

NEW YORK BIGHT BENTHIC
SAMPLING SURVEY:
COPROSTANOL, POLYCHLORINATED
BIPHENYL AND POLYNUCLEAR
AROMATIC HYDROCARBON MEASURE-
MENTS IN SEDIMENTS
(1980 - 1981)

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. Administrative Information

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1.2 Organization

ERCO (Energy Resources Co. Inc.),

1.3 Present Funding Level

\$25,996

1.4 Title of Work Unit

New York Bight Benthic Sampling Survey:
Coprostanol, PCB and Polynuclear Aromatic
Hydrocarbon Measurements in Sediments
(1980-1981)

1.5 Major NEMP Cruises

None

1.6 Reports or Publications

None at present

1.7 NEMP Work Monitor

Mr. Robert Reid

1.8 Duration of Work

23 September 1981 - 31 March 1982

2. Objectives

The goal of this effort was to perform analytical measurements of the coprostanol and polychlorinated biphenyl (PCB) content of 42 surface sediment samples from the New York Bight and to analyze 6 selected samples for their polynuclear aromatic hydrocarbon (PAH) content. This effort is a continuation of the benthic survey started in 1980 (Boehm, 1980). Therefore, another objective of this work was to compare previous (1980) and current (1981) results.

The presence of coprostanol, a fecal steroid, has been utilized previously as an indicator of municipal sewage contamination in a given region (Hatcher and McGillivray, 1979; Hatcher et al., 1977; Escalona et al., 1980; Kanazawa and Teshima, 1978; Boehm 1981; Boehm 1982a,b; Boehm et al., 1982).

PCB compounds are ubiquitous contaminants of estuarine and near-shore sediment (e.g., Saylor et al., 1978; West and Hatcher, 1980) as are PAH (e.g., Windsor and Hites, 1979); these two categories of pollutants include both toxic and mutagenic compounds.

The organic chemical makeup of these sediments, along with the important support measurements of total organic carbon and grain size determinations, define the geochemical pollutant sources in the area and can thus be used to measure changes in the nature and quantity of these compounds with time.

3. Summary of Activities and Rationale

3.1 Sampling Activities

Forty-two (42) samples (100 g) of surface sediment from New York Bight were provided by NOAA/NMFS personnel for analysis. Samples were collected at those stations indicated in Section 6, Figures 6-1 and 6-2 and Table 6-1. Samples were collected during R/V Albatross cruise no. AL-81-09, 10-19 August 1981.

3.2 Analytical Methodology

All samples were processed as before (Boehm, 1981) (i.e., extracted and fractionated) using the ball-mill tumbler method of Brown et al. (1979) as modified for the shaking table by Boehm et al. (1980) and adapted for coprostanol analysis using the method of Hatcher and McGillivray (1979). This latter method involves isolation of the f_3 , or polar, fraction from a silica gel column in a methanol eluate followed by drying and silylation using N,O-bis (trimethyl silyl) acetamide in pyridine solution, to form the trimethyl silyl ethers of the alcoholic compounds (e.g., sterols).

The entire analytical scheme is illustrated in Figure 3-1. This scheme allows for simultaneous preparation of extract fractions for PCB and PAH analysis. PCB analyses were performed by electron capture gas chromatography (EC-GC), PAH analysis by glass capillary gas chromatography/mass spectrometry (GC²/MS), and sterol analysis by GC².

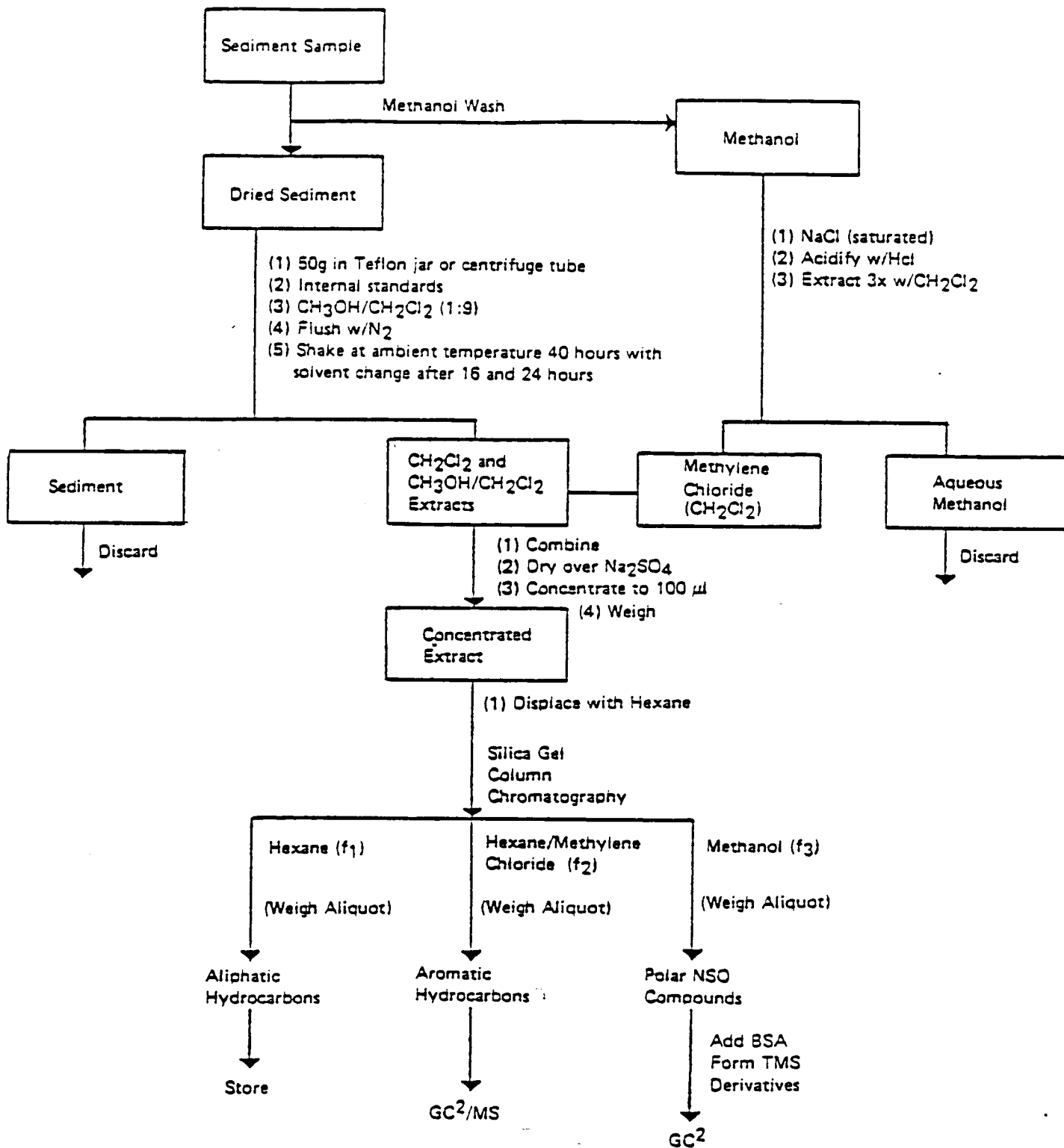


Figure 3.1. Analytical scheme for sediment samples.

