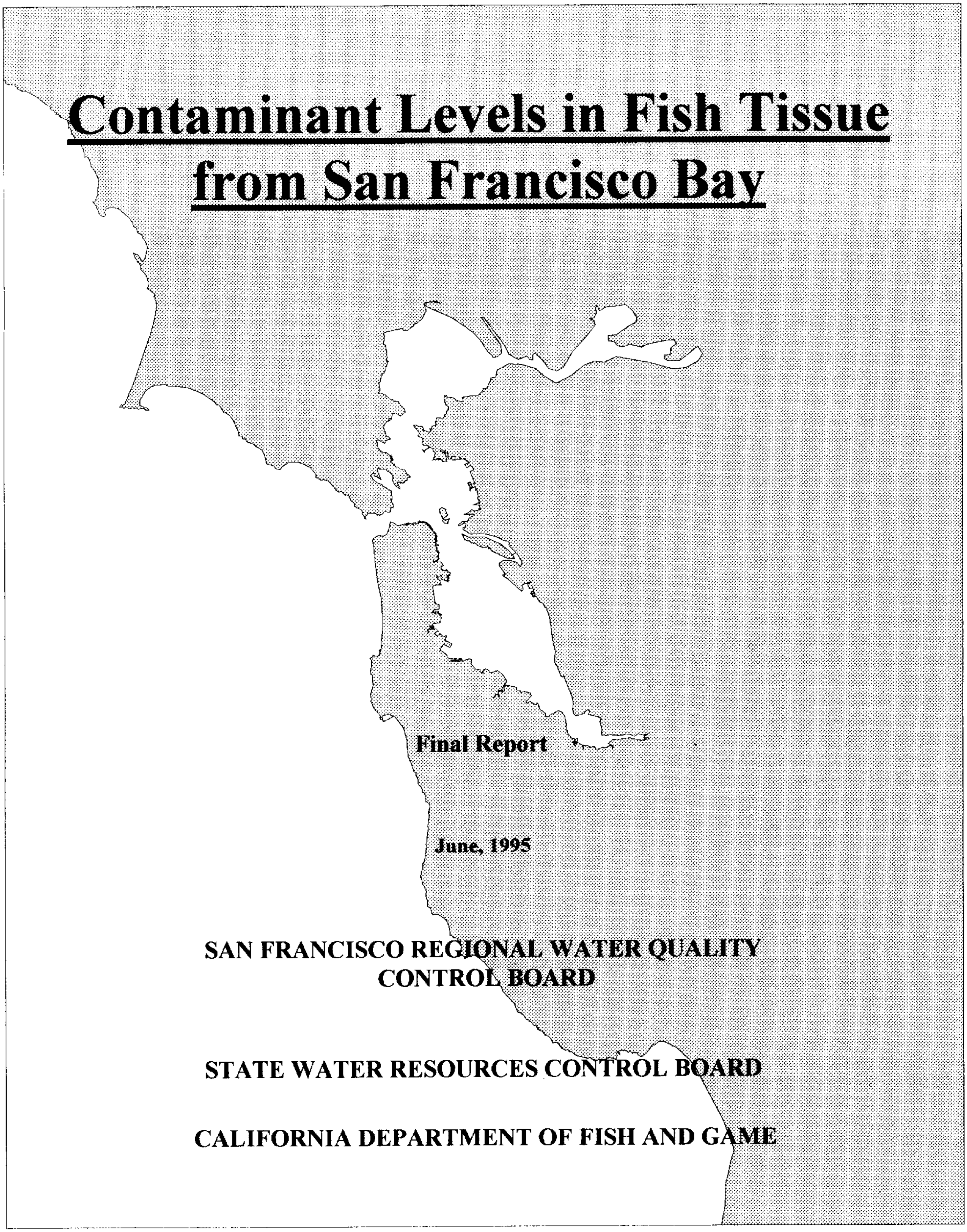
Contaminant Levels in Fish Tissue from San Francisco Bay



Final Report

June, 1995

SAN FRANCISCO REGIONAL WATER QUALITY CONTROL BOARD

STATE WATER RESOURCES CONTROL BOARD

CALIFORNIA DEPARTMENT OF FISH AND GAME

CONTAMINANT LEVELS IN FISH TISSUE

FROM SAN FRANCISCO BAY

FINAL REPORT
June, 1995

San Francisco Bay Regional Water Quality Control Board

California Department of Fish and Game
Marine Pollution Studies Laboratory

State Water Resources Control Board

EXECUTIVE SUMMARY

The main purpose of this study was to measure levels of contaminants in edible fish tissue from species caught by anglers in San Francisco Bay. The study was designed in a cooperative effort between state agencies, environmental groups and anglers. This study was managed by the San Francisco Bay Regional Water Quality Control Board, funded by the Bay Protection and Toxic Cleanup Program and conducted by the California Department of Fish and Game. Due to limited funding, the study was designed as a pilot, rather than a comprehensive survey. The main objective of the study was to identify, to the maximum extent possible, chemicals, fish species and geographic areas of concern in San Francisco Bay in order to aid in developing a more comprehensive study. The EPA guidance document, Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories- Volume 1- Fish Sampling And Analysis (EPA 823-R-93-002, 1993), was used as a model for designing the study and determining potential chemicals of concern. As the design developed, the study was expanded to provide enough information to perform a limited health risk assessment on consuming certain fish species caught in San Francisco Bay. The Office of Environmental Health Hazard Assessment will be evaluating data collected from this study to determine if health advisories should be issued. Advisories are issued to ensure that the fishing public can make informed decisions about consumption of fish caught in the Bay. The purpose of this report is to provide information on concentrations of contaminants in certain species and at certain geographic areas in the Bay, and to identify potential chemicals of concern in the Bay as a whole. It is not intended to be a health risk assessment.

