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NATURE, DISTRIBUTION, AND EXTENT OF PCB CONTAMINATION SEEN IN
EXTANT MOLLUSCS OF THE HUDSON RIVER ESTUARY, NEW YORK

by

PAUL M. FEINBERG

A dissertation submitted to the Graduate Faculty in Earth and Environmental Sciences in
partial fulfillment of the degree of Doctor of Philosophy,
The City University of New York

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This manuscript has been read and accepted for the Graduate Faculty in Earth and Environmental Sciences in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

_____	<u>Frederick C. Shaw</u>
Date	Chair of Examining Committee

_____	<u>Yehuda Klein</u>
Date	Executive Officer

Frederick C. Shaw
Cecilia M.G. McHugh
John A. Chamberlain
David C. Locke

THE CITY UNIVERSITY OF NEW YORK

Abstract

NATURE, DISTRIBUTION AND EXTENT OF PCB CONTAMINATION SEEN IN EXTANT MOLLUSCS OF THE HUDSON RIVER ESTUARY, NEW YORK

by

Paul M. Feinberg

Advisor: Dr. Frederick C. Shaw

With the battle in full force between the United States Environmental Protection Agency (USEPA) and General Electric (GE), the question naturally asserted itself of whether the downstream presence of PCBs could be linked to the two GE plants in Hudson Falls, NY and Fort Edward, NY. It was decided that a sedentary, bottom sediment dwelling organism might be a good indicator of the fate of the upstream PCBs.

A sampling program was developed in order to determine whether the PCBs known to have been present in the operations of the two plants upriver, could be detected in bivalve molluscs in the lower 66 kilometers of the Hudson River Estuary. A roughly one kilometer sampling grid was used to collect live bivalve molluscs. A total of 30 live specimens were collected from the 98 Peterson grab samples of the Hudson River bottom sediments from each of the sampling stations along the various transects throughout the study area. These specimens were then analyzed for PCBs.

Of the 98 locations sampled, eight concentrations above the limit of detection were revealed in seven of them. These included locations T22A, T22C, T5C, T9A, T11B, T15C and T19D. In all but one case, the PCBs detected were found to be Aroclor 1254.

The PCB concentrations for Aroclor 1254 typically are considered linked to the upriver contamination. Aroclor 1248 was found only in the live sample tissue taken from location T9A. The presence of PCB type 1248 in this location is viewed as potentially deriving from either a lower river source or possibly as a product of PCB weathering of the contaminated sediments linked to GE operations.

In terms of water quality, the concentrations in the bivalves exceed both federal USEPA and New York State standards for fish consumption. The concentrations found in clams range from 0.056µg/L to 840µg/L. In terms of recommended fish consumption, the federal limit prescribed by the USEPA of no more than one meal per month containing 0.023 to 0.047 ppm is exceeded in six locations, T11B (840µg/L), T15C (770µg/L), T19D (340µg/L), T22C (200µg/L), T5C(150µg/L), and T22A (84µg/L).

Statistical regressions performed for water quality indicators (salinity, dissolved oxygen, percent oxygen saturation, pH, and eH) measured at the time of the grab sampling demonstrated an inability to predict levels of PCB. This inability to predict PCB levels was also the case with respect to individual trace metal concentrations reported for each of the sampling locations in the work done by Ashkan (2000). In the case of latitude however, a statistical “trend” was found showing that for each degree of increasing latitude, there was an expected increase of 647µg/L in PCB concentration.

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Section I Introduction

Background

As reported in the 2002 EPA Superfund Record of Decision (ROD) published by the United States Environmental Protection Agency (USEPA), “the Hudson River PCBs Site...includes a nearly 330 km (205 river-mile) stretch of the Hudson River in eastern New York State from the Village of Hudson Falls to the Battery in New York City” (see Figure 1-1). The primary focus of the study was to determine whether or not the PCBs initially put into the Hudson River by two GE plants located in Hudson Falls, NY and Fort Edward, NY could be detected in the tissues of bivalve organisms indigenous to the river sediments of the lower 113 km (70 miles) of the Hudson River Estuary.

With the long history of PCB dumping in the upper Hudson River and consequent decades-long responsive actions by the USEPA, it seemed logical to gauge the degree of the pervasiveness of the contamination by examining the biomass of organisms at extreme downriver locations of the estuary itself. In light of the recently signed consent agreement between the USEPA and GE, dredging activities in the upper Hudson River would seem to necessitate some form of current baseline study of any effective concentrations of PCB seen in the lowermost region of the estuary before dredging commences. If PCBs were found to be present in this part of the river, the clams could well act as stationary recorders.

Further, the prospect of using stationary, relatively short-lived infaunal organisms which relied on filter-feeding and/or deposit bottom feeding mechanisms seemed an ideal means for effectively measuring the potential current day down-river existence of the toxic

compounds. The limited life spans of the bivalves would also lend credence to a real-time gauge of the fate and transport issue, most likely bounding any finding to within ten years. In this way, if PCBs were found to be present in any significant quantity, the study would consider the relationships of those “contaminated” clams, by species if possible, to the other variables also measured during the sampling event (e.g. geographic location, dissolved oxygen, salinity, trace metal concentrations, etc.).

In fact, the findings of two other dissertation projects (Ashkan, 2000; Rudolph, 2004) were considered in conjunction with the research done for the PCB focus of the current study. In this way, sampling was done simultaneously, utilizing the same sampling locations, making use of unique dredge samples to collect sediments and bivalve organisms, while simultaneously taking readings for various water quality parameters of dissolved oxygen, oxygen saturation, salinity, pH, and Eh. Although the other two studies did not monitor for PCB concentrations as a part of their focus, the results still were useful for studying any cross-correlation effects among the findings, uniquely extending the analysis of the Hudson River Estuary.

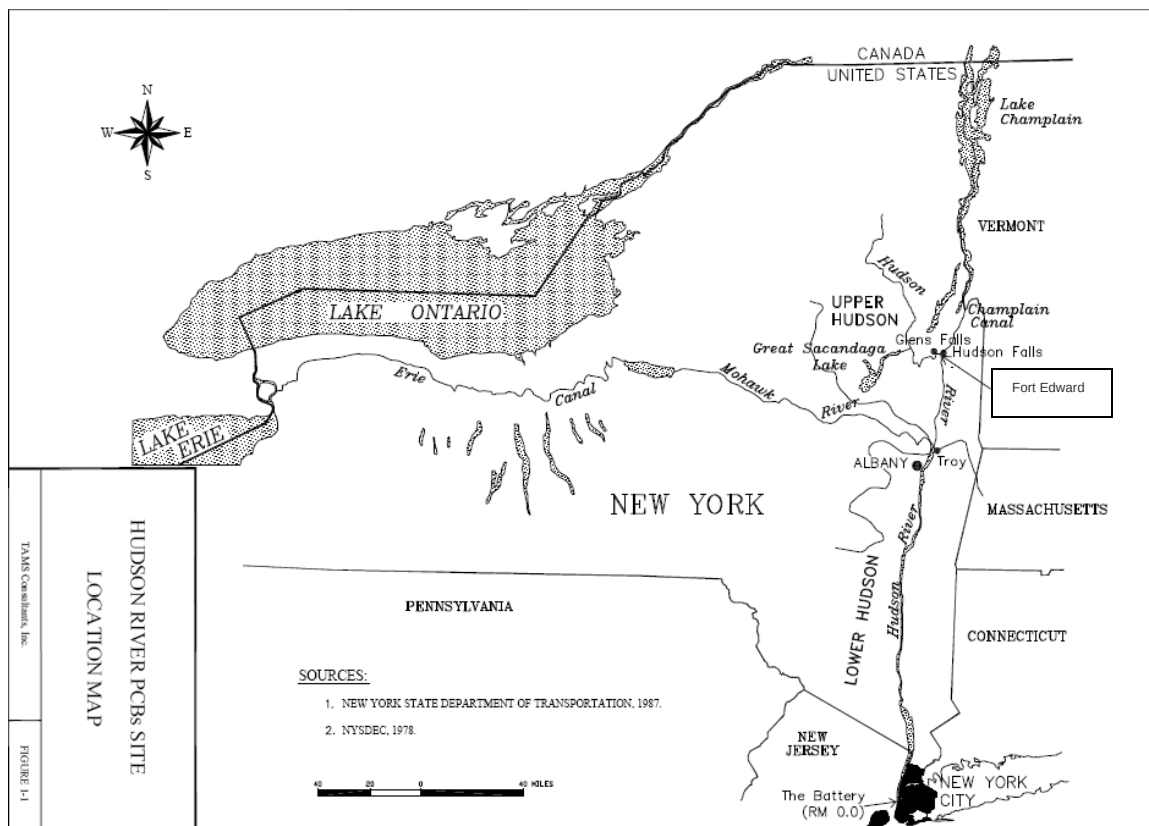


Figure 1-1 Hudson River PCBs Site (modified from USEPA 2002 Record of Decision)

Section II Hudson River Basin

Geologic Setting

The source of the Hudson River is the Lake Tear of the Clouds, located at an elevation of 1317 meters (4322 feet) in the southwest part of the Adirondack Mountains, on the southwest side of Mount Marcy, the highest peak in New York State at 1629 meters (5344 feet) (Geise and Barr, 1967). From this point, the river flows 507 kilometers (315 miles) south to the Battery in New York City. Approximately 34,637 km² of the southeastern part of New York, southwestern New England, and northeastern New Jersey lie within the Hudson River basin (Geise and Barr, 1967). Weiss, 1974 states that “the present valley of the Hudson River estuary was modified as a result of ice scouring and deposition during several Pleistocene glaciations and also by Pleistocene lacustrine, fluvial, estuarine processes.” The deepening of the bedrock channel is attributed to the ice sheet scouring, with the subsequent rise in sea level due to the melting of glacial ice, ca. 17,000 to 18,000 years before present, drowning much of the valley surrounding the present estuary (Newman et al., 1969; Connally and Sirkin, 1970). In fact, the isostatic rebound effects as well as sea level rise have all been factored into numerous studies in order to gain an understanding of the current sedimentation dynamics as well as recent history of the river (McHugh et al, 2004; Peltier, 1998; Olsen et al, 1978).

Such a setting has given way to a present dynamic river basin with both freshwater and estuarine qualities. It is now appropriate to elaborate upon several of the pertinent attributes of the river within this framework, as each stands to render a contributing impact on the environmental character of the Hudson River today, particularly with respect to its potential to cause deleterious effects on its current ecosystem.

River and Estuary

Estuarine Character - Salt water wedge

The Hudson River maintains two characters simultaneously, that of a freshwater river in the upper 264 kilometers, and also that of a tidal estuary in the lower 243 kilometers of the river, influenced by tidal fluctuations which generate a salinity gradient from several parts per mil to near normal ocean salinity down-gradient (Geyer et al, 2004). In fact, the Hudson River has been divided into four reaches over the length of the river extending between Troy, NY to the Battery of New York City (Abbott and Carter, 1994). Each of these have broad salinity ranges associated with them.

Beginning in the north, Reach four (Reach 4), was set from Troy, south to Poughkeepsie, the limit of the brackish waters from the south (Abbott and Carter, 1994; Rudolph, 2003), and extends to the Hudson Highlands. The third reach (Reach 3) continues southward from the Hudson Highlands to Haverstraw. The study area for this study includes the two southern reaches, the first of which extends from the Battery to Yonkers and which is termed Reach One (Reach 1). The second reach (Reach 2) extends from Yonkers to Croton-on-Hudson. In fact, the northernmost sample site in this study was taken at a location on the river adjacent to Haverstraw-Croton. Reach 1 is situated largely in a polyhaline salinity zone, with salinities ranging from 18 to 30 parts per thousand (ppt) (Rudolph, 2004, Venice salinity zonation scheme, 1959). Reach 2 is a mesohaline zone, with contingent salinities less than 18 ppt, but greater than 5 ppt (see Figure 2.1). Of course the physical extent of each salinity range is dependent upon many environmental

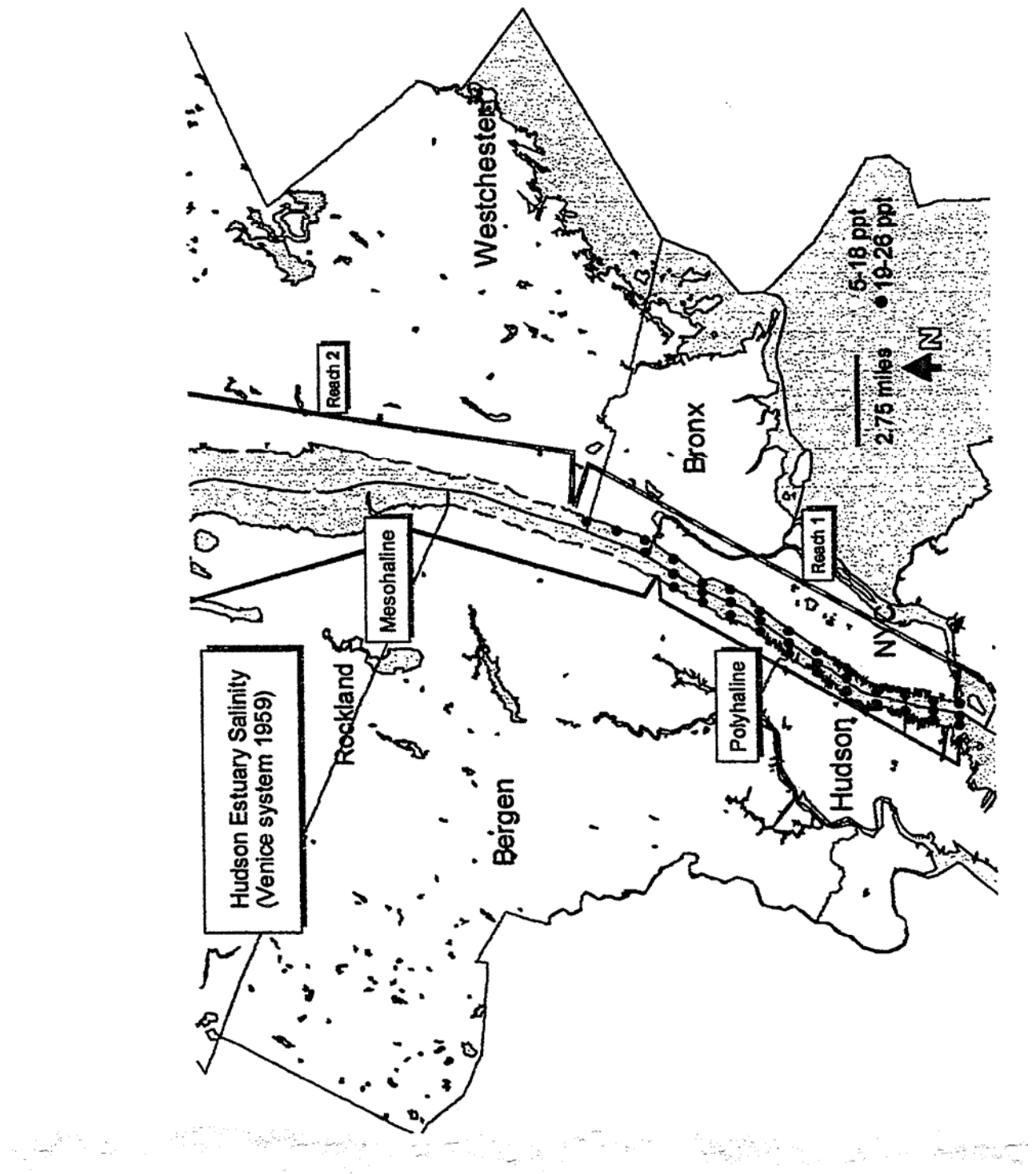


Figure 2.1 Hudson River Estuary Salinity Base Map extending from New York City to West Haverstraw (from Rudolph (2003) used with permission from author)

factors, which contributes to a fluctuation in location of the salt-water front at any given time.

According to the data previously collected by researchers and the recent study done in the identical study area by Rudolph (2004), the salt-water front “oscillates over a distance of approximately 50 miles, between Chelsea Pump station (Poughkeepsie) and Hastings, New York depending upon the season. Previous work has been done regarding freshwater and tidal mixing (Geyer et al., 2000), which naturally have an influence on the location of the front. These researchers have asserted that both the spring rains and melt-water of winter snows and ice act to push the salt water wedge south.

Weiss et al (1978) noted that a two-layered salinity structure is created as a result of tidal effects and river basin freshwater contributions. Apparently this condition is exacerbated in the summer months. (Rachlin et al., in Weiss et al., 1975, Weiss, Geitzner, & Shaw, 1978). During the remainder of the year, the Hudson River is found to be partially mixed with respect to salinity. Rudolph (2004) cites again the work of Ristich & Fortier (1977) stating that “the gradient stimulates both lateral and vertical turbulence and influences the distribution of bottom sediments and resident organisms at least while in larval stage.

Work done by Holland (1985) focusing on the long-term variation in Macrobenthos in a mesohaline region of Chesapeake Bay showed that most of the resident species responded to salinity changes with predictable increases or decreases in abundance.

Holland’s study also showed that the macrobenthos populations in Chesapeake Bay were also persistent for more than 11 years, fluctuating within particular abundance boundaries.

Downstream and Cross-channel Sedimentation

Geyer et al.(2001) investigated a pronounced turbidity maximum zone in the Hudson River, which is located in the lower estuary 10 to 15 km north of the Battery. Here they noted that suspended sediment concentrations can reach more than 1000 mg per liter (also see Geyer et al., 1998). This zone they termed the estuarine turbidity maximum (ETM) zone which they described as having “rapid, short-term deposition of sediment during and following the spring freshet. During their study, they confirmed an estimated net convergence of sediment in the lower estuary as being on the order of 300,000 tons. Unexpectedly however, they also found during the spring of 1999 that an even larger quantity of sediment was transported into the river during the same three month period, from a source beyond the mouth of the river. They determined that “the amplitude of the spring freshet and its timing with respect to the spring-neap cycle cause large interannual variations in estuarine sediment flux. These variations can result in the remobilization of previously deposited sediment, the mass of which may exceed the annual inputs from the watershed.” Sediment accumulation in the Hudson estuary over the long-term has been estimated to be from 1 to 3 mm per year (Olsen et al., 1978 in Geyer et al., 2001). It appears also that the long-term sediment accumulation rate is also in equilibrium with sea-level rise (Peteet and Wong, 2000; Geyer et al., 2001), however in 1974, D. Weiss noted that the salinity of waters in the Hudson estuary had decreased during the past 1500 to 3000 years, identifying the likely source of this phenomenon to be “the result of the filling of the estuary by sediment faster than subsidence of the area or rise of sea level.” He went on to identify the process as an in-progress marine transgression. Therefore the

dynamics of the Hudson estuary have been in constant flux, carrying with it a variety of related effects on both the physical estuary, its saline nature, and the biological aspects of the river.

More recently, McHugh et al (2004), determined that the “overwhelming evidence in nearly all areas studied reveals that the Hudson River estuary is now effectively filled at or near sea level. The evidence cited for this was quite compelling and included: (1) radiocarbon ages for oyster shells and wood that range between ca. 3 and 1 ka in the upper 150 cm, (2) the presence of coal and other relicts of coal burning that are found scattered on the estuary floor, (3) borehole data from bridge and tunnel construction across and beneath the river (Newman et al., 1969) showing the disparity between sediment accumulation rate from 6400 to 3400 years before present (3.55 mm per year) than the present rate estimated to 1.2mm per year (Pekar et al., 2002 and Klingbeil, 2003, McHugh et al., 2004), and (4) the “fluvially dominated” area of the Hudson north of Kingston which is presently undergoing the formation of islands, shallow banks, and channels requiring dredging for the purpose of maintaining open navigation routes along the river.

McHugh et al. (2004) have observed that “the Hudson River estuary is characterized nearly everywhere by sedimentary bypass and by the rapid filling of any available space by sediments.” They state that:

“Sediments younger than 1965, defined as ‘recent’ as revealed by the presence of ¹³⁷Cs, are represented by layers no more than 50 cm thick that accumulated at rates as high as 5-10 mm/yr. These sedimentary “caps” are associated with regions of pronounced topography that are not in equilibrium with their sediment load, such as the Hudson Highlands... Sediment is also known to be accumulating

today at bends in the channel.... In the lower estuary, substantial trapping is associated with the estuarine turbidity maximum....”

Nitsche, et al. (2004) were able to distinguish between eight different sedimentary classes among the sediments examined in the Hudson in the Haverstraw Bay section, each of which were linked in varying degrees to the dynamic processes taking place in the river including contemporary deposition, erosion, and sediment migration in sand waves.

McHugh et al. (2004) summarize the sedimentation process of the estuary as well as the long term implications as follows:

“The Hudson River estuary represents a low-sediment-budget, estuarine to open-marine system that was filled between ca. 3 and 1 ka and has begun its regressive cycle. The condensed interval that is developing has a variable thickness that averages a few meters and includes areas of recent (younger than 1965) deposition controlled by local topography, where sedimentation rates can be as high as 10 mm/yr. ...In the muddy central reach of the estuary, the condensed interval is lithologically uniform, but ranges in age from 10 to 10^3 yr owing to variable rates of filling.”

Therefore, the variability in sedimentation rates throughout the Hudson River estuary impedes the ability to refine the temporal scope of a study to track the recent downstream progress of particular upstream environmental contamination. For example, unless a sampling study is augmented throughout its scope with some means of age testing of the various sediments analyzed, it would be difficult to limit the scope of the study to the most recent effects taking place within the last few decades. This would impede the ability to understand the fate and transport of certain pollutant analytes found throughout the estuary. Chillrud, et al. (2003) used radionuclide, stable lead isotope, and trace metal analyses on fine-grained sediment cores collected along a 24-mile reach of the upper Hudson River to “establish temporal trends of contaminant loadings, to establish stable lead isotopes as an additional stratigraphic tool, and as tracers for resolving particle

transport fluxes over periods of decades.” In this study they were able to discern the relative fluxes of sediment entering the river between two coring locations. This allowed them to establish that the amount of sediment entering the river between the two coring sites was three to four times greater than that received from the upstream location alone.

Bopp (1979) also noted that in order to demonstrate that a particular sample was recent sediment, an independent indicator of its recent nature needed to be established. He suggested ^{137}Cs as an excellent indicator and emphasized the importance of determining such an indicator in the very heterogeneous nature of recent sedimentation found in the Hudson.

A comment made by Carriker et al. (1985) regarding the New York Bight seems most illuminating when one seeks to study a particular type of contamination in the Hudson River Estuary proper:

“To partition the effects of these materials on natural benthic populations would be a Herculean task. As a result, much of the data on effects of specific toxicants on individual species or species assemblages have come from laboratory studies.”

Since there has been a unique opportunity to collect information on mollusc species, trace metals in surrounding sediments, PCB analytical data for the individual live molluscs, and various water quality parameters, it was the intention of the present study to try to examine any potential relationships among the parameters which were measured.

Trace Metals in the Hudson River Estuary

For the identical sampling stations utilized in this study, split sediment samples were taken and analyzed by Ashkan (2000) in a study of trace metal contamination in the

surficial bottom sediment of the present study area of the Hudson River Estuary (Ashkan, 2000). She found that for the study area, there were simultaneous increases and/or decreases in trace metal concentrations for Ag, Cd, Cr, Cu, Ni, Pb, Zn, and V, with substantial increases downstream in the vicinity of NJ/NY Water Pollution Control Plants (WPCPs). Trace metal concentration were also seen to be higher along the New Jersey shoreline, where sediments were found to be finer grained. Ultimately, Ashkan (2000) determined that “sediment particle size, proximity to present locations of NY/NJ WPCPs, and river hydrodynamics were found to be the main factors controlling spatial distribution of trace metals” of the surficial bottom sediments. Gibbs, Jha, and Chakrapani (1994) noted bottom sediment size appeared to be controlled by two components: (1) sand derived from the ocean and (2) particles in the flocs.

Of the metallic analytes studied, Ag was found to be the most pervasive contaminant followed by Pb and Cr. In addition, it was determined that the trace metal concentrations exceeded sediment quality guidelines established for bioassay toxicity. In the present study, I examined the same sediment metals analyses and compared it to any trends or patterns determined for any PCB contamination.

PCBs in River Sediments

In his doctoral dissertation, Richard Bopp (1979) predicted that “although direct discharges of PCB’s to the upper Hudson were stopped in 1976, the contaminated sediments of the upper Hudson will continue to be the major source of PCB’s to the tidal

Hudson for decades to come.” He noted the affinity of PCB for fine grained sediments and that generally, PCB concentrations determined in the Hudson showed a “general downstream decrease” in point of fact of the upstream source.

Bopp described the decrease as being a result of “the dilution of highly contaminated sediments from the upper Hudson with relatively uncontaminated sediments originating in the lower basin and to the partitioning of PCBs from suspended matter into the water phase. He further noted the association of PCB components with organic matter, stating that this could “tend to make the organic content of the sediments an important factor in determining their PCB concentrations.” At that time, the highest concentration of PCB determined for a sediment sample was given as 140 ppm.

Indigenous Invertebrate Species

Weiss et al.(1978) sampled the lower 184 km of the Hudson Estuary during a period from 1974 to 1975 and found that foraminifera, diatoms, and bivalves show distinctive distribution assemblages along the length of the channel. Prior to their work, with the exception of only one other study (Ristich et al., 1977), prior molluscan studies dealt with single economically important species, such as oysters, or did not cover the full range of salinities and bottom conditions of the estuary (Weiss et al., 1978). Their work showed that typical assemblages of these invertebrates existed and also corresponded geographically to a decrease or increase in salinity factor as one moved along the Hudson channel. They determined that only freshwater forms were found north of Peekskill, low brackish-water forms extended only as far south as mid-Manhattan, that high brackish-

water forms could only be found up to 16 km north of this same point, and finally, that “normal marine faunas” do not penetrate significantly northward of New York Harbor.

Six major species of bivalves occupy the Hudson River estuary in the current study area between the Battery and Haverstraw. These included *Macoma balthica*, *Mya arenaria*, *Crassostrea virginica*, *Rangia cuneata*, *Mulinia lateralis*, and *Mytilopsis leucophaeatus*.

These were all seen to have what was described as “nearly coincident or mutually exclusive ranges” and the assemblages were developed accordingly (Weiss et al., 1978).

Two assemblages were defined for the saline portion of the estuary: The first assemblage, occurring north of Hastings, was characterized by *Mytilopsis*. A second assemblage dominated by *Mya* and *Mulinia* was also determined to extend south of Hastings to upper New York Bay.

Using the baseline sampling plan of this early study (also that of the present study), work was done on the Hudson River by Elizabeth Rudolph (2004), focusing on bivalve species. Although it was acknowledged that factors such as salinity flux in the river, anthropogenic pollutant influx from air deposition, urban and agricultural runoff, leaching and wastewater discharge from sewage treatment plants, and groundwater transport of contaminants from septic systems may have greatly modified any original ecologic assemblages (Carriker et al., 1985), as a general finding, most species present in the mid-1970’s were still persistent along the same reach of river. It was noted however that the number of individuals of particular species had increased dramatically.

These organisms primarily reside in the soft bottom sediments of the Hudson River and are mainly stationary in their respective habitats. They are filter or deposit feeders and their presence can function as indicators of various toxicants, including PCB, which become incorporated and/or adsorbed into the biomass of the bivalve. A short, but detailed description of each of the mollusc species encountered in the study area of the Hudson River Estuary follows:

Species of Mollusc encountered in the Hudson River Estuary

Macoma balthica:

This mollusc is prevalent in estuaries and inter-tidal flats and has been found to have a high tolerance for changing conditions of salinity. Its average lifespan is five to ten years (Gilbert, 1973). It functions as both a deposit and filter feeder and is most commonly associated with mud-silt bottoms in salinities ranging from 5 to 25 o/oo (Shaw, 1978).

Mya arenaria:

This species is an infaunal burrowing mollusc which resides in intertidal, estuarine environments with polyhaline to mesohaline salinity conditions. It is

associated with muddy sand not subjected to strong wave activity where the adult animal can burrow up to 40 cm deep (Stanley, 1970). A lifespan of 10-12 years is considered normal, however a maximum of 28 years was recorded in the Bay of Fundy (Tyler-Walters, H., 2003; Strasser, 1999).

Crassostrea virginica:

Crassostrea oysters once ranged widely in the Tappan Zee and lower sections of the Hudson and are now staging a slow return (Shaw, 1978). They inhabit areas of near-constant salinity and turbidity (Osborne, 1999). A salinity range generally above the 0 to 8 o/oo observed in the Tappan Zee area for the oyster has been described as being at “the low end of oyster tolerance” (Wells, 1961; Galtsoff, 1964; Shaw, 1978). Oysters usually colonize in beds, which are a permanent social structure unless they are separated physically and forcefully (Osborne, 1999). Additionally, the competition for space is the factor most important to the mortality of the oyster. As Osborne (1999) has noted, in an uncrowded condition, oysters can live to be 20 years old.

Rangia cuneata:

This mollusc species is described as an epifaunal freshwater mollusc that has adapted to life in brackish environments of salinities no greater than 18 parts permil. Individuals generally live four to five years, up to a maximum of 15. It is a non-selective filter feeder which feeds off of both plant debris and phytoplankton. It is considered a recent and successful immigrant, first noted in 1988

(Strayer et al., 2006). Like *Mytilopsis leucophaeta*, it may have been brought in via ballast water, however is now well established in the Hudson.

Mulinia lateralis:

This mollusc is a dwarf surf clam similar to the larger surf clam, *Spissula solidissima*. It is an estuarine and bay species, inhabiting muddy-silty bottoms in salinities from 8 to 25 o/oo (Levinton and Rhoads (1974)). It is a suspension feeder (Buskey et al., 1997), and grows to a maximum size of 19 mm and has a roughly triangular shape with a thin delicate shell (Bird, 1970; Stanley, 1979; Maurer and Watling, 1973; Castagna and Chanley, 1966; Rudolph, 2004).

Mytilopsis leucophaeta:

This species is found in the central and upper reaches of the Tappan Zee in highly reduced salinity (Shaw, 1978; Frederick Shaw, personal communication). It is an introduced and opportunistic species occupying an oligohaline-mesohaline setting. The salinity range in which this species has been found in the Hudson ranges from 0.1 to 15 o/oo (Shaw, 1978). It has been observed also that this species appears to have a general dependence on the presence of a hard substrate for attachment (Williams et al., 1973).

The various species brought up in the grab sampler and seen among the live clam specimens which were ultimately analyzed in the current study are listed according to sample location in Table 2-1. The Hudson River molluscs which are noted above all feed either by filtration of plankton or, in the case of *Macoma*, by both filtration and

TABLE 2.1 SPECIES FOUND AT SITES WHERE LIVE SPECIMENS WERE COLLECTED FOR PCB ANALYSIS

Sample	Shells/Meat	Macoma	Mya	Crassostrea	Rangia	Mulinia	Mytilopsis	Comments
T2A	Shell	15		1				Two samples were submitted to the laboratory for extraction
T3A	Meat	12						
T3C	Shell	1						
T4C M	Shell/Meat		5	5				
T5A	Shell	4		1			1	
T5C**	Meat	6						
T6A	Shell	3						
T6C	Shell	1			2			
T8A	Shell			10				
T8C	Shell	2		20		2		
T9A**	Shell			2				Clam species not delineated - assume similar to T22C
T10A	Shell					1		
T11A	Shell	2		12			10	
T11B**	Meat	2						
T11C	Shell				1			
T12A	Meat				1			
T12D	Shell	9		4	3	1		
T13D	Meat			10	2	2	55	
T15C**	Meat			3	2	2	114	
T17B	Shell				6			
T17D	Meat	2		6		1	9	
T18C	Meat	1						
T19D**	Meat				2	2	1	
T22A**	Meat							
T22C**	Shell/Meat	3	5					
T32B	Meat					11		

Note:

* The laboratory report in Appendix gives the pertinent detail of the actual species utilized in the extraction process.

** Indicates a location where live mollusc yielded a PCB hit above the analytical limit of detection.

Individual mollusc counts are from Rudolph (2004)

processing of fine surface sediment. They appear to be basically salinity-controlled with a probably strong but unknown overprint by particular sediment type or accumulation rate. PCB concentrations in clams, therefore, can be expected to reflect a complex interaction of food source, sediment type and accumulation rate.

Several past studies have involved PCBs in clams. Burgess et al. (2004) studied the PCB accumulation in *Mya arenaria* on both water column and sediment bed activities. Also, Hatch et al (1981), investigated PCBs in the clams and oysters taken from New Bedford Harbor in 1978. Similarly, Novak et al. (1988) performed long term monitoring of PCBs in macroinvertebrates in the Hudson River, using caddis fly larvae among other non-molluscs.

As stated previously, in this study, I undertook to discern the “recent” and measurable effects of the PCB which had been dumped in the northern part of the river by GE. To this end, we were helped in two ways: First, the GE plant had ended discharge of PCBs into the Hudson, at the end of the 1970’s. Thus any Aroclors uniquely linked to GE would be readily identifiable downstream as having been derived from the far-distant upstream sources. Secondly, utilizing the clam biomass in order to determine the presence of PCBs limited the likely temporal duration to within 12 years or less, based on the short-lived clam life spans from the majority of the particular species collected during the sampling efforts.

Nature of Biomass Uptake of PCBs by Molluscs

In her dissertation on the “Distribution and Geochemistry of Shells of Extant Molluscs of the Hudson Estuary, New York”, Dr. Elizabeth Rudolph noted the widely distributed presence of opportunistic estuarine bivalves seen in the same study area of the Hudson River estuary (Shaw (1974, 1975, 1978); Rudolph, 2004). Similar to the findings of Holland (1985), it was noted by Rudolph that most of these organisms were able to tolerate a “fair amount of salinity fluctuations and anthropogenic disturbance.” She cited many examples of the various feeding mechanisms found in the various molluscs observed in the study area. In fact, the “live” samples of molluscs which were sent for PCB analysis in this study are those used in her identifications of the various species.

Rudolph analyzed the sample set in order to delineate molluscs by species classification. The species identified included: *Macoma balthica*, *Mya arenaria*, *Crassostrea virginica*, *Rangia cuneata*, *Mulinia lateris*, and *Mytilopsis leucophaeta*. In each case, the expected lifespan of the particular species was assessed to be not more than 10 years, thus giving a very narrow range of years for any contaminant uptake into the given species biomass (Dr. Elizabeth Rudolph, personal communication). In addition because each of the species in question was either a filter feeder, suspension feeder or bottom forager, they collectively allow for the “full coverage” of all nutrient sources in terms of both water column (dissolved and suspended components) and river sediment nutrient availability. This increases the likelihood of the potential capture of any PCB compounds.

Rudolph noted the usefulness of estuarine bivalves as “excellent potential markers of metal-influx stemming from upstream industrialization since they tend to be immobile

but otherwise extremely reactive to environmental stresses” (Shaw, 1978; Rudolph, 2004). It is because these various species are sedentary with potentially short lifespans, and because they are bottom/filter feeders that they are ideal subjects for the PCB analysis of their respective biomasses. Such specimens naturally lent themselves to analyses for the purpose of exploring for the presence of any of the suspect PCB congeners/Aroclors in near real time conditions, ultimately originating in the upper Hudson River from the GE plants.

Finally, it should be pointed out that the analyses of the current study sought to extract any and all PCBs from each clam biomass. This was due to the very small quantities of biomass present in the samples collected during sampling efforts. In this way, any PCB concentrations may be “diluted” as a consequence of taking into account the total biomass of the organism as opposed to the mass of a smaller target organ within the bivalve biomass. Therefore PCBs reported may be at much lower concentrations than those which exist within a target organ or specific region within the bivalve living tissue.

Section III Sources of PCB in the Hudson River

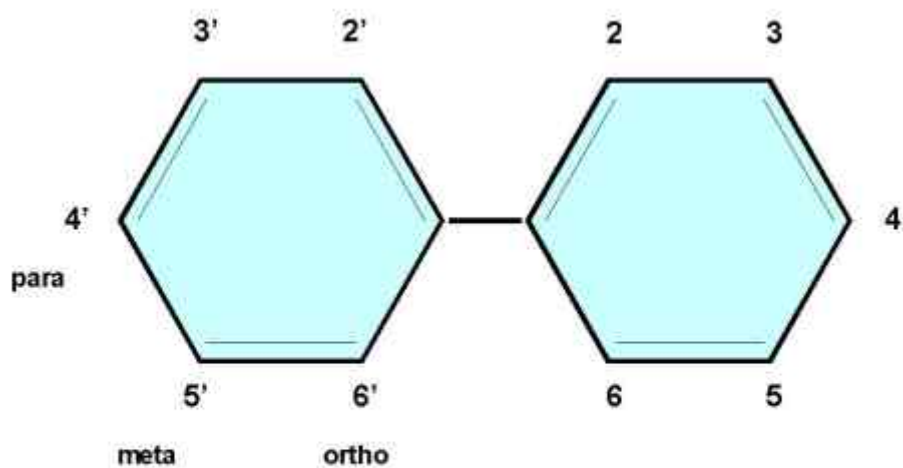
Background

The primary focus of the study was to determine whether or not the PCBs initially put into the Hudson River by the two GE plants located in Hudson Falls, NY and Fort Edward, NY were detectable in living tissue of the various molluscs found in the lower estuary. Since both of these plants have not actively contributed to PCBs to the river since 1977, any PCBs detected from these operations would necessarily emanate from those organic compounds which had previously accumulated in an upstream sediment trap(s). This effectively introduces a river-born PCB load, destabilizing the entire downstream ecosystem of the river basin.

As the mitigation dredging operations gear up in the source area as the means selected for remediation during the 2008 dredging season, it is essential to understand the full potential for transport of these compounds as they are newly agitated in the water column. A brief description of PCBs, the regulatory environment concerning PCBs, the history of the GE plant operations as they pertain to PCBs, and the ongoing response by the USEPA to the environmental problems posed by the emplacement of PCBs in the Hudson River basin is therefore in order.

Chemistry and use of PCBs

Both of the GE plants made wide use of PCBs. Polychlorinated biphenyls or PCBs are a group of chemical compounds in which from one to ten chlorine atoms are attached to biphenyl (Erickson, 1997; USEPA, 1997) (see figure 3-1). There are 209 distinct



Structure of Polychlorinated Biphenyl (PCB) Molecule

monochlorobiphenyl = 1 chlorine atom per molecule
 dichlorobiphenyl = 2 chlorine atoms per molecule
 trichlorobiphenyl = 3 chlorine atoms per molecule
 tetrachlorobiphenyl = 4 chlorine atoms per molecule
 pentachlorobiphenyl = 5 chlorine atoms per molecule
 hexachlorobiphenyl = 6 chlorine atoms per molecule
 heptachlorobiphenyl = 7 chlorine atoms per molecule
 octachlorobiphenyl = 8 chlorine atoms per molecule
 nonachlorobiphenyl = 9 chlorine atoms per molecule
 decachlorobiphenyl = 10 chlorine atoms per molecule

Figure 3-1 - There are 209 varieties of PCBs, known individually as congeners. A congener may have between 1 and 10 chlorine atoms, which may be located at various positions on the PCB molecule. (from USEPA, URL: <http://www.epa.gov/hudson/pcbs101.htm>)

individual compounds associated with this class of organic contamination, each one referred to as a congener. In fact, the New York Academy of Science noted in their publication “Pollution Prevention And Management Strategies For Polychlorinated Biphenyls in the New York/New Jersey Harbor” (2005), that “PCB congener pattern analyses may assist in track-down efforts”, referring to the high-level chemical detective work that may be involved in identifying a potentially responsible party (PRP).

The major manufacturer of PCBs was the Monsanto Corporation in St. Louis Missouri. They marketed PCBs under the trade name of Aroclor during the years 1930 to 1977 (Erickson, 1997). Aroclors are assigned numbers based upon the combination of PCB compounds contained in the given Aroclor mixture. “Aroclors are made up of different congeners, which group into homologs based on the degree of chlorination (e.g. tetra refers to PCBs with four chlorine atoms)” (NYAS, 2005). It is important to note that the higher the number of the Aroclor, the more chlorinated the substance is. Aroclors found uses in transformers, capacitors, printing inks, paints, dedusting agents, pesticides, and many other applications, thereby presenting more than a few potential sources of infiltration into the environment.

Aroclors are one means of separating out the potentially responsible party (PRP) when USEPA is performing an evaluation of a specific contamination source. With respect to GE, Aroclor 1254 is closely linked to GE operations (Mark Greenberg, Senior Environmental Toxicologist, USEPA, personal communication October 7, 2005), although it is also potentially linked to the Niagara-Mohawk Plant, also located in the upper Hudson River Basin. In addition to Aroclor 1254, Aroclors 1242 and 1016 were

also identified as the main ones used by GE (Greenberg, USEPA, personal communication October 7, 2005). Direct inputs of any PCB Aroclor to the Hudson River estuary by either of the GE plants located in Fort Edward, NY and Hudson Falls, NY were ceased voluntarily by GE in 1977.

Battelle was employed by USEPA in order to assess and optimize the analytical methodology employed to determine the impact of PCBs in the study area as well as surrounding areas. Based on congener analysis, it was estimated by Battelle, that one-half of the total PCB load into the lower estuary from all sources includes tributaries, combined sewer overflows (CSO), and effluent discharges from Publicly Owned Treatment Works (POTW) which discharge to the lower New York/New Jersey Harbor Estuary (www.battelle.org/environment/pcb-nynj.stm). Additionally, it was found that the sum of the PCB congener concentrations seen in the influents ranged from 50 to 380 ng/L, while concentrations found in the effluents from the identical plants ranged from 9 to 90 ng/L. Furthermore it was determined that “distinct PCB congener patterns could distinguish effluents from each plant.” Thus the importance and usefulness of determining specific PCB input by congener or Aroclor is key to understanding the fate and transport of these toxic compounds in the Hudson River Estuary.

Residual PCBs in the Hudson River Estuary

Action planned for early 2007 includes the dredging of 2.65 million cubic yards of PCB-contaminated sediments from the upper Hudson River which are “estimated to contain 70,000 kg (about 150,000 lbs) of total PCBs (approximately 65% of the total PCB mass

present within the Upper Hudson River)”(USEPA, 2005; see also www.epa.gov/hudson/consent_decree/2005factsheet.htm). It is interesting to note that a similar amount, 76,000 kg had been estimated by Richard Bopp in 1979 in his estimation of a preliminary PCB budget for the sediments of the tidal Hudson (Bopp, 1979). He further noted that “much of the uncertainty in the budget arises from the heterogeneity of sedimentation in the river and the associated problem of estimating the extent of particular sedimentary regimes.”

New York State, New Jersey, and Federal Standards and Guidelines

There are both State and Federal regulations which have been promulgated with regard to the “acceptable” levels of PCBs in water bodies. All of the regulations which have been promulgated by the USEPA as a consequence of the Toxic Substances Control Act (TSCA), PL 94-469 appear under 40 CFR § 761 (Erickson, 1997). As per Erickson (1997), the regulations ban “the manufacture, processing, use, and distribution in commerce of materials containing *any detectable* PCBs, unless specific authorizations were contained in the rule.” (note: italics mine). This wording is therefore inclusive of any improvements in technology affording a higher resolution of detection. It consequently has the effect of becoming more stringent if technological limits of detection improve through time. Table 3-1 gives an overview of PCB Concentration thresholds as they pertain to human health.

As outlined in the New York Academy of Sciences “Pollution Prevention and Management Strategies for Polychlorinated Biphenyls in the New York/New Jersey

Table 3.1 Comparison of PCB Concentration Thresholds for Federal and State Agencies

Standards/Guidelines	Government Agency	Concentration*	Equivalent µg/L**
Maximum Level of PCBs in drinking water	Federal/USEPA	0.0005 mg/L	0.5 µg/L
Fish Consumption Limits monthly	Federal/USEPA	0.023 to 0.047 ppm	23 to 47 µg/L
Fish Consumption Limit for any given meal	Federal/USEPA	>0.094 ppm	>94 µg/L
PCB limits on fish	Federal/Food and Drug Admin.	2 ppm	2000 µg/L
Fish Consumption	New York State/NYDEC	1 pg/L	0.000001 µg/L
Freshwater & Estuary/Coastal Waters	New York State/NYDEC	0.12 ng/L	0.00012 µg/L
Surface Water Quality (SWQ) - cancer protection in humans	New Jersey/(NJ AC7: 9B)	170 pg/L	0.000170 µg/L
SWQ - freshwater aquatic/chronic criteria	New Jersey/(NJ AC7: 9B)	14 ng/L	0.014 µg/L
SWQ - saline (estuary/coastal) aquatic/chronic criteria	New Jersey/(NJ AC7: 9B)	30 ng/L	0.030 µg/L

* As reported in NYAS (2005)

** For the purpose of reconciling the analytical results with the respective standard/guideline

Harbor” (2005), exclusions to this rule include manufacturing processes that result in “inadvertent generation” of PCBs as by-products or impurities, provided that manufacturers comply with the specific conditions specified in Section 761.3. These companies must meet the following restrictions on PCB releases:

- PCB concentrations in the components of detergent bars are limited to 5 parts per million (ppm).
- Concentrations of PCB in all other products are limited to an annual average of less than 25 ppm, with a maximum of 50 ppm. If the average concentration exceeds 25 ppm, total concentrations in products must be reported.
- PCB concentrations at the point where such PCBs are manufactured or processed and are vented to the ambient air are limited to less than 10 ppm.
- PCB concentrations discharged from manufacturing or processing sites to water are limited to less than 0.1 ppm for any resolvable gas chromatographic peak.
- All process waste containing PCBs at 50 ppm or greater are to be disposed of in accordance with the PCB disposal requirements of 40 CFR Part 761, subpart D.