4. Summary of Findings

This section presents the absolute levels and areal distributions of PCB, coprostanol and PAH compounds in the sediment samples along with a presentation of several key parameter ratios and their use. Data from the current effort are compared with that obtained previously (Boehm 1981).

4.1 Polychlorinated Biphenyls

PCB concentrations ranged from 0.5 at stations 23 and 33 to 430 ppb (=ng/g) at Station NYB-18 (Table 4-1). This range of values compares well with those of West and Hatcher (1980) from the New York Bight Apex which ranged from 0.5 to 2,220 ppb. The 2,220 ppb value is associated with the sewage sludge dumpsite in the region (West and Hatcher, 1980). The comparable values here are from Stations 6 and 7 (144 and 23 ppb, respectively), which may indicate that the heart of the sludge deposit was not sampled. Most of the West and Hatcher values of surface sediments fall in the 0.5 to 360 ppb range.

Previously obtained results from this laboratory (Boehm, 1981) indicated maximum PCB levels in sewage dumpsite samples were 120 ppb.

In order to evaluate temporal changes in the data one must know what variability is seen in the results of replicate analyses. Replicate PCB analyses (three sediment subsamples from same grab analyzed separately) from Station 2 gave PCB concentrations of 102, 22, and 78 ppb ($\bar{x}=67\pm 41$; coefficient of variation of 0.61) indicating a high degree of small-scale patchiness inherent in the pollutant distributions in the area. The analyses of subsamples of sediments from five separate grabs (Boehm 1982b) indicate coefficients of variation (s/\bar{x}) of 0.28 at Station 6 and 0.26 at Station 15. Given this variability, an observed temporal change of an order of magnitude should indicate a likely temporal change. Order of magnitude increases (1980 to 1981) in PCB levels were observed at Stations 8, 10, 14, 15, 16, 21, 31, and 37 while decreases were observed at Stations 9, 19, and 33. These differences may be attributable to (1) region-wide PCB changes, (2) movement of PCB contaminated material, and/or (3) ship positioning variability.

Striking changes in PCB levels are apparent at many stations at which one would expect a high degree of patchiness (i.e., in the dumpsite areas 18, 6, and 8). However, PCB increases at Stations 31, 10, and 1 may indicate movement of PCB-contaminated material into these areas. (Note below that coprostanol increases are also seen at Stations 1, 10, 31, and 18, among others, and a PAH increase is observed at Station 31).

The nature of the PCB composition most closely resembles a combination of Aroclor 1016, consisting mainly of di- and trichlorobiphenyls, and to a lesser extent Aroclor 1254, consisting of tri-, tetra-, and pentachlorobiphenyls. The composition of a typical sample is shown in Figure 4-1.

Table 4.1. PCB and Coprostanol Content of New York Bight Sediments

| Station | PCB ng/g=ppb | | Coprostanol µg/g=ppm | | Coprostanol/ Σ Steroids | | Coprostanol/ PCB | |
|---------|-----------------|------|-------------------------|-------|----------------------------|-------|---------------------|------|
| | 1981 | 1980 | 1981 | 1980 | 1981 | 1980 | 1981 | 1980 |
| 1 | 170 | 31 | 6.4 | 1.2 | 0.27 | 0.24 | 38 | 40 |
| 2 | 67 | 34 | 2.3 | 1.6 | 0.26 | 0.30 | 23 | 50 |
| 3 | 17 | 29 | 1.1 | 0.7 | 0.21 | 0.26 | 65 | 20 |
| 4 | 28 | 26 | 0.06 | 0.03 | 0.05 | 0.02 | 2 | 1 |
| 5 | 120 | 120 | 3.4 | 0.13 | 0.28 | 0.02 | 28 | 1 |
| 6 | 144 | 55 | 17.4 | 11.0 | 0.58 | 0.74 | 121 | 200 |
| 7 | 23 | 32 | 5.3 | 5.6 | 0.59 | 0.47 | 230 | 170 |
| 8 | 33 | 4.0 | 0.70 | 0.10 | 0.14 | 0.04 | 21 | 1 |
| 9 | 3.0 | 28 | 0.06 | 1.9 | 0.01 | 0.38 | 20 | 70 |
| 10 | 160 | 17 | 3.1 | 0.26 | 0.12 | 0.20 | 19 | 20 |
| 11 | 8.0 | 9.2 | 0.83 | 2.3 | 0.24 | 0.41 | 104 | 250 |
| 12 | 1.0 | 2.0 | 0.07 | 0.03 | 0.03 | 0.01 | 70 | 20 |
| 13 | 16 | 17 | 0.36 | 0.10 | 0.06 | <0.01 | 23 | 6 |
| 14 | 4.0 | <0.5 | 0.05 | 0.07 | 0.01 | 0.02 | 13 | -- |
| 15 | 8.8 | <0.5 | 0.05 | 0.07 | 0.01 | 0.03 | 6 | -- |
| 16 | 38 | <0.5 | 1.3 | 0.23 | 0.08 | 0.03 | 34 | 30 |
| 17 | 14 | NA | 0.37 | NA | 0.05 | NA | 26 | -- |
| 18 | 430 | 66 | 4.5 | 0.14 | 0.15 | 0.03 | 10 | 2 |
| 19 | 3.0 | 20 | 0.06 | 0.06 | 0.02 | 0.01 | 20 | 3 |
| 20 | 3.0 | 0.5 | 0.03 | 0.02 | 0.03 | 0.01 | 10 | 4 |
| 21 | 4.0 | <0.5 | 0.14 | 0.07 | 0.14 | 0.06 | 35 | -- |
| 22 | 3.0 | 0.7 | 0.45 | 0.31 | 0.21 | 0.25 | 150 | 400 |
| 23 | 0.5 | NA | <0.01 | NA | 0.01 | NA | -- | -- |
| 24 | 1.0 | 1.4 | 0.01 | 0.01 | 0.01 | <0.01 | 10 | 7 |
| 25 | 2.0 | 0.5 | 0.02 | 0.01 | 0.01 | 0.02 | 10 | 30 |
| 26 | 2.0 | <0.5 | <0.01 | 0.01 | 0.01 | 0.01 | -- | -- |
| 27 | 1.0 | <0.5 | <0.01 | <0.01 | <0.01 | <0.01 | -- | -- |
| 28 | 1.0 | 3.8 | 0.03 | 0.09 | 0.01 | 0.13 | 30 | 20 |
| 29 | 1.0 | NA | <0.01 | NA | <0.01 | NA | -- | -- |
| 30 | 1.0 | <0.5 | 0.01 | 0.29 | <0.01 | <0.01 | 10 | -- |
| 31 | 79 | <0.5 | 4.1 | <0.01 | 0.36 | <0.01 | 52 | -- |
| 32 | 1.0 | NA | 0.01 | NA | 0.01 | NA | 10 | -- |
| 33 | 0.5 | 4.0 | <0.01 | 0.04 | 0.01 | 0.03 | -- | 10 |
| 34 | 1.0 | <0.5 | 0.01 | NA | <0.01 | 0.07 | 10 | -- |
| 35 | 2.0 | NA | 0.03 | NA | <0.01 | --- | 15 | -- |

