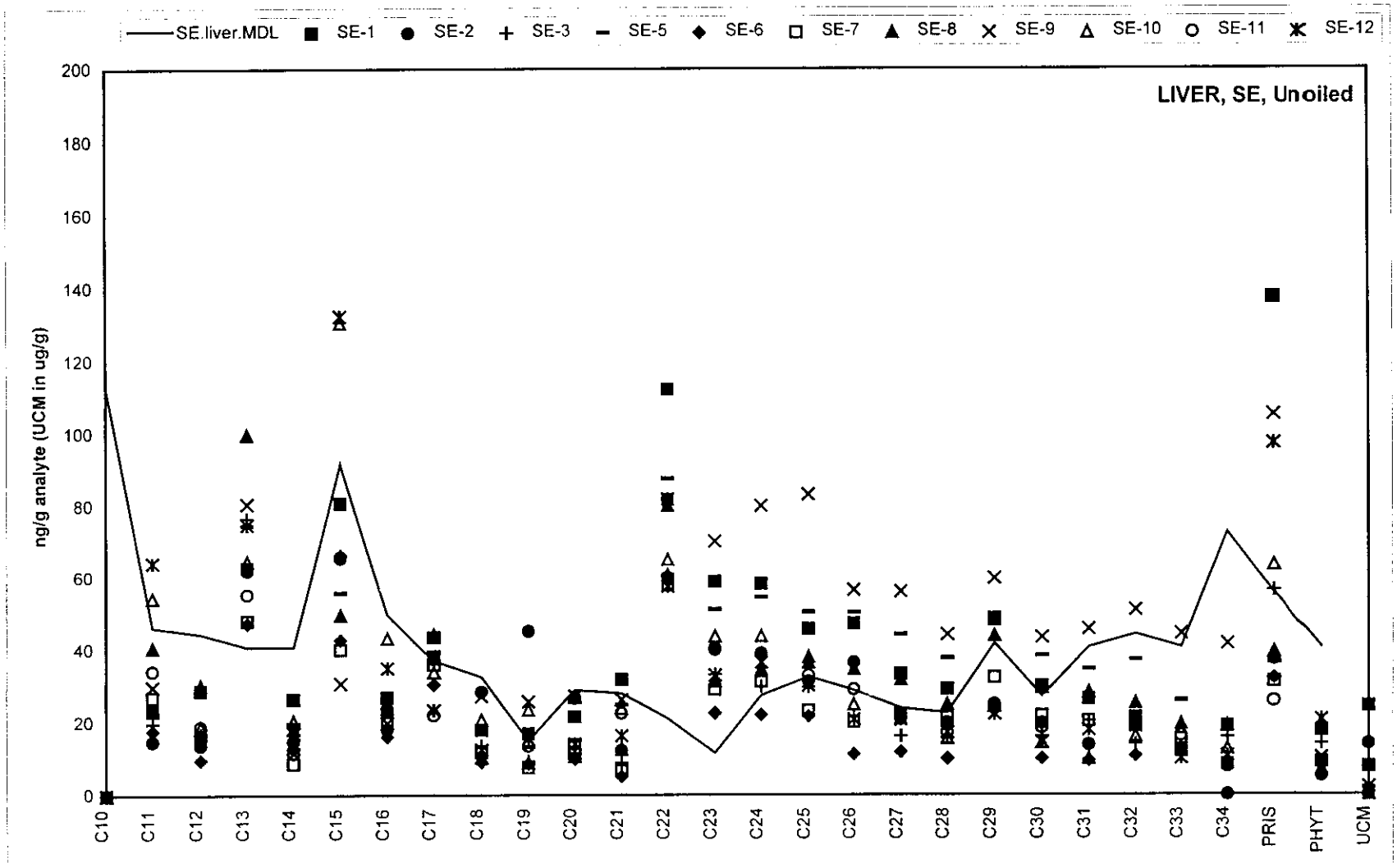

Figure 2. Aliphatic hydrocarbon concentrations in liver samples from 12 unoiled sea otters killed in southeast Alaska. Units are in nanograms per gram except UCM which is in micrograms per gram. The solid line indicates the mean MDL for liver samples from this group. The area under the MDL line is not a significant factor, rather it the points are connected to aid in distinguishing MDLs from data points. Abbreviations: C10-C34: n-alkanes; PRIS: pristane; PHYT: phytane; UCM: unresolved complex mixture.

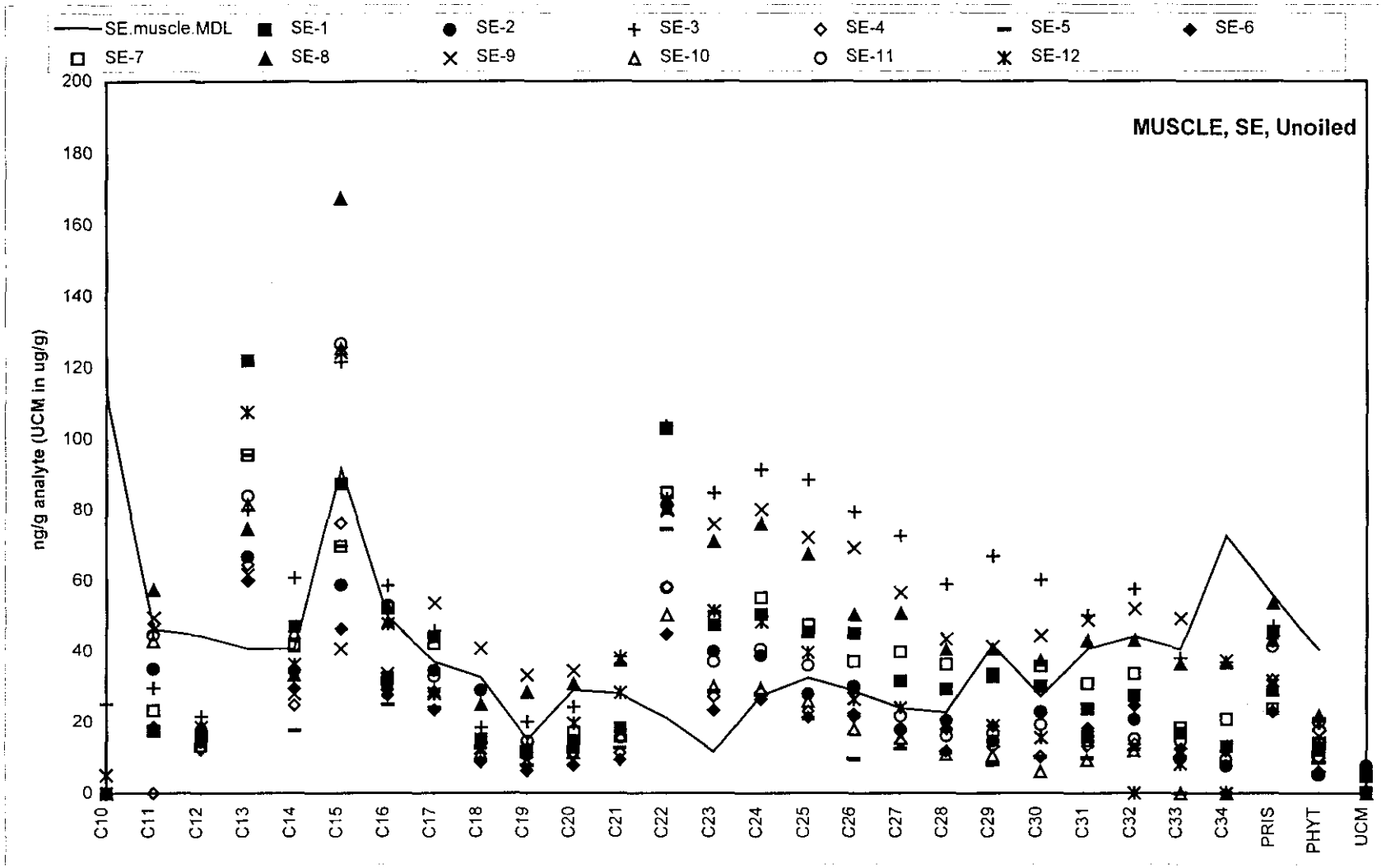

Figure 3. Aliphatic hydrocarbon concentrations in muscle samples from 12 unoiled sea otters killed in southeast Alaska. Units are in nanograms per gram except UCM which is in micrograms per gram. The solid line indicates the mean MDL for muscle samples from this group. The area under the MDL curve is not a significant factor, *rather the points are connected* to aid in distinguishing MDLs from data points. Abbreviations: C10-C34: n-alkanes; PRIS: pristane; PHYT: phytane; UCM: unresolved complex mixture.