A total of 16 geographic areas throughout the Bay were sampled in this study: thirteen geographically discrete "stations", and three geographically non-discrete "regions" of the Bay (for collection of sharks). Criteria used to select discrete sampling stations were: 1) good geographic representation of all areas of the Bay, 2) proximity to commonly fished shorelines or piers, 3) geographically discrete "stations" that were near contaminated areas in order to evaluate worst case conditions, and 4) geographically discrete "stations" that were thought to be physically distant from chemically-contaminated areas and, therefore, more likely to be chemically uncontaminated reference sites.

The thirteen geographically discrete "stations" which were sampled were:

1. San Mateo Bridge
2. Dumbarton Bridge
3. Fremont Forebay
4. Richmond Inner Harbor (Friendship Shamada Park)
5. Berkeley Pier
6. Oakland Inner Harbor (Fruitvale)
7. Oakland Middle Harbor Pier
8. Double Rock (Candlestick)
9. Islais Creek

10. Point Molate
11. Rodeo Pier
12. San Francisco Pier #7
13. Vallejo Pier- Mare Island Strait

The two stations thought to be least contaminated were Berkeley Pier and San Francisco Pier #7. Although these were chosen originally as reference sites, results showed that these stations were not the least contaminated for all chemicals. These two stations were chosen also because of the large amount of fishing done from these piers. Three geographically non-discrete "regions" were sampled for sharks. These were the North Bay (north of the Richmond-San Rafael Bridge), Central Bay (between the Richmond-San Rafael Bridge and the San Mateo Bridge) and South Bay (south of the San Mateo Bridge). In addition, one composite sample of sturgeon was collected from Grizzly Bay and one composite sample of striped bass was collected from the Sacramento River.

Fish species were selected and prioritized based on two criteria: 1) likelihood of catch and consumption by Bay area anglers, and 2) likelihood of contaminant accumulation based on tissue lipid content or feeding behavior. White croaker was the highest priority species at all 13 stations. Other fish species collected included: shiner surfperch, walleye surfperch, leopard sharks, brown smoothhound sharks, striped bass, sturgeon and halibut.

Fish Sample Collection

At each of the thirteen discrete stations, enough fish to prepare four composites of fillets were collected. At each station, three composites of the highest prioritized fish with sufficient numbers, and one composite of the second most abundant fish, in order of priority, were collected. Three composites of shark were collected in each region. When three composites of any fish were collected they were size-classed. Composites were comprised of fillets from a standard number of fish for each particular species. The number of fish per composite depended on fish species size, and ranged from three for sharks, sturgeon, striped bass and halibut to twenty for shiner surfperch. In total, sixty-six composite fish samples were prepared from 494 individual fish that were collected.

Fish were collected between May 2nd and June 10th, 1994 by several standard collection methods such as seines, gill nets, and hook and line. All materials with which fish came into contact were chemically cleaned via a process designed to leave materials non-contaminated with trace metals and trace organic chemicals. Once the fish were caught, they were wrapped in chemically-cleaned teflon sheeting and frozen for transport to the laboratory. Dissections and tissue sample preparations were performed in a clean room laboratory using non-contaminating techniques.

Laboratory Analyses

All sample composites were analyzed for trace metals, PAHs, PCB congeners and pesticides. The largest size-class composite at each station was analyzed for dioxins, furans and coplanar PCB congeners, in addition to standard analyses previously listed. For all chemical analyses, small fish (white croaker and surfperch) were analyzed with skin intact, and larger fish (shark, striped bass, sturgeon and halibut) were analyzed with skin removed. Although the skin generally contains higher lipid levels than muscle tissue, this approach was chosen to better represent the manner in which anglers most often cook and consume particular fish species.

Data Analysis

The EPA approach to assessing chemical contaminants in fish tissue, contained in the EPA guidance document, has been used in this report. This approach allows pilot study screening values (PS-SVs) to be calculated for identification of potential chemicals of concern. PS-SVs are more conservative (i.e.- protective with respect to human consumption) than EPA screening values because they include calculations based on a tissue consumption rate of 30 grams/day (one meal a week) rather than the 6.5 grams/day rate (one meal per month) used by the EPA. The 30 gram/day rate was chosen because it better represents recreational fisherman, the target group addressed by the pilot study. Comparisons of sample tissue levels with PS-SVs are meant to assist in guiding further investigations and focusing activities at the Regional Board. They should not be construed as regulatory action levels or be used as definitive answers to questions concerning the safety of fish consumption.

Results

Six chemicals or chemical groups exceeded their respective pilot study screening values. Therefore, for the purposes of this study, these chemicals appear to be the main chemicals of concern for consumption of fish from San Francisco Bay. These chemicals were PCBs (total Aroclors), mercury, dieldrin, total chlordanes, total DDTs, and total dioxin/furans (TEQ).

The PS-SV of 3 ppb for total PCBs, based on the sum of Aroclors, was exceeded in all sixty-six tissue composite samples analyzed in this study. Levels were highest (638 ppb) at stations nearest San Francisco and Vallejo-Mare Island, particularly in fish with higher tissue lipid contents, such as white croaker. PCBs, which were banned from production in the U.S. by the EPA in 1979, have been one of many chemicals monitored by the California Mussel Watch Program. Long-term monitoring of this contaminant in tissues of filter feeding mussels revealed that PCB concentrations have decreased dramatically since 1979. However, despite these encouraging declines, PCBs should be one of the primary chemicals of concern in the Bay, due to elevated levels of PCBs and large number of screening value exceedences found in this study.

Mercury exceeded the PS-SV of 0.14 ppm in forty of sixty-six composite samples. Mercury levels were highest in composites from large leopard sharks (1.26 ppm) and brown smoothhound sharks, regardless of where they were collected in the Bay.

Mercury was also elevated in other species, with larger fish exhibiting higher levels of mercury contamination, especially in the North Bay. Mercury is a naturally-occurring element that is assimilated by fish in its organic form, methylmercury. The major sources of mercury in the Bay area are naturally-occurring mercury deposits, many of which were historically mined. Other mining activities, urban runoff, and discharges from some industrial and agricultural processes are also mercury sources (Phillips 1987). Most of the fish consumption advisories issued in the U.S. are in response to elevated methylmercury levels. The Food and Drug Administration currently recommends that shark and swordfish be consumed no more than once a week (7 ounces) for the general population and no more than once a month for pregnant women and women of childbearing age who might become pregnant (FDA, 1994).