Table 4.1. Continued.

| Station | PCB ng/g=ppb | | Coprostanol μg/g=ppm | | Copro/ Σ Steroids | | Copro/ PCB | |
|---------|-----------------|------|-------------------------|------|----------------------|------|---------------|------|
| | 1981 | 1980 | 1981 | 1980 | 1981 | 1980 | 1981 | 1980 |
| 36 | 1.0 | NA | <0.01 | NA | <0.01 | NA | -- | -- |
| 37 | 8.0 | <0.5 | <0.01 | 0.01 | <0.01 | 0.04 | -- | -- |
| 38 | 3.0 | <0.5 | 0.01 | 0.01 | <0.01 | 0.03 | 3 | -- |
| 39 | NA | NA | NA | 0.15 | --- | 0.12 | -- | -- |
| 40 | 43 | 71 | 1.6 | 0.13 | 0.15 | 0.02 | 37 | 2 |
| 41 | 1.0 | 1.0 | <0.01 | 0.01 | 0.03 | 0.07 | -- | 10 |
| 42 | 8.0 | 7.2 | 0.13 | 0.01 | 0.05 | 0.01 | 16 | 1 |
| 43 | 3.0 | <0.5 | 0.06 | 0.01 | 0.03 | <.10 | 20 | -- |
| 44 | 1.0 | 3.5 | 0.02 | 0.01 | <0.01 | 0.02 | 20 | 3 |

NA = not analyzed

--- = indeterminate due to NA or less than number for coprostanol or PCB value.

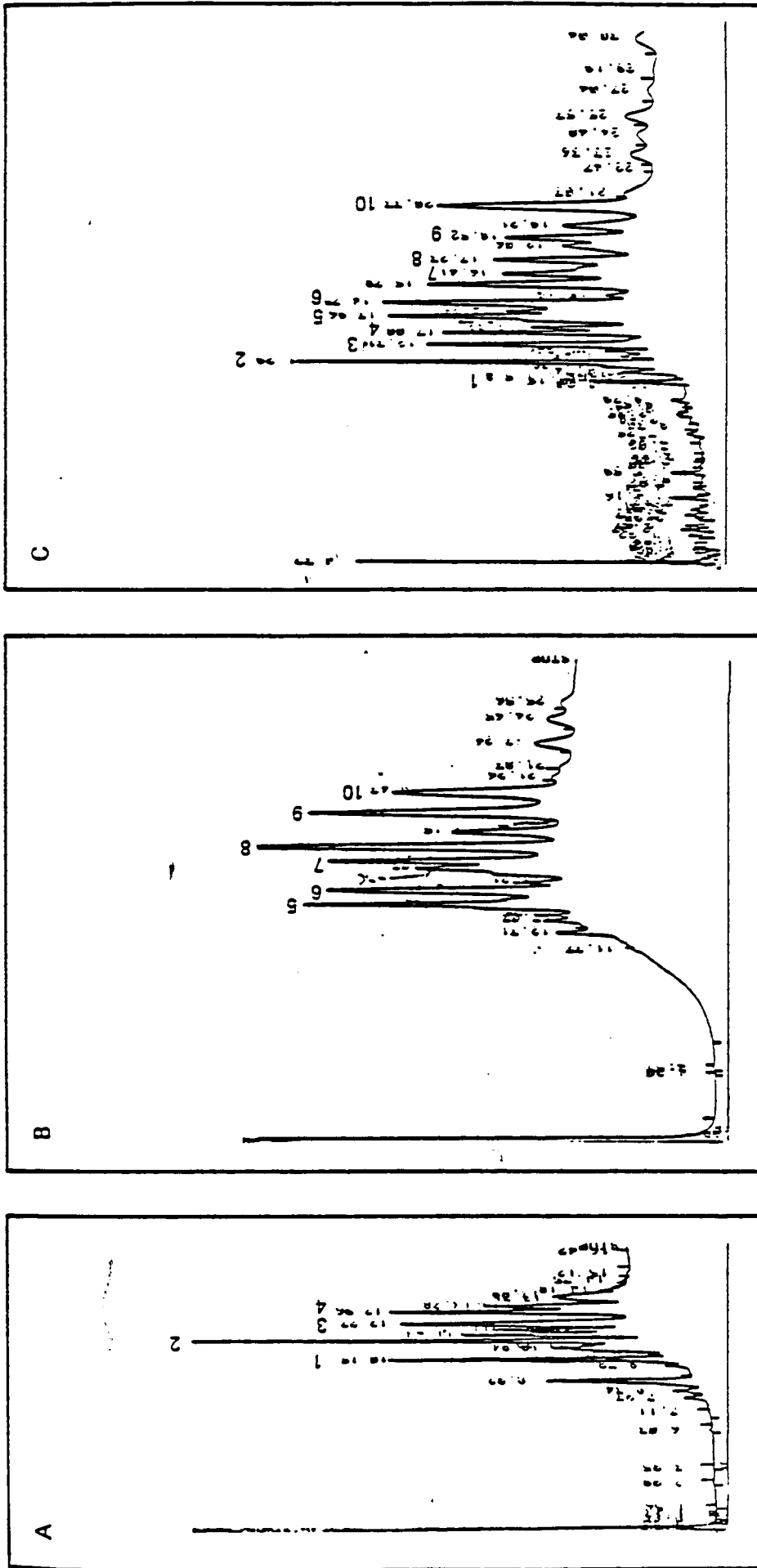


Figure 4.1. Electron Capture Gas Chromatograms of PCB Composition in Surface Sediment; A—Aroclor 1016 Standard; B—Aroclor 1254 Standard; C—Representative Sediment Sample.

