RETURN TO 1998 ROD AR INDEX

Site: New Bedford Harbor
Breaks: 3.4.4
Other: 223265

PRELIMINARY DATA REPORT

NEW BEDFORD HARBOR PROJECT

DRAFT

October 1, 1986

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REVISED 12/27/88

EXPERIMENTAL DESIGN AND SAFETY CONSIDERATIONS FOR EXPERIMENTS USING NEW BEDFORD HARBOR SEDIMENTS.

The following documents describe the design of two experiments to investigate: 1, the toxicity of New Bedford Harbor sediments to two amphipods, Ampelisca and Rhepoxinius and 2, the effects of contaminants including PCBs accumulated in Cyprinodon gametes on survival and growth of progeny. Included are the design, chain- of-custody requirements, and safety considerations because the degree of contamination is severe and the data will be used in litigation.

Sediment collection and processing in New Bedford and before testing

Safety considerations: Dr. Royal Nadeau from Region 2's Environmental Response Team has stated that personnel that participate in collecting these sediments should wear Class C protective clothing. This should consist of two layers of gloves, the outer layer being made of rubber, and a full body suit made of Tivex-Saran. A wet suit or mustang suit should be worn beneath the body suit in case of cold-water immersion. A full-faced pesticide mask is also required. Dennis Body is investigating requirements relative to mask design and the requirements, if any, for pulmonary function tests. Hansen and Scott have been fitted. Dr. Nadeau has sent us a copy of the Environmental Response Team's manual of safety practices for the handling of hazardous materials, which is available for review. All personnel involved in the handling of the sediments (Hansen, Scott, Redmond, and Berry) will be required to have their blood analyzed for PCBs before and after that handling.

Sediments will be collected from about 12 sites that span the range of contamination found in the harbor, approximately 1-10,000 ppm PCB on a dry weight basis. Sediment will be collected beginning at zones of low contamination and progress to zones of increasing contamination in order to minimize cross-contamination and to develop proficiency to minimize handling and contamination. First, up to ten samples will be collected in the area below the Coggeshall St. Bridge, where the sediment is below the 50 ppm PCB (by weight) level of contamination, and "Class C" protection is not required. Then, up to four samples will be from sites above the bridge, where PCB concentrations in sediments will range from 50-10,000 ppm. Here "Class C" protective clothing will be required for all those handling the sediments. A Ponar grab will be used to collect the sediment. Small cores will be taken from each of the first

three grabs at each site for chemical analysis as described in the analytical section. In addition three cores will be taken at each of ten sites for Ampelisca sediment core experiments. Each set of three cores will be capped, placed in a plastic bag, and the bags will be sealed in 4 gallon plastic buckets. Each bucket will hold the cores from two sites. Sediment from below the bridge (<50ppm) will be placed directly in 16 gallon polyethylene drums with lids and sealers. The four drums from above the bridge (>50 ppm PCB) will be placed into 30 gallon drums which also have lids and sealers as an extra precaution. After transport to ERL-N all the drums will be stored at 4C in the walk-in refrigerator in G-04, along with the buckets containing the cores for the amphipod work. All drums and buckets will be washed and rinsed as per the requirements in Dr. Nadeau's manual.

We will contract SAIC to do the sediment collection. The integrity of the boat and the personnel doing the collecting will be the responsibility of the Corps of Engineers. This will greatly reduce our contact with the sediment. There will, however, have to be at least one ERLN person on board to take care of chain-of-custody and to handle "clean" samples (David Hansen). In addition , John Scott will assist the two people actually taking the samples, both for ERLN and COE. His role will be to core dredge samples and process them in the manner described in the Analytical Chemistry section of this document, and to seal the samples for storage. Each sample must be logged in when it is taken, and sealed with an EPA chain-of-custody seal. Every time that the sample is opened, and the seal broken and sediment removed it must be entered into the log, and a new seal must be re-applied when the sample container is resealed. Signatures and record keeping will be those for reasonable chain-of-custody. The Litigation Response Team from the National Enforcement Investigations Center is planning to instruct us at ERL-N on chain-of-custody procedures and will conduct a litigation audit for analytical and biological QA/QC.

Six sample sites will be chosen on the basis of the results from the initial chemical analyses. The samples from these sites will be homogenized out-of-doors at ERL-N and placed directly in their own storage or testing containers. A large fiberglass tank will be set up, and draped with a plastic sheet. This will be used for spill and splash containment. All the operations involving homogenization and transfer of the sediment will take place inside this tank. A short length of PVC pipe will be used to mix the samples, progressing from least to most contaminated. After each sample has been homogenized a small aliquot will be taken for chemical analysis. See the analytical section of this document for details. The rest of the sample will be placed

directly into exposure chambers or into individual containers for storage. The storage containers and exposure chambers will be covered with a plastic sheet with a hole in it during filling. This will minimize the contamination of the outside of the chambers and containers. Any unused sediment will be disposed of or kept in storage barrels and will be kept in the laboratory at 4C. Only the exact amount of sediment needed from each site will be processed in this way, any extra sediment will be disposed of. Once the sediment is in the exposure chambers it will be covered with a layer of seawater. The water layer serves as a protective barrier because of the low solubility of PCBs in water. The experimental chambers will then be covered and placed into a covered, spill-proof cart before they are brought into the laboratory.

All effluents will be routed through the effluent treatment system. The system is being modified to prevent the escape of PCB contaminated air into the laboratory. At the end of the NBH testing the sand and charcoal in the effluent treatment system will be chemically analyzed for PCBs. If the sand or charcoal is significantly more contaminated than it was before the NBH testing it will be removed and replaced. If flow-through procedures are used effluents entering and leaving the treatment system will be chemically monitored weekly.

The aquaria and exposure area will be labled appropiately to identify risk of exposure and only designated employees (Hansen, Scott, Redmond, and Berry) will be allowed access to the exposure areas. The laboratory space in G-17 will be given wipe tests and chemical analysis before, during, and after the experiment.

SEDIMENT HANDLING AND TEST TERMINATION

At the termination of all tests sufficient water will be drained from the exposure chambers into the effluent treatment system, to facilitate the removal of the exposure chambers from the laboratory. Sediments with greater than 50 mg/kg PCB and highly contaminated equipment and supplies will be placed in drums appropriate for high hazard disposal by Hansen and Scott. In addition, the work areas will be washed and rinsed with solvents to remove contamination.

All personnel (Hansen and Scott) working directly with the contaminated sediments, during collection, homogenization, experimental set-up and breakdown, and seiving (see amphipod experimental protocols) will have to wear the class C protective clothing described above. Because of the limited exposure potential once the sediments have been covered with water the personnel working with the exposure systems in the laboratory should be adequately protected if they wear appropriate gloves, labcoats, and face-shields.

Glassware will be disposed of as hazardous waste, or decontaminated according to the following procedure:

1. Outside, while containers are being seived and emptied, all large particles will be rinsed off with seawater by personnel(Scott) wearing class C clothing.
2. Using covered spill-proof carts, glassware will be transported to G07. Glassware will be given a double acetone rinse in the hood in G07, and allowed to dry in the hood. (A double rinse is necessary, since the first application of acetone may be removing mainly residual water.) Waste acetone will be stored in an appropriate hazardous waste container.
3. In the contaminated sink in G17, glassware will be washed with soap and water, and rinsed with copious amounts of deionized water.
4. At this point, glassware will be considered decontaminated and will be sent to the dishroom for normal procedures.

Analytical Chemistry: Handling Practices.

Sediment samples for chemical analysis will be collected using small glass core liners. One core will be taken from each of three Ponar samples collected at each of the 18-20 stations. The contents of the three cores will be extruded into a small disposable container and mixed on board. After the sample is mixed, a small (less than 10g) aliquot will be removed and placed into a glass jar. This jar will be sealed with aluminum foil beneath the lid and then the outside will be rinsed with seawater followed by a rinse with acetone. Someone wearing clean gloves will then place this glass jar inside a plastic container that can be sealed and a chain-of-custody label attached. The sample will then be placed into a cooler which will be locked prior to leaving the vessel.

Sediment samples (18-20) will arrive at the laboratory in the locked, plastic cooler which will be placed into the walk-in freezer. The samples (less than ten grams wet weight each) inside the cooler will be in sealed glass jars with aluminum foil beneath the lid. The jars will in turn be sealed inside individual plastic containers.

When samples are to be analyzed the cooler will be taken to the organic analytical sample preparation laboratory, unlocked and the plastic containers placed in a fume hood until the samples are thawed. A chemist wearing appropiate gloves will then remove the glass jar from the plastic container, open it and remove 3 aliquots from each sample. One aliquot (1-2g) will be placed in a plastic vial for metals analysis, a second (1-2g) will go into a glass centrifuge tube for organic analysis. Wet to dry weight measurements will be taken using the third aliquot. This will be done by removing and weighing a small aliquot (about 100mg) of wet sediment and then placing it into a desiccator. The desiccator will be kept inside a fume hood in the organic preparation laboratory. When the sample is dry it will be removed from the desiccator and reweighed in balances in room 135.

The sealed plastic vial will be brought to the fume hood in the inorganic preparation laboratory where it will be prepared for instrumental analysis. One ml of 2N, HNO_3 will be carefully added to the sample to desorb the metals from the sediment. If high concentrations of PCB oils are present two layers may form, an agueous acid layer and an oil layer. After sample digestion is complete the aqueous layer will be withdrawn for instrumental analysis. The oil will be left in the container and the entire container will be disposed of as hazardous waste.

The aliquot to be analyzed for organic contaminants will be extracted using the sonic probe in the hood in which it was removed from the jar. The remaining portion of each sample will be resealed in its glass jar and placed back into its plastic container. The plastic containers will then be locked into the cooler which will be brought back to the walk-in freezer. The samples will be held in the freezer until the chemical analyses have been completed (probably a few weeks) and then will be disposed of as hazardous waste. The gloves used during all sample transfers will also be disposed of as hazardous waste.

SHEEPSHEAD MINNOW TESTS

Title

Effect of PCBs Associated with sediments in New Bedford Harbor on Reproduction of an Estuarine Fish.

Summary

The study will be modelled after a study done at ERL, Gulf Breeze performed by Hansen et al (1973) using an aqueous exposure to Aroclor 1254. Briefly: adult sheepshead minnows will be exposed to NBH sediments and a control sediment for 28 days and their survival monitored. The females will be induced to spawn at the end of that time. Eggs will be stripped from the females, fertilized and held for four weeks in clean water. Hatching success and survival and growth of the fry will be monitored. At the end of the experiment percent fertility, percent hatch, and fry survival and growth will be compared with the levels of PCBs and metals in the sediments, and in the eggs immediately after spawning. In addition the PCB and metals levels in the post-exposure adults may also be quantified.

Sediment Collection

Sediment collections of 5-10 gallons each will be obtained from 18-20 sites in New Bedford Harbor. The sites will be chosen to ensure a wide range of PCB and metals contamination.

Sediment analysis

The samples will be analyzed for PCBs, with at least some characterization of the isomeric composition, and for metals, of which chromium, copper, lead, and zinc are probably the most important. In addition analysis will be done at ERL-N to determine the TOC, grain size, and moisture con-

tent of the samples.

Sediment selection

Six to eight of the samples will be chosen for use in the experiment. Five samples will be chosen to represent a range of PCB contamination, possibly from 10,000 to 1 ppm, irrespective of the level of metals contamination. An additional three sediments will be chosen which have similar PCB levels but which cover a range of metals concentrations.

Experimental Procedure

Adult sheepshead minnows will be kept in static or low-flow systems which have 4cm of sediment on the bottom. This requires about a gallon of sediment. The fish will be kept in the exposure systems for one month, and fed a commercial flake food and reference brine shrimp during that time. Each exposure aquarium will be replicated, and contain 6 females and 3 males. The sediment will be transferred to the aquaria as described in the sediment processing section above.

For the Cyprinodon reproductive study ten-gallon aquaria will be used as the exposure chambers. They will be placed in room G-17, in table 6A. The clean sediment controls will be placed in another table. Tentatively the exposures will take place under static conditions, with surface aeration. Air will be discharged through a foam plug in the cover. If adequate water quality cannot be maintained without using a flow-through system we will use only the minimum flows necessary to maintain adequate dissolved oxygen in the tank.

Observations on the exposure systems will be limited to daily checks for survivors, water quality measurements, and feeding. We plan to limit access to G-17 during these observations. We hope to be able to remove the sheepshead from the exposure systems prior to the injection of the females. This would minimize the number of transfers of fish which must be made while the fish are in contaminated systems. The adults would be removed to clean water in room G-06. The injection, spawning, hacthing and larval phases of the experiment will all be carried out in clean water.

Temperature and salinty (and flow-rate if any) will be monitored daily. Dissolved oxygen concentrations will be monitored 3 times per week. The sediment surface will be

siphoned periodically to eliminate any buildup of excess food on the bottom. Any water siphoned off in this process will be put through the effluent treatment system and replaced with filtered seawater. The temperature will be maintained at 25C, plus-or-minus one degree, and evaporative losses will be made up with deionized water.

During the last week of the exposure (or after) the females in each aquaria will be injected with HCG to induce egg production. At the end of the exposure eggs will be stripped from individual females and fertilized with the combined milt of all the males in the same replicate. Not all females will respond to the hormone, so the 5 best females will be chosen from each sediment for use in the remainder of the experiment.

Subsamples will be taken from the eggs of each of the chosen females for assessment of percent fertility and for percent hatch and larval survival, the rest of the eggs will be used for chemical analysis.

The eggs to be used in the hatching and juvenile survival part of the experiment will be placed in nitex egg cups in clean flowing seawater at 25C. The eggs and resulting larvae will be monitored for 28 days. The larvae will be fed reference brine shrimp daily.

Experimental Procedure

The adult exposures will be done in glass aquaria approximately ten gallons in volume. Ideally the aquaria will be static (no-flow), with only gentle aeration, but some flow may be required to maintain the water quality in the aquaria. The flow would not exceed 40 mls/min from each tank. The aquaria will have covers of glass or plexiglas if they are static and plastic grating if they are run flow-through.

Space Requirements

There will be 16 exposure aquaria, that will hold approximately 10 gallons each. This is the equivalent of two tables in G-17. The aquaria must be kept in a water bath capable of maintaining 25C, and have access to flowing seawater of 20C or warmer. The sediments used in this exposure are highly contaminated, with up to 10,000 ppm PCB, and this puts additional restraints on where this exposure can be performed.

The egg and larval portion of the experiment also requires flow- through capability and the ability to maintain 25C, but there is no contamination involved. The water level in the systems must be able to fluctuate in order to ensure water exchange across the egg cups.

Analytical Needs

The study will require 18-20 analyses of sediment for PCBs, with some degree of isomeric seperation, and a selected number of metals analyses. The metals will probably include chromium, lead, copper, and zinc. In addition there will be 35-40 individual fish which will be analyzed for PCBs, and an equal number of samples of eggs which will be analyzed for PCBs. This requires a total of 80-100 analyses for PCBs.

New Bedford Harbor Amphipod Tests

PERSONNEL

to work with sediment(class C clothing): K. J. Scott
to work with water-covered sediment in laboratory: M. S. Redmond

SUMMARY OF AMPHIPOD TESTS

Using two amphipod species, Ampelisca abdita and Rhepoxynius abronius, the following tests will be conducted:

1. Solid phase tests using both Ampelisca and Rhepoxynius in a gradient of PCB-contaminated sediment and sediments covering a range of metals concentrations

2. Solid phase tests using both Ampelisca and Rhepoxynius in a selected PCB-contaminated sediment mixed with control sediment in proportions such that an LC50 can be determined

3. A test with Ampelisca where they are directly exposed in cores of sediment taken from the field

4. Suspended phase tests with Ampelisca.

EXPERIMENTAL PROCEDURE FOR AMPHIPOD TESTS

1. Gradient solid phase tests

Ampelisca

There will be 6-8 treatments plus a control, 3 replicates per treatment, 250 ml. of sediment per replicate, for a total of 750ml of sediment from each station.

An aliquot of sediment from 6 to 8 stations mixed as described in the "Sediment Collection" section will be added to exposure containers outside the building with personnel(Hansen and Scott) wearing class C protective clothing. After sediment is added to a container, about 2 inches of seawater will be carefully added to cover the sediment and the container will be transferred to a spill-proof cart. The cart will be covered with plastic and moved to G17, where the containers will be placed in the experimental tables. More seawater will be added to each container, and seawater at 20 C will flow through the containers continuously for 24 hours prior to the start of the experiment.

A. abdita will be exposed for 10 days at 20 C in quart-sized glass canning jars(see figure), using a flow-through system at a flow rate of 165 ml/min for each entire experiment. The experiments will be conducted in table 5A in G17, with flowing 20 C seawater in the table serving as a water bath. Water from the bath and effluent will flow out the contaminated drain to the effluent treatment system. Temperature and salinity will be monitored daily from control chambers. Also, the exposure containers will be checked once a day for mortalities and amphipods that have emerged onto the sediment surface. Dead amphipods will not be removed. Algal food will be delivered overnight with the seawater to each chamber. Air will be delivered through a 2-ml glass disposable pipette to circulate the algae. For monitoring of the experiment, Saranex-covered Tyvek lab coats, double gloves(inner layer latex or polyethylene, outer layer Viton), and face shields will be worn. It should not be necessary to disturb the sediments to monitor the assay.

At the end of the experiment, the animals must be seived from the sediments. The experimental containers will be removed to the outside from G17 using the covered spill-proof cart, and each non- control container will be seived through a 0.5mm screen into a large hazardous waste container(plastic 55 gal. drum??), with personnel(Scott) again wearing class C clothing.

It would be preferable to transfer contaminated water from this drum into the waste treatment system after sediments have been allowed to settle. Where can this drum be stored? The amphipods, tubes, and other residue will then be transferred, while outside, into 8-oz. screw-cap jars containing 5% buffered formalin. The outside of each jar will be kept clean.

Preserved samples will be processed in the hood in G07. The researcher, wearing lab coat and gloves, will pour the preserved sample through a seive such that the preservative and DI rinse are contained in a bucket. This liquid material will be transferred into a waste fixative container. The animals and their tubes will be examined in DI water under a dissecting scope. After sorting, the amphipods will be transferred into scintillation vials for later measurement. Leftover tubes and detritus will be discarded into the hazardous waste drum.

Glassware will be disposed of as hazardous waste, or decontaminated as described in the test termination section above.

Rhepoxynius

These tests will be set up and conducted as with A. abdita as described above, except for the following:

a. Tests will be static and animals will not be fed, so water will not be disturbed at all.

b. Exposure containers will be 1-liter glass beakers(see figure). Each beaker will be covered with a watch glass and have air delivered to it with a glass 2-ml disposable pipette.

c. Test will be run at 15 C, so a 15 C water bath will be required, ie. flowing 15 C water in exposure table.

2. Solid phase "LC50" tests

These tests will be conducted as in 1(above), except:

a. Sediments previously mixed and stored under refrigeration will be remixed outside before addition to experimental containers. They will be mixed by volume in a large glass beaker using a glass rod. Concentrations will be mixed from low to high. Class C clothing will be worn during this process.

b. There will be 5 treatments plus a control, 3 replicates per treatment.

3. Suspended phase tests

No suspended phase tests are planned for this component of New Bedford Harbor studies(next 6 months). Any experimental designs for systems are subject to approval by the Safety Committee.

4. Field core tests

Cores will be taken in the field for possible later testing. 3 cores will be taken from each of 10 field sites for a total of 30 cores. Cores will be capped in the field, rinsed with seawater, and placed into plastic sealable bags and then into 5 covered and sealed plastic buckets(2 sites of cores/bucket). These will be stored, frozen, on site at ERLN(particular freezer has not been determined).

If other tests show that cores are not needed, they will be disposed of as hazardous waste. If they are used, they will be brought into G17 still frozen and allowed to thaw in the experimental table. The rest of the experimental procedure will be as in 1(above), with the core itself serving as the exposure chamber.

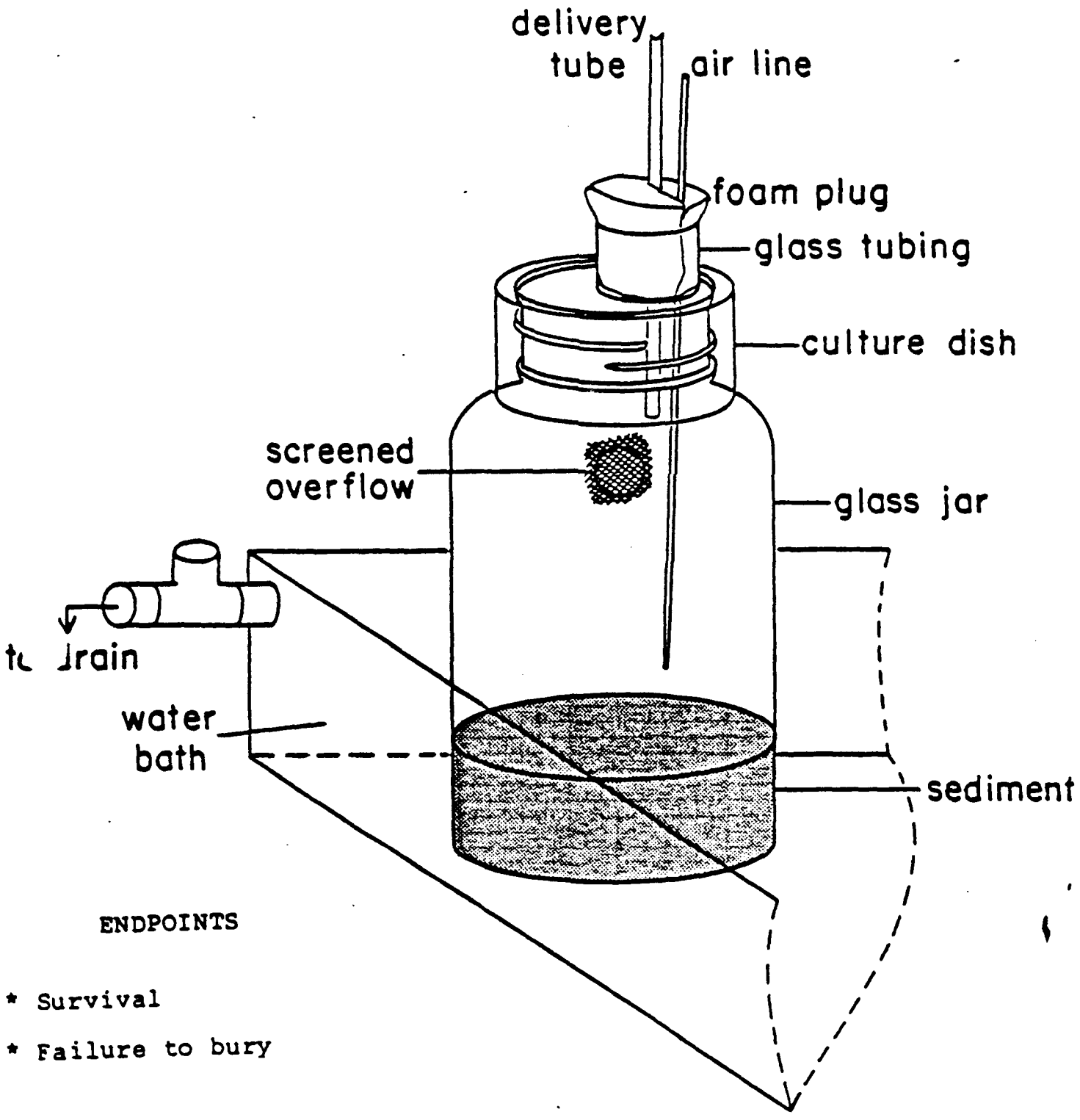
SPACE NEEDS

Two tables will be required in G17 for conducting tests, one with 20 C flowing seawater and one with 15 C flowing seawater.

ANALYTICAL NEEDS

No chemical analysis will be required on the amphipods.

FIGURE A



ENDPOINTS

* Survival
* Failure to bury

CRUISE REPORT: MAP OF STUDY SITE

CRUISE REPORT

NEW BEDFORD HARBOR

SEDIMENT SAMPLING

JANUARY 21-22, 1986

D R A F T

HMM Document No. 85-944-15(2)

February 10, 1986

Prepared for:

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During the period January 21 and 22, 1986, HMM Associates, Inc., and its subcontractor Science Applications International Corporation (SAIC), conducted sediment sampling operations for the New England Division of the U.S. Army Corps of Engineers in New Bedford Harbor/Acushnet River, Massachusetts. All operations were conducted from the R/V East Passage, a 24 foot workboat owned by the Corps of Engineers. Fourteen sediment sampling stations were chosen, based on the concentration of polychlorinated biphenyls (PCBs) in the harbor sediment determined from previous work by the Corps.