Thirty-five of sixty-six tissue composite samples analyzed for dieldrin exceeded the PS-SV of 1.5 ppb. Concentrations of this pesticide were highest in white croaker composites (4.2 ppb), and screening value exceedences were found at stations throughout the Bay. Striped bass and shiner surfperch composites also exceeded screening values throughout the Bay. As with PCB's, dieldrin exhibits a strong tendency to accumulate in fatty tissue and is found in highest concentrations in fish with high lipid content.

Total chlordanes exceeded the PS-SV of 18 ppb in seven of sixty-six composite samples analyzed. Of the seven, the three highest levels occurred at the Vallejo-Mare Island station, with a maximum concentration (36 ppb) found in the largest size class of white croakers. The use of chlordane was phased out beginning in 1975. Long-term data from the Mussel Watch program indicate declining concentrations of this pesticide in mussel tissues over the past 15 years.

Total DDT exceeded the PS-SV of 69 ppb for nine of sixty-six tissue composite samples analyzed. Concentrations of this pesticide were found to be highest (155 ppb) in composites prepared from white croakers caught near the north end of the Bay. DDT was banned from use in 1972. Long-term data from the Mussel Watch program indicate declining concentrations of this pesticide in mussel tissues over the past 15 years.

Due to the high cost of dioxin analysis, only nineteen of sixty-six tissue composite samples were analyzed. Sixteen of the nineteen samples exceeded the dioxin-TEQ PS-SV of 0.15 parts per trillion. The highest levels (1.3 to 1.75 parts per trillion) were found in composites from white croaker caught at stations near the San Mateo and Dumbarton Bridges. Although dioxin values from the Bay exceed the screening value, they fall well within the range of background dioxin values reported by the EPA for sixty fish samples collected from relatively clean areas across North America. However, in a draft document, EPA stated that these background levels are of health concern (EPA, 600/6-88/005Ca, 1994).

A number of chemicals measured in this study fell below the pilot study screening values. Based on the results of this report, these chemicals are not considered chemicals of concern for consuming fish from the Bay, at this time. These chemicals are cadmium, selenium, endosulfan, endrin, heptachlor epoxide, hexachlorobenzene, mirex, toxaphene and chlorpyrifos. Many chemicals measured in this study have no EPA screening values and therefore pilot study screening values could not be calculated. However, some generalizations can be made about these chemicals. The PAH analysis in this study indicated that levels were near or below method detection limits in all samples measured. Levels of other analytes measured in this study appeared to be at low levels which are not cause for concern. One exception to this may be arsenic levels in sharks which deserve further evaluation.

Additional evaluation of study results and statistical analysis of data are included in the report. The main conclusions of the study are:

1) The EPA guidance document, Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories- Volume 1- Fish Sampling And Analysis (EPA 823-R-93-002, 1993), was an effective tool for designing the pilot study and analyzing data collected from the San Francisco Bay study.

2) Based on calculated pilot study screening values (PS-SVs), six chemicals or chemical groups are identified as potential chemicals of concern in San Francisco Bay. They are PCBs, mercury, dieldrin, total DDT, total chlordane and the dioxin/furans.

3) High levels of the pesticides dieldrin, total DDT and total chlordane were most often found in fish from the North Bay.

4) Levels of PCBs, mercury and the dioxin/furans were found at concentrations exceeding the pilot study screening values throughout the Bay.

5) Fish with high lipid content (croaker and shiner surfperch) in their tissue samples generally exhibited higher organic contaminant levels, with the exception of methyl mercury. Fish with low lipid levels (halibut and shark) generally exhibited lower organic contaminant levels. It should be noted though that skin on/skin off sampling differences may have magnified lipid differences between species in this study.

6) Of Bay fish collected, white croaker consistently exhibited the highest tissue lipid concentrations. Lipophilic PCBs and pesticides concentrated to the highest levels in the tissue of this fish.

7) Mercury levels were found to be highest in the two shark species collected; leopard shark and brown smoothhound shark. Leopard sharks and white croaker exhibited increasing mercury concentration with increasing fish size, suggesting bioaccumulation of this metal in Bay area fish.

8) Vallejo-Mare Island is the sampling location from which fish most often exhibited high levels of chemical contaminants. Oakland Inner Harbor also exhibited a high incidence of tissue contamination.

9) A comprehensive study of potential chemicals of concern, and accumulation of these chemicals in fish and invertebrate tissues, is recommended for the San Francisco Bay area and its tributaries.

Data presented in this report will be evaluated in detail by the Office of Environmental Health Hazard Assessment (OEHHA), with input from the California Department of Health Services, in order to prepare a health risk assessment. Recommendations or advisories concerning consumption of fish caught from San Francisco Bay will be developed and issued, if necessary, as a result of that assessment. Recommendations are made in this report regarding the need for additional studies. However, after analysis of the data by OEHHA, additional recommendations will be made based on the adequacy of the data to perform human health risk assessments.