A contour map (Figure 4-2) illustrating PCB distributions in the study region indicates that the main source of PCB in the region is the sewage sludge dumpsite. Dredge spoils do contribute to PCB but their inputs are not evident in the contours due to a lack of stations in the vicinity of the dredge spoil dumpsite. Secondary PCB "hot spots" are seen at Station 10 in the upper Hudson Valley (a depositional area), at Station 13 further down the valley, and at Station 31 east of the area shown in Figure 4.2. Surely direct transport out of the estuary of PCB material is occurring (Boehm, 1982a), but levels are low and sediment distributions caused by direct transport are masked by the greater influences of dumping.

4.2 Coprostanol

The amounts of the fecal steroid coprostanol in the surface sediment (Table 4-1) ranged from not detectable (<0.01 ppm) to 17 ppm. Hatcher and McGillivray (1979) reported concentrations in the area from 0.06 to 5.2 ppm and Boehm (1981) reported a range of <0.1 to 11 ppm (see Table 4-1). The importance of sewage-derived organic matter relative to other inputs can be examined using the ratio of coprostanol to total measured sterols (=coprostanol + sitosterol + cholesterol + cholestanol). This ratio in sewage sludge is approximately 33% (Hatcher and McGillivray, 1979). Thus a scale of 0 to 33% should define the relative sewage versus other organic inputs to the sediments. The percentage of coprostanol in clean sands from stations within the region is generally about 1% or less, indicating low inputs of sewage-derived organics, according to this scheme, while Stations 6 and 7 from the sewage dump site contain a high percentage of sewage. Coprostanol/total steroid values reported here range from 0 to 0.59, thus establishing a scale for the extent of sewage impact. Boehm (1981) previously reported a range of values from 0 to 0.74.

The values reported in Table 4-1 do define a percent sewage input scale, assuming that the 74% value is that found in the sludge itself (not analyzed here). It appears that regardless of the absolute coprostanol value observed that this ratio is of considerable importance in discerning dumping impact regions in the Bight. Thus ratios greater than 0.2 would delineate regions impacted to a major extent by the deposition of sewage material (Stations 1, 2, 3, 5, 6, 7, 11, 22, 31). Values greater than 0.1 indicate significant albeit lesser impacts. Values around 0.1 may also be derived from materials dredged from sewage-impacted harbors.

Another potentially useful parameter is that of the ratio of coprostanol to PCB. PCB are, of course, found in both dredged material and sewage sludge. Elevated coprostanol-to-PCB ratios thus indicate that the bulk of the PCBs present are sewage-derived. The absolute quantity of coprostanol in the sewage material itself is unknown. Coprostanol/PCB ratios in sediments in or near the sewage dump site (e.g., Stations 6 and 7) are 100-200. Other stations with PCBs apparently derived from sewage (i.e., copros: PCB > 100) are Stations NYB 11 and 22). Station 22 contains low quantities of both PCB and coprostanol, but appears to be influenced by sewage. Several other samples (NYB 1, 2, 5, 12, 13, 16, 17, 21, 28, 31, and 40) are suspected to be influenced by sewage-derived organic matter by virtue of the coprostanol/PCB ratio (30-100).

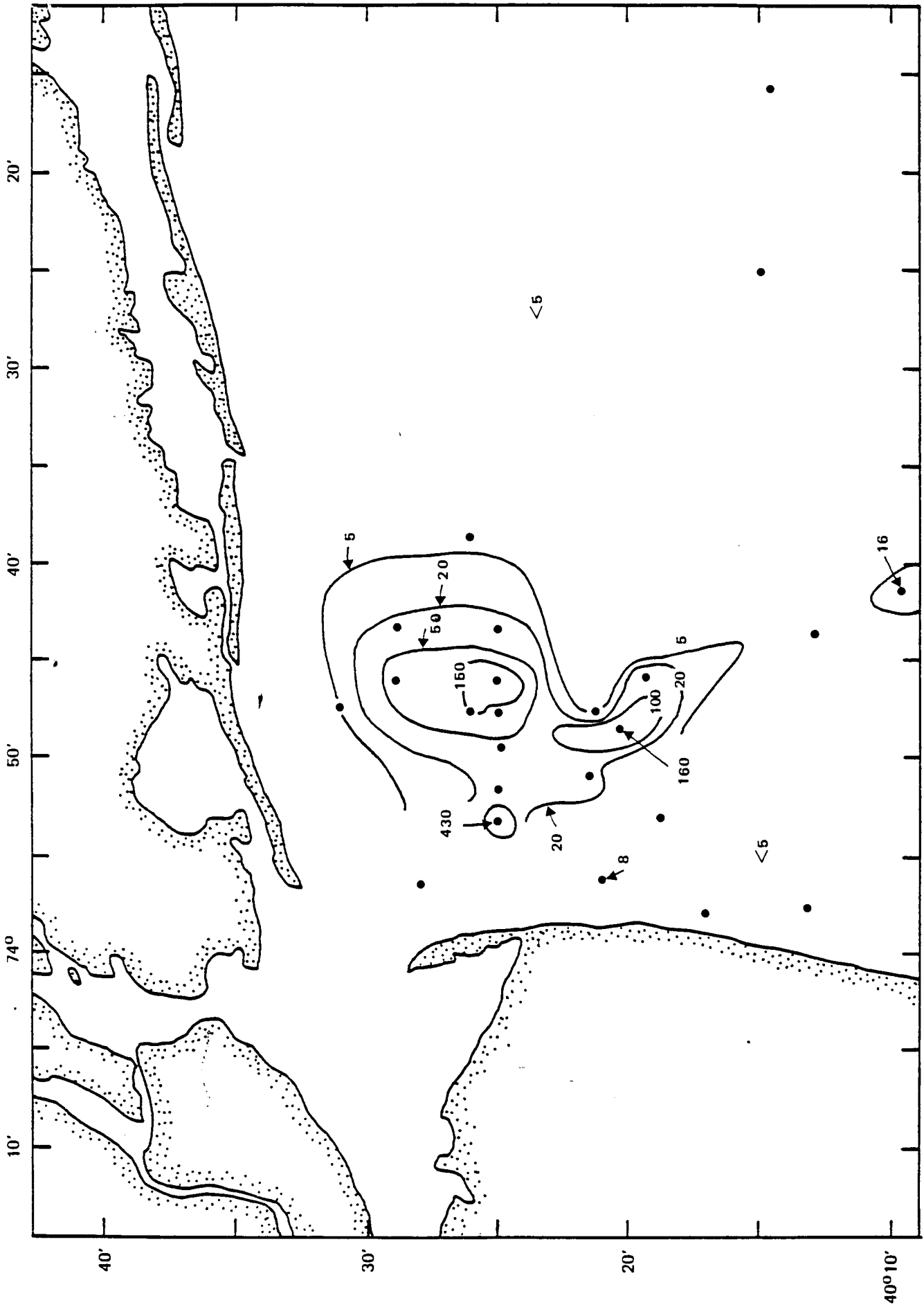


Figure 4.2 Subjective PCB Concentration Contours (ppb).