Stations 1-11 represented areas along the Acushnet River axis having known PCB concentration levels of less than 50 ppm. Stations 12-14 represented areas in the "hot zone" which have reported PCB concentration levels up to 36,000 ppm. (Station 11 was not sampled because of coarse sediments).

A PONAR grab sampler ($0.625m^2$) was used for sediment collection. The intent was to collect sufficient sediment quantities at each station to provide fifteen gallons for extensive bioassay testing at the EPA Naragansett Laboratory. Sediment compaction and composition precluded collection of sufficient quantities Stations 1 and 11. In addition, composite and analytical subsamples were taken at each station, except Station 1 from which only an analytical subsample was retained.

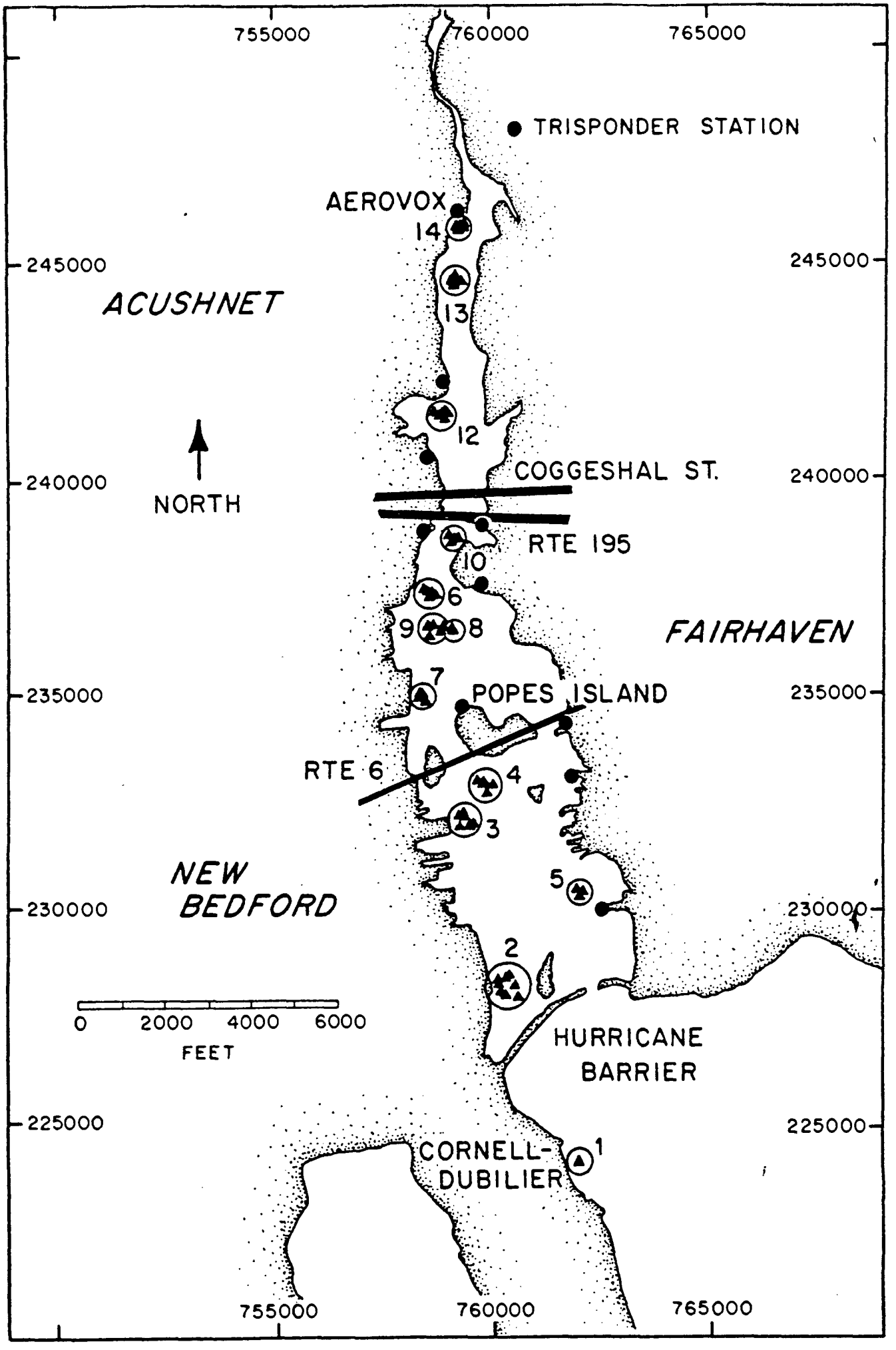
The composite subsample was taken for amphipod bioassay testing. A composite represented the combination of 5cm core tubes pushed into each PONAR grab sample that was retained for the bulk (15 gallon) collection effort at each station. Approximately nine full PONAR grabs were required to fill a 15 gallon container. These nine grabs comprised the composite subsample. The subsamples were accumulated in a 1 ~~gallon~~ QUART GLASS JAR ~~Ziplock bag~~. The bag was shaken to homogenize the composite. From the composite, a spoonful size of "analytical" subsample was taken for chemical analysis (PCB, Cu, Cd, Cr, Pb, Zn). The analytical subsample was placed in a clean labelled glass jar which was then placed in a plastic cube container. Analytical and composite samples were stored in a cooler at $4^{o}C$.

All samples were sealed and logged on a Chain of Custody Record for delivery to the EPA Environmental Research Laboratory in Narragansett, Rhode Island (see Attachment I). EPA representatives retained custody throughout the collection and delivery processes. Samples from the "hot zone" were collected utilizing strict safety procedures as described in the "General Health and Safety Plan for PCB Contaminated Sediment Collection Activities New Bedford Superfund Site (Upper Acushnet River Estuary)" as submitted separately to the Corps of Engineers.

A total of 10 Trisponder stations were utilized in this study. Owing to obstructions from man made and natural objects in the survey area, no more than three Trisponder stations were used for any one sampling station. The names and locations of these stations as well as their positions in both latitude and longitude and Massachusetts State Plane Coordinates are presented in Table 1. Following completion of the field work in the project, these ranges were converted to both latitude and longitude as well as state plane coordinates using the SAIC Integrated Navigation and Data Acquisition System (INDAS). The positions of each sampling station as well as the location of each individual sample from within a given station are now stored on computer disk and can be called up and reoccupied at any future time. For the sake of simplicity, the sampling stations used in this study were numbered 1 through 14 and progressed at a more or less south to north direction up the Acushnet River starting at the Cornell Dublier plant located south of the New Bedford Hurricane Barrier. Due to the coarse sediment present at Stations 1 and 11, it was impossible to obtain a sufficient quantity of sediment at these locations. A description of the twelve remaining stations is presented in Table 2.

In order to depict graphically the locations of these sampling stations, it was necessary to divide the operations area into three sections which were designated as areas 1, 2, and 3, respectively. Area 1 consists of New Bedford Harbor from the Hurricane Barrier extending northward to approximately the intersection of Route 6 causeway and Pope's Island. Area 2 extends from the northern boundary of area 1 to a point about 300 feet north of the Coggeshall Street Bridge. Area 3 extends further north to a point approximately 1000 feet north of the Aerovox Corporation facility. Figure 1 depicts the entire operations area as previously described. Shown on this chart are the locations of each grab sample from the 12 sampling stations as well as some prominent landmarks including the Del Norte Trisponder stations used in this study. This chart is drawn in a Lambert projection at a scale of 1/25,000, which will directly overlay with U.S.G.S. quadrangle sheet #6867 III SW. Please note that the natural distortion resulting from the Xerographic process will show up as an approximately 6% discrepancy with the quadrangle chart when overlayed with Figure 1; however, the original of this and all other figures used in this report are available for inspection on request. All coordinates depicted on this chart as well as in subsequent figures represent Massachusetts State Plane Coordinates calculated from the proper constants for the Massachusetts Mainland Lambert Coordinate System. Figures 2, 3 and 4 depict essentially the same information for areas 1, 2 and 3

respectively, but are drawn at a much larger scale for the sake of clarity and to give a better indication of the spatial distribution of the individual grab samples from each sampling site. Finally, Tables 3 through 14 list the actual location of each grab sample on a site by site basis.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760000
765000
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AEROVOX
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13
12
245000
ACUSHNET
NORTH
240000
COGGESHAL ST.
RTE 195
10
6
9
8
FAIRHAVEN
7
POPES ISLAND
235000
RTE 6
4
3
NEW
BEDFORD
5
230000
2
0
2000
4000
6000
FEET
HURRICANE
BARRIER
225000
CORNELL-
DUBILIER
1

ANALYTICAL METHODS

DKJ: 2-22-90 NBSEDMETH.DOC

Inorganic Sample Preparation and Analysis

Sediment sample preparation--

Sediment samples were homogenized by hand-stirring with a spatula and aliquots of the wet sediment (approximately 5 g) were transferred to tared, 60 ml, acid cleaned, polyethylene bottles. The wet weights of all sample were then determined. The samples aliquots were frozen and freeze-dried in a Virtis lyophilizer (Model No. 10-145MR-BA) for 2 days. The dry weight of each sample was then determined. The dried sediment samples were acidified with 50 ml of 2 N HNO_3 (reagent grade), sealed with a polyethylene screw cap, and immersed in an ultrasonic water bath for six hours. After standing overnight, the samples were filtered through acid washed (2 N HNO_3) Whatman 41 filter paper into 60 ml, acid cleaned, polyethylene bottles so that insoluble residue would not interfere with subsequent atomic absorption analysis.

Atomic absorption analysis--

Flame atomization (FA) and heated graphite atomization (HGA) atomic absorption (AA) was conducted on the samples with a Perkin-Elmer (Model 5000) AA spectrophotometer. All sediment elemental determinations were made using FA-AA, except Cd in samples 45028, 45029 and 45030. Cd concentrations in the

specified sediment samples were too low to determine by FA-AA and had to be analyzed by HGA-AA. For HGA-AA analyses, a Perkin-Elmer Model 500 graphite furnace equipped with Zeeman-effect background correction (Fernandez et al, 1980, Fernandez and giddings,1982) was used. FA-AA and transient HGA-AA signals were recorded with a Perkin-Elmer strip chart recorder (Model 56) and the absorbance data sent directly to a Perkin-Elmer Model 3600 data station microcomputer. Standard curves generated by polynomial regression of absorbance data for standards were used to determine concentrations in unknown samples.

The instrument setup conditions for all FA-AA and HGA-AA determinations are similiar to those described in "Methods for Chemical Analysis of Water and Wastes" (U.S. EPA, 1979) and those found in the manufacturer's reference manuals. The AA instrument was calibrated each time samples were analyzed for a given element. Instrument calibrations were generally checked after every five samples had been atomized into the flame. All samples were analyzed at least twice to determine signal reproducability. For each set of sediment samples, two samples were analyzed for each element (except iron) by the method of standard additions and one procedural blank sample was analyzed.

Aliquots of in-house reference materials (Black Rock Harbor dredge material and Long Island Sound reference sediment) were

prepared and analyzed along with the New Bedford Harbor sediments to validate the accuracy of the sample preparation/analysis procedures. The results obtained for the reference samples analyzed as a quality control check, along with the reference values determined previously for those materials, are given in Table A_1. Spike recovery and procedural blank data for the metals determined in the sediments are given in Table A_2.

Data generated during the preparation and analysis of samples (e.g. dry weight, wet weight, volume, etc.) were entered into the Analytical Chemistry Database System working data bases AAPREP and AADATA. Upon completion of the analyses, results obtained were reviewed for quality control and entered into the final data base METALS.

References

Fernandez, F.J., Meyers, S.A. and Slavin, W., 1980, Background correction in atomic absorption utilizing the Zeeman Effect, Anal. Chem., 52, 741-746.

U.S. Environmental Protection Agency, 1979, Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Monitoring and Support Laboratory, Office of Research and Development, EPA/600-4-79-020.

Fernandez, F.J. and Giddings, R., 1982, Elimination of spectral

interferences using Zeeman Effect background correction, Atomic Spectroscopy, 3, 61-65.

Table A_1 . Reference Sample Metal Concentrations

Reference material: DREDGE SPOILS

REP	Cr	Cu	Zn	Cd	Pb	Ni	Mn	Fe
	Concentration (ug/g)							
1	1490 ± 9	2830 ± 14	1463 ± 9	21.56 ± .00	398.0 ± 2.6	146.0 ± .4	266.4 ± .0	26844 ± 266
	Wet-to-dry ratio: 3.12							
2	1438 ± 16	2563 ± 1	1312 ± 0	22.99 ± .22	411.9 ± 1.6	151.9 ± 1.3	273.5 ± 1.8	26898 ± 127
	Wet-to-dry ratio: 3.18							
Reference Value	1475 ± 76	2833 ± 289	1334 ± 151	23.53 ± .76	418.0 ± 21.6	167.1 ± 16.4	305.3 ± 39.1	30239 ± 2917
	Wet-to-dry ratio: 3.16 ± .17							

Reference material: L.I. SOUND REFERENCE SEDIMENTS

REP	Cr	Cu	Zn	Cd	Pb	Ni	Mn	Fe
	Concentration (ug/g)							
1	52 ± 0	58 ± 0	138 ± 0	0.10 ± .00	45.6 ± .5	19.1 ± .4	386.2 ± 1.4	18034 ± 80
	Wet-to-dry ratio: 2.34							
Reference Value	50 ± 14	61 ± 3	163 ± 6	0.23 ± .04	54.6 ± 2.0	25.5 ± 2.5	462.9 ± 25.1	21443 ± 1414
	Wet-to-dry ratio: 2.35 ± .12							

Table A_2 . Spike Recoveries

Cr	Cu	Zn	Cd	Pb	Ni	Mn
97 ± 9%	103 ± 1%	104 ± 5%	104 ± 1%	107 ± 3%	103 ± 2%	106 ± 2%

All blanks were below instrumental detection limits.

ORGANIC ANALYSIS

Extraction

Sediment samples were mixed using a stainless steel spatula and then 1-3 g were removed to determine a wet to dry weight ratio. This portion was placed in a preweighed aluminum pan, weighed and dried to a constant weight at room temperature in a dessicator. One to 10 g of the original wet sediment were placed into a glass centrifuge bottle for extraction. The recovery standard octachloronaphthalene and fifty ml of acetonitrile were added and the samples were sonicated with an ultrasonic probe for 60 seconds. After sonication the samples were centrifuged at 10,000 rpm for 5 minutes in a refrigerated centrifuge at 4 C. The supernatant (acetonitrile-water) was decanted into a 1 liter separatory funnel containing 300 ml of deionized water that had previously been extracted with pentane. This was repeated twice more and the pentane extracts were also added to the separatory funnel. The funnel was shaken, and the pentane layer was poured off into a 500 ml Erlenmeyer flask. This partitioning was repeated 2 more times using 50 ml of pentane each time. The pentane extracts were combined in the Erlenmeyer flask and the extract dried with sodium sulfate that had been baked out at 750 C for 4 hours. The pentane was then volume re-

duced and solvent exchanged to hexane and brought to 1 ml in a tube heater. The sample was then ready for fractionation on the separation column.

Fish samples were homogenized using a polytron with teflon bearings for 20 seconds at 25,000 rpm. A portion of the homogenized sample (about 2 g)was removed for the determination of a wet to dry weight ratio (dried at 95 C to a constant weight). An appropriate amount of homogenate (usually 5 to 10 g wet weight) was added to a preweighed glass centrifuge tube, and the sample weight recorded. Fifty ml of acetonitrile was added, and the sample was homogenized in the polytron for 20 seconds. The sample was centrifuged and then the supernatent was drawn off into a separatory funnel containing 300 ml of deionized water that had been preextracted with pentane. This polytron extraction was repeated twice more with 50 ml of acetonitrile. The supernatents from each of these extractions were also added to the separatory funnel. The funnel was shaken, and then the pentane drawn off. This was repeated two more times using 50 ml of pentane each time, and the pentane extracts were combined. A measured portion of the extract was removed for a total extractable lipid weight measurement. For this measurement the solvent was allowed to evaporate and then the residue was dried at 90 C to a constant weight. The remaining portion was volume reduced as previously described in preparation

for chemical class separations by silicic acid column chromatography.

Egg samples from individual fish were also analyzed for PCBs. For wet/dry weight determinations subsamples of eggs were collected from fish from each group and combined. About 0.02 - 0.05 g wet weight samples were used for these measurements which were conducted as described for the fish tissue samples.

The egg samples for extraction were placed in a glass centrifuge tube and then octachloronaphthalene and 25 ml of acetonitrile were added. These samples were then extracted using the ultrasonic method described previously for sediments. However, all of the volumes used were one-half of those used for sediments.

Separation

Chemical class separations were achieved on a 0.9 x 45 cm column which contained 11.5 g of BioSil A silicic acid (100-200 mesh) that had been fully activated, and then 7.5% deactivated with water. This deactivation step was accomplished by adding an appropriate amount of water to the silica in a glass bottle and rolling it overnight.

Before samples were added, the column was cleaned with 50 ml of methylene chloride and 50 ml of pentane. All sample extracts were added to a separation column in 1 ml of hexane and then an additional container rinse of 1 ml of hexane was also added. The first fraction (f1)

was eluted from the column with 50 ml of pentane. The second fraction (f2) was eluted using 35 ml of 20% methylene chloride in pentane. The first fraction of sediment samples was treated with activated copper powder to remove sulfur. Each fraction was then volume reduced in a round bottom flask using a heating mantle and a Kuderna-Danish evaporator with a 3-ball Snyder column. The sample was solvent exchanged into about 5 ml of hexane and transferred to a 10 ml concentrator tube fitted with a micro-Snyder column. An ebulator and 0.8 ml of heptane was added to each tube, and the fractions were volume reduced to 0.8 ml in a tube heater with a foil cape. The ebulator was removed and rinsed into the sample with heptane which was brought up to 1 ml.

The f1 fractions were analysed by electron capture glass capillary gas chromatography (GC) for polychlorinated biphenyls (PCBs). The f2 fractions were not analysed for this study.

Gas Chromatography

The f1 fractions were analysed for PCBs. For these analyses, 1 ul of each sample (usually at a volume of 1 ml) was injected splitless into a Hewlett Packard 5840 gas chromatograph equipped with an electron capture detector and a 30m DB-5 fused silica capillary column (J + W Scientific). Helium was used as the carrier gas at a flow rate of about 1.5 ml/min and the flow of a 95:5 mixture of argon:methane to the detector was

35 ml/min. The oven temperature was held at 80 C for 4 m and then programmed from 80 to 290 C at 10 C/min. The injector temperature was 270 C, and the detector was maintained at 300 C.

Concentrations were calculated as Aroclor 1254. The amount of Aroclor 1254 was measured by comparing the sums of the heights of 7 peaks in the sample chromatograms to those of the same peaks in standards of Aroclor 1254 that were analyzed at the beginning and end of each day. Sample concentrations were then calculated using the laboratory computer system.

Quality Assurance

Quality assurance steps were conducted for each s › of the analysis procedures. This includes the cleaning of glassware and the extraction, separation, and quantification of PCBs. All glassware that was used for sample analysis was washed with Alconox and then rinsed with tap water and deionized water. The glassware was capped with aluminum foil and muffled at 450 C for 6 hours. It was then stored capped with foil until used when it was uncapped and rinsed with an appropriate solvent. Also, blank analyses were conducted with each set of samples. This averaged to be one blank analysis for every 6.2 samples. None of the blanks analyzed in this study contained measurable amounts of PCBs. Consistent ˢ ˙icic acid column activity was quality assured by testing each batch. A mix of PCB and PAH isomers were

separated on a column made up of the newly deactivated silica and the relative distributions of compounds in the column fractions were monitored. Gas chromatography analyses were quality assured in several ways. Standards were analyzed at the beginning and end of each day. The results from these analyses were compared, and if the standard deviation of the two results was greater than 10% all of the samples analysed that day were reanalysed. Standard curves were also periodically generated on each instrument to assure that the response of the detector was linear over the range of concentrations measured.

Extraction efficiency was quality assured by conducting spike and recovery studies and by measuring the recovery of octachloronaphthalene that was spiked into each sample. Spike and recovery studies were conducted with both sediment and mussel homogenates to document the recovery of PCBs and the precision of Aroclor 1254 measurements using the acetonitrile/pentane ultrasonic extraction procedure. The sediment and mussel homogenates used for this study have been extensively characterized by this laboratory. In addition, the mussel homogenate has previously been analyzed as part of a Mussel Watch Program intercalibration study (Galloway et al., 1983).

The recoveries of several individual PCB congeners and octachloronaphthalene from the spiking studies are

shown in Table 3. The recoveries from sediment were 71, 30, 81, 71 and 71 %, respectively, for 2, ichlorobiphehyl, 3,3',4,4'-tetrachlorobiphenyl, 2,2',3,3',4,4', 5,5'-octachlorobiphenyl, decachlorobiphenyl, and octachloronaphthalene. The spike recoveries from the mussel homogenate averaged 79, 79, 67, and 86 % for 2,4-dichlorobiphenyl, 2,2',3,3',4,4',5,5'-octachlorobiphenyl, decachlorobiphenyl, and octachloronaphthalene, respectively. The precision (relative standard deviations) of Aroclor 1254 measurements on the replicate sediment and mussel homogenates were 0.6 % and 11.8 %, respectively.

Besides the spike and recovery studies described above each sample to be analyzed was spiked with octach onaphthalene and its recovery in the final extract was calculated. The recoveries for this compound in the sediment samples that were analyzed as part of this study averaged 88.6 % + 21.9 (n=34). Octachloronaphthalene recovery for the fish samples was 76.9 % + 19.3 (n=14). The egg samples showed recoveries of 86.6 % + 15.5 (n=39).

References

BLOWAY
o , W.B., J.L. Lake, D.K. Phelps, P.F. Rogerson, V.T. Bowen, J.W. Farrington, E.D. Goldberg, J.L. Lasiter, G.C. Lawler, J.H. Martin and R.W. Risebrough. 1983. The Mussel Watch: Intercomparison of trace level constituent determinations. Environmental Toxicology and Chemistry 2: 395-410.

ABLE B

Results of sediment and mussel spike and recovery studies.

Sediment Homogenate

% Recovery					Concentration
A	B	C	D	OCN	A-1254
73.0	81.7	81.5	71.1	67.8	60.2
66.9	82.5	87.8	77.6	81.8	60.5
73.0	74.6	74.3	64.6	63.6	59.8
71.0	79.6	81.2	71.1	71.1	60.2 + 0.35(0.6%) X + S.D.(RSD)

Mussel Homogenate

% Recovery				Concentration
A	C	D	OCN	A-1254
73.3	81.3	67.6	92.7	465
80.0	77.9	66.9	84.8	567
84.4	77.6	67.4	80.4	581
79.2	78.9	67.3	86.0	538 +63.3(11.8%) X +S.D.(RSD)

A = 2,4-dichlorobiphenyl
B = 3,3',4,4'-tetrachlorobiphenyl
C = 2,2',3,3',4,4',5,5'-octachlorobiphenyl
D = decachlorobiphenyl
OCN = octachloronaphthalene
A-1254 = Aroclor 1254

PCB'S AND METALS IN SEDIMENTS

TABLE 1. - Concentration (ug/g dry weight) of polychlorinated biphenyls (Aroclor 1254) and selected metals in sediment collected from New Bedford Harbor on January 21 and 22, 1986. Samples analyzed were composites of cores from 9 to 13 ponar dredge samples from Stations 2 to 14; one dredge sample was analyzed from Station 1.