ACKNOWLEDGEMENTS

This study was a completed thanks to the efforts of the following institutions and individuals:

San Francisco Bay Regional Water Quality Control Board
Karen Taberski

San Jose State University- Moss Landing Marine Laboratories
Sample Collection And Data Analysis

Russell Fairey	Eric Johnson	Patience Brown
Ross Clark	James Downing	Stewart Lamerdin

California Department of Fish and Game
Environmental Services Division

Mark Stephenson	Gary Ichikawa	Jon Goetzl
Kim Paulson	Jim Kanihan	
Chuck Armor	Bob Tasto	

University of California at Santa Cruz
Trace Organics Laboratory
Ronald Tjeerdema John Newman

California EPA Hazardous Materials Laboratory
Myrto Petreas Mandy Mok
Mike McKinney

California Department of Health Services
Alyce Ujihara Diana Lee

Office of Environmental Health Hazard Assessment
Gerald Pollock Robert Brodberg

Aquatic Habitat Institute
Bruce Thompson

Save San Francisco Bay
Lori Lee

Baykeeper
Courtney Cassidy

SAFER
Kalon Wofford

Citizens for a Better Environment
Greg Karras

This project was possible thanks to funding provided by:

California State Water Resources Control Board
Bay Protection and Toxic Cleanup Program

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

PURPOSE

Although health advisories for mercury have been issued on consumption of striped bass from San Francisco Bay since the early 1970's, limited information is available for contaminant levels found in tissues of other Bay fish species. It is likely that other fish, which are caught and consumed by Bay area anglers, bioaccumulate or bioconcentrate contaminants at an equal or possibly greater rate than striped bass, due to their differences in feeding behavior and tissue fat content. This data gap causes researchers to raise questions regarding the impact of contaminants on local fish species and the people and other organisms that consume fish from the Bay.

In response to these concerns, the San Francisco Bay Regional Water Quality Control Board (RWQCB) initiated a pilot study aimed at measuring contaminant levels in the tissue of a number of common San Francisco Bay fish species. The RWQCB organized a committee to assist with sample design and is grateful for the participation of representatives from the Office of Environmental Health Hazard Assessment, Department of Health Services, Department of Fish and Game, Department of Toxic Substances Control, Aquatic Habitat Institute, Save San Francisco Bay, SAFER, Baykeeper and Citizens for a Better Environment. The study was funded by the State Water Resources Control Board's Bay Protection and Toxic Cleanup Program and was managed by the RWQCB. Field work and analyses were contracted to the Department of Fish and Game. In addition, citizen volunteers were trained in sampling protocols and participated with sampling at one location.

The study was designed as a pilot study to screen for chemicals of concern in the tissue of fish caught near public fishing piers and public accesses in the San Francisco Bay area. The basic goal of any pilot study is to provide the information which is needed to design a cost-effective comprehensive study. This study was designed to enable researchers to screen a number of fish species and stations for a large number of chemical contaminants. This will allow a subsequent comprehensive study to effectively concentrate on the most elevated chemicals and impacted fish species. However, a comprehensive study may additionally include other species and chemicals not addressed in this study. Fishing areas near suspected point and non-point sources, for a variety of contaminants, were of primary concern. Most of the stations sampled addressed this concern, but for comparative purposes, fish were caught at heavily fished locations thought to be less contaminated, such as the Berkeley fishing pier and San Francisco Pier #7. Additional analyses were performed to determine which sites and species were relatively most contaminated. The study design relied on recommendations and guidelines provided in the EPA's recent publication Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories- Volume 1- Fish Sampling And Analysis (EPA 823-R-93-002, 1993).

An expansion of the pilot design, which increased the number of samples collected at each station, increased the likelihood that data collected would be useful for an interim analysis of any health risks associated with the consumption of contaminated tissues. However, it was acknowledged by the study design committee, that a more comprehensive study may be required in the future in order to provide sufficient data to undertake a complete health risk assessment for the species and locations studied.

The objectives of this document are to report the levels of contaminants found in edible tissue of fish species caught from the Bay, identify potential chemicals of concern and compare relative contaminant levels of different species and sites in the Bay. Data analyses were performed to better focus the RWQCB on design of a comprehensive study and to provide understandable information to the public. This report is not a health risk assessment and should not be interpreted as guidance for the safety of consuming fish caught from the Bay. The Office of Environmental Health Hazard Assessment will be performing a human health risk assessment with this data set and will determine if advisories will be warranted for consuming fish from the Bay.

STUDY AREA AND DESIGN

Increased inputs of anthropogenic contaminants to San Francisco Bay began soon after the discovery of gold in the Sierra Nevada during 1848 (Nichols *et al.*, 1986). Trace element contamination has continued from riverine loading, urbanization and industrialization until today, and persists extensively throughout the system. An excellent review of the distribution of trace elements and industrial contaminants in the Bay can be found in Luoma and Phillips (1988). Beginning in the 1940's, use of fertilizers, pesticides, herbicides and soil additives became widespread in the Central Valley, and began influencing the Bay waters through the San Joaquin and Sacramento Rivers and their tributaries. These synthetic organic chemicals have been produced in increasing numbers and may have found their way into Bay waters. Mass loading of these contaminants is discussed extensively in Gunther *et al.* (1987).

With widespread point and non-point source input of these contaminants to the Bay it is difficult to accurately evaluate such a complex system with a limited number of study sites. However, the pilot study design committee decided to adopt the following criteria for selecting sites and fish species. These would provide the most scientifically revealing, yet economical, data set from which to assess contaminant levels in fish.

The criteria for selection of sites were:

1. Geographical representation of all four regions of the Bay (South Bay, Central Bay, San Pablo Bay and the Carquinez Straits/Suisun Bay)
2. Proximity to known chemically contaminated areas.
3. Proximity to popular fishing areas.
4. Proximity to relatively uncontaminated areas for inclusion of a reference station.

The thirteen fishing areas that were selected and sampled were:

1. San Mateo Bridge (West shoreline near pier)
2. Dumbarton Bridge (East shoreline near pier)
3. Fremont Forebay (East of the Fremont Landfill)
4. Richmond Inner Harbor (Friendship Shamada Park)
5. Berkeley Pier
6. Oakland Inner Harbor (Fruitvale)
7. Oakland Middle Harbor Pier
8. Double Rock (Candlestick)
9. Islais Creek Channel
10. Point Molate (San Pablo Strait)
11. Rodeo Pier (Carquinez Strait)
12. San Francisco Pier #7 (Municipal Pier)
13. Vallejo Pier - Mare Island Strait (Knight Is.)