Of note is the fact that several other stations (NYB 4, 8, 10, and 18) contain somewhat equivalent PCB concentrations to those influenced by sewage, but by virtue of low coprostanol/PCB and percent coprostanol values (Table 4-1) are linked with another source material; i.e., dredge spoil. The highest PCB concentration of 430 ppb is found at Station 18, in close proximity to the dredge spoil dumping area. Station 10, although seemingly close to another station influenced by the sewage material (Station 11), is primarily composed of dredging material by this criterion.

Contours (Figure 4-3) of coprostanol concentrations in the sediment strongly suggest two sources or components of the coprostanol distribution: (1) the sewage sludge deposit, and (2) transport of sewage related organics directly from the New York Harbor area via resuspension and transport of outer and inner harbor material.

That the nature of the pollutant material has changed (1980 to 1981) at several stations is indicated by changes in the values for these diagnostic ratios. For example, Station 5 seems now (1981) to be noticeably impacted by sewage material, although the copros/total steroids and copros/PCBs ratios were low (0.02 and 1) in 1980. A lesser change is apparent (Table 4.1) at Stations 8 and 40 where sewage-derived material is now a more important input than had been discerned previously.

Variability in coprostanol measurements is not as great as that for PCB. Replicate analyses at Station 2 indicate close agreement among three subsamples (1.9, 1.8, and 2.3 ppm). Additional data (Boehm, 1982b) obtained from the analysis of five replicate grabs indicate reasonable precision as well (17.4 ± 5.7 ; $s/\bar{x} = 0.33$). Thus we can have greater confidence in temporal changes in coprostanol levels. Thus real temporal variability is observed at many of the stations studied (Table 4.1). That these changes may be attributable to imperfect repositioning of the ship cannot be ruled out, however.

4.3 Polynuclear Aromatic Hydrocarbons

PAHs are widely distributed in the study region (Table 4.2). PAH levels are greatest at Station NYB 6 (Σ PAH=31 ppm) followed by NYB 31 (2.3 ppm) > NYB 7 (1.0 ppm) = NYB 4 (0.95 ppm) > NYB 15 (0.5 ppm) > NYB 15 (0.14 ppm) > NYB 9 (0.05 ppm) >> NYB 26 (0 ppm). This sequence differs from that observed in 1980 (Boehm, 1981) due to the observed large increase in PAH levels at NYB 31 (see Table 4.2) and decrease at NYB 9. The NYB 9 decrease is probably due to a sampling problem which occurred in 1981 when a sandy patch was sampled. However, the observed increase at NYB 31 is difficult to explain. This observation may be due to movement of contaminated sediment from the dumping area. Indeed, all parameters (PAH, coprostanol, and PCB) are higher at this station in 1981.

Precise sources of PAH compounds to the sediments are difficult to discern. However, a mixed source represented by petroleum material and combustion products seems most likely. Petroleum sources are indicated by a high amount of alkylated (C_1, C_2, C_3, C_4) naphthalenes, phenanthrenes, fluorenes, and dibenzothiophenes relative to the parent (unsubstituted) compounds (i.e., C_0) (Youngblood and Blumer, 1975). Combustion sources are indicated by an equal or larger amount of C_0 compounds relative to