STATION	Aroclor 1254	Cd	Cu	Cr	Fe	Mn	Ni	Pb	Zn	Wet + Dry weight
1	2.64	1.75	113	56.6	7,020	71.5	7.58	54.9	122	1.72
2	3.88	4.06	368	178	11,600	98.8	18.5	124	264	2.00
3	5.06	3.77	466	213	16,600	135	22.5	150	332	2.53
4	5.45	4.32	648	343	17,100	141	24.1	174	331	2.34
5	3.76	4.42	441	177	15,700	122	27.3	153	392	2.22
6	13.9	10.3	1,520	753	18,400	134	46.1	294	655	2.55
7	11.1	5.82	892	421	22,600	165	39.3	251	522	3.59
8	19.3	6.07	1,800	944	22,300	164	35.8	524	485	2.63
9	14.3	8.00	1,490	768	14,300	103	32.6	259	562	2.21
10	13.6	7.93	934	465	14,400	110	50.5	235	577	2.27
12	151	78.4	2,540	1,700	19,400	139	214	617	2,150	2.57
13	306	69.6	1,480	1,120	17,400	158	142	731	2,420	2.90
14	540	46.8	1,180	710	16,900	156	142	882	2,530	2.85

TABLE 2. - Concentration (ug/g dry weight) of polychlorinated biphenyls (Aroclor 1254) and selected metals in sediments from New Bedford Harbor. Values are from triplicate samples from one composite from 9 to 13 ponar dredge samples from each station in New Bedford Harbor that have been tested for their toxicity.

STATION	Aroclor 1254	Cd	Cu	Cr	Fe	Mn	Ni	Ph	Zn	Wet Dry weight	Organic carbon,%
	0.0581	0.155	54.6	47.2	17,100	383	20.0	48.5	134	2.23	
South Reference*	0.0480	0.189	56.5	49.3	18,200	373	20.6	47.2	140	2.35	
	0.0480	0.099	50.0	44.6	16,200	346	18.9	43.0	124	2.11	
	6.95	3.98	401	174	13,900	106	28.3	141	337	2.38	
NBH-5	7.05	4.35	418	189	14,600	116	30.4	149	349	2.48	
	7.92	4.21	426	192	14,800	115	30.3	149	361	2.48	
	12.3	5.73	882	411	21,900	162	39.7	268	546	3.60	
NBH-7	12.7	5.90	911	416	22,000	162	41.6	274	563	3.64	
	14.9	5.67	882	405	21,500	159	38.8	268	539	3.56	
	19.6	10.4	1,570	730	19,700	140	47.9	311	707	2.82	
NBH-6	18.6	10.2	1,540	709	19,500	139	48.8	306	684	2.79	
	19.8	9.82	1,420	657	17,900	132	45.0	292	634	2.67	
	29.2	5.34	1,640	838	22,700	171	37.5	337	470	2.97	
NBH-8	32.5	5.35	1,620	834	22,800	172	39.6	324	464	2.92	
	31.2	5.43	1,590	814	22,300	172	37.6	321	458	2.94	
	256	92.6	2,920	1,810	25,000	195	268	742	2,790	3.73	
NBH-12	193	70.6	2,350	1,460	21,900	153	215	596	2,260	3.33	
	245	74.4	2,480	1,530	21,100	160	228	637	2,380	3.19	
	913	41.6	1,150	690	18,400	176	143	888	2,330	3.66	
NBH-14	1,140	40.5	1,120	683	17,600	164	139	843	2,300	3.46	
	1,240	39.4	1,070	637	16,800	156	135	789	2,180	3.30	

* South Reference sediment is from central Long Island Sound (41° 7.95'N and 72° 52.7'W).

TABLE 3 : Concentration (ug/g dry weight) of polychlorinated biphenyls (Aroclor 1254) and selected metals in sediments from New Bedford Harbor. Values are means of triplicate samples from a composite of 9 to 13 Ponar dredge sediment samples from each station in New Bedford Harbor which was used in the fish studies.

STATION	AROCLOR 1254	Cd	Cu	Cr	Fe	Mn	Ni	Pb	Zn
REF*	0.051	0.148	53.7	47.0	17100	367	19.8	46.2	133
NBH-5	7.30	4.18	415	185	14500	112	29.7	147	349
NBH-6	19.3	10.2	1509	699	19027	137	47.3	303	675
NBH-7	13.3	5.76	891	410	21800	161	40.0	270	549
NBH-8	30.9	5.37	1620	829	22600	172	38.2	328	464
NBH-12	231	79.2	2580	1600	22700	170	237	658	2480
NBH-14	1100	40.5	1110	670	17600	165	139	840	2270

* The reference sediment is from Central Long Island Sound.

TABLE 3B

Concentrations (ug/g dry weight) of polychlorinated biphenyls (Aroclor 1254) and selected metals in sediments from New Bedford Harbor.

SUBSTANCE	LOCATION		
	POPES ISLAND TO HURRICANE BARRIER (Sta. 2-5)	POPES ISLAND TO I-195 (Sta. 6-10)	NORTH OF I-195 (Sta. 12-14)
PCB	3.8-5.4	13.6-19.3	151-540
Cd	3.8-4.4	5.82-10.3	46.8-78.4
Cu	368-648	892-1800	1,180-2,500
Cn	177-343	421-944	710-1,700
Fe	11,600-15,700	14,300-22,600	16,900-19,400
Mn	98.8-141	103-165	139-156
Ni	18.5-27.3	32.6-50.5	142-214
Pb	124-174	235-524	617-882
Zn	264-392	485-655	2,150-2,530

PCB HOMOLOGUES IN NBH SEDIMENTS AND REFERENCE MIXTURES

U.S. ENVIRONMENTAL PROTECTION AGENCY

Environmental Research Laboratory

Narragansett, R.I.

Date: June 26, 1986

Subject: Chlorine Number PCB Distributions in New Bedford Harbor Sediments by GC/MS

From: Dr. Peter Rogerson, Analytical Chemist

To: Dave Hansen

Please find attached the chlorine number distributions from the PCB-contaminated sediments from the New Bedford study, along with all of the Arochlor mixtures. They have been analyzed using the EMSL-Cincinatti GC/MS procedures. Each sediment sample has been analyzed in triplicate, and the results displayed as a bar graph normalized to emphasize the qualitative distributions. Further data will be forthcomming as it is available, but I thought you would like to see these results as soon as possible. I will analyze the tissue samples soon. If you have any questions, please do not hesitate to ask me.

cc: Jerry Hoffman

Table 4. Concentration (ug/g dry weight) of polychlorinated biphenyls (PCBs) in sediments from New Bedford Harbor. Analysis was performed by GC/MS. Concentrations are reported by chlorine number congeners, and as total PCBs. Values are from triplicate samples from one composite from 9 to 13 Ponar dredge samples from each station in New Bedford Harbor that have been tested for their toxicity.

Sample ID	Cl - 1	Cl - 2	Cl - 3	Cl - 4	Cl - 5	Cl - 6	Cl - 7	Cl - 8	Cl - 9	Cl - 10	Σ ug/g
3082 Ref	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*
3083 Ref	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*	nd*
3084 Ref	nd*	nd*	nd*	nd*	0.02	0.02	0.02	0.02	nd*	0.02	0.08
3085 5B	nd*	0.22	1.4	4.0	4.0	2.1	0.20	nd*	nd*	nd*	12
3086 5B	nd*	0.21	1.2	3.4	3.1	1.4	0.08	nd*	nd*	nd*	9.4
3087 5B	nd*	0.21	1.2	3.4	3.2	1.6	0.21	nd*	nd*	nd*	9.7
3088 6B	nd*	0.46	4.1	13	12	5.6	0.67	nd*	nd*	nd*	36
3090 6B	nd*	0.49	3.9	11	10	4.5	0.43	nd*	nd*	nd*	30
3091 6B	nd*	0.50	3.5	9.8	9.8	5.6	0.72	nd*	nd*	nd*	30
3092 7B	nd*	0.15	1.5	5.5	5.8	3.0	0.22	nd*	nd*	nd*	16
3093 7B	nd*	0.08	1.4	5.6	6.2	1.8	nd*	nd*	nd*	nd*	15
3094 7B	nd*	0.38	2.1	6.3	6.8	3.0	0.30	nd*	nd*	nd*	19
3095 8B	nd*	0.60	6.2	17	18	8.2	1.4	nd*	nd*	nd*	51
3096 8B	nd*	0.88	8.0	19	18	7.8	0.55	nd*	nd*	nd*	55
3098 8B	nd*	0.97	8.2	21	21	9.4	1.6	0.06	nd*	nd*	62
3099 12B	nd*	3.5	36	91	62	19	1.8	nd*	nd*	nd*	210
3100 12B	nd*	5.0	35	75	49	17	2.0	nd*	nd*	nd*	180
3101 12B	nd*	8.6	51	110	73	24	3.6	nd*	nd*	nd*	270
3102 14B	7.8	390	830	910	380	110	13	1.3	0.43	nd*	2600
3103 14B	8.9	380	770	790	350	100	11	0.71	0.36	nd*	2400
3104 14B	9.6	440	920	990	410	120	12	0.91	nd*	nd*	2900

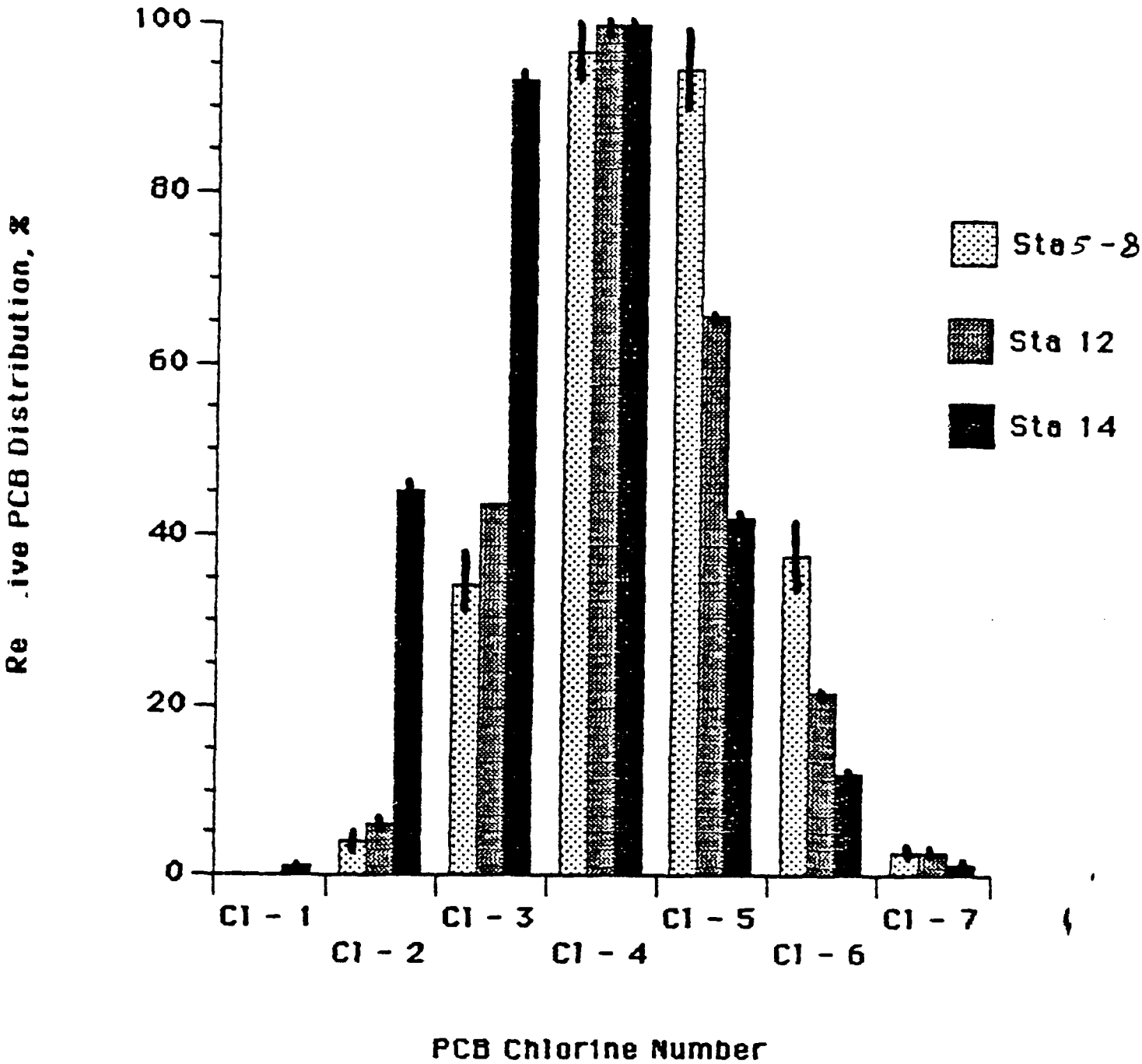
*nd = non detectable (As low as 0.02 ug/g, depending on sample dry weight and congener response)

Table 5. Mean concentration (ug/g dry weight) of polychlorinated biphenyls (PCBs) in sediments from New Bedford Harbor. Analysis was performed by GC/MS. Concentrations are reported by chlorine number congeners, and as total PCBs. Values are from triplicate samples (see Table 4) from one composite from 9 to 13 Ponar dredge samples from each station in New Bedford Harbor that have been tested for their toxicity.

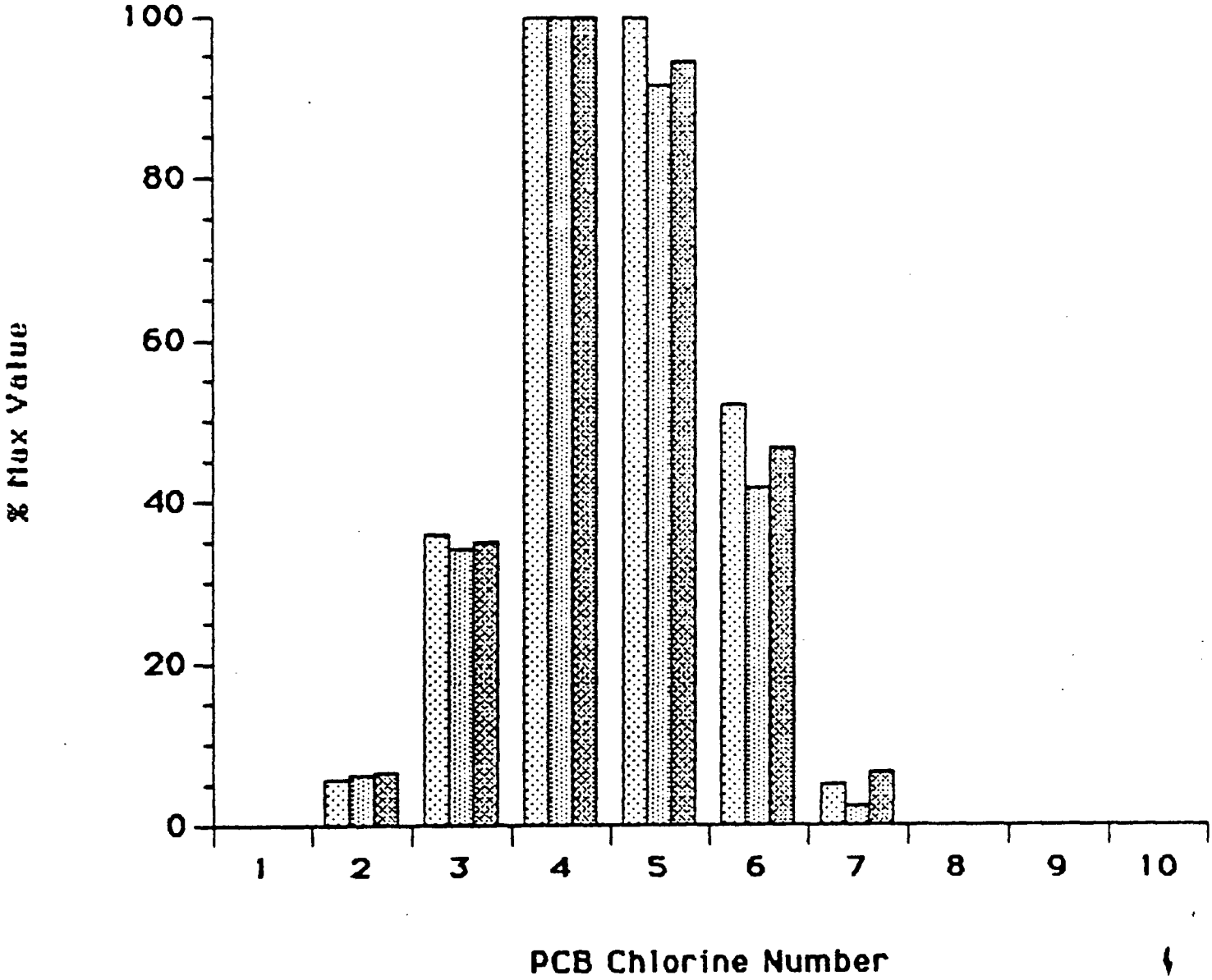
Sample ID	Cl - 1	Cl - 2	Cl - 3	Cl - 4	Cl - 5	Cl - 6	Cl - 7	Cl - 8	Cl - 9	Cl - 10	Σ ug/g
Avg Ref	nd*	nd*	nd*	nd*	0.01	0.01	0.01	0.01	nd*	0.01	0.03
Avg 5 B	nd*	0.22	1.2	3.6	3.4	1.7	0.16	nd*	nd*	nd*	10
Avg 6 B	nd*	0.49	3.8	11	11	5.2	0.61	nd*	nd*	nd*	32
Avg 7 B	nd*	0.20	1.7	5.8	6.3	2.6	0.17	nd*	nd*	nd*	17
Avg 8 B	nd*	0.82	7.5	19	19	8.5	1.2	0.02	nd*	nd*	56
Avg 12 B	nd*	5.7	40	93	61	20	2.4	nd*	nd*	nd*	220
Avg 14 B	8.8	410	840	900	380	110	12	0.98	0.26	nd*	2600

*nd = non detectable (As low as 0.02 ug/g, depending on sample dry weight and congener response)

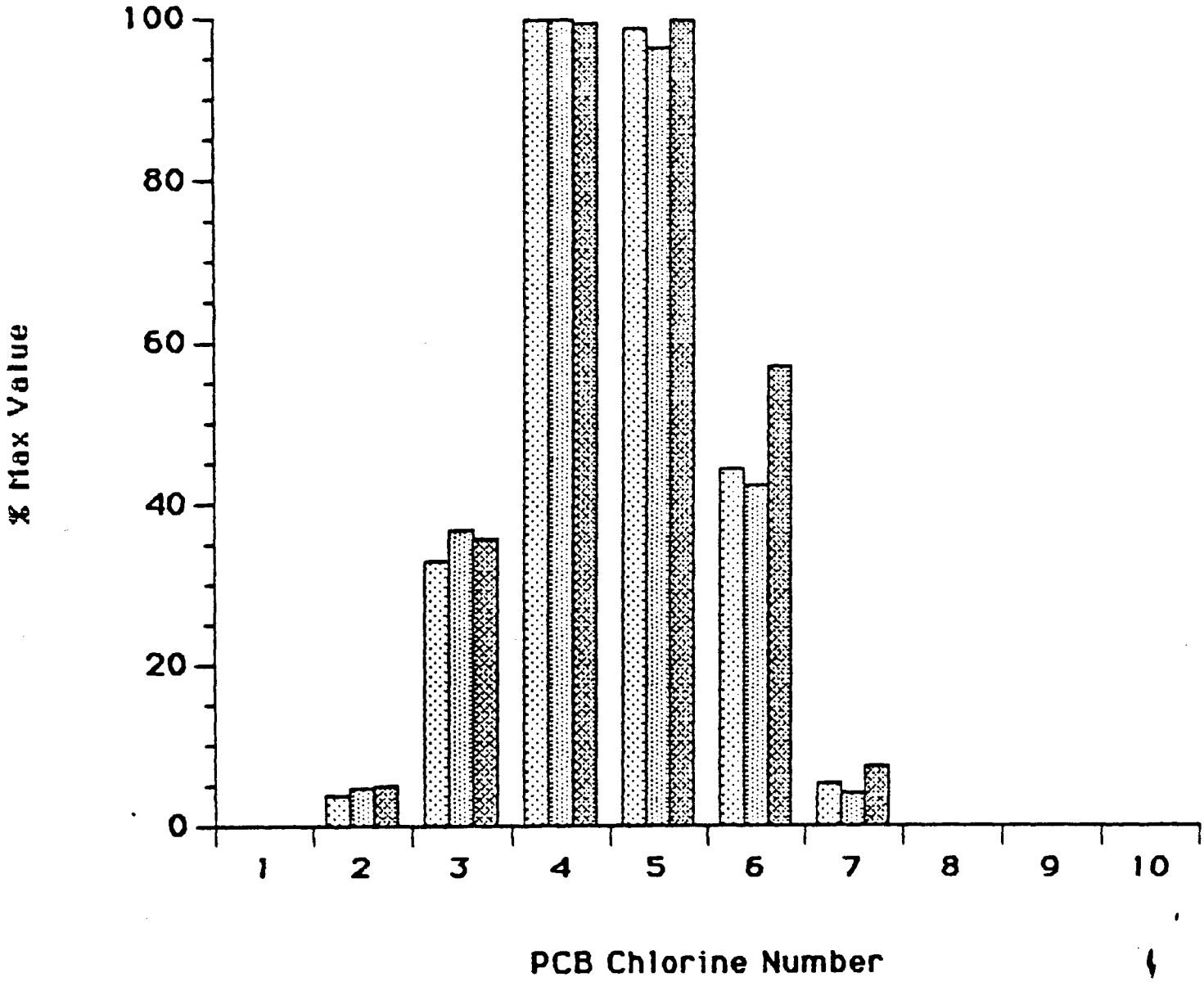
Relative PCB Congener Distribution by Location, Mean ± Standard Deviation



Station 5B, reps A,B,C



Station 6B reps A,B,C



RESULTS OF AMPHIPOD TESTS

Materials and Methods

Ampelisca abdita

Collection and Holding

Ampelisca abdita is a euryhaline benthic amphipod which ranges from Maine to southcentral Florida and the eastern Gulf of Mexico, from the intertidal zone to depths of 60 m.(Bousefield, 1973). A tube dwelling amphipod which constructs a soft, upright membranous tube 3 to 4 cm. long in surface sediments, *A.abdita* is a particle feeder, ingesting either surface-deposited particles or particles in suspension. Where large communities of *Ampelisca* are present, the patches of amphipod tubes may affect the benthic community structure by creating a topographically complex microhabitat and by trapping suspended material(Mills, 1967). This amphipod is also a common food source for bottom fish(Richards, 1963).

Ampelisca were collected from tidal flats in the Pettaquamscutt(Narrow) River, a small estuary flowing into Narragansett Bay, Rhode Island. The sediment containing the amphipods was transferred to the laboratory within one half hour, and seived through a 0.5mm. screen using laboratory seawater at ambient Narragansett Bay temperature and salinity. *Ampelisca* were collected by flotation from the air/water interface. The amphipods were held in the laboratory in preseived uncontaminated sediment and flowing filtered seawater, and acclimated to the assay temperature at the rate of 1 to 2°C per day. During acclimation, the *Ampelisca* were fed, *ad libidum*, the laboratory cultured diatom

Phaeodactylum tricornutum. Surface temperature and salinity at the collection site, and the length of time the amphipods were held in the laboratory before each test are shown in Table .

Exposure System Design

In each assay, *Ampelisca* were exposed for 10 days to control and New Bedford Harbor sediments in the solid phase, with flowing filtered seawater and algal food(*Phaeodactylum tricornutum*) delivered to each exposure container. Lighting was continuous.

The system used to deliver seawater and algae is shown in Figure . Filtered seawater at the rate of 150 ml./min. and algal culture at the rate of 15 ml./min. were delivered into a small upper chamber with an umbrella siphon. Algae was delivered via a Harvard Apparatus peristaltic pump. The upper chamber periodically emptied into a lower, larger mixing chamber. When the mixing chamber was full, it in turn emptied into the delivery chamber below it. The bottom of the delivery chamber was fitted with 30 glass capillary tubes, and was levelled so that each tube delivered the same amount of liquid as every other tube. The capillary tubes emptied into delivery tubes attached to a plate beneath the delivery chamber. The delivery tubes carried the fluid to individual exposure containers, and so that siphoning action could be prevented, they were not continuous with the capillary tubing. A weight, attached to a counter mechanism, hung in the mixing chamber. As the mixing chamber filled, the weight would float gradually upward, and when the chamber emptied, the weight would drop and trip the counter. In this way the number of cycles which had occurred

during any given time period could be determined, and system operation during periods when experimenters had been absent could be checked. Turnover rate for each exposure chamber was approximately 13 turnovers per day.