In addition to this, the New York Academy reported that the current state ambient water quality standard for New York as follows:

- For the protection against cancer in humans eating fish: 1 pg/L (ppq)
- For the protection of aquatic and wildlife resources: 0.12 ng/L (ppt) for both freshwater and estuary or coastal waters (salt water).

For the State of New Jersey, the surface water quality criteria are given in the New Jersey Administrative Code (NJ AC7, 9B regulation):

- For human health protection against cancer: 170 pg/L

- For freshwater aquatic/chronic criteria: 14 ng/L
- For saline waters (estuary/coastal) aquatic/chronic criteria: 30 ng/L

PCBs as a risk to Human Health

The persistent nature of these contaminants is cause for much concern about long term health effects in human beings as well as animals. The USEPA published a Human Health Risk Assessment (HHRA) for the Mid-Hudson River in 1999 (USEPA, HHRA, 1999). In it, summary tables were provided for cancer risk in the PCB affected area as well as non-cancer risks. These tables appear in Tables 3-2 and 3-3 respectively. The results are a reflection of the analysis done for what is assumed to be the risks on a reasonably maximum exposed (RME) individual. The HHRA (1999) noted that the USEPA has classified PCBs as “probable human carcinogens and known animal carcinogens.” Furthermore, it noted that “other long-term adverse health effects of PCBs observed in laboratory animals include a reduced ability to fight infections, low birth weights, and learning problems.” The summary of major findings by the USEPA taken from this report includes the following:

- Eating fish is the primary pathway for humans to be exposed to PCBs from the Mid-Hudson.
- Under the RME scenario for eating fish, the calculated risk is approximately four additional cases of cancer for every 10,000 people exposed. This excess cancer risk is more than 100 times higher than USEPA’s goal of protection and within the upper bound of the cancer risk range generally allowed under the federal Superfund law.
- For non-cancer health effects, the RME scenario for eating fish from the Mid-Hudson results in a level of exposure to PCBs that is 30 times higher than USEPA’s reference level (Hazard Index) of one.

- Under baseline conditions, the RME cancer risks and non-cancer hazards for eating fish would be above USEPA's generally acceptable levels for a 40-year exposure period beginning in 1999.
- For the fish consumption pathway, central tendency cancer risks lie within the risk range of 10^{-5} to 10^{-4} , and non-cancer hazards under central tendency assumptions fall slightly above the USEPA's reference level (Hazard Index) of one.
- Risks from being exposed to PCBs in the Mid-Hudson River through skin contact with contaminated sediments and river water, residential ingestion of river water for drinking water, incidental ingestion of sediments, and inhalation of PCBs in air are significantly below USEPA's levels of concern for cancer and non-cancer health effects.

The cancer risks are based on uniform exposure throughout the Mid-Hudson River

Cancer Risk Summary		
Pathway	Central Tendency Risk	RME Risk
Ingestion of Fish:		
Adult	9×10^{-6} (9 in 1,000,000)	4×10^{-4} (4 in 10,000)
Child	3×10^{-6} (6 in 1,000,000)	1×10^{-4} (1 in 10,000)
Recreational Exposure to Sediment*	2×10^{-8} (2 in 100,000,000)	2×10^{-7} (2 in 10,000,000)
Recreational Dermal Exposure to Water*	9×10^{-9} (9 in 1,000,000,000)	6×10^{-8} (6 in 100,000,000)
Consumption of Drinking Water*	2×10^{-8} (2 in 100,000,000)	1×10^{-7} (1 in 10,000,000)

*Total risk for child (aged 1-6), adolescent (aged 7-18), and adult (over 18).

Table 3-2 Cancer Risks based on a assessment of uniform exposure throughout the Mid-Hudson River (from USEPA, HHRA, 1999)

Non-Cancer Hazard Summary		
Pathway	Central Tendency Non-Cancer Hazard Index	RME Non-Cancer Hazard Index
Ingestion of Fish:		
Adult	3	30
Child	1	10
Recreational Exposure to Sediment*	0.002	0.004
Recreational Dermal Exposure to Water*	0.005	0.007
Consumption of Drinking Water*	0.01	0.02

**Higher of value for child or adolescent, which are both higher than adult for these pathways.*

Table 3-3 Non-Cancer Hazard Summary for the Mid-Hudson River (from USEPA, HHRA, 1999)

Abbreviated USEPA Regulatory History with respect to GE PCBs and the Hudson River Estuary

Two Records of Decision (ROD) have been made by the USEPA with regard to GE and the PCB contamination put into the Hudson River. The first was issued by the USEPA on September 25, 1984. In this decision, the USEPA chose a remedy which included the “in-place containment of the Remnant Deposits; evaluation of the downstream domestic water quality at Waterford, New York; and opted for an interim “No Action” with regard to the PCB-contaminated river sediment. The 1984 ROD indicated that both this “No Action” decision for the river sediments as well as the containment remedy for the Remnant Deposits might be reexamined by EPA in the future” (USEPA, ROD, 2002).

Indeed, in 1989 the USEPA announced its decision to begin a new remedial investigation/feasibility study (RI/FS) to re-assess the nature of the PCB-contaminated sediments in the Hudson River. The containment remedy for the “Remnant Deposits”

mentioned in the 1984 ROD, was however carried out by GE per a 1990 Consent Decree with the USEPA. Interestingly, in 1990, the New York State Department of Environmental Conservation (NYSDEC) concluded that PCB concentrations found in a domestic water quality study at Waterford, NY, were below instrumental limits of detection after treatment, thereby meeting the standards for public water supplies.

In February 2002, the USEPA decided that it was appropriate to remediate the Upper Hudson River (USEPA, 2004). Further, the selected remedy included the dredging of 2.65 million cubic yards of PCB-contaminated sediments from the upper Hudson River which are “estimated to contain 70,000 kg (about 150,000 lbs) of total PCBs (approximately 65% of the total PCB mass present within the Upper Hudson River)”(USEPA, 2004). In October of 2005, the USEPA made an agreement with GE to “cover Phase 1 dredging, the construction of the sediment transfer/processing facility needed for the cleanup project, independent peer review of Phase 1, and the remaining dredging work” (www.epa.gov/udson/consent_decree/2005factsheet.htm ; USEPA, 2005). The agreement by GE and USEPA also includes payment by GE to the USEPA of up to \$78 million for past and future costs. It was also noted in the announcement that up until that time that GE had already paid \$37 million through past settlements.

Section IV Study Design and Thesis

Background

As outlined previously, the initial focus of the present study was to gather bivalve soft tissue data to determine whether the presence of PCBs discharged by GE into the Hudson River at Hudson Falls, NY and Fort Edward, NY could be seen downriver in the bivalves of the lower 66 kilometers of the Hudson Estuary. Two other studies were also undertaken simultaneously, sharing the same basic sampling grid and basic sample data collected during the time of sediment and bivalve collection efforts.

The first of these efforts was a study by Fatemah Ashkan of Brooklyn College, CUNY, on the contamination by trace metals of the surficial bottom sediment. The second study was conducted by Elizabeth Rudolph of City College of New York, CUNY, and focused on mollusc distribution and shell geochemistry. Since the original inception of the work on the study was geared to determine the various Mollusc distributions of the Hudson River Estuary, an attempt was made to replicate the original monthly sampling scheme designed and initiated by Dr. Frederick Shaw (1977) of Lehman College, CUNY. This initial study, as summarized by Elizabeth Rudolph (2003), was focused on the characterization of the benthic distribution of organisms and the establishing of assemblage zones for any observed associations.

Sampling Grid Layout

As reported by Rudolph (2003), “although the sample sites were located by GPS, pinpoint site replication was problematic due [to SIC] drift resulting from tides.

Transects were laid out from the Battery (T34) to just north of Croton Point (T20), with stations established along each of these. Across each transect, sample locations were established ideally to capture samples along each shoreline (beginning with the “A” designation for the sample to be taken on the New Jersey shore side of the transect), one or two from the navigation channel, and finally, one from the New York shoreline side. The number of navigation channel sampling locations was determined based on the width of the channel along a given transect. Figure 4-1 shows all of the sample station points utilized in the PCB in bivalve study.

Sample Procurement

In 1997, sediment sampling and Hydrolab testing was conducted over two days via a small 17 foot powerboat utilizing a small Peterson grab sampler. Approximately one quarter of the sampling stations were sampled for sediments along with simultaneous monitoring of ambient surface and bottom water conditions. Measurements were made of depth in meters (m), temperature (°C), salinity, dissolved oxygen (DO), saturation of oxygen (OS), and pH utilizing Hydrolab sonde probe.

The remainder of the study grid was sampled over two additional days aboard the R/V Lionel A. Walford, a vessel also owned and operated by the New Jersey Science Consortium, Sandy Hook Field Station, Fort Hancock, NJ. A re-sampling of selected sites was also carried out via the Walford in August of 1998. Once aboard the Walford, the initially conceived sampling grid had to be modified, effectively eliminating sampling of the navigation channel. (Please note that Figure 4-1 shows the final configuration of the sampling grid). In addition to the limited coverage possible along the Hudson using

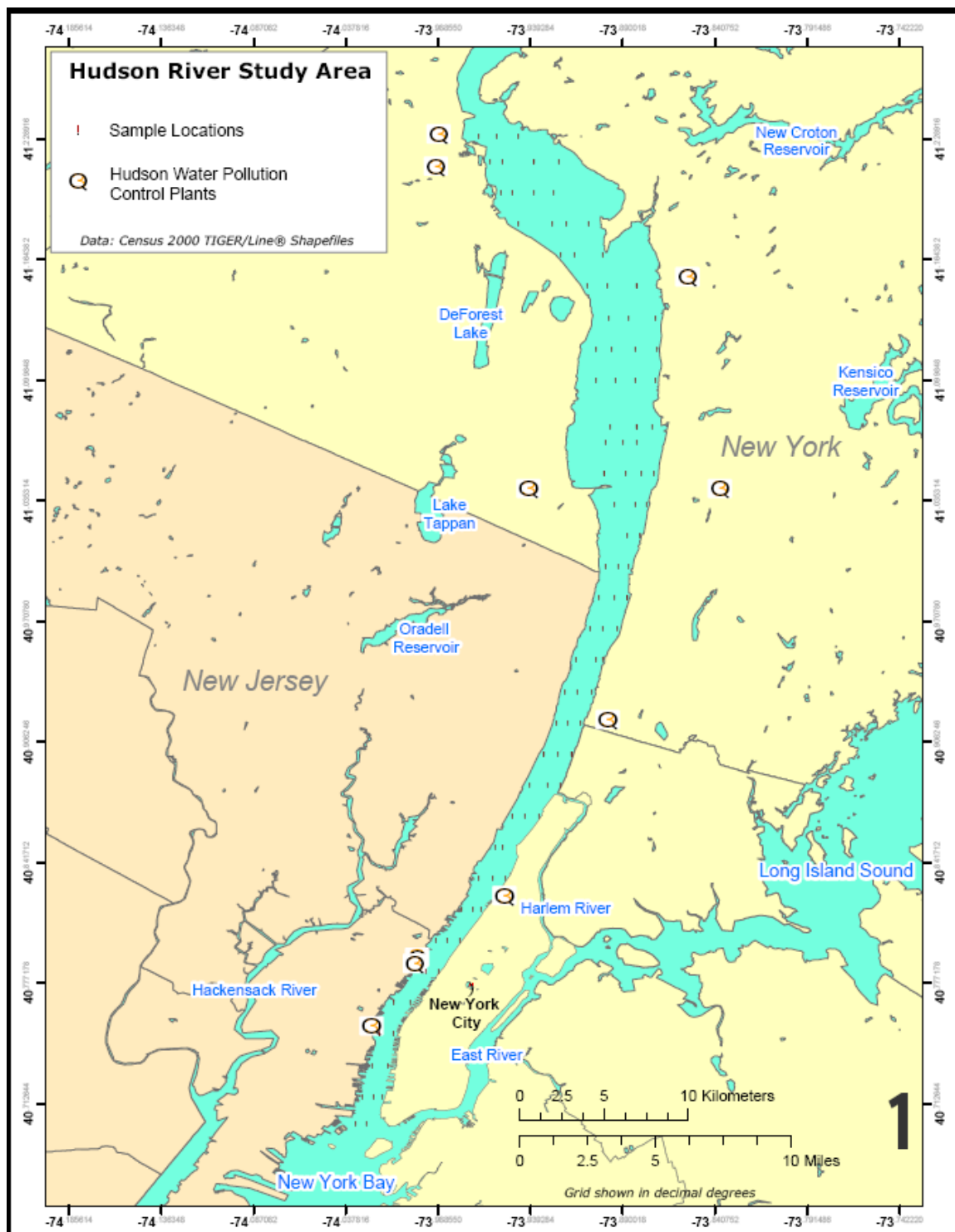


Figure 4-1 Hudson River Sampling Grid

the larger Walford, limiting the sampling stations of the navigation channel allowed the team to effectively concentrate on gathering samples of value to Rudolph and the author, i.e. live specimens with identifiable species. As reported by Rudolph (2003), channel samples were found to “contain only shell hash and other debris, with no live organisms.”

Utilization of the Peterson grab sampler allowed the collection of the benthic samples through its weighted spring activation claw. Upon reaching the bottom sediment surface of the river, the claw snapped shut, collecting approximately one cubic foot of sample without disrupting the upper silty oxidized layer. Live clams were observed by Rudolph to be collected in “living position” (Rudolph, 2003).

The 1997 sampling set included the both shoreline (west-coast-NJ side and east coast-NYC side) shoreline samples from station transects T-34 (the Battery) to a location immediately north of transect T20, north of Croton Point. Intermediate sampling along the respective transects included one or two, depending upon the width of the channel encountered. The 1998 sampling run included west-coast samples from transects T34 through T25. The purpose for the 1998 sampling was to determine the success of sample replication primarily for river bottom surficial sediment heavy metal analyses by Ashkan (Ashkan, 2000). After processing by Rudolph, samples of the live clams were taken by the author in order to process them for PCB laboratory analyses.

Hydrolab Measurements of Water Quality

At each location of the river, measurements were made of the water quality for both the surface and bottom water of each sampling station. Measurements were made

approximately within one foot of the surface water of the river and within one foot of the bottom water. The temperature ($^{\circ}\text{C}$), salinity, dissolved oxygen (DO), saturation of oxygen (OS), and pH were all measured utilizing a Hydrolab Corp Data Sonde 3 (Model #100012) submersible water quality data logger or a similar Hydrolab Corp. Scout 2 Water Quality System data probe Sonde. For ease of reference, these measurements will be referred to as Hydrolab measurements. In the present study, the bottom water quality parameters were of particular interest, particularly where they could be related to the presence of PCB in live clams after subsequent laboratory analyses were conducted of the biomass.

Section V LABORATORY PROCEDURES

The analytical procedure for determining the presence and quantity of Polychlorinated Biphenyls (PCBs) was taken from Method 8082 and Method 8000B from the United States Environmental Protection Agency approved protocol document “Test Methods for Evaluating Solid Waste, SW-846”(3rd Edition, Final Update III, December, 1996; USEPA, Office of Solid Waste and Emergency Response, Washington, D.C.). In addition, the Woods Hole Group Environmental Laboratories, which performed the analytical work by gas chromatography (GC), followed the standards established in the “USEPA Contract Laboratory Program Statement of Work for Organics Analysis; Multi-Media, Multi-Concentration”(Document Number OLM 03.1), published in August, 1991.

The extractions of the actual live specimens and/or their shells were performed by Dr. Fred Youngs of the University of Massachusetts at Lowell, using a non-standard procedure, due to the small quantities of biomass involved with most of the samples collected from the Hudson River. This inhibited the ability to conduct pervasive quality assurance/quality control throughout the entire through-put of samples. As stated by Jerry Zschau of Woods Hole Group Environmental Laboratories, “QC Samples must be prepared along with the analytical samples when they are extracted.” Due to the non-standard procedure designed to work for the small quantity of clam biomass/shell material, as well as equipment difficulties with the GC instrumentation at UMass, it was not possible to accommodate this normal QC provision in the actual protocol followed. The analytical portion of the Woods Hole Standard Operating Procedure (SOP) however, is still valid (Jerry Zschau, 2005, personal communication). QA/QC specific to this portion is given in the description which follows. Both the description of the protocol for

extraction for the clam samples as well as the analytical method description provided by the Woods Hole laboratory are provided in Appendix 1.

Extraction of the Live Clam Samples, Dr. Fred Youngs, UMass Lowell

As summarized above, the laboratory procedure took place in two stages. The first part of the analysis consisted of the extraction of each of the live specimens ultimately into a solvent which could be analyzed through gas chromatography. Live specimens of each of the clams which had sufficient biomass were weighed and then placed into a vial with 100 uL of water, 400 uL of methanol and 500 uL of hexane. In cases where insufficient biomass was available, just the shell of the live specimen was used.

If the volume of the mixture over each sample was not sufficient to completely cover the sample, additional aliquots of each of the solvents were added. After the biomass/shell material was covered, the live specimen was chopped into fine pieces by hand utilizing a spatula. This material was then sonicated for 30 minutes. After the solvent layers were given time to separate, the hexane layer was removed and placed into a vial in preparation for the GC analysis to determine the presence and quantity of PCB.

Extraction QA/QC

As stated previously, the details of this extraction process were provided by Dr. Fred Youngs of the University of Massachusetts at Lowell and can be found in Appendix 1, along with the chain of custody records for shipment to the laboratory at Woods Hole Group Environmental Laboratories for GC analysis. No QA/QC was carried through at

this portion of the analysis because of the non-standard procedure utilized, followed by a hand-off to the Woods Hole Group Environmental Laboratories after unresolvable difficulties were encountered with the GC equipment at UMass Lowell.

Gas Chromatography Analysis, Woods Hole Group Environmental Laboratories

Analysis of Extracted Samples

After the extracted samples were received by the Woods Hole Group, they proceeded to analyze them for PCB according to the methodology 8082, approved by the United States Environmental Protection Agency for analysis of Polychlorinated Biphenyls as Aroclors or Congeners. A detailed description of the procedure is provided in the Case Narrative of the laboratory report, which can be found in Appendix 1. Per the Woods Hole SOP,

“the 8082 method provides procedures for the determination of selected individual PCB congeners and should be used depending on regulatory and project needs. The PCB congener approach potentially affords greater quantitative accuracy when PCBs are known to be present. The congener method is of particular value in determining weathered Aroclors.”

Per the Woods Hole Group, the final volume for each sample, which was used in the determination of the presence/concentration of PCB, was taken directly from the volume of hexane extract, listed in the client procedure given by the extraction lab. The sample amount is the actual weight of tissue which had been reported by Fred Youngs doing the extraction, or if just a clamshell leachate, the amount was given as one shell with the solvent extract being analyzed and reported based as µg/shell. All others were reported as µg/liter.

Further, the lab at Woods Hole prepared each sample by cleaning them with sulfuric acid prior to the analysis, diminishing the usable solvent volume, and thereby requiring all

samples (with the exception of T12A) to be diluted by a factor of two prior to the analysis. According to the Woods Hole SOP, sub-section 3.1, under Section 3, Summary of Method, this was done to assist with the analysis of multicomponent Aroclors or congeners, apparently limiting interferences which prevent detection of analytes (per sub-section 2.3, Section 2, Scope and Application).

Analytical QA/QC

Per the Woods Hole SOP for EPA Method 8082, a method blank is needed for each batch of samples which are processed. It also makes reference to the method blank with respect to the method detection limit (MDL). Sub-section 9.2 under Section 9, Quality Control states:

“The analysis of the method blank extract will demonstrate the background contamination of the apparatus and procedures in the laboratory. The method blank must not contain any analytes of interest at concentrations greater than two times the MDL” To ensure the cleanliness of the procedure, an aliquot of hexane solvent was brought through the acid cleaning process as well, analyzed in the same manner as the samples and reported as the “method blank”.

To ensure the cleanliness of the procedure, an aliquot of hexane solvent was brought through the acid cleaning process, analyzed in the same manner as the samples and reported as the “method blank”. More specific details on the particular method blank are given in the actual lab report in the Appendix 2.

Instrumentation

The description of the GC is given in the Woods Hole SOP as a HP 5890A Series II gas chromatograph or a Perkin-Elmer Autosys. The HP system is equipped with a splitless

injector, 7673-type autosampler, and electron capture detector (ECD). The SOP also reports that the instrument is interfaced to the Perkin-Elmer Turbochrom data system for control of the instrument and acquisition of the detector response (see Appendix 1).

The initial calibration is described in Section 7-2 of the Woods Hole SOP. Here, external standard calibration is used for Aroclor analysis. In this methodology, “the response of each individual peak and the total response of the PCB in the sample are compared to a calibration curve to determine the analyte concentration in the sample.” Furthermore, “the calibration curves are generated during initial calibration through the analysis of standards which define the working range of the method. A detailed analytical sequence order is also given in the SOP.

Section VI Statistical Analysis of the PCB Data

Analytical Results from Woods Hole Group Environmental Laboratories

The first stage of the statistical analysis focused on determining whether or not any patterns or relationships existed among the analytical values for PCBs reported by the laboratory for each of the live clam specimens collected. A total of 30 live specimens were collected from the 98 grab samples of the Hudson River bottom sediments at the stations along the various transects (see Figure 6-1).

All were extracted per the methodology already discussed and sent for GC-ECD analysis at Woods Hole Oceanographic Institute (see Appendix 1). The analytical results yielded PCB levels above the limits of detection in only 7 of the 30 live specimens from 26 locations. The general results for the remaining 26 live specimens therefore could be viewed in either one of two ways: (1) they were either free of PCB compounds or (2) they had PCB levels which were at or below the instrumental limit of detection of the GC-Mass Spectral apparatus. While the initial observation that only a limited number of samples existed which showed readable levels of PCBs is potentially heartening at first report to those concerned with widespread PCB contamination in the Hudson River, this low number still indicates an alarming abundance of the chlorinated contaminant among the actual specimens procured. Stated differently, if the sampling had yielded live clam specimens for all 98 locations, it is not unlikely to expect that there would then be seen a similar three-fold increase in the number of clams with detectable PCBs, or roughly 20% of the entire grid area.

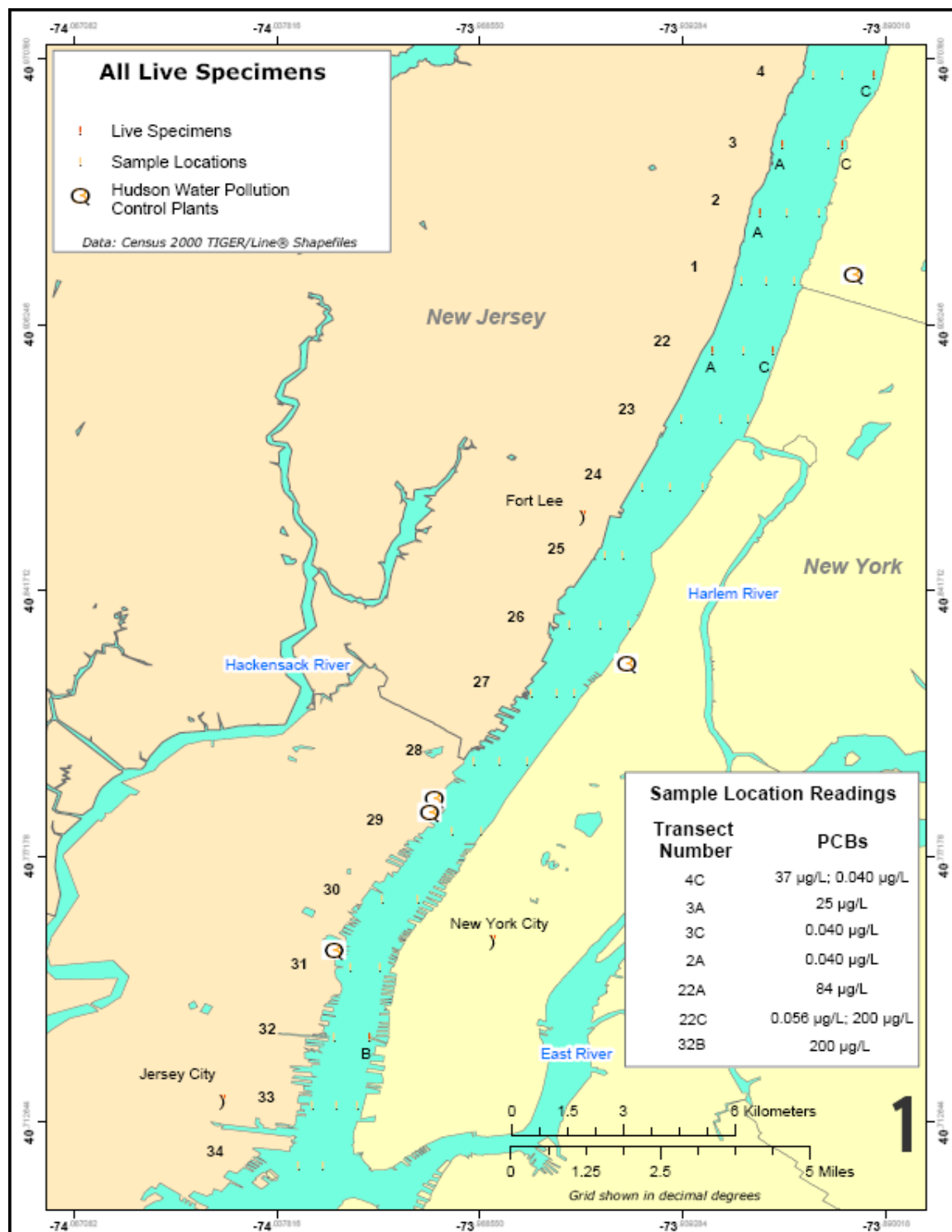


Figure 6-1 Southern Sampling Station Grid Locations in the Hudson River Estuary

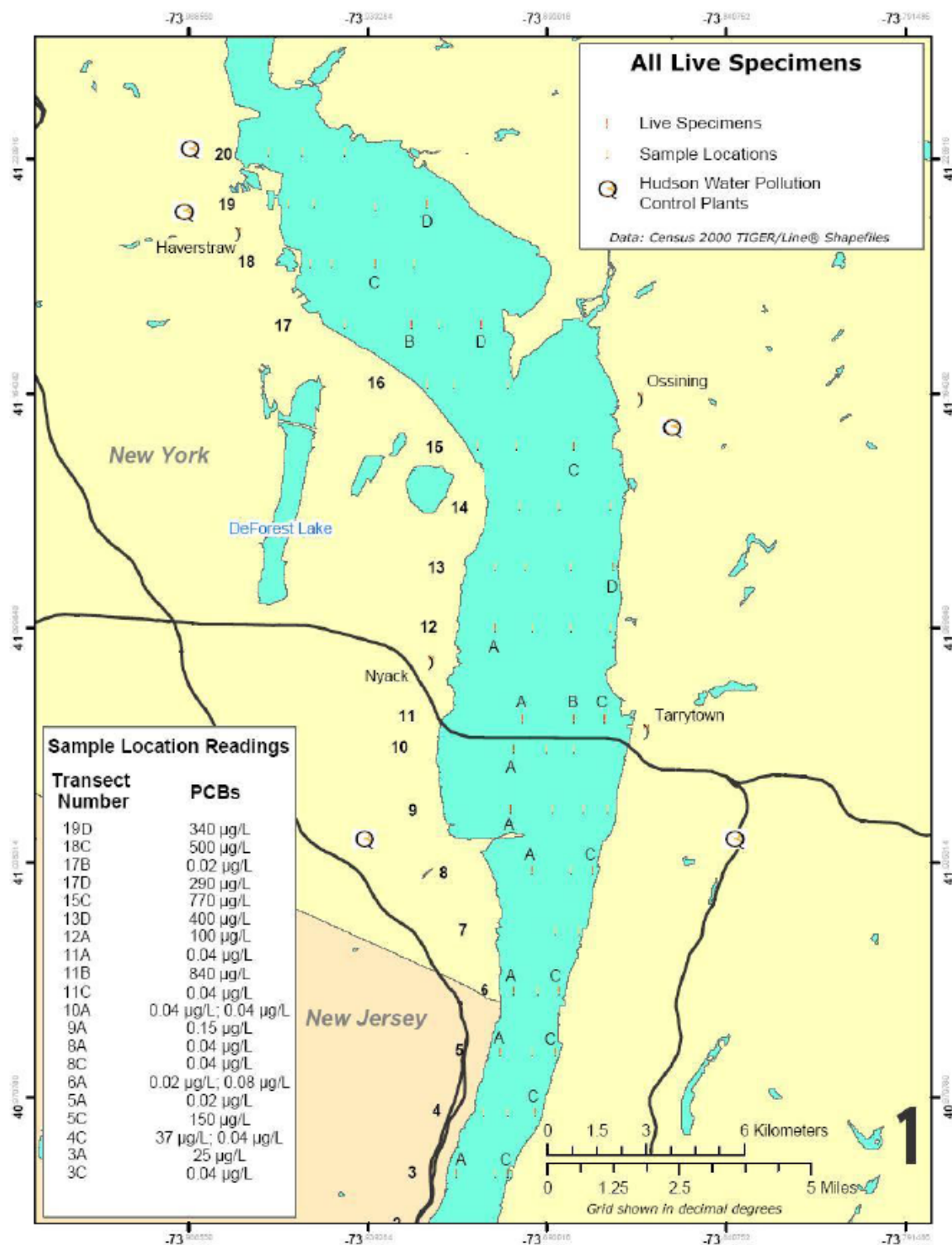


Figure 6-1 Continued – Southern Sampling Station Grid Locations in the Hudson River Estuary

Also, if the source of the PCBs can be assumed to derive from the upstream contamination of river sediments affected by the former operations of the upstream GE plants, there could also be serious ramifications for the upcoming US EPA-sanctioned dredging which is to commence in early 2007, should these activities result in resuspension and/or enhanced transport of PCBs downriver. The persistent nature of the contamination is also a cause for concern, since both plants ceased using PCBs over two decades ago. These toxic chlorinated substances are of particular concern in these lower river miles since any detectable level of PCB in this more densely populated region could be derived from either of the GE Plants located upriver or may derive from some other potentially unknown point source. In any case, the specific detectable PCB concentrations shown in the data which actually exceed the governmental standards discussed earlier are a cause for concern.

Initial Statistical Assessment

By employing several different statistical techniques to examine the data, patterns within the PCB concentrations reported by the lab may be detected and explored. In addition, patterns may emerge in conjunction with the other parameters measured for the same study area when each is compared with the PCB levels. Specifically, these other parameters would include those measured in the water with the Sonde instrument at each of the stations at the time the Peterson grab sample was employed to collect the bivalves in the sediment. In addition to these, comparisons made with the trace metals concentrations reported by Ashkan (2000), can also provide the potential means to uncover other patterns and/or relationships between trace metals and PCBs.

The complete listing of data derived from PCB analyses of the clams is shown in Table 6-1. The Hydrolab measurements of water quality parameters include temperature, salinity of the bottom (B) water in ppt, dissolved oxygen (DO) of the bottom water in mg/L, percent of oxygen saturation (OS) of the bottom water, the activity of electrons in solution expressed in millivolts or (Eh), and the pH of the bottom water. These are shown in Table 6-2. The analytical results for trace metal contamination for the corresponding sediments are shown in Table 6-3.

In Table 6-1, the PCB data are shown beside each of the live specimens. All analytical data are shown in the column labeled “pcb1.” If more than one live specimen was collected in the Peterson grab sampler and sent to the lab for analysis, a second analytical value is shown under column heading “pcb2.”

The initial statistical analysis performed examined differences in values of the data for PCB level (usually in $\mu\text{g/L}$), the specific river location (latitude and longitude), water depth (in meters), salinity (as measured on the river bottom (B)), dissolved oxygen (DO) as measured on the river bottom (B), bottom water oxygen saturation (OS B), pH (as measured on the river bottom), and Eh (also as measured on the river bottom). The data in Table 6-1 have been listed according to ascending latitude for ease of analysis in each of the statistical runs done for PCB when compared to the respective parameter of interest.

As stated previously, comparisons were also made using the trace metals analytical data found to be present in the river sediments at corresponding sampling points by Ashkan

Table 6.1 PCB Data - Laboratory Analytical Results

Site	Latitude	Longitude	pcb#1	> lim. of detect.***	pcb#2	> lim. of detect.***	PCB data
T34A	40.7019	74.0325					
T34B	40.7019	74.0267					
T33A	40.7167	74.0292					
T33B	40.7167	74.0233					
T33C	40.7167	74.0183					
T32A	40.7333	74.0239					
T32B	40.7333	74.0153	200 µg	No			*
T31A	40.75	74.02					
T31B	40.75	74.0128					
T30A	40.7667	74.0122					
T30B	40.7667	74.0036					
T29B	40.7833	73.9953					
T29C	40.7833	73.9883					
T28A	40.8	73.99					
T28B	40.8	73.9839					
T28C	40.8	73.9772					
T27A	40.8167	73.9761					
T27B	40.8167	73.97					
T27C	40.8167	73.9656					
T26A	40.8333	73.9669					
T26B	40.8333	73.9594					
T26C	40.8333	73.9525					
T25A	40.85	73.9583					
T25B	40.85	73.9539					
T24A	40.8667	73.9492					
T24B	40.8667	73.9425					
T24C	40.8667	73.9347					
T23A	40.8833	73.9397					
T23B	40.8833	73.9303					
T23C	40.8833	73.9236					
T22A	40.9	73.9322	84 µg	Yes, Aroclor1254			*
T22B	40.9	73.9247					
T22C	40.9	73.9175	0.056 µg	Yes, Aroclor1254	200 µg	Yes, Aroclor 1254	**
T1A	40.9167	73.9253					
T1B	40.9167	73.9192					
T1C	40.9167	73.9125					
T2A	40.9333	73.9208	0.040 µg	No			*
T2B	40.9333	73.9142					
T2C	40.9333	73.9064					
T3A	40.95	73.9153	25 µg	No			*
T3B	40.95	73.9042					
T3C	40.95	73.9008	0.040 µg	No			*
T4A	40.9667	73.9078					
T4B	40.9667	73.9008					
T4C	40.9667	73.8931	37 µg	No	0.040 µg	No	**

Table 6.1 PCB Data - Laboratory Analytical Results - Continued

Site	Latitude	Longitude	pcb#1	> lim. of detect.***	pcb#2	> lim. of detect.***	PCB data
T5A	40.9833	73.9028	0.020 µg	No			*
T5B	40.9833	73.8942					
T5C	40.9833	73.8875	150 µg	Yes, Aroclor 1254			*
T6A	41	73.8992	0.020 µg	No	0.060 µg	No	**
T6B	41	73.8925					
T6C	41	73.8867	0.040 µg	No			*
T7B	41.0167	73.8875					
T7C	41.0167	73.8811					
T8A	41.0333	73.8942	0.040 µg	No			*
T8B	41.0333	73.8833					
T8C	41.0333	73.8775	0.040 µg	No			*
T9A	41.05	73.9	0.15 ug	Yes, Aroclor 1248			*(A,B,C,D)
T9B	41.05	73.8883					
T9C	41.05	73.88					
T9D	41.05	73.8733					
T10A	41.0667	73.8992	0.040 µg	No	0.040 µg	No	**
T10B	41.0667	73.89					
T10C	41.0667	73.8825					
T11A	41.075	73.8967	0.040 µg	No			*
T11B	41.075	73.8825	840 µg	Yes, Aroclor 1254			*
T11C	41.075	73.8742	0.040 µg	No			*
T12A	41.1	73.9042	100 µg	No			*
T12B	41.1	73.8941					
T12C	41.1	73.8833					
T12D	41.1	73.8725	0.040 µg	No			*
T13A	41.1167	73.9042					
T13B	41.1167	73.8958					
T13C	41.1167	73.8833					
T13D	41.1167	73.8717	400 µg	No			*
T14B	41.1333	73.8975					
T14C	41.1333	73.8867					
T14D	41.1333	73.8725					
T15A	41.15	73.9094					
T15B	41.15	73.8983					
T15C	41.15	73.8825	770 µg	Yes, Aroclor 1254			*
T16A	41.1667	73.9231					
T16B	41.1667	73.9158					
T16C	41.1667	73.9008					
T17A	41.1833	73.9458					
T17B	41.1833	73.9275	0.020 µg	No			*
T17C	41.1833	73.92					
T17D	41.1833	73.9083	290 µg	No			*
T18A	41.2	73.9553					
T18B	41.2	73.9492					
T18C	41.2	73.9375	500 µg	No			*
T18D	41.2	73.9269					
T19A	41.2167	73.9611					
T19B	41.2167	73.9542					

Table 6.1 PCB Data - Laboratory Analytical Results - Continued

Site	Latitude	Longitude	pcb#1	> lim. of detect.***	pcb#2	> lim. of detect.***	PCB data
T19D	41.2167	73.9375	340 µg	Yes, Aroclor 1254			*
T19E	41.2167	73.9242					
T20A	41.2306	73.9667					
T20B	41.2306	73.9575					
T20C	41.2306	73.9458					

* = presence of one live clam specimen

** = presence of two live clam specimens

*** = indicates that the sample was above the laboratory apparatus limits of detection capability, i.e. a true finding in that it was above the lower limit of detection of the laboratory equipment.

Note also: DO is measured in mg/L

Note also: Salinity is measured in ppt

Table 6.2 Hydrolab Water Quality Data

Site	Water Depth(m)	Salinity(B) ppt	DO(B) mg/L	%OS(B)	pH(B)	Eh(B)
T34A	14.7	24.9	3.88	63.9	7.36	388
T34B	18.3	23.1	4.27	55.8	7.3	366
T33A	11.7	25.7	4.36	59.3	7.51	363
T33B	14.3	25.1	4.29	58.8	7.52	365
T33C	10.7	25.7	4.42	59.8	7.51	360
T32A	16.8	23.2	3.88	51.6	7.33	384
T32B	19.4	23.8	3.85	51.5	7.33	376
T31A	14.3	19.3	4.83	64.1	7.08	357
T31B	13.1	24.9	4.02	53.4	7.22	363
T30A	16.5	21.6	4.08	54.3	7.34	372
T30B	17	20.2	4.21	56.3	7.34	374
T29B	17.4	25.4	3.96	53.2	7.32	370
T29C	8.8	22.1	4.54	66.6	7.27	357
T28A	15.8	14	5.87	77	7.33	345
T28B	10.1	22.2	4.79	50.8	7.35	373
T28C	1.8	19.6	4.32	57.3	7.34	369
T27A	7	24.1	4	51.7	7.31	366
T27B	13.1	23.4	3.97	53.1	7.35	364
T27C	7.9	23.5	4	52.3	7.33	363
T26A	4.6	15.6	5.17	67.5	7.34	364
T26B	25.9	20	4.26	56.3	7.33	371
T26C	6.1	18.1	4.83	63.2	7.33	362
T25A	5.5	22	4.04	52	7.34	365
T25B	11.9	23.1	3.95	52	7.39	380
T24A	5.8	16	5.26	69.4	7.34	336
T24B	10.1	18.9	4.45	60.2	7.34	359
T24C	11.9	17.1	4.16	62.3	7.35	357
T23A	4.9	20.1	4.26	53.8	7.38	357
T23B	10.1	20.9	4.06	53.6	7.46	370
T23C	11.3	20.9	4.06	53.6	7.45	370
T22A	3.7	11.3	6.3	81.9	7.33	340
T22B	9.1	19.7	4.02	51.9	7.33	367
T22C	14	18.8	4.21	54.5	7.34	354
T1A	6.4	18.2	4.56	57.5	7.42	350
T1B	14.3	17.8	4.81	61.9	7.44	353
T1C	13.4	18	4.41	58	7.44	359
T2A	3.7	14.2	5.02	64.1	7.34	360
T2B	13.7	19.3	4.11	55.2	7.36	356
T2C	11.3	17.5	4.3	57.2	7.35	347
T3A	2.4	14.9	4.54	59.7	7.36	288
T3B	13.7	17.6	4.18	55.1	7.37	293
T3C	25.9	11.1	6.62	87.8	7.36	275
T4A	5.8	14.7	4.88	63	7.34	339
T4B	12.5	17.9	4.34	57.2	7.35	348
T4C	5.8	10.7	6.85	90.2	7.34	333

Table 6.2 Hydrolab Water Quality Data - Continued

Site	Water Depth(m)	Salinity(B) ppt	DO(B) mg/L	%OS(B)	pH(B)	Eh(B)
T5A	4.3	9.8	6.37	82.9	7.36	284
T5B	14.3	15.8	4.31	56.6	7.37	304
T5C	6.1	13.8	4.85	63.3	7.35	301
T6A	5.8	11	6.3	81.4	7.35	337
T6B	11.3	16.3	4.55	58.4	7.36	350
T6C	4.6	14.7	4.76	61.8	7.35	346
T7B	13.7	14.7	4.53	59.1	7.36	313
T7C	3.1	9.7	6.87	90.9	7.34	297
T8A	4	11.3	5.68	72.3	7.35	333
T8B	16.8	14.9	4.64	60.5	7.37	340
T8C	4.6	11.4	6.13	79	7.35	327
T9A	2.4	9	6.03	78.5	7.33	300
T9B	4.9	9.9	5.39	69.7	7.34	304
T9C	11.6	13.3	4.83	63.3	7.35	311
T9D	1.8	ND	ND	ND	ND	ND
T10A	2.7	ND	6.5	ND	ND	ND
T10B	3.7	ND	11.3	ND	7.31	336
T10C	13.1	ND	ND	ND	ND	ND
T11A	3.7	8.3	6.05	77.8	7.32	303
T11B	13.4	13.2	4.73	61.5	7.35	314
T11C	2.1	ND	ND	ND	ND	ND
T12A	2.7	8.5	6.34	80.7	7.32	322
T12B	3.4	9.7	5.67	72.3	7.32	327
T12C	8.5	10.2	5.69	73.2	7.33	330
T12D	3.1	9.5	5.95	76.8	7.32	333
T13A	3.7	8.3	5.95	76.5	7.32	305
T13B	3.7	8.2	6.07	78.2	7.32	303
T13C	7.6	11.6	4.91	63.3	7.32	310
T13D	3.1	9	5.8	73.7	7.32	300
T14B	6.1	10.2	5.28	67.4	7.33	339
T14C	8.8	10.8	5.26	67.6	7.33	334
T14D	2.7	7.5	6.43	81.4	7.32	325
T15A	3.1	6.9	5.95	75.5	7.31	303
T15B	9.5	12	4.84	62.7	7.33	312
T15C	2.7	8.1	5.67	71.9	7.31	302
T16A	9.1	7.5	5.85	74.8	7.33	313
T16B	12.8	9.3	5.16	66.4	7.34	340
T16C	4.9	7	5.99	76.2	7.33	333
T17A	2.7	6	6.07	76.5	7.31	300
T17B	8.8	9.8	4.77	61.9	7.32	307
T17C	3.7	7.2	5.64	71.8	7.31	299
T17D	3.7	6.7	5.84	72.9	7.31	288
T18A	3.1	6.3	5.72	73.3	7.33	310
T18B	ND	ND	ND	ND	ND	ND
T18C	8.2	6.9	5.3	68.2	7.33	296
T18D	7	ND	ND	ND	ND	ND

Table 6.2 Hydrolab Water Quality Data - Continued

Site	Water Depth(m)	Salinity(B) ppt	DO(B) mg/L	%OS(B)	pH(B)	Eh(B)
T19A	7	7.9	5.45	69.6	7.32	333
T19B	9.1	8.3	5.38	68.9	7.33	329
T19D	4.3	6.7	5.9	74.6	7.31	305
T19E	3.1	6.5	5.81	73.2	7.31	295
T20A	5.4	5.5	5.75	72.7	7.33	288
T20B	14.2	7.8	5.17	66.7	7.35	277
T20C	5.1	ND	ND	ND	ND	ND

Notes:

ND means measurement not done due to equipment malfunction

DO is measured in mg/L

Salinity is measured in ppt

Bold Entries denote Sampling Points where live specimen of clam was found

Table 6.3 Hudson River Sampling Grid - Trace Metals Data*

Site	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
T34A	4.87	3.44	113	114	2.36	404	35	152	235	28
T34B	2.73	0.71	71	63	2.95	718	35	83	147	33
T33A	3.32	1.66	80	84	3.36	952	42	140	225	34
T33B	3.2	0.95	64	66	2.49	538	34	95	134	27
T33C	3.2	1.18	64	74	2.44	534	31	129	162	26
T32A	5.1	3.55	105	171	3.17	593	64	266	397	35
T32B	4.39	2.84	78	108	2.75	610	34	141	181	30
T31A	6.41	2.37	126	169	3.62	1015	48	239	333	40
T31B	1.19	0.59	37	31	2.59	946	30	65	95	30
T30A	6.41	3.08	139	145	3.32	807	44	180	255	35
T30B	2.61	1.42	74	71	3.46	1276	39	98	194	32
T29B	3.09	0.95	61	74	2.65	901	28	97	153	27
T29C	9.61	4.26	148	188	3.01	594	43	223	274	37
T28A	2.37	0.95	61	61	3.03	1010	35	78	161	28
T28B	3.09	0.71	65	70	2.97	1276	33	96	166	28
T28C	6.88	2.13	84	178	3.5	895	44	254	315	37
T27A	4.63	0.59	89	95	3.62	2144	40	129	205	35
T27B	2.02	0.59	44	48	2.05	1266	23	66	115	20
T27C	10.8	5.33	166	268	3.31	461	47	385	418	40
T26A	5.22	0.95	102	106	4.16	2503	46	144	243	43
T26B	2.37	0.83	55	60	2.72	1047	27	79	144	25
T26C	2.61	1.3	63	65	3.09	954	36	87	166	28
T25A	2.73	1.18	80	112	3.91	913	48	458	225	35
T25B	4.27	0.95	90	94	3.88	1704	43	188	212	38
T24A	3.68	2.13	80	83	3.65	1704	42	107	202	33
T24B	4.15	0.95	77	80	3.41	1415	38	116	188	34
T24C	1.78	0.83	49	63	2.54	748	28	89	134	25
T23A	3.8	1.07	73	81	3.18	1346	36	98	183	28
T23B	2.49	0.95	71	67	3.5	1154	40	92	195	31
T23C	2.26	0.71	47	75	2.2	651	26	81	131	21
T22A	4.27	1.42	90	95	3.96	2225	44	130	229	37
T22B	0.83	0.59	39	40	3.13	1017	33	44	105	28

* Metals Data are from Ashkan (2000) in ppm

Table 6.3 Continued - Hudson River Sampling Grid - Trace Metals Data*

Site	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
T22C	2.14	1.66	59	60	3.14	772	37	81	170	27
T1A	4.04	1.07	84	87	3.82	1404	45	119	216	35
T1B	2.02	0.95	64	57	3.45	882	42	75	184	31
T1C	1.78	0.59	45	75	2.49	704	26	128	121	28
T2A	2.85	1.18	70	114	3.79	703	45	184	237	34
T2B	0.24	0.95	30	15	3.22	938	32	19	79	28
T2C	1.54	0.83	38	53	2.08	493	23	74	111	20
T3A	4.27	1.3	92	93	4.12	1890	47	127	231	40
T3B	0.24	3.79	36	21	3.73	1052	38	25	96	33
T3C	1.78	0.95	44	50	2.41	555	27	63	131	21
T4A	3.2	0.83	74	77	3.56	1797	38	99	194	32
T4B	0.47	1.9	34	25	2.9	838	31	31	97	23
T4C	1.66	0.83	44	53	2.32	511	26	74	122	22
T5A	3.8	1.42	87	86	4.06	1623	46	114	227	38
T5B	0.59	0.59	33	26	2.35	1169	25	45	108	20
T5C	2.49	0.95	64	113	3.22	684	38	108	230	31
T6A	1.31	1.66	47	39	3.15	934	32	58	130	29
T6B	1.31	0.71	50	43	3.25	1196	37	58	136	30
T6C	3.8	1.9	73	84	3.17	872	37	103	188	31
T7B	1.78	0.59	55	74	3.22	854	34	96	171	28
T7C	1.66	1.3	50	52	2.6	558	33	75	138	24
T8A	0.83	0.59	42	35	2.96	1033	32	46	118	25
T8B	0.24	0.59	29	19	3.18	1047	33	21	89	25
T8C	0.95	1.18	41	36	3.09	863	33	45	114	26
T9A	1.42	0.83	44	42	2.68	947	27	61	118	27
T9B	1.54	0.83	52	50	2.97	916	30	66	145	27
T9C	0.24	0.59	34	20	3.56	1152	36	24	93	31
T9D	3.92	1.66	106	103	3.36	619	42	134	215	32
T10A	1.31	0.71	48	43	2.87	877	32	58	141	22
T10B	0.47	4.15	33	24	3.03	876	31	31	96	24
T10C	1.31	1.3	62	56	3.37	1012	40	78	183	28
T11A	2.49	1.07	73	68	3.72	1128	43	94	200	32

* Metals Data are from Ashkan (2000) in ppm

Table 6.3 Continued - Hudson River Sampling Grid - Trace Metals Data*

Site	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
T11B	1.9	1.54	70	66	3.52	875	42	89	196	31
T11C	2.61	2.01	90	105	3.17	662	36	121	211	30
T12A	2.14	1.42	74	67	3.33	1020	39	92	186	32
T12B	1.78	3.55	71	62	3.25	835	37	86	177	30
T12C	1.9	0.83	60	102	3.08	807	35	80	166	29
T12D	2.73	1.78	75	104	3.11	719	34	114	180	27
T13A	1.19	0.83	59	89	3.59	1173	37	67	156	26
T13B	0.36	0.59	36	25	3.29	841	33	30	96	27
T13C	1.78	0.71	57	52	2.94	909	33	72	159	25
T13D	2.02	0.59	63	59	3.13	1311	34	80	167	28
T14B	1.54	1.3	62	52	3.76	1093	40	68	168	31
T14C	1.66	1.3	58	52	3.01	779	36	76	162	27
T14D	1.54	0.59	60	55	3.24	1427	37	75	162	28
T15A	1.66	1.18	64	65	3.61	1369	40	92	192	36
T15B	1.9	1.07	63	59	3.23	910	38	83	175	28
T15C	1.66	1.18	65	59	3.34	1554	39	81	181	28
T16A	2.37	1.18	81	78	4.04	2769	47	105	227	34
T16B	0.71	0.59	41	47	2.87	1064	33	50	140	23
T16C	0.71	0.71	37	29	2.18	1140	26	47	113	20
T17A	2.02	1.66	92	82	3.97	2167	48	123	238	35
T17B	0.95	1.42	50	40	2.79	902	35	57	153	23
T17C	0.59	0.83	41	33	2.47	1254	28	51	134	20
T17D	0.59	0.83	38	31	2.9	1158	32	41	116	23
T18A	1.66	2.49	97	81	3.4	693	45	120	238	32
T18B	1.07	1.42	56	47	2.95	838	39	64	160	25
T18C	1.31	1.18	57	51	3.1	1152	36	63	169	24
T18D	0.83	1.66	51	44	2.81	986	32	56	154	22
T19A	1.54	1.42	71	65	3.71	1438	44	85	206	29
T19B	1.19	1.9	64	58	3.41	1369	39	75	187	27
T19D	0.71	1.54	45	40	2.71	836	33	51	144	21
T19E	1.07	1.42	64	57	3.37	1670	40	76	189	28

* Metals Data are from Ashkan (2000) in ppm

Table 6.3 Continued - Hudson River Sampling Grid - Trace Metals Data*

Site	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
T20A	0.59	1.07	40	34	2.79	989	35	46	137	20
T20B	1.31	1.9	74	63	3.73	1531	44	84	211	30
T20C	1.42	2.13	73	67	3.54	1117	42	85	204	31

* Metals Data are from Ashkan (2000) in ppm

NOTE: Bold indicates measurements of Trace Metals for locations where live clam specimens were taken

(2000). Specifically the trace metals of interest included Ag, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, and V. The trace metals concentrations are given in Table 6-3. Despite the difficulty in procuring live specimens for analysis, several interesting relationships emerge from the data.

Descriptive Statistics

As seen in Table 6-4, the mean for the parameter PCB is calculated to be 117.4µg/L, with a corresponding standard deviation of 222.0. The median is calculated to be 4.7µg/L. The non-normal measure of asymmetry, or skewness, is measured at 2.56, showing the data to be positively skewed to the right (note that “0 skewness” indicates perfect symmetry around the mean). The high degree of skewness is also reflected by the fact that the mean, the statistical average of all measured PCB concentrations, is so much higher than the median, or middle-center value of the data set, after all the data are ranked from highest value to lowest value.

With regard to the interpretation of the results of the PCB data, it is important to note that where a 0 ppb was reported for a given live clam specimen procured during the collection effort, PCB could still potentially exist below the limit of detection. It also must be taken into account that even if a true value of PCB was present but below the limit of detection, it would still be reported as “0 ppb.” The potential for the frequent occurrence of this phenomenon should also be kept in mind when noting the preponderance of zeros in the lab results for PCBs. Although analysis by linear regression is useful for analyzing such

Table 6.4 Summary Statistics for Available PCB data – The MEANS Procedure

Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
Latitude	98	40.9891582	0.1566626	40.9577493	41.0205670	40.7019000	41.0000000	41.2306000
Longitude	98	73.9299633	0.0444269	73.9210562	73.9388703	73.8717000	73.9196000	74.0325000
pcb1	26	113.8621538	222.9888058	23.7950260	203.9292817	0.0100000	0.1030000	840.0000000
pcb2	4	50.0175000	99.9883334	-109.0862512	209.1212512	0.0200000	0.0250000	200.0000000
pcb	26	117.3522308	221.9791366	27.6929171	207.0115444	0.0100000	4.7050000	840.0000000

data, the very high Coefficient of Variation (189.16) (see Appendix 3, p. 4 of the analysis) indicates the inherent problems with the limited number of live specimens which were able to be brought up by the Peterson grab sampler and possibly also the non-detectable PCB concentrations in the clams collected during the sampling effort. A description of the statistical measures and tests follows which summarize the findings.

STATISTICAL ANALYSES AND CONFIDENCE BOUNDS OF ALL ANALYTES

Table 6-4 (see also Appendix 3, p.7 of the analysis) gives the summary statistics for each of the parameters compared with PCB, including the corresponding mean and standard deviation, the upper and lower 95% confidence boundaries for the mean specific concentration of each analyte, and finally the minimum, median, and maximum concentrations found for that analyte. As already mentioned, the mean concentration for PCB was found to be 117.4µg/L with a standard deviation of 222.0µg/L. The 95% confidence limits range from 27.69µg/L to 207.01µg/L (given in Table 6-4 under “Lower 95% CL for Mean” and “Upper 95% CL for Mean” respectively). Therefore, in the sampled locations, there is a 95% probability that the value will be found to be between 27.69µg/L and 207.01µg/L. Further, the table shows that whenever PCB was discovered in clam tissue, the minimum value detected was 0.01µg/L (under “Minimum”), and the maximum value was 840 µg/L (under “Maximum”).

Similarly, Table 6-5 and 6-6 may be read for each of the other parameters for which data was measured or gathered. These include the parameters measured by the Hydrolab equipment, which included salinity, DO, OS, pH, and Eh (see Table 6-5 for Hydrolab parameter data analysis). The analysis of the trace metal concentrations found in the river

Table 6.5 Summary statistics for Hydrolab Data – The MEANS Procedure

Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
Latitude	98	40.9891582	0.1566626	40.9577493	41.0205670	40.7019000	41.0000000	41.2306000
Longitude	98	73.9299633	0.0444269	73.9210562	73.9388703	73.8717000	73.9196000	74.0325000
Water Depth	97	8.6742268	5.3579046	7.5943700	9.7540836	1.8000000	7.6000000	25.9000000
Salinity	90	14.7022222	6.0898327	13.4267315	15.9777130	5.5000000	14.4500000	25.7000000
DO_B	92	5.1154348	1.0598128	4.8959538	5.3349158	3.8500000	4.8450000	11.3000000
OS_B	90	65.5088889	10.1342410	63.3863132	67.6314646	50.8000000	63.3000000	90.9000000
pH_B	91	7.3431868	0.0533725	7.3320715	7.3543022	7.0800000	7.3400000	7.5200000
Eh_B	91	335.0109890	29.2508289	328.9192091	341.1027690	275.0000000	337.0000000	388.0000000

Table 6.6 Summary statistics for Trace Metals Data– The MEANS Procedure

Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
Latitude	98	40.9891582	0.1566626	40.9577493	41.0205670	40.7019000	41.0000000	41.2306000
Longitude	98	73.9299633	0.0444269	73.9210562	73.9388703	73.8717000	73.9196000	74.0325000
Ag	98	2.3783673	1.8354525	2.0103824	2.7463523	0.2400000	1.8400000	10.8000000
Cd	98	1.3921429	0.9092823	1.2098433	1.5744424	0.5900000	1.1800000	5.3300000
Cr	98	65.5204082	25.2154549	60.4650292	70.5757871	29.0000000	63.0000000	166.0000000
Cu	98	70.5306122	39.4655544	62.6182691	78.4429554	15.0000000	63.0000000	268.0000000
Fe	98	3.1648980	0.4845239	3.0677571	3.2620389	2.0500000	3.1750000	4.1600000
Mn	98	1067.11	438.3390366	979.2308272	1154.99	404.0000000	953.0000000	2769.00
Ni	98	36.7551020	6.7809029	35.3956170	38.1145871	23.0000000	36.0000000	64.0000000
Pb	98	98.2448980	66.6192538	84.8885825	111.6012135	19.0000000	83.0000000	458.0000000
Zn	98	175.5612245	59.4096501	163.6503431	187.4721059	79.0000000	168.5000000	418.0000000
V	98	29.0000000	5.2129893	27.9548618	30.0451382	20.0000000	28.0000000	43.0000000

sediments by Ashkan (2000) for Ag, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, and V is included in Table 6-6. For example, the metal silver (Ag), has a mean concentration of approximately 2.4µg/L with a standard deviation of 1.84µg/L. Its 95% confidence value would be between 2.01 ppb and 2.75 ppb. Please note that in using statistical analyses to probe for relationships among the data, that latitude and longitude is also included in order to monitor any potential geographic effects or patterns that take place with simple displacement in latitude or longitude. While longitude is expected to be negligible owing to the narrow geographic range of the Hudson River, the parameter for latitude of this north-south trending river could reveal potential relationships of statistical significance and importance.

TRANSECT STATION LOCATION COMPARISONS ALONG THE MAINSTEM HUDSON RIVER – A Calculation of the mean PCB concentrations across like stations.

Since the sampling station locations designated A, B, C, D, and E, are located along each of the transects made across the study area (or a smaller number of stations A, B, C, and D, where a given transect was not sufficiently wide), the data collected were subdivided and analyzed accordingly (see Table 6-6, also Appendix 3, pp 8-10 of the analysis). For each transect the station locations denoted “A” represented the station nearest the New Jersey side of the river. The number of sample station measurements (number of observations at all stations A for example) are shown for each of the parameters measured at like stations across all transect locations and is given under the column labeled “N.” For example in the PCB data, there were 30 “A” stations in total, with 10

Table 6.7 Summary statistics for all available data by Location
The MEANS Procedure

location	N	Obs	Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
A	30	30	Latitude	30	40.9652533	0.1621872	40.9046916	41.0258150	40.7019000	40.9583500	41.2306000
			Longitude	30	73.9453767	0.0443471	73.9288172	73.9619362	73.8942000	73.9359500	74.0325000
			Water_Depth	30	6.6433333	4.5739656	4.9353865	8.3512801	2.4000000	5.1500000	16.8000000
			Salinity	29	14.0034483	6.3838372	11.5744057	16.4324908	5.5000000	14.0000000	25.7000000
			DO_B	30	5.2980000	0.8661504	4.9745741	5.6214259	3.8800000	5.5650000	6.5000000
			OS_B	29	68.3896552	10.1179242	64.5410027	72.2383077	51.6000000	69.6000000	82.9000000
			pH_B	29	7.3355172	0.0627686	7.3116413	7.3593932	7.0800000	7.3300000	7.5100000
			Ek_B	29	334.6551724	30.3129815	323.1247309	346.1856139	284.0000000	337.0000000	388.0000000
			Ag	30	3.0500000	1.6128728	2.4477434	3.6522566	0.5900000	2.7900000	6.4100000
			Cd	30	1.4766667	0.7901040	1.1816370	1.7716964	0.5900000	1.1800000	3.5500000
			Cr	30	79.2333333	23.8265041	70.3363705	88.1302962	40.0000000	80.0000000	139.0000000
			Cu	30	85.3666667	34.3224902	72.5504382	98.1828951	34.0000000	82.5000000	171.0000000
			Fe	30	3.4836667	0.4617096	3.3112615	3.6560719	2.3600000	3.6000000	4.1600000
			Mn	30	1319.00	594.5084321	1097.01	1540.99	404.0000000	1080.50	2769.00
			Ni	30	41.5333333	7.1280569	38.8716731	44.1949935	27.0000000	42.5000000	64.0000000
			Pb	30	127.0333333	80.8768682	96.8334144	157.2332523	46.0000000	110.5000000	458.0000000
			Zn	30	209.5000000	58.3737955	187.7028665	231.2971335	118.0000000	211.0000000	397.0000000
			V	30	32.3000000	5.2839606	30.3261899	34.2738101	20.0000000	33.5000000	43.0000000
			pcb1	10	20.9350000	38.4394003	-6.5628905	48.4328905	0.0200000	0.0400000	100.0000000
			pcb2	2	0.0500000	0.0141421	-0.0770620	0.1770620	0.0400000	0.0500000	0.0600000
			pcb	10	20.9370000	38.4381917	-6.5600259	48.4340259	0.0200000	0.0400000	100.0000000

Table 6.7, continued

location	N Obs	Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
B	33	Latitude	33	40.9663909	0.1607392	40.9093953	41.0233866	40.7019000	40.9667000	41.2306000
	33	Longitude	33	73.9360091	0.0458922	73.9197364	73.9522818	73.8825000	73.9247000	74.0267000
	32	Water_Depth	32	12.1781250	4.8861050	10.4164963	13.9397537	3.4000000	12.9500000	25.9000000
	31	Salinity	31	16.8838710	5.7421887	14.7776191	18.9901228	7.8000000	17.8000000	25.4000000
	32	DO_B	32	4.7915625	1.3120634	4.3185132	5.2646118	3.8500000	4.4900000	11.3000000
	31	OS_B	31	59.5677419	6.8040374	57.0720009	62.0634830	50.8000000	58.4000000	78.2000000
	32	pH_B	32	7.3500000	0.0506729	7.3317305	7.3682695	7.2200000	7.3400000	7.5200000
	32	En_B	32	341.9687500	28.7293334	331.6106486	352.3268514	277.0000000	349.0000000	380.0000000
	33	Ag	33	1.7587879	1.1874809	1.3377254	2.1798503	0.2400000	1.5400000	4.3900000
	33	Cd	33	1.3139394	0.9578685	0.9742940	1.6535848	0.5900000	0.9500000	4.1500000
	33	Cr	33	55.4242424	16.6095423	49.5347548	61.3137300	29.0000000	56.0000000	90.0000000
	33	Cu	33	52.8787879	22.1228920	45.0343515	60.7232243	15.0000000	57.0000000	108.0000000
	33	Mn	33	1027.09	253.3108717	937.2707796	1116.91	538.0000000	946.0000000	1704.00
	33	Ni	33	34.8484848	5.1424776	33.0250416	36.6719281	23.0000000	34.0000000	44.0000000
	33	Pb	33	73.1212121	35.2648529	60.6168390	85.6255852	19.0000000	75.0000000	188.0000000
	33	Zn	33	148.2727273	39.5073353	134.2640353	162.2814193	79.0000000	153.0000000	212.0000000
	33	V	33	28.0909091	3.9871954	26.6771111	29.5047071	20.0000000	28.0000000	38.0000000
	3	pcb1	3	346.6733333	438.7783041	-743.3123989	1436.66	0.0200000	200.0000000	840.0000000
	0	pcb2	0	346.6733333	438.7783041	-743.3123989	1436.66	0.0200000	200.0000000	840.0000000
	0	pcb3	0	346.6733333	438.7783041	-743.3123989	1436.66	0.0200000	200.0000000	840.0000000

Table 6.7, continued

location	N Obs	Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
C	27	Latitude	27	40.9952704	0.1410235	40.9394833	41.0510574	40.7167000	41.0000000	41.2306000
		Longitude	27	73.9148111	0.0385880	73.8995462	73.9300760	73.8742000	73.9008000	74.0183000
		Water_Depth	27	8.2814815	5.0591149	6.2801623	10.2828007	1.8000000	7.9000000	25.9000000
		Salinity	24	14.4916667	5.5171603	12.1619742	16.8213591	6.9000000	13.5500000	25.7000000
		DO_B	24	5.1091667	0.8899141	4.7333889	5.4849444	4.0000000	4.8400000	6.8700000
		OS_B	24	67.2208333	11.1052662	62.5314907	71.9101760	52.3000000	63.3000000	90.9000000
		pH_B	24	7.3504167	0.0498240	7.3293779	7.3714555	7.2700000	7.3400000	7.5100000
		EH_B	24	333.0000000	27.9735900	321.1877889	344.8122111	275.0000000	333.5000000	370.0000000
		Ag	27	2.5974074	2.5214489	1.5999554	3.5948594	0.2400000	1.7800000	10.8000000
		Cd	27	1.4333333	1.0604842	1.0059080	1.8607587	0.5900000	1.1800000	5.3300000
		Cr	27	63.4444444	30.4483590	51.3994748	75.4894141	34.0000000	58.0000000	166.0000000
		Cu	27	78.2592593	54.3589159	56.7555883	99.7629302	20.0000000	60.0000000	268.0000000
		Fe	27	2.9025926	0.4517197	2.7238982	3.0812870	2.0800000	3.0800000	3.5600000
		Mn	27	829.1481481	270.8019009	722.0224840	936.2738123	461.0000000	779.0000000	1554.00
		Ni	27	34.1481481	6.3227532	31.6469503	36.6493460	23.0000000	36.0000000	47.0000000
		Pb	27	102.8518519	74.5647389	73.3550235	132.3486802	24.0000000	81.0000000	385.0000000
		Zn	27	174.0740741	69.9966625	146.3843166	201.7638316	93.0000000	162.0000000	418.0000000
		V	27	27.2962963	5.2609945	25.2151162	29.3774764	20.0000000	27.0000000	40.0000000
		pcb1	9	161.9128889	280.8084216	-53.9355716	377.7613494	0.0400000	0.0560000	770.0000000
		pcb2	2	100.0200000	141.3930720	-1170.35	1370.39	0.0400000	100.0200000	200.0000000
		pcb	9	170.9675556	276.7398264	-41.7535058	383.6886169	0.0400000	18.5200000	770.0000000

Table 6.7, continued

location	N	Obs	Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
D/E	8		Latitude	8	41.1520875	0.0613649	41.1007851	41.2033899	41.0500000	41.1583000	41.2167000
			Longitude	8	73.8983625	0.0287582	73.8743201	73.9224049	73.8717000	73.8908000	73.9375000
			Water Depth	8	3.6000000	1.5519573	2.3025312	4.8974688	1.8000000	3.1000000	7.0000000
			Salinity	6	7.6500000	1.2957623	6.2901808	9.0098192	6.5000000	7.1000000	9.5000000
			DO_B	6	5.9550000	0.2395621	5.7035950	6.2064050	5.8000000	5.8700000	6.4300000
			OS_B	6	75.4333333	3.2426327	72.0303990	78.8362676	72.9000000	74.1500000	81.4000000
			pH_B	6	7.3150000	0.0054772	7.3092520	7.3207480	7.3100000	7.3150000	7.3200000
			En_B	6	307.6666667	17.6370821	289.1576841	326.1756493	288.0000000	302.5000000	333.0000000
			Ag	8	1.6762500	1.1636634	0.7034031	2.6490969	0.5900000	1.3050000	3.9200000
			Cd	8	1.2587500	0.5038548	0.8375169	1.6799831	0.5900000	1.4800000	1.7800000
			Cr	8	62.7500000	21.0288917	45.1694066	80.3305934	38.0000000	61.5000000	106.0000000
			Cu	8	61.6250000	27.5055189	38.6298107	84.6201893	31.0000000	56.0000000	104.0000000
			Fe	8	3.0787500	0.2489083	2.8706574	3.2888426	2.7100000	3.1200000	3.3700000
			Mn	8	1090.75	366.1076149	784.6763743	1396.82	619.0000000	1072.00	1670.00
			Ni	8	35.5000000	3.7796447	32.3401379	38.6598621	32.0000000	34.0000000	42.0000000
			Pb	8	78.3750000	31.6901855	51.8813419	104.8686581	41.0000000	75.5000000	134.0000000
			Zn	8	165.8750000	29.9305744	140.8524136	190.8975864	116.0000000	164.5000000	215.0000000
			V	8	26.1250000	3.7583241	22.9829624	29.2670376	21.0000000	27.5000000	32.0000000
			pcb1	4	257.5100000	177.4395683	-24.83559493	539.8559493	0.0400000	315.0000000	400.0000000
			pcb2	0	.	.	.	.	.	.	.
			pcb	4	257.5100000	177.4395683	-24.83559493	539.8559493	0.0400000	315.0000000	400.0000000

PCB measurements from live specimens derived from all of the sampling transects at the A location (nearest New Jersey); 3 PCB measurements from live specimens from all the B locations, 9 PCB measurements from live specimens at all the “C” locations, and finally, 4 PCB measurements from live specimens at all the “D/E” locations. Note that since not all the individual transects included a separate location “E”, the sample measurements from stations “D” and “E” have been grouped into one category “D/E” due to small sample size.

The data show that, using the mean as the basis for comparison, the highest values for PCB occur at station “B”, with a value of 313.4 ppb (with a standard deviation of 458.84 μ g/L). The second highest level occurs along stations “D/E”, with a mean of 171.3 ppb (with a standard deviation of 140.61 μ g/L). The standard deviations in each case however, are also very high, approaching the level of the actual concentration given by the mean. Therefore, while the data are useful to look at for existing trends, it is also important to keep in mind that, because of such high standard deviations, any pattern or trend emerging would require further testing to gather corroborative data given the limitations of the data set. From the data examined for like sample stations across a transect however, there at least appears to be no preferential “side” for accumulations of PCBs.

Table 6-8 (see also Appendix 3, p 11 of the analysis) gives a summary listing of the means calculated for all of the data collected from samples which were found to contain PCB. The table shows that for each parameter, the number of observations N is always a maximum of 26, representing the 26 live specimen locations where measurements for any

**Table 6.8 Summary statistics for all available data for those samples with PCB measured
The MEANS Procedure**

Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
Latitude	26	41.0368538	0.1101360	40.9923690	41.0813387	40.7333000	41.0416500	41.2167000
Longitude	26	73.9052769	0.0296727	73.8932318	73.9172620	73.8717000	73.8996000	74.0153000
Water_Depth	26	6.3538462	5.7595993	4.0274936	8.6801987	2.1000000	4.1500000	25.9000000
Salinity	24	11.3541667	3.9716363	9.6770917	13.0312416	6.7000000	10.8500000	23.8000000
DO_B	25	5.614000	0.8107716	5.2797299	5.9490701	3.8500000	5.8400000	6.8500000
OS_B	24	72.0375000	10.3563386	67.6644017	76.4105983	51.5000000	73.3000000	90.2000000
pH_B	24	7.3354167	0.0166757	7.3283751	7.3424582	7.3100000	7.3350000	7.3600000
Eh_B	24	317.6666667	26.2391454	306.5868473	328.7464861	275.0000000	310.5000000	376.0000000
Ag	26	2.1684615	1.1521760	1.7030876	2.6338355	0.5900000	1.9600000	4.3900000
Cd	26	1.3069231	0.5008534	1.1046240	1.5092222	0.5900000	1.2400000	2.8400000
Cr	26	62.4230769	17.1094666	55.5124138	69.3337400	38.0000000	63.5000000	92.0000000
Cu	26	66.9615385	27.2565306	55.9523875	77.9706894	31.0000000	59.5000000	114.0000000
Fe	26	3.1734615	0.4682815	2.9843186	3.3626045	2.3200000	3.1350000	4.1200000
Mn	26	1016.00	413.5624741	848.9585017	1183.04	511.0000000	889.5000000	2225.00
Ni	26	36.1538462	5.7667482	33.8246062	38.4830862	26.0000000	35.5000000	47.0000000
Pb	26	87.5384615	35.0499424	73.3814834	101.6954396	41.0000000	81.0000000	184.0000000
Zn	26	171.9230769	40.6565351	155.5015470	188.3446068	114.0000000	175.0000000	237.0000000
V	26	28.4230769	5.2013312	26.3222138	30.5239401	21.0000000	28.0000000	40.0000000
pcb1	26	143.7163846	241.0589689	46.3505600	241.0822093	0.0200000	0.1030000	840.0000000
pcb2	4	50.0350000	99.9766671	-109.0501874	209.1201874	0.0400000	0.0500000	200.0000000
pcb	26	146.8514615	239.8358176	49.9796784	243.7232447	0.0200000	9.3350000	840.0000000

other given parameter were also determined. In cases where the number for N is less than 26, this means that for some reason (instrument malfunction, reading not recorded, etc.), there were one or more missing measurements for that given parameter corresponding to one (or more) of the live clam locations.

The General Linear Model (GLM) Procedure:

After the mean concentrations for measured PCB were determined, an Analysis of Variance was performed in order to examine the location (A,B,C, D, E) differences in PCB concentration. Initially, the GLM Procedure was to be used to examine all of the 98 observations collected from the respective sampling points in the study area. However, due to the limited numbers of locations for the live clams, only 26 observations were available for the analysis.

GLM is a statistical technique that evaluates the separation of means relative to the variability in the data. An F value or statistic is the ratio of two variances (mean separation divided by error) and is used to gauge the level of significance and the probability of its occurrence. The F value for these data was determined to be 1.75, with an associated probability greater than .05, the threshold value needed to show statistical significance. In addition, the probability or p-value (labeled “Pr” in the statistical output) was calculated at 0.1853 (see Table 6-9; also Appendix 3, p.13 of the analysis). Thus the PCB level changes across a given transect were not explainable by any pattern found in the measurements taken throughout the study area.

Table 6.9 GLM Statistical Technique Applied to PCB Data

Analysis of Variance to examine location (A,B,C,D,E) differences in PCB

The GLM Procedure

Dependent Variable: pcb

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	237811.072	79270.357	1.75	0.1853
Error	22	994057.355	45184.425		
Corrected Total	25	1231868.427			

R-Square	Coeff Var	Root MSE	pcb Mean
0.193049	181.1353	212.5663	117.3522

Source	DF	Type I SS	Mean Square	F Value	Pr > F
location	3	237811.0721	79270.3574	1.75	0.1853

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	237811.0721	79270.3574	1.75	0.1853

Parameter	Estimate	Standard Error	t Value	Pr > t
Intercept	171.2550000 B	106.2831422	1.61	0.1214
location A	-156.5790000 B	125.7559097	-1.25	0.2262
location B	142.0816667 B	162.3501814	0.88	0.3909
location C	-29.1030000 B	127.7364396	-0.23	0.8219
location D/E	0.0000000 B	.	.	.

When similar location data are analyzed separately for potential relationships among the PCB concentrations, the probabilities (or p-values) indicate a potential relationship in only one of the four segments. In this case, the “least weak” relationship is among the station “A” PCB data (New Jersey side of any transect) with the greatest number of observations (10). Here the probability (or p-value) was 0.23, not strong enough to indicate a trend. In contrast, the station B data (3 observations) shows that the p-value degrades further to .39. Similarly, the station C data (9 observations) shows that the probability is less certain, determined to be .82, the weakest calculated statistical relationship. Thus, there is still no statistically significant relationship found. Specifically stated, there are no patterns found among any of the data determined for each relative sampling station position along any transect in the study area. A “trend” however is suggested among the A station data for PCB.

At this point it must also be understood that statistical analyses were not performed for data obtained for locations along a given transect since no transect ever yielded more than two locations with live PCB data in detectable concentrations. Any statements made about potential relationships discovered in such a river cross-sectional data analysis would have no value or applicability to the real world.

BI-VARIATE LINEAR REGRESSION ANALYSIS USING PCB AS THE DEPENDENT VARIABLE

The statistical analyses then proceeded with an analysis of variance for each of the parameters used as an independent variable, compared with the PCB levels, although this time not focusing on like stations along a transect. Linear regression analyses using SAS

software were run on all of the data, again making the PCB parameter the dependent variable for each of the other measured parameters (including the results from the trace metals analyses performed by Ashkan, 2000). Independent variables included latitude, water depth, salinity, dissolved oxygen, oxygen saturation, pH, Eh, and concentrations for each of the metals Ag, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, and V. The analyses of variance for each of the parameters run individually with PCB as the dependent variable are shown in the statistical analysis in Appendix 3 and are summarized below.

Latitude

An interesting relationship emerges in the linear regression of the PCB data with the latitude position of the respective sampling points: With the increase of each degree of latitude, the PCB value is seen to increase by 647µg/L. This trend in the data is supported by the p-value of 0.11 which emerges from the regression analysis (see Appendix 3, p.18). Because the probability value is above the p-value level required for significance of 0.05, this particular relationship may be sited as a statistical “trend” only. It is interesting to note that the empirical data gathered in the sampling of the Hudson is seen to be in agreement with what might be expected intuitively, in terms of diffusion away from an upstream source. In this case the upstream source is assumed to be the discharged remnants of PCB contamination from the GE plants in Fort Edward, NY and Hudson Falls, NY. The data trend from the samples collected downstream support the idea of natural attenuation as one travels down river, to waters with progressively lower concentrations of PCBs.

If one assumes the null hypothesis to be that the distance downstream from the GE plants has no effect on PCB concentrations found in the molluscs, then the relevant variable might be defined as the distance (in kilometers for example) from the GE property. The findings described in the present study are stated differently and in terms of latitude. The focus is on latitude because of the differences in salinity between the upstream fresh water portion of the Hudson in the region of the GE plants and downstream estuary. In fact, these differences are reflected in the different mollusc populations which occupy these different regions. There is currently insufficient data available in terms of PCB concentrations found in the biomass of freshwater molluscs to directly support an assertion about the increasing distance from the plant beginning from the freshwater location.

Despite any obvious shortcomings of the analysis based upon the final number of live bivalves which proved to be affected by PCB contamination, the data do seem to suggest a potential predictive tool for future studies of PCBs in clams collected along the main stem of the Hudson. This hypothesis will of course need to be tested and validated in the future, ideally through a more robust and comprehensive specimen collection effort for the bivalves.

Water Depth

With water depth, another pattern emerges from the PCB concentrations. The linear regression analysis shows that with every unit of water depth (units of measure are in feet), the concentration of PCB in clam tissue increases by a factor of 4µg/L (see Appendix 3, p.19). Said differently, the deeper the clam is below the water surface of the

Hudson River Estuary, the higher the potential concentration of PCB. Unfortunately, the p-value ($P > |t|$) of 0.60 indicates that the confidence level is far too weak even to state the indication of a statistical “trend.”

Salinity

Linear regression performed on the salinity and PCB data, indicates an inverse relationship (see Appendix 3, p.20). As the salinity increases by one ppt, the PCB concentration is seen to decrease by $7\mu\text{g/L}$. Again, this might be expected intuitively in salinity measurements when moving away from the mouth of the Hudson and upstream in the estuary. As one moved toward the theoretical upstream source of PCB contamination and away from the downstream confluence and increasing tidal effects of the ocean, the pattern of downstream diffusion and lessening of PCB concentrations is also born out. The p-value of the regression was calculated as 0.57, again too weak statistically to indicate an actual trend in the data. The direction of the relationship suggested however, was entirely logical.

As with latitude however, the salinity is only relevant in the downstream portion of the Hudson, where the sampling grid was established. Even if the analyses had indicated a significant relationship or even a trend, since the freshwater molluscs have not been tested, it cannot be stated definitively that salinity and corresponding PCB concentration in freshwater molluscs are related.

Oxygen (Bottom Measurements)

Regression analysis further showed that as the mg/L of dissolved oxygen increases in the bottom water of the estuary, the PCB concentration is seen to decrease by a factor of 60µg/L (see Appendix 3, p.21). The implication seems that future research might focus on determining whether oxygen saturation might ultimately impede PCB presence in clam biomass or potentially, might impede a bivalve organism from settling on the bottom of the river which would be otherwise susceptible to PCB uptake in its biomass. It could also be that PCB concentrations tend to be higher in anaerobic environments. Although suggested by the data, the p-value of 0.30 is again too high to even demarcate a trend. The relationship is only suggested by the data, but it is too weak a relationship to support statistically.

OS_B (Bottom Measurements)

A trend of similar strength to that discovered for dissolved oxygen and PCB is found for OS_B and PCB (see Appendix 3, p.22). In one sense, it is a confirmation of the data collection for the dissolved oxygen readings which were made simultaneously, since percentage of oxygen saturation of the bottom water would naturally be related to the specific levels in milligrams per liter of dissolved oxygen in the same water. In this regression, a similar p-value probability of 0.28 was derived. Furthermore, it was determined that as the OS-B measurement increased, the PCB concentration decreased by 5µg/L. Ultimately however the statistical relationship must be viewed as a pattern which needs to be explored since the p-value was too weak to support even stating the presence of a trend in the data for this parameter when linked with PCB from a live specimen.

pH (Bottom Measurements)

An interesting trend is found with increasing pH and PCB concentration. It was found that for each unit of increase of pH, the concentration of PCB in $\mu\text{g/L}$ is reduced by $3574\mu\text{g/L}$ (see Appendix 3, p.23). Given the minimum and maximum values for pH of the bottom water were 7.08 and 7.52 respectively (see Table 6-4) and that no live bivalve examined in the study was higher than $840\mu\text{g/L}$ (see also Table 6-4), this implies that very little change occurred because of pH fluctuation. Again with a probability greater than 0.05 ($p = 0.22$), although not strong enough to identify an actual statistical trend, one might be led to consider the suggestion that the more basic water condition inhibits either the PCB concentration in clam tissue or perhaps inhibits the accumulation of PCBs in the bivalve biomass or even the very presence of clams in such water conditions. Again, the p-value is too high even to suggest such a trend in the data, however future research can be geared to determining whether this condition actually exists.

Eh_B (Bottom Measurements)

Regression of the Eh_B bottom data, i.e. the activity of electrons in solution expressed in millivolts, with the data for PCB concentrations showed decreasing PCB concentrations by approximately $1.5\mu\text{g/L}$ with each unit of increasing Eh (see Appendix 3, p.24). The pattern suggests that as the electron activity decreases, the PCB concentrations tend to increase. The p-value determined for these two parameters in this case is 0.42, showing a weak statistical association in this pattern.

Metals Concentration Data in Bottom Sediment from Hudson River

As stated previously, one of the goals of this research was to extend the analyses and comparisons made of PCB concentrations to the trace metals data determined and compiled by Ashkan (2000). Although there was no a priori belief that any of the trace metals would be found in close association with polychlorinated biphenyl compounds, it was of interest to see if any associations might exist due to riverine sedimentation patterns, current flows, etc. Since an ideal set of trace metals data existed for each sampling location in the grid from the same time frame, it was decided to examine the results accordingly. Factor analysis was used to simplify the search for relationships and was used to empirically reduce the dimensional structure (i.e. number of variables or underlying factors) common to the measured trace metals.

Statistical regression was performed for each trace metal concentration found at each of the sampling stations throughout the sampling grid common to both studies (Table 6-3). Regression analyses were run as before to determine if ultimately, one can tie changes in the PCB concentrations found in the corresponding locations to changes in trace metals concentrations (see Appendix 3, pp.25 to 34). This included the metals Ag, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, and V. The regressions produced no statistically significant associations. The lowest probabilities (p-values) occurred for the trace metals nickel, manganese, and silver with p-values of 0.36, 0.47, and 0.39 respectively.

At first glance, it appears that the trace metals Ni, Mn, and Ag appear to be the most strongly related to PCB found in the bivalves. However, in each of these cases, the p-value, although relatively low when compared to results of the regressions completed for

the other trace metals examined, is still too large to indicate a quantifiable trend or relationship in terms of changes in concentration of PCBs. For example, the statistical analysis shows that for each increase in unit concentration of nickel, there is a corresponding increase in PCB concentration by 7µg/L (see Appendix 3, p.31), however the strength of this association has a p-value of only 0.36, denoting an association not even strong enough to be called a trend.

Similarly, in the case of Silver and Manganese, the concentrations of PCB either diminish or increase respectively with the presence of Silver or Manganese, however the relationships are not statistically strong (p-value of 0.39 for Silver (see Appendix 3, p.25); p-value of .47 for Manganese (see Appendix 3, p.30)). It is also interesting to note that the regression analyses suggest that only the metals silver, copper, lead, and vanadium yield diminishing concentrations of PCB in the clam tissues where a concurrent increase of concentration of each individual metal in the surrounding sediment is associated. The increasing presences of other metals (cadmium, chromium, iron, & zinc) however, seem to point to associations with increasing PCB concentrations. Further research into this area might determine possible links between PCBs in clams and associated peaks of concentrations of particular trace metals in the river sediments.

LOGISTIC MODEL TO EXAMINE THE PREDICTORS OF BINARY PCB (PRESENT/ABSENT)

With the exception of the statistical trend found showing decreasing PCB concentration with distance from the potential source of contamination, nothing of significance was

found with simple regression analyses of the analytical data from the field effort. Before moving on to Factor analysis of the data as a means of checking for the coexistence of metals with PCB concentration, it was decided that it would be best to run a logistic regression analysis on the data representing concentrations in clams as having a concentration of PCBs either above or below the limit of detection of the laboratory equipment. This would have the effect of applying the statistical regression to that aspect of the data which was detectable vs. non-detectable to the instruments.

The separation of the specimens was accomplished in this analysis by encoding the sample with either a “1” for detectable PCB or a “0” for samples in which PCB was not detected (see Appendix 3, pp.35 to 68). As mentioned previously, per the Woods Hole laboratory report this separated out the actual live samples with confirmed concentrations of PCB into a group of 7, substantially restricting the sampling universe. Once all of the regressions for each of the parameters were rerun, the inability to predict levels of PCB based on changes in individual parameters was re-confirmed. Any existing relationships found in the logistic model between each of the parameters measured and the levels of PCB found in the clams were not statistically strong enough to even document a trend. In the case of latitude the probability was found to be p-value was found to be 0.94, clearly not significant.

FACTOR ANALYSIS

A factor analysis was performed on the data set (water depth, dissolved oxygen, salinity, Eh, pH, OS, Ag, Cd, Cr, Cu, Fe, Mn, Ni, Pb, V, and Zn) in order to determine the

presence of any latent variables or factors among the variables capable of explaining the observed associations among measures. By organizing a matrix of correlation coefficients for all of the variables which have been generated, factors can be extracted, grouping variables with similar characteristics together (whose values co-vary) in an attempt to parsimoniously explain any underlying similarities among the measures. As per the University of Newcastle upon Tyne, “With factor analysis you can produce a small number of factors from a large number of variables which is capable of explaining the observed variance in the larger number of variables.”

<http://www.ncl.ac.uk/iss/statistics/docs/factoranalysis.html>). In the current study, factor analysis was applied to the data with particular attention paid to changing latitude, since it was the only statistical trend which emerged from the regression analysis.

Once the correlation coefficients were laid out in a matrix, the factors were then extracted and rotated in order to determine an interpretable underlying structure. In this way, a smaller number of factors were produced from the larger number of variables for which data had been collected and which were potentially capable of explaining the observed variance among those variables. Eigenvalues, the percent of variance attributable to each factor, were also calculated as a part of the factor analysis. Factors were extracted using the rule that the factor had to have an eigenvalue of at least 1.0 (a common rule used in factor extraction).

As seen in the “Preliminary Eigenvalues” table shown in Table 6-10 (see Appendix 3, p.69) of the analysis, three eigenvalues larger than 1.0 emerged from the 16 variables in the analysis of the Hudson River data. Under the Rotated Factor Pattern in Table 6-11

Table 6.10 Preliminary Eigenvalues of Factor Analysis
Factor analysis showing interrelationship among predictors (3 factor solution)
The FACTOR Procedure

Initial Factor Method: Iterated Principal Factor Analysis

Prior Communality Estimates: ONE

Preliminary Eigenvalues: Total = 16 Average = 1

	Eigenvalue	Difference	Proportion	Cumulative
1	6.83073043	2.90280961	0.4269	0.4269
2	3.92792081	2.26214112	0.2455	0.6724
3	1.66577969	0.78707601	0.1041	0.7765
4	0.87870368	0.16905452	0.0549	0.8314
5	0.70964916	0.18780366	0.0444	0.8758
6	0.52184550	0.12274339	0.0326	0.9084
7	0.39910212	0.03514542	0.0249	0.9334
8	0.36395670	0.11805405	0.0227	0.9561
9	0.24590265	0.06972720	0.0154	0.9715
10	0.17617545	0.08271350	0.0110	0.9825
11	0.09346196	0.02363538	0.0058	0.9883
12	0.06982658	0.01944155	0.0044	0.9927
13	0.05038503	0.02273321	0.0031	0.9958
14	0.02765183	0.00637286	0.0017	0.9976
15	0.02127897	0.00364954	0.0013	0.9989
16	0.01762943		0.0011	1.0000

Table 6.11 Rotated Factor Pattern

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure

Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3
1	0.89533	-0.31425	0.31564
2	0.13674	0.86838	0.47667
3	-0.42388	-0.38362	0.82046

Rotated Factor Pattern

	Factor1	Factor2	Factor3
Cu	0.96836	-0.12368	0.04246
Cr	0.92082	-0.05791	0.24186
Zn	0.91020	0.01002	0.29210
Ag	0.89196	-0.23902	0.06975
Pb	0.81378	-0.20256	0.12348
Cd	0.69899	-0.01897	-0.05354
DO_B	-0.15812	0.94457	-0.00277
OS_B	-0.10504	0.90713	-0.07337
pH_B	-0.17700	-0.29830	-0.06222
Water_Depth	-0.04322	-0.56305	-0.24197
Eh_B	0.30613	-0.71881	-0.08572
Salinity	0.29553	-0.90715	-0.11006
Fe	0.25818	0.14661	0.94418
Mn	-0.08154	0.17347	0.67143
V	0.62867	-0.10840	0.66593
Ni	0.62493	0.07364	0.64129

Variance Explained by Each Factor

Factor1	Factor2	Factor3
5.6698665	3.6467515	2.4528841

Table 6.12 Sampling Effort Validation

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-115.812	64.0411	-241.330	9.7060	3.27	0.0705
Latitude	1	2.7995	1.5612	-0.2604	5.8594	3.22	0.0729
Scale	0	1.0000	0.0000	1.0000	1.0000		

NOTE: The scale parameter was held fixed.