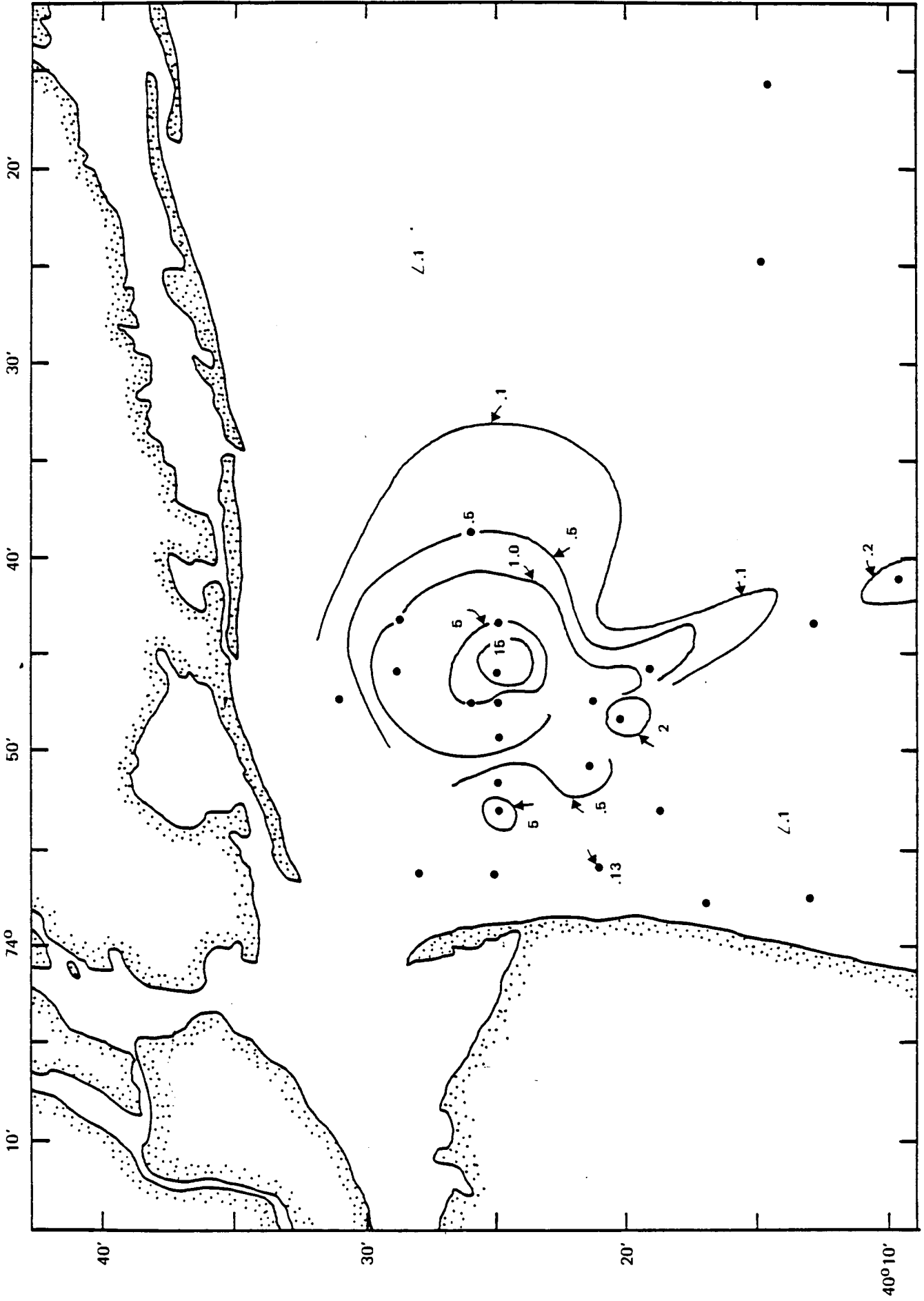


Figure 4.3. Subjective Coprostanol Concentration Contours (ppm).

Table 4.2. Summary of PAH Data (ng/g dry weight = ppb)

| Compound or Homologous Compound Series | 4 | 6 | 7 | 9 | 14 | 15 | 26 | 31 |
|--|-------|--------|-------|-------|------|-----|-----|-------|
| 1-Total naphthalenes (C ₀ -C ₄) | nd | 6,600 | 300 | nd | nd | 10 | nd | 380 |
| 2-Total dibenzothiophenes (C ₀ - C ₃) | nd | 1,700 | nd | nd | nd | <1 | nd | nd |
| 3-Total phenanthrenes (C ₀ - C ₄) | 150 | 13,000 | 390 | 20 | 25 | 130 | nd | 870 |
| Phenanthrene (C ₀) | 84 | 1,300 | 23 | 20 | 6.2 | 110 | -- | 200 |
| 4-Total m/e 202 and 216 | 200 | 3,800 | 77 | 4.0 | 34 | 140 | nd | 500 |
| Flouranthene (202) | 80 | 1,600 | 38 | 2.0 | 20 | 72 | -- | 220 |
| Pyrene (202) | 70 | 1,400 | 39 | 2.0 | 14 | 55 | -- | 250 |
| 5-Total m/e 228 and 242 | 350 | 2,400 | 100 | 13.1 | 22.0 | 87 | nd | 300 |
| Benzanthracene (228) | 100 | 660 | 51 | 4.1 | 5.2 | 18 | -- | 80 |
| Chrysene (228) | 120 | 840 | 46 | 9.0 | 16.0 | 32 | -- | 210 |
| 6-Total m/e 252 | 250 | 3,360 | 139 | 17.1 | 64.0 | 126 | nd | 244 |
| Benzo(a)pyrene | 75 | 670 | 36 | nd | 11.0 | 26 | -- | 75 |
| Benzo(e)pyrene | 32 | 1,000 | 21 | 8.1 | 9.5 | 40 | -- | 32 |
| Benzofluoranthenes | 120 | 1,300 | 51 | 9.0 | 37 | 45 | -- | 120 |
| Perylene | 17 | 380 | 31 | nd | 6.0 | 15 | -- | 17 |
| 7-Total PAH (1-6) | 950 | 31,000 | 1,010 | 50 | 150 | 493 | nd | 2,300 |
| % Petroleum PAH (1981) ^a | 7% | 59% | 64% | 0% | 10% | 14% | -- | 38% |
| Total PAH | 7,800 | 20,000 | 1,800 | 9,900 | 300 | 300 | 60 | 100 |
| % Petroleum PAH (1980) ^a | 64% | 23% | 64% | 31% | 17% | 18% | 10% | 15% |

^a % Petroleum PAH = $\frac{\text{total naphthalenes} + \text{total dibenzothiophenes} + (\text{C}_3 + \text{C}_4 \text{ Phenanthrenes}) + 1/2(\text{C}_0 + \text{C}_1 + \text{C}_2 \text{ Phenanthrenes})}{\text{total PAH}}$

^bFrom Boehm (1981).

are indicated by an equal or larger amount of C₀ compounds relative to C₁ and C₂ plus large relative quantities of the larger PAH compounds (fluoranthene and pyrene [4 rings], benzofluoranthene and the benzopyrenes [5 rings]). Several of the samples contain significant levels of anthracene, known to be abundant in combustion products of coal (Lee et al., 1977). Recent studies by Tripp et al. (1981) indicate that PAH compounds from petroleum may be difficult to distinguish from those from uncombusted coal, thus complicating the source evaluation of PAH to these sediment samples.

A "percent petroleum" scale is presented taking into account the relative amounts of the petroleum-related PAH and pyrogenic PAH (see Table 4.2). Thus the PAH at Stations 6 and 7 remain primarily of a petroleum origin (64%) while 14 and 15 remain primarily pyrogenic (~10%). Major shifts in composition are observed at Stations 4, 31, and 9, reflecting the heterogeneity in the system. This PAH parameterization represents a powerful means for observing the changes not only in absolute PAH levels but also in the nature (sources) of the pollutants.

5. Interpretation of Findings

The PCB, coprostanol and PAH data sets represent a powerful set of data with which one can monitor changes in both absolute levels and sources of pollutants to the New York Bight. The major sources of these pollutants are easily distinguishable from each other through consideration of the key parameter ratios of coprostanol/PCB, coprostanol/total steroids and potentially through ratios of these chemical components to total organic carbon content of the sediment. The coprostanol/total steroid ratio signifies the relative impact of sewage-derived material at a station, ranging from 0 to NO.75; and the coprostanol/PCB ratio indicates the relative contribution of sewage-PCB vis-a-vis other inputs (i.e., dredge spoils). PAH concentrations and composition vary as well, with the highest concentrations of total PAH associated with sewage sludge deposits. PAH have their origins in both petroleum and pyrogenic sources, with greater relative quantities of four- and five-ringed pyrogenic (combustion-related) aromatic hydrocarbons found in the pyrogenics. By examining the relative inputs of the petroleum aromatics to the total PAH (Table 4-2), the relative quantities of the two major PAH inputs can be discerned. Major inputs of petroleum aromatics are observed at Station 6, 7 and 31 in the survey while pyrogenic PAH dominate elsewhere.

Thus while the organic pollutant assemblage is quite complex in this region, compound groupings fall roughly, but notably, into monitorable source functions, as was seen in Sections 4.2, 4.2, and 4.3.