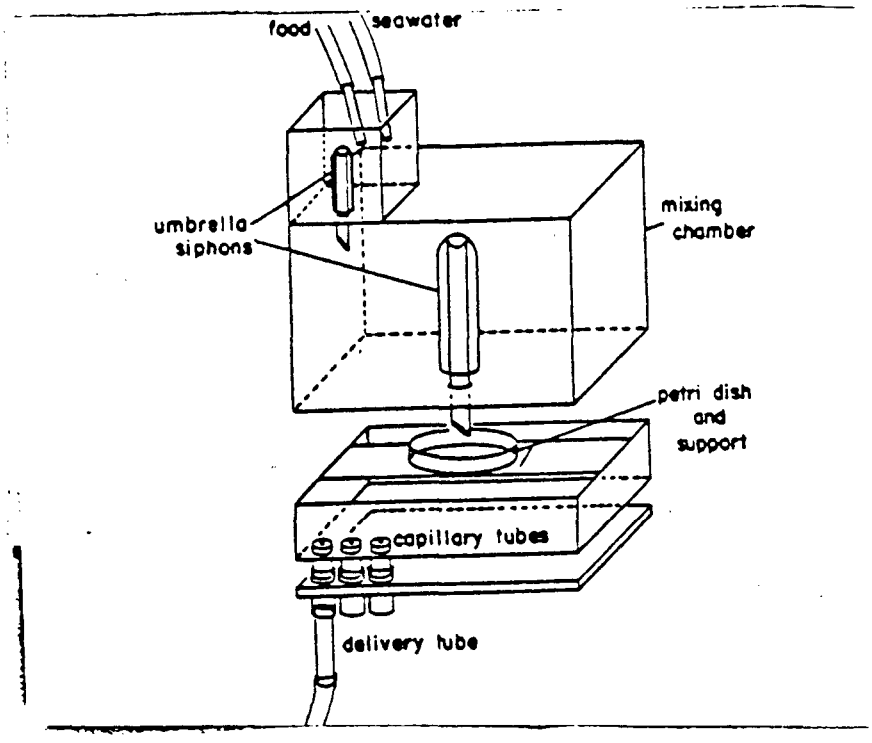


Figure . System used to deliver seawater and algae to Ampelisca abdita exposure chambers in assays with New Bedford Harbor sediment. Not shown is the weight which hung in the mixing chamber. The weight was attached to a counter mechanism which tripped once per mixing chamber cycle.

The exposure container(Figure) was a quart-sized glass canning jar with a half inch overflow hole covered with 400μm Nitex mesh. Two hundred milliliters of control or test sediment filled the bottom of the jar, covered with approximately 600 ml. of seawater. The tube from the delivery system described above entered a hole in the glass cover(3 1/2" diameter glass culture dish) of the exposure jar, emptying above the water

surface. Air was delivered via Silent Giant air pumps into the water column through a glass 2ml. pipette inserted through the cover opening. Air delivery ensured acceptable dissolved oxygen concentration and circulation of the newly delivered seawater and algae. Contaminated aerosol particles were prevented from leaving through the cover opening by a foam plug. The overflow water exited the screened overflow in the exposure chamber, flowed into a water bath, and then to the drain and treatment system. Additional seawater at the test temperature flowed to the water baths to stabilize the temperature in the exposure containers.

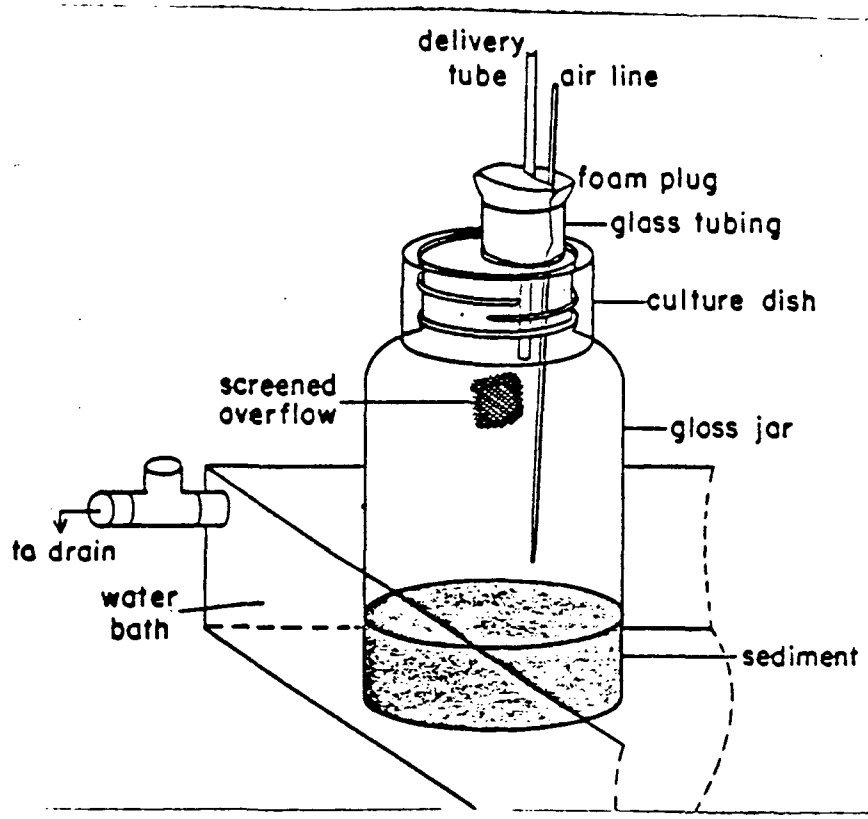


Figure . Containers used to expose *Ampelisca abdita* to New Bedford Harbor sediments.

Experimental Design

Two sets of experiments were conducted, each set consisting of two replicate assays. Control sediment for all experiments was collected from an uncontaminated site in central Long Island Sound(40 7.95'N and 72 52.7'W) with a Smith-MacIntyre grab sampler. The sediment was returned to the laboratory, press seived wet through a 2 mm. mesh stainless steel screen, homogenized, and stored at 4°C in clean glass jars until used. A.abdita has been tested many times in this sediment and both its survival and reproduction have been good(Gentile et.al. 1985).

In Tests 1 and 2, A.abdita were exposed to sediments from stations 5, 6, 7, 8, 12, and 14 from New Bedford Harbor(see Figure), as well as the control sediment described above. Stations were selected so as to represent a gradient of PCB contamination and a range of metals concentrations. There were three replicate exposure containers for each treatment. Twenty and thirty amphipods were tested in each replicate in Test 1 and Test 2, respectively.

In Tests 3 and 4, the amphipods were exposed to the sediments from the most contaminated New Bedford Harbor stations mixed by volume in a dilution series with control sediment. These experiments had two goals: 1)to determine an LC50 for the most highly PCB-contaminated New Bedford Harbor sediment, and 2)to compare the response of A.abdita in sediments with similar PCB concentrations but different metals concentrations. Treatments were control, station 5, 1.5% of station 14, 3% of station 14, 14% of station 12, 6% of station 14, 12% of station 14, 21% of station 14, and station 12. Chemical analysis of sediment from stations 12 and 14 had indicated that station 12 was approximately equal in PCB concentration to 21% of station 14, but had a higher concentration of metals. Fourteen

percent of station 12 and 3% of station 14 could be similarly paired. These 4 treatments consisted of 3 replicate containers each, whereas 2 replicates were tested in all other treatments in Tests 3 and 4. Thirty amphipods were exposed in each replicate.

System Monitoring

The flow rate of seawater entering the seawater delivery system was checked daily, and the algal delivery rate measured at least twice per test. The volume delivered to each exposure container was measured two to four times per test.

Temperature in the water baths was monitored daily, salinity of the incoming seawater measured regularly with a refractometer, and dissolved oxygen measured in the water column of each exposure container with a LG Nester oxygen meter twice during each assay.

Once during each assay, a 50 ml. sample was taken from the water column in each exposure container and filtered through a preweighed 0.3μm glass fiber filter. The filter was dried 3-4 hours at 103°C and reweighed, to provide a dry weight measurement of suspended solids in each jar. A sample of the algal culture delivered to the jars was taken each day for a similar dry weight determination. Algae dry weight was converted to cells/ml. by using a previously determined relationship for *Phaeodactylum tricornutum* between mg./l. dry weight and cells/ml. as determined by cell counts.

Biological Design

Each sediment was thoroughly homogenized before use in an experiment. The day before amphipods were added to the exposure system, sediments were mixed and added to exposure containers, and the containers filled to the overflow with filtered seawater. A plastic disk was used when adding seawater to minimize disturbance of the sediment. Exposure containers were placed in the water baths, and air and seawater delivery begun.

The next day, amphipods were seived from holding containers through a 0.5mm. stainless steel screen using 20°C filtered seawater. Subadult amphipods were distributed sequentially into 100-ml. plastic beakers containing 20°C filtered seawater. After sorting, these were examined for dead or outsized animals, which were replaced with others fr n the same seived population. The beakers were randomized, and one aker of organisms preserved in 5% buffered formalin for later measurement use of a computerized digitizer and camera lucida device. Air delivery the exposure containers was halted, and the remaining amphipods were adde to the experiment. After one hour containers were checked, any amphipods not burrowed into the sediment were noted, and air delivery was restarted.

Exposure containers were checked daily and the number of individuals dead, moribund, on the sediment surface, and on the water surface were recorded. The number of molts and condition of the tubes constructed were also monitored. Dead amphipods and molts were removed.

After 10 days, the assay was terminated and the contents of each exposure container were seived through a 0.5mm. screen. Material retained on the seive was preserved in 5% buffered formalin with Rose Bengal for

later sorting. Recovered animals were counted, and any missing individuals were assumed to be mortalities.

Statistical Analyses

LC50 values were calculated using the probit or moving average method as appropriate. Abbott's formula was used to correct for control mortality.

When between-station comparisons were made(Tests 1 and 2, and station 12 and 14 comparisons in Tests 3 and 4), an arc sine transformation of the square root of proportional mortality was conducted, and the transformed data analyzed using a one-way analysis of variance and Duncan's multiple range test.

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Mills, E.L. 1967. The biology of an ampeliscid amphipod crustacean sibling species pair. J.Fish. Res. Bd. Canada 24: 305-355.

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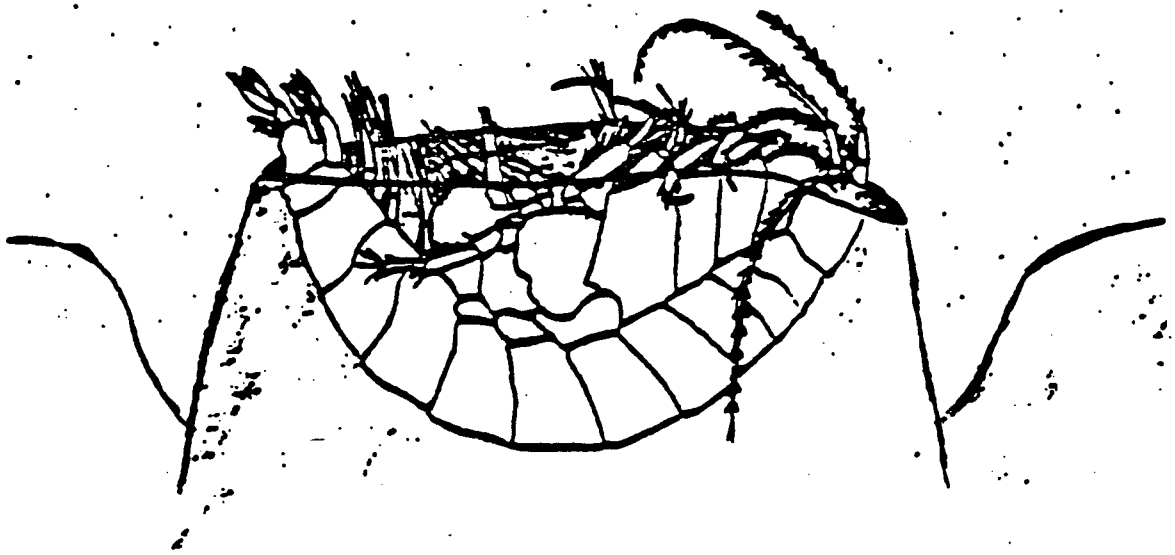


A. abdita in feeding position in its tube

Ampelisca abdita

* Infaunal tube dwelling amphipod

* Surface deposit and suspension feeder in fine sediments

* Widely distributed – Nova Scotia to Florida

* Exposure via particles or interstitial water

TEST CONDITIONS

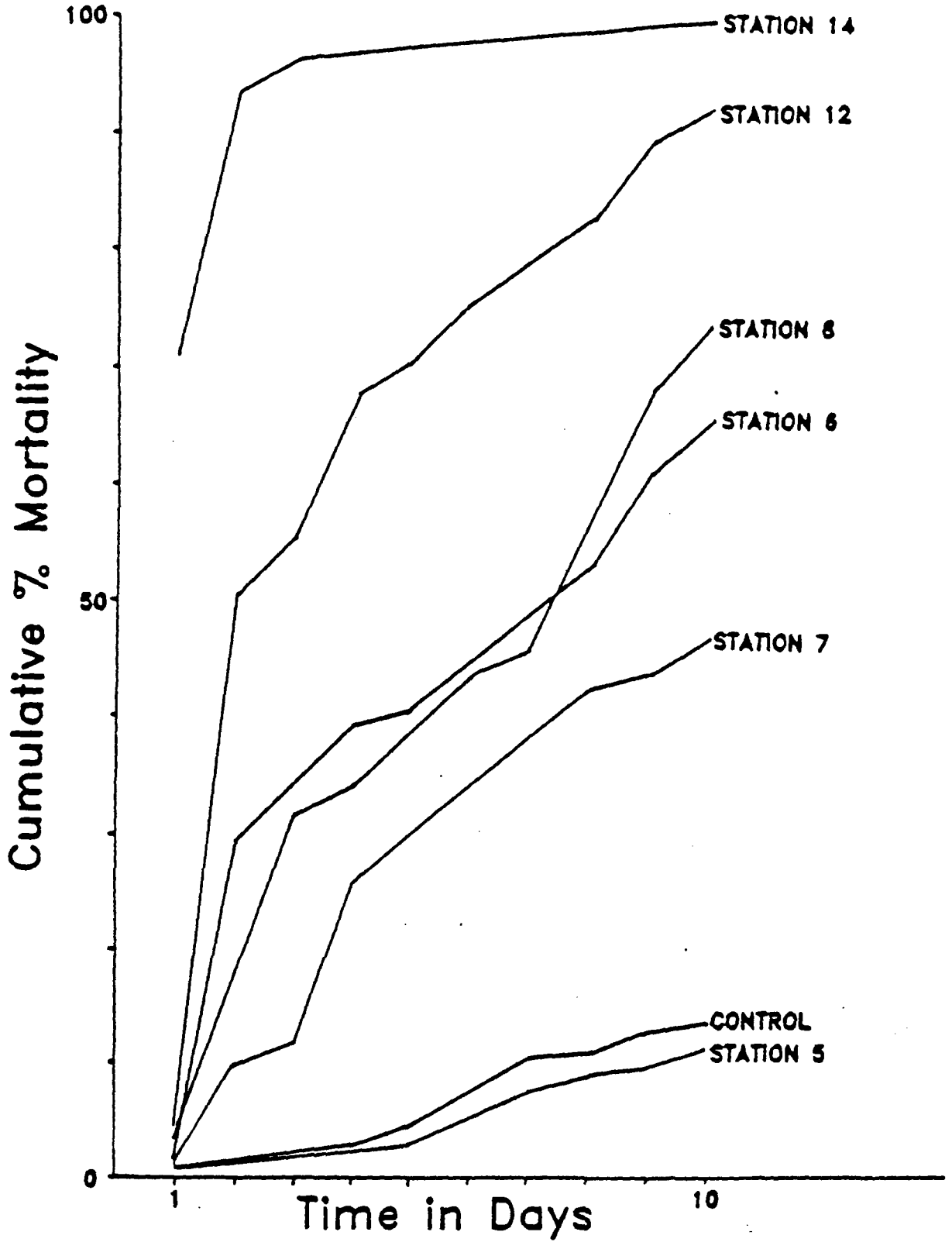
* Ten day sediment exposures

* Flow-through water delivery with aerated water column

* Biological endpoints:

  Mortality - 4 and 10 day

  Emergence rate - mean of survivors emerging per day



Mortality of A.abdita exposed to New Bedford Harbor sediments from selected stations

Ampelisca abdita

Solid Phase Test

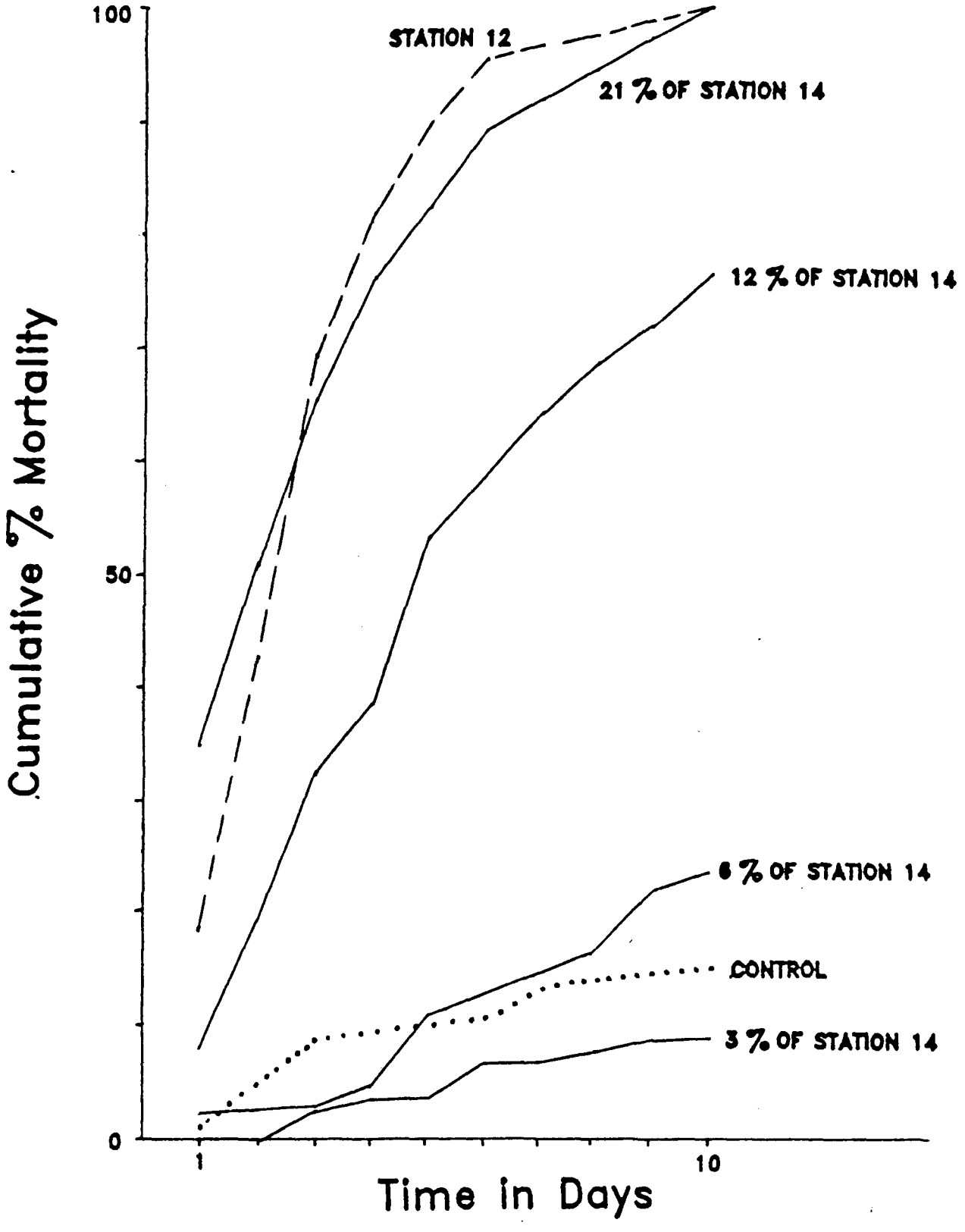
SEDIMENT GRADIENT EXPOSURES

SEDIMENT	% MORTALITY		DAILY AVERAGE % OF AMPHIPODS EMERGED
	4 DAY	10 DAY	
REFERENCE	2.7	13.3	0.0
NBH 5	2.2	11.1	6.6
NBH 7	25.6	46.7	13.4
NBH 5	39.3	65.5	19.9
NBH 8	34.0	73.3	24.1
NBH 12	67.6	92.2	34.1
NBH 14	96.7	100.0	NM*

*Not Measured

Sediment Concentrations (ug/g)

SUBSTANCE	100%NBH14	21%NBH14	100%NBH12
PCB	1100	231	231
Cd	40.5	8.50	79.2
Cu	1110	231	2580
Cr	670	141	1600
Fe	17600	3700	22700
Mn	165	34.6	170
Ni	139	29.2	237
Pb	840	176	658
Zn	2270	477	2480



Mortality of A.abdita exposed to dilutions of New Bedford Harbor sediments with control sediment

Ampelisca abdita

Conclusions

Solid Phase Testing:

* Survival and emergence showed a response to a spatial gradient of NBH sediments

* Survival and emergence rates in sediments from station NBH 5, with a resident Ampelisca population, were not different from those in the Reference control.