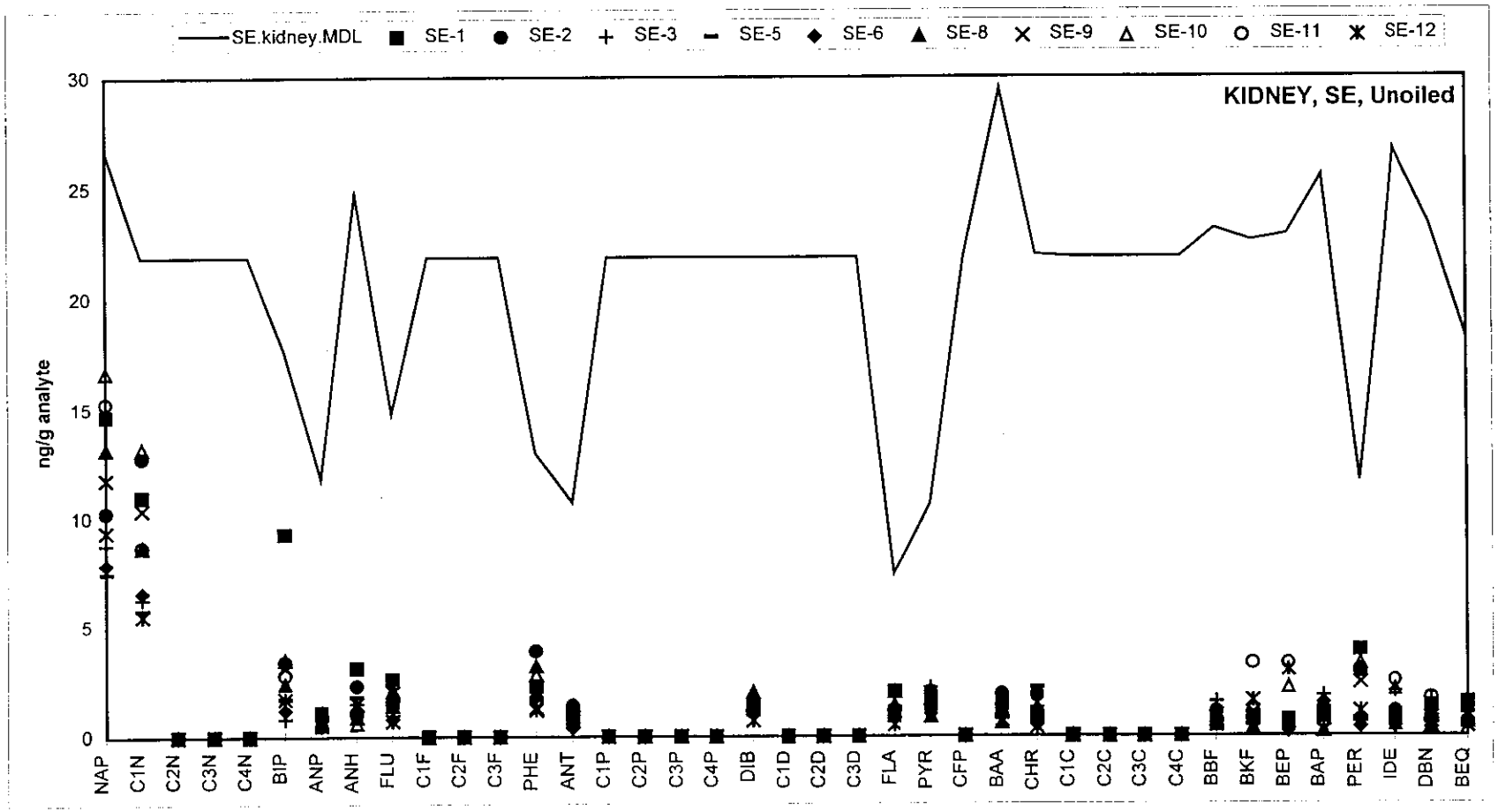

Figure 4. Aromatic hydrocarbon concentrations in kidney samples from 12 unoiled sea otters killed in southeast Alaska. Units are in nanograms per gram. The solid line indicates the mean MDL for kidney samples from this group. The area under the MDL curve is not a significant factor, rather the points are connected to aid in distinguishing between MDLs and data points. Abbreviations: NAP: naphthalene; C1N-C4N: C1-C4-methylated naphthalenes; BIP: biphenyl; ANP: acenaphthalene; ANH: acenapthene; FLU: fluorene; C1F-C3F: C1-C3-methylated fluorenes; PHE: phenanthrene; ANT: anthracene; C1P-C4P: C1-C4-phenanthrenes/anthracenes; DIB: dibenzothiophene; C1D-C3D: C1-C3-dibenzothiophenes; FLA: fluoranthene; PYR: pyrene; CFP: C1-fluoranthenes/pyrenes; BAA: benzo[a]anthracene; CHR: chrysene; C1C-C4C: C1-C4-chrysenes; BBF: benzo[b]fluoranthene; BKF: benzo[k]fluoranthene; BEP: benzo[e]pyrene; BAP: benzo[a]pyrene; PER: perylene; IDE: indeno[1,2,3-c,d]pyrene; DBN: dibenzo[a,h]anthracene; BEQ: benzo[g,h,i]perylene.