Martinez Pier originally was chosen as a study site, but after one and a half days of fishing effort, no fish were caught in sufficient quantities to complete a sample composite. It is unknown why the Martinez station lacked fish, but in an effort to adequately collect samples from the North Bay, a station at Vallejo-Mare Island was substituted in its place. Figure 1 illustrates the thirteen specific sampling stations throughout San Francisco Bay.

Fish species targeted for collection were selected and prioritized based on three criteria:

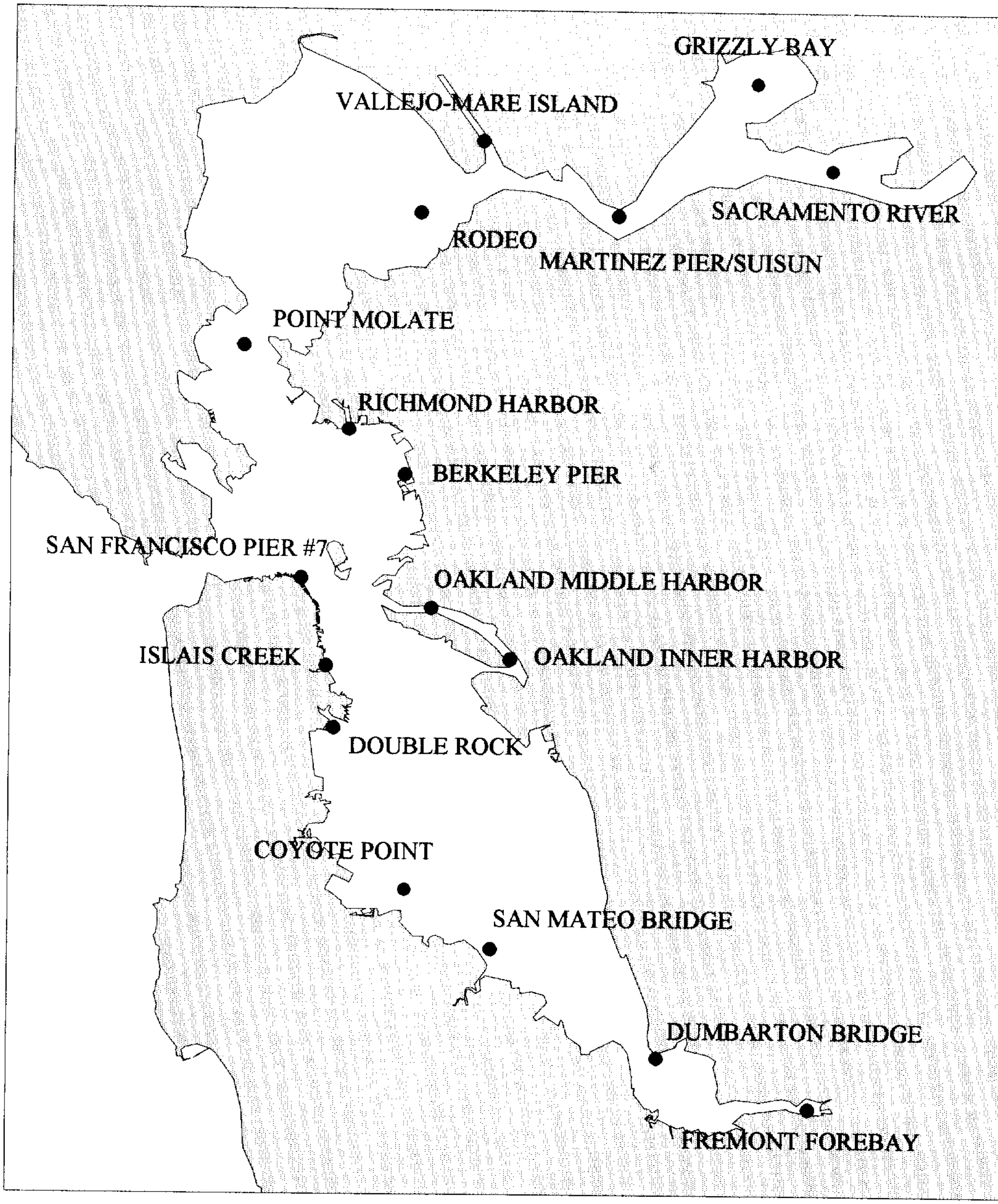
1. Relative abundance of species of interest.
2. Behavior of the species i.e. - feeding behavior and habitat range.
3. Frequency of consumption by anglers.

Fish species selected and number of fish needed to complete a composite at each station in order of priority were:

1. White Croaker *(Genyonemus lineatus)* (5 per composite)
2. Walleye (*Hyperprosopob argenteum)* or White Surfperch *(Phanerdon furcatus)* (5 per composite)
3. Shiner Surfperch *(Cymatogaster aggregata)* (20 per composite)
4. Jacksmelt *(Atherinopsis californiensis)* (5 per composite)
5. Leopard Shark (*Triakis semifasciata)* or Brown Smoothhound Shark *(Mustelus henlei)* (3 per composite)
6. Striped Bass *(Roccus saxatilis)* (3 per composite)
7. White Sturgeon *(Acipenser transmontanus)* (3 per composite)
8. Halibut *(Paralichthys californicus)* (3 per composite)

It was necessary to use composite tissue samples to maximize the number of stations and fish species on which chemical analysis could be performed. The number of fish required to complete a composite was selected as five for smaller species and three for larger species. Shiner surf perch required a composite of twenty to provide sufficient tissue for multiple chemical analyses. At each site, four composites of fish were collected. Three composites of the most abundant species and one composite of the second most abundant fish in order of priority was collected at each station.

Figure 1
San Francisco Bay Fish Contaminant Study
Station Locations



largest size composite, based on standard length, at each site was analyzed for dioxins, furans and coplanar PCB congeners. Additionally, striped bass, shark, sturgeon and halibut composites were analyzed for dioxins, furans and coplanar PCBs.