* Sediment dilutions elicited a biological response consitent with contaminated sediment concentrations

* Station NBH 14 (northernmost) had a no effect concentration of 6%

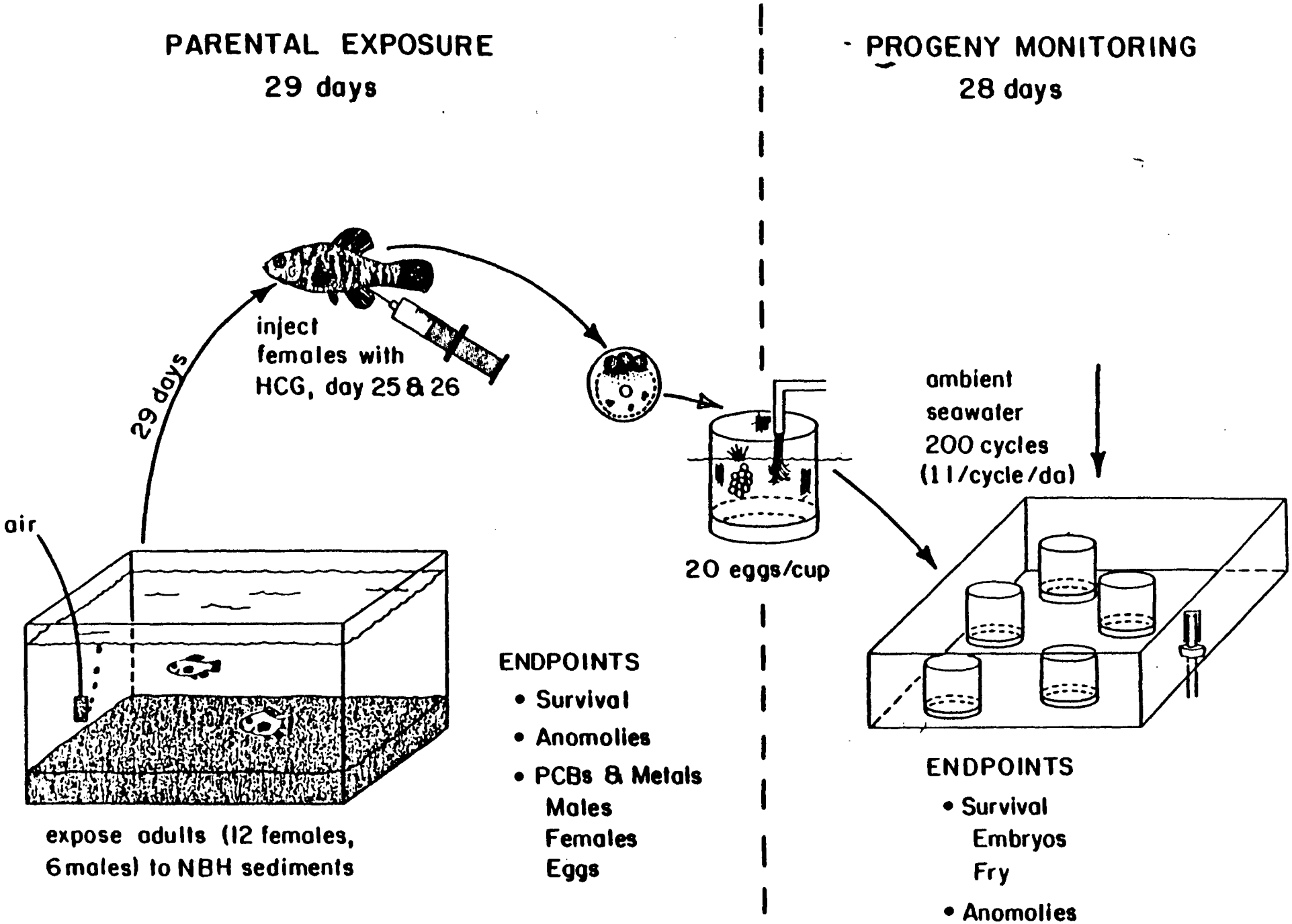
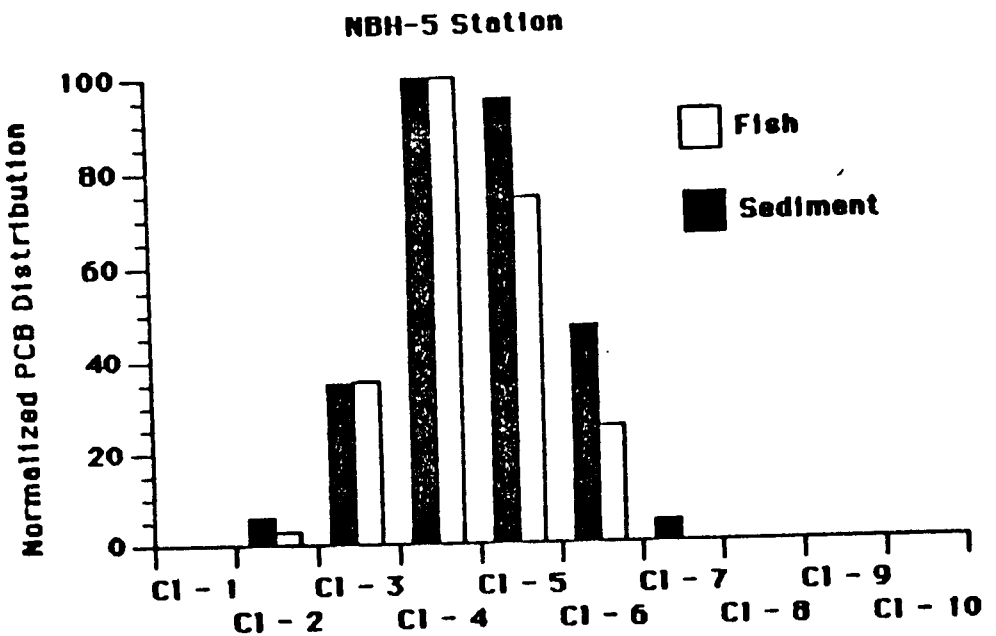
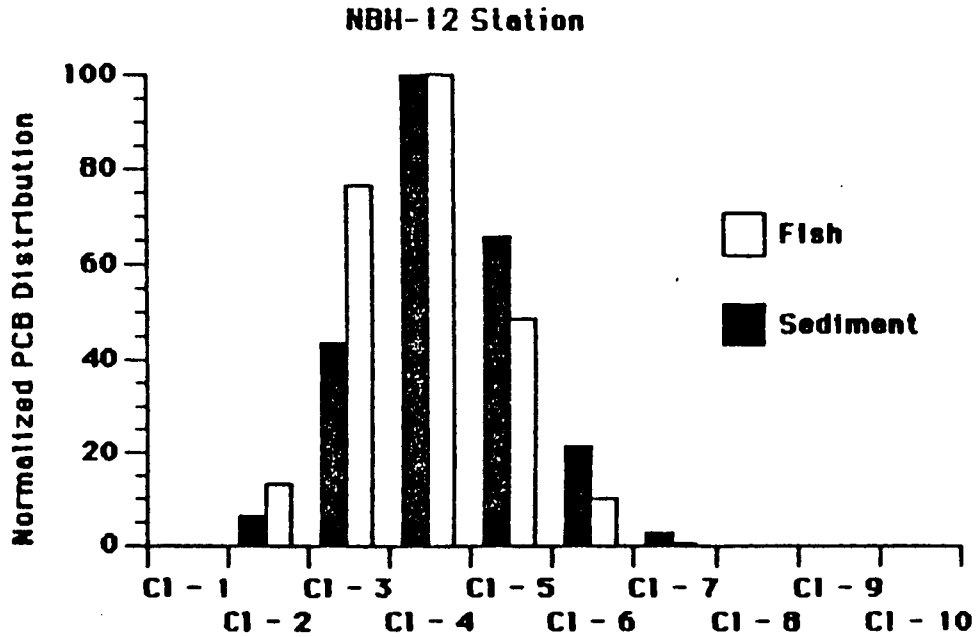
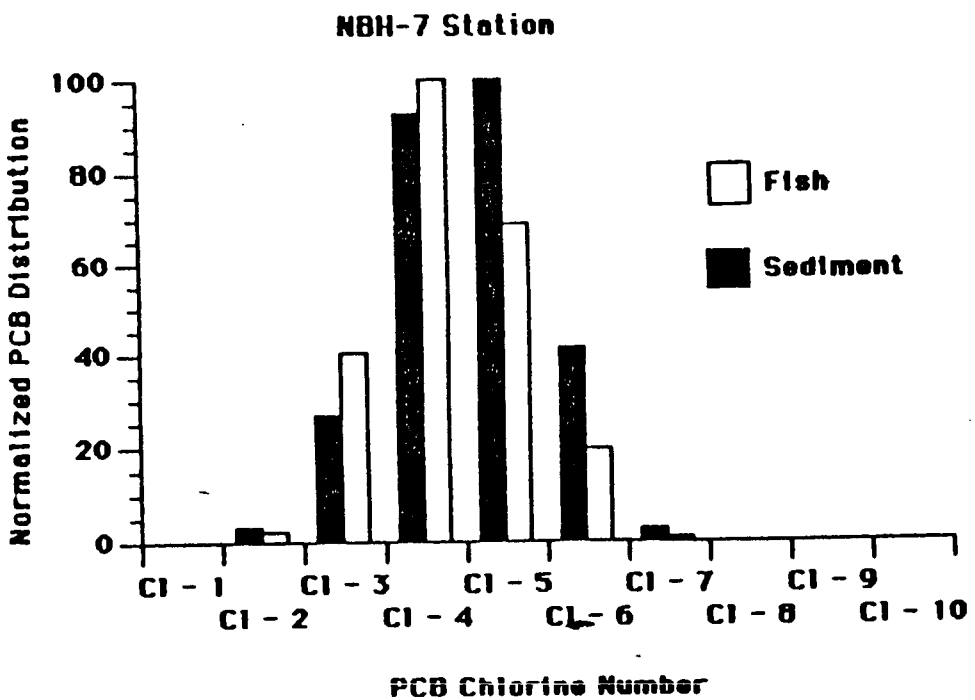

PARENTAL EXPOSURE
29 days
PROGENY MONITORING
28 days
29 days
inject
females with
HCG, day 25 & 26
air
expose adults (12 females,
6 males) to NBH sediments
ENDPOINTS
• Survival
• Anomolies
• PCBs & Metals
Males
Females
Eggs
20 eggs/cup
ambient
seawater
200 cycles
(1 l/cycle/da)
ENDPOINTS
• Survival
Embryos
Fry
• Anomolies

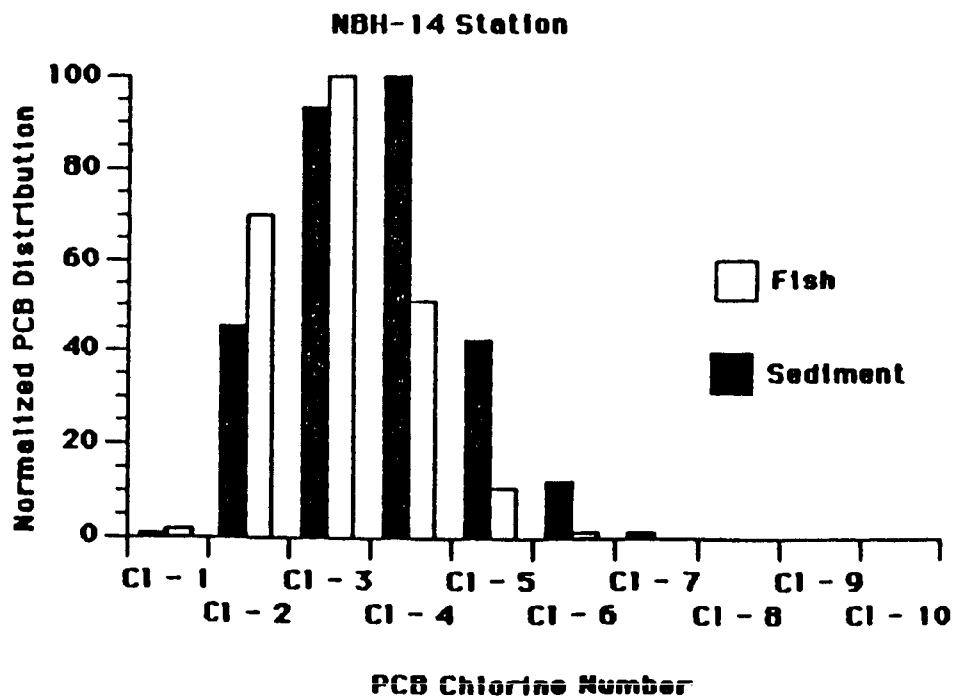
Table : Concentration of PCB (Aroclor 1254) in sediments from New Bedford Harbor, in adult sheepshead minnows exposed to those sediments for 29 days, and in eggs from the exposed fish.

TREATMENT	SEDIMENT	MALES	FEMALES	EGGS
REF-1	0.0514(0.59)	0.456(0.22)	0.513(0.00)	0.143
REF-2	0.0514(0.59)	0.445(N.A.)	0.634(0.49)	0.147
NBH-5	7.31(1.4)	15.6(0.94)	21.0(0.73)	8.96
NBH-7	13.3(1.3)	76.5(0.38)	43.4(0.37)	20.0
NBH-8	30.9(1.8)	73.8(0.84)	59.0(0.95)	28.9
NBH-12	231(0.95)	127(1.1)	142(1.3)	78.5
NBH-14	1,100(2.4)	100(8.0)	107(8.5)	67.2


NBH-5 Station
Normalized PCB Distribution
100
80
60
40
20
0
Fish
Sediment
Cl - 1
Cl - 2
Cl - 3
Cl - 4
Cl - 5
Cl - 6
Cl - 7
Cl - 8
Cl - 9
Cl - 10


NBH-12 Station
Normalized PCB Distribution
100
80
60
40
20
0
Fish
Sediment
Cl - 1
Cl - 2
Cl - 3
Cl - 4
Cl - 5
Cl - 6
Cl - 7
Cl - 8
Cl - 9
Cl - 10


NBH-7 Station
Normalized PCB Distribution
100
80
60
40
20
0
Fish
Sediment
Cl - 1
Cl - 2
Cl - 3
Cl - 4
Cl - 5
Cl - 6
Cl - 7
Cl - 8
Cl - 9
Cl - 10
PCB Chlorine Number


NBH-14 Station
Normalized PCB Distribution
100
80
60
40
20
0
Fish
Sediment
Cl - 1
Cl - 2
Cl - 3
Cl - 4
Cl - 5
Cl - 6
Cl - 7
Cl - 8
Cl - 9
Cl - 10
PCB Chlorine Number

MEAN PCB CONGENER CONCENTRATIONS (ug/ RY WEIGHT) IN ADULT FISH EXPOSED TO SEDIMENTS FROM NEW BEDFORD HARBOR AND A REFERENCE SITE FOR 29 DAYS.

Sediment	Cl-1	Cl-2	Cl-3	Cl-4	Cl-5	Cl-6	Cl-7	Total
REF	nd*	0.01	0.02	0.05	0.04	0.01	nd*	0.13
NBH-5	ND*	0.17	2.2	6.3	4.7	1.6	0.01	15
NBH-7	0.01	0.23	3.9	9.7	6.7	1.9	0.09	23
NBH-8	nd*	1.2	12	22	17	5.4	0.37	59
NBH-12	0.02	8.7	51	66	32	5.5	0.23	170
NBH-14	7.1	260	360	190	40	4.8	nd*	860

* nd= non detectable (Can be as low as 0.02 ug/g depending on sample dry weight and congener response.) No congeners containing 8 to 10 chlorines were detected.

TABLE : Concentration (ug/g dry weight) of polychlorinated biphenyls (Aroclor 1254) and selected metals in sheepshead minnows exposed to sediments from New Bedford Harbor for 29 days. NBH-14 fish were exposed for 11 days because the fish exposed to NBH-14 sediment in the beginning of the exposure period died within 14 days. Values are from single analyses done on composites of 3-9 females (F) or 2-4 males (M).

TREAT	sex	AROCLOR 1254	Cd	Cu	Cr	Fe	Mn	Ni	Pb	Zn
REF-1	F	0.513	0.000	11.0	0.26	30.6	6.66	0.16	0.38	85.2
REF-1	M	0.456	0.000	4.90	0.07	18.4	3.64	0.14	0.00	53.3
REF-2	F	0.634	0.000	9.00	0.17	26.2	5.74	0.31	0.10	79.7
REF-2	M	0.445	0.000	7.00	0.35	19.7	3.88	0.30	0.00	50.3
NBH-5	F	21.0	0.049	12.3	0.61	48.5	3.65	0.48	0.62	85.5
NBH-5	M	15.6	0.017	8.10	0.91	36.2	2.95	0.66	0.29	81.2
NBH-7	F	43.4	0.000	8.40	0.35	45.9	3.20	0.32	0.17	68.5
NBH-7	M	76.5	0.000	9.70	0.76	48.5	3.47	0.45	0.16	72.0
NBH-8	F	59.0	0.000	10.0	0.91	34.7	2.90	0.44	0.56	81.5
NBH-8	M	73.8	0.000	5.00	0.76	21.7	2.34	0.52	0.17	80.1
NBH-12	F	142	0.010	11.5	0.28	38.4	3.49	0.29	0.33	106
NBH-12	M	127	0.000	10.4	2.72	44.3	2.95	2.06	1.03	83.4
NBH-14	F	107	0.000	8.10	0.06	23.8	3.56	0.00	0.00	63.3
NBH-14	M	100	0.000	9.60	0.94	30.3	3.91	0.59	0.06	77.9

* The reference sediment is from Central Long Island Sound.

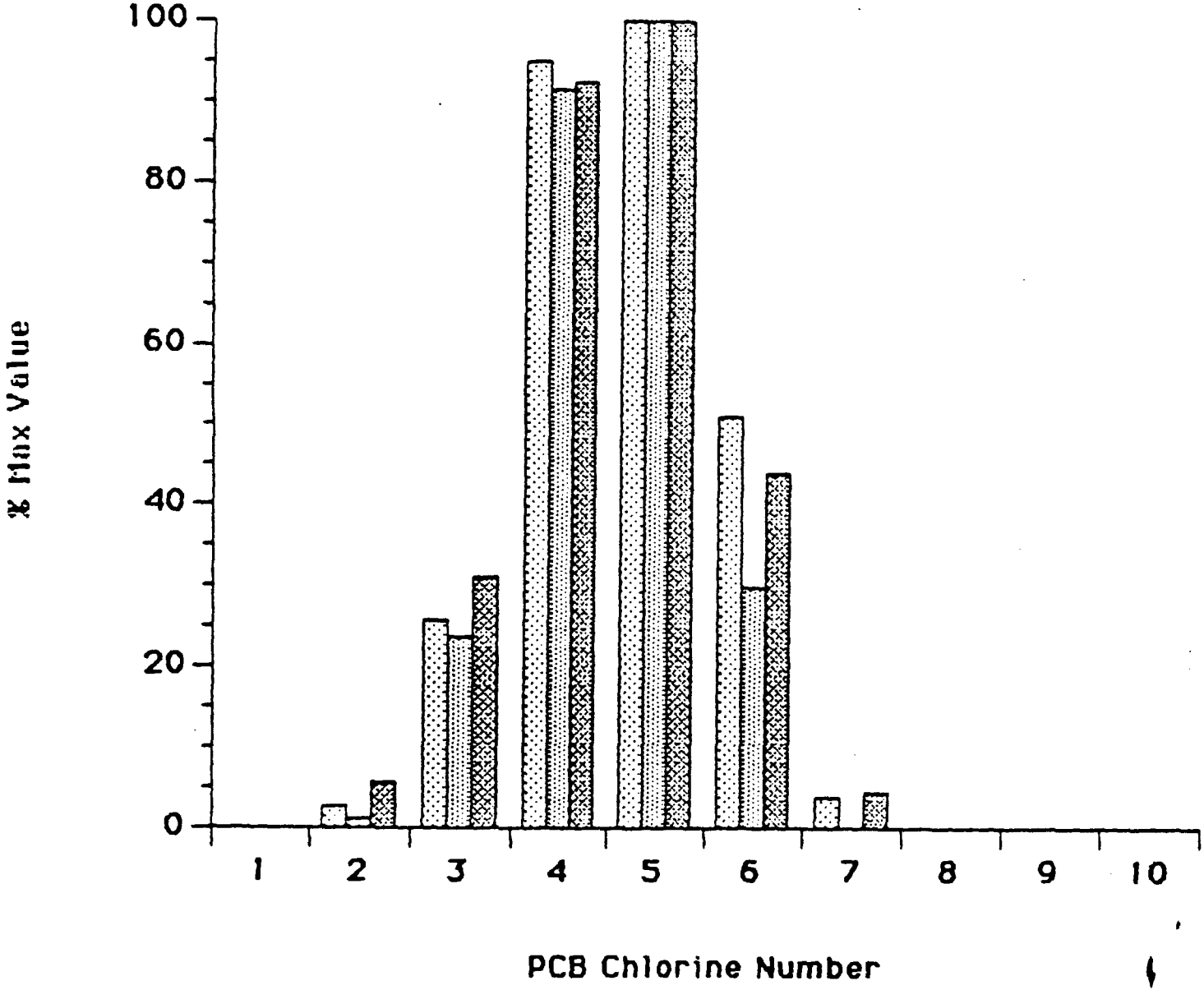
Table : ffects of New Bedford Harbor (NBH) se ents on sheepshead minnows. Adult fi (12 females and 6 males per treatment) were exposed to a reference sediment from Central Long Island Sound and to sediments from five locations within NBH. Females were injected with human choronic gonadotropin and stripped of their eggs. The eggs from 4-5 individual females were fertilized with milt from males taken from the same treatment as the females. The effects of exposure of parental fish on development and survival of embryos and resultant hatched fish was assessed by holding progeny in clean flowing seawater for 28 days.

	Parental Fish Exposure (29 DAYS)		Progeny (28 DAYS)			
			Embryos		Fish	
Treatment	Survival	Survivors with fin rot or mouth erosion	Survival to Day 1	Survival: day 1 to hatch	Hatched Fish survival	Incidence of fin rot
REF-1	100%	0%	69%	94%	99%	0%
REF-2	100%	0%	54%	66%	88%	2%
NBH-5	100%	0%	42%	65%	65%	0%
NBH-7	94%	0%	11%*	45%	55%	4%
NBH-8	100%	0%	30%	73%	88%	2%
NBH-12	72%*	42%*	15%*	56%	20%*	45%
NBH-14	0%*	80%*,**	17%*	55%	58%	23%

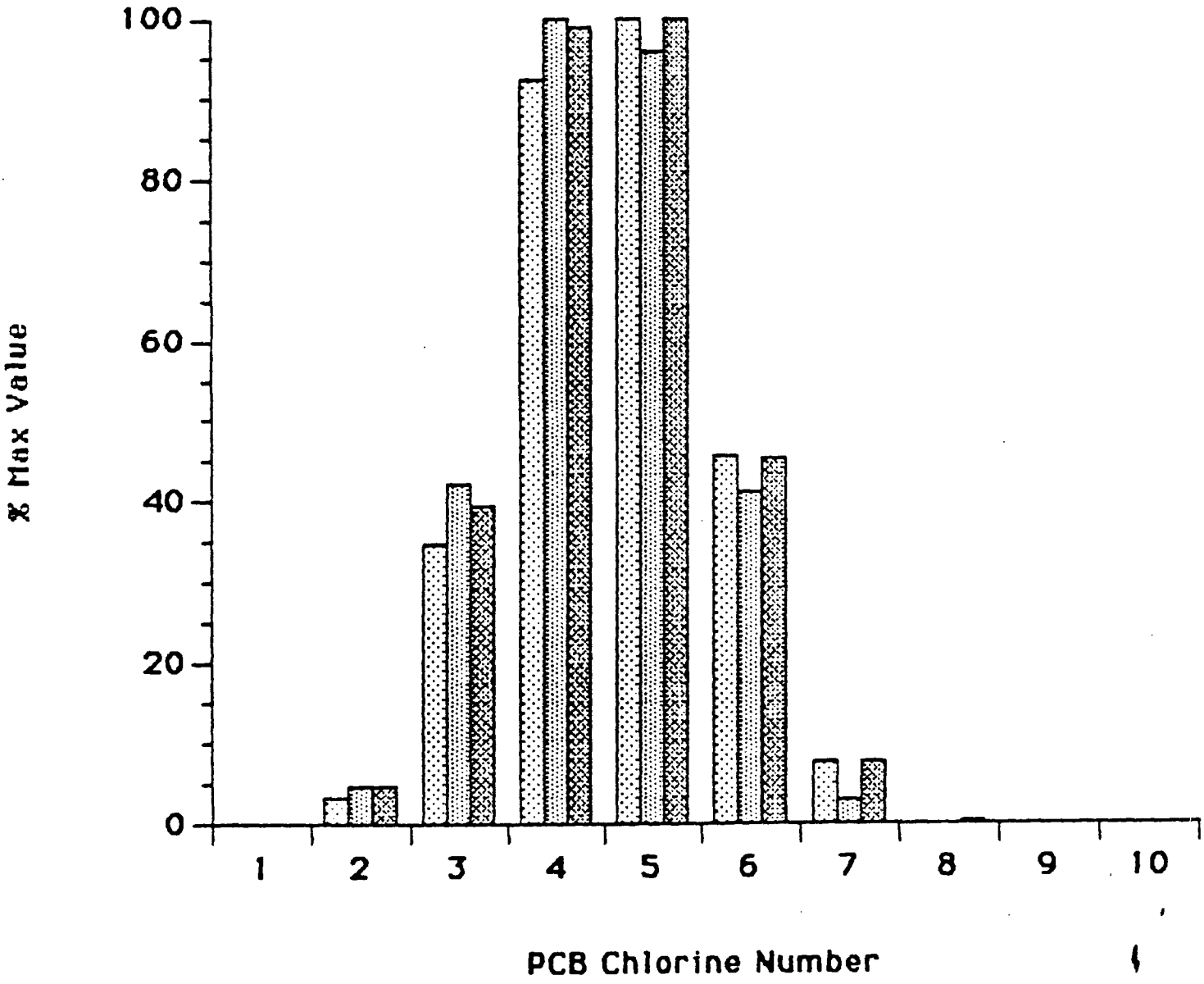
* Significantly different from Ref-2.