(see Appendix 3, p.74), factor one shows the highest correlations with copper, chromium, zinc, silver, lead, and cadmium. Factor two shows that the OS parameter data and Dissolved Oxygen data, co-vary in an inverse relationship with the other parameters of the data set. Finally, factor three contains the highest correlations with iron, manganese, vanadium, and nickel. In short, each of the factors represents clusters of specific parameters that consistently co-vary.

The next step was to determine if any of the three extracted factors were related to PCB. The factors, which can be described by its highest correlating parameters, were used in linear regressions and were found to be significantly related to latitude. More specifically:

Factor One (Cu, Cr, Zn, Ag, Pb, Cd) – In the case of Factor one, the probability value is 0.0032 indicating that there are approximately 3 chances out of 1000 that the changes are occurring by coincidence. For each degree of latitude, Factor one decreases by 3.69 units (see Appendix 3, p.77). This shows that, relative to Factor one, the upstream locations of the Hudson River have lower concentrations (are “cleaner”) with respect to these parameters.

Factor Two (DO bottom, OS bottom) – In the case of Factor two, for each degree of increasing latitude, Factor two goes up by 3.5 units (see Appendix 3, p.78). The Pr value of 0.0308 indicates that the finding is unlikely to occur by chance, as there are only three chances in every 100 (or 31 chances in 1000) that the combined changes in DO and OS measured along the bottom of the river are due to chance. The fact that these two parameters, that of dissolved oxygen

measured in mg/L, and that of oxygen saturation, given as in ppt were found to be similarly loaded on the same factor is a good indicator that the readings were done correctly as these two readings must be directly related.

Factor Three (Fe, Mn, V, and Ni) – In the case of Factor three, with each degree of increasing latitude, there is a downward trend in these combined parameters only, since the p-value is 0.0702 (70 chances out of 1000) (see Appendix 3, p.79). Although this relationship emerges as a factor, the lack of significance of the relationship prevents stating the relationship between Factor three and latitude as a certainty.

The Factor analysis has given us an enhanced look at the effects of the combinations of the related variables derived initially from their correlation coefficients. As summarized above, the statistical probabilities support the contention that the metals Cu, Cr, Zn, Ag, Pb, and Cd diminish as one goes upstream of the Hudson River. Because this has been based upon readings which were compared with PCB concentrations deriving strictly from the lower estuarine waters where PCB samples were taken, it is a contention which needs to be further refined through additional sampling. The metals of Factor one show a statistically significant decrease as we go upstream, or said differently, these trace metals become progressively heavier in concentration as one moves in a southerly direction from Transect 11 to Transect 32. It is therefore a good basis to begin considering potential point source contributions for these particular trace metals from south of this northern transect.

In Factor 2, the combination of the parameters of dissolved oxygen (DO) and oxygen saturation (OS) also showed a statistically significant increase in the upriver direction. Again with respect to the study area, this would indicate a trend beginning from transect 32 and extending upward to transect 11, not altogether unexpected given the northerly movement away from the City's potential impact to the estuary.

Finally, Factor 3 represents the combined effect of Fe, Mn, V, and Ni. This factor shows that the combined effect of these four metals is seen to decrease as one moves upstream (as was the case for Factor 1). Northward of Transect 11, the statistical implication is that the combined effect will in fact decrease (see Appendix 2, p.79). However, unlike Factor 1, the statistical probability 0.07 is suggestive of a "trend" only.

Validation of Soundness of Sampling Effort

Finally, the statistical analysis sought to examine by means of regression of the data as it pertained to all 98 separate sampling efforts to obtain clam samples. Since only 33 live specimens were actually obtained for chemical analysis for the presence of PCB in the bivalve tissue, it made sense to view the locations where a live sample was obtained with respect to each of the parameters measured in conjunction with the sample location. This consisted of using a logistical model to take into account the presence or absence of a live clam specimen as it might pertain to the predictability of the parameter measured (see Appendix 3).

When samples were analyzed based on the latitude, it was determined that as the latitude itself increased, the probability of getting an actual live estuarine clam specimen

increased. In the case of this statistical model, the probability was determined to be approximately 0.07, indicating a statistical trend in the data (see Table 6-12; Appendix 3, p.2). The interesting aspect of this result is that it tends to validate the entire sampling effort by indicating such a result. It is important to recognize that there would be no statistical trend determined at all if the results were simply a random pattern. Any errors made with the dredge sampling process would not result in such a trend in the data. In fact, as one might expect in traveling upstream away from the perceived effects of increased urban impact to the river, the clams would be easier to obtain to an ever-increasing degree if the river conditions became more progressively conducive to mollusc habitats.

Similarly, the data also reveal that as the water depth increased, the probability was diminished that a live specimen (without any reference to species) would be obtained (see Appendix 3, p.4). In addition, it was also noted that as the salinity increased, the likelihood was even less that one would be able to pull a live clam sample from that location (see Appendix 3, p.6). Increasing Eh also indicated a diminished likelihood of finding live specimens as well (see Appendix 3, p.14).

A statistically significant relationship was found for dissolved oxygen: the higher the concentration of dissolved oxygen in a location in the river, the greater the likelihood of finding live clams, at least of the type of species collected downstream, assuming all other required conditions for the presence be held constant (see Appendix 3, p.8). This fosters the notion that more favorable aerobic conditions favor clam presence. A

similarly strong statistical trend was also observed for increasing bottom water oxygen saturation (OSB)(see Appendix 3, p.10).

No relationship was found for pH levels (see Appendix 3, p.12), nor any of the individual metals (see Appendix 4, pp.16 to 34).

Tobit Analysis: An Alternate Approach

Because the sample size of molluscs with PCB concentrations above the limit of detection, we have conducted a Tobit statistical analysis, designed for samples with limited data (Venables et al., 1999). The Tobit approach is an alternate approach, designed especially for limited data sets, allowing the censoring of the samples found below the instrumental limit of detection. The results of this analysis did not reveal anything different from the previous statistical approaches. More details on the Tobit analytical approach and results are shown in Appendix 4.

Section VII Discussion and Conclusion

Aroclor Findings and Implications

The basic answer to the question of whether PCBs originally deriving from discharges to the upper Hudson River could be detected in present-day bivalve tissues from clams taken from the lower Hudson River Estuary can only be answered after a consideration of the analytical laboratory results. In fact, several substantial concentrations were found in the clam tissues of the present study. Figure 6-1 shows all of the concentrations measured for live specimens and their relative locations among the sampling stations.

Although the Aroclor concentrations may seem to cluster in the middle (T22A, T22C, T5C, T9A, and T11B) and upper locations (T15C and T19D) of the sampling grid established in the lower Hudson Estuary, one must consider carefully, the nature of the Aroclors discovered. The specific Aroclor found in every location but one (T9A) was Aroclor 1254. This points essentially to a GE source upriver, although it is possible that another source, such as the Niagara-Mohawk power plant, could conceivably have made a contribution of this particular Aroclor (Dr. Mark Greenberg, Senior Environmental Toxicologist, USEPA, personal communication, October 2005). And while it is generally regarded that other potential contributing sources do exist for this particular Aroclor, the primary source of 1254 in the Hudson River is generally recognized to be from the GE plant operations in both the Hudson Falls and Fort Edward plants. This has also culminated in the recent Settlement agreement between USEPA and GE which is to initiate dredging of the up-river sediments in the vicinity of these plants which are contaminated with this Aroclor.

The finding of Aroclor 1248 at station T9A however presents to us another matter for consideration. Per my discussion with Dr. Mark Greenberg, Senior Environmental Toxicologist of the USEPA (October, 2005), it is entirely possible, and even probable that such a finding is a result of PCB weathering. In PCB weathering, a given Aroclor with a higher degree of chlorination is degraded to one of lower chlorination. It is important to remember that the higher the number of the Aroclor, the higher the degree of chlorination in this Aroclor). In the case of the T9A tissue sample, the appearance of Aroclor 1248 may be seen as a potential product of degradation of a higher Aroclor such as 1254 or 1260 for example.

PCB weathering has been described as a two step process, the first being an anaerobic reaction which strips chlorine atoms from the biphenyl ring, replacing them with hydrogen (Schmidt, 2001). Later, “as the chlorine atoms are removed, the PCBs become increasingly soluble and rise in the water column, where they can be further degraded by anaerobic processes.” Richard Bopp (1979) discussed the evidences for the possibility of PCB weathering as it pertained to Aroclors 1242 and 1254, however Aroclor 1248 was not discussed as a potential by-product. It is not one of the intentions of this study to suggest the likelihood of PCB weathering to explain the presence of Aroclor 1248 found in the biomass of the live specimen taken at T9A. It is merely mentioned as a potential explanation for the occurrence without dismissing altogether a similar upstream origin potentially in common with those specimens found to have Aroclor 1254. The alternative explanation would be a different source of this particular highly chlorinated Aroclor.

There has also been speculation that suggests that significant sources of higher molecular weight (MW) PCBs exist in the NY/NJ Harbor Estuary. In a section of the NYAS report “Pollution Prevention and Management Strategies for Polychlorinated Biphenyls in the New York/New Jersey Harbor (2005), discussing "sources and pathways of PCB mobilization in the NY/NJ Watershed” it was suggested that another downriver source of “higher MW PCBs” might exist in the estuary near River Mile 10. It is important to note that the T9A is located above River Mile 10. It was also suggested that these higher molecular weight “congener patterns may also be caused by volatilization of the lower MW congeners.” Finally, it was also reported that after a statistical analysis on congener patterns seen in water samples collected from Raritan Bay (Gigliotti, 2003 in Panero et al., 2005), a source with a congener profile similar to Aroclor 1248 was attributed to the higher molecular weight shift, however it was noted that it was also clearly differentiated from PCB sources from the Hudson River at Troy Dam. The report suggested the potential contribution by Combined Sewer Overflows (CSOs), however also conceded that possibility that “other, significant sources of PCBs exist in the estuary that have not been identified.” In any case, all other compounds found in the bivalve tissues sampled in this study are Aroclor 1254, which has been generally associated with former GE operations that were carried out upriver. The contaminated sediment source area which is targeted for dredging is a known contributor of the higher MW PCBs and is the most logical source for at least the majority of the hits found above River Mile 10 in the present study.

It may be possible in the future to increase the duration of the sampling event, facilitating multiple dredge sampling efforts at each sampling point. Perhaps such energetic sampling

would increase the sheer number of live specimens available for the same analytical testing employed during the present study. Such a study would also yield a potentially more geographically distributed set of concentrations across the grid stations, giving us a firmer foundation for this conclusion.

Water Quality in Terms of PCBs

As already discussed, the results of the statistical analyses make it clear that the concentrations of PCBs found in the lower Hudson River Estuary are generally attenuated as one proceeds downstream. Only two readings of PCB have been reported by the USEPA for PCBs in bivalves (samples from pisidium “pill” clams) in the data collected for the Hudson River. These included two upstream hits of 2.88 ppm and 0.814 ppm measured at River Mile 174 and River Mile 192 respectively (Database for the Hudson River PCBs Reassessment, Release 5.0, RI/FS, USEPA, 2000). As shown in Section III, these concentrations exceed the standards for both Federal and New York State standards. Since the maximum contaminant level for PCBs in drinking water set by the Federal government is 0.0005 mg/L, each of these concentrations exceeds the standards by at least three orders of magnitude! The Federal limit which was set by the USEPA for cancer protection for fish consumption is that no more than one meal of fish containing 0.023 to 0.047 ppm PCBs should be eaten per month and none should be eaten if the fish contains > 0.094 ppm (USEPA, 2000; NYAS, 2005). Again, both standards are exceeded in the upstream data collected by USEPA.

Similarly, the ambient water quality standard set by the NYDEC is also a stringent 1 pg/L of PCBs in consumed fish. For the protection of aquatic/wildlife resources, the ambient

water quality limit was set for both freshwater and estuary/coastal waters at the limit of 0.12 ng/L. Again the levels reported for bivalves by the USEPA are in excess of these standards, to an even greater degree. It is no wonder that the remedial actions taken with respect to the contaminated sediments of the Hudson River upstream have been so energetically pursued. A listing of various federal and state standards/guidelines for PCBs is given in Table 3-1.

The PCB concentrations in the present study similarly give reason for concern. The concentrations found in clams range from 0.056 µg/L to 840 µg/L. The USEPA has set the maximum contaminant level of PCBs permissible for drinking water concentration standard of 0.0005 mg/L (0.5 µg/L). Within the bivalves, this level is exceeded in six concentrations found at T11B (840 µg/L), T15C (770 µg/L), T19D (340 µg/L), T22C (200 µg/L), T5C(150 µg/L), and T22A (84 µg/L). These are shown in Figure 7-1.

Generally speaking, the locations of the high concentrations of PCBs seem to coincide with present-day locations of known sedimentation. The results seem to correlate well with the work done by McHugh et al (2004). As pointed out by Dr. Cecilia McHugh (personal communication), there is a potential to explain increased density of living molluscs found in the study area (as well as areas where no live species were found) as being due to the nature of the active sedimentation taking place in the various sample locations (see Figure 7-2). Future studies should attempt to link live clam species closely with respect to the known areas where sedimentation is taking place. It will also be instructive to determine whether the dearth of live clam specimens in the present study is due to the lack of active sedimentation processes.

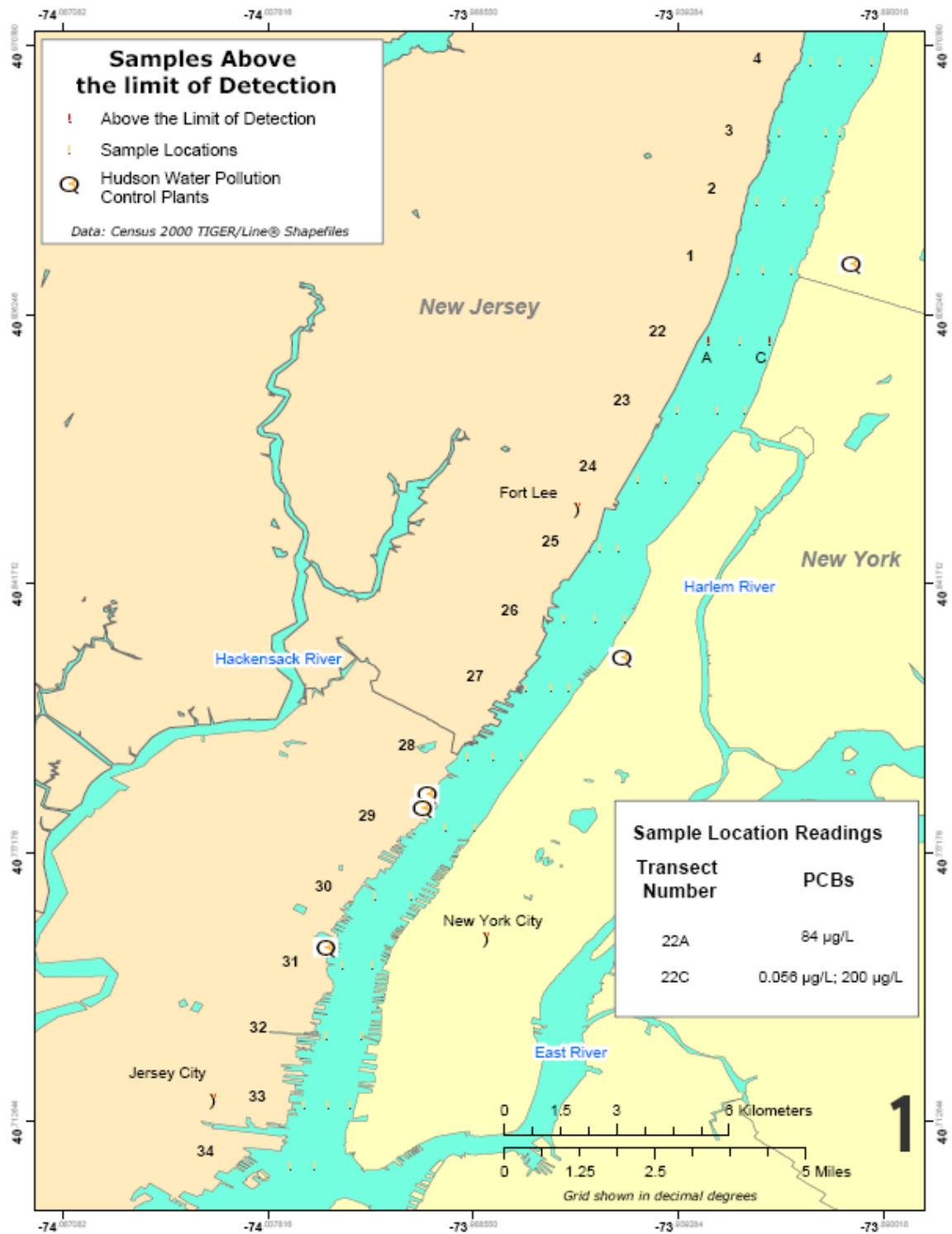


Figure 7-1 Sample Concentrations Found Above the Limit of Detection

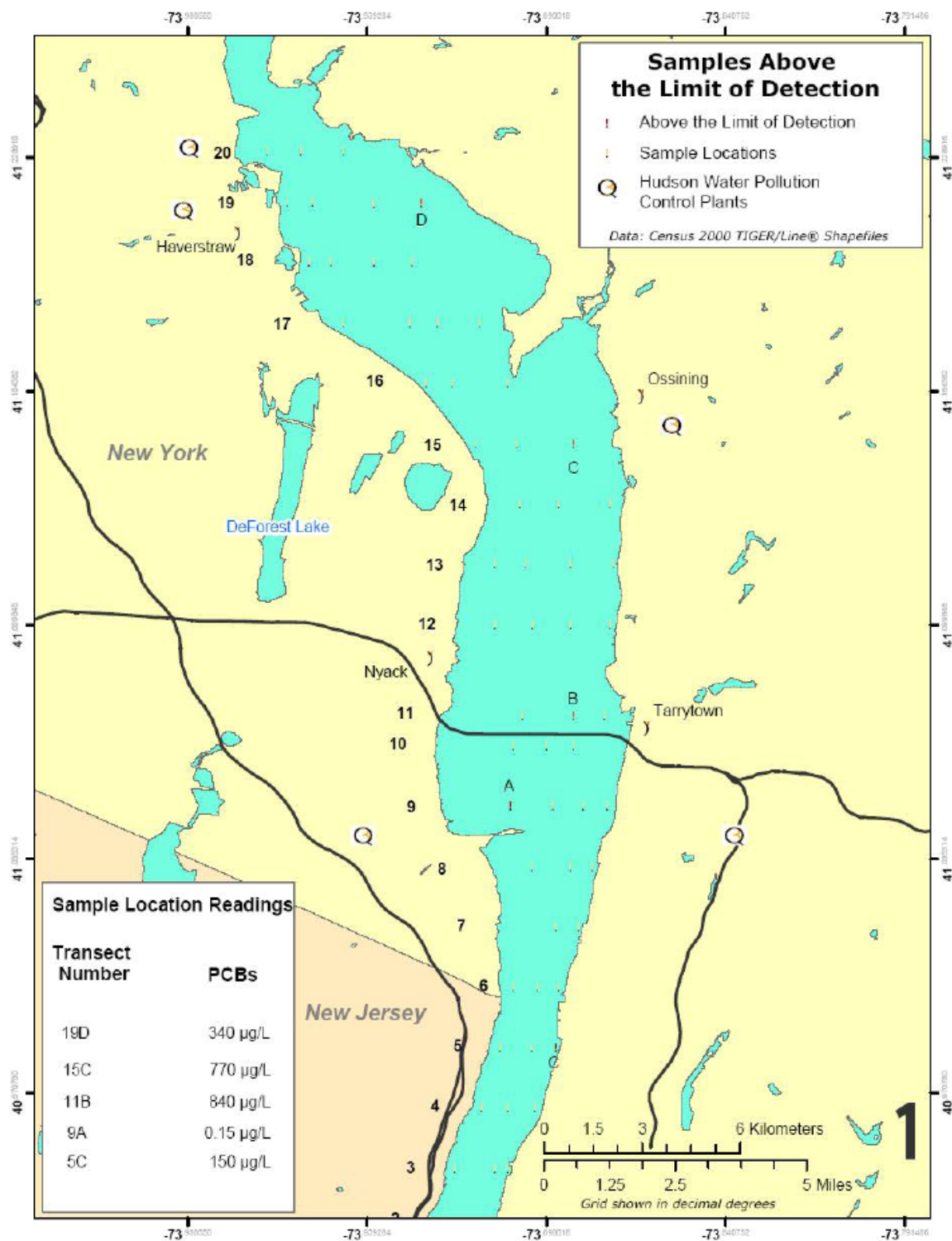


Figure 7-1 Continued - Sample Concentrations Found Above the Limit of Detection

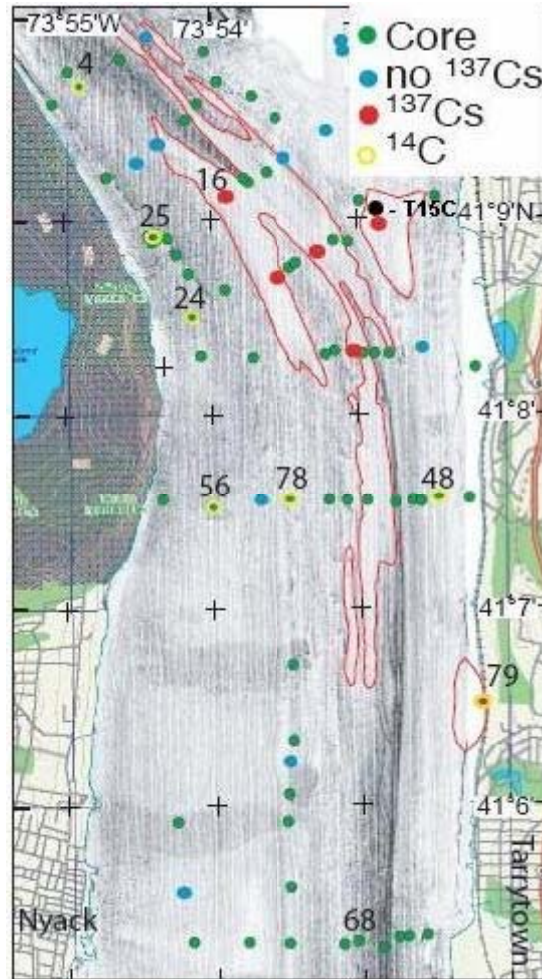


Figure 7-2 Sample Location T-15 C is located within an area of active sedimentation in the Hudson River Estuary as determined by McHugh et al (2004). Diagram modified from McHugh et al (2004) with permission.

In terms of fish consumption, the limit prescribed by the USEPA of no more than one meal per month containing 0.023 to 0.047 ppm is also exceeded in these same six locations. The given guideline against a ingesting a meal of fish containing greater than 0.094 ppm is exceeded in five locations of these six, the sample station T22A being the exception, however still very near to this limit.

In comparing the data with the New York State regulatory standards, the standard of 1 pg/L (.000001 mg/L) set for fish consumption for protection against cancer in human beings is exceeded in all cases where a PCB concentration was detected above the instrumental limits of detection, adding back the two additional locations, T9A (0.15 µg/L) and T22C (0.056 µg/L) (see Figure 7-1). Note that this T22C represents a separate live bivalve sample also found to have a concentration above the limit of detection. Thus we see that in each case the standard is exceeded by a minimum of 4 orders of magnitude. It is interesting to note that the standard for fish consumption set by the Food and Drug Administration is much less stringent than that set for fish consumption by the USEPA (see Table 3-1)!

PCBs by Bivalve Species

The actual bivalve species located in the Hudson River Estuary associated with each of the locations where live specimens were taken and sent for analysis are shown in Table 2-1. While a species comparison in terms of PCB concentrations according to biomass is desirable in order to better understand the nature and tendencies of PCB accumulation, the resulting set of affected organisms collected are too diverse and too limited in total number to make such an assessment with statistical confidence. A principle finding of

this study is that in spite of the complex interactions of food sources, sediment types, and accumulation rates, several species of clams collectively reflect a clear increase in PCBs as one moves up the Hudson towards the presumed contaminating source.

Thus while high level concentrations of PCBs were found at various locations and in a wide variety of species, it is not clear at this time to what degree PCB is preferentially incorporated into the biomass of a bivalve species, whether the species be *Macoma balthica*, *Mya arenaria*, *Crassostrea virginica*, *Rangia cuneata*, *Mulinia lateris*, and *Mytilopsis leucophaeta*. Of all the species found in the grid area, only *Macoma* is a sediment feeder. Most of the other species are plankton feeders, filtering out of the water column, which would involve loose sediment to varying degrees. It may be possible to add to our understanding of the nature and tendencies among bivalves to incorporate PCBs within their respective biomasses if future sampling efforts can increase substantially the sheer number of “live specimens” available for analysis.

Relationships of PCBs to other Riverine Parameters and Attributes

As mentioned previously, it seems that the high concentrations of PCBs in live specimens seem to correspond well with known areas of active sedimentation in the Hudson River (McHugh et al, 2004). Indeed the high concentrations found north of the George Washington Bridge appear to correspond well with the location of the estuarine turbidity maximum documented by Geyer et al (2001). Future PCB studies should attempt to correlate the findings of live PCBs seen in bivalves according to the physical processes of sedimentation taking place in the river.

The statistical regressions for each of the water quality parameters measured were unable to predict levels of PCB based on the measurements taken throughout the sampling grid for bottom water salinity, dissolved oxygen, oxygen saturation, the activity of electrons in solution (Eh), or pH. It is important to note that the Hydrolab parameters are only instantaneous measurements, subject to greater variability in terms of the time of measurement, response to the state of the estuary, etc.

This inability to predict PCB levels was also true with respect to individual trace metal concentrations reported for each of the sampling locations by Ashkan (2000). In fact, the analyses show that the trace metals appear to emanate from a downstream source while the PCBs appear to be coming from upriver.

In fact, with respect to all of the statistical analyses done for single parameters compared to corresponding PCB concentrations, with the exception of geographic latitude, any of the existing relationships which emerged from the analyses were not statistically strong enough to even document a trend. In the case of latitude however, the probability was found to be .1099. The results of the statistical analyses make it clear that the concentrations of PCBs found in the lower Hudson River Estuary are generally attenuated as one proceeds downstream. This mirrors the earlier thinking of Bopp (1979) with respect to tidal Hudson sediments:

“Concentrations show a general downstream decrease which is to be expected from an upstream point source. The decrease is due to dilution of highly contaminated sediments from the upper Hudson with relatively uncontaminated sediments originating in the lower basin and to the partitioning of PCBs from suspended matter into the water phase...”

If one considers specific Aroclors, as the upstream source, this statement is supported by the data collected in the present study.

The factor analysis however did yield an interesting relationship with respect to trace metals. For the Factor One grouping of the metals Cu, Cr, Zn, Ag, Pb, and Cd, it was seen that there was a probability of 0.0032 (approximately 3 chances out of 1000) that for each degree of latitude, Factor One showed a decrease. Generally speaking, the data for these metals collected in the sampling grid are lower in concentration as one proceeds upstream.

Similarly, the Factor Two grouping of Dissolved Oxygen with Oxygen Saturation, showed that for each degree of increasing latitude, this factor concerning would increase. This was shown to have a probability of .0308 (or approximately 31 chances out of 1000). Although inherently related, the high degree of relatedness of these two parameters emerging from the analysis is a good indicator that readings were taken properly.

Statistical Confidence

When samples were analyzed with respect to latitude, it was determined that as the latitude increased, the probability of obtaining a live clam also increased. The statistical analysis showed a probability of 0.1099, indicating a “trend” in the data. This trend helps to validate the soundness of the study by the simple fact that random dredging events would not be expected to produce such a pattern.

Summary

Since dredging of the Hudson River is expected to commence in early 2007, it is important that we see that the baseline data here shows a direct relationship with the PCBs currently sourced upriver, in a nearly real-time setting owing to the fact of the various mollusc's life spans. As previously mentioned, these are all assumed to be no more than approximately 10 years in duration, usually 5 or 6 years generally speaking. Since the dredging activities have the potential to stir up PCB-laden sediments, putting them back into immediate circulation, the concentrations determined by this study will provide at least a potential means of gauging any significant increases in PCB concentrations downriver. Such knowledge will be vital not only in protecting human health and the environment in general for the present Hudson River concerns, but may also serve in devising future mitigation strategies for such riverborn contaminants elsewhere.

As alluded to before, a future study of PCBs in bivalve tissues may be augmented with a concentrated dredge sampling procedure in which live clams would be procured with multiple grab samples if necessary, at each sample station on the sampling grid. In this way, potential limitations posed by the sparseness of clam species would be counteracted, assuming that the population of bivalves was actually present, albeit not densely present.

Future sampling should also be performed with strict attention paid to natural physical processes of sedimentation taking place in the river. If live bivalves are primarily limited to areas of active sedimentation in the Hudson River Estuary, then all future sampling for

such should be guided accordingly. This knowledge of likelihood of species distribution based upon sedimentation processes within the river becomes especially important if the downstream water quality study seeks to measure the presence of a harmful contaminant in the biomass of live species present in the river.

Additionally, further sampling closer to Fort Edward and Hudson Falls, might also prove interesting, allowing a demonstration of whether the PCB concentrations would increase in similar or even different species as the statistical model suggests.

Appendix I

METHOD 8082

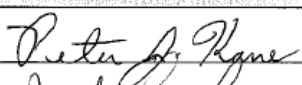
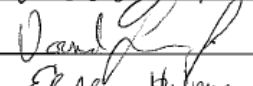
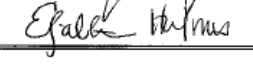
Polychlorinated Biphenyls (PCBs) as Aroclors or Congeners By Gas Chromatography/Electron Capture Detection(GC/ECD)

1. Method Reference

- 1.1. Method 8082 and Method 8000B, Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Final Update III, December 1996 (USEPA, Office of Solid Waste and Emergency Response, Washington, DC).
- 1.2. "USEPA Contract Laboratory Program Statement of Work for Organics Analysis; Multi-Media, Multi-Concentration" August 1991. Document Number OLM03.1.

2. Scope and Application

- 2.1. This method is applicable to the quantification of PCBs as Aroclors and congeners in water, soil, sediment, sludge and tissue samples. The applicable compound list can be found in Table 1. Additional congeners may be added or substituted to this list without SOP revision, upon determination of their retention times on both analytical columns.
- 2.2. This method is in substantial conformance with the guidelines established in the SW-846 for performing chromatographic analysis as defined in the Method 8000B ("Gas Chromatography"), Method 8082 ("Polychlorinated Biphenyls"), Method 3545 ("Pressurized Fluid Extraction"), Method 3510C ("Separatory Funnel Liquid - Liquid Extraction"). The data quality objectives of these methods is met or exceeded by this SOP.
- 2.3. The sensitivity of method usually depends on the concentration of interferences rather than on instrumental limitations. If interferences prevent detection of the analytes, Method 8082 may also be performed on samples that have undergone cleanup. Typical reporting limits are derived from annual MDL studies and may also be based on the concentration of the lowest level standard used in the initial calibration curve.
- 2.4. Quantitation of PCBs as Aroclors is appropriate for many regulatory compliance determinations, but is particularly difficult when the Aroclors have been weathered by long exposure in the environment. Therefore, the 8082 method provides procedures for the determination of selected individual PCB congeners and should be used depending on regulatory requirements and project needs. The PCB congener approach potentially affords greater quantitative accuracy when PCBs are known to be present. The congener method is of particular value in determining weathered Aroclors. Caution should be used when using the congener method where regulatory requirements are based on Aroclor concentrations.

	Approval Signatures	
Laboratory Director		Date: 3/6/00
Organic Laboratory Manager		Date: 3/6/00
Quality Assurance Manager		Date: 3/6/00

3. Summary of Method

- 3.1. Aqueous samples are extracted with methylene chloride in a separatory funnel. Soil samples are extracted in a methylene chloride:acetone (70:30) mixture by Dionex Accelerated Solvent Extractor (ASE). Cleanup techniques are applied as necessary. The extract may be treated with Florisil (3620B) or GPC (3640A) (for hydrocarbon removal), and/or copper (3660B) (for sulfur removal), and/or sulfuric acid (3665A) for the analysis of multicomponent Aroclors or congeners. The extract is exchanged into hexane and concentrated to the appropriate volume, usually 10 mL, for analysis. Alternatively, this method can be employed for lower detection limits by decreasing the final volume to 1-4 mL. The extract is analyzed on a gas chromatograph which is fitted with two capillary columns of differing polarities each employing separate detectors. The target analytes are resolved on each column and detected using an electron capture detector (ECD). Concentrations of congeners or aroclors are calculated from the ECD response using either external standard or internal standard techniques. Identification of the multiple peak components (Aroclors) are made by comparison to analytical standards.

4.0 Sample Handling and Preservation

- 4.1. Water samples are collected in a pre-cleaned 1-L amber glass bottle with a teflon-lined screw cap. Approximately one liter of sample is required for the analysis. Soil samples are collected in a pre-cleaned 250 mL glass jar with teflon-lined screw cap. Approximately 50 g of soil is required for the analysis although more may be collected to provide a representative sample, or to provide for additional QC samples, (MS/MSD analysis).
- 4.2. Samples should be preserved by cooling to 4°C. No chemical preservative is required, and would interfere with the analysis.
- 4.3. Water samples should be extracted within seven days of collection. Soil samples should be extracted within 14 days of collection. Sample extracts should be analyzed within 40 days of sample preparation.

5. General Points

- 5.1. Aroclors are multi-component mixtures. When samples contain more than one Aroclor, a higher level of analyst expertise is required to attain acceptable levels of qualitative and quantitative analysis. The same is true of Aroclors that have been subjected to environmental degradation ("weathering") or degradation by treatment technologies. Such weathered multi-component mixtures may have significant differences in peak patterns than those of Aroclor standards. Re-analysis of the sample and comparison/quantification to the PCB congener method may be more appropriate for very weathered samples.
- 5.2. The ECD is theoretically a halogen specific detector. However, phthalate esters can be a major source of contamination in that they do respond to the ECD. No forms of plastic or any material containing plasticizers (phthalates) should be used in conjunction with any part of this analysis. These materials can be removed through the use of Method 3665 (sulfuric acid cleanup).
- 5.3. Elemental sulfur is readily extracted from soil samples and may cause chromatographic interferences in the determination of PCBs. Sulfur can be removed through the use of Method 3660B.
- 5.4. Care must be taken to ensure a complete hexane exchange is performed on the extract, because residual methylene chloride would be an interferent in the analysis.
- 5.5. Oven-drying of glassware used for PCB analysis can increase contamination because PCBs are readily volatilized in the oven and spread to other glassware. Therefore, exercise caution, and do not dry glassware from samples containing high concentrations of PCBs with glassware that may be used for trace analyses, unless glassware has undergone meticulous cleaning.

6. Equipment and Reagents

- 6.1. Gas chromatograph - Programmable; heating range from 40°C to 325°C; splitless-type inlet system; electron capture detector (Hewlett-Packard HP 5890 Series II GC or similar).
- 6.2. Chromatography Column - A combination of two of the following.
 - 6.2.1 Restek's "RTX-1701" Stationary Phase, 30m length x 0.25mm ID, 0.25 µm film thickness - Restek Corporation, PN 10223, or equivalent.
 - 6.2.2 Restek's proprietary "RTX-CLPesticide 1" Stationary Phase, 30m length x 0.25mm ID, 0.25µm film thickness - Restek Corporation, PN 11123, or equivalent.
 - 6.2.3 Restek's "RTX-5" Stationary Phase, 30m length x 0.25mm ID, 0.25 µm film thickness - Restek Corporation, PN 10223, or equivalent.
 - 6.2.4 Restek's proprietary "RTX-CLPesticide 2" Stationary Phase, 30m length x 0.25mm ID, 0.20µm film thickness - Restek Corporation, PN 11323, or equivalent.
 - 6.2.5 Guard column, deactivated fused silica phenyl-methyl, 5 m x 0.25 mm ID. Restek PN 10045 or equivalent.
 - 6.2.6 The flow from the guard column can be split between the two analytical columns using a press tight Y-splitter. Restek PN 20405 or equivalent.
 - 6.2.7 Restek's proprietary "RTX-CLPesticide 1" Stationary Phase, 60m length x 0.25mm ID, 0.25µm film thickness - Restek Corporation, PN 11123, or equivalent.
 - 6.2.8 Restek's proprietary "RTX-CLPesticide 2" Stationary Phase, 60m length x 0.25mm ID, 0.20µm film thickness - Restek Corporation, PN 11323, or equivalent.
- 6.3. Data Acquisition System - Computerized system for collecting, storing, and processing detector output (Turbochrom, Perkin-Elmer).
- 6.4. Gases - High purity hydrogen and nitrogen.
- 6.5. Laboratory Supplies - Syringes, pipettes, autosampler vials, crimper, filter paper, glass filter, glass wool
 - 6.5.1 Uniliners for direct injection can be used to decrease the potential for breakdown of compounds in the injector in stead of the standard splitless liners. Uniliner is a product of Restek Corporation, PN 20838.
- 6.11. Reagents
 - 6.11.1 Methylene Chloride - Ultra-Resi. J.T. Baker is the vendor.
 - 6.11.2 Hexane - Ultra-Resi grade from J.T. Baker.
 - 6.11.3 Copper powder - Copper, fine granular Mallinckrodt 4649 or equivalent.
 - 6.11.4 HCL - prepared at a concentration of 1:1 (trace metal grade).
- 6.12. Analytical Standards
 - 6.12.1 Surrogate Spiking solution - Two surrogates will be used for the *Aroclor* method: 2,4,5,6-tetrachloro-m-xylene(TMx) and decachlorobiphenyl (DCB) (Restek PN 32000-500 at 200 µg/mL or

equivalent. To prepare the spiking solution add one mL of each 200 µg/mL stock into a 200 mL the flask. Bring to volume to make a 1000 ng/mL solution. 1 mL of this solution is spiked into each sample. The concentration in the final 10 mL extract will be 100 ng/mL. Alternatively, DBOB and BZ-198 may be substituted for surrogates.

6.12.2 Surrogate Spiking solution - two surrogates will be used for the *Congener* method and are commercially available from a variety of vendors: DBOB (4,4'-dibromooctafluorobiphenyl) at 100 ug/mL and BZ 198 (2,2',3,3',4,5,5',6-octachlorobiphenyl) at 100 ug/mL. To prepare the spiking solution, add 0.2 mL of BZ 198 and DBOB to a 200-mL volumetric flask and bring it up to volume in acetone, for a final concentration of 0.1 ug/mL. 1.0 mL of this solution is spiked into each sample, blank, matrix spike, spike duplicate and blank spike QC sample.

6.12.3 Matrix spiking solution - is commercially obtained from Accustandard at 1000 µg/mL. To prepare the spiking solution add 1 mL of the 1000 µg/mL solution to a 100 mL volumetric flask and bring it to volume. 1 mL of this solution is spiked into each matrix spike, spike duplicate and blank spike QC sample. The final concentration in a 10 mL extract will be 1 µg/mL. For congeners a representative subset may be chosen and is usually based on project specific requirements. The MS congener concentration will also reflect the project specific requirements.

6.12.4 *Aroclor* calibration standard solution - commercially available Aroclors are obtained at 100 µg/mL from Ultra Scientific.

Compound	Part Number
Aroclor 1016	PP-281
Aroclor 1260	PP-361
Aroclor 1221	PP-291
Aroclor 1232	PP-301
Aroclor 1242	PP-311
Aroclor 1248	PP-341
Aroclor 1254	PP-351

Aroclors 1016 and 1260 is combined into one standard called AR1660. Individual standards of all other Aroclors are prepared. The following tables describe the initial calibration standard preparation procedure. An intermediate dilution of the surrogate mix is made by diluting 1mL of ampule material with hexane to a 10mL final volume. This yields a concentration of 20 µg/mL. A minimum of 5 levels are analyzed for the curve although more levels may be analyzed.

8-Level Curve Preparation for Aroclors

Calibration Level	Aroclor Conc.	Surrogate Conc.	Volume of Std Added	Final Volume Diluted with Hexane
Stock	10 µg/mL	0.4 µg/mL	2.5 mL of ampul (100 µg/mL)	
(intermediate)	(10,000 µg/L)	(400 µg/L)	50 µL of surrogate ampul (200 µg/L)	25 mL
1*	0.02 µg/mL	0.0008 µg/mL	0.2 mL of Level 6 Std.	10 mL
2*	0.05 µg/mL	0.002 µg/mL	0.5 mL of Level 6 Std.	10 mL
3	0.10 µg/mL	0.004 µg/mL	1.0 mL of Level 6 Std.	10 mL
4*	0.25 µg/mL	0.01 µg/mL	2.5 mL of Level 6 Std.	10 mL
5	0.5 µg/mL	0.02 µg/mL	5 mL of Level 6 Std.	10 mL
6**	1.0 µg/mL	0.04 µg/mL	2.5 mL of stock	25 mL
7	2.5 µg/mL	0.1 µg/mL	2.5 mL of stock	10 mL
8	5 µg/mL	0.2 µg/mL	5 mL of stock	10 mL

*optional, additional levels.

** CCV Level

6.12.5 **Congener** Calibration standard solution – are custom or commercial mixes that vary in composition. The base list of components can be found in Table 1. Additional congeners may be added to this base list of targets. Additional targets must be run under the same GC conditions to document retention times on both analytical columns. Congeners may be added without additional method proficiency demonstration.

The following table describes the congener initial calibration standard preparation procedure. An intermediate dilution of the surrogate mix is made by diluting 1.25 mL of a 100 ug/mL standard in 25 mL of hexane. This yields a concentration of 5 ug/mL. A *high level* congener stock at 1 ug/mL is made by adding 0.25 mL of the congener components at 100 ug/mL to a 25-mL volumetric flask brought up to volume in hexane.

Multi-Level Calibration Solution Preparation for Congeners and Surrogates

Calibration Level	Analyte Conc. ng/mL	Surrogate Conc. ng/mL	Volume of Std Added	Volume in Hexane
Level 1	1	1	.05 mL of Level 8 standard	10 mL
Level 2	5	5	.25 mL of Level 8 standard	10 mL
Level 3	10	10	.50 mL of Level 8 standard	10 mL
Level 4	20	20	.2 mL of Cong stock std and 0.04 mL of Surr. stock	10 mL
Level 5	50	50	.5 mL of Cong stock std and 0.1 mL of Surr. stock	10 mL
Level 6	100	100	1 mL of Cong stock std and 0.2 mL of Surr. stock	10 mL
Level 7	150	150	1.5 mL of Cong stock std and 0.3 mL of Surr. stock	10 mL
Level 8	200	200	2 mL of Cong stock std and 0.4 mL of Surr. stock	10 mL

8 levels are described, however a minimum 5 levels are required for initial calibration.

6.12.6 **Internal Standard Spiking solution** - one internal standard will be used for this method: BZ 192. Prepare a spiking solution so that a 20-uL spike into the sample extract prior to analysis, will produce a mid-calibration range response at 50 ng/mL in final sample extract.

7. Procedure

7.1 Instrument Setup

7.1.1. The instrument used for the analysis is a HP 5890A Series II gas chromatograph or a Perkin-Elmer Autosys. The HP system is equipped with a splitless injector, 7673-type autosampler, and ECD. The instrument is interfaced to the Perkin-Elmer Turbochrom data system for control of the instrument and acquisition of the detector response.

7.1.2. The GC columns used are a combination of two differing phase columns listed in the equipment section. The helium flow or hydrogen is at 10 mL/min.

7.1.3. The basic GC parameters are as follows for Aroclor analysis:

Injector A Temp	220°C
Detector Temp	370°C (PE) or 300°C (HP)
Hold. Time	0.1 minutes
Oven Temp	155°C
Initial Value	180°C

Initial Time	1 minute
Rate	10°/minute to 200°C
Rate	4°/minute to 280°C
Final Value	300°C
Final Time	0 minutes
Purge/Valve A <u>ON</u>	0.6 minutes
Run Time	20.0 minutes

7.1.4 The basic GC parameters are as follows for Congener analysis:

Injector A Temp	220°C (PE) or 250°C (HP)
Detector Temp	320°C (PE) or 300°C (HP)
Hold. Time	0 minutes
Oven Temp	160°C
Initial Value	160°C
Initial Time	0 minute
Rate	20°C/minute to 197°C
Rate	0.5°C/minute to 210°C
Rate	5.0°C/minute to 270°C
Final Value	270°C
Final Time	7 minutes
Purge/Valve A <u>ON</u>	0.6 minutes
Run Time	46.85 minutes

7.1.5 Establish daily retention time windows as the retention time of the component in the opening verification standard $\pm$.05, .07, or .10 minutes as listed in Table 2. Retention time windows are calculated each time a new GC column is installed. The windows given in Table 2, established by the Contract Laboratory Program based on analysis of real-life environmental samples, are compared with the laboratory calculated windows.