Methods

Fish were collected between May 2nd and June 10th, 1994. Collection methods included the use of a 1 1/4" size nylon stretch mesh otter trawl (towed behind an 18' Boston Whaler), trammel nets (18" & 8" nylon stretch mesh panels), gill nets (2 1/2" monofilament mesh) and hook & line. Initial sampling effort for the study relied heavily on otter trawls for the capture of smaller species (perch and croaker). During low light periods of early morning and evening, capture rates seemed to increase using this method. This was a concern because it appeared that net avoidance might be occurring. As the sampling progressed, gill nets were deployed more regularly when trawling was ineffective. Increased reliance on gill nets as sampling progressed may have created a bias toward increased size of croaker collected near the end of the sampling effort. This should be considered when comparisons of chemicals for different size classes and stations are made later in this report. A complete description of collection methods and sampling effort can be found in the Cruise Report in Appendix IV.

Once samples were collected they were wrapped in chemically cleaned teflon sheeting, to prevent trace metal and trace organic contamination during sample handling, and frozen for transportation to the laboratory. Dissections and tissue sample preparations were performed using non-contaminating techniques in a clean room environment. Fillets of muscle tissue were removed in 5 to 10 g portions with teflon forceps. Equal weight fillets were taken from each fish of the sample to composite a total of 200 grams. All samples were polytroned to provide a homogeneous material for analysis. Sample splits were taken for each analysis after homogenization was completed.

Tissue samples were prepared for trace metal analysis by digesting with concentrated 4:1 nitric:perchloric acid in a Teflon vessel. Tissue samples were first heated on hot plates for five hours. Caps were tightened and heated in a vented oven at 130° C for four hours. The liquid digestate was diluted with Type II Milli-Q® water to a final volume of 20.0 ml.

Tissue digestates were analyzed for trace metal analysis by graphite furnace atomic absorption spectrophotometry (GFAAS) on a Perkin-Elmer Model 3030 Zeeman or by flame atomic absorption spectrophotometry (FAAS) on a Perkin-Elmer Model 2280 for Ag, Al, As, Cu, Cd, Cr, Mn, Ni, Pb, Se, Sn, and Zn depending on concentration. Mercury was analyzed by cold vapor technique using the Perkin-Elmer Model 2280. Detection limits for trace metal analysis are shown in Table 1.

Table 1 - Trace Metal Wet Weight Detection Limits

Trace Metal	ug/g (ppm) wet
Aluminum	4.0
Arsenic	0.05
Cadmium	0.002
Chromium	0.02
Copper	0.03
Iron	0.03
Lead	0.02
Manganese	0.3
Mercury	0.01
Selenium	0.03
Silver	0.002
Tin	0.02
Zinc	0.02

Tissue homogenates were analyzed for detection of PCBs, pesticides and PAHs after extraction with methylene chloride. The extract was divided into three portions: one quarter of the volume for lipid weight determination, one half for aromatic and chlorinated hydrocarbon (AH/CH) analysis and one quarter for validation of the single fraction analysis. The AH/CH fraction was analyzed by capillary gas chromatography for chlorinated hydrocarbons, utilizing an electron capture detector. The AH/CH fraction was also analyzed by gas chromatography mass spectrometry (GC/MS) for aromatic hydrocarbons. Detection limits for synthetic organic analyses are shown in Tables 2-4.

Table 2 - Pesticide Wet Weight Detection Limits

PESTICIDES	ng/g(ppb), wet weight
Aldrin	0.2
cis-Chlordane	0.2
trans-Chlordane	0.2
alpha-Chlordane	0.2
gamma-Chlordane	0.2
Chlorpyrifos	0.8
Dacthal	0.2
o,p'-DDD	1
p,p'-DDD	0.6
o,p'-DDE	0.6
p,p'-DDE	0.2
p,p'-DDMS	4
p,p'-DDMU	1
o,p'-DDT	0.8
p,p'-DDT	0.8
p,p'-Dichlorobenzophenone	5
Dieldrin	0.2
Endosulfan I	0.2
Endosulfan II	0.6
Endosulfan sulfate	1
Endrin	1.2
alpha-HCH	0.2
beta-HCH	0.6
gamma-HCH	0.2

Table 2 - Pesticide Wet Weight Detection Limits (continued)

PESTICIDES	ng/g(ppb), wet weight
delta-HCH	0.4
Heptachlor	0.2
Heptachlor Epoxide	0.2
Hexachlorobenzene	0.2
Methoxychlor	3
Mirex	0.2
cis-Nonachlor	0.2
trans-Nonachlor	0.2
Oxychlordane	0.2
Toxaphene	20

Table 3 - PCB Wet Weight Detection Limits

PCB CONGENERS	ng/g(ppb), wet weight
PCB5	0.2
PCB8	0.2
PCB15	0.2
PCB18	0.2
PCB27	0.2
PCB28	0.2
PCB29	0.2
PCB31	0.2
PCB44	0.2
PCB49	0.2
PCB52	0.2
PCB66	0.2
PCB70	0.2
PCB74	0.2
PCB87	0.2
PCB95	0.2
PCB97	0.2
PCB99	0.2
PCB101	0.2
PCB105	0.2
PCB110	0.2
PCB118	0.2
PCB128	0.2
PCB132	0.2
PCB137	0.2
PCB138	0.2
PCB149	0.2
PCB151	0.2
PCB153	0.2
PCB156	0.2
PCB157	0.2
PCB158	0.2
PCB170	0.2
PCB174	0.2
PCB177	0.2
PCB180	0.2
PCB183	0.2
PCB187	0.2

Table 3 - PCB Wet Weight Detection Limits (continued)

PCB CONGENERS	ng/g(ppb), wet weight
PCB189	0.2
PCB194	0.2
PCB195	0.2
PCB201	0.2
PCB203	0.2
PCB206	0.2
PCB209	0.2
AROCLOR1248	6
AROCLOR1254	2
AROCLOR1260	2
AROCLOR5460	20