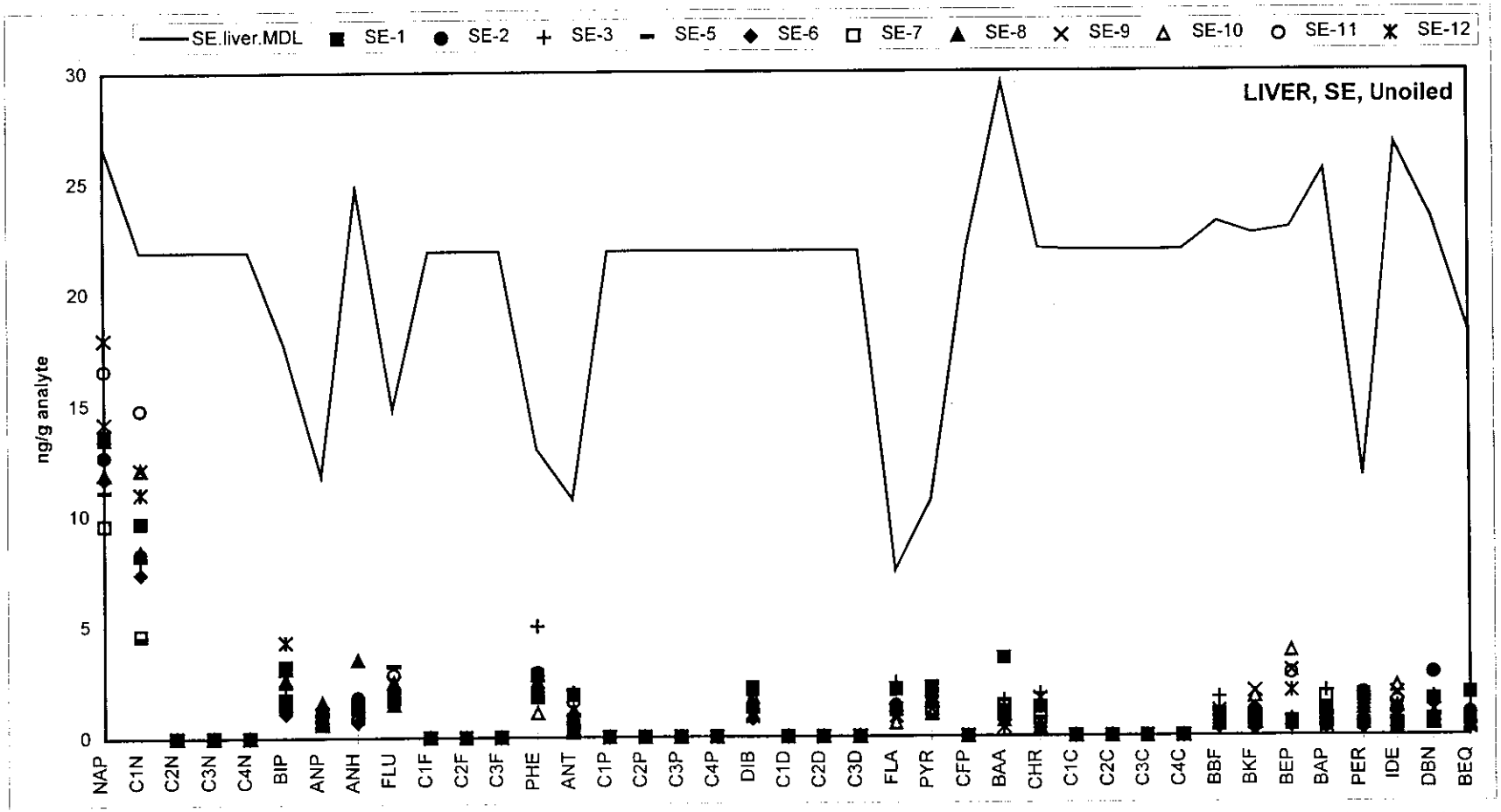

Figure 5. Aromatic hydrocarbon concentrations in liver samples from 12 unoiled sea otters killed in southeast Alaska. Units are in nanograms per gram. The solid line indicates the mean MDL for liver samples from this group. The area under the MDL curve is not a significant factor, rather the points are connected to aid in distinguishing between MDLs and data points. Abbreviations: NAP: naphthalene; C1N-C4N: C1-C4-methylated naphthalenes; BIP: biphenyl; ANP: acenaphthalene; ANH: acenapthene; FLU: fluorene; C1F-C3F: C1-C3-methylated fluorenes; PHE: phenanthrene; ANT: anthracene; C1P-C4P: C1-C4-phenanthrenes/anthracenes; DIB: dibenzothiophene; C1D-C3D: C1-C3-dibenzothiophenes; FLA: fluoranthene; PYR: pyrene; CFP: C1-fluoranthenes/pyrenes; BAA: benzo[a]anthracene; CHR: chrysene; C1C-C4C: C1-C4-chrysenes; BBF: benzo[b]fluoranthene; BKF: benzo[k]fluoranthene; BEP: benzo[e]pyrene; BAP: benzo[a]pyrene; PER: perylene; IDE: indeno[1,2,3-c,d]pyrene; DBN: dibenzo[a,h]anthracene; BEQ: benzo[g,h,i]perylene.