7.2 Initial Calibration

7.2.1 The method of external standard calibration is used for *Aroclor* analysis. The response of each individual peak and the total response of the PCB in the sample is compared to a calibration curve to determine the analyte concentration in the sample. The calibration curves are generated during initial calibration through the analysis of standards which define the working range of the method.

7.2.2 The following analytical sequence order should be followed for initial calibration of the system. The primer is used at the beginning of the analysis sequence to ensure all sites of activation in the system have been covered or deactivated prior to performing trace level analysis. The sequence below is a general sequence for determination of PCBs as Aroclors and uses a minimum of 5 levels for AR1660 and a single-point initial calibration for the remaining Aroclors near the midpoint of the expected calibration range.

7.2.2.1 For projects where only a few Aroclors are of interest, the analyst may employ a five point initial calibration for each of the Aroclors of interest (i.e. 5 standards for AR1232), and not use the AR1660 mixture or the single point calibration of the other Aroclors.

1. Primer - (10 times more concentrated than Level 3)
2. Hexane
3. AR1660 Level 1
4. AR1660 Level 2
5. AR1660 Level 3
6. AR1660 Level 4
7. AR1660 Level 5

8. Hexane
9. Independent check
10. Hexane
11. AR1221 -1000 ng/mL
12. AR1232 -1000 ng/mL
13. AR1242 -1000 ng/mL
14. AR1248 -1000 ng/mL
15. AR1254 -1000 ng/mL
16. Hexane

7.2.3. Inject 1-2 μ L of each standard into the GC operated in the splitless mode for trace analyses. Evaluate the standard chromatograms for all compounds contained within the calibration standards.

7.2.4. Using the GC system software (Turbochrom), the analyst must choose 3-5 peaks from the pattern which are characteristic of the Aroclor and are the least subject to degradation and weathering to obtain the response for the component of interest. Choose peaks that are at least 25% of the height of the largest Aroclor peak, the set of 3 to 5 peaks should include at least one peak that is unique to that Aroclor. Use at least 5 peaks for the AR1660, none of which should be found in both. Tabulate the peak area for each analyte against the mass injected of the analyte in the standard analyzed to obtain a calibration curve for each analyte across the working range of the method.

7.2.5. Calibration factors are determined for individual peaks: Choose 3 to 5 peaks in the standard to calculate a calibration factor for that Aroclor. These calibration factors are then used to calculate the concentration of each corresponding peak in the sample chromatogram. The 3 to 5 resulting concentrations are averaged to provide the final result for the sample.

7.2.6. The method of internal standard calibration is used for *Congener* analysis. The response of each individual peak to the corresponding internal standard is determined in the curve to determine the analyte concentration in the sample. The calibration curves are generated during initial calibration through the analysis of standards, which define the working range of the method.

7.2.7. The following analytical sequence order should be followed for initial calibration of the system. The primer is used at the beginning of the analysis sequence to ensure all sites of activation in the system have been deactivated prior to performing trace level analysis. The sequence below is a general sequence for determination congeners.

Congener Sequence

1. Primer - (20 times more concentrated than Level 3)
2. Hexane
3. PEM
4. Hexane
5. Level 1
6. Level 2
7. Level 3
8. Level 4
9. Level 5
10. Level 6
11. Level 7
12. Level 8
13. Hexane
14. Toxaphene (100 ng/mL – if required per project specs.)
15. Independent Check
16. Hexane

7.2.8. Inject 1 or 2 μ L of each standard into the GC operated in the splitless mode for trace analyses. Evaluate the standard chromatograms for all compounds contained within the calibration standards.

7.2.9. Using the GC system software, the analyst must choose the correct retention time for all analytes on both columns.

7.2.10. For all compounds, a linear regression model (first order) is employed, provided that the coefficient of determination (COD or r^2) is ≥ 0.99 . Otherwise, construct a nonlinear calibration of no more than a third order equation. Statistical considerations in developing a non-linear calibration model require more data than the more traditional linear approach. A quadratic (second order) model requires six standards, and a third order polynomial requires seven standards. In setting model parameters, do not force the line through the origin. The COD or r^2 must be ≥ 0.99 . The analyst should select the regression order which introduces the least calibration error into the quantitation.

*Alternatively, %RSD must be less than 20%. If one or more peaks have %RSD greater than 20%, the calibration may still be acceptable if the average %RSD for all analytes in the calibration curve is less than 20%.

7.2.11. If the curve does not meet criteria, the analyst should check the calculation of the standard preparation that was performed. If the problem appears to be isolated to a single calibration standard, that standard may be reanalyzed and the COD may be recalculated. If chromatographic problems are indicated by the standard chromatograms already analyzed, then the injection port should be serviced. This consists of cutting 6 to 12 inches off of the injector end of the column, changing the liner, glass wool and the septa. The detector may be cleaned by raising it to 380°C for the HP GC or 425°C for the Autosys GC for 4 hours or overnight. This may be done with the column removed from the detector and the detector base capped. The make-up gas must be on when the detector is heated. If this does not resolve the problem the column should be replaced and curves re-analyzed.

7.2.12. Reference standards (AR1660 mixture for Aroclors and a chosen subset for Congeners) must be from a separate source or different lot are analyzed after every initial calibration for evaluation against calibration standard solutions. %Difference should not be greater than 15%.

7.3. Continuing Calibration

7.3.1. The calibration must be verified with the analysis of the CCV (mid-level concentration) each day at the beginning of the run and each twelve hour shift, or once every 20 samples, whichever is more frequent. However, it is recommended that the CCV is run every ten samples to minimize the number of samples requiring reanalysis. The general daily calibration sequence is as follows:

1. Primer - (20 times more concentrated than Level 3)
2. Hexane
3. AR1660/Mid-Level Congener Std. - CCV
4. Toxaphene (100 ng/mL - if required per project specs.)
5. Hexane
6. 10 samples
7. Hexane
8. AR1660/ Mid-Level Congener Std - CCV
9. Hexane
10. 10 samples
11. Hexane
12. AR1660/ Mid-Level Congener Std - CCV

7.3.2. Establish daily retention time windows as the retention time of the component in the opening verification standard $\pm$ window from Table 1.

7.3.3. Calculate the %Difference (%D) for each analyte in the verification standard relative to the initial calibration curves. If the %D $\leq \pm 15\%$, sample analysis may take place following this verification standard. If the %D $> \pm 15\%$ for Aroclors and %D $> \pm 25\%$ for individual congeners, the CCV may still be acceptable if

ALL components (regardless of whether they have been targeted for a specific project) had an average %D of $\leq \pm 15\%$. If a noncompliant analyte exhibits an increase in response in the noncompliant CCV and is not detected in the associated samples, the analyses may be reported and the CCV noncompliance narrated. In this case CCV data or a detailed narrative must be provided to the client. Otherwise, corrective action must take place. See the calculations section for the %Difference calculation. (*Note:* For USACOE work, all target compounds will be monitored at $\pm 15\%$.)

7.3.3.1 Corrective Action: If the verification is the beginning standard of the sequence, corrective action may consist of prepping the injection port (replace injection liner, clip column and replace septa) and re-analysis of the standard. If, after re-analyzing the standards, the acceptance criteria are still not met, a new initial calibration must be performed. The system must be in-control with all calibration criteria before sample analysis may proceed.

7.3.3.2 Corrective Action: If the CCV is a closing CCV, the data for the samples run before this CCV may be evaluated for hits. If there are no hits for the compounds that did not meet %D criteria, those samples do not need to be reanalyzed provided that the analyte had increased and would have been detected in the sample if it were present.

7.3.3.3 Corrective Action: The CCV may be reanalyzed once, if %D criteria is still not met, then a new initial calibration must be analyzed following any necessary instrument maintenance. Samples associated with the unacceptable CCV should be reanalyzed.

7.3.4. The analyst judgment from continuous daily use of the instrument is important in determining the validity of a continuing calibration. Even if the %D criteria are met, the peak shape may have deteriorated to a point where maintenance is required and a new initial calibration is in order. Both columns should meet QC criteria, however, they may be evaluated with the above corrective actions in mind.

7.3.5. Confirmation for Aroclor analysis may not be necessary if the composition of the sample matrix is well established by prior analysis, for instance, when a PCB is known to be produced or used in a facility is found in a sample from that facility.

7.4. Sample Analysis

7.4.1. Analyze extracts using the same experimental conditions used for the analysis of the calibration standards. Ensure that calibration verification standards are interspersed, at least, every 20 samples or every 12 hour period. Area measurements should all be to baseline unless an unresolved complex mixture (UCM) is observed, in which case, the areas measured should skim the top of the UCM.

7.4.2. Qualitative identification of multicomponent analytes (Aroclors) requires pattern matching between the calibration standards and the response observed in the sample on both columns. Retention time windows should be used as a gauge; however, pattern recognition for the multicomponent analytes is most important. Qualitative identification for Congeners is made when a peak in a sample is observed within the retention time window for a calibrated analyte on both columns. In other words, an analyte is not considered present in a sample unless the analyte is detected on both columns within the retention time windows for that analyte established during calibration.

7.4.3. For samples with PCB Aroclors positively identified on both columns, compare the responses of the 3 to 5 major peaks in the single point calibration standard for that Aroclor with the peaks observed in the sample extract. The relative peaks and number of peaks in the sample should be similar to that observed in the standard; however, degradation, weathering and interferences may cause the sample pattern to differ from that observed from the standard. The peaks chosen for quantitation must be free from interferences. Calculate the concentration of each corresponding peak in the sample chromatogram and the 3 to 5 resulting concentrations are averaged to provide the final result for the sample.

7.4.4. If 5 levels of the AR1660 mixture was used to describe the linear range of the instrument, the single point calibration standard must follow the same calibration model. Also, because one can only perform a

linear (point to point) calibration for a single point calibration, then the AR1660 curve must also use a point to point calibration.

7.4.5. Calculate the relative percent difference (RPD) between compound concentrations on both columns using the calculation in section 8.6. If the calculated RPD is >40%, check the chromatograms to see if an overlapping peak is causing an erroneously high result. If no overlapping peaks are noted, examine baseline parameters established by the data system (or operator) during peak integration.

- *If no anomalies are noted, review the chromatographic conditions. If there is no evidence of chromatographic problems, report the higher result. This approach is conservative relative to protection of the environment. The disparity between the two columns should be noted by a P qualifier.
- *If the high RPD is clearly the result of an interferent on one of the columns, the lower result may be reported.

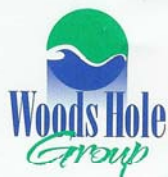
7.4.6. Calculate the recovery for the surrogates TMX and DCB for Aroclors, and DBOB and BZ 198 for Congeners, in each field, blank, and quality control sample extract on both columns. Calculate the recovery of the matrix spike and LCS compounds in the appropriate samples on both columns.

7.4.7. Evaluate whether or not a dilution of an extract is needed by ensuring that all target PCBs areas measured fall within the calibration range of the instrument. If the range is exceeded, a dilution analysis is required. Dilute the extract to bring the out-of-range component(s) to within 50-100% of the full calibration range. Also evaluate the sample chromatogram for possible saturation of the detector.

7.4.8. If a dilution analysis is made, compare this run to the initial analysis to ensure that the chromatography is similar, that compound detection is similar, and that the reported values for detected compounds make sense (i.e., that the final value for any compound detected in both analyses is about the same value). If the dilution run is not comparable to the initial run, corrective action should take place.

7.4.8.1 **Corrective Action:** Re-evaluate both analyses (un-diluted and diluted) ensuring that integration of all peaks was performed properly and that the correct calibration curves were used for quantitation. Determine whether or not the results are off by a systematic bias which might be indicative of a poor injection or of an inaccurate dilution. If the initial run's injection is determined to have been poor and if this analysis does not need to be reported to the client (based on project specific requirements) then the results of the dilution analysis only should be reported to the client (unless there are special project requirements to report data at specific reporting limits). If an inaccurate dilution is suspected, a new dilution of the extract should be made and this second dilution analyzed. The results from all three runs should be compared to verify the corrective action and to determine which result should be reported to the client.

7.4.8.2 Reporting of the results for a sample where two different dilution analyses are conducted, depends upon the results of the two runs. If an initial analysis detects a compound that is non-detected in the dilution run, and if the initial result was reported at less than or equal to twice the reporting limit for that compound, only the second analysis should be reported. If however, the initial run has a compound at a concentration greater than twice the reporting limit but it is non-detected in the dilution analysis, the data for both runs should be reported to the client. In this case, a single data sheet should be prepared for reporting the sample with all components reported from the initial run except for the over-range component, which should be reported from the dilution run with a flag indicating that this was the case. The project narrative must accurately explain how the data are reported whether one or two data sheets are used to report one sample.



ANALYTICAL REPORT

Prepared for:

**MyKro Waters, Inc
2132 Main Street
P.O. BOX 1088
Concord, MA 01742**

Project: PCB Tissue
ETR: 0404122
Report Date: May 11, 2004

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CASE NARRATIVE

Woods Hole Group Environmental Laboratories

ETR: 0404122
Project: PCB Tissue

The enclosed results of analyses are representative of the sample extracts as received by the laboratory. Woods Hole Group Environmental Laboratories makes no representations or certifications as to the method of sample collection, sample identification, sample preparation, sample extraction or transporting/handling procedures used prior to the receipt of samples by Woods Hole Group Environmental Laboratories.

Polychlorinated Biphenyls by 8082

1. Sample extracts received from the client were analyzed for Polychlorinated Biphenyls as Aroclors. For reporting purposes the final volume used was the volume of hexane extract listed in the client procedure, which could potentially be slightly biased due to the miscible nature of the water/methanol/hexane mixture. The sample amount is the actual weight of tissue documented by the client, or if just a clamshell leachate, the amount is one shell and the solvent extract was analyzed and reported based as $\mu\text{g}/\text{shell}$. All sample extracts were sulfuric acid cleaned prior to analysis, which diminished the usable solvent volume, requiring all samples except T12A (0404122-23) to be diluted by a factor of two prior to analysis. An aliquot of hexane solvent was brought through this acid cleaning process, analyzed in the same manner as the samples and reported as method blank, PT042204B24. The date-extracted field reflects a date of 4/22/04, which corresponds to the date samples were scheduled for analysis. The actual date of sample preparation, which was performed by the client, is unknown.

To the best of my knowledge, the information contained in this report is accurate and complete.

Approved by: *Sandra B. Gibson* Title: *Sr. Project Manager* Date: *05-11-04*

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Woods Hole Group Environmental Laboratories, 375 Paramount Drive, Suite 2, Raynham, MA 02767, 508-822-9300, whale@whgrp.com



Sample ID Cross Reference

Client: MyKro Waters, Inc
Project: PCB Tissue

Lab Code: MA00030
ETR: 0404122

Lab Sample ID	Client Sample ID
0404122-01	T6A LG
0404122-02	T4C
0404122-03	T8C
0404122-04	TA8
0404122-05	T6C
0404122-06	T3A
0404122-07	T22C LIVE
0404122-08	T11C
0404122-09	T13D
0404122-10	T5A
0404122-11	T32B
0404122-12	T3C
0404122-13	T17D
0404122-14	T11A LIVE CRASS
0404122-15	T11B
0404122-16	T18C
0404122-17	T22C MAY
0404122-18	T2A
0404122-19	T10A COARSE
0404122-20	T22A
0404122-21	T19D
0404122-22	T5C
0404122-23	T12A
0404122-24	T15C
0404122-25	T6A MB LIVE
0404122-26	T10A LG
0404122-27	T9
0404122-28	T17B
0404122-29	T12D



Sample ID Cross Reference

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**

Lab Code: **MA00030**
ETR: **0404122**

Lab Sample ID

Client Sample ID

0404122-30

T4C MB LIVE



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T6A LG**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-01**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/28/04	100	1.00	0.5	2	CMF

Parameter	Result
Aroclor 1016	0.020 U
Aroclor 1221	0.020 U
Aroclor 1232	0.020 U
Aroclor 1242	0.020 U
Aroclor 1248	0.020 U
Aroclor 1254	0.020 U
Aroclor 1260	0.020 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:36



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T4C**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-02**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/28/04	100	1.07	1	2	CMF

Parameter	Result
Aroclor 1016	37 U
Aroclor 1221	37 U
Aroclor 1232	37 U
Aroclor 1242	37 U
Aroclor 1248	37 U
Aroclor 1254	37 U
Aroclor 1260	37 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T8C**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-03**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/28/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:36

375 Paramount Drive, Suite 2, Raynham, Massachusetts 02767, (508) 822-9300, Fax (508) 822-3288, whale@whgrp.com



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **TA8**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-04**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/28/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:36



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T6C**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-05**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/28/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:36



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T3A**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-06**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/28/04	100	0.79	0.5	2	CMF

Parameter	Result
Aroclor 1016	25 U
Aroclor 1221	25 U
Aroclor 1232	25 U
Aroclor 1242	25 U
Aroclor 1248	25 U
Aroclor 1254	25 U
Aroclor 1260	25 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:36



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T22C LIVE**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-07**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

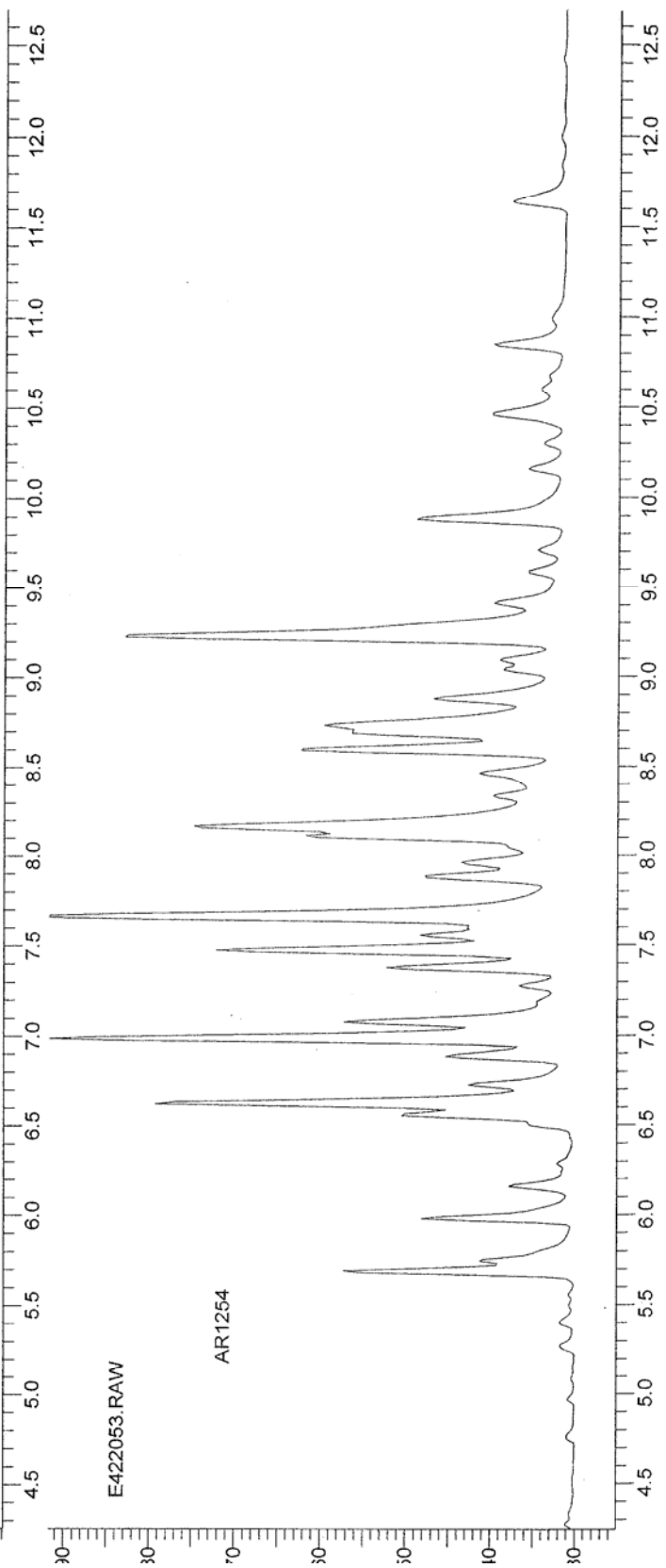
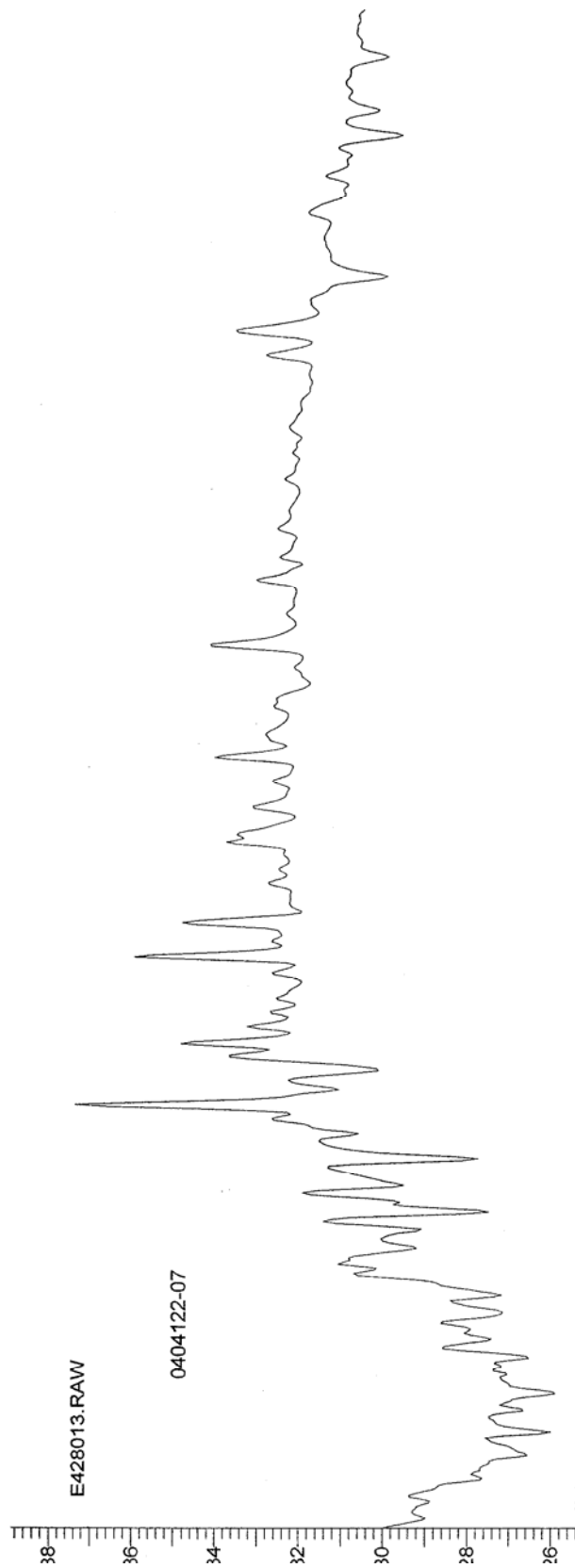
Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	0.5	2	CMF

Parameter	Result
Aroclor 1016	0.020 U
Aroclor 1221	0.020 U
Aroclor 1232	0.020 U
Aroclor 1242	0.020 U
Aroclor 1248	0.020 U
Aroclor 1254	0.056 P
Aroclor 1260	0.020 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

P - Greater than 40% RPD between the two columns, the higher value is reported according to the method.
U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
 Project: **PCB Tissue**
 Client ID: **T11C**
 Case: **N/A** SDG: **N/A**
 Matrix: **Shell**

Lab Code: **MA00030**
 ETR: **0404122**
 Lab ID: **0404122-08**
 Associated Blank: **PT042204B24**
 Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
 N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T13D**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-09**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.05	0.5	2	CMF

Parameter	Result
Aroclor 1016	400 U
Aroclor 1221	400 U
Aroclor 1232	400 U
Aroclor 1242	400 U
Aroclor 1248	400 U
Aroclor 1254	400 U
Aroclor 1260	400 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T5A**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-10**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	0.5	2	CMF

Parameter	Result
Aroclor 1016	0.020 U
Aroclor 1221	0.020 U
Aroclor 1232	0.020 U
Aroclor 1242	0.020 U
Aroclor 1248	0.020 U
Aroclor 1254	0.020 U
Aroclor 1260	0.020 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T32B**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-11**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.10	0.5	2	CMF

Parameter	Result
Aroclor 1016	200 U
Aroclor 1221	200 U
Aroclor 1232	200 U
Aroclor 1242	200 U
Aroclor 1248	200 U
Aroclor 1254	200 U
Aroclor 1260	200 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T3C**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-12**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T17D**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-13**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.07	0.5	2	CMF

Parameter	Result
Aroclor 1016	290 U
Aroclor 1221	290 U
Aroclor 1232	290 U
Aroclor 1242	290 U
Aroclor 1248	290 U
Aroclor 1254	290 U
Aroclor 1260	290 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T11A LIVE CRASS**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-14**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
 Project: **PCB Tissue**
 Client ID: **T11B**
 Case: **N/A** SDG: **N/A**
 Matrix: **Tissue**

Lab Code: **MA00030**
 ETR: **0404122**
 Lab ID: **0404122-15**
 Associated Blank: **PT042204B24**
 Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.54	3.5	2	CMF

Parameter	Result
Aroclor 1016	260 U
Aroclor 1221	260 U
Aroclor 1232	260 U
Aroclor 1242	260 U
Aroclor 1248	260 U
Aroclor 1254	840
Aroclor 1260	260 U

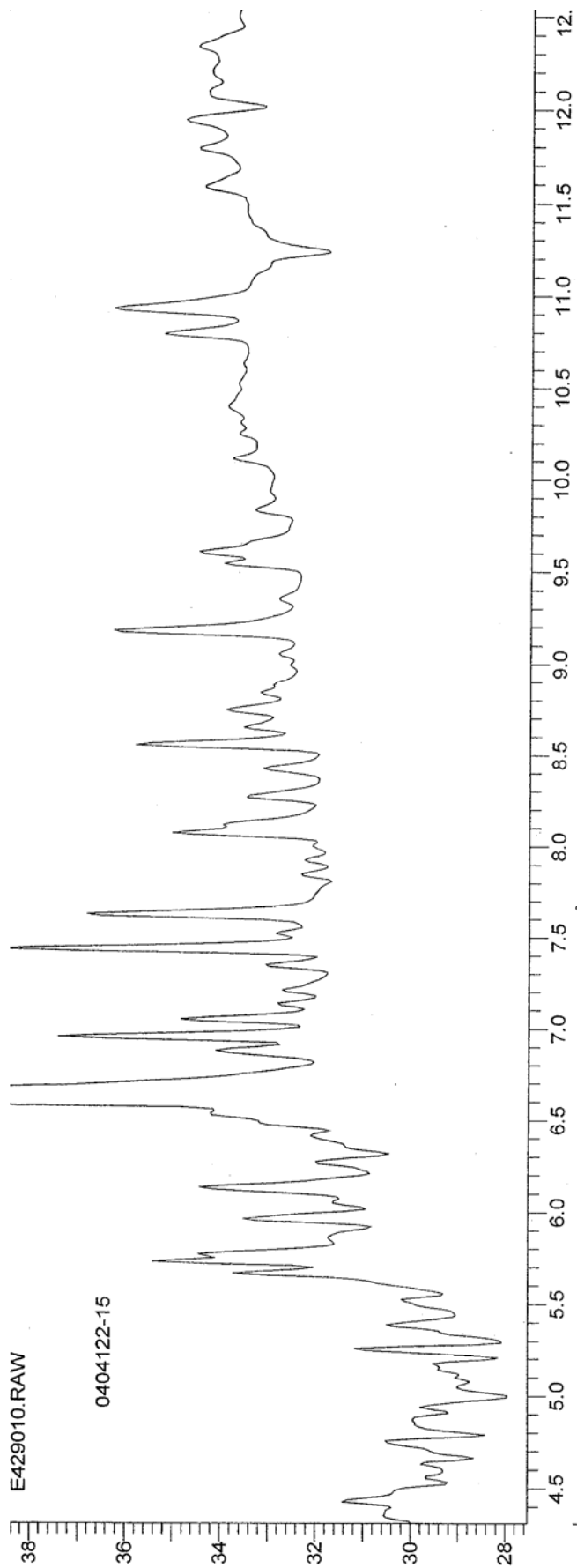
Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
 N/A - Not Applicable

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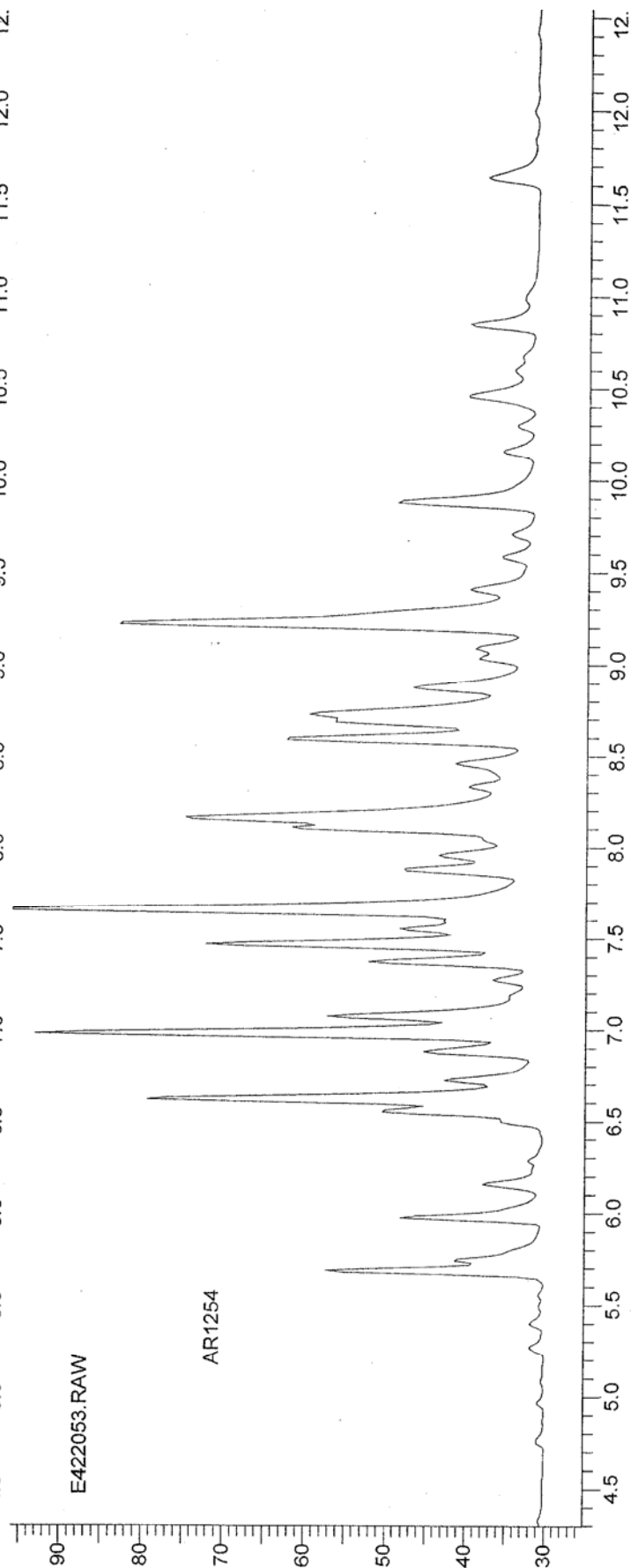
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0404122-15



E422053.RAW

AR1254





Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
 Project: **PCB Tissue**
 Client ID: **T18C**
 Case: **N/A** SDG: **N/A**
 Matrix: **Tissue**

Lab Code: **MA00030**
 ETR: **0404122**
 Lab ID: **0404122-16**
 Associated Blank: **PT042204B24**
 Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.04	0.5	2	CMF

Parameter	Result
Aroclor 1016	500 U
Aroclor 1221	500 U
Aroclor 1232	500 U
Aroclor 1242	500 U
Aroclor 1248	500 U
Aroclor 1254	500 U
Aroclor 1260	500 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
 N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T22C MAY**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-17**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.46	1	2	CMF

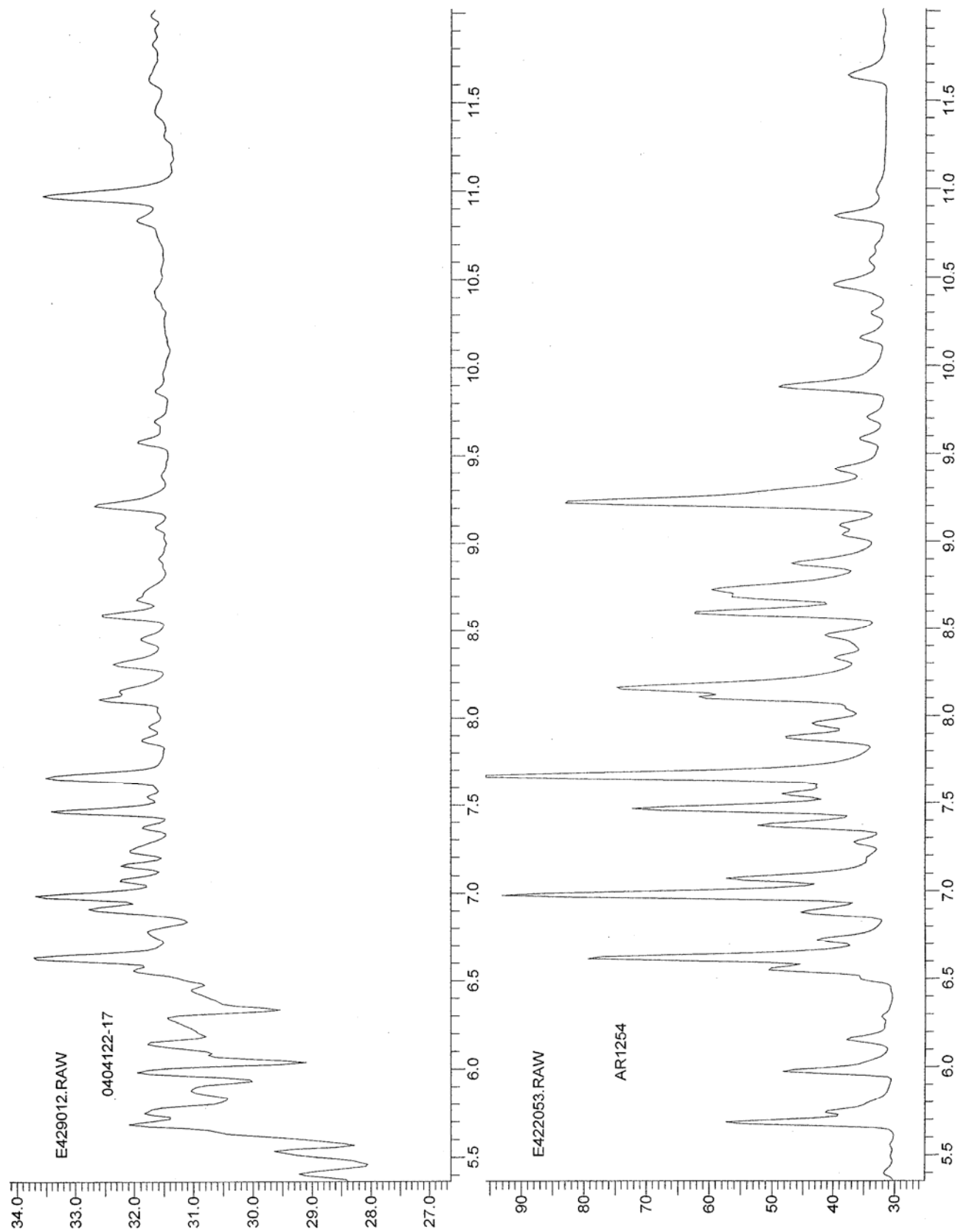
Parameter	Result
Aroclor 1016	87 U
Aroclor 1221	87 U
Aroclor 1232	87 U
Aroclor 1242	87 U
Aroclor 1248	87 U
Aroclor 1254	200
Aroclor 1260	87 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T2A**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-18**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: MyKro Waters, Inc
Project: PCB Tissue
Client ID: T10A COARSE
Case: N/A SDG: N/A
Matrix: Shell

Lab Code: MA00030
ETR: 0404122
Lab ID: 0404122-19
Associated Blank: PT042204B24
Concentration Units: µg/Shell

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T22A**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-20**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

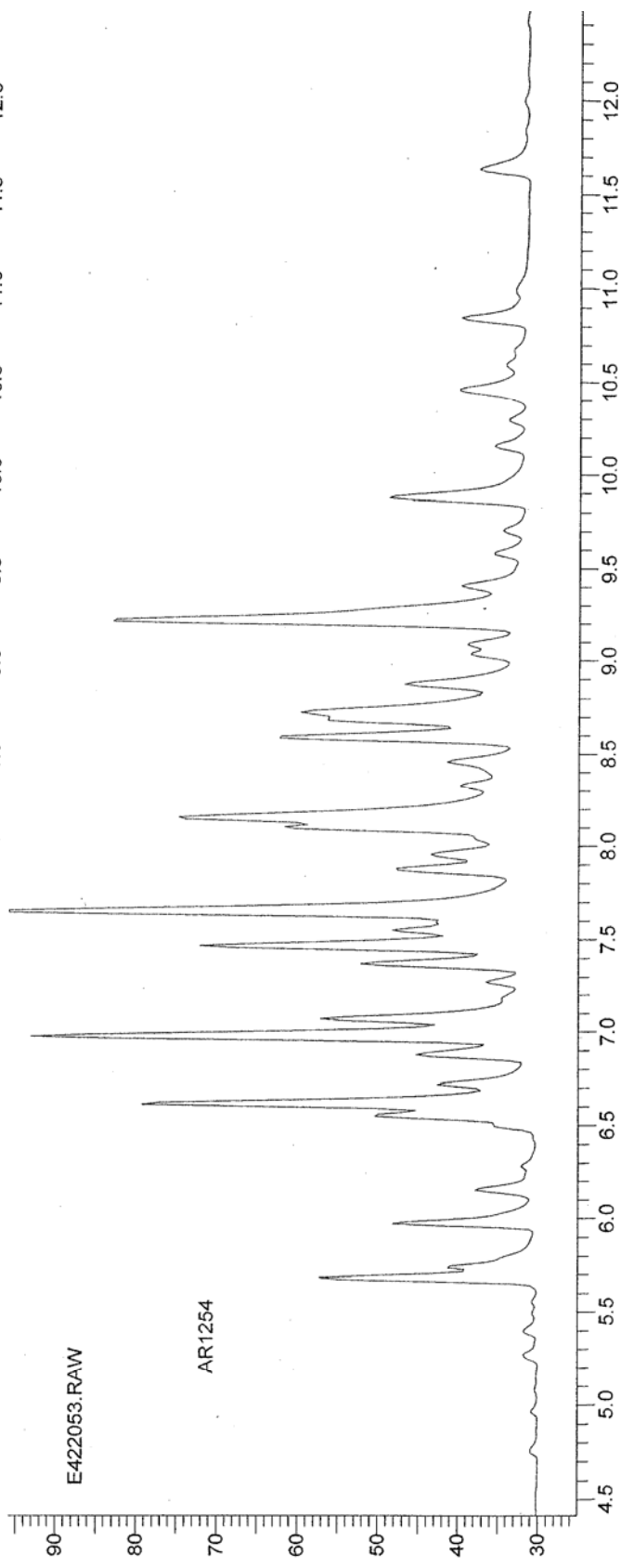
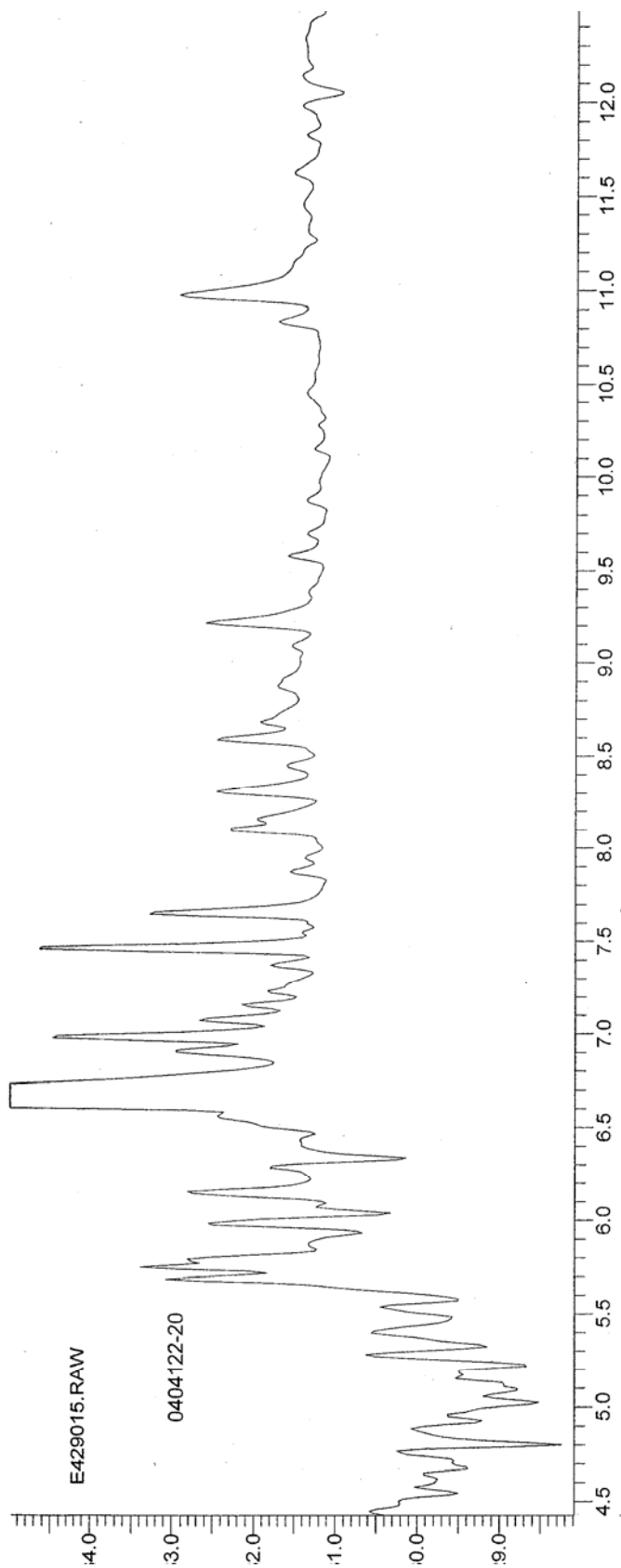
Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.49	0.5	2	CMF

Parameter	Result
Aroclor 1016	41 U
Aroclor 1221	41 U
Aroclor 1232	41 U
Aroclor 1242	41 U
Aroclor 1248	41 U
Aroclor 1254	84
Aroclor 1260	41 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T19D**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-21**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