Table 4 - PAH Wet Weight Detection Limits

PAHS	ng/g(ppb), wet weight
Naphthalene	2
2-Methylnaphthalene	2
1-Methylnaphthalene	2
Biphenyl	2
2,6-Dimethylnaphthalene	2
Acenaphthylene	2
Acenaphthene	2
2,3,5-Trimethylnaphthalene	2
Fluorene	2
Phenanthrene	2
Anthracene	2
1-Methylphenanthrene	2
Fluoranthene	2
Pyrene	2
Benz[a]anthracene	2
Chrysene	2
Benzo[b]fluoranthene	2
Benzo[k]fluoranthene	2
Benzo[e]pyrene	2
Benzo[a]pyrene	2
Perylene	2
Indo[1,2,3-cd]pyrene	3
Dibenz[a,h]anthracene	3
Benzo[ghi]perylene	3

Samples were analyzed for PCDD/PCDFs and coplanar PCBs according to the HML Method 880 (Hazardous Materials Laboratory, 1992). Fish tissues were freeze dried and homogenized with sodium sulfate. ^{13}C-labeled internal standards were added and each sample cleaned through potassium silicate/silica gel/sodium sulfate, rinsed with 9:1 hexane:methylene chloride and drained under pressure through an Ax21 carbon column. Eluants were collected as fraction 1 and discarded. The carbon column was eluted with 20:80 hexane:methylene chloride and the eluant collected as fraction 2. Toluene extraction of the carbon column in the reverse direction resulted in fraction 3. Each fraction was passed through potassium silicate/40% acid silica/sodium sulfate and eluted with hexane. The extracts were transferred to vials containing ^{13}C-labeled recovery standards in tetradecane. PCDD/PCDFs and PCBs 77, 126, and 169 were determined in fraction 3. PCBs 105 and 118 were determined in fraction 2. Fractions 2 and 3 were analyzed by High Resolution Gas Chromatography/Mass Spectrometry (Varian 3400, Finnigan MAT 90) with a 60m, 0.25μm, DB-5 column, using a temperature program. The MS operated in the EI mode (50eV) with a 0.8mA emission and a minimum resolution of 8000 amu. Method detection limits are unique for each sample analyzed and are reported in Appendix I, Section VI.

Quality Assurance documents have been provided under separate cover by the analytical laboratories to the San Francisco Bay Regional Water Quality Control Board. In depth quality assurance evaluations are provided in those documents. A summary of quality assurance procedures and evaluations is provided in the detailed Laboratory Operating Procedures in Appendix III.

RESULTS AND DISCUSSION

For the purposes of this study, the EPA approach to assessing chemical contaminants in fish tissue (U.S. EPA, 1993) has been utilized. The EPA manual provides guidance for what the EPA Office of Water believes to be scientifically sound methods for sample collection, chemical analysis and data analysis of fish contaminant data. The initial study design for the pilot study relied heavily on this EPA approach, and it is reasonable that evaluation of subsequent data should adopt these procedures as well. The EPA document is not the only guidance document available for assessing contaminants in fish tissue, but it is the most complete and standardized work plan currently available to states which are performing contaminant monitoring programs. Screening values derived in the EPA document are defined as "concentrations of target analytes in fish or shellfish that are of potential public health concern and that are used as standards against which levels of contamination in similar tissue collected from the ambient environment can be compared" (U.S. EPA, 1993). Pilot study screening values were developed for this report, using the EPA approach, to help identify chemicals of concern in San Francisco Bay. Other studies and regulatory agencies have proposed screening levels which range above and below those used by this pilot study report. In Appendix II a number of these values are reported for comparative purposes. Pilot study screening values (PS-SVs) were used in this report because they were developed for the particular purposes of this study and are based on an EPA approach which has received extensive public and scientific review. PS-SVs are more conservative (i.e.-protective with respect to human consumption) than EPA screening values because they include calculations based on a tissue consumption rate of 30 grams/day (one meal a week) rather than the 6.5 grams/day rate (one meal per month) used by the EPA. The 30 gram/day rate was chosen because it better represents recreational fisherman, the target group addressed by the pilot study. Appendix II gives a complete description of the assumptions and variables which were used when calculating the PS-SVs.

Exceedence of these PS-SVs should be taken as an indication that more intensive site and species specific monitoring and/or evaluation of human health risk should be conducted. These preliminary comparisons are meant to help direct further analysis, and should not be construed as regulatory action levels or definitive answers to questions concerning the safety of fish consumption. Data presented in this report will be evaluated in detail by the Office of Environmental Health Hazard Assessment, with input from the Department of Health Services, to assess health risks. Recommendations or warnings concerning the consumption of fish caught from San Francisco Bay will be made based on the health risk assessment of the data.

Six chemicals or chemical groups exceeded the PS-SVs during analysis of the pilot study results (Table 5) and for the purposes of this report will be considered chemicals of concern. These chemicals were mercury, dieldrin, total chlordane, total DDT, PCBs (as total Aroclors) and the dioxin/furans-TEQs. Each of these six is discussed separately in the following sections of this report.

PCBs
A significant concern is the polychlorinated biphenyls (PCBs) levels found in fish throughout the Bay. This class of chemicals is comprised of 209 compounds, called congeners, each of which differ in their chlorine substitution pattern. Mixtures of various PCB congeners have been manufactured in the U.S. since 1929 (Phillips, 1987) and used commercially under the trade name Aroclor. Each Aroclor mixture is numerically designated (i.e.- Aroclor 1254) with the last two numbers indicating the percentage of chlorine in the mixture. These mixtures were used extensively in the U.S. prior to 1979 for industrial applications requiring fluids with thermal stability, fire and oxidation resistance and solubility in organic compounds (Hodges, 1977). PCBs have proven to be extremely persistent in the environment and have demonstrated a variety of adverse carcinogenic and non-carcinogenic effects (U.S.EPA, 1993c). Individual PCB congeners may differ not only in the dose at which toxicity is observed, but also in the toxic effect(s) observed. All congeners have not been tested in a complete battery of toxicity tests (e.g., acute and chronic dosing, and developmental, reproductive and cancer testing), so there are serious gaps in the toxicological database when trying to evaluate the results congener by congener. The toxicology data on Aroclor mixtures, while not perfect, is overall better. In this study, PCBs were analyzed as 48 individual congeners and as 4 Aroclor equivalents. EPA recommends that 18 specific congeners be summed to determine total PCB concentration (NOAA, 1989b) or that the Aroclors be summed to determine a total Aroclor concentration (U.S. EPA, 1993). Total PCB values were determined for 19 of the fish tissue samples and total Aroclors were determined for all samples. These two methods of congener summation are highly correlated in this study (r^2=0.98). Total Aroclor values are reported since they are the larger data set, and the EPA recommends using them to compare to screening values at this time. The PCB values presented in the remainder of this document represent a total of the Aroclors