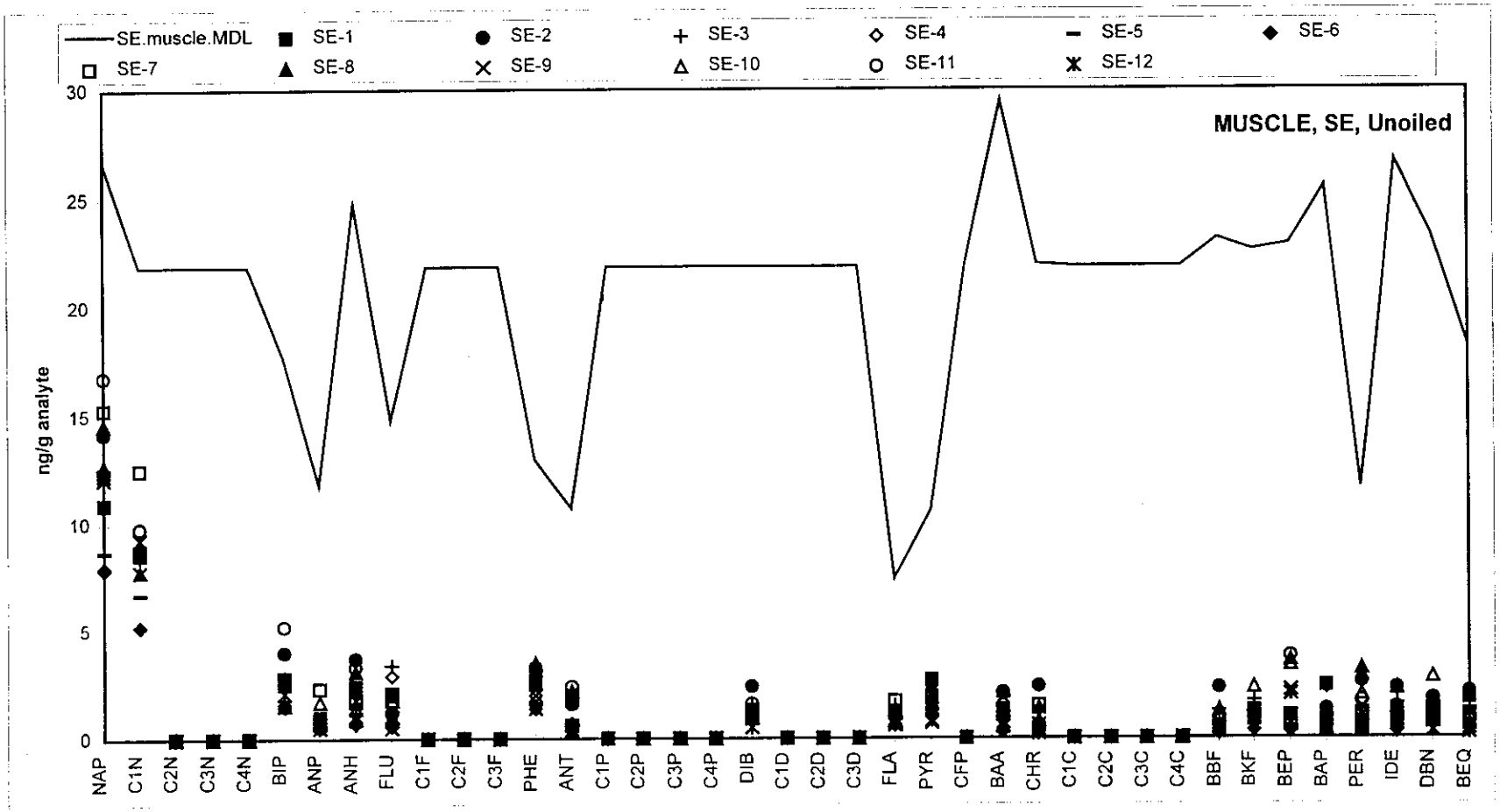

Figure 6. Aromatic hydrocarbon concentrations in muscle samples from 12 unoiled sea otters killed in southeast Alaska. Units are in nanograms per gram. The solid line indicates the mean MDL for muscle samples from this group. The area under the MDL curve is not a significant factor, rather the points are connected to aid in distinguishing between MDLs and data points. Abbreviations: NAP: naphthalene; C1N-C4N: C1-C4-methylated naphthalenes; BIP: biphenyl; ANP: acenaphthalene; ANH: acenapthene; FLU: fluorene; C1F-C3F: C1-C3-methylated fluorenes; PHE: phenanthrene; ANT: anthracene; C1P-C4P: C1-C4-phenanthrenes/anthracenes; DIB: dibenzothiophene; C1D-C3D: C1-C3-dibenzothiophenes; FLA: fluoranthene; PYR: pyrene; CFP: C1-fluoranthenes/pyrenes; BAA: benzo[a]anthracene; CHR: chrysene; C1C-C4C: C1-C4-chrysenes; BBF: benzo[b]fluoranthene; BKF: benzo[k]fluoranthene; BEP: benzo[e]pyrene; BAP: benzo[a]pyrene; PER: perylene; IDE: indeno[1,2,3-c,d]pyrene; DBN: dibenzo[a,h]anthracene; BEQ: benzo[g,h,i]perylene.

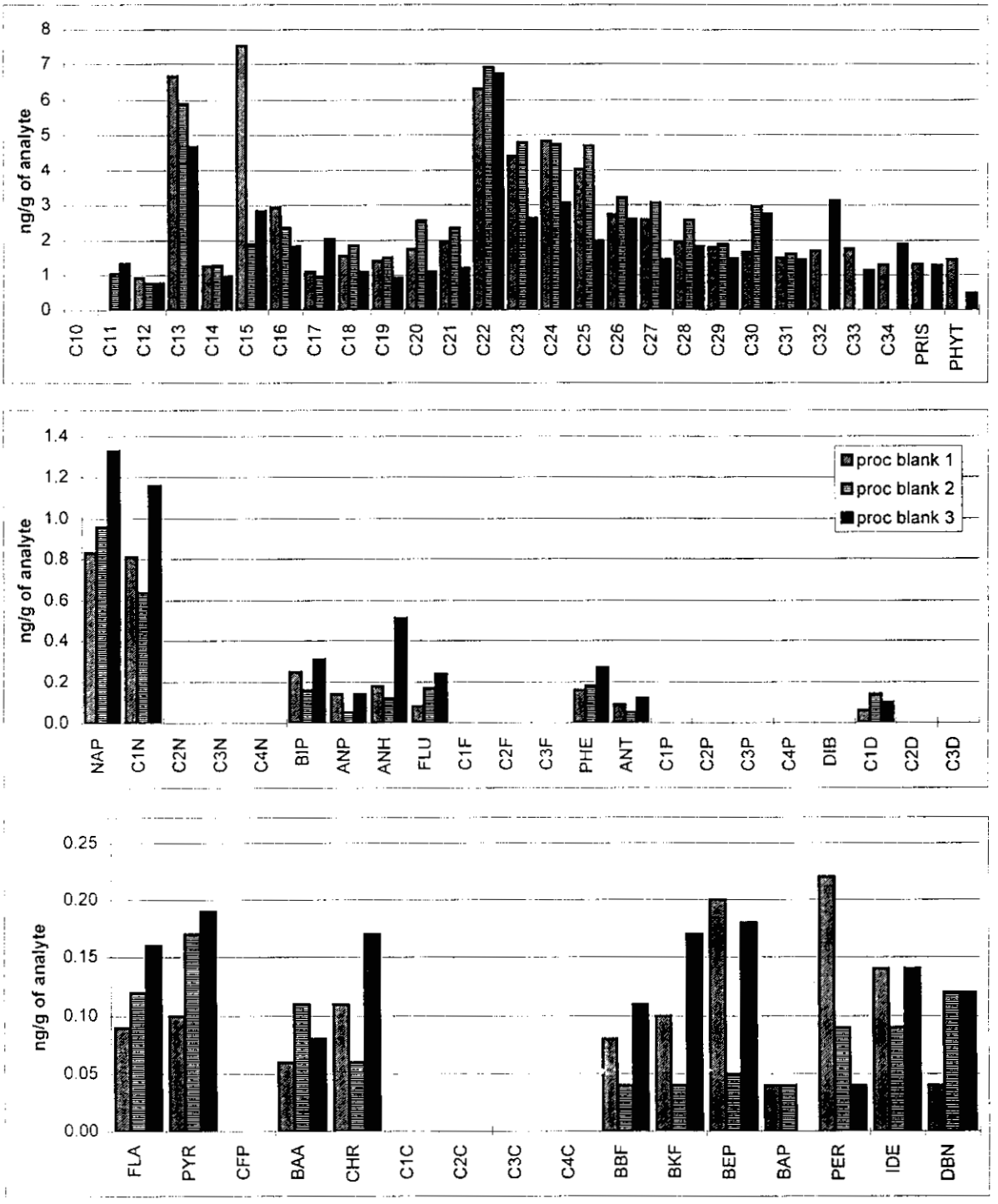

Figure 7. Aliphatic, low, and high molecular weight aromatic hydrocarbon concentrations in the procedural blanks from GERG catalog 6711. This is the catalog of southeast Alaska sea otter tissues. Abbreviations are the same as in Figures 1-6.

APPENDICES

Table A-1. Method detection limits (MDLs) in ng and ng/g for aliphatic and aromatic hydrocarbons analyzed by GERG.[a, b]

Aliphatic hydrocarbons			Aromatic hydrocarbons					
	MDL			MDL			MDL	
	ng	ng/g		ng	ng/g		ng	ng/g
C10	124.6	95.9	NAP	29.4	22.6	1MP	37.7	29.0
C11	50.9	39.1	C1N	--	--	DIB	--	--
C12	48.9	37.6	C2N	--	--	C1D	--	--
C13	--	--	C3N	--	--	C2D	--	--
C14	--	--	C4N	--	--	C3D	--	--
C15	101.0	77.7	1MN	32.8	25.2	FLA	8.2	6.3
C16	54.8	42.1	2MN	46.5	35.	PYR	11.7	9.0
C17	40.8	31.4	2,6MN	33.4	25.7	CFP	--	--
C18	35.9	27.6	2,3,5MN	28.6	22.0	BAA	32.4	24.9
C19	16.6	12.8	BIP	19.5	15.0	CHR	24.2	18.6
C20	31.9	24.5	ANP	13.0	10.0	C1C	--	--
C21	30.9	23.8	ANH	27.3	21.0	C2C	--	--
C22	23.3	17.9	FLU	16.3	12.5	C3C	--	--
C23	12.8	9.9	C1F	--	--	C4C	--	--
C24	30.2	23.2	C2F	--	--	BBF	25.5	19.6
C25	35.9	27.6	C3F	--	--	BKF	24.9	19.1
C26	31.8	24.5	ANT	11.8	9.1	BEP	25.2	19.4
C27	26.4	20.3	PHE	14.3	11.0	BAP	28.1	21.6
C28	25.0	19.2	C1P	--	--	PER	12.9	9.9
C29	46.1	35.5	C2P	--	--	IDE	29.4	22.6
C30	30.1	23.1	C3P	--	--	DBN	25.7	19.8
C31	--	--	C4P	--	--	BEQ	20.0	15.4
C32	48.9	37.6						
C33	44.9	34.6						
C34	--	--						
PRIS	61.7	47.5						
PHY	--	--						
UCM	--	--						

[a] ng/g are on a dry weight basis.