While most of the organic pollutants related to ocean-dumping activities are restricted to the Bight Apex and to the Christiaensen Basin in particular, movement of those PCB, PAH and coprostanol compounds out onto the continental shelf (e.g., Station 31) was detected as was transport of coprostanol and PAH compounds seaward within the Hudson Canyon (Stations 14, 15, 16, and 17).

The relationship of levels of PCB and PAH reported here in the benthic substrate with those in benthic organisms is unknown at present, and the

two data sets must be co-interpreted. However, Boehm (1980) has explored levels of these compounds in species of finfish and have determined that those silver hake and flounder species obtained in the Bight area do contain higher levels of these pollutants. PCB compositions, though, are different, with most resembling Aroclor 1254 in fish but composed of both 1016 and 1254-type formulations in the sediment. Resuspension of bottom sediment and movement in the water column, thus directly impacting finfish, or resuspension followed by uptake by the prey of the finfish could result in loss of the more soluble 1016 prior to PCB accumulation by finfish. Indeed, such sediment resuspension has been observed near the sewage disposal site by virtue of water column samplings (Boehm, 1982a; Boehm et al., 1982).

The sources and transport of polluted sediment, uptake by benthic organisms and final assimilation by higher trophic levels (finfish) all merit both further, more detailed organic biogeochemical study and most importantly coincident data interpretation and synthesis so as to best understand the "biogeochemical system" and hence focus upon the best strategy of monitoring of chemical change in this stressed environment. Such an effort is presently under way (ERCO, unpublished data), examining in fine detail levels of organic pollutants in animals and within sediments.

Large variability in the PCB measurements due to patchiness in the region make temporal changes at a given station difficult to discern unless an order of magnitude change is observed. Such large changes are observed in the study area (Station 31) and indicate important movement of contaminated sediment within the region.

6. Inventory of Data

Table 6-1 presents the identify of those sediment samples analyzed and the nature of the analyses performed on each sample.

The locations of the samples are indicated in Figures 6-1 and 6-2.

Table 6-1. Summary of Sediment Samples Analyzed for Organic Contaminants (1981)

| Station | Analysis | | |
|---------|-------------|-----|-----|
| | Coprostanol | PCB | PAH |
| NYB: 1 | X | X | |
| 2 | X | X | |
| 3 | X | X | |
| 4 | X | X | X |
| 5 | X | X | |
| 6 | X | X | X |
| 7 | X | X | X |
| 8 | X | X | |
| 9 | X | X | X |
| 10 | X | X | |
| 11 | X | X | |
| 12 | X | X | |
| 13 | X | X | |
| 14 | X | X | X |
| 15 | X | X | X |
| 16 | X | X | |
| 17 | X | X | |
| 18 | X | X | |
| 19 | X | X | |
| 20 | X | X | |
| 21 | X | X | |
| 22 | X | X | |
| 23 | X | X | |
| 24 | X | X | |
| 25 | X | X | |
| 26 | X | X | X |
| 27 | X | X | |
| 28 | X | X | |
| 29 | X | X | |
| 30 | X | X | |
| 31 | X | X | X |
| 32 | X | X | |
| 33 | X | X | |
| 34 | X | X | |
| 35 | X | X | |
| 36 | X | X | |
| 37 | X | X | |
| 38 | X | X | |
| 39 | X | X | |
| 40 | X | X | |
| 41 | X | X | |
| 42 | X | X | |
| 43 | X | X | |
| 44 | X | X | |

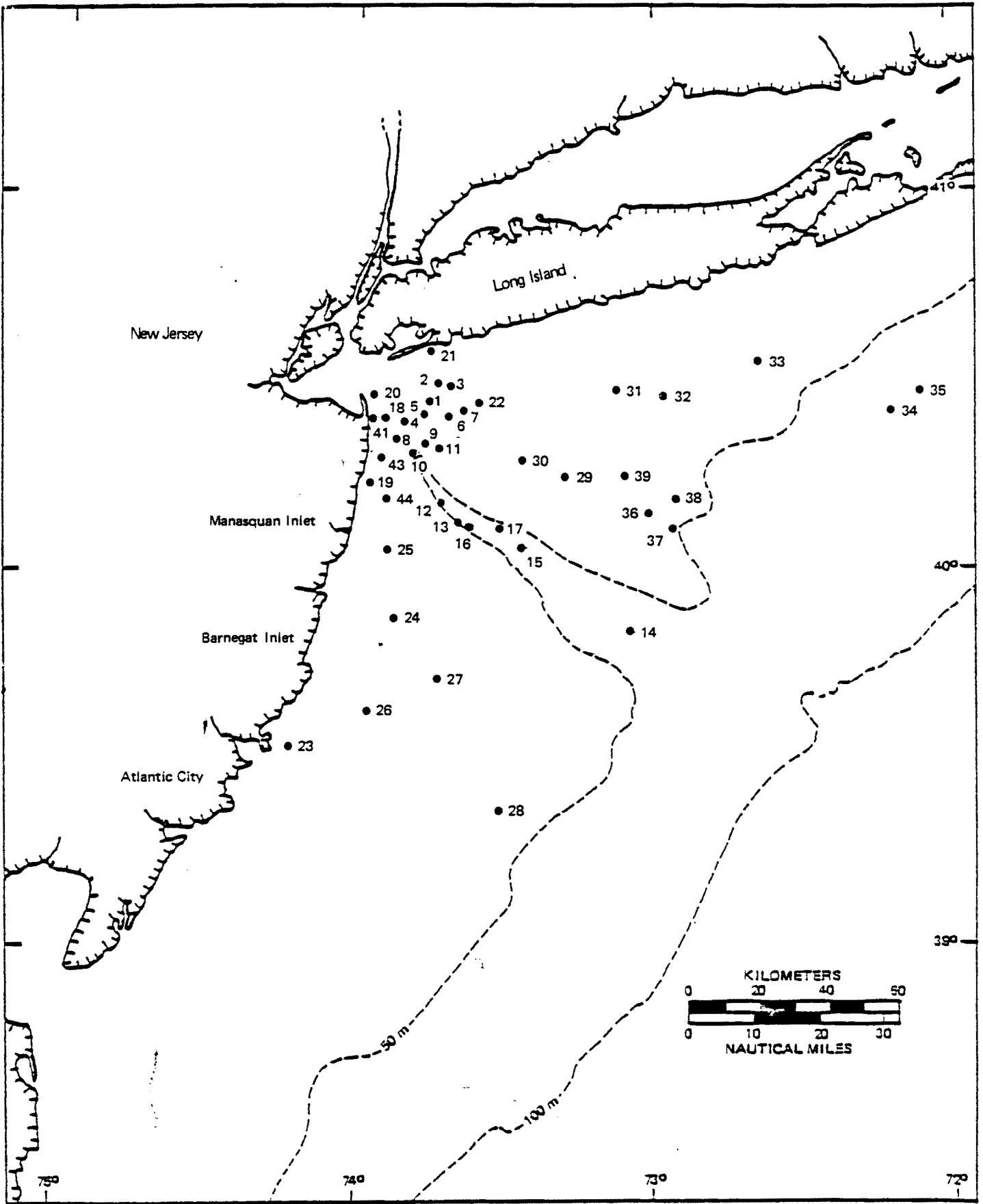


Figure 6.1. Location of Samples Selected for Analysis.