** Restarted with 10-day exposure.

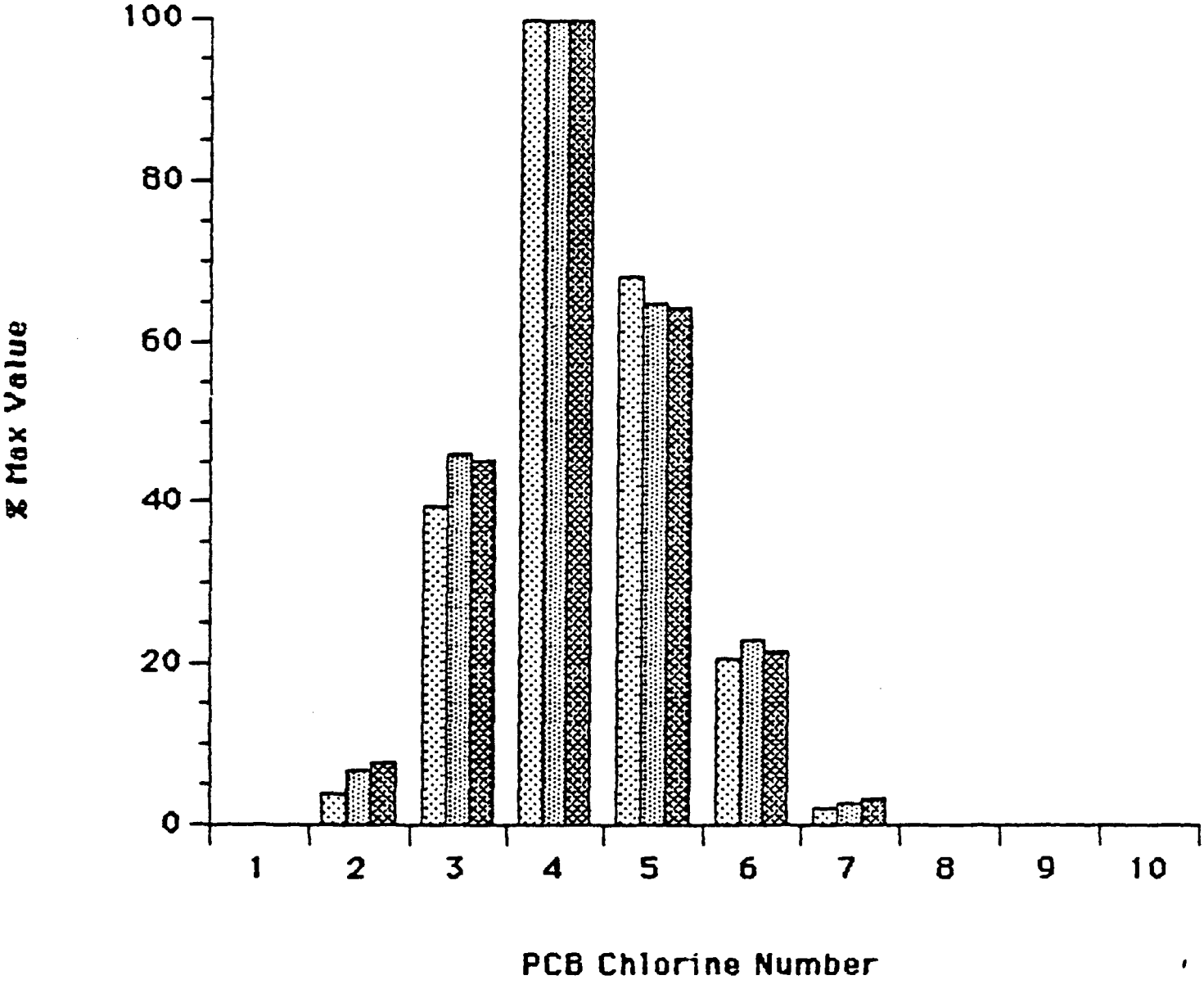
Station 7B reps A,B,C



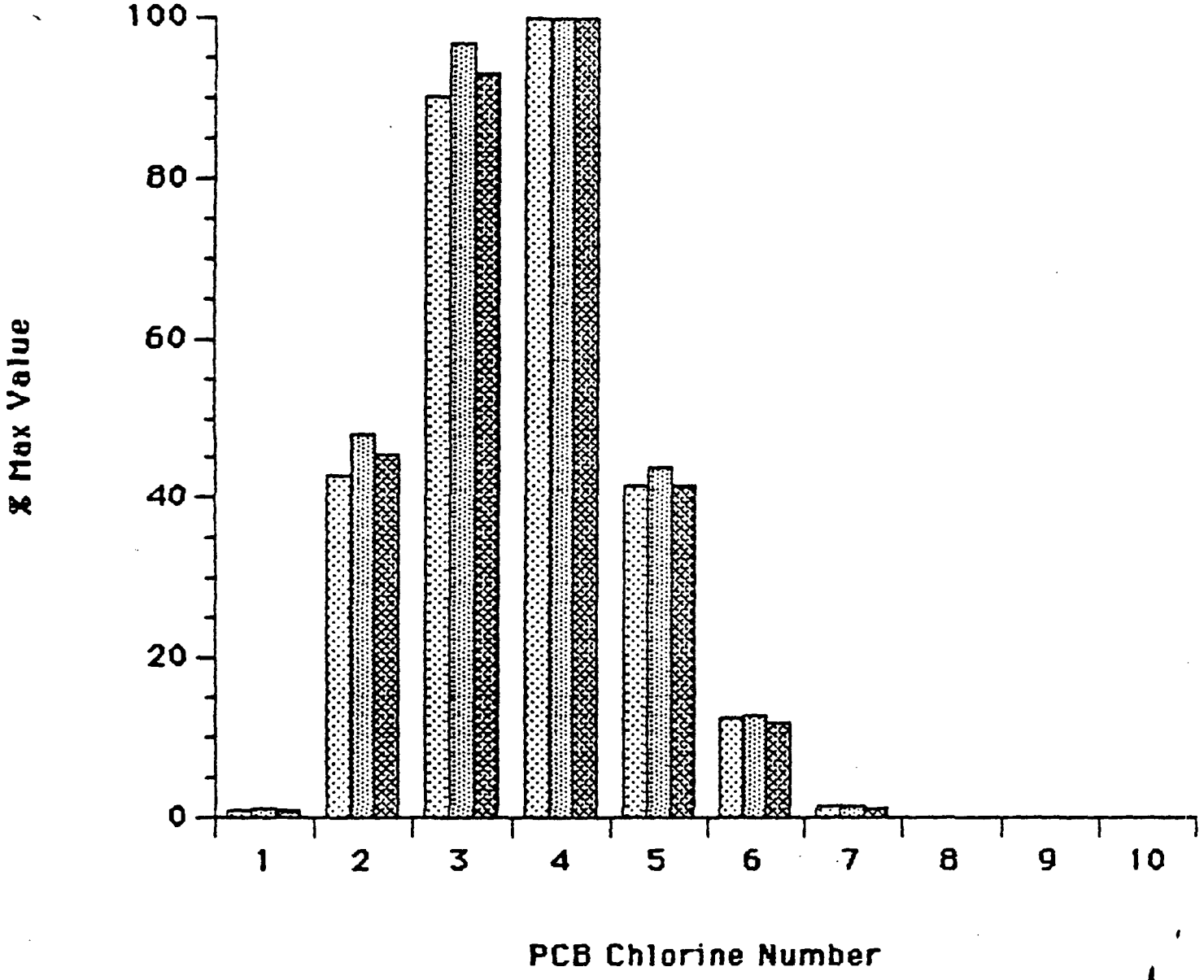
Station 8B reps A,B,C

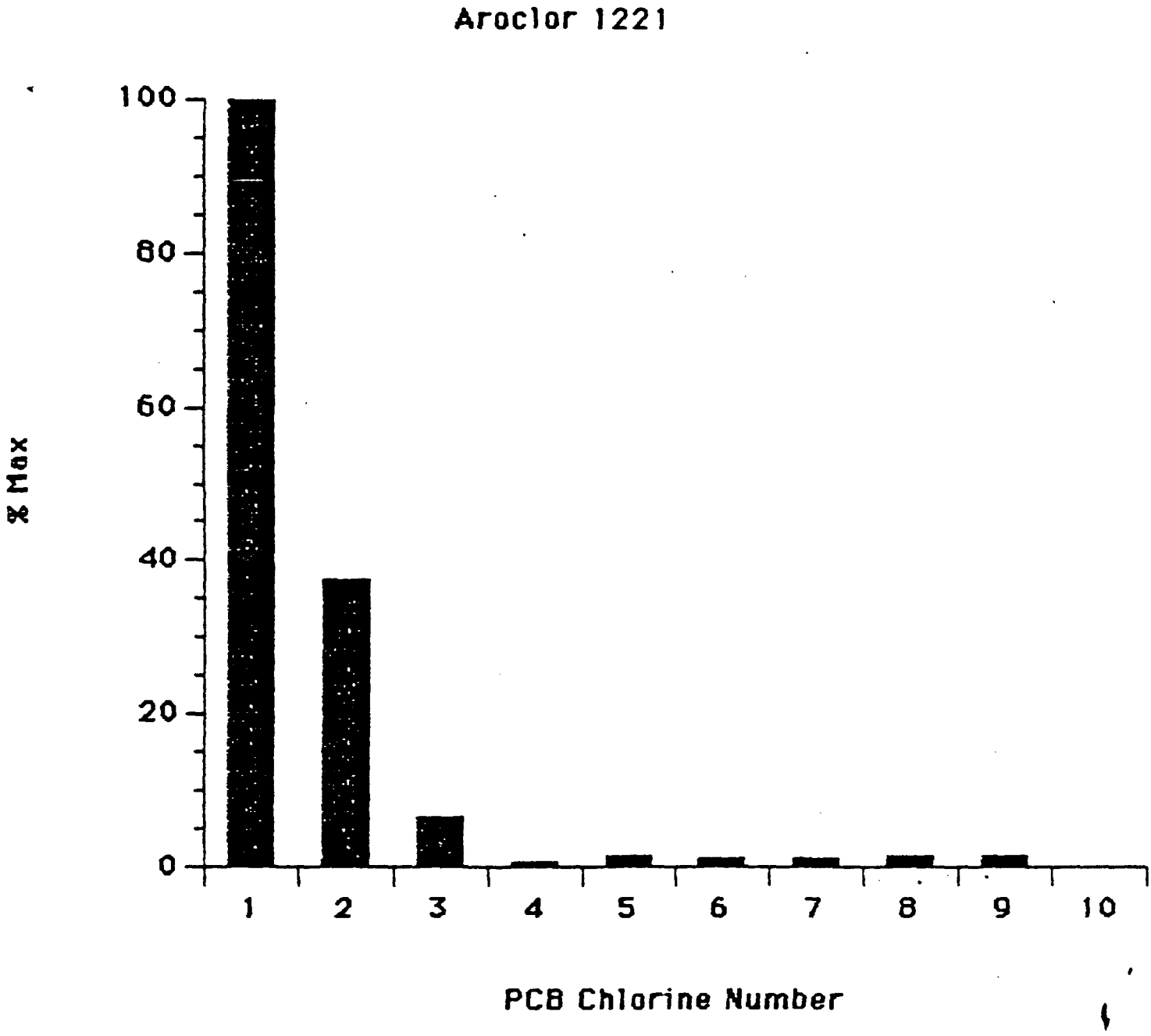


Station 12B reps A, B, C



Station 14B Reps A, B, C




Aroclor 1221
100
80
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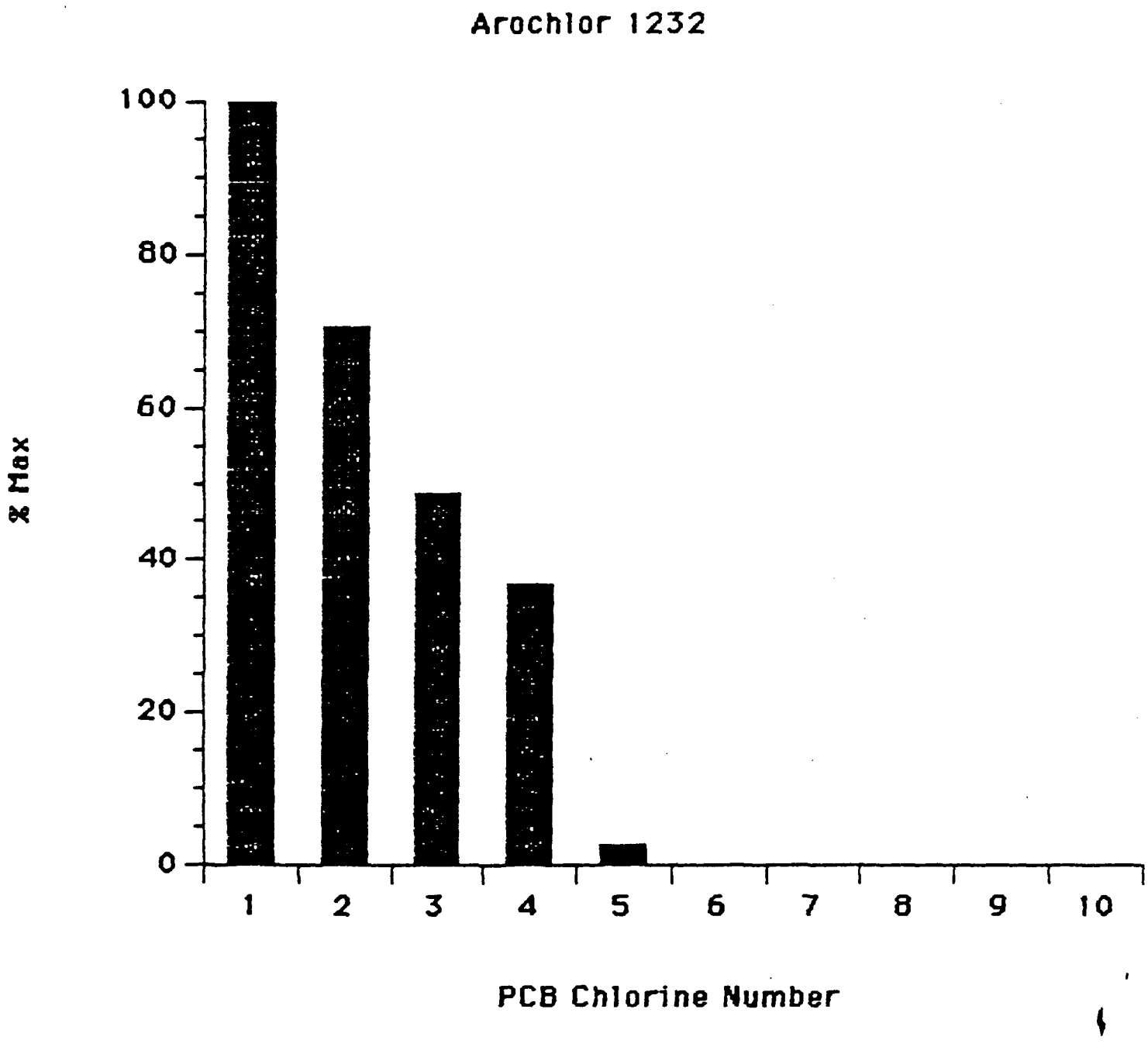
40
20
0
% Max
1
2
3
4
5
6
7
8
9
10
PCB Chlorine Number