[b]Abbreviations: C_{10} through C_{34}: n-alkanes (the subscript represents the number of carbon atoms); PRIS: pristane; PHY: phytane; UCM: unresolved complex mixture; NAP: naphthalene; C1N: C1-naphthalene; C2N: C2-naphthalene; C3N: C3-naphthalene; C4N: C4-naphthalene; 1MN: 1-methylnaphthalene; 2MN: 2-methylnaphthalene; 2,6MN: 2,6-dimethylnaphthalene; 2,3,5MN: 2,3,5-trimethylnaphthalene; BIP: biphenyl; ANP: acenaphthylene; ANH: acenaphthene; FLU: fluorene; C1F: C1-fluorene; C2F: C2-fluorene; C3F: C3-fluorene; ANT: anthracene; PHE: phenanthrene; C1P: C1-phenanthrene; C2P: C2-phenanthrene; C3P: C3-phenanthrene; C4P: C4-phenanthrene; 1MP: 1-methylphenanthrene; DIB: dibenzothiophene; C1D: C1-dibenzothiophene; C2D: C2-dibenzothiophene; C3D: C3-dibenzothiophene; FLA: fluoranthene; PYR: pyrene; CFP: methyl fluoranthene-pyrene; BAA: benz(a)anthracene; CHR: chrysene; C1C: C1-chrysene; C2C: C2-

chrysene; C3C: C3-chrysene; C4C: C4-chrysene; BBF: benzo(b)fluoranthene; BKF: benzo(k)fluoranthene; BEP: benzo(e)pyrene; BAP: benzo(a)pyrene; PER: perylene; IDE: ideno(1,2,3-cd)pyrene; DBN: dibenzo(a,h)anthracene; BEQ: benzo(g,h,i)perylene.

Table A-2. Aliphatic hydrocarbon concentrations (ng/g) measured in sea otter tissue samples collected in southeast Alaska, summer 1991.[a, b] Values in boldface are greater than MDL.

Tissue	Lab ID	Otter #	Sample wt.[c]	C10	C11	C12	C13	C14	C15	C16	C17	PRI	C18	PHY	C19	C20	C21	C22
Kidney	29920	1	1.02	0	**55.1**	46.4	**142.5**	**57.4**	**127.9**	49.4	**91.4**	**189.3**	18	33.3	**20.6**	27.4	30.6	**105.9**
	29923	2	1.02	0	30.4	20.1	**91.9**	21.8	67.7	29.9	35.6	41.5	**41.3**	8.6	8.6	**41.1**	16.1	**122.5**
	29926	3	1.26	0	27.7	27.7	**68.3**	23	72.8	25.9	**72**	**90.8**	9.2	7.5	**19.3**	9.7	11	**57**
	29930	5	1.14	0	19.4	17.1	**58.9**	17.7	50.7	22.2	**38**	41.4	13.1	8.2	**18.6**	13.5	17.2	**75.7**
	29933	6	1	0	28	24.2	**78.9**	21.1	55.4	24.7	**48.9**	**71.2**	8.7	14.1	**17.1**	13	12.2	**69.7**
	29938	8	1.04	0	21	7	**84.2**	10.3	22.8	25.3	12.8	6.9	18.1	0	13.3	25.1	18	**85**
	29941	9	1.09	0	43.8	40.3	**100.4**	**45.8**	**177.6**	**69.1**	**122.3**	**165**	**54**	39.3	**55.4**	**57.8**	**35.1**	**97.2**
	29944	10	1.04	0	**74.2**	33.2	**71.9**	22.6	**109**	40.1	**64.4**	**74.1**	23.6	18.7	**26.7**	25.2	26.9	**72.4**
	29947	11	1.09	5	**83.6**	**65.3**	**77.5**	40.2	**126.1**	45.8	**64.7**	**63.1**	14.6	15.8	**18.1**	18	20.6	**61.2**
	29950	12	1.32	7.2	**67.3**	**37.8**	**80.6**	19.9	**95.1**	30.1	**34.3**	**120.7**	11.3	13.7	**15.9**	13.4	15	**49.3**
Liver	29921	1	1.13	0	23.3	28.9	**62.9**	26.5	80.9	27	**43.6**	**137.6**	18.1	17.8	**17.1**	21.7	**31.9**	**112.3**
	29924	2	1.09	0	14.9	13.8	**62.2**	15	65.6	18.3	**37.6**	37.6	28.6	5.2	**45.3**	26.8	12.5	**82**
	29927	3	1.11	0	19.8	15.7	**76.7**	17	66.5	23.7	**36.9**	**56.7**	13.7	14.2	9.4	11.6	8.9	**61.2**
	29931	5	1.01	0	22.6	16.8	**74.8**	19.8	55.9	21.8	39.6	36.7	17	8.9	13.4	15.2	24.9	**87.7**
	29934	6	1.07	0	17.9	9.8	**47.4**	12.8	42.9	16.3	30.6	32.4	9.2	5.2	8.7	10	5.2	**60.8**
	29936	7	1.21	0	27	16.4	**48.1**	8.7	40.2	20.6	**36**	31.4	11.8	9.1	7.6	11.7	6.8	**58**
	29939	8	1.08	0	40.7	30.4	**99.9**	18.4	49.8	24.3	**44.4**	39.6	10.3	7.1	9.1	10.7	12.7	**80.3**
	29942	9	1.11	0	29.9	15.4	**80.7**	11.7	30.8	20	**37.5**	**105.4**	27.3	10.3	**25.9**	27.4	26.4	**82**
	29945	10	1.04	0	**54.5**	18.9	**64.8**	20.6	**130.7**	43.3	34	**63.8**	20.9	19.9	**23.6**	27.1	24	**65.3**
	29948	11	1.23	0	34.3	19	**55.5**	11.6	66.1	23.9	22.2	26	12.1	9.3	**13.7**	14.1	22.7	**60.3**
	29951	12	1	0	**64.3**	17	**74.9**	17.2	**132.5**	35.1	23.5	**97.5**	12.6	20.8	15.6	14.2	16.4	**57.7**
Muscle	29922	1	1.03	0	17.5	16.6	**122.1**	**47.1**	87.5	32.5	**44.1**	45.4	14	12.2	12	13.2	18.3	**103.1**