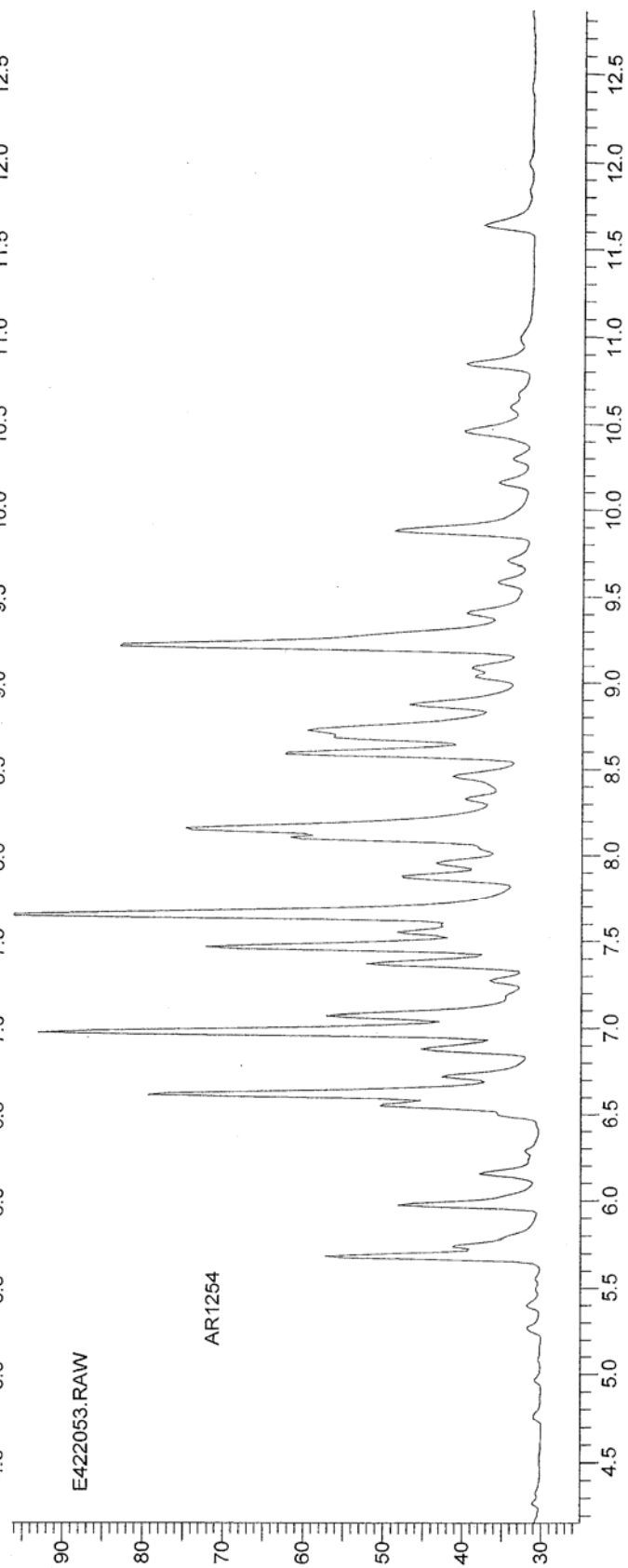
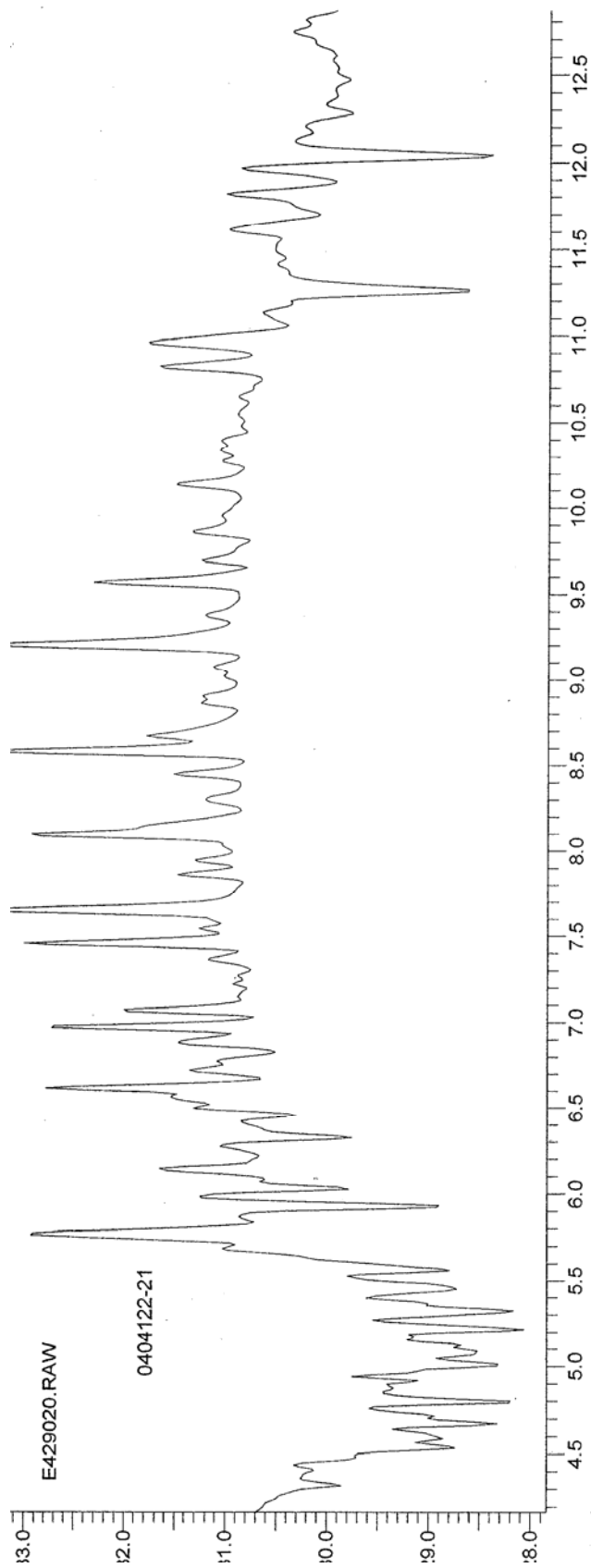
Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.12	0.5	2	CMF

Parameter	Result
Aroclor 1016	170 U
Aroclor 1221	170 U
Aroclor 1232	170 U
Aroclor 1242	170 U
Aroclor 1248	170 U
Aroclor 1254	340
Aroclor 1260	170 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
 Project: **PCB Tissue**
 Client ID: **T5C**
 Case: **N/A** SDG: **N/A**
 Matrix: **Tissue**

Lab Code: **MA00030**
 ETR: **0404122**
 Lab ID: **0404122-22**
 Associated Blank: **PT042204B24**
 Concentration Units: **µg/Kg**

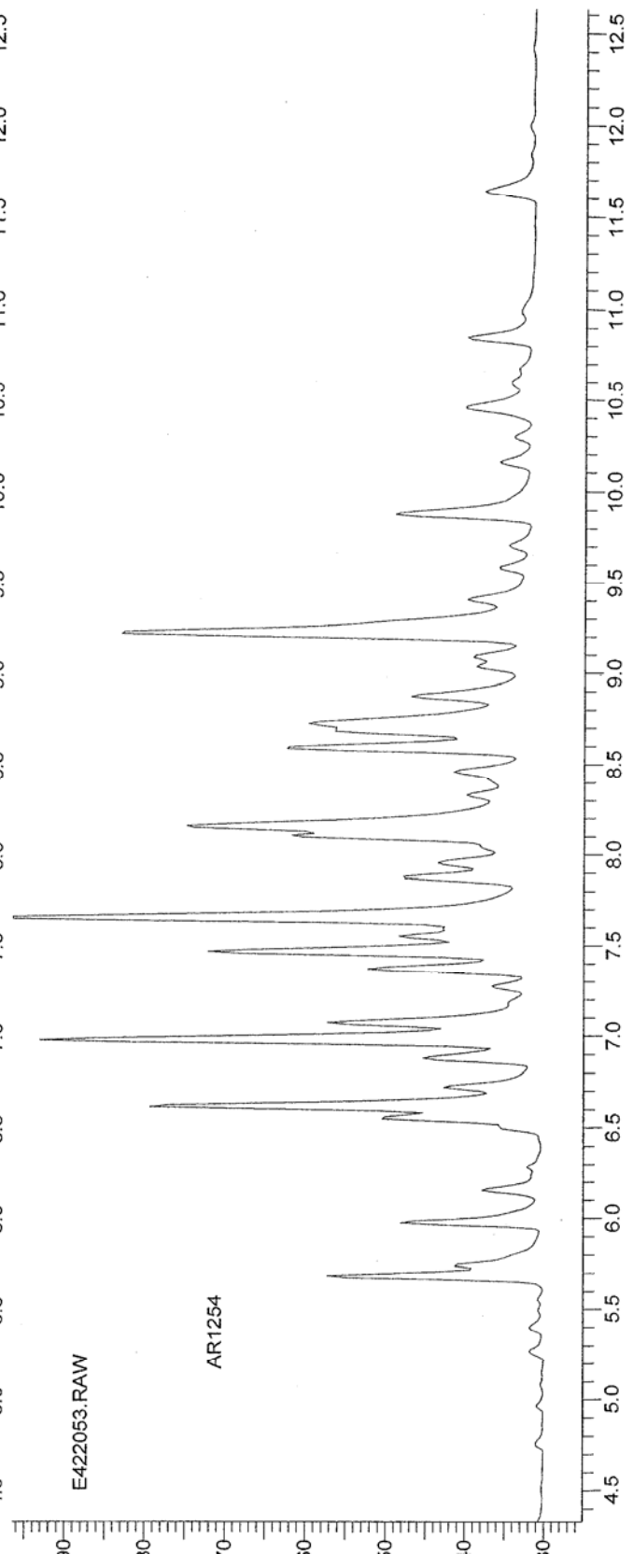
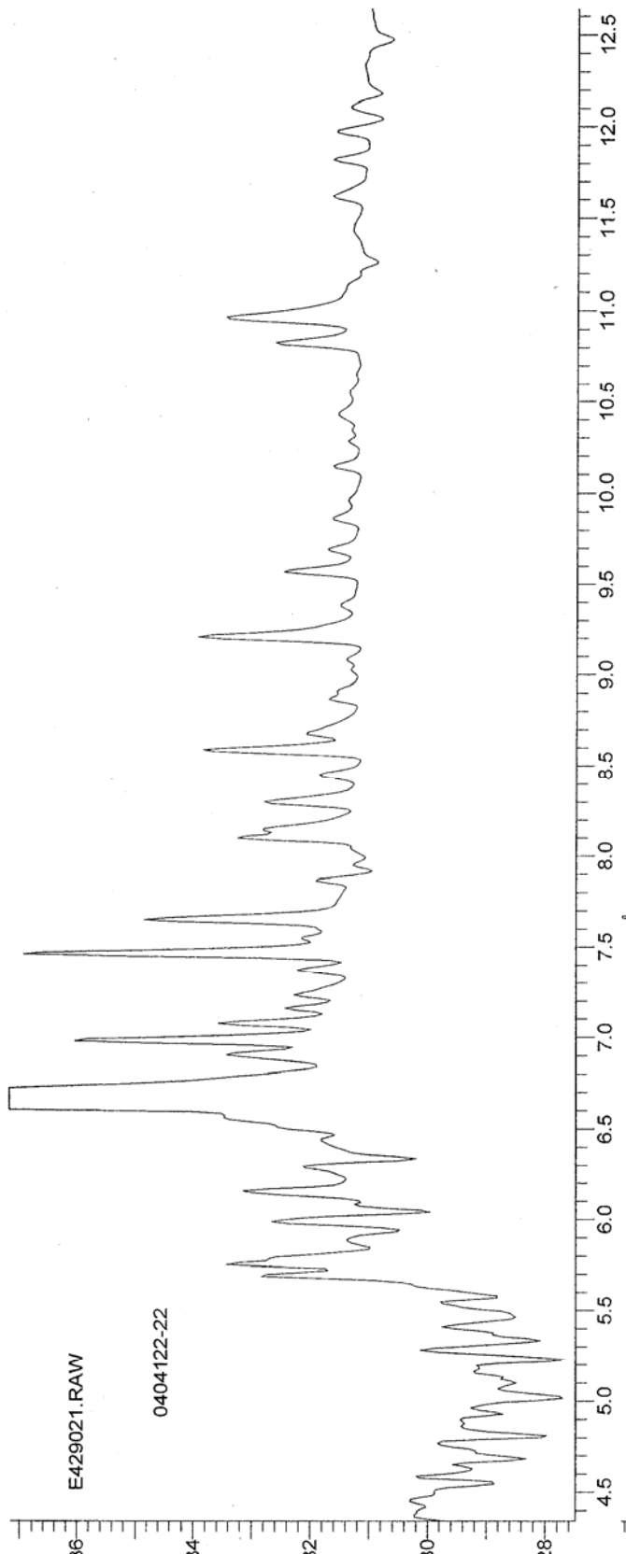
Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.58	1	2	CMF

Parameter	Result
Aroclor 1016	69 U
Aroclor 1221	69 U
Aroclor 1232	69 U
Aroclor 1242	69 U
Aroclor 1248	69 U
Aroclor 1254	150
Aroclor 1260	69 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
 N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T12A**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-23**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/29/04	100	0.19	1	1	CMF

Parameter	Result
Aroclor 1016	100 U
Aroclor 1221	100 U
Aroclor 1232	100 U
Aroclor 1242	100 U
Aroclor 1248	100 U
Aroclor 1254	100 U
Aroclor 1260	100 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T15C**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-24**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Kg**

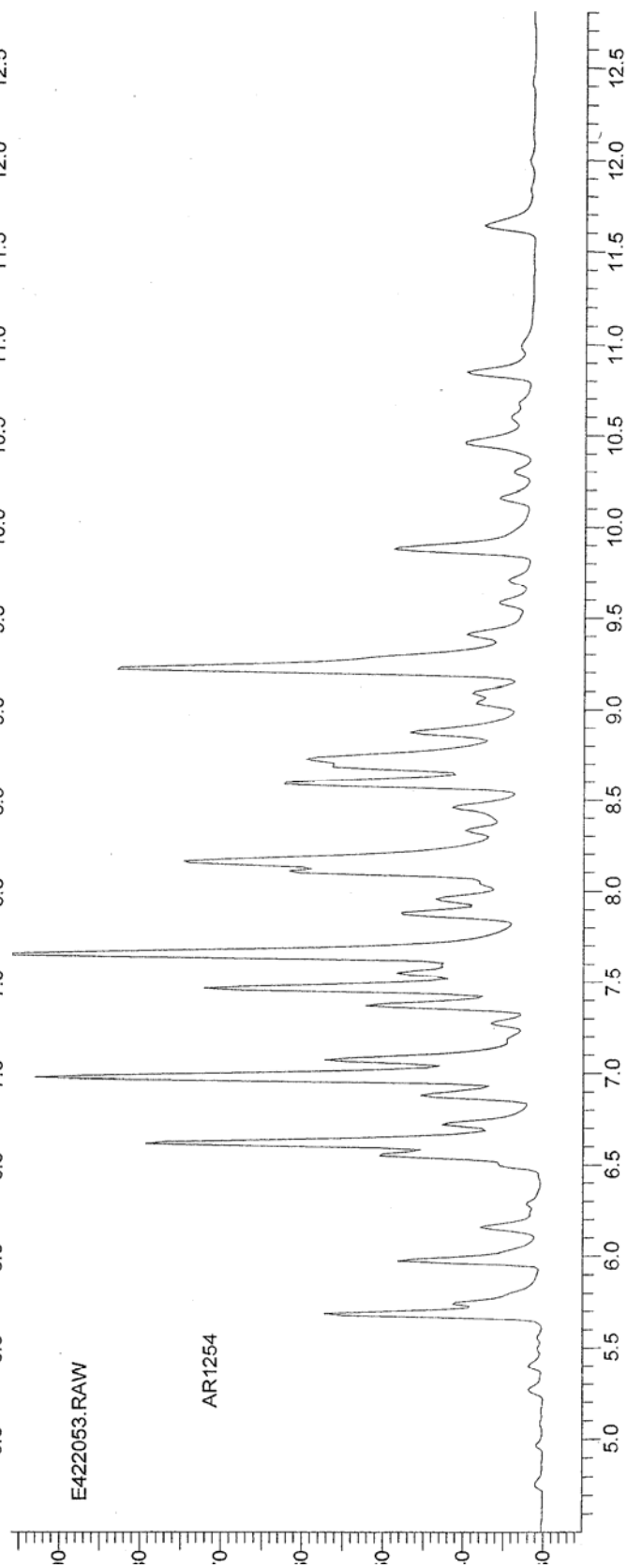
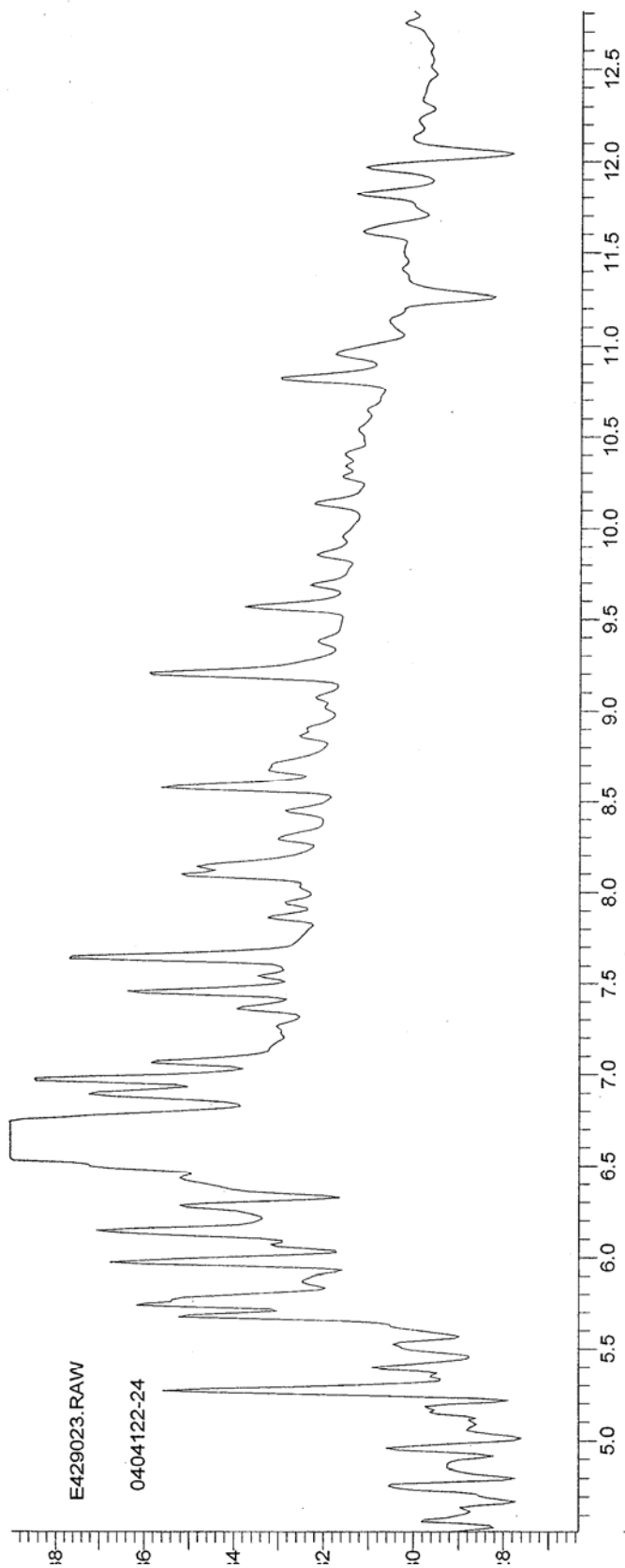
Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	0.08	0.5	2	CMF

Parameter	Result
Aroclor 1016	250 U
Aroclor 1221	250 U
Aroclor 1232	250 U
Aroclor 1242	250 U
Aroclor 1248	250 U
Aroclor 1254	770
Aroclor 1260	250 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T6A MB LIVE**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-25**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	1.00	1.5	2	CMF

Parameter	Result
Aroclor 1016	0.060 U
Aroclor 1221	0.060 U
Aroclor 1232	0.060 U
Aroclor 1242	0.060 U
Aroclor 1248	0.060 U
Aroclor 1254	0.060 U
Aroclor 1260	0.060 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:38



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T10A LG**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-26**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:38



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T9**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-27**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

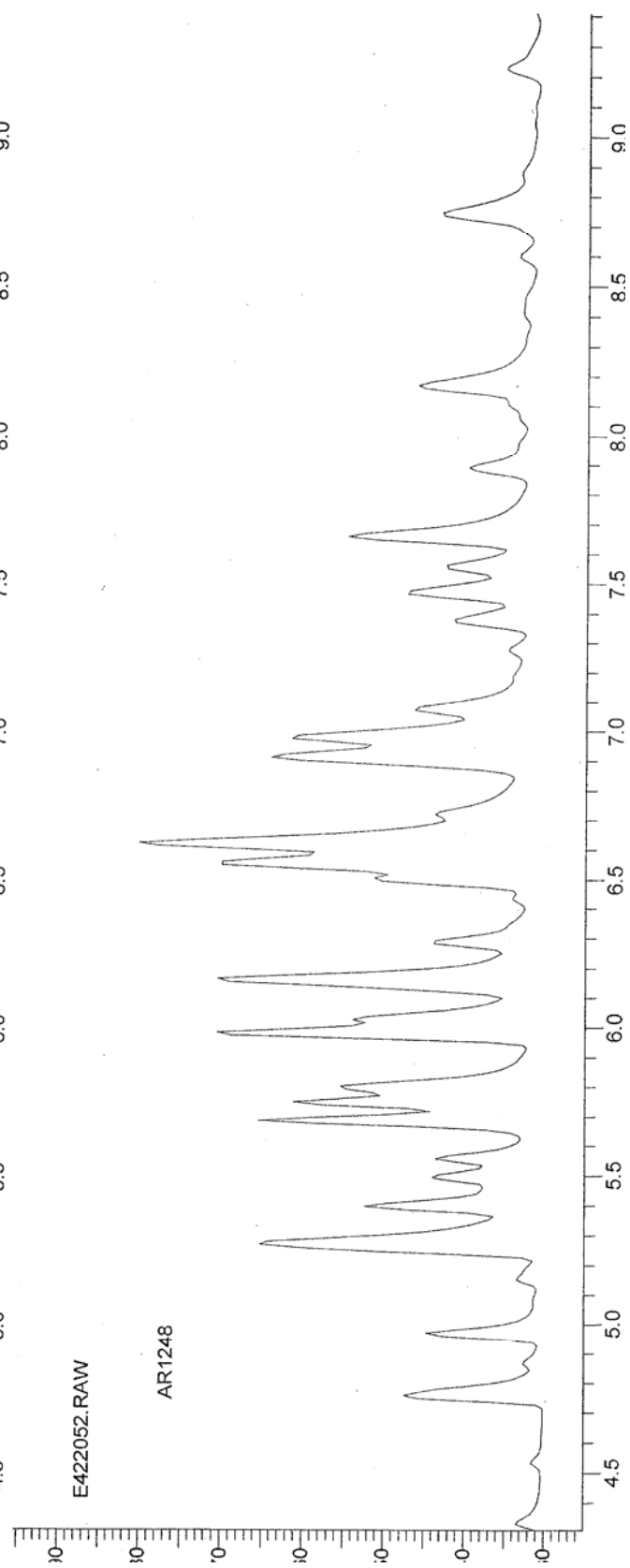
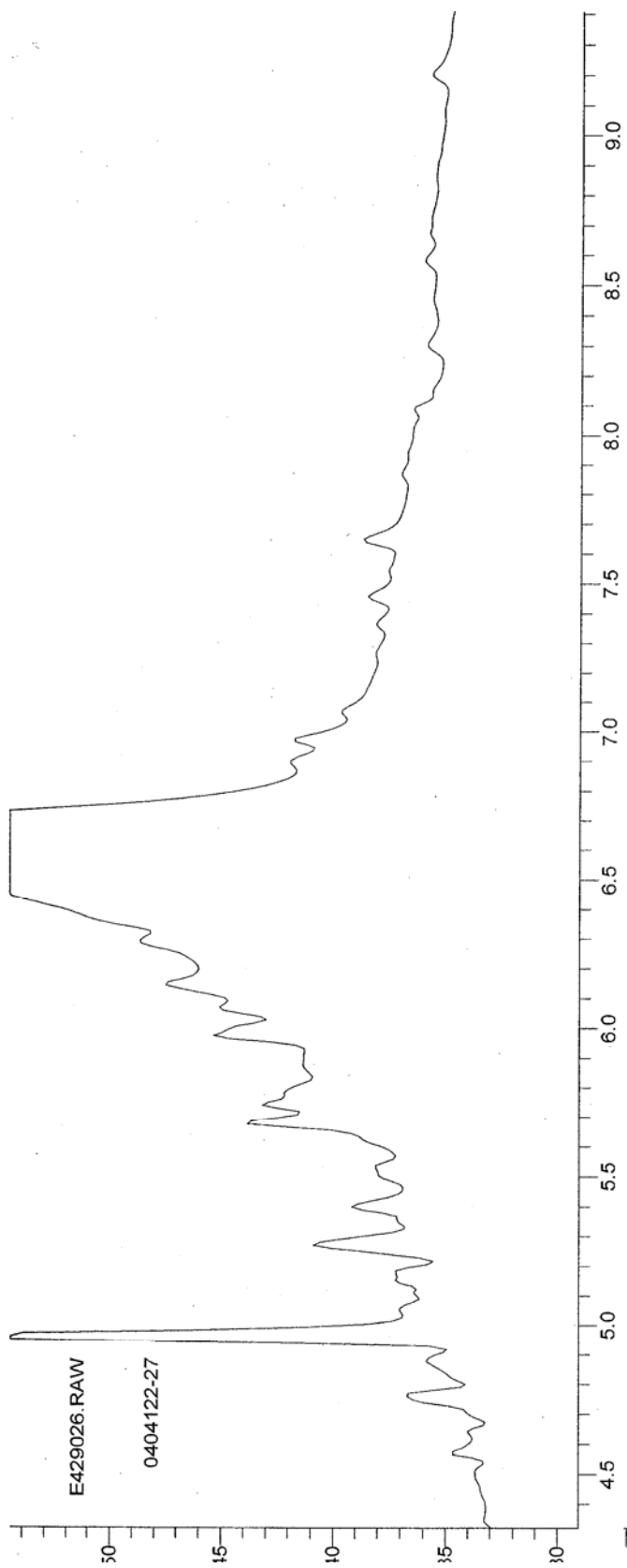
Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.15
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:38





Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T17B**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-28**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	1.00	0.5	2	CMF

Parameter	Result
Aroclor 1016	0.020 U
Aroclor 1221	0.020 U
Aroclor 1232	0.020 U
Aroclor 1242	0.020 U
Aroclor 1248	0.020 U
Aroclor 1254	0.020 U
Aroclor 1260	0.020 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

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Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T12D**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-29**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:38



Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **T4C MB LIVE**
Case: **N/A** SDG: **N/A**
Matrix: **Shell**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **0404122-30**
Associated Blank: **PT042204B24**
Concentration Units: **µg/Shell**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount	Final Volume (ml)	Dilution Factor	Analyst
04/15/04	04/16/04	04/22/04	04/30/04	100	1.00	1	2	CMF

Parameter	Result
Aroclor 1016	0.040 U
Aroclor 1221	0.040 U
Aroclor 1232	0.040 U
Aroclor 1242	0.040 U
Aroclor 1248	0.040 U
Aroclor 1254	0.040 U
Aroclor 1260	0.040 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:38



Blank
Polychlorinated Biphenyls by 8082

Client: **MyKro Waters, Inc**
Project: **PCB Tissue**
Client ID: **Blank**
Case: **N/A** SDG: **N/A**
Matrix: **Tissue**

Lab Code: **MA00030**
ETR: **0404122**
Lab ID: **PT042204B24**
Associated Blank: **N/A**
Concentration Units: **µg/Kg**

Date Collected	Date Received	Date Extracted	Date Analyzed	Percent Solid	Sample Amount (g)	Final Volume (ml)	Dilution Factor	Analyst
N/A	N/A	04/22/04	04/28/04	100	1.00	1	1	CMF

Parameter	Result
Aroclor 1016	20 U
Aroclor 1221	20 U
Aroclor 1232	20 U
Aroclor 1242	20 U
Aroclor 1248	20 U
Aroclor 1254	20 U
Aroclor 1260	20 U

Surrogate	% Recovery	Acceptance Range (%)
Tetrachloro-meta-xylene	N/A	30-150
Decachlorobiphenyl	N/A	30-150

U - The analyte was analyzed for but not detected at the sample specific level reported.
N/A - Not Applicable

05/07/04 17:36



University of
Massachusetts
Lowell

One University Avenue, Kitson 200
Lowell, Massachusetts 01854-2867 USA
tel: 978.934.3250
fax: 978.452.5711
web site: <http://www.uml.edu/Dept/WE>



DEPARTMENT OF WORK ENVIRONMENT

DATE: April 15, 2004
TO: Mykrowaters, Inc.
FROM: Fred Youngs, Ph.D.
University of Massachusetts
Work Environment Department
RE: Extraction protocol for clam samples

Extraction of Clam and Clam Shell Samples for PCB Analysis

Samples consisted of either the meat from a clam or mussel or, in some cases, just the shell itself. For samples that contained meat, the sample was weighed and then placed in a clean vial with 100 uL of water, 400 uL of methanol and 500 uL of hexane. If this volume was not sufficient to completely cover the sample, additional aliquots of each solvent were added. Total volumes were recorded. Once covered, the meat was chopped into fine pieces by hand with the use of a spatula. The vial was then sealed and sonicated for 30 minutes. The solvent layers were allowed to separate and the hexane layer was removed and placed into a GC vial.

Samples that consisted of only shells were treated in similar fashion. The shells were placed in a vial and the solvents were added in sufficient quantity to completely cover them. The vials were sealed and sonicated for 30 minutes. The solvent layers were allowed to separate and the hexane layer was removed and placed into a GC vial.

Appendix II

Listing of data

Latitude	Longitude	Water		DO_B	OS_B	pH_B	Eh_B	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V	pcb1	pcb2	pcb	pcb_present
		Depth	Salinity																		
41.0667	73.8992	2.7	.	6.50	.	7.31	336	1.31	0.71	48	43	2.87	877	32	58	141	22	0.020	0.02	0.020	0
41.0667	73.8900	3.7	.	11.30	.	7.31	336	0.47	4.15	33	24	3.03	876	31	31	96	24	.	.	.	.
41.0667	73.8825	13.1	.	.	.	7.31	336	1.31	1.30	62	56	3.37	1012	40	78	183	28	.	.	.	.
41.0750	73.8967	3.7	8.3	6.05	77.8	7.32	303	2.49	1.07	73	68	3.72	1128	43	94	200	32	0.020	.	0.020	0
41.0750	73.8825	13.4	13.2	4.73	61.5	7.35	314	1.90	1.54	70	66	3.52	875	42	89	196	31	840.000	.	840.000	1
41.0750	73.8742	2.1	.	.	.	.	.	2.61	2.01	90	105	3.17	662	36	121	211	30	0.020	.	0.020	0
41.1000	73.9042	2.7	8.5	6.34	80.7	7.32	322	2.14	1.42	74	67	3.33	1020	39	92	186	32	50.000	.	50.000	0
41.1000	73.8941	3.4	9.7	5.67	72.3	7.32	327	1.78	3.55	71	62	3.25	835	37	86	177	30	.	.	.	.
41.1000	73.8833	8.5	10.2	5.69	73.2	7.33	330	1.90	0.83	60	102	3.08	807	35	80	166	29	.	.	.	.
41.1000	73.8725	3.1	9.5	5.95	76.8	7.32	333	2.73	1.78	75	104	3.11	719	34	114	180	27	0.020	.	0.020	0
41.1167	73.9042	3.7	8.3	5.95	76.5	7.32	305	1.19	0.83	59	89	3.59	1173	37	67	156	26	.	.	.	.
41.1167	73.8958	3.7	8.2	6.07	78.2	7.32	303	0.36	0.59	36	25	3.29	841	33	30	96	27	.	.	.	.
41.1167	73.8833	7.6	11.6	4.91	63.3	7.32	310	1.78	0.71	57	52	2.94	909	33	72	159	25	.	.	.	.
41.1167	73.8717	3.1	9.0	5.80	73.7	7.32	300	2.02	0.59	63	59	3.13	1311	34	80	167	28	200.000	.	200.000	0
41.1333	73.8975	6.1	10.2	5.28	67.4	7.33	339	1.54	1.30	62	52	3.76	1093	40	68	168	31	.	.	.	.
41.1333	73.8867	8.8	10.8	5.26	67.6	7.33	334	1.66	1.30	58	52	3.01	779	36	76	162	27	.	.	.	.
41.1500	73.9094	3.1	6.9	5.95	75.5	7.31	303	1.66	1.18	64	65	3.61	1369	40	92	192	36	.	.	.	.
41.1500	73.8983	9.5	12.0	4.84	62.7	7.33	312	1.90	1.07	63	59	3.23	910	38	83	175	28	.	.	.	.
41.1500	73.8825	2.7	8.1	5.67	71.9	7.31	302	1.66	1.18	65	59	3.34	1554	39	81	181	28	770.000	.	770.000	1
41.1667	73.9231	9.1	7.5	5.85	74.8	7.33	313	2.37	1.18	81	78	4.04	2769	47	105	227	34	.	.	.	.
41.1667	73.9158	12.8	9.3	5.16	66.4	7.34	340	0.71	0.59	41	47	2.87	1064	33	50	140	23	.	.	.	.
41.1667	73.9008	4.9	7.0	5.99	76.2	7.33	333	0.71	0.71	37	29	2.18	1140	26	47	113	20	.	.	.	.
41.1833	73.9458	2.7	6.0	6.07	76.5	7.31	300	2.02	1.66	92	82	3.97	2167	48	123	238	35	.	.	.	.
41.1833	73.9275	8.8	9.8	4.77	61.9	7.32	307	0.95	1.42	50	40	2.79	902	35	57	153	23	0.010	.	0.010	0
41.1833	73.9200	3.7	7.2	5.64	71.8	7.31	299	0.59	0.83	41	33	2.47	1254	28	51	134	20	.	.	.	.
41.1833	73.9083	3.7	6.7	5.84	72.9	7.31	288	0.59	0.83	38	31	2.90	1158	32	41	116	23	145.000	.	145.000	0
41.2000	73.9553	3.1	6.3	5.72	73.3	7.33	310	1.66	2.49	97	81	3.40	693	45	120	238	32	.	.	.	.
41.2000	73.9492	.	.	.	.	.	.	1.07	1.42	56	47	2.95	838	39	64	160	25	.	.	.	.
41.2000	73.9375	8.2	6.9	5.30	68.2	7.33	296	1.31	1.18	57	51	3.10	1152	36	63	169	24	250.000	.	250.000	0
41.2000	73.9269	7.0	.	.	.	.	.	0.83	1.66	51	44	2.81	986	32	56	154	22	.	.	.	.
41.2167	73.9611	7.0	7.9	5.45	69.6	7.32	333	1.54	1.42	71	65	3.71	1438	44	85	206	29	.	.	.	.
41.2167	73.9542	9.1	8.3	5.38	68.9	7.33	329	1.19	1.90	64	58	3.41	1369	39	75	187	27	.	.	.	.
41.2167	73.9375	4.3	6.7	5.90	74.6	7.31	305	0.71	1.54	45	40	2.71	836	33	51	144	21	340.000	.	340.000	1
41.2167	73.9242	3.1	6.5	5.81	73.2	7.31	295	1.07	1.42	64	57	3.37	1570	40	76	189	28	.	.	.	.
40.9167	73.9253	6.4	18.2	4.56	57.5	7.42	350	4.04	1.07	84	87	3.82	1404	45	119	216	35	.	.	.	.
40.9167	73.9192	14.3	17.8	4.81	61.9	7.44	353	2.02	0.95	64	57	3.45	882	42	75	184	31	.	.	.	.

Listing of data

Latitude	Longitude	Water_ Depth	Salinity	DO_B	OS_B	pH_B	Eh_B	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V	pcb1	pcb2	pcb	pcb_ present
40.9167	73.9125	13.4	18.0	4.41	58.0	7.44	359	1.78	0.59	45	75	2.49	704	26	128	121	28	.	.	.	.
41.2306	73.9667	5.4	5.5	5.75	72.7	7.33	288	0.59	1.07	40	34	2.79	989	35	46	137	20	.	.	.	.
41.2306	73.9575	14.2	7.8	5.17	66.7	7.35	277	1.31	1.90	74	63	3.73	1531	44	84	211	30	.	.	.	.
41.2306	73.9458	5.1	.	.	.	.	.	1.42	2.13	73	67	3.54	1117	42	85	204	31	.	.	.	.
40.9000	73.9322	3.7	11.3	6.30	81.9	7.33	340	4.27	1.42	90	95	3.96	2225	44	130	229	37	84.000	.	84.000	1
40.9000	73.9247	9.1	19.7	4.02	51.9	7.33	367	0.83	0.59	39	40	3.13	1017	33	44	105	28	.	.	.	.
40.9000	73.9175	14.0	18.8	4.21	54.5	7.34	354	2.14	1.66	59	60	3.14	772	37	81	170	27	0.056	200.00	100.028	1
40.8833	73.9397	4.9	20.1	4.26	53.8	7.38	357	3.80	1.07	73	81	3.18	1346	36	98	183	28	.	.	.	.
40.8833	73.9303	10.1	20.9	4.06	53.6	7.46	370	2.49	0.95	71	67	3.50	1154	40	92	195	31	.	.	.	.
40.8833	73.9236	11.3	20.9	4.06	53.6	7.45	370	2.26	0.71	47	75	2.20	651	26	81	131	21	.	.	.	.
40.8667	73.9492	5.8	16.0	5.26	69.4	7.34	336	3.68	2.13	80	83	3.65	1704	42	107	202	33	.	.	.	.
40.8667	73.9425	10.1	18.9	4.45	60.2	7.34	359	4.15	0.95	77	80	3.41	1415	38	116	188	34	.	.	.	.
40.8667	73.9347	11.9	17.1	4.16	62.3	7.35	357	1.78	0.83	49	63	2.54	748	28	89	134	25	.	.	.	.
40.8500	73.9583	5.5	22.0	4.04	52.0	7.34	365	2.73	1.18	80	112	3.91	913	48	458	225	35	.	.	.	.
40.8500	73.9539	11.9	23.1	3.95	52.0	7.39	380	4.27	0.95	90	94	3.88	1704	43	188	212	38	.	.	.	.
40.8333	73.9669	4.6	15.6	5.17	67.5	7.34	364	5.22	0.95	102	106	4.16	2503	46	144	243	43	.	.	.	.
40.8333	73.9594	25.9	20.0	4.26	56.3	7.33	371	2.37	0.83	55	60	2.72	1047	27	79	144	25	.	.	.	.
40.8333	73.9525	6.1	18.1	4.83	63.2	7.33	362	2.61	1.30	63	65	3.09	954	36	87	166	28	.	.	.	.
40.8167	73.9761	7.0	24.1	4.00	51.7	7.31	366	4.63	0.59	89	95	3.62	2144	40	129	205	35	.	.	.	.
40.8167	73.9700	13.1	23.4	3.97	53.1	7.35	364	2.02	0.59	44	48	2.05	1266	23	66	115	20	.	.	.	.
40.8167	73.9656	7.9	23.5	4.00	52.3	7.33	363	10.80	5.33	166	268	3.31	461	47	385	418	40	.	.	.	.
40.8000	73.9900	15.8	14.0	5.87	77.0	7.33	345	2.37	0.95	61	61	3.03	1010	35	78	161	28	.	.	.	.
40.8000	73.9839	10.1	22.2	4.79	50.8	7.35	373	3.09	0.71	65	70	2.97	1276	33	96	166	28	.	.	.	.
40.8000	73.9772	1.8	19.6	4.32	57.3	7.34	369	6.88	2.13	84	178	3.50	895	44	254	315	37	.	.	.	.
40.7833	73.9953	17.4	25.4	3.96	53.2	7.32	370	3.09	0.95	61	74	2.65	901	28	97	153	27	.	.	.	.
40.7833	73.9883	8.8	22.1	4.54	66.6	7.27	357	9.61	4.26	148	188	3.01	594	43	223	274	37	.	.	.	.
40.9333	73.9208	3.7	14.2	5.02	64.1	7.34	360	2.85	1.18	70	114	3.79	703	45	184	237	34	0.020	.	0.020	0
40.9333	73.9142	13.7	19.3	4.11	55.2	7.36	356	0.24	0.95	30	15	3.22	938	32	19	79	28	.	.	.	.
40.9333	73.9064	11.3	17.5	4.30	57.2	7.35	347	1.54	0.83	38	53	2.08	493	23	74	111	20	.	.	.	.
40.7667	74.0122	16.5	21.6	4.08	54.3	7.34	372	6.41	3.08	139	145	3.32	807	44	180	255	35	.	.	.	.
40.7667	74.0036	17.0	20.2	4.21	56.3	7.34	374	2.61	1.42	74	71	3.46	1276	39	98	194	32	.	.	.	.
40.7500	74.0200	14.3	19.3	4.83	64.1	7.08	357	6.41	2.37	126	169	3.62	1015	48	239	333	40	.	.	.	.
40.7500	74.0128	13.1	24.9	4.02	53.4	7.22	363	1.19	0.59	37	31	2.59	946	30	65	95	30	.	.	.	.
40.7333	74.0239	16.8	23.2	3.88	51.6	7.33	384	5.10	3.55	105	171	3.17	593	64	266	397	35	.	.	.	.
40.7333	74.0153	19.4	23.8	3.85	51.5	7.33	376	4.39	2.84	78	108	2.75	610	34	141	181	30	100.000	.	100.000	0
40.7167	74.0292	11.7	25.7	4.36	59.3	7.51	363	3.32	1.66	80	84	3.36	952	42	140	225	34	.	.	.	.
40.7167	74.0233	14.3	25.1	4.29	58.8	7.52	365	3.20	0.95	64	66	2.49	538	34	95	134	27	.	.	.	.