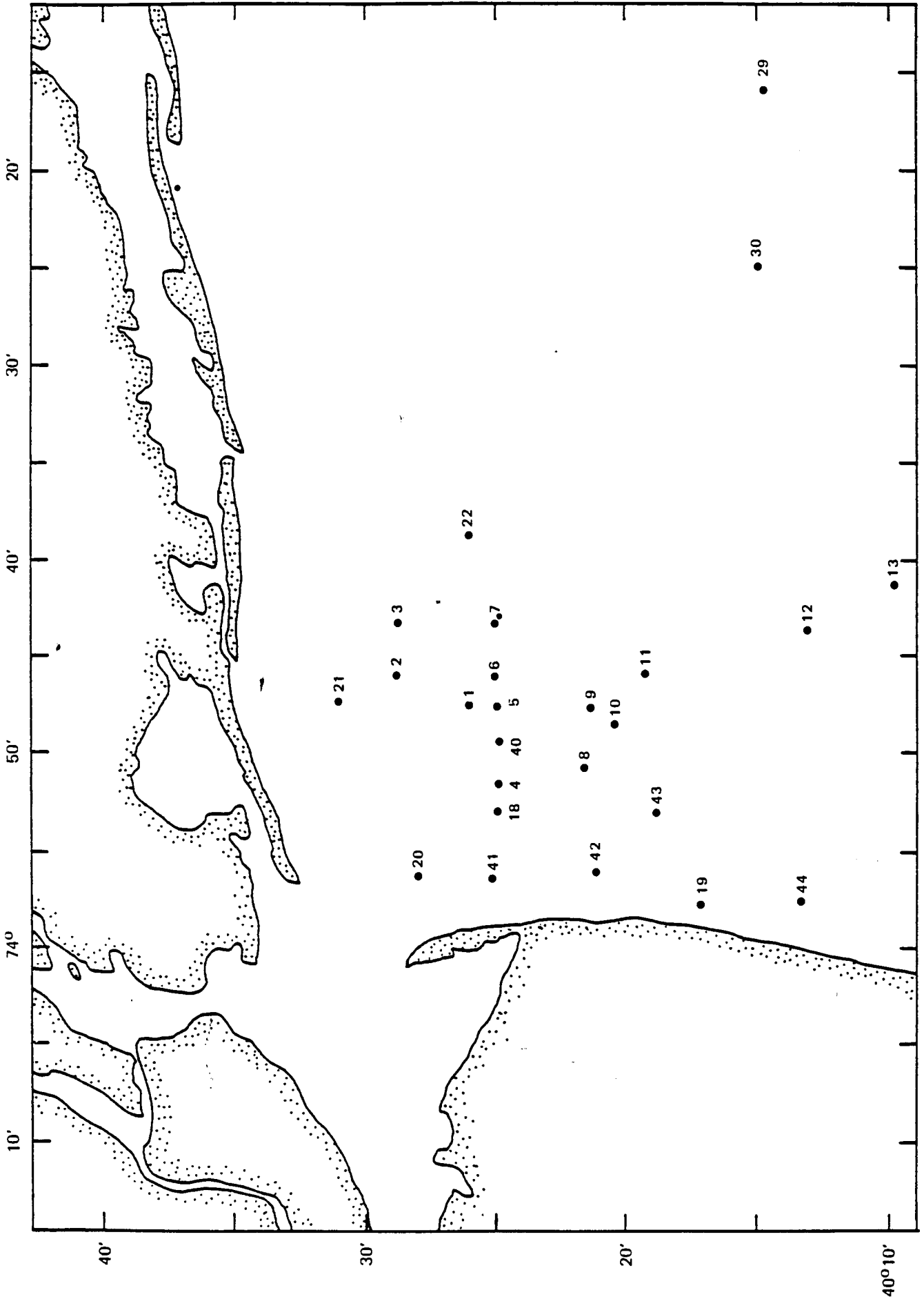


Figure 6.2. New York Bight Detail Station Locations for R/V Albatross IV Cruise 81-09, Northeast Monitoring Program (NEMP 81-10). Sediment Quality Monitoring Survey, During 10-19 August 1981.

7. Statement of Problems

In Boehm (1981) several recommendations were made to increase the value of the type of survey undertaken. These are repeated here.

There are several areas for improvement of both the caliber and interpretability of the generated data which would aid greatly in future monitoring work.

The first pertains to source materials and refining our ability to discern the identity of the specific pollutant source in the various samples. Simply stated, samples of dredge spoil(s) and sewage sludge(s) should be obtained for analysis for PCB, coprostanol and PAH compounds to establish not only absolute levels but, perhaps more importantly, the ratio of the various compounds to one another.

Secondly, total organic carbon and grain size measurements should be provided prior to the interpretation of the organic chemistry data, as these parameters are essential for interpretation of geochemical distributions.

Thirdly, PCB measurements should be broken down into specific chlorinated hydrocarbons, i.e., monochloro-, dichloro-, trichloro-, tetrachloro-, pentachloro-, and hexachlorobiphenyls, instead of Aroclor formulations. Such work, involving high-resolution GC² and GC²/MS, would greatly fine-tune the PCB distribution on the same level of sophistication as the PAH compounds. Thus the ability to monitor changes in absolute concentrations and sources of PCB would be greatly enhanced.

An additional comment pertains to the ability to monitor changes in the measured parameters in sediments. The sampling and subsampling variabilities must be studied further both in low-level and high-level samples in order to be able to note a statistically significant change at a given station. Multiple sampling such as that conducted in the 1981 Northeast Areawide Study (Boehm 1982b), wherein each parameter value at each station consisted of the mean and standard deviation of that measured parameter obtained from the analysis of five replicate grabs at each station, needs to be undertaken routinely. Lastly, the relationship of sediment pollutant levels to benthic animal pollutant burdens needs to be included in future studies.

8.0 Data Appendices

(None.)

9. References Cited

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