Tissue	Lab ID	Otter #	Sample wt.[c]	C10	C11	C12	C13	C14	C15	C16	C17	PRI	C18	PHY	C19	C20	C21	C22
	29925	2	1.11	0	35.1	15.9	**66.9**	34.6	58.9	30.7	34.7	29	29	5.2	10.9	14.2	17.8	**81.6**
	29928	3	1.01	25.2	29.6	21.7	**80.2**	**60.9**	**121.8**	**58.7**	**45.8**	47.3	18.4	14.4	**20.1**	24.2	**38.5**	**103.8**
	29929	4	1.24	0	0	12.4	**64.7**	24.9	76.4	29.2	28.7	32.1	8.8	10.1	7.9	11.3	11.3	**58.4**
	29932	5	1.08	0	16.9	13.4	**95.6**	17.7	69.9	25	24.2	27.8	9.1	8.8	7.9	11.6	12.7	**74.7**
	29935	6	1.3	0	18.7	14.5	**60.1**	29.6	46.5	27.6	23.5	23.1	8.8	6.2	6.3	7.9	9.4	**45**
	29937	7	1.09	0	23.3	13.4	**95.7**	**41.4**	69.8	**52.3**	**42.2**	23.9	15.1	14.2	11.5	17.1	15.9	**85**
	29940	8	1.13	0	**57.4**	19.1	**74.7**	33.4	**167.5**	**52.3**	**44.1**	53.9	25	21.9	**28.5**	**30.9**	**37.4**	**80.6**
	29943	9	1.16	0	**49.5**	14.7	**61.8**	28	40.7	33.7	**53.8**	31.8	**40.8**	16.1	**33.3**	**34.5**	**38**	**79.9**
	29946	10	1.05	0	42.9	15.6	**81.5**	**45.3**	**125.5**	48.5	28.9	43.4	11.2	13.4	11.8	11.3	16.3	**50.4**
	29949	11	1.01	0	44.7	17.9	**84.1**	41.8	**126.9**	53.1	33	41.6	14.7	20.3	14.7	14.9	15.6	**58.2**
	29952	12	1.01	5.1	46.3	18.7	**107.6**	36.3	**124.4**	47.8	28.1	43.1	12.6	19.8	12.9	19.7	28.3	**83.3**

Table A-2. Continued.

Tissue	Lab ID	Otter #	Sample wt.	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	Total	UCM (ng/g)[d]
Kidney	29920	1	1.02	**62.3**	**72.6**	**63**	**65**	**52.4**	**49**	**62**	**49.2**	**50.9**	**53.1**	32.2	31.3	1638.2	0
	29923	2	1.02	**58.4**	**55.7**	**46**	**40.1**	**35.4**	**29.1**	40.2	**29.9**	19.9	25.7	18.8	15.1	991.4	19.6
	29926	3	1.26	**25**	**25.7**	23.2	21.8	**24**	13.2	27.3	14.6	17.7	15.9	10.8	8.2	749.3	6.8
	29930	5	1.14	**37.1**	**35.3**	**31.5**	19.7	**27.6**	**22.9**	34.4	24.8	19.8	21.2	14.5	11	711.4	1.7
	29933	6	1	**28.3**	27.1	20.2	18.3	22.7	14.6	27.8	15.9	13.9	15.8	12.9	0	704.6	6.8
	29938	8	1.04	**47.5**	**45.7**	**41.6**	25	**26.2**	**26.1**	19.2	26	11	0	0	0	617.9	18.2
	29941	9	1.09	**94.4**	**102.9**	**92.3**	**73.8**	**74.1**	**56.6**	**93.5**	**58.4**	**75.5**	**73.3**	**69.7**	61.8	2029.4	14.3
	29944	10	1.04	**58.5**	**65.1**	**55.2**	**44.2**	**44**	**36.2**	**53**	**35.3**	**55.5**	45.3	39.9	36.4	1251.5	0.9
	29947	11	1.09	**40.9**	**45.7**	**41.9**	26.7	**45.1**	22.6	42	20.5	**41.3**	22.7	12.6	12.9	1094.1	0
	29950	12	1.32	**27.3**	**30.1**	24.4	16.1	19.8	10.5	20.5	18.7	8.3	12.5	10.4	9.4	819.7	0
Liver	29921	1	1.13	**59.1**	**58.4**	**45.8**	**47.3**	**33.4**	**29.3**	**48.4**	**30.2**	26.6	21.5	12.1	19	1081	24.5
	29924	2	1.09	**40.5**	**39.1**	31.4	**36.6**	21.6	20	25.1	19.9	13.9	18.9	12.1	7.8	752.5	14.1
	29927	3	1.11	**33.3**	**30**	29.8	21.7	16.3	15.8	25.1	16.2	20.6	14.1	12.9	16.1	683.9	1.7
	29931	5	1.01	**51.3**	**54.7**	**50.6**	**50.4**	**44.3**	**37.8**	**50**	**38.5**	34.8	37.4	26.1	0	931	1.9
	29934	6	1.07	**22.7**	22.2	21.8	11.3	11.9	10.1	23.4	10.1	9.6	10.9	12.7	0	475.9	7.7
	29936	7	1.21	**29.1**	**31.3**	23.3	20.1	**22.4**	**21.5**	32.5	21.9	20.5	19.4	15.5	8.4	599.3	7.7
	29939	8	1.08	**31.5**	**34.8**	**36.7**	**34.8**	**31.9**	**25.1**	**44.1**	**29.7**	28.5	25.5	19.7	19.3	839.1	0
	29942	9	1.11	**70.3**	**80.1**	**83.3**	**56.7**	**56.3**	**44.3**	**60**	**43.6**	**45.9**	**51.2**	**44.6**	41.8	1208.6	2.1
	29945	10	1.04	**43.8**	**43.9**	**38.2**	25	21.2	15.7	24.6	14.4	10.1	16.3	13	12.8	890.1	0
	29948	11	1.23	**40.1**	**38.9**	**33.1**	**29.2**	**22.5**	17.3	24.5	18.6	14	20.1	16.4	0	665.4	0
	29951	12	1	**33.1**	**36.6**	30.2	20.9	20.8	17.3	22.4	14.6	18	19	10.1	10.8	852.9	0
Muscle	29922	1	1.03	**47.5**	**50.6**	**45.5**	**45.2**	**31.7**	**29.3**	33	**30.2**	23.9	27.6	17.1	13.2	978.5	4.7

Tissue	Lab ID	Otter #	Sample wt.	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	Total	UCM (ng/g)[d]
	29925	2	1.11	**40.1**	**39**	28.1	**29.7**	18	20.5	14.8	23	16.2	20.9	9.9	7.7	732.4	7.7
	29928	3	1.01	**84.9**	**91.6**	**88.7**	**79.7**	**72.8**	**59.1**	**67.2**	**60.4**	**50.4**	**57.8**	38.4	37.1	1498.7	4.7
	29929	4	1.24	**27.3**	**28.4**	23.2	21.7	14.4	11.8	13.2	10.3	13.4	13.9	10.6	7.9	572.3	7.7
	29932	5	1.08	**28.8**	27.8	21.1	9.6	12.5	11.3	8	10.2	9.9	12.3	0	0	566.8	1.5
	29935	6	1.3	**23.4**	**26.6**	21.5	22.5	17.6	18.2	19	22.6	18.4	24.8	12.7	12	566.6	0.8
	29937	7	1.09	**49.9**	**55.3**	**47.6**	**37.3**	**39.9**	**36.4**	33.6	**35.9**	31	33.8	18.5	20.9	960.8	5.6
	29940	8	1.13	**71.2**	**76.2**	**67.7**	**50.5**	**50.9**	**40.6**	40.7	**37.5**	**43.2**	**43.3**	36.7	37	1322.1	0
	29943	9	1.16	**76.1**	**80.3**	**72.4**	**69.5**	**56.8**	**43.5**	**41.5**	**44.5**	**49**	**52.2**	**49.6**	37.6	1229.6	0
	29946	10	1.05	**30**	**29.5**	25.9	18.1	15.5	10.8	10.5	6	9.3	12	0	0	713.6	0
	29949	11	1.01	**37.2**	**40.7**	**36.2**	30.3	21.8	16.1	16.9	19.4	14.9	15.4	14.9	9.5	854.6	0
	29952	12	1.01	**51.5**	48.5	**39.8**	26.6	24.1	19.3	19.1	15.6	15.9	0	8.3	0	902.6	0

[a] Reported by GERG, NRDA Aliphatic Hydrocarbon Data, Catalog 6711.