Arochlor 1232
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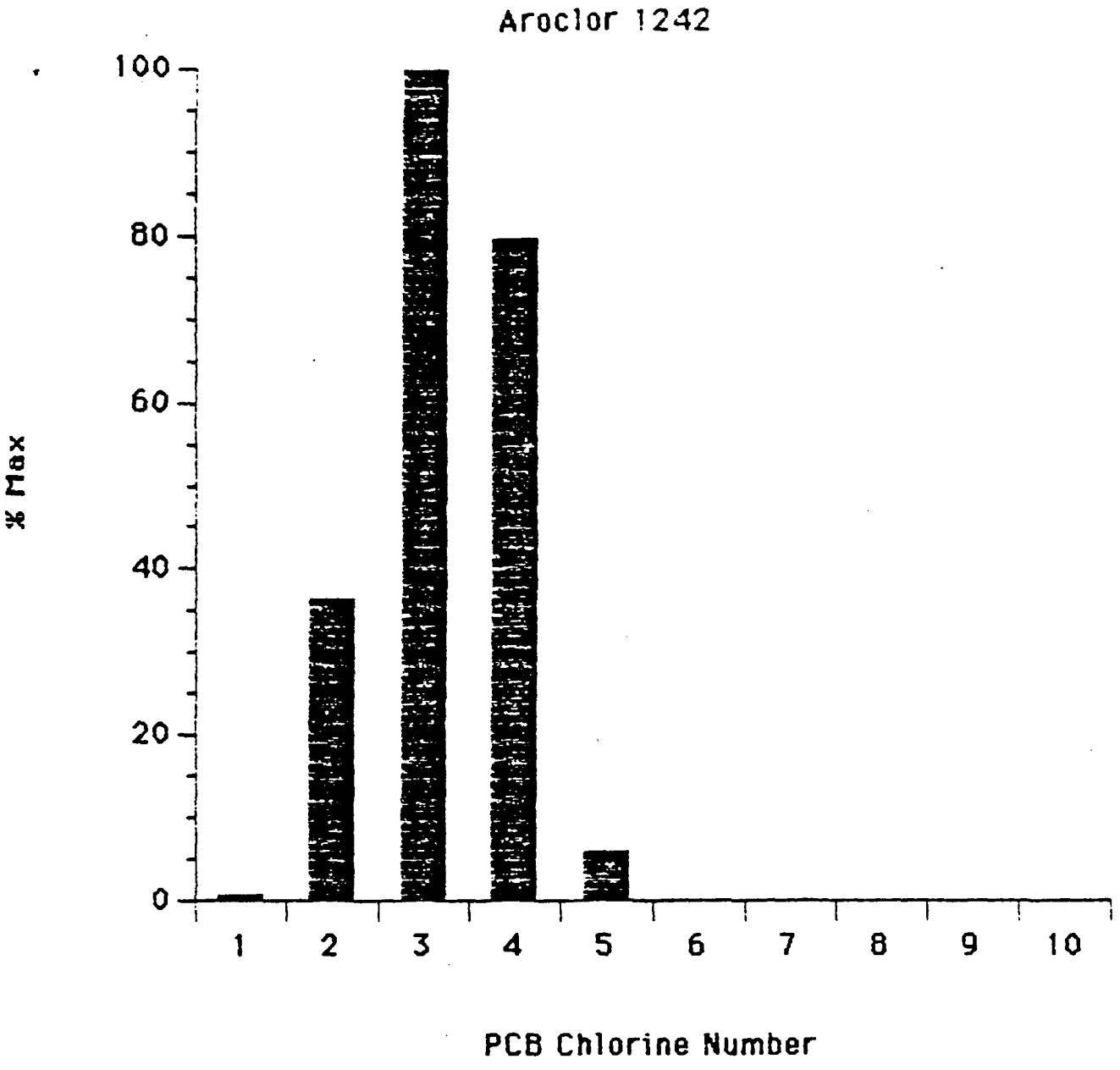
PCB Chlorine Number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% Max
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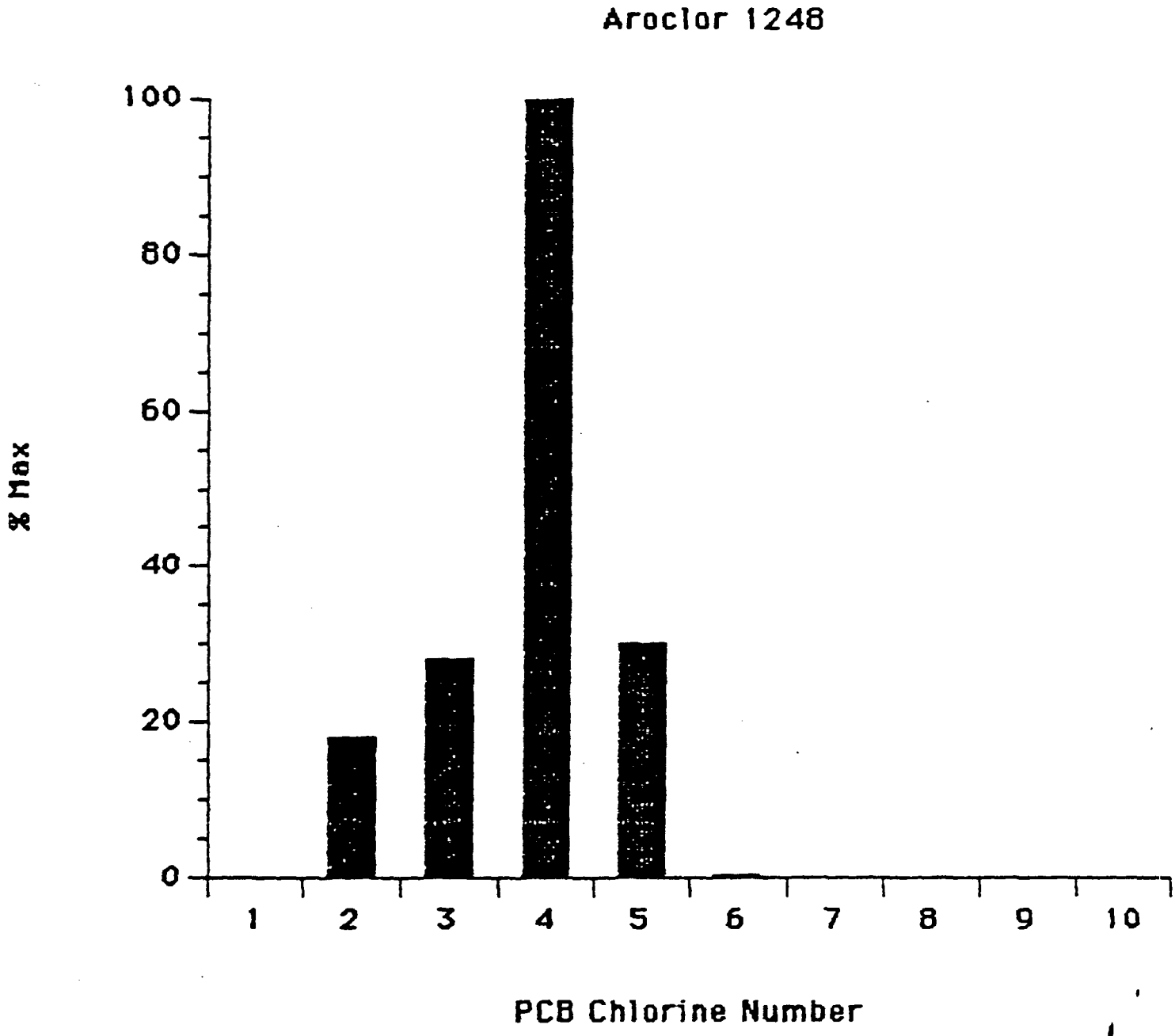
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% Max
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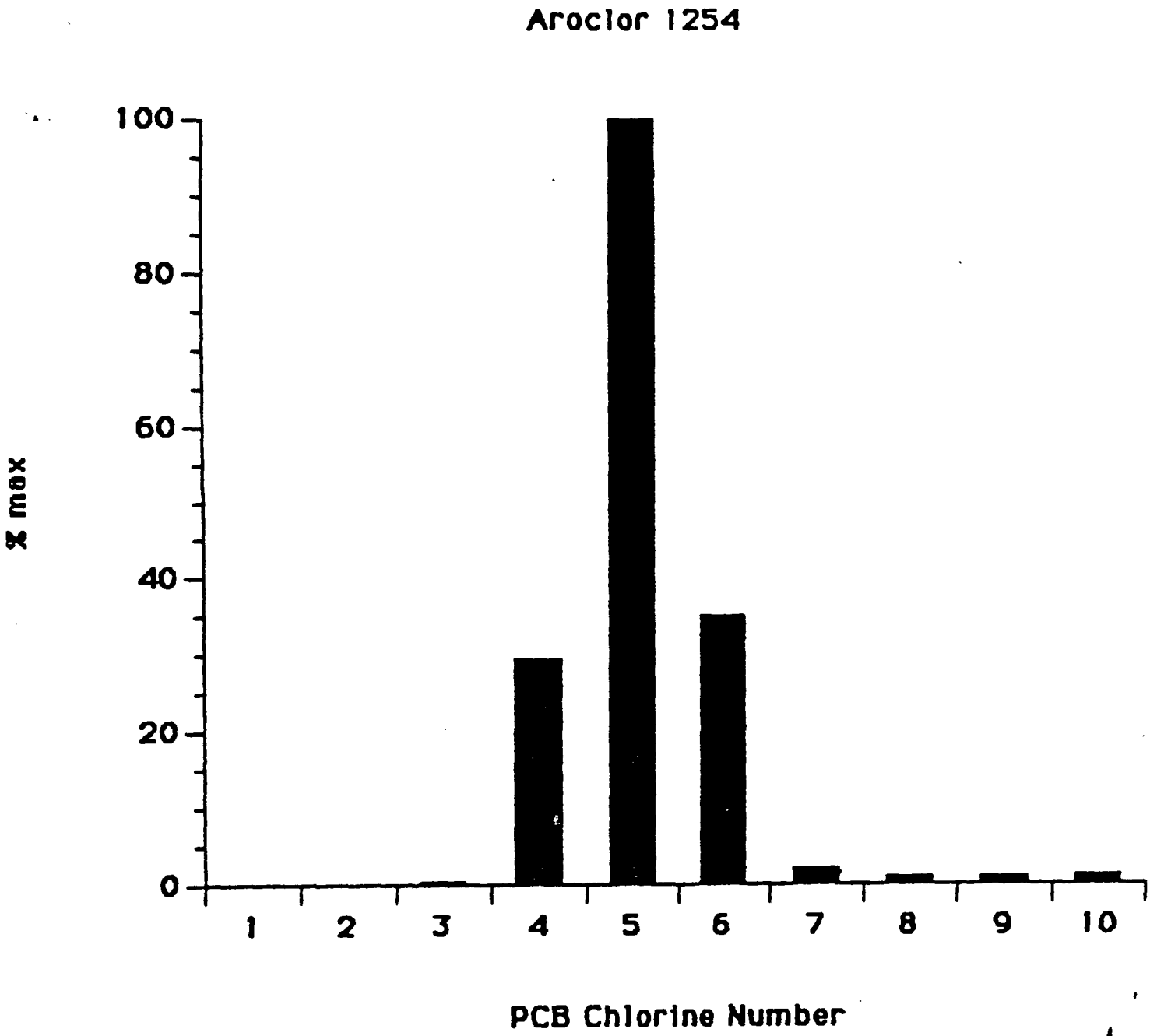
PCB Chlorine Number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% max
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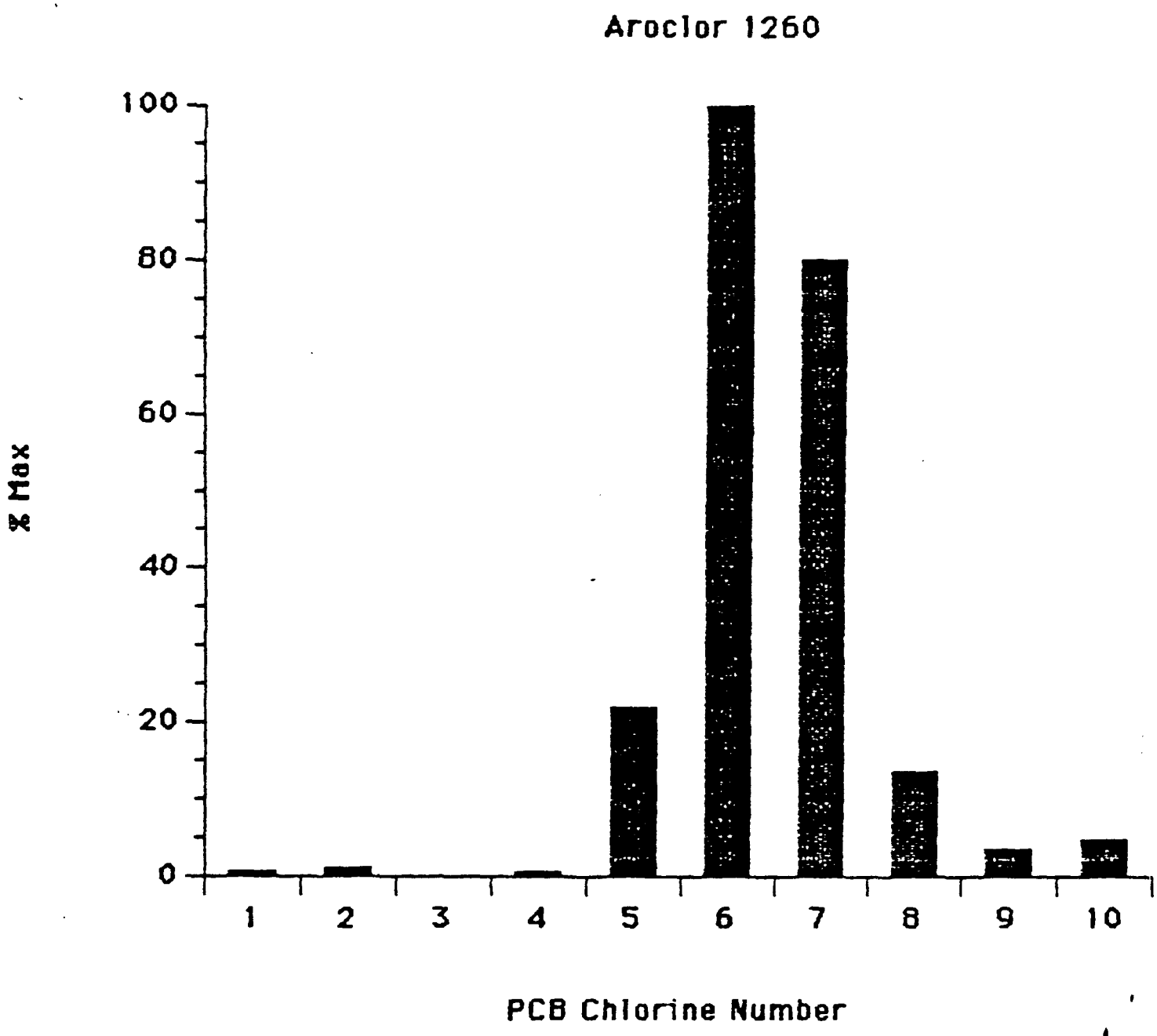
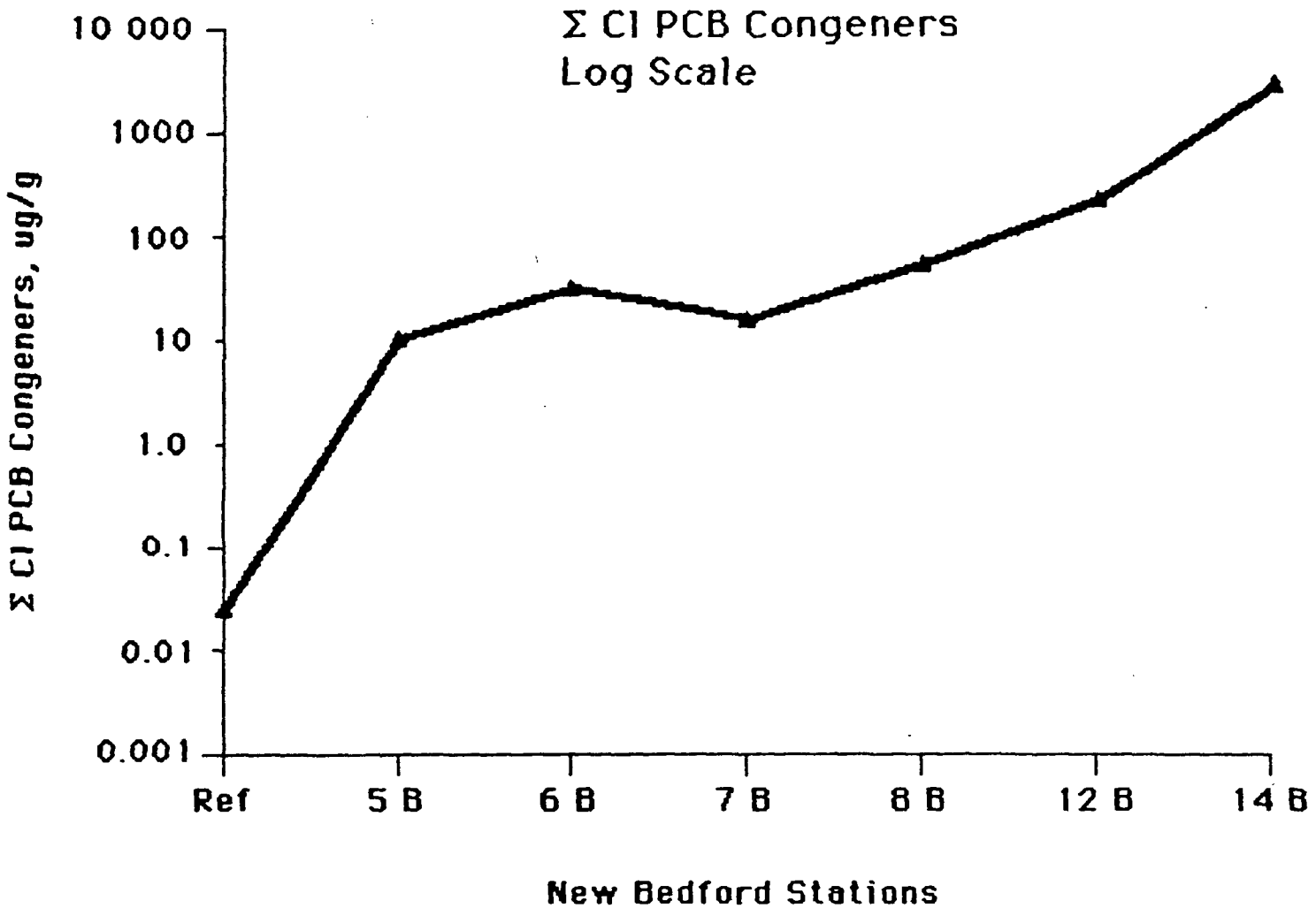
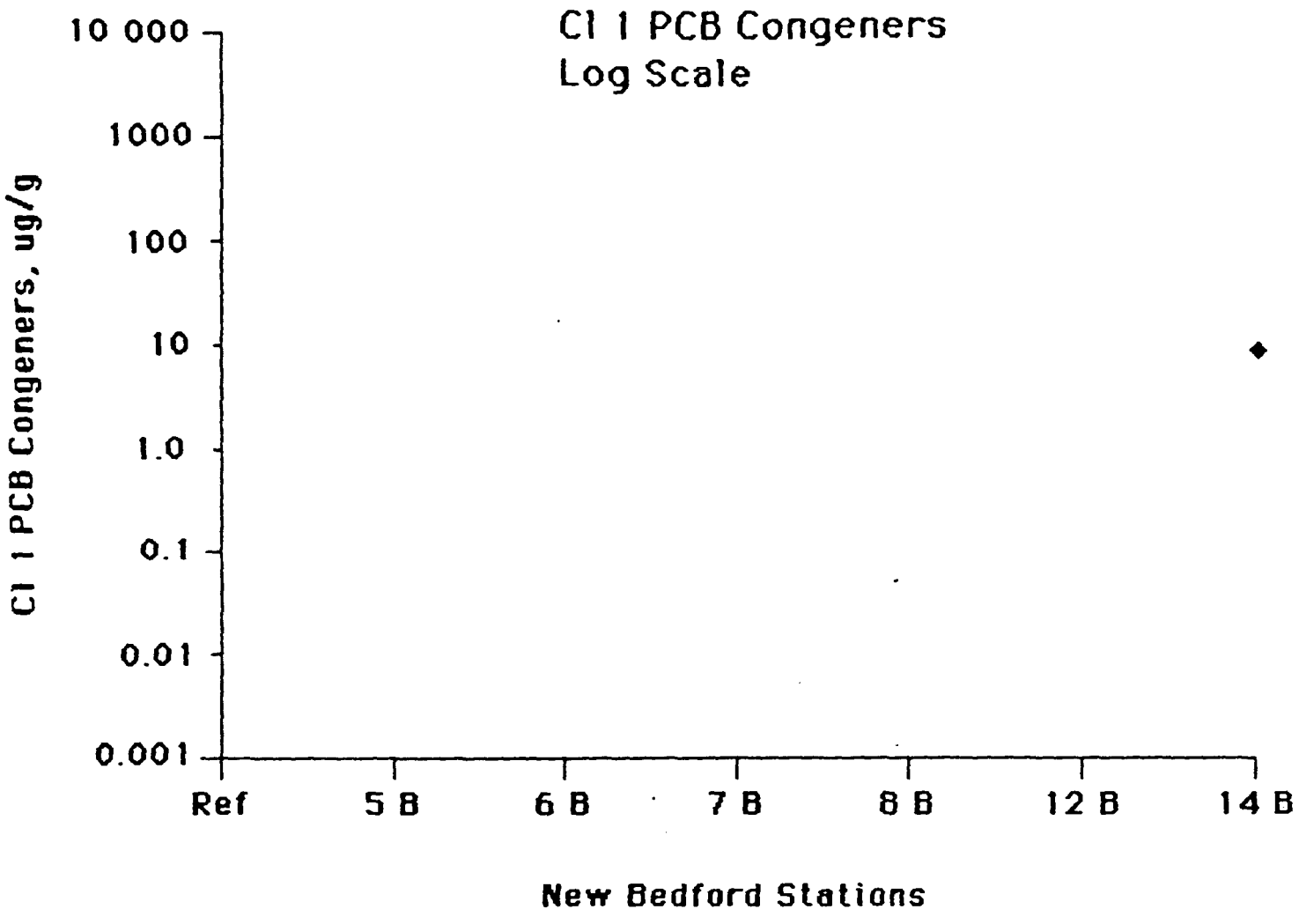
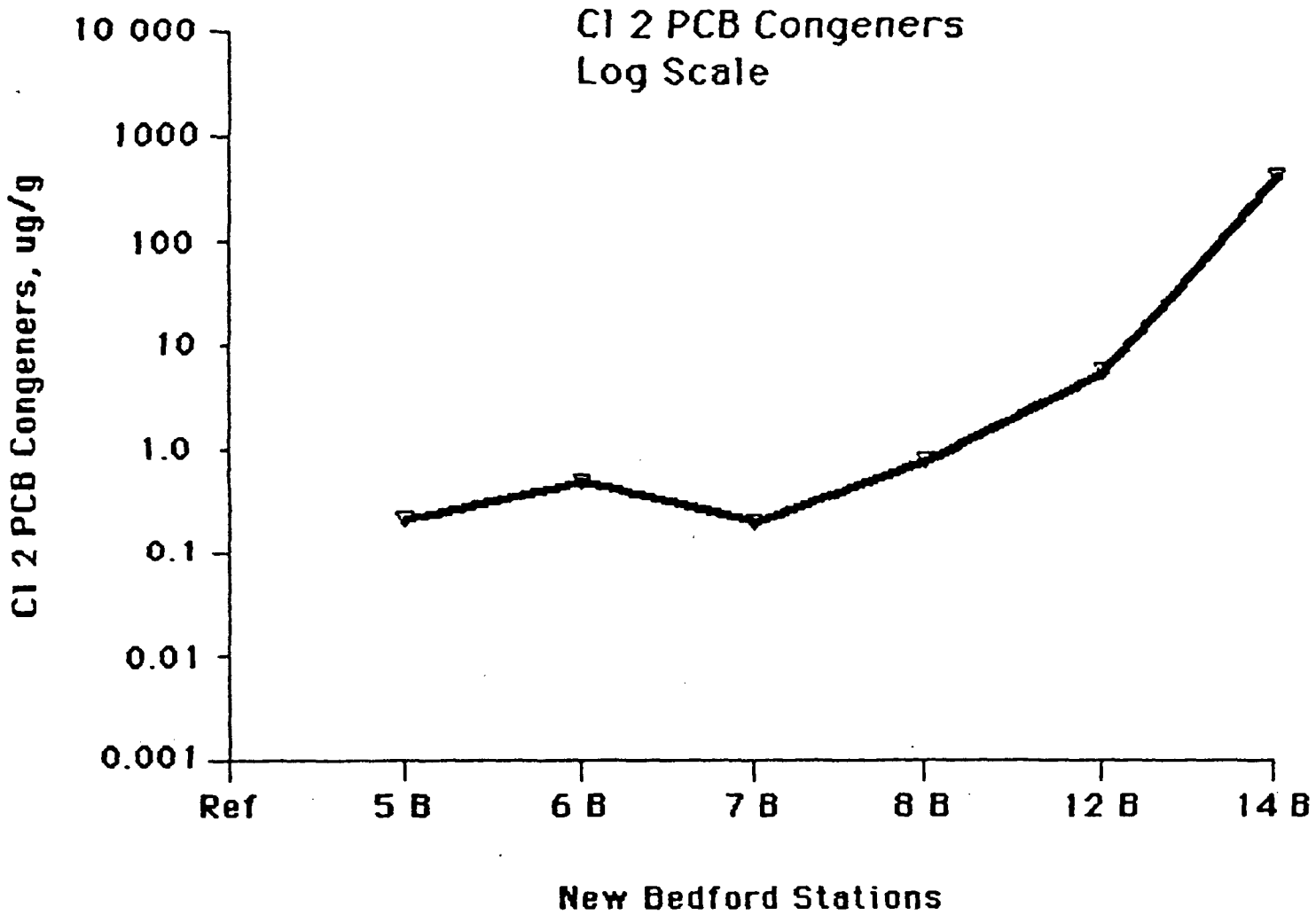
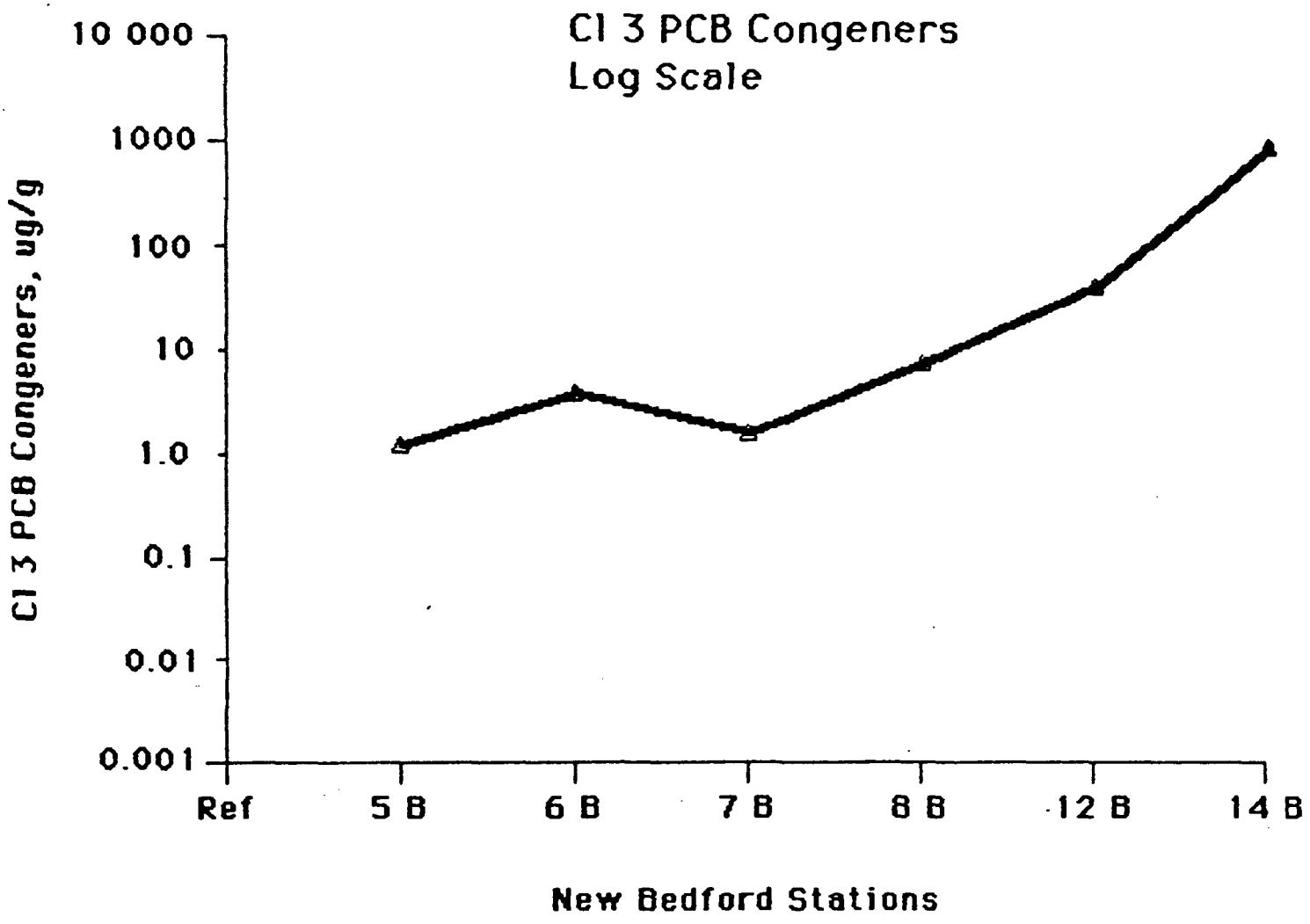
PCB Chlorine Number