Listing of data

Latitude	Longitude	Water Depth	Salinity	DO_B	OS_B	pH_B	Eh_B	Ag	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	V	pcb1	pcb2	pcb	pcb_present
40.7167	74.0183	10.7	25.7	4.42	59.8	7.51	360	3.20	1.18	64	74	2.44	534	31	129	162	26	.	.	.	.
40.7019	74.0325	14.7	24.9	3.88	63.9	7.36	388	4.87	3.44	113	114	2.36	404	35	152	235	28	.	.	.	.
40.7019	74.0267	18.3	23.1	4.27	55.8	7.30	366	2.73	0.71	71	63	2.95	718	35	83	147	33	.	.	.	.
40.9500	73.9153	2.4	14.9	4.54	59.7	7.36	288	4.27	1.30	92	93	4.12	1890	47	127	231	40	12.500	.	12.500	0
40.9500	73.9042	13.7	17.6	4.18	55.1	7.37	293	0.24	3.79	36	21	3.73	1052	38	25	96	33	.	.	.	.
40.9500	73.9008	25.9	11.1	6.62	87.8	7.36	275	1.78	0.95	44	50	2.41	555	27	63	131	21	0.020	.	0.020	0
40.9667	73.9078	5.8	14.7	4.88	63.0	7.34	339	3.20	0.83	74	77	3.56	1797	38	99	194	32	.	.	.	.
40.9667	73.9008	12.5	17.9	4.34	57.2	7.35	348	0.47	1.90	34	25	2.90	838	31	31	97	23	.	.	.	.
40.9667	73.8931	5.8	10.7	6.85	90.2	7.34	333	1.66	0.83	44	53	2.32	511	26	74	122	22	18.500	0.02	9.260	0
40.9833	73.9028	4.3	9.8	6.37	82.9	7.36	284	3.80	1.42	87	86	4.06	1623	46	114	227	38	0.010	.	0.010	0
40.9833	73.8942	14.3	15.8	4.31	56.6	7.37	304	0.59	0.59	33	26	2.35	1169	25	45	108	20	.	.	.	.
40.9833	73.8875	6.1	13.8	4.85	63.3	7.35	301	2.49	0.95	64	113	3.22	684	38	108	230	31	150.000	.	150.000	1
41.0000	73.8992	5.8	11.0	6.30	81.4	7.35	337	1.31	1.66	47	39	3.15	934	32	58	130	29	0.010	0.03	0.020	0
41.0000	73.8925	11.3	16.3	4.55	58.4	7.36	350	1.31	0.71	50	43	3.25	1196	37	58	136	30	.	.	.	.
41.0167	73.8867	4.6	14.7	4.76	61.8	7.35	346	3.80	1.90	73	84	3.17	872	37	103	188	31	0.020	.	0.020	0
41.0167	73.8875	13.7	14.7	4.53	59.1	7.36	313	1.78	0.59	55	74	3.22	854	34	96	171	28	.	.	.	.
41.0167	73.8811	3.1	9.7	6.87	90.9	7.34	297	1.66	1.30	50	52	2.60	558	33	75	138	24	.	.	.	.
41.0333	73.8942	4.0	11.3	5.68	72.3	7.35	333	0.83	0.59	42	35	2.96	1033	32	46	118	25	0.020	.	0.020	0
41.0333	73.8833	16.8	14.9	4.64	60.5	7.37	340	0.24	0.59	29	19	3.18	1047	33	21	89	25	.	.	.	.
41.0333	73.8775	4.6	11.4	6.13	79.0	7.35	327	0.95	1.18	41	36	3.09	863	33	45	114	26	0.020	.	0.020	0
41.0500	73.9000	2.4	9.0	6.03	78.5	7.33	300	1.42	0.83	44	42	2.68	947	27	61	118	27	0.150	.	0.150	1
41.0500	73.8883	4.9	9.9	5.39	69.7	7.34	304	1.54	0.83	52	50	2.97	916	30	66	145	27	.	.	.	.
41.0500	73.8800	11.6	13.3	4.83	63.3	7.35	311	0.24	0.59	34	20	3.56	1152	36	24	93	31	.	.	.	.
41.0500	73.8733	1.8	.	.	.	.	.	3.92	1.66	106	103	3.36	619	42	134	215	32	.	.	.	.

```

Distribution of PCB

The UNIVARIATE Procedure
Variable:  pcb

Moments

N          26          Sum Weights          26
Mean      117.352231   Sum Observations    3051.158
Std Deviation 221.979137   Variance      49274.7371
Skewness    2.55771406   Kurtosis      6.23462297
Uncorrected SS 1589928.63   Corrected SS   1231868.43
Coeff Variation 189.156299   Std Error Mean  43.5336904

```

Basic Statistical Measures

```

Location          Variability

Mean      117.3522   Std Deviation      221.97914
Median    4.7050    Variance      49275
Mode      0.0200    Range      839.99000
               Interquartile Range   144.98000

```

Tests for Location: Mu0=0

```

Test      -Statistic-      -----p Value-----

Student's t   t   2.695665   Pr > |t|   0.0124
Sign         M    13       Pr >= |M|   <.0001
Signed Rank   S   175.5   Pr >= |S|   <.0001

```

Tests for Normality

```

Test      --Statistic--      -----p Value-----

Shapiro-Wilk      W      0.589455   Pr < W      <0.0001
Kolmogorov-Smirnov      D      0.298535   Pr > D      <0.0100
Cramer-von Mises      W-Sq    0.740623   Pr > W-Sq    <0.0050
Anderson-Darling      A-Sq    4.080499   Pr > A-Sq    <0.0050

```

```

Distribution of PCB
The UNIVARIATE Procedure
Variable:  pcb

Quantiles (Definition 5)

Quantile      Estimate
100% Max      840.000
99%           840.000
95%           770.000
90%           340.000
75% Q3        145.000
50% Median    4.705
25% Q1        0.020
10%           0.020
5%            0.010
1%            0.010
0% Min        0.010

Extreme Observations

-----Lowest-----      -----Highest-----
Value      Obs      Value      Obs
0.01        84      200      14
0.01        25      250      30
0.02        94      340      34
0.02        92      770      20
0.02        89      840       5

```

-1	0	+1	+2

Summary statistics for all available data

The MEANS Procedure

Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
Latitude	98	40.9891582	0.1566626	40.9577493	41.0205670	40.7019000	41.0000000	41.2306000
Longitude	98	73.9299633	0.044269	73.9210562	73.9388703	73.8717000	73.9196000	74.0325000
Water_Depth	97	8.6742268	5.3579046	7.5943700	9.7540836	1.8000000	7.6000000	25.9000000
Salinity	90	14.7022222	6.0898327	13.4267315	15.9777130	5.5000000	14.4500000	25.7000000
DO_B	92	5.1154348	1.0598128	4.8959538	5.3349158	3.8500000	4.8450000	11.3000000
OS_B	90	65.5088889	10.1342410	63.3863132	67.6314646	50.8000000	63.3000000	90.9000000
pH_B	91	7.3431868	0.0533725	7.3320715	7.3543022	7.0800000	7.3400000	7.5200000
Eh_B	91	335.0109890	29.2508289	328.9192091	341.1027690	275.0000000	337.0000000	388.0000000
Ag	98	2.3783673	1.8354525	2.0103824	2.7463523	0.2400000	1.8400000	10.8000000
Cd	98	1.3921429	0.9092823	1.2098433	1.5744424	0.5900000	1.1800000	5.3300000
Cr	98	65.5204082	25.2154549	60.4650292	70.5757871	29.0000000	63.0000000	166.0000000
Cu	98	70.5306122	39.4655544	62.6182691	78.4429554	15.0000000	63.0000000	268.0000000
Fe	98	3.1648980	0.4845239	3.0677571	3.2620389	2.0500000	3.1750000	4.1600000
Mn	98	1067.11	438.3390366	979.2308272	1154.99	404.0000000	953.0000000	2769.00
Ni	98	36.7551020	6.7809029	35.3956170	38.1145871	23.0000000	36.0000000	64.0000000
Pb	98	98.2448980	66.6192538	84.885825	111.6012135	19.0000000	83.0000000	458.0000000
Zn	98	175.5612245	59.4096501	163.6503431	187.4721059	79.0000000	168.5000000	418.0000000
V	98	29.0000000	5.2129893	27.9548618	30.0451382	20.0000000	28.0000000	43.0000000
pcb1	26	113.8621538	222.9888058	23.7950260	203.9292817	0.0100000	0.1030000	840.0000000
pcb2	4	50.0175000	99.9883334	-109.0862512	209.1212512	0.0200000	0.0250000	200.0000000
pcb	26	117.3522308	221.9791366	27.6929171	207.0115444	0.0100000	4.7050000	840.0000000

Summary statistics for all available data by Location

The MEANS Procedure

Loc	Obs	N	Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
A	30	30	Latitude	30	40.9652533	0.1621872	40.9046916	41.0258150	40.7019000	40.9583500	41.2306000
			Longitude	30	73.9453767	0.0443471	73.9288172	73.9619362	73.8942000	73.9359500	74.0325000
			Water_Depth	30	6.6433333	4.5739656	4.9353865	8.3512801	2.4000000	5.1500000	16.8000000
			Salinity	29	14.0034483	6.3858372	11.5744057	16.4324908	5.5000000	14.0000000	25.7000000
			DO_B	30	5.2980000	0.8661504	4.9745741	5.6214259	3.8800000	5.5650000	6.5000000
			OS_B	29	68.3896552	10.1179242	64.5410027	72.2383077	51.6000000	69.6000000	82.9000000
			pH_B	29	7.3355172	0.0627686	7.3116413	7.3593932	7.0800000	7.3300000	7.5100000
			EH_B	29	334.6551724	30.3129815	323.1247309	346.1856139	284.0000000	337.0000000	388.0000000
			Ag	30	3.0500000	1.6128728	2.4477434	3.6522566	0.5900000	2.7900000	6.4100000
			Cd	30	1.4766667	0.7901040	1.1816370	1.7716964	0.5900000	1.1800000	3.5500000
			Cr	30	79.2333333	23.8265041	70.3363705	88.1302962	40.0000000	80.0000000	139.0000000
			Cu	30	85.3666667	34.3224902	72.5504382	98.1828951	34.0000000	82.5000000	171.0000000
			Fe	30	3.4836667	0.4617096	3.3112615	3.6560719	2.3600000	3.6000000	4.1600000
			Mn	30	1319.00	594.5084321	1097.01	1540.99	404.0000000	1080.50	2769.00
			Ni	30	41.5333333	7.1280569	38.8716731	44.1949935	27.0000000	42.5000000	64.0000000
			Pb	30	127.0333333	80.8768682	96.8334144	157.2332523	46.0000000	110.5000000	458.0000000
			Zn	30	209.5000000	58.3737955	187.7028665	231.2971335	118.0000000	211.0000000	397.0000000
			V	30	32.3000000	5.2859606	30.3261899	34.2738101	20.0000000	33.5000000	43.0000000
			pcb1	10	14.6750000	28.9802961	-6.0562549	35.4062549	0.0100000	0.0200000	84.0000000
			pcb2	2	0.0250000	0.0070711	-0.0385310	0.0885310	0.0200000	0.0250000	0.0300000
			pcb	10	14.6760000	28.9797340	-6.0548528	35.4068528	0.0100000	0.0200000	84.0000000
B	33	33	Latitude	33	40.9663909	0.1607392	40.9093953	41.0233866	40.7019000	40.9667000	41.2306000
			Longitude	33	73.9360091	0.0458922	73.9197364	73.9522818	73.8825000	73.9247000	74.0267000
			Water_Depth	32	12.1781250	4.8861050	10.4164963	13.9397537	3.4000000	12.9500000	25.9000000
			Salinity	31	16.8838710	5.7421887	14.7776191	18.9901228	7.8000000	17.8000000	25.4000000
			DO_B	32	4.7915625	1.3120634	4.3185132	5.2646118	3.8500000	4.4900000	11.3000000
			OS_B	31	59.5677419	6.8040374	57.0720009	62.0634830	50.8000000	58.4000000	78.2000000
			pH_B	32	7.3500000	0.0506729	7.3317305	7.3682695	7.2200000	7.3400000	7.5200000
			EH_B	32	341.9687500	28.7295334	331.6106486	352.3268514	277.0000000	349.0000000	380.0000000
			Ag	33	1.7587879	1.1874809	1.3377254	2.1798503	0.2400000	1.5400000	4.3900000
			Cd	33	1.3139394	0.9578685	0.9742940	1.6535848	0.5900000	0.9500000	4.1500000
			Cr	33	55.4242424	16.6095423	49.5347548	61.3137300	29.0000000	56.0000000	90.0000000
			Cu	33	52.8787879	22.1228920	45.0343515	60.7232243	15.0000000	57.0000000	108.0000000

Summary statistics for all available data by Location

The MEANS Procedure

Loc	Obs	N	Variable	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
B	33	33	Fe	3.1106061	0.4253009	2.9598009	3.2614112	2.0500000	3.1800000	3.8800000
	33	33	Mn	1027.09	253.3108717	937.2707796	1116.91	538.0000000	946.0000000	1704.00
	33	33	Ni	34.8484848	5.1424776	33.0250416	36.6719281	23.0000000	34.0000000	44.0000000
	33	33	Pb	73.1212121	35.2648529	60.6168390	85.6255852	19.0000000	75.0000000	188.0000000
	33	33	Zn	148.2727273	39.5073353	134.2640353	162.2814193	79.0000000	153.0000000	212.0000000
	33	33	V	28.0909091	3.9871954	26.6771111	29.5047071	20.0000000	28.0000000	38.0000000
	3	3	pcb1	313.3366667	458.8357005	-826.4744004	1453.15	0.0100000	100.0000000	840.0000000
	0	0	pcb2	.	.	.	.	.	.	.
	3	3	pcb	313.3366667	458.8357005	-826.4744004	1453.15	0.0100000	100.0000000	840.0000000
C	27	27	Latitude	40.9952704	0.1410235	40.9394833	41.0510574	40.7167000	41.0000000	41.2306000
	27	27	Longitude	73.9148111	0.0385880	73.8995462	73.9300760	73.8742000	73.9008000	74.0183000
	27	27	Water_Depth	8.2814815	5.0591149	6.2801623	10.2828007	1.8000000	7.9000000	25.9000000
	24	24	Salinity	14.4916667	5.5171603	12.1619742	16.8213591	6.9000000	13.5500000	25.7000000
	24	24	DO_B	5.1091667	0.8899141	4.7333889	5.4849444	4.0000000	4.8400000	6.8700000
	24	24	OS_B	67.2208333	11.1052662	62.5314907	71.9101760	52.3000000	63.3000000	90.9000000
	24	24	pH_B	7.3504167	0.0498240	7.3293779	7.3714555	7.2700000	7.3400000	7.5100000
	24	24	Eh_B	333.0000000	27.9735900	321.1877889	344.8122111	275.0000000	333.5000000	370.0000000
	27	27	Ag	2.5974074	2.5214489	1.5999554	3.5948594	0.2400000	1.7800000	10.8000000
	27	27	Cd	1.4333333	1.0804842	1.0059080	1.8607587	0.5900000	1.1800000	5.3300000
	27	27	Cr	63.4444444	30.4483590	51.3994748	75.4894141	34.0000000	58.0000000	166.0000000
	27	27	Cu	78.2592593	54.3599159	56.7555883	99.7629302	20.0000000	60.0000000	268.0000000
	27	27	Fe	2.9025926	0.4517197	2.7238982	3.0812870	2.0800000	3.0800000	3.5600000
	27	27	Mn	829.1481481	270.8019009	722.0224840	936.2738123	461.0000000	779.0000000	1554.00
	27	27	Ni	34.1481481	6.3227532	31.6469503	36.6493460	23.0000000	36.0000000	47.0000000
	27	27	Pb	102.8518519	74.5647389	73.3550235	132.3486802	24.0000000	81.0000000	385.0000000
	27	27	Zn	174.0740741	69.9966625	146.3843166	201.7638316	93.0000000	162.0000000	418.0000000
	27	27	V	27.2962963	5.2609945	25.2151162	29.3774764	20.0000000	27.0000000	40.0000000
	9	9	pcb1	132.0706667	255.2592569	-64.1389673	328.2803006	0.0200000	0.0560000	770.0000000
	2	2	pcb2	100.0100000	141.4072141	-1170.48	1370.50	0.0200000	100.0100000	200.0000000
	9	9	pcb	142.1520000	251.5269941	-51.1887628	335.4927628	0.0200000	9.2600000	770.0000000
D/E	8	8	Latitude	41.1520875	0.0613649	41.1007851	41.2033899	41.0500000	41.1583000	41.2167000
	8	8	Longitude	73.8983625	0.0287582	73.8743201	73.9224049	73.8717000	73.8908000	73.9375000

Summary statistics for all available data by Location

The MEMS Procedure

Loc	Obs	N	Variable	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
D/E	8	8	Water_Depth	3.600000	1.5519573	2.3025312	4.8974688	1.8000000	3.1000000	7.0000000
		6	Salinity	7.6500000	1.2957623	6.2901808	9.0098192	6.5000000	7.1000000	9.5000000
		6	DO_B	5.9550000	0.2395621	5.7035950	6.2064050	5.8000000	5.8700000	6.4300000
		6	OS_B	75.4333333	3.2426327	72.0303990	78.8362676	72.9000000	74.1500000	81.4000000
		6	pH_B	7.3150000	0.0054772	7.3092520	7.3207480	7.3100000	7.3150000	7.3200000
		6	Chl_B	307.6666667	17.6370821	289.1576841	326.1756493	288.0000000	302.5000000	333.0000000
		8	Ag	1.6762500	1.1636634	0.7034031	2.6490969	0.5900000	1.3050000	3.9200000
		8	Cd	1.2587500	0.5038548	0.8375169	1.6799831	0.5900000	1.4800000	1.7800000
		8	Cr	62.7500000	21.0288917	45.1694066	80.3305934	38.0000000	61.5000000	106.0000000
		8	Cu	61.6250000	27.5055189	38.6298107	84.6201893	31.0000000	56.0000000	104.0000000
		8	Fe	3.0787500	0.2489083	2.8706574	3.2868426	2.7100000	3.1200000	3.3700000
		8	Mn	1090.75	366.1076149	784.6763743	1396.82	619.0000000	1072.00	1670.00
		8	Ni	35.5000000	3.7796447	32.3401379	38.6598621	32.0000000	34.0000000	42.0000000
		8	Pb	78.3750000	31.6901855	51.8813419	104.8686581	41.0000000	75.5000000	134.0000000
		8	Zn	165.8750000	29.9305744	140.8524136	190.8975864	116.0000000	164.5000000	215.0000000
		8	V	26.1250000	3.7583241	22.9829624	29.2670376	21.0000000	27.5000000	32.0000000
		4	pcb1	171.2550000	140.6080845	-52.4838395	394.9938395	0.0200000	172.5000000	340.0000000
		0	pcb2	.	.	.	.	.	.	.
		4	pcb	171.2550000	140.6080845	-52.4838395	394.9938395	0.0200000	172.5000000	340.0000000

Summary statistics for all available data for those samples with PCB measured

The MEMS Procedure

Variable	N	Mean	Std Dev	Lower 95% CL for Mean	Upper 95% CL for Mean	Minimum	Median	Maximum
Latitude	26	41.0368538	0.1101360	40.9923690	41.0813387	40.7333000	41.0416500	41.2167000
Longitude	26	73.9052769	0.0296727	73.8932918	73.9172620	73.8717000	73.8996000	74.0153000
Water Depth	26	6.3538462	5.7595993	4.0274936	8.6801987	2.1000000	4.1500000	25.9000000
Salinity	24	11.3541667	3.9716363	9.6770917	13.0312416	6.7000000	10.8500000	23.8000000
DO_B	25	5.6144000	0.8107716	5.2797299	5.9490701	3.8500000	5.8400000	6.8500000
OS_B	24	72.0375000	10.3563386	67.6644017	76.4105983	51.5000000	73.3000000	90.2000000
pH_B	24	7.3354167	0.0166757	7.3283751	7.3424582	7.3100000	7.3350000	7.3600000
Eh_B	24	317.6666667	26.2391454	306.5868473	328.7464861	275.0000000	310.5000000	376.0000000
Ag	26	2.1684615	1.1521760	1.7030876	2.6338355	0.5900000	1.9600000	4.3900000
Cd	26	1.3069231	0.5008534	1.1046240	1.5092222	0.5900000	1.2400000	2.8400000
Cr	26	62.4230769	17.1094666	55.5124138	69.3337400	38.0000000	63.5000000	92.0000000
Cu	26	66.9615385	27.2565306	55.9523875	77.9706894	31.0000000	59.5000000	114.0000000
Fe	26	3.1734615	0.4682815	2.9843186	3.3626045	2.3200000	3.1350000	4.1200000
Mn	26	1016.00	413.5624741	848.9585017	1183.04	511.0000000	889.5000000	2225.00
Ni	26	36.1538462	5.7667482	33.8246062	38.4830862	26.0000000	35.5000000	47.0000000
Pb	26	87.5384615	35.0499424	73.3814834	101.6954396	41.0000000	81.0000000	184.0000000
Zn	26	171.9230769	40.6565351	155.5015470	188.3446068	114.0000000	175.0000000	237.0000000
V	26	28.4230769	5.2013312	26.3222138	30.5239401	21.0000000	28.0000000	40.0000000
pcb1	26	113.8621538	222.9888058	203.9292817	203.9292817	0.0100000	0.1030000	840.0000000
pcb2	4	50.0175000	99.9833334	-109.0862512	209.1212512	0.0200000	0.0250000	200.0000000
pcb	26	117.3522308	221.9791366	27.6929171	207.0115444	0.0100000	4.7050000	840.0000000

Analysis of Variance to examine location (A,B,C,D,E) differences in PCB

The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	A B C D/E

Number of observations 98

NOTE: Due to missing values, only 26 observations can be used in this analysis.

Analysis of Variance to examine location (A,B,C,D,E) differences in PCB

The GIM Procedure

Dependent Variable: pcb

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	237811.072	79270.357	1.75	0.1853
Error	22	994057.355	45184.425		
Corrected Total	25	1231868.427			
R-Square		Root MSE	pcb Mean		
0.193049		181.1353	212.5663	117.3522	
Source	DF	Type I SS	Mean Square	F Value	Pr > F
location	3	237811.0721	79270.3574	1.75	0.1853
Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	237811.0721	79270.3574	1.75	0.1853

Parameter	Estimate	Standard Error	t Value	Pr > t
Intercept	171.2550000 B	106.2831422	1.61	0.1214
location A	-156.5790000 B	125.7559097	-1.25	0.2262
location B	142.0816667 B	162.3501814	0.88	0.3909
location C	-29.1030000 B	127.7364396	-0.23	0.8219
location D/E	0.0000000 B	.	.	.

Analysis of Variance to examine location (A,B,C,D,E) differences in PCB

The GLM Procedure

Dependent Variable: pcb

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

Analysis of Variance to examine location (A,B,C,D,E) differences in PCB

The GLM Procedure
Least Squares Means

location	pcb LSMEAN
A	14.676000
B	313.336667
C	142.152000
D/E	171.255000

Logistic model to examine location differences (A,B,C,D,E) in binary PCB

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Class Level Information

Class	Levels	Values
location	4	A B C D/E

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	22	29.7831	1.3538
Scaled Deviance	22	29.7831	1.3538
Pearson Chi-Square	22	26.0000	1.1818
Scaled Pearson X2	22	26.0000	1.1818
Log Likelihood		-14.8915	

Logistic model to examine location differences (A,B,C,D,E) in binary PCB

The GENMOD Procedure

Algorithm converged.

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.0986	1.1547	-3.3618 1.1646	0.91	0.3414
location A	1	-0.2877	1.3994	-3.0305 2.4551	0.04	0.8371
location B	1	0.4055	1.6833	-2.8936 3.7046	0.06	0.8096
location C	1	0.4055	1.3540	-2.2483 3.0593	0.09	0.7646
location D/E	0	0.0000	0.0000	0.0000 0.0000	.	.
Scale	0	1.0000	0.0000	1.0000 1.0000	.	.

NOTE: The scale parameter was held fixed.

Linear Regression to predict PCB by Latitude

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	126879	126879	2.76	0.1099
Error	24	1104989	46041		
Corrected Total	25	1231868			

Root MSE 214.57215 R-Square 0.1030
 Dependent Mean 117.35223 Adj R-Sq 0.0656
 Coeff Var 182.84454

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	-26427	15990	-1.65	0.1114
Latitude	1	646.83929	389.64953	1.66	0.1099

Linear Regression to predict PCB by Water_Depth

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	13968	13968	0.28	0.6046
Error	24	1217901	50746		
Corrected Total	25	1231868			

Root MSE 225.26841 R-Square 0.0113
 Dependent Mean 117.35223 Adj R-Sq -0.0299
 Coeff Var 191.95921

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	91.27637	66.49859	1.37	0.1826
Water_Depth	1	4.10395	7.82236	0.52	0.6046

Linear Regression to predict PCB by Salinity

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	17923	17923		
Error	22	1184118	53824	0.33	0.5698
Corrected Total	23	1202040			

Root MSE	231.99898	R-Square	0.0149
Dependent Mean	127.12992	Adj R-Sq	-0.0299
Coeff Var	182.48968		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	206.93365	146.17894	1.42	0.1709
Salinity	1	-7.02859	12.18015	-0.58	0.5698

Linear Regression to predict PCB by DO_B

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	57366	57366	1.14	0.2973
Error	23	1160184	50443		
Corrected Total	24	1217551			

Root MSE 224.59475 R-Square 0.0471
 Dependent Mean 122.04552 Adj R-Sq 0.0057
 Coeff Var 184.02540

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	460.59965	320.62922	1.44	0.1643
DO_B	1	-60.30103	56.54516	-1.07	0.2973

Linear Regression to predict PCB by OS_B

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	62628	62628	1.21	0.2834
Error	22	1139412	51791		
Corrected Total	23	1202040			

Root MSE 227.57736 R-Square 0.0521
 Dependent Mean 127.12992 Adj R-Sq 0.0090
 Coeff Var 179.01165

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	490.10218	333.33158	1.47	0.1556
OS_B	1	-5.03866	4.58204	-1.10	0.2834

Linear Regression to predict PCB by pH_B

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	81683	81683	1.60	0.2186
Error	22	1120357	50925		
Corrected Total	23	1202040			

Root MSE	225.66637	R-Square	0.0680
Dependent Mean	127.12992	Adj R-Sq	0.0256
Coeff Var	177.50847		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	26342	20699	1.27	0.2164
pH_B	1	-3573.70306	2821.74827	-1.27	0.2186

Linear Regression to predict PCB by Eh_B

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	35987	35987	0.68	0.4188
Error	22	1166053	53002		
Corrected Total	23	1202040			

Root MSE 230.22257 R-Square 0.0299
 Dependent Mean 127.12992 Adj R-Sq -0.0142
 Coeff Var 181.09236

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	606.01317	583.07055	1.04	0.3099
Eh_B	1	-1.50750	1.82951	-0.82	0.4188

Linear Regression to predict PCB by Ag

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	37933	37933	0.76	0.3912
Error	24	1193936	49747		
Corrected Total	25	1231868			

Root MSE	223.04107	R-Square	0.0308
Dependent Mean	117.35223	Adj R-Sq	-0.0096
Coeff Var	190.06121		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	190.66341	94.66699	2.01	0.0553
Ag	1	-33.80792	38.71649	-0.87	0.3912

Linear Regression to predict PCB by Cd

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	987.54026	987.54026		
Error	24	1230881	51287	0.02	0.8908
Corrected Total	25	1231868			

Root MSE 226.46568 R-Square 0.0008
 Dependent Mean 117.35223 Adj R-Sq -0.0408
 Coeff Var 192.97944

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	100.95212	126.25714	0.80	0.4318
Cd	1	12.54864	90.43192	0.14	0.8908

Linear Regression to predict PCB by Cr

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	653.23092	653.23092	0.01	0.9111
Error	24	1231215	51301		
Corrected Total	25	1231868			

Root MSE 226.49643 R-Square 0.0005
 Dependent Mean 117.35223 Adj R-Sq -0.0411
 Coeff Var 193.00565

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	98.70252	171.13747	0.58	0.5695
Cr	1	0.29876	2.64762	0.11	0.9111

Linear Regression to predict PCB by Cu

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	10612	10612	0.21	0.6520
Error	24	1221256	50886		
Corrected Total	25	1231868			

Root MSE 225.57855 R-Square 0.0086
 Dependent Mean 117.35223 Adj R-Sq -0.0327
 Coeff Var 192.22348

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	167.96792	119.33927	1.41	0.1721
Cu	1	-0.75589	1.65523	-0.46	0.6520

Linear Regression to predict PCB by Fe

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	9994.62980	9994.62980	0.20	0.6617
Error	24	1221874	50911		
Corrected Total	25	1231868			

Root MSE	225.63557	R-Square	0.0081
Dependent Mean	117.35223	Adj R-Sq	-0.0332
Coeff Var	192.27207		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	-18.14787	309.00342	-0.06	0.9537
Fe	1	42.69789	96.36750	0.44	0.6617

Linear Regression to predict PCB by Mn

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	Df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	27253	27253	0.54	0.4683
Error	24	1204615	50192		
Corrected Total	25	1231868			

Root MSE 224.03638 R-Square 0.0221
 Dependent Mean 117.35223 Adj R-Sq -0.0186
 Coeff Var 190.90935

Parameter Estimates

Variable	Df	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	36.23896	118.52288	0.31	0.7624
Mn	1	0.07984	0.10834	0.74	0.4683

Linear Regression to predict PCB by Ni

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	42526	42526		
Error	24	1189342	49556	0.86	0.3635
Corrected Total	25	1231868			

Root MSE	222.61158	R-Square	0.0345
Dependent Mean	117.35223	Adj R-Sq	-0.0057
Coeff Var	189.69522		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	-141.22079	282.52021	-0.50	0.6217
Ni	1	7.15202	7.72052	0.93	0.3635

Linear Regression to predict PCB by Pb

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	11392	11392	0.22	0.6403
Error	24	1220476	50853		
Corrected Total	25	1231868			

Root MSE 225.50649 R-Square 0.0092
 Dependent Mean 117.35223 Adj R-Sq -0.0320
 Coeff Var 192.16209

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	170.66657	121.01293	1.41	0.1713
Pb	1	-0.60904	1.28677	-0.47	0.6403

Linear Regression to predict PCB by Zn

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	12899	12899	0.25	0.6189
Error	24	1218969	50790		
Corrected Total	25	1231868			

Root MSE	225.36720	R-Square	0.0105
Dependent Mean	117.35223	Adj R-Sq	-0.0308
Coeff Var	192.04338		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	21.29724	195.65813	0.11	0.9142
Zn	1	0.55871	1.10864	0.50	0.6189

Linear Regression to predict PCB by V

The REG Procedure

Model: MODEL1

Dependent Variable: pcb

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2405.88765	2405.88765	0.05	0.8303
Error	24	1229463	51228		
Corrected Total	25	1231868			

Root MSE 226.33516 R-Square 0.0020
 Dependent Mean 117.35223 Adj R-Sq -0.0396
 Coeff Var 192.86822

Parameter Estimates

Variable	Parameter DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	170.95957	251.31621	0.68	0.5029
V	1	-1.88605	8.70297	-0.22	0.8303

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2847	1.2619
Scaled Deviance	24	30.2847	1.2619
Pearson Chi-Square	24	26.0005	1.0834
Scaled Pearson X2	24	26.0005	1.0834
Log Likelihood		-15.1424	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-12.7538	168.6948	-343.390 317.8819	0.01	0.9397
Latitude	1	0.2865	4.1106	-7.7703 8.3432	0.00	0.9444
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2626	1.2609
Scaled Deviance	24	30.2626	1.2609
Pearson Chi-Square	24	25.9837	1.0827
Scaled Pearson X2	24	25.9837	1.0827
Log Likelihood		-15.1313	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)
The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.0797	0.6644	-2.3819 0.2225	2.64	0.1041
Water_Depth	1	0.0126	0.0759	-0.1361 0.1613	0.03	0.8682
Scale_	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	24
Missing Values	74

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	17

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	22	28.9480	1.3158
Scaled Deviance	22	28.9480	1.3158
Pearson Chi-Square	22	23.9973	1.0908
Scaled Pearson X2	22	23.9973	1.0908
Log Likelihood		-14.4740	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.0993	1.3752	-3.7946 1.5959	0.64	0.4240
Salinity	1	0.0186	0.1133	-0.2036 0.2407	0.03	0.8698
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	25
Missing Values	73

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	18

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	23	28.8451	1.2541
Scaled Deviance	23	28.8451	1.2541
Pearson Chi-Square	23	24.7090	1.0743
Scaled Pearson X2	23	24.7090	1.0743
Log Likelihood		-14.4226	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)
The GENMOD Procedure

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	1.8177	3.1018	-4.2617 7.8970	0.34	0.5579
DO B	1	-0.4978	0.5592	-1.5938 0.5982	0.79	0.3734
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	24
Missing Values	74

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	17

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	22	28.3347	1.2879
Scaled Deviance	22	28.3347	1.2879
Pearson Chi-Square	22	23.8057	1.0821
Scaled Pearson X2	22	23.8057	1.0821
Log Likelihood		-14.1674	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	1.6521	3.2101	-4.6396 7.9439	0.26	0.6068
OS_B	1	-0.0356	0.0450	-0.1239 0.0526	0.63	0.4288
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	24
Missing Values	74

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	17

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	22	28.3806	1.2900
Scaled Deviance	22	28.3806	1.2900
Pearson Chi-Square	22	23.8848	1.0857
Scaled Pearson X2	22	23.8848	1.0857
Log Likelihood		-14.1903	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	156.4762	206.8067	-248.857 561.8098	0.57	0.4493
pH_B	1	-21.4560	28.2018	-76.7306 33.8186	0.58	0.4468
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	24
Missing Values	74

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	17

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	22	28.9566	1.3162
Scaled Deviance	22	28.9566	1.3162
Pearson Chi-Square	22	23.9904	1.0905
Scaled Pearson X2	22	23.9904	1.0905
Log Likelihood		-14.4783	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)
The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.1392	5.5956	-11.1064 10.8281	0.00	0.9802
Eh_B	1	-0.0024	0.0176	-0.0368 0.0321	0.02	0.8934
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2358	1.2598
Scaled Deviance	24	30.2358	1.2598
Pearson Chi-Square	24	25.9905	1.0829
Scaled Pearson X2	24	25.9905	1.0829
Log Likelihood		-15.1179	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.8020	0.9513	-2.6666 1.0625	0.71	0.3992
Ag	1	-0.0918	0.3984	-0.8726 0.6890	0.05	0.8178
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2889	1.2620
Scaled Deviance	24	30.2889	1.2620
Pearson Chi-Square	24	25.9993	1.0833
Scaled Pearson X2	24	25.9993	1.0833
Log Likelihood		-15.1445	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-0.9683	1.2576	-3.4332 1.4965	0.59	0.4413
Cd	1	-0.0231	0.9026	-1.7922 1.7459	0.00	0.9796
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2896	1.2621
Scaled Deviance	24	30.2896	1.2621
Pearson Chi-Square	24	26.0000	1.0833
Scaled Pearson X2	24	26.0000	1.0833
Log Likelihood		-15.1448	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.0002	1.7035	-4.3390 2.3386	0.34	0.5571
Cr	1	0.0000	0.0264	-0.0516 0.0517	0.00	0.9992
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2789	1.2616
Scaled Deviance	24	30.2789	1.2616
Pearson Chi-Square	24	25.9975	1.0832
Scaled Pearson X2	24	25.9975	1.0832
Log Likelihood		-15.1394	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.1134	1.1972	-3.4598 1.2330	0.86	0.3523
Cu	1	0.0017	0.0165	-0.0306 0.0340	0.01	0.9174
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.1731	1.2572
Scaled Deviance	24	30.1731	1.2572
Pearson Chi-Square	24	25.9619	1.0817
Scaled Pearson X2	24	25.9619	1.0817
Log Likelihood		-15.0865	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)
The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-2.0406	3.0953	-8.1073 4.0261	0.43	0.5097
Fe	1	0.3267	0.9559	-1.5468 2.2003	0.12	0.7325
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	29.6030	1.2335
Scaled Deviance	24	29.6030	1.2335
Pearson Chi-Square	24	26.1490	1.0895
Scaled Pearson X2	24	26.1490	1.0895
Log Likelihood		-14.8015	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)
The GENMOD Procedure

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-1.9031	1.1987	-4.2526 0.4464	2.52	0.1124
Mn	1	0.0009	0.0010	-0.0012 0.0029	0.69	0.4049
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable pcb_present
 Observations Used 26
 Missing Values 72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	29.9974	1.2499
Scaled Deviance	24	29.9974	1.2499
Pearson Chi-Square	24	25.9619	1.0817
Scaled Pearson X2	24	25.9619	1.0817
Log Likelihood		-14.9987	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-2.5389	2.9176	-8.2574 3.1795	0.76	0.3842
Ni	1	0.0422	0.0784	-0.1115 0.1960	0.29	0.5901
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CLAM
Distribution Binomial
Link Function Logit
Dependent Variable pcb_present
Observations Used 26
Missing Values 72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2665	1.2611
Scaled Deviance	24	30.2665	1.2611
Pearson Chi-Square	24	25.9828	1.0826
Scaled Pearson X2	24	25.9828	1.0826
Log Likelihood		-15.1332	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)
The GENMOD Procedure

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-0.8268	1.2116	-3.2014 1.5478	0.47	0.4950
Pb	1	-0.0020	0.0130	-0.0275 0.0236	0.02	0.8797
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	pcb_present
Observations Used	26
Missing Values	72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	29.7751	1.2406
Scaled Deviance	24	29.7751	1.2406
Pearson Chi-Square	24	25.9613	1.0817
Scaled Pearson X2	24	25.9613	1.0817
Log Likelihood		-14.8875	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-2.4011	2.0572	-6.4332 1.6309	1.36	0.2431
Zn	1	0.0080	0.0113	-0.0141 0.0302	0.50	0.4777
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CLAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable pcb_present
 Observations Used 26
 Missing Values 72

Response Profile

Ordered Value	pcb_present	Total Frequency
1	1	7
2	0	19

PROC GENMOD is modeling the probability that pcb_present='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	24	30.2207	1.2592
Scaled Deviance	24	30.2207	1.2592
Pearson Chi-Square	24	25.9759	1.0823
Scaled Pearson X2	24	25.9759	1.0823
Log Likelihood		-15.1103	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.6444	2.5062	-6.5566 3.2677	0.43	0.5117
V	1	0.0226	0.0860	-0.1459 0.1911	0.07	0.7925
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
 Initial Factor Method: Iterated Principal Factor Analysis
 Prior Communality Estimates: ONE

Preliminary Eigenvalues: Total = 16 Average = 1

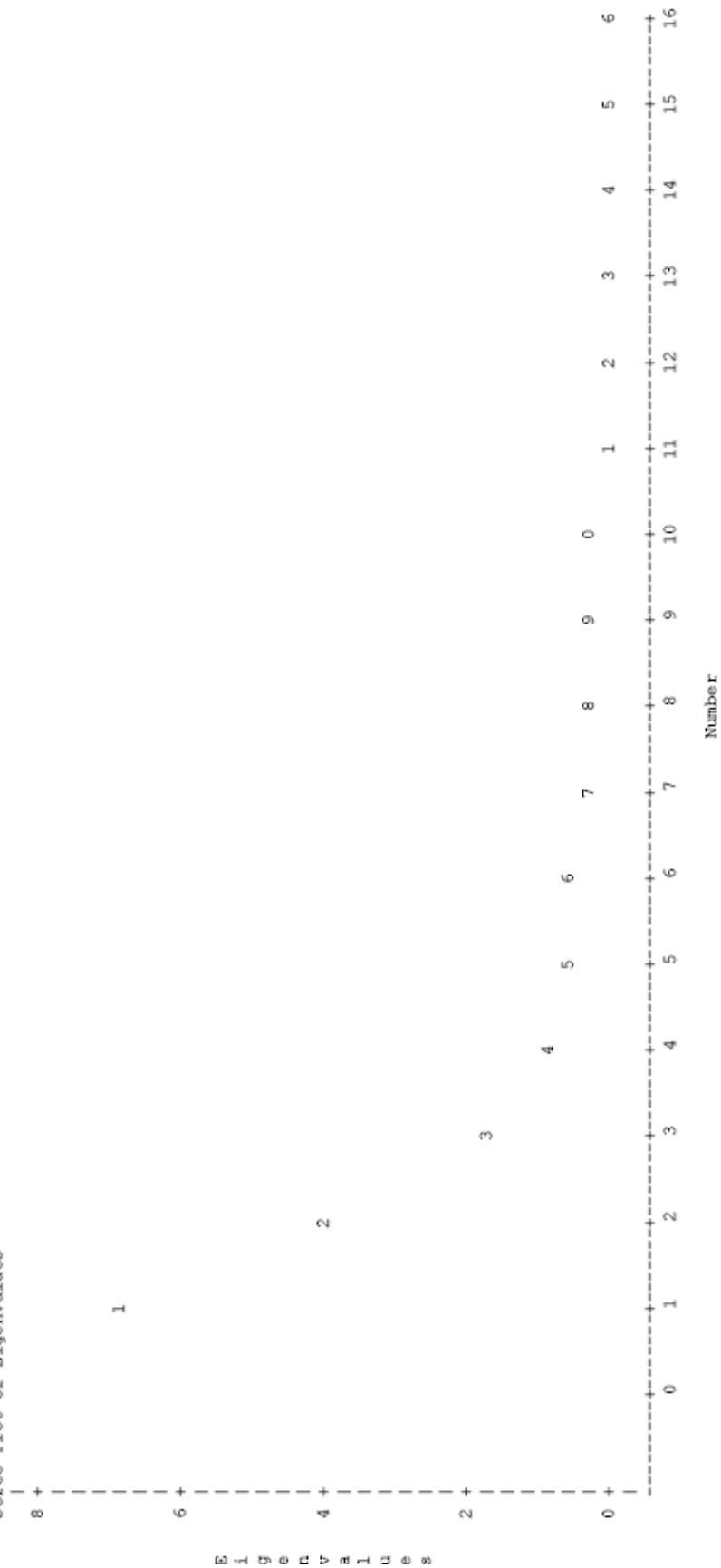
	Eigenvalue	Difference	Proportion	Cumulative
1	6.83073043	2.90280961	0.4269	0.4269
2	3.92792081	2.26214112	0.2455	0.6724
3	1.66577969	0.78707601	0.1041	0.7765
4	0.87870368	0.16905452	0.0549	0.8314
5	0.70964916	0.18780366	0.0444	0.8758
6	0.52184550	0.12274339	0.0326	0.9084
7	0.39910212	0.03514542	0.0249	0.9334
8	0.36395670	0.11805405	0.0227	0.9561
9	0.24590265	0.06972720	0.0154	0.9715
10	0.17617545	0.08271350	0.0110	0.9825
11	0.09346196	0.02363538	0.0058	0.9883
12	0.06982658	0.01944155	0.0044	0.9927
13	0.05038503	0.02273321	0.0031	0.9958
14	0.02765183	0.00637286	0.0017	0.9976
15	0.02127897	0.00364954	0.0013	0.9989
16	0.01762943		0.0011	1.0000

3 factors will be retained by the NFACTOR criterion.

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Initial Factor Method: Iterated Principal Factor Analysis

Scree Plot of Eigenvalues



Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Initial Factor Method: Iterated Principal Factor Analysis

Iteration	Change	Communalities														
1	0.7723 0.49579 0.91039 0.89042 0.84832 0.22772 0.70044 0.86072 0.64050 0.90622 0.92481 0.89471 0.74921 0.83285 0.76237 0.90992 0.87004															
2	0.1157 0.39955 0.91426 0.89656 0.83622 0.13142 0.63950 0.84936 0.53766 0.90436 0.93425 0.89261 0.63347 0.80681 0.72606 0.90958 0.85196															
3	0.0641 0.38211 0.91974 0.90629 0.83726 0.12446 0.62445 0.85178 0.50799 0.90739 0.94447 0.90987 0.56940 0.80520 0.72021 0.91272 0.85138															
4	0.0356 0.37876 0.92195 0.91177 0.83845 0.12407 0.62008 0.85422 0.49864 0.90880 0.94997 0.92804 0.53378 0.80666 0.71907 0.91384 0.85242															
5	0.0197 0.37799 0.92257 0.91449 0.83901 0.12408 0.61864 0.85567 0.49520 0.90931 0.95260 0.94294 0.51412 0.80765 0.71874 0.91404 0.85278															
6	0.0112 0.37775 0.92265 0.91583 0.83922 0.12411 0.61812 0.85648 0.49369 0.90950 0.95381 0.95419 0.50317 0.80800 0.71861 0.91401 0.85259															
7	0.0082 0.37764 0.92259 0.91650 0.83929 0.12413 0.61791 0.85694 0.49293 0.90959 0.95436 0.96237 0.49691 0.80799 0.71855 0.91395 0.85216															
8	0.0058 0.37757 0.92252 0.91684 0.83931 0.12415 0.61783 0.85720 0.49249 0.90964 0.95462 0.96820 0.49321 0.80784 0.71853 0.91391 0.85170															
9	0.0041 0.37752 0.92246 0.91702 0.83932 0.12416 0.61779 0.85736 0.49222 0.90968 0.95473 0.97232 0.49095 0.80767 0.71852 0.91389 0.85130															
10	0.0029 0.37749 0.92242 0.91712 0.83931 0.12417 0.61777 0.85746 0.49205 0.90971 0.95478 0.97521 0.48951 0.80751 0.71851 0.91389 0.85098															
11	0.0020 0.37747 0.92240 0.91718 0.83931 0.12418 0.61776 0.85752 0.49194 0.90973 0.95481 0.97723 0.48858 0.80738 0.71851 0.91388 0.85074															
12	0.0014 0.37746 0.92238 0.91721 0.83931 0.12418 0.61776 0.85756 0.49187 0.90974 0.95482 0.97864 0.48797 0.80729 0.71851 0.91388 0.85057															
13	0.0010 0.37745 0.92237 0.91723 0.83930 0.12418 0.61775 0.85759 0.49182 0.90975 0.95483 0.97963 0.48755 0.80722 0.71851 0.91388 0.85044															

Convergence criterion satisfied.