[b] Abbreviations: Abbreviations: C_{10} through C_{34}: n-alkanes (the subscript represents the number of carbon atoms); PRI: pristane; PHY: phytane; UCM: unresolved complex mixture; Total: *total aliphatic (not including the UCM).*

[c] Sample wet weight in grams.

[d] UCM = Unresolved complex mixture.

Table A-3. Aromatic hydrocarbon concentrations (ng/g) measured in sea otter tissue samples collected in southeast Alaska, summer 1991.[a, b]

Lab ID	Otter #	Sample wt.[c]	NAP	C1N	C2N	C3N	C4N	BIP	ANP	ANH	FLU	C1F	C2F	C3F	PHE	ANT	C1P	C2P	C3P	C4P	DIB	C1D
Kidney																						
29920	1	1.02	14.7	11	0	0	0	9.3	1.1	3.1	2.6	0	0	0	2.3	1	0	0	0	0	1.4	0
29923	2	1.02	10.3	12.8	0	0	0	3.4	1.1	2.3	1.4	0	0	0	3.9	1.4	0	0	0	0	1.1	0
29926	3	1.26	8.8	6.3	0	0	0	0.8	0.9	1.5	1.6	0	0	0	2	0.8	0	0	0	0	1.7	0
29930	5	1.14	7.5	5.8	0	0	0	1.7	0.4	1.8	1.7	0	0	0	1.7	0.6	0	0	0	0	1	0
29933	6	1	7.9	6.6	0	0	0	1.2	0.5	1.1	0.8	0	0	0	1.8	0.4	0	0	0	0	1.1	0
29938	8	1.04	13.2	8.7	0	0	0	2.4	0.6	0.9	2.1	0	0	0	3.2	1.4	0	0	0	0	2	0
29941	9	1.09	11.8	10.4	0	0	0	3.1	0.7	1.5	2	0	0	0	1.3	0.7	0	0	0	0	0.7	0
29944	10	1.04	16.7	13.2	0	0	0	3.5	1.1	0.6	1.4	0	0	0	2.8	0.7	0	0	0	0	1.5	0
29947	11	1.09	15.3	8.7	0	0	0	2.8	0.5	1	1.6	0	0	0	1.6	1.2	0	0	0	0	1.2	0
29950	12	1.32	9.4	5.5	0	0	0	1.7	0.5	0.9	0.7	0	0	0	1.2	0.9	0	0	0	0	0.7	0
Liver																						
29921	1	1.13	13.5	9.7	0	0	0	3.2	0.8	1.3	2	0	0	0	2.8	1.9	0	0	0	0	2.1	0
29924	2	1.09	12.7	8.3	0	0	0	1.7	1.1	1.8	1.5	0	0	0	2.2	0.7	0	0	0	0	1.4	0
29927	3	1.11	13.9	8	0	0	0	2	1.4	1.2	2.1	0	0	0	5	2	0	0	0	0	1.5	0
29931	5	1.01	11.1	4.5	0	0	0	2.3	1.1	1.8	3.2	0	0	0	1.7	1	0	0	0	0	1.1	0
29934	6	1.07	11.7	7.4	0	0	0	1.1	0.7	0.7	1.9	0	0	0	1.9	1	0	0	0	0	0.8	0
29936	7	1.21	9.6	4.6	0	0	0	1.6	0.6	1.5	1.8	0	0	0	1.8	0.2	0	0	0	0	2.2	0
29939	8	1.08	11.9	8.4	0	0	0	2.6	1.6	3.5	2.5	0	0	0	2.8	1.2	0	0	0	0	1	0
29942	9	1.11	14.2	12.1	0	0	0	1.5	0.7	1.5	2.5	0	0	0	2.5	0.3	0	0	0	0	1	0
29945	10	1.04	13.7	12.1	0	0	0	3.1	0.6	1.5	1.5	0	0	0	1.1	0.4	0	0	0	0	1.8	0
29948	11	1.23	16.6	14.8	0	0	0	3.2	0.8	0.8	2.8	0	0	0	2.9	1.6	0	0	0	0	1.4	0
29951	12	1	18	11	0	0	0	4.3	0.8	1.2	1.9	0	0	0	2.3	0.7	0	0	0	0	0.9	0

Lab ID	Otter #	Sample wt.[c]	NAP	C1N	C2N	C3N	C4N	BIP	ANP	ANH	FLU	C1F	C2F	C3F	PHE	ANT	C1P	C2P	C3P	C4P	DIB	C1D
Muscle																						
29922	1	1.03	10.9	8.6	0	0	0	2.8	0.8	2.4	2.1	0	0	0	2.5	2	0	0	0	0	1.1	0
29925	2	1.11	14.2	8.9	0	0	0	4	0.8	3.7	1.2	0	0	0	2.7	1.6	0	0	0	0	2.4	0
29928	3	1.01	12.2	8.5	0	0	0	1.8	0.6	1.2	3.4	0	0	0	2.9	1.6	0	0	0	0	1.5	0
29929	4	1.24	8	5.2	0	0	0	1.6	0.6	0.8	2.9	0	0	0	2	0.4	0	0	0	0	1.1	0
29932	5	1.08	8.7	6.7	0	0	0	1.3	1.2	2	2.3	0	0	0	1.6	0.6	0	0	0	0	0.7	0
29935	6	1.3	7.9	5.2	0	0	0	1.5	0.5	0.7	0.6	0	0	0	1.4	0.7	0	0	0	0	0.8	0
29937	7	1.09	15.3	12.5	0	0	0	2.6	2.3	1.7	2	0	0	0	2.7	0.6	0	0	0	0	1.3	0
29940	8	1.13	12.7	7.8	0	0	0	2.7	0.9	3.1	1	0	0	0	3.4	2.2	0	0	0	0	1	0
29943	9	1.16	12.1	7.8	0	0	0	2.5	0.7	0.9	0.5	0	0	0	2	0.4	0	0	0	0	0.9	0
29946	10	1.05	14.6	8.9	0	0	0	2.8	1.7	1.4	1.8	0	0	0	3.5	2.1	0	0	0	0	1.2	0
29949	11	1.01	16.8	9.8	0	0	0	5.2	0.7	3.3	1.7	0	0	0	3.3	2.4	0	0	0	0	1.6	0
29952	12	1.01	12.3	9.3	0	0	0	2.1	0.5	1.8	1	0	0	0	1.4	0.3	0	0	0	0	0.5	0

Table A-3. Continued.