Aroclor 1260
100
80
60
40
20
0
% Max
1
2
3
4
5
6
7
8
9
10
PCB Chlorine Number


Σ Cl PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Σ Cl PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 1 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 1 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 2 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 2 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 3 PCB Congeners
Log Scale
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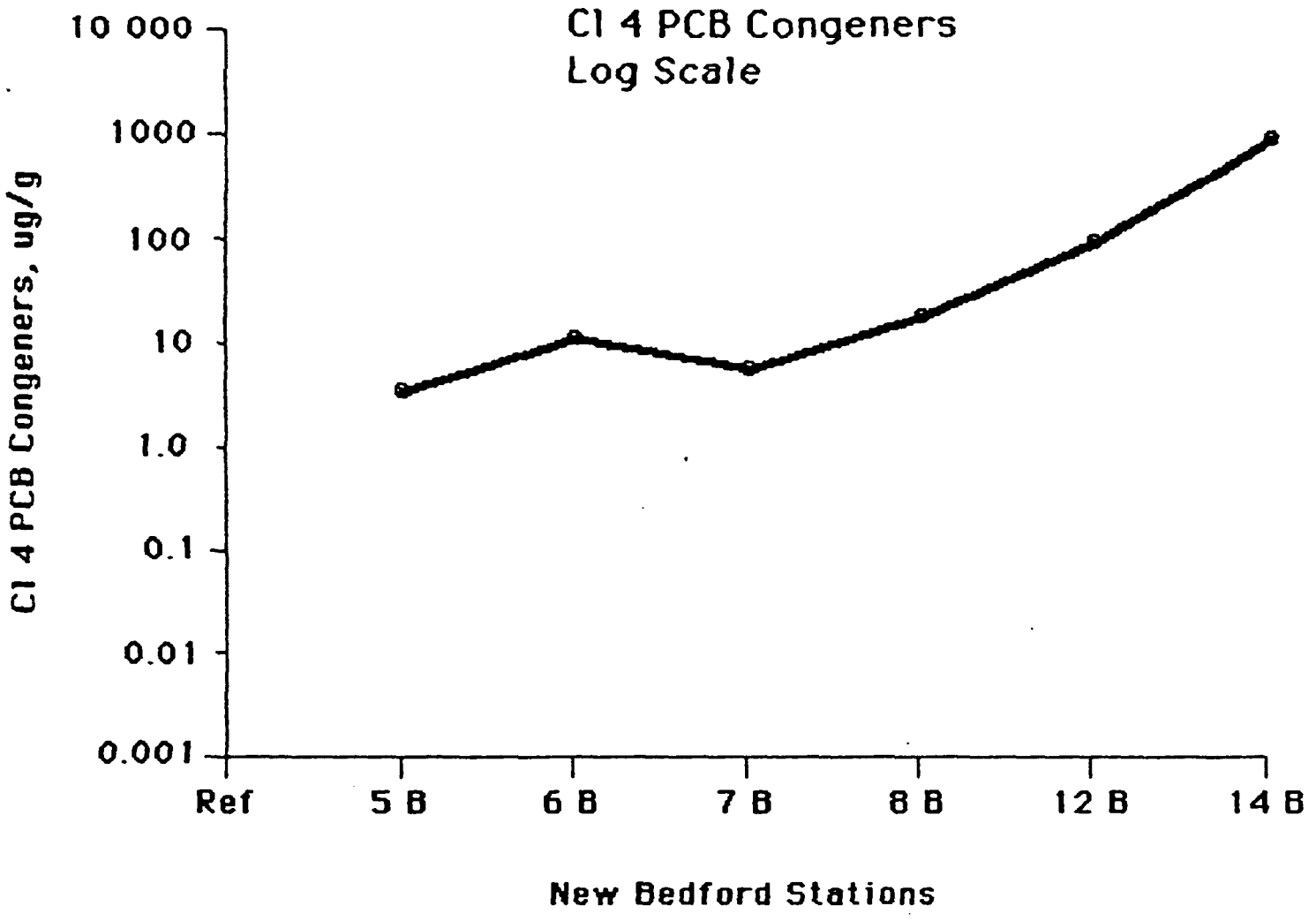
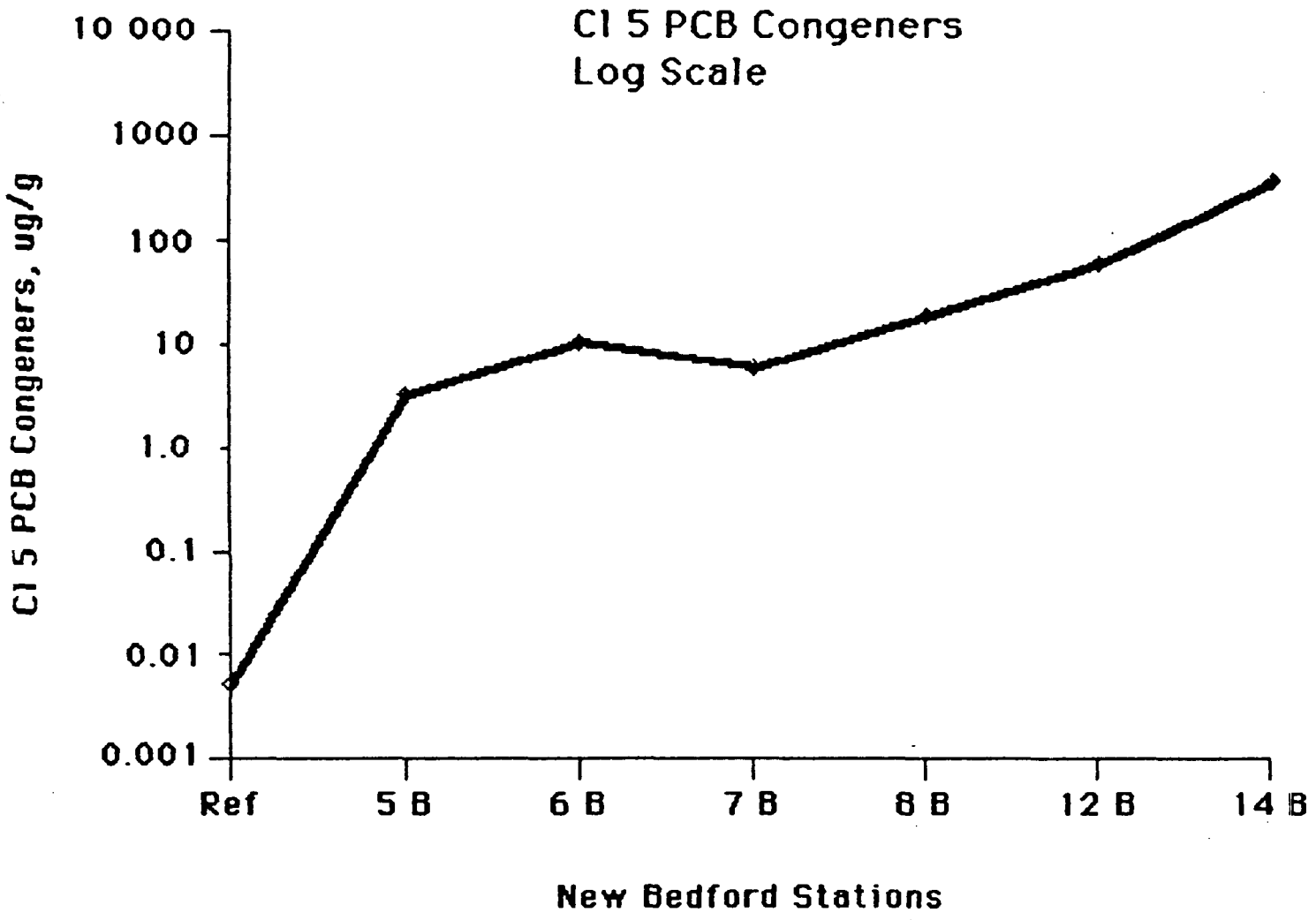
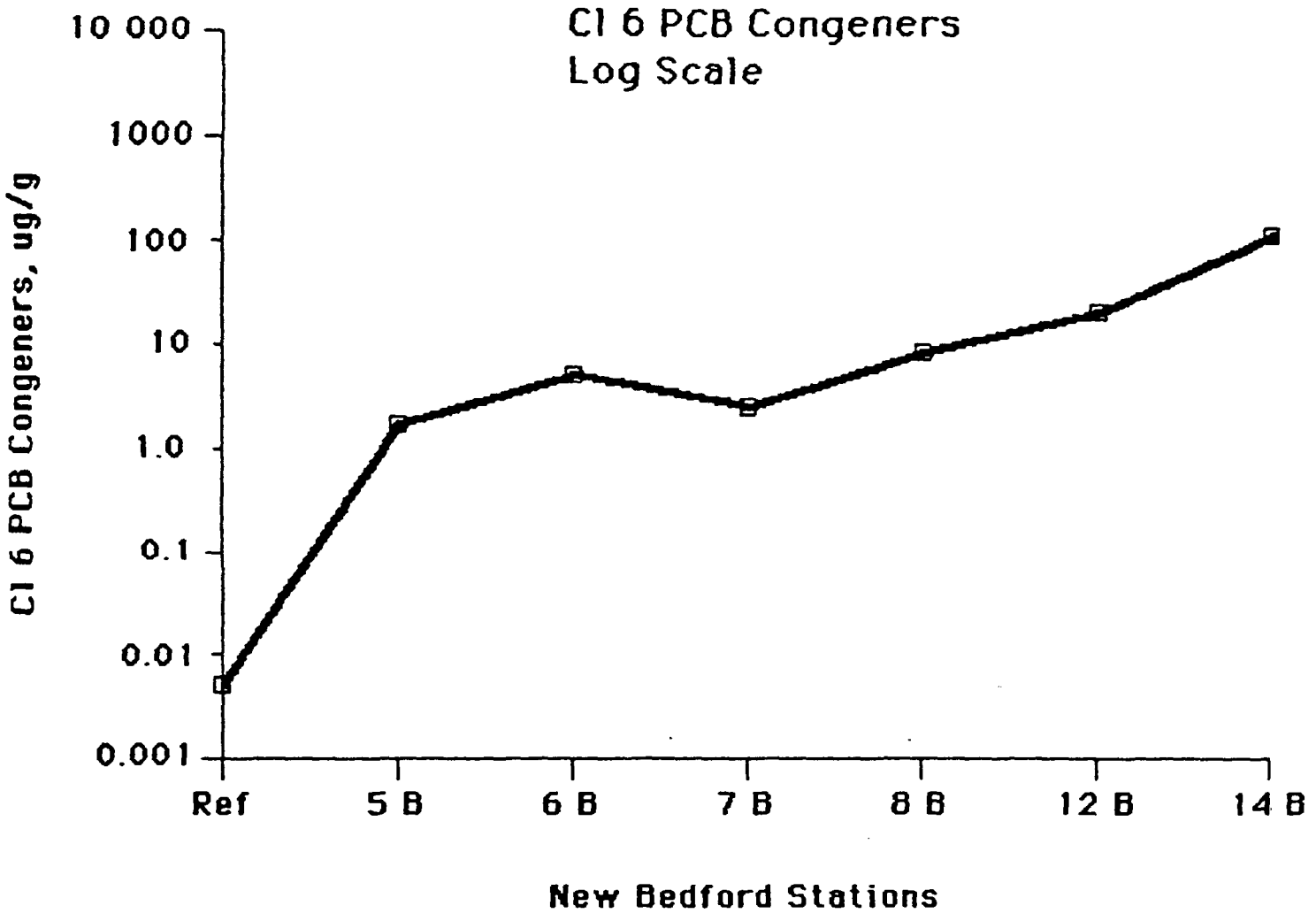
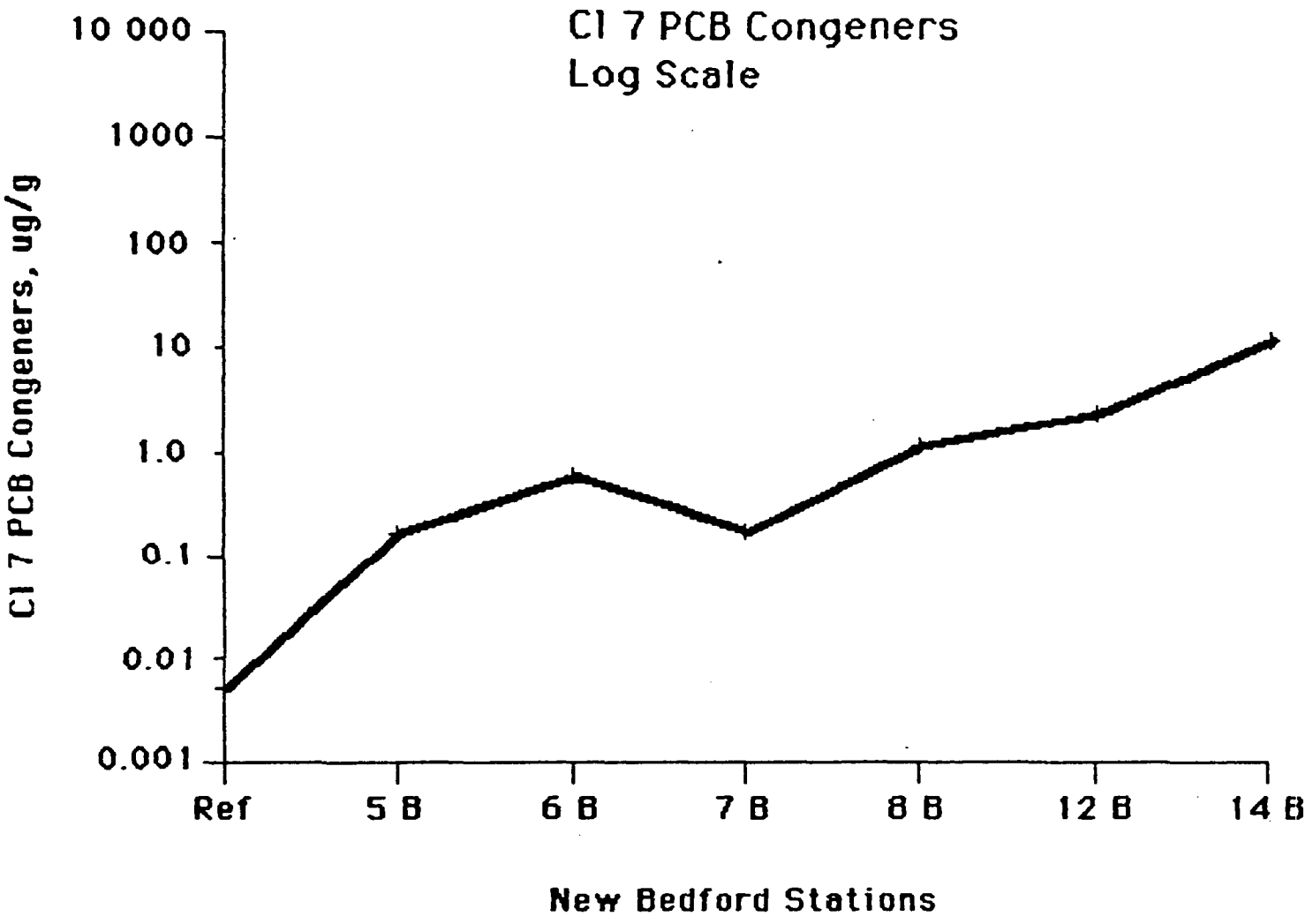
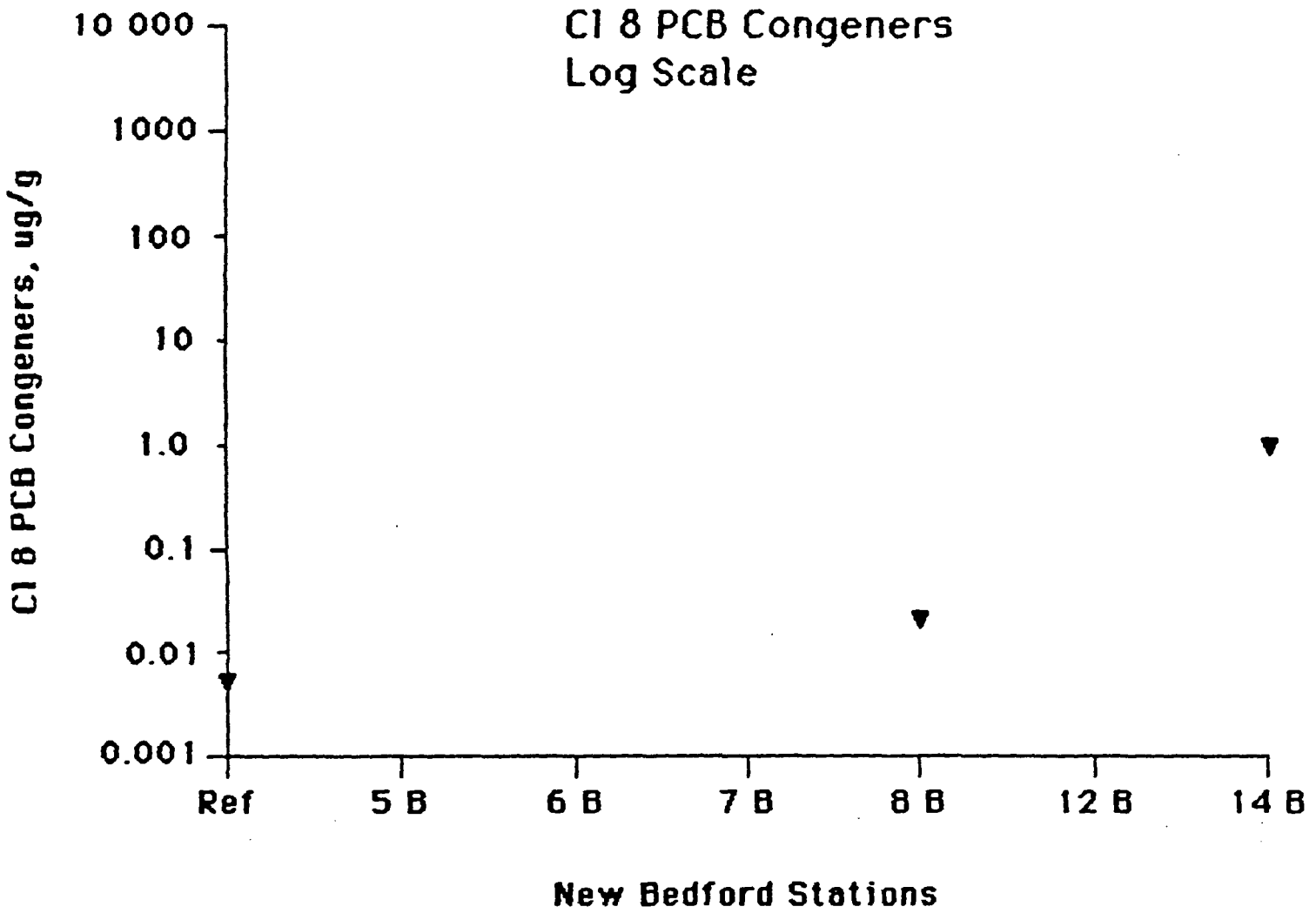
1000
100
10
1.0
0.1
0.01
0.001
Cl 3 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations

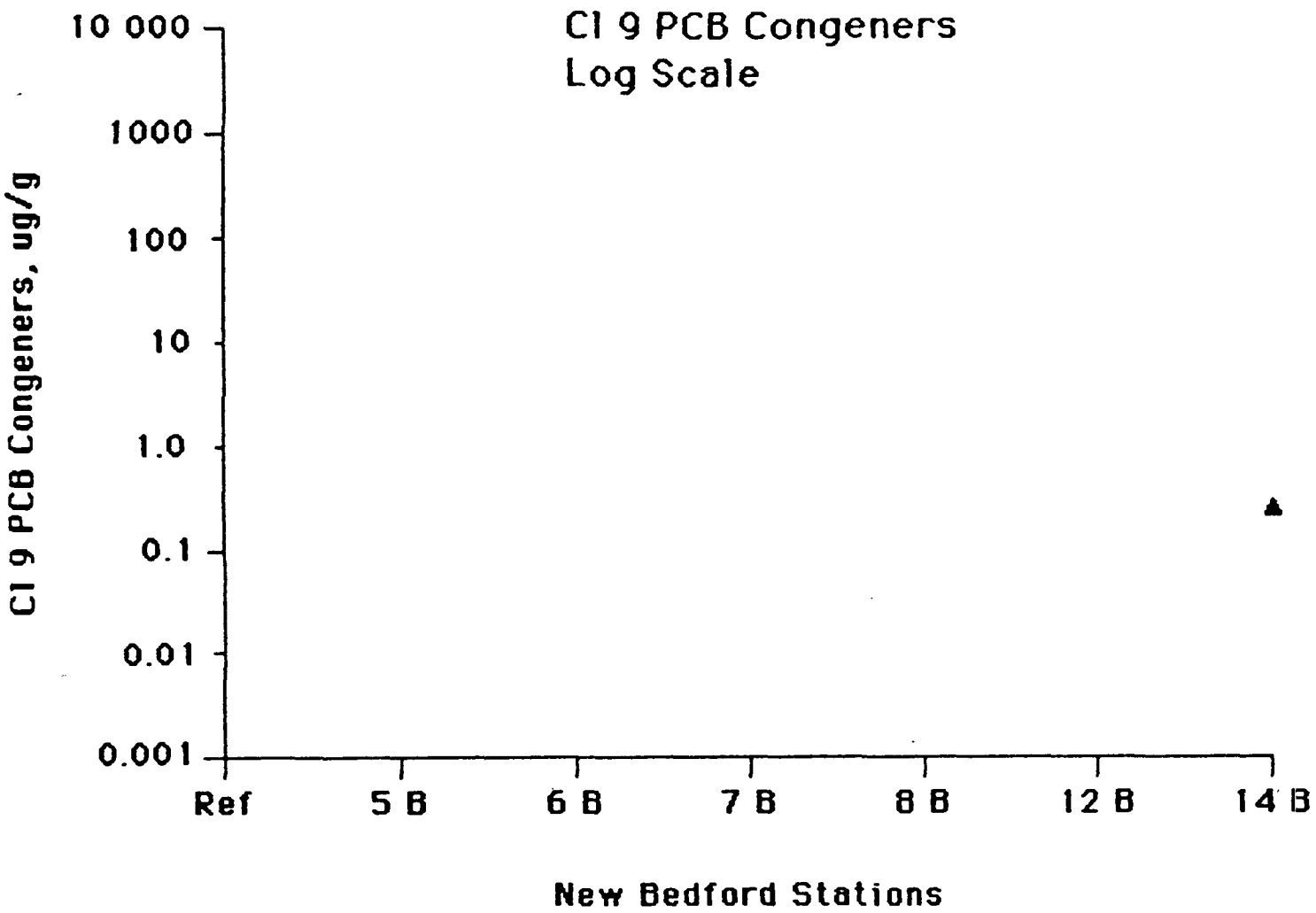

Cl 4 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 4 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations

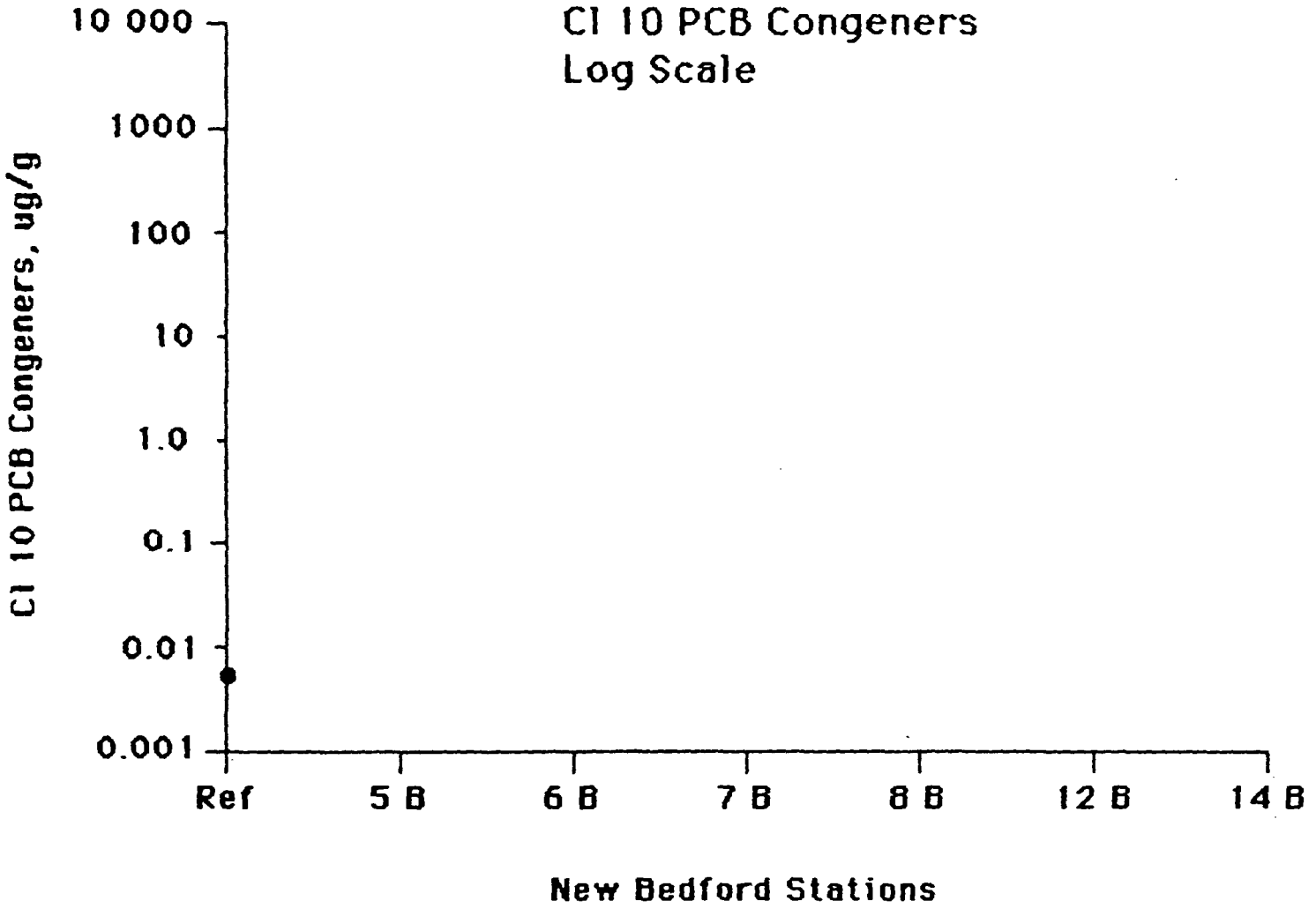

Cl 5 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 5 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 6 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 6 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 7 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 7 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 8 PCB Congeners
Log Scale
10 000
1000
100
10
1.0
0.1
0.01
0.001
Cl 8 PCB Congeners, ug/g
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 9 PCB Congeners
Log Scale
Cl 9 PCB Congeners, ug/g
10 000
1000
100
10
1.0
0.1
0.01
0.001
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations


Cl 10 PCB Congeners
Log Scale
Cl 10 PCB Congeners, ug/g
10 000
1000
100
10
1.0
0.1
0.01
0.001
Ref
5 B
6 B
7 B
8 B
12 B
14 B
New Bedford Stations

CONCLUSIONS

Sheepshead Minnow Reproductive Test:

- Adult fish exposed to sediments from above I-195 died; 28%NBH 12, 100%NBH 14.
- PCB concentrations in adult fish were similar to concentrations in sediments
- Predominance of higher chlorinated PCB congeners in sediments relative to fish suggest insufficient exposure duration.
- PCB concentrations in eggs are slightly less than those in females.
- Metals were not accumulated from sediments by adult fish.
- Survival of embryos and fry from adults exposed to NBH sediments were reduced.
- Fin rot was common in surviving adult fish and their progeny.