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure

Initial Factor Method: Iterated Principal Factor Analysis

Eigenvalues of the Reduced Correlation Matrix: Total = 11.7691414 Average = 0.73557134

	Eigenvalue	Difference	Proportion	Cumulative
1	6.67045231	2.98357650	0.5668	0.5668
2	3.68687581	2.27470180	0.3133	0.8800
3	1.41217402	1.04855383	0.1200	1.0000
4	0.36362018	0.17742932	0.0309	1.0309
5	0.18619086	0.01975917	0.0158	1.0467
6	0.16643169	0.10834904	0.0141	1.0609
7	0.05808265	0.04640035	0.0049	1.0658
8	0.01168230	0.02906529	0.0010	1.0668
9	-0.01738298	0.02227157	-0.0015	1.0653
10	-0.03965455	0.03446503	-0.0034	1.0620
11	-0.07411958	0.00992832	-0.0063	1.0557
12	-0.08404790	0.01512084	-0.0071	1.0485
13	-0.09916874	0.01143110	-0.0084	1.0401
14	-0.11059984	0.02393913	-0.0094	1.0307
15	-0.13453897	0.09231689	-0.0114	1.0193
16	-0.22685586		-0.0193	1.0000

Factor Pattern

	Factor1	Factor2	Factor3
Cu	0.91928	0.04525	-0.32819
Cr	0.91898	0.19092	-0.16967
Zn	0.90398	0.27240	-0.15000
Ag	0.89573	-0.05234	-0.22917
Pb	0.83123	-0.00576	-0.16593
V	0.80713	0.30926	0.32147
Ni	0.73880	0.45509	0.23301
Cd	0.61489	0.05359	-0.33295
DO_B	-0.43927	0.79731	-0.29761
OS_B	-0.40226	0.73840	-0.36367
Fe	0.48310	0.61268	0.60899

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Initial Factor Method: Iterated Principal Factor Analysis

Factor Pattern

	Factor1	Factor2	Factor3
pH_B	-0.08438	-0.31290	0.13841
Water_Depth	0.06187	-0.61020	0.03579
Eh_B	0.47292	-0.62320	0.07565
Salinity	0.51493	-0.79980	0.13243
Mn	0.08441	0.45954	0.51890

Variance Explained by Each Factor

Factor1	Factor2	Factor3
6.6704523	3.6868758	1.4121740

Final Communality Estimates: Total = 11.769502

Water_Depth	Salinity	DO_B	OS_B	pH_B	Eh_B	Ag	Cd
0.37744739	0.92237386	0.91722764	0.83930286	0.12418418	0.61775198	0.85759083	0.49181524
Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
0.90975305	0.95482565	0.97962658	0.48755158	0.80721738	0.71850743	0.91388406	0.85044242

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3
1	0.89533	-0.31425	0.31564
2	0.13674	0.86838	0.47667
3	-0.42388	-0.38362	0.82046

Rotated Factor Pattern

	Factor1	Factor2	Factor3
Cu	0.96836	-0.12368	0.04246
Cr	0.92082	-0.05791	0.24186
Zn	0.91020	0.01002	0.29210
Ag	0.89196	-0.23902	0.06975
Pb	0.81378	-0.20256	0.12348
Cd	0.69899	-0.01897	-0.05354
DO_B	-0.15812	0.94457	-0.00277
OS_B	-0.10504	0.90713	-0.07337
pH_B	-0.17700	-0.29830	-0.06222
Water_Depth	-0.04322	-0.56305	-0.24197
Eh_B	0.30613	-0.71881	-0.08572
Salinity	0.29553	-0.90715	-0.11006
Fe	0.25818	0.14661	0.94418
Mn	-0.08154	0.17347	0.67143
V	0.62867	-0.10840	0.66593
Ni	0.62493	0.07364	0.64129

Variance Explained by Each Factor

	Factor1	Factor2	Factor3
5.6698665	3.6467515	2.4528841	

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure

Rotation Method: Varimax

Final Communality Estimates: Total = 11.769502

Water Depth	Salinity	DO_B	OS_B	pH_B	Eh_B	Ag	Cd
0.37744739	0.92237386	0.91722764	0.83930286	0.12418418	0.61775198	0.85759083	0.49181524
Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
0.90975305	0.95482565	0.97962658	0.48755158	0.80721738	0.71850743	0.91388406	0.85044242

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Rotation Method: Varimax

Scoring Coefficients Estimated by Regression

Squared Multiple Correlations of the Variables with Each Factor

Factor1	Factor2	Factor3
0.9884786	0.9962060	1.0328655

Standardized Scoring Coefficients

	Factor1	Factor2	Factor3
Cu	0.84794554	0.1026759	-1.0716182
Cr	0.3839074	0.03886205	-0.0799156
Zn	-0.0717178	-0.150616	0.895205
Ag	-0.254933	0.13275294	0.38175913
Pb	-0.0366069	0.06850129	0.0372228
Cd	0.0405533	0.0633091	-0.1054684
DO_B	0.16306781	0.90737485	-0.2587898
OS_B	-0.0209444	-0.3790128	0.10788225
pH_B	0.00643502	0.05856752	-0.0475077
Water_Depth	-0.0071595	0.08479069	-0.0400706
Eh_B	-0.0445274	0.0272965	0.06196341
Salinity	0.07769276	-0.7586249	0.0754031
Fe	-0.3264563	-0.2709262	1.46137783
Mn	0.00665253	0.00173469	-0.1202257
V	0.13718483	0.21227227	-0.1924969
Ni	0.19462607	0.07172056	-0.5666786

Prediction of factor 1 by PCB and latitude, controlling for depth of measurement

The REG Procedure

Model: MODEL1

Dependent Variable: Factor1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2.82987	0.94329	3.80	0.0264
Error	20	4.96813	0.24841		
Corrected Total	23	7.79800			

Root MSE 0.49840 R-Square 0.3629
 Dependent Mean -0.07620 Adj R-Sq 0.2673
 Coeff Var -654.06498

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	151.47509	45.21955	3.35	0.0032
pcb	1	0.00051537	0.00050070	1.03	0.3156
Latitude	1	-3.68940	1.10106	-3.35	0.0032
Water_Depth	1	-0.03382	0.02019	-1.67	0.1095

Prediction of factor 2 by PCB and latitude, controlling for depth of measurement

The REG Procedure

Model: MODEL1

Dependent Variable: Factor2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	4.06417	1.35472	2.95	0.0576
Error	20	9.18708	0.45935		
Corrected Total	23	13.25125			

Root MSE 0.67776 R-Square 0.3067
 Dependent Mean 0.62899 Adj R-Sq 0.2027
 Coeff Var 107.75362

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	-142.84832	61.49201	-2.32	0.0308
pcb	1	-0.00094685	0.00068088	-1.39	0.1796
Latitude	1	3.50129	1.49728	2.34	0.0299
Water_Depth	1	-0.01113	0.02746	-0.41	0.6896

Prediction of factor 3 by PCB and latitude, controlling for depth of measurement

The REG Procedure

Model: MODEL1

Dependent Variable: Factor3

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	6.71841	2.23947	2.86	0.0626
Error	20	15.65319	0.78266		
Corrected Total	23	22.37160			

Root MSE	0.88468	R-Square	0.3003
Dependent Mean	-0.00606	Adj R-Sq	0.1954
Coeff Var	-14590		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	153.54812	80.26595	1.91	0.0702
pcb	1	0.00132	0.0008876	1.49	0.1531
Latitude	1	-3.72991	1.95441	-1.91	0.0708
Water_Depth	1	-0.10009	0.03584	-2.79	0.0112

Appendix III

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	clam
Observations Used	98

Response Profile

Ordered Value	clam	Frequency	Total
1	1	26	
2	0	72	

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	109.9922	1.1458
Scaled Deviance	96	109.9922	1.1458
Pearson Chi-Square	96	95.4938	0.9947
Scaled Pearson X2	96	95.4938	0.9947
Log Likelihood		-54.9961	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-115.812	64.0411	-241.330	9.7060	0.0705
Latitude	1	2.7995	1.5612	-0.2604	5.8594	0.0729
Scale	0	1.0000	0.0000	1.0000	1.0000	

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	clam
Observations Used	97
Missing Values	1

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	71

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	95	105.1264	1.1066
Scaled Deviance	95	105.1264	1.1066
Pearson Chi-Square	95	122.4988	1.2895
Scaled Pearson X2	95	122.4988	1.2895
Log Likelihood		-52.5632	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	0.0720	0.4521	-0.8142 0.9581	0.03	0.8735
Water_Depth	1	-0.1383	0.0552	-0.2465 -0.0302	6.28	0.0122
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 90
 Missing Values 8

Response Profile

Ordered Value	clam	Total Frequency
1	1	24
2	0	66

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	88	93.5061	1.0626
Scaled Deviance	88	93.5061	1.0626
Pearson Chi-Square	88	84.8853	0.9646
Scaled Pearson X2	88	84.8853	0.9646
Log Likelihood		-46.7531	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	0.9538	0.6536	-0.3272 2.2348	2.13	0.1445
Salinity	1	-0.1458	0.0489	-0.2416 -0.0500	8.90	0.0028
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	clam
Observations Used	92
Missing Values	6

Response Profile

Ordered Value	clam	Frequency	Total
1	1	25	25
2	0	67	67

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	90	100.0304	1.1114
Scaled Deviance	90	100.0304	1.1114
Pearson Chi-Square	90	103.3285	1.1481
Scaled Pearson X2	90	103.3285	1.1481
Log Likelihood		-50.0152	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-4.4724	1.4795	-7.3722 -1.5726	9.14	0.0025
DO_B	1	0.6692	0.2770	0.1263 1.2120	5.84	0.0157
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 90
 Missing Values 8

Response Profile

Ordered Value	clam	Total Frequency
1	1	24
2	0	66

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	88	90.4372	1.0277
Scaled Deviance	88	90.4372	1.0277
Pearson Chi-Square	88	91.5427	1.0403
Scaled Pearson X2	88	91.5427	1.0403
Log Likelihood		-45.2186	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-7.3229	1.9074	-11.0613 -3.5846	14.74	0.0001
OS_B	1	0.0936	0.0274	0.0399 0.1472	11.68	0.0006
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CIAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	clam
Observations Used	91
Missing Values	7

Response Profile

Ordered Value	clam	Total Frequency
1	1	24
2	0	67

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	89	104.2968	1.1719
Scaled Deviance	89	104.2968	1.1719
Pearson Chi-Square	89	89.9735	1.0109
Scaled Pearson X2	89	89.9735	1.0109
Log Likelihood		-52.1484	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	26.9792	33.9437	-39.5492 93.5077	0.63	0.4267
pH_B	1	-3.8151	4.6253	-12.8805 5.2503	0.68	0.4095
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	clam
Observations Used	91
Missing Values	7

Response Profile

Ordered Value	clam	Total Frequency
1	1	24
2	0	67

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	89	93.0702	1.0457
Scaled Deviance	89	93.0702	1.0457
Pearson Chi-Square	89	88.8768	0.9986
Scaled Pearson X2	89	88.8768	0.9986
Log Likelihood		-46.5351	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	8.8454	3.0348	2.8972 14.7935	8.49	0.0036
Eh_B	1	-0.0300	0.0093	-0.0482 -0.0117	10.33	0.0013
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	112.8975	1.1760
Scaled Deviance	96	112.8975	1.1760
Pearson Chi-Square	96	97.5488	1.0161
Scaled Pearson X2	96	97.5488	1.0161
Log Likelihood		-56.4487	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.8026	0.3836	-1.5545 -0.0507	4.38	0.0364
Ag	1	-0.0938	0.1380	-0.3641 0.1766	0.46	0.4968
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	113.0636	1.1777
Scaled Deviance	96	113.0636	1.1777
Pearson Chi-Square	96	97.6416	1.0171
Scaled Pearson X2	96	97.6416	1.0171
Log Likelihood		-56.5318	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.8109	0.4302	-1.6541 0.0324	3.55	0.0595
Cd	1	-0.1525	0.2734	-0.6882 0.3833	0.31	0.5770
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information	
Data Set	WORK.CLAM
Distribution	Binomial
Link Function	Logit
Dependent Variable	clam
Observations Used	98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	112.8303	1.1753
Scaled Deviance	96	112.8303	1.1753
Pearson Chi-Square	96	97.5328	1.0160
Scaled Pearson X2	96	97.5328	1.0160
Log Likelihood		-56.4151	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.5577	0.6610	-1.8533 0.7379	0.71	0.3988
Cr	1	-0.0072	0.0098	-0.0263 0.0120	0.53	0.4647
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CLAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	113.0869	1.1780
Scaled Deviance	96	113.0869	1.1780
Pearson Chi-Square	96	97.7575	1.0183
Scaled Pearson X2	96	97.7575	1.0183
Log Likelihood		-56.5435	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.7845	0.4843	-1.7338 0.1647	2.62	0.1053
Cu	1	-0.0034	0.0063	-0.0157 0.0089	0.29	0.5902
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CLAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	113.3815	1.1811
Scaled Deviance	96	113.3815	1.1811
Pearson Chi-Square	96	97.9983	1.0208
Scaled Pearson X2	96	97.9983	1.0208
Log Likelihood		-56.6908	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-1.1776	1.5239	-4.1644 1.8091	0.60	0.4396
Fe	1	0.0502	0.4752	-0.8812 0.9816	0.01	0.9158
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	112.8855	1.1759
Scaled Deviance	96	112.8855	1.1759
Pearson Chi-Square	96	98.0286	1.0211
Scaled Pearson X2	96	98.0286	1.0211
Log Likelihood		-56.4427	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates						
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-0.6083	0.6248	-1.8329 0.6162	0.95	0.3302
Mn	1	-0.0004	0.0006	-0.0015 0.0007	0.48	0.4877
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

```

Data Set      WORK.CIAM
Distribution   Binomial
Link Function  Logit
Dependent Variable  clam
Observations Used      98
  
```

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	113.1083	1.1782
Scaled Deviance	96	113.1083	1.1782
Pearson Chi-Square	96	97.8723	1.0195
Scaled Pearson X2	96	97.8723	1.0195
Log Likelihood		-56.5541	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.3490	1.2788	-2.8554 2.1574	0.07	0.7849
Ni	1	-0.0183	0.0346	-0.0861 0.0495	0.28	0.5965
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	112.3407	1.1702
Scaled Deviance	96	112.3407	1.1702
Pearson Chi-Square	96	96.9299	1.0097
Scaled Pearson X2	96	96.9299	1.0097
Log Likelihood		-56.1703	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.6336	0.4535	-1.5224 0.2552	1.95	0.1623
Pb	1	-0.0041	0.0043	-0.0126 0.0044	0.89	0.3458
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	113.2560	1.1797
Scaled Deviance	96	113.2560	1.1797
Pearson Chi-Square	96	97.8821	1.0196
Scaled Pearson X2	96	97.8821	1.0196
Log Likelihood		-56.6280	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.7639	0.7285	-2.1917 0.6639	1.10	0.2944
Zn	1	-0.0015	0.0040	-0.0093 0.0064	0.13	0.7146
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Model Information

Data Set WORK.CIAM
 Distribution Binomial
 Link Function Logit
 Dependent Variable clam
 Observations Used 98

Response Profile

Ordered Value	clam	Total Frequency
1	1	26
2	0	72

PROC GENMOD is modeling the probability that clam='1'.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	96	112.9511	1.1766
Scaled Deviance	96	112.9511	1.1766
Pearson Chi-Square	96	98.0081	1.0209
Scaled Pearson X2	96	98.0081	1.0209
Log Likelihood		-56.4755	

Algorithm converged.

Logistic model to examine predictors of binary PCB (present/absent)

The GENMOD Procedure

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-0.1658	1.3033	-2.7203 2.3887	0.02	0.8988
V	1	-0.0296	0.0448	-0.1174 0.0582	0.44	0.5090
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure

Initial Factor Method: Iterated Principal Factor Analysis

Prior Communality Estimates: ONE

Preliminary Eigenvalues: Total = 16 Average = 1

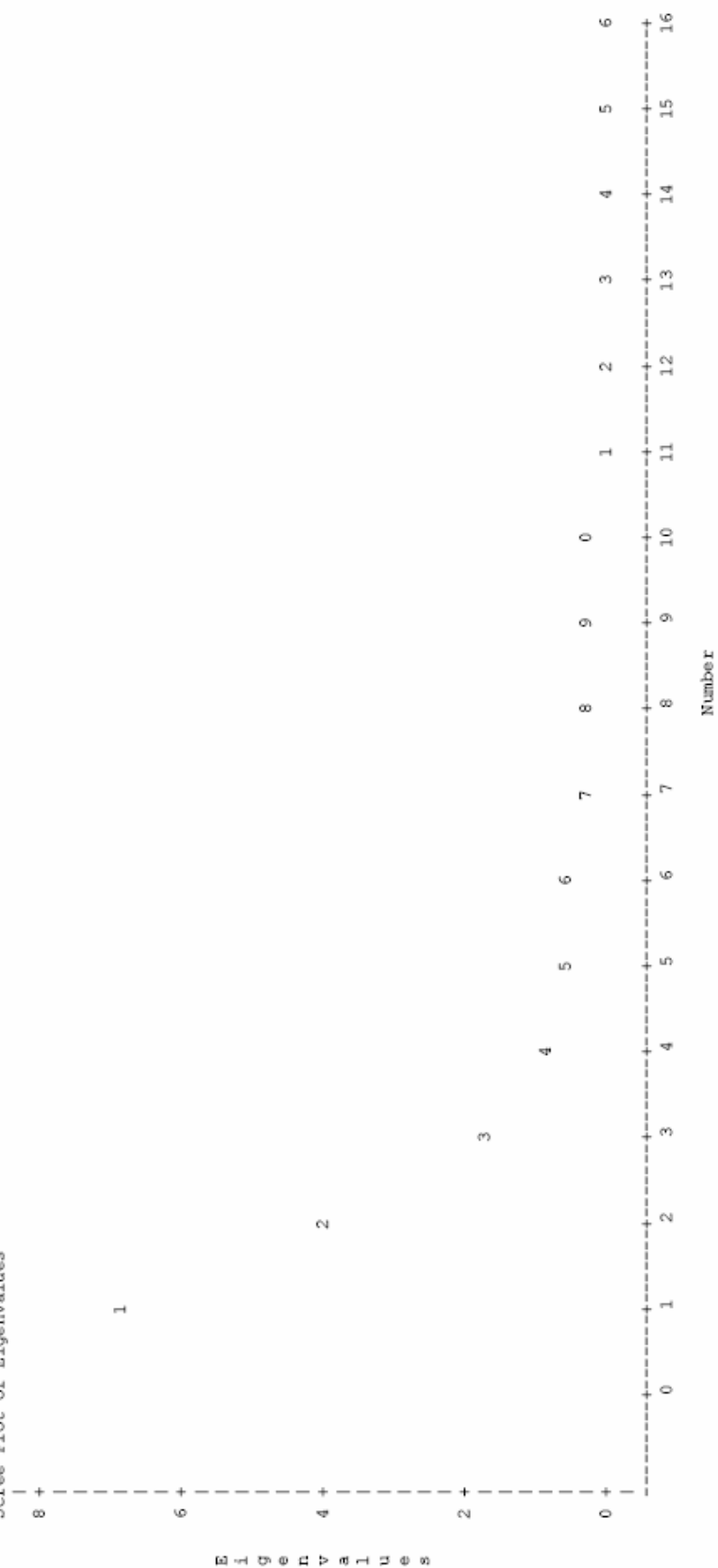
	Eigenvalue	Difference	Proportion	Cumulative
1	6.83073043	2.90280961	0.4269	0.4269
2	3.92792081	2.26214112	0.2455	0.6724
3	1.66577969	0.78707601	0.1041	0.7765
4	0.87870368	0.16905452	0.0549	0.8314
5	0.70964916	0.18780366	0.0444	0.8758
6	0.52184550	0.12274339	0.0326	0.9084
7	0.39910212	0.03514542	0.0249	0.9334
8	0.36395670	0.11805405	0.0227	0.9561
9	0.24590265	0.06972720	0.0154	0.9715
10	0.17617545	0.08271350	0.0110	0.9825
11	0.09346196	0.02363538	0.0058	0.9883
12	0.06982658	0.01944155	0.0044	0.9927
13	0.05038503	0.02273321	0.0031	0.9958
14	0.02765183	0.00637286	0.0017	0.9976
15	0.02127897	0.00364954	0.0013	0.9989
16	0.01762943		0.0011	1.0000

3 factors will be retained by the NFACTOR criterion.

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Initial Factor Method: Iterated Principal Factor Analysis

Scree Plot of Eigenvalues



Factor analysis showing intership among predictors (3 factor solution)

The FACTOR Procedure

Initial Factor Method: Iterated Principal Factor Analysis

Iteration		Change		Communalities														
1	0.7723	0.49579	0.91039	0.89042	0.84832	0.22772	0.70044	0.86072	0.64050	0.90622	0.92481	0.89471	0.74921	0.83285	0.76237			
		0.90992	0.87004															
2	0.1157	0.39955	0.91426	0.89656	0.83622	0.13142	0.63950	0.84936	0.53766	0.90436	0.93425	0.89261	0.63347	0.80681	0.72606			
		0.90958	0.85196															
3	0.0641	0.38211	0.91974	0.90629	0.83726	0.12446	0.62445	0.85178	0.50799	0.90739	0.94447	0.90987	0.56940	0.80520	0.72021			
		0.91272	0.85138															
4	0.0356	0.37876	0.92195	0.91177	0.83845	0.12407	0.62008	0.85422	0.49864	0.90880	0.94997	0.92804	0.53378	0.80666	0.71907			
		0.91384	0.85242															
5	0.0197	0.37799	0.92257	0.91449	0.83901	0.12408	0.61864	0.85567	0.49520	0.90931	0.95260	0.94294	0.51412	0.80765	0.71874			
		0.91404	0.85278															
6	0.0112	0.37775	0.92265	0.91583	0.83922	0.12411	0.61812	0.85648	0.49369	0.90950	0.95381	0.95419	0.50317	0.80800	0.71861			
		0.91401	0.85259															
7	0.0082	0.37764	0.92259	0.91650	0.83929	0.12413	0.61791	0.85694	0.49293	0.90959	0.95436	0.96237	0.49691	0.80799	0.71855			
		0.91395	0.85216															
8	0.0058	0.37757	0.92252	0.91684	0.83931	0.12415	0.61783	0.85720	0.49249	0.90964	0.95462	0.96820	0.49321	0.80784	0.71853			
		0.91391	0.85170															
9	0.0041	0.37752	0.92246	0.91702	0.83932	0.12416	0.61779	0.85736	0.49222	0.90968	0.95473	0.97232	0.49095	0.80767	0.71852			
		0.91389	0.85130															
10	0.0029	0.37749	0.92242	0.91712	0.83931	0.12417	0.61777	0.85746	0.49205	0.90971	0.95478	0.97521	0.48951	0.80751	0.71851			
		0.91389	0.85098															
11	0.0020	0.37747	0.92240	0.91718	0.83931	0.12418	0.61776	0.85752	0.49194	0.90973	0.95481	0.97723	0.48858	0.80738	0.71851			
		0.91388	0.85074															
12	0.0014	0.37746	0.92238	0.91721	0.83931	0.12418	0.61776	0.85756	0.49187	0.90974	0.95482	0.97864	0.48797	0.80729	0.71851			
		0.91388	0.85057															
13	0.0010	0.37745	0.92237	0.91723	0.83930	0.12418	0.61775	0.85759	0.49182	0.90975	0.95483	0.97963	0.48755	0.80722	0.71851			
		0.91388	0.85044															

Convergence criterion satisfied.

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure

Initial Factor Method: Iterated Principal Factor Analysis

Eigenvalues of the Reduced Correlation Matrix: Total = 11.7691414 Average = 0.73557134

	Eigenvalue	Difference	Proportion	Cumulative
1	6.67045231	2.98357650	0.5668	0.5668
2	3.88687581	2.27470180	0.3133	0.8800
3	1.41217402	1.04855383	0.1200	1.0000
4	0.36362018	0.17742932	0.0309	1.0309
5	0.18619086	0.01975917	0.0158	1.0467
6	0.16643169	0.10834904	0.0141	1.0609
7	0.05808265	0.04640035	0.0049	1.0658
8	0.01168230	0.02906529	0.0010	1.0668
9	-0.01738298	0.02227157	-0.0015	1.0653
10	-0.03965455	0.03446503	-0.0034	1.0620
11	-0.07411958	0.00992832	-0.0063	1.0557
12	-0.08404790	0.01512084	-0.0071	1.0485
13	-0.09916874	0.01143110	-0.0084	1.0401
14	-0.11059984	0.02393913	-0.0094	1.0307
15	-0.13453897	0.09231689	-0.0114	1.0193
16	-0.22685586		-0.0193	1.0000

Factor Pattern

	Factor1	Factor2	Factor3
Cu	0.91928	0.04525	-0.32819
Cr	0.91898	0.19092	-0.16967
Zn	0.90398	0.27240	-0.15000
Ag	0.89573	-0.05234	-0.22917
Pb	0.83123	-0.00576	-0.16593
V	0.80713	0.30926	0.32147
Ni	0.73880	0.45509	0.23301
Cd	0.61489	0.05359	-0.33295
DO_B	-0.43927	0.79731	-0.29761
OS_B	-0.40226	0.73840	-0.36367
Fe	0.48310	0.61268	0.60899

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Initial Factor Method: Iterated Principal Factor Analysis

Factor Pattern

	Factor1	Factor2	Factor3
pH_B	-0.08438	-0.31290	0.13841
Water_Depth	0.06187	-0.61020	0.03579
Eh_B	0.47292	-0.62320	0.07565
Salinity	0.51493	-0.79980	0.13243
Mn	0.08441	0.45954	0.51890

Variance Explained by Each Factor

Factor1	Factor2	Factor3
6.6704523	3.6868758	1.4121740

Final Communality Estimates: Total = 11.769502

Water_Depth	Salinity	DO_B	OS_B	pH_B	Eh_B	Ag	Cd
0.37744739	0.92237386	0.91722764	0.83930286	0.12418418	0.61775198	0.85759083	0.49181524
Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
0.90975305	0.95482565	0.97962658	0.48755158	0.80721738	0.71850743	0.91388406	0.85044242

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3
1	0.89533	-0.31425	0.31564
2	0.13674	0.86838	0.47667
3	-0.42388	-0.38362	0.82046

Rotated Factor Pattern

	Factor1	Factor2	Factor3
Cu	0.96836	-0.12368	0.04246
Cr	0.92082	-0.05791	0.24186
Zn	0.91020	0.01020	0.29210
Ag	0.89196	-0.23902	0.06975
Pb	0.81378	-0.20256	0.12348
Cd	0.69899	-0.01897	-0.05354
DO_B	-0.15812	0.94457	-0.00277
OS_B	-0.10504	0.90713	-0.07337
pH_B	-0.17700	-0.29830	-0.06222
Water_Depth	-0.04322	-0.56305	-0.24197
Et_B	0.30613	-0.71881	-0.08572
Salinity	0.29553	-0.90715	-0.11006
Fe	0.25818	0.14661	0.94418
Mn	-0.08154	0.17347	0.67143
V	0.62867	-0.10840	0.66593
Ni	0.62493	0.07364	0.64129

Variance Explained by Each Factor

	Factor1	Factor2	Factor3
5.6698665	3.6467515	2.4528841	

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Rotation Method: Varimax

Final Communality Estimates: Total = 11.769502

Water Depth	Salinity	DO_B	OS_B	pH_B	Eh_B	Ag	Cd
0.37744739	0.92237386	0.91722764	0.83930286	0.12418418	0.61775198	0.85759083	0.49181524
Cr	Cu	Fe	Mn	Ni	Pb	Zn	V
0.90975305	0.95482565	0.97962658	0.48755158	0.80721738	0.71850743	0.91388406	0.85044242

Factor analysis showing interrelationship among predictors (3 factor solution)

The FACTOR Procedure
Rotation Method: Varimax

Scoring Coefficients Estimated by Regression

Squared Multiple Correlations of the Variables with Each Factor

Factor1	Factor2	Factor3
0.9884786	0.9962060	1.0328655

Standardized Scoring Coefficients

	Factor1	Factor2	Factor3
Cu	0.84794554	0.1026759	-1.0716182
Cr	0.3839074	0.03886205	-0.0799156
Zn	-0.0717178	-0.150616	0.895205
Ag	-0.254933	0.13275294	0.38175913
Pb	-0.0366069	0.06850129	0.0372228
Cd	0.0405533	0.0633091	-0.1054684
DO_B	0.16306781	0.90737485	-0.2587898
OS_B	-0.0209444	-0.3790128	0.10788225
pH_B	0.00643502	0.05856752	-0.0475077
Water_Depth	-0.0071595	0.08479069	-0.0400706
Eh_B	-0.0445274	0.0272965	0.06196341
Salinity	0.07769276	-0.7586249	0.0754031
Fe	-0.3264563	-0.2709262	1.46137783
Mn	0.00665253	0.00173469	-0.1202257
V	0.13718483	0.21227227	-0.1924969
Ni	0.19462607	0.07172056	-0.5666786

Prediction of presence of clams by factor 1

The LOGISTIC Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Response Variable	clam
Number of Response Levels	2
Number of Observations	90
Model	Binary logit
Optimization Technique	Fisher's scoring

Response Profile

Ordered Value	clam	Total Frequency
1	1	24
2	0	66

Probability modeled is clam=1.

NOTE: 8 observations were deleted due to missing values for the response or explanatory variables.

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	106.385	108.184
SC	108.885	113.183
-2 Log L	104.385	104.184

Prediction of presence of clams by factor 1

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	0.2012	1	0.6538
Score	0.1944	1	0.6593
Wald	0.1932	1	0.6602

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.0145	0.2390	18.0191	<.0001
Factor1	1	-0.1121	0.2549	0.1932	0.6602

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits
Factor1	0.894	0.542 1.473

Association of Predicted Probabilities and Observed Responses

Percent Concordant	46.3	Somers' D	-.037
Percent Discordant	50.1	Gamma	-.039
Percent Tied	3.6	Tau-a	-.015
Pairs	1584	c	0.481

```

Prediction of presence of clams by factor 2
The LOGISTIC Procedure

      Model Information

Data Set      WORK.FACOR_SCORES
Response Variable      clam
Number of Response Levels      2
Number of Observations      90
Model      binary logit
Optimization Technique      Fisher's scoring

      Response Profile

Ordered      Total
Value      clam      Frequency

   1         1         24
   2         0         66

Probability modeled is clam=1.

NOTE: 8 observations were deleted due to missing values for the response or explanatory variables.

```

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	106.385	94.217
SC	108.885	99.217
-2 Log L	104.385	90.217

Prediction of presence of clams by factor 2

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	14.1673	1	0.0002
Score	13.1431	1	0.0003
Wald	11.4014	1	0.0007

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.2383	0.2890	18.3569	<.0001
Factor2	1	1.0133	0.3001	11.4014	0.0007

Odds Ratio Estimates

Effect	P oint Estimate	95% Wald Confidence Limits
Factor2	2.755	1.530 4.960

Association of Predicted Probabilities and Observed Responses

Percent Concordant	75.4	Somers' D	0.510
Percent Discordant	24.4	Gamma	0.511
Percent Tied	0.3	Tau-a	0.202
Pairs	1584	C	0.755

Prediction of presence of clams by factor 3

The LOGISTIC Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Response Variable	clam
Number of Response Levels	2
Number of Observations	90
Model	Binary logit
Optimization Technique	Fisher's scoring

Response Profile

Ordered Value	clam	Total Frequency
1	1	24
2	0	66

Probability modeled is clam=1.

NOTE: 8 observations were deleted due to missing values for the response or explanatory variables.

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	106.385	108.384
SC	108.885	113.383
-2 Log L	104.385	104.384

Prediction of presence of clams by factor 3

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	0.0012	1	0.9726
Score	0.0012	1	0.9726
Wald	0.0012	1	0.9726

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-1.0116	0.2384	18.0104	<.0001
Factor3	1	-0.00810	0.2358	0.0012	0.9726

Odds Ratio Estimates

Effect	Estimate	Point Estimate	95% Wald Confidence Limits
Factor3	0.992	0.625	1.575

Association of Predicted Probabilities and Observed Responses

Percent Concordant	36.6	Somers' D	0.057
Percent Discordant	30.9	Gamma	0.084
Percent Tied	32.4	Tau-a	0.022
Pairs	1584	c	0.528

Appendix IV

Appendix 4

A supplementary analysis of PCB levels in sampled clams was suggested by Professor Yehuda Klein (Program in Earth and Environmental Sciences). Tobit analysis was developed by economist James Tobin, who integrated linear regression with probit analysis. The approach combines the analysis of a measured variable, suitable to regression, with a binary variable, suitable to probit analysis. The name, tobit, a contraction of Tobin and probit, was not assigned to the method by Tobin himself. Per Professor Klein's suggestion, data with undetectable PCB levels were censored and those with measured PCB were analyzed in their full metric. The tobit method is parallel to the regression and logistic models already performed on the PCB data, but applies them, in a sense, synchronously.

The results of the tobit analyses did not differ from the previously reported analyses. Predictors employed were latitude and the three composite measures derived from factor analysis. The model using latitude as a predictor did yield a trend, as has been seen in previously reported analyses. Due to the high skew of the PCB in those clams with measurable quantities, a second set of analyses was performed on the data using the log of the PCB concentrations. This analysis did not yield any significant results, either. All analyses are provided below.

In summary, an appropriate statistical method, tobit analysis, was applied to the PCB levels in the sampled clams. Unfortunately, no significant findings can be reported. The results were consistent with the results obtained from logistic and regression modeling. The projection of increased PCB concentration by change in latitude cannot be applied meaningfully to the different upstream fresh water mollusk species for which there is no correlative data. However the general predicted increase in concentration is meaningful.

* "Estimation of Relationships for Limited Dependent Variables"; James Tobin; *Econometrica* Vol. 26 No. 1, January 1958.

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Factor1
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.4910877

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Factor1	1	0.1351	0.7132

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	431.6860	93.9732	247.5019 615.8700	21.10	<.0001
Factor1	1	-54.4435	148.1219	-344.757 235.8702	0.14	0.7132
Scale	1	271.6606	61.8508	173.8713 424.4488		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BIQ/0 from Factor1
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-15.34130441

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Factor1	1	0.1500	0.6985

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	2.6878	0.4296	1.8458 3.5298	39.14	<.0001
Factor1	1	0.2793	0.7212	-1.1342 1.6928	0.15	0.6985
Scale	1	1.2740	0.3384	0.7569 2.1442		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Factor2
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.54313259

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Factor2	1	0.0301	0.8622

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	427.2324	107.5064	216.5237 637.9411	15.79	<.0001
Factor2	1	18.4478	106.2736	-189.845 226.7402	0.03	0.8622
Scale	1	274.0450	62.6921	175.0235 429.0891		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Factor2
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-15.37173345

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Factor2	1	0.0889	0.7656

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	2.7392	0.4869	1.7848 3.6935	31.65	<.0001
Factor2	1	-0.1411	0.4732	-1.0686 0.7864	0.09	0.7656
Scale	1	1.2731	0.3396	0.7548 2.1474		

Program: tobit.sas run on 26APR06

Model1: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Factor3
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.49020944

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Factor3	1	0.1394		0.7089

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Limits	Chi-Square	Pr > ChiSq
Intercept	1	432.8244	92.7580	251.0221 614.6266	21.77	<.0001
Factor3	1	34.7391	93.0425	-147.621 217.0991	0.14	0.7089
Scale	1	269.0981	61.9656	171.3576 422.5888		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Factor3
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-15.35506322

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Factor3	1	0.1249	0.7238

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	2.6634	0.4212	1.8379 3.4888	39.99	<.0001
Factor3	1	0.1561	0.4418	-0.7099 1.0221	0.12	0.7238
Scale	1	1.2621	0.3408	0.7434 2.1425		

Program: tobit.sas run on 26APR06

Model: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Latitude
Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-51.4623725

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Latitude	1	2.8633	0.0906

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-40097.5	23937.08	-87013.3 6818.294	2.81	0.0939
Latitude	1	987.3046	583.4667	-156.269 2130.878	2.86	0.0906 close
Scale	1	237.5670	53.4539	152.8484 369.2422		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Latitude
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.25967698

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Latitude	1	0.3263	0.5678

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	-65.4937	119.3022	-299.322 168.3343	0.30	0.5830
Latitude	1	1.6606	2.9071	-4.0372 7.3584	0.33	0.5678
Scale	1	1.2565	0.3333	0.7471 2.1131		not so.

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Water_Depth
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.56633691

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Water_Depth	1	0.1938	0.6598

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	388.8705	142.8375	108.9141 668.8270	7.41	0.0065
Water_Depth	1	7.5238	17.0905	-25.9730 41.0206	0.19	0.6598
Scale	1	266.3878	60.3304	170.8983 415.2322		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Water_Depth
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.15321877

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Water_Depth	1	0.5316	0.4659

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square Pr > ChiSq
Intercept	1	2.2714	0.6551	0.9875 3.5553	12.02 0.0005
Water_Depth	1	0.0574	0.0788	-0.0969 0.2118	0.53 0.4659
Scale	1	1.2353	0.3277	0.7345 2.0775	

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Salinity
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.33187244

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Salinity	1	0.4786	0.4891

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	581.7903	238.0866	115.1491 1048.432	5.97	0.0145
Salinity	1	-12.9853	18.7709	-49.7756 23.8050	0.48	0.4891
Scale	1	267.7229	60.8808	171.4432 418.0717		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BIQ/0 from Salinity
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

```

Data Set      WORK.FACOR_SCORES
Dependent Variable  log_pcb
Censoring Variable  censor
Censoring Value(s)  1
Number of Observations      24
Noncensored Values          7
Right Censored Values      17
Left Censored Values        0
Interval Censored Values    0
Missing Values              74
Name of Distribution      Normal
Log Likelihood      -15.41516427
    
```

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq	Wald
Salinity	1	0.0010	0.9750	

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	2.6429	1.0656	0.5544 4.7315	6.15	0.0131
Salinity	1	0.0027	0.0852	-0.1643 0.1697	0.00	0.9750
Scale	1	1.2869	0.3419	0.7645 2.1663		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from DO_B
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	25
Noncensored Values	7
Right Censored Values	18
Left Censored Values	0
Interval Censored Values	0
Missing Values	73
Name of Distribution	Normal
Log Likelihood	-52.60633318

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
DO_B	1	0.0156		0.9005

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	510.4192	585.9095	-637.942 1658.781	0.76	0.3837
DO_B	1	-13.3157	106.4932	-222.039 195.4072	0.02	0.9005
Scale	1	270.5716	62.0424	172.6238 424.0954		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from DO_B
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	25
Noncensored Values	7
Right Censored Values	18
Left Censored Values	0
Interval Censored Values	0
Missing Values	73
Name of Distribution	Normal
Log Likelihood	-15.2704339

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
DO_B	1	0.3022	0.5825

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	4.0952	2.6515	-1.1016 9.2920	2.39	0.1225
DO_B	1	-0.2651	0.4823	-1.2105 0.6802	0.30	0.5825
Scale	1	1.2501	0.3327	0.7420 2.1062		

Program: tobit.sas run on 26APR06

Model1: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from OS_B
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information	
Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.51823221

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
OS_B	1	0.0820	0.7746

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	604.2369	596.9255	-565.716 1774.189	1.02	0.3114
OS_B	1	-2.4077	8.4085	-18.8882 14.0727	0.08	0.7746
Scale	1	269.7619	62.2396	171.6292 424.0043		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from OS_B
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-15.17926943

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
OS_B	1	0.5014	0.4789

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	4.5204	2.6801	-0.7324 9.7733	2.84	0.0917
OS_B	1	-0.0268	0.0378	-0.1009 0.0473	0.50	0.4789
Scale	1	1.2316	0.3294	0.7291 2.0804		

Program: tobit.sas run on 26APR06

Model: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from pH_B
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.53154401

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
pH_B	1	0.0545	0.8153

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	9158.766	37352.07	-64050.0 82367.49	0.06	0.8063
pH_B	1	-1189.72	5094.397	-11174.6 8795.117	0.05	0.8153
Scale	1	270.9279	62.1779	172.7838 424.8195		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BIQ/0 from pH_B
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-15.28605648

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
pH_B	1	0.2659	0.6061

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	97.9675	184.8416	-264.315 460.2504	0.28	0.5961
pH_B	1	-13.0013	25.2146	-62.4210 36.4185	0.27	0.6061
Scale	1	1.2656	0.3340	0.7545 2.1228		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Eh_B
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-52.29232777

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Eh_B	1	0.5641	0.4526

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	1216.339	1053.143	-847.784 3280.461	1.33	0.2481
Eh_B	1	-2.4756	3.2963	-8.9363 3.9850	0.56	0.4526
Scale	1	263.9317	60.4404	168.4870 413.4440		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Eh_B
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	24
Noncensored Values	7
Right Censored Values	17
Left Censored Values	0
Interval Censored Values	0
Missing Values	74
Name of Distribution	Normal
Log Likelihood	-15.41504717

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Eh_B	1	0.0012		0.9721

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	2.4932	5.1801	-7.6596 12.6460	0.23	0.6303
Eh_B	1	0.0006	0.0163	-0.0315 0.0326	0.00	0.9721
Scale	1	1.2868	0.3420	0.7643 2.1664		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Ag
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.42076262

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Ag	1	0.5273	0.4677

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	540.8883	174.2974	199.2717 882.5049	9.63	0.0019
Ag	1	-50.0527	68.9274	-185.148 85.0426	0.53	0.4677
Scale	1	261.4984	59.2602	167.7149 407.7244		

Program: tobit.sas run on 26APR06

The LIFEREG Procedure

Model Information

```

Data Set
Dependent Variable      WORK.FACOR_SCORES
Censoring Variable      log_pcb
Censoring Variable(s)   censor
Number of Observations   26
Noncensored Values       7
Right Censored Values    19
Left Censored Values     0
Interval Censored Values 0
Missing Values           72
Name of Distribution      Normal
Log Likelihood           -15.40137936

```

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq	Wald
Ag	1	0.0314	0.8594	

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	2.5436	0.8412	0.8950 4.1923	9.14	0.0025
Ag	1	0.0612	0.3456	-0.6162 0.7386	0.03	0.8594
Scale	1	1.2866	0.3403	0.7661 2.1608		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Cd
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.59289791

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Cd	1	0.1455		0.7029

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	341.4143	268.1523	-184.154 866.9831	1.62	0.2029
Cd	1	75.5671	198.1001	-312.702 463.8361	0.15	0.7029
Scale	1	268.0947	60.5672	172.1817 417.4354		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Cd
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

```

Data Set          WORK.FACOR_SCORES
Dependent Variable log_pcb
Censoring Variable censor
Censoring Value(s) 1
Number of Observations      26
Noncensored Values          7
Right Censored Values      19
Left Censored Values        0
Interval Censored Values    0
Missing Values              72
Name of Distribution      Normal
Log Likelihood          -15.15893342
    
```

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq	Wald
Cd	1	0.4968	0.4809	

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	1.8714	1.1636	-0.4092 4.1521	2.59	0.1078
Cd	1	0.6082	0.8629	-1.0830 2.2995	0.50	0.4809
Scale	1	1.2381	0.3288	0.7357 2.0836		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Cr
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.63202436

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Cr	1	0.0726	0.7876

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	352.9579	332.2121	-298.166 1004.082	1.13	0.2880
Cr	1	1.3907	5.1610	-8.7247 11.5060	0.07	0.7876
Scale	1	269.3666	60.7341	173.1503 419.0485		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Cr
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.12864699

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Cr	1	0.5933		0.4412

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	1.4555	1.5926	-1.6658 4.5768	0.84	0.3607
Cr	1	0.0192	0.0250	-0.0297 0.0681	0.59	0.4412
Scale	1	1.2375	0.3278	0.7363 2.0798		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Cu
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.52456436

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Cu	1	0.2935		0.5880

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	548.3600	227.3769	102.7096 994.0104	5.82	0.0159
Cu	1	-1.6434	3.0335	-7.5890 4.3023	0.29	0.5880
Scale	1	266.8294	60.0925	171.6071 414.8893		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BIQ/0 from Cu
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.3721301

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Cu	1	0.0908	0.7632

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	2.3546	1.1257	0.1483	4.5608	0.0365
Cu	1	0.0047	0.0156	-0.0260	0.0354	0.7632
Scale	1	1.2755	0.3380	0.7588	2.1441	

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Fe
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.60532985

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Fe	1	0.1275		0.7210

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	225.1978	603.4436	-957.530 1407.925	0.14	0.7090
Fe	1	66.6957	186.7812	-299.389 432.7803	0.13	0.7210
Scale	1	267.0802	60.6435	171.1461 416.7892		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Fe
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.3163851

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Fe	1	0.2082	0.6482

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	1.3579	2.8873	-4.3011 7.0169	0.22	0.6381
Fe	1	0.4103	0.8991	-1.3519 2.1724	0.21	0.6482
Scale	1	1.2531	0.3366	0.7402 2.1215		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Mn
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.6502537

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Mn	1	0.0358	0.8499

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	476.4000	216.2318	52.5935 900.2064	4.85	0.0276
Mn	1	-0.0331	0.1748	-0.3757 0.3095	0.04	0.8499
Scale	1	271.4351	61.4149	174.2101 422.9205		

Program: tobit.sas run on 26APR06

Model12: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Mn
Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

```
Data Set          WORK.FACOR_SCORES
Dependent Variable log_pcb
Censoring Variable censor
Censoring Value(s) 1
Number of Observations      26
Noncensored Values          7
Right Censored Values      19
Left Censored Values        0
Interval Censored Values    0
Missing Values              72
Name of Distribution         Normal
Log Likelihood              -15.41396063
```

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Chi-Square	Pr > ChiSq
Mn	1	0.0065	0.0065	0.9357

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	2.5987	1.0182	0.6030 4.5944	6.51	0.0107
Mn	1	0.0001	0.0008	-0.0016 0.0017	0.01	0.9357
Scale	1	1.2843	0.3398	0.7646 2.1572		

Program: tobit.sas run on 26APR06

Model1: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Ni
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.39294447

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Ni	1	0.5859		0.4440

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	24.8615	539.5264	-1032.59 1082.314	0.00	0.9632
Ni	1	11.1552	14.5735	-17.4083 39.7188	0.59	0.4440
Scale	1	257.1204	59.3880	163.5052 404.3351		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Ni
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-14.85176695

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq
Ni	1	1.3096	0.2525

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-0.1818	2.4692	-5.0213 4.6577	0.01	0.9413
Ni	1	0.0768	0.0671	-0.0547 0.2083	1.31	0.2525
Scale	1	1.1455	0.3159	0.6672 1.9666		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Pb
 Wednesday, April 26, 2006 14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.63102792

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Pb	1	0.0765		0.7821

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	500.6788	242.2888	25.7819 975.5758	4.27	0.0388
Pb	1	-0.7145	2.5828	-5.7766 4.3477	0.08	0.7821
Scale	1	269.0343	60.6695	172.9237 418.5629		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BLQ/0 from Pb
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.35705566

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Pb	1	0.1199	0.7292

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	2.2531	1.2676	-0.2313 4.7375	3.16	0.0755
Pb	1	0.0049	0.0141	-0.0227 0.0324	0.12	0.7292
Scale	1	1.2777	0.3378	0.7610 2.1451		

Program: tobit.sas run on 26APR06

Modell: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from Zn
Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.66725432

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald	Pr > ChiSq
Zn	1	0.0020		0.9640

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	456.7176	383.2547	-294.448 1207.883	1.42	0.2334
Zn	1	-0.0937	2.0782	-4.1669 3.9795	0.00	0.9640
Scale	1	270.9419	61.4339	173.7293 422.5512		

Program: tobit.sas run on 26APR06

Model2: Tobit analysis to predict log coded PCB level with censoring for BUQ/0 from Zn
 Wednesday, April 26, 2006

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	_log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.22781893

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
Zn	1	0.4056	0.5242

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	1.5296	1.8102	-2.0184 5.0776	0.71	0.3981
Zn	1	0.0064	0.0100	-0.0132 0.0259	0.41	0.5242
Scale	1	1.2282	0.3313	0.7239 2.0841		

Program: tobit.sas run on 26APR06

Model: Tobit analysis to predict linear coded PCB level with censoring for BLQ/0 from V
 Wednesday, April 26, 2006

14:12

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-52.5979389

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Pr > ChiSq	Wald
V	1	0.1421	0.7062	

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	616.8049	483.7299	-331.288 1564.898	1.63	0.2023
V	1	-6.2055	16.4629	-38.4721 26.0611	0.14	0.7062
Scale	1	269.5641	60.6449	173.4458 418.9482		

Program: tobit.sas run on 26APR06

The LIFEREG Procedure

Model Information

Data Set	WORK.FACOR_SCORES
Dependent Variable	_log_pcb
Censoring Variable	censor
Censoring Value(s)	1
Number of Observations	26
Noncensored Values	7
Right Censored Values	19
Left Censored Values	0
Interval Censored Values	0
Missing Values	72
Name of Distribution	Normal
Log Likelihood	-15.39508425

Algorithm converged.

Type III Analysis of Effects

Effect	DF	Chi-Square	Wald Pr > ChiSq
V	1	0.0445	0.8329

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits	Chi- Square	Pr > ChiSq
Intercept	1	3.1583	2.3497	-1.4469 7.7636	1.81	0.1789
V	1	-0.0170	0.0805	-0.1748 0.1408	0.04	0.8329
Scale	1	1.2833	0.3396	0.7640 2.1557		

Program: tobit.sas run on 26APR06

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