Lab ID	Otter #	Sample wt.[c]	C2D	C3D	FLA	PYR	CFP	BAA	CHR	C1C	C2C	C3C	C4C	BBF	BKF	BEF	BAP	PER	IDE	DBN	BEQ	Total
Kidney																						
29920	1	1.02	0.	0.	2.	1.5	0.	1.6	0.9	0.	0.	0.	0.	0.53	0.71	0.7	1.	3.9	0.9	1.3	1.5	63.04
29923	2	1.02	0.	0.	1.2	2.	0.	1.9	1.8	0.	0.	0.	0.	1.11	0.8	0.7	1.2	3.	1.1	0.7	1.2	54.41
29926	3	1.26	0.	0.	1.3	2.2	0.	0.9	1.3	0.	0.	0.	0.	1.55	0.7	0.5	1.8	0.6	2.	1.6	1.	39.85
29930	5	1.14	0.	0.	0.9	1.4	0.	0.8	2.2	0.	0.	0.	0.	0.36	0.67	0.4	1.2	0.7	0.5	1.3	0.6	33.23
29933	6	1.	0.	0.	0.9	1.	0.	1.4	0.5	0.	0.	0.	0.	0.58	0.53	0.2	1.5	0.4	0.4	0.6	0.6	30.01
29938	8	1.04	0.	0.	1.4	0.9	0.	0.6	0.8	0.	0.	0.	0.	0.49	0.36	0.6	0.9	0.9	0.5	0.4	0.6	42.95
29941	9	1.09	0.	0.	0.9	1.6	0.	0.7	0.8	0	0.	0.	0.	0.92	1.04	3.	0.7	2.4	0.9	0.6	0.8	46.56
29944	10	1.04	0.	0.	2.	1.7	0.	1.2	1.3	0.	0.	0.	0.	0.71	1.38	2.2	0.2	3.3	2.1	1.	0.7	59.29
29947	11	1.09	0.	0.	1.2	1.4	0.	1.2	1.9	0.	0.	0.	0.	1.04	3.31	3.3	0.6	2.9	2.5	1.7	0.6	55.55
29950	12	1.32	0.	0.	0.5	0.9	0.	1.1	0.4	0.	0.	0.	0.	0.46	1.6	3.	0.2	1.1	0.7	0.8	0.4	32.66
Liver																						
29921	1	1.13	0.	0.	2.1	2.2	0.	3.5	1.3	0.	0.	0.	0.	0.95	0.53	0.6	1.2	1.8	0.4	1.6	1.9	55.38
29924	2	1.09	0.	0.	1.1	1.8	0.	0.8	1.3	0.	0.	0.	0.	0.89	1.1	0.6	0.7	0.4	1.1	2.8	1.	44.99
29927	3	1.11	0.	0.	2.4	1.5	0.	1.6	1.9	0	0.	0.	0.	1.73	1.12	0.6	2.	1.5	1.	1.7	0.9	55.05
29931	5	1.01	0.	0.	1.2	1.3	0.	1.6	1.1	0	0.	0.	0.	0.75	0.9	0.8	1.	1.7	0.4	0.9	0.6	40.05
29934	6	1.07	0.	0.	1.3	1.5	0.	1.1	1.3	0.	0.	0.	0.	0.37	0.3	0.4	0.5	0.4	0.3	0.6	0.5	35.77
29936	7	1.21	0.	0.	1.2	1.2	0.	1.1	0.8	0.	0.	0.	0.	0.55	0.78	0.5	1.7	0.5	0.5	0.7	0.7	34.13
29939	8	1.08	0.	0.	1.4	1.6	0.	1.	0.4	0.	0.	0.	0.	0.56	0.56	0.7	0.7	0.9	0.6	0.6	0.5	45.02
29942	9	1.11	0.	0.	0.9	1.2	0.	1.2	1.7	0	0.	0.	0.	0.89	1.99	2.9	0.4	1.4	1.9	0.6	0.7	52.08
29945	10	1.04	0.	0.	0.6	1.	0.	0.7	0.4	0.	0.	0.	0.	0.49	1.74	3.8	0.8	1.2	2.2	0.5	0.4	49.63
29948	11	1.23	0.	0.	1.4	1.1	0.	0.8	0.6	0.	0.	0.	0.	0.44	0.85	2.8	0.4	1.9	1.5	0.7	0.5	57.89
29951	12	1.	0.	0.	1.2	1.5	0.	0.4	0.6	0.	0.	0.	0.	1.11	0.79	2.	0.6	1.6	1.3	1.1	0.3	53.6

Lab ID	Otter #	Sample wt.[c]	C2D	C3D	FLA	PYR	CFP	BAA	CHR	C1C	C2C	C3C	C4C	BBF	BKF	BEF	BAP	PER	IDE	DBN	BEQ	Total
Muscle																						
29922	1	1.03	0.	0.	1.2	2.7	0.	1.3	0.4	0.	0.	0.	0.	0.52	1.18	1.	2.4	0.4	0.7	1.3	1.8	48.1
29925	2	1.11	0.	0.	1.1	2.5	0.	2.1	2.4	0.	0.	0.	0.	2.32	1.17	1.	1.3	2.6	2.3	1.8	2.1	62.19
29928	3	1.01	0.	0.	1.5	2.2	0.	1.2	1.3	0.	0.	0.	0.	1.26	1.72	0.5	0.6	0.9	2.	0.5	1.3	48.68
29929	4	1.24	0.	0.	1.3	1.1	0.	1.2	0.6	0.	0.	0.	0.	0.58	0.82	0.3	2.3	0.6	0.9	1.1	0.8	34.2
29932	5	1.08	0.	0.	0.9	1.3	0.	1.9	0.6	0.	0.	0.	0.	0.43	0.61	0.4	1.	0.9	0.8	1.	1.1	36.04
29935	6	1.3	0.	0.	0.6	1.1	0.	0.3	0.5	0.	0.	0.	0.	0.19	0.34	0.4	0.8	0.3	0.3	0.7	0.4	25.23
29937	7	1.09	0.	0.	1.7	1.8	0.	1.3	1.5	0.	0.	0.	0.	0.44	1.25	0.7	0.5	1.1	0.6	1.1	1.	53.99
29940	8	1.13	0.	0.	0.8	1.6	0.	1.2	0.8	0.	0.	0.	0.	1.29	1.22	3.6	0.4	3.2	1.4	1.	0.6	51.91
29943	9	1.16	0.	0.	0.6	0.7	0.	0.5	0.6	0.	0.	0.	0.	0.61	0.89	2.2	0.8	1.4	1.	0.7	0.4	38.2
29946	10	1.05	0.	0.	1.3	1.9	0.	1.2	1.4	0.	0.	0.	0.	1.02	2.35	3.4	0.8	2.	2.3	2.8	0.6	59.07
29949	11	1.01	0.	0.	1.1	1.9	0.	1.5	0.6	0.	0.	0.	0.	0.84	1.25	3.8	0.9	1.7	1.4	0.7	0.5	60.99
29952	12	1.01	0.	0.	0.7	0.8	0.	0.7	0.2	0.	0.	0.	0.	0.4	0.84	2.	0.4	1.	1.3	0.3	0.2	38.04

[a] Reported by GERG, NRDA Aliphatic Hydrocarbon Data, Catalog 6711.

[b] Abbreviations: NAP: naphthalene; C1N: C1-naphthalene; C2N: C2-naphthalene; C3N: C3-naphthalene; C4N: C4-naphthalene; BIP: biphenyl; ANP: acenaphthylene; ANH: acenaphthene; FLU: fluorene; C1F: C1-fluorene; C2F: C2-fluorene; C3F: C3-fluorene; ANT: anthracene; PHE: phenanthrene; C1P: C1-phenanthrene; C2P: C2-phenanthrene; C3P: C3-phenanthrene; C4P: C4-phenanthrene; DIB: dibenzothiophene; C1D: C1-dibenzothiophene; C2D: C2-dibenzothiophene; C3D: C3-dibenzothiophene; FLA: fluoranthene; PYR: pyrene; CFP: methyl fluoranthene-pyrene; BAA: benz(a)anthracene; CHR: chrysene; C1C: C1-chrysene; C2C: C2-chrysene; C3C: C3-chrysene; C4C: C4-chrysene; BBF: benzo(b)fluoranthene; BKF: benzo(k)fluoranthene; BEP: benzo(e)pyrene; BAP: benzo(a)pyrene; PER: perylene; IDE: ideno(1,2,3-cd)pyrene; DBN: dibenzo(a,h)anthracene; BEQ: benzo(g,h,i)perylene.

[c] Sample wet weight, in grams.