Table 5 - S.F.Bay Pilot Study Screening Value (PS-SV) Exceedences (Bolded)

IDORG #	STATION NAME	FISH TYPE	MERCURY (ppm)	TTLDDT (ppb)	DIELDRIN (ppb)	TTLCLOR (ppb)	TTLARO (ppb)	DIOXIN-TEQ (ppt)
1234	SAN MATEO BRIDGE	5 White Croaker	**0.264**	62.58	**3.28**	17.02	**451.28**	**1.3**
1235	SAN MATEO BRIDGE	5 White Croaker	0.112	**69.27**	**3.784**	**18.27**	**383.19**	NA
1236	SAN MATEO BRIDGE	5 White Croaker	0.0692	35.60	**1.795**	10.81	**210.22**	NA
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	0.0676	26.61	1.25	4.51	**114.00**	NA
1238	DUMBARTON BRIDGE	5 White Croaker	**0.175**	**78.92**	**3.691**	16.54	**432.98**	**1.46**
1239	DUMBARTON BRIDGE	5 White Croaker	0.113	36.65	**1.532**	9.86	**233.40**	NA
1240	DUMBARTON BRIDGE	5 White Croaker	0.0825	46.00	**3.464**	12.65	**228.41**	NA
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	0.124	18.48	1.177	4.61	**98.11**	NA
1242	FREMONT FOREBAY	3 Striped Bass	**0.150**	40.11	**2.971**	**18.89**	**148.55**	**0.67**
1243	FREMONT FOREBAY	3 Striped Bass	**0.286**	42.82	**2.423**	17.35	**242.27**	NA
1244	FREMONT FOREBAY	3 Striped Bass	**0.232**	42.83	**1.638**	16.09	**133.56**	NA
1245	FREMONT FOREBAY	4 Striped Bass	**0.245**	17.20	1.072	4.25	**56.98**	NA
1246	RICHMOND HARBOR	20 Shiner Surf Perch	0.130	42.49	**1.635**	4.82	**181.20**	**0.89**
1247	RICHMOND HARBOR	20 Shiner Surf Perch	0.109	36.97	**1.527**	5.26	**147.60**	NA
1248	RICHMOND HARBOR	20 Shiner Surf Perch	0.100	34.22	**1.752**	4.35	**162.93**	NA
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	**0.572**	7.31	0.341	0.50	**36.28**	NA
1250	BERKELEY PIER	20 Shiner Surf Perch	0.133	21.44	0.86	4.16	**138.74**	**0.97**
1251	BERKELEY PIER	20 Shiner Surf Perch	0.0903	15.03	ND	2.44	**88.38**	NA
1252	BERKELEY PIER	20 Shiner Surf Perch	0.0827	13.75	0.632	2.14	**89.70**	NA
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	**0.236**	6.19	ND	0.95	**38.02**	NA
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	**0.420**	**72.56**	**1.752**	15.76	**369.67**	**0.85**
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	**0.206**	27.41	**1.591**	14.86	**242.18**	NA
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	**0.197**	29.60	**2.586**	14.66	**240.08**	NA
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	**0.327**	30.57	**1.87**	10.03	**218.34**	NA
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	**0.327**	**70.65**	**3.227**	16.16	**638.13**	**1.75**
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	0.0999	34.98	1.418	8.48	**236.04**	NA
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	0.0871	34.71	**2.022**	10.26	**238.34**	NA
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	0.104	32.80	**2.25**	10.40	**314.50**	NA
1262	ISLAIS CREEK	5 White Croaker	0.0847	39.56	1.433	9.87	**314.50**	**0.89**
1263	ISLAIS CREEK	5 White Croaker	0.0926	41.81	1.139	10.09	**230.11**	NA
1264	ISLAIS CREEK	5 White Croaker	0.0799	22.33	ND	5.14	**138.34**	NA
1265	ISLAIS CREEK	20 Shiner Surf Perch	0.0800	20.35	ND	5.51	**100.65**	NA
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	0.109	59.71	**3.598**	14.36	**353.23**	**0.88**
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	0.110	46.01	**2.807**	13.85	**346.97**	NA
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	0.0800	52.23	**2.407**	13.74	**323.96**	NA
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	0.124	47.36	0.956	5.82	**166.99**	NA
1270	POINT MOLATE	5 White Croaker	**0.296**	58.44	**2.588**	13.46	**273.09**	**0.73**
1271	POINT MOLATE	5 White Croaker	**0.183**	57.91	**2.285**	12.95	**294.50**	NA
1272	POINT MOLATE	5 White Croaker	0.111	68.68	**1.722**	9.26	**212.27**	NA
1273	POINT MOLATE	5 Walleye Surf Perch	0.0865	10.44	0.491	1.99	**33.93**	NA
1274	RODEO	5 White Croaker	**0.342**	67.73	**2.226**	16.45	**279.95**	**0.57**
1275	RODEO	5 White Croaker	**0.295**	37.46	0.92	8.51	**232.56**	NA
1276	RODEO	5 White Croaker	**0.255**	**83.44**	**1.789**	**19.45**	**418.67**	NA
1277	RODEO	3 Leopard Sharks	**0.283**	4.94	ND	1.11	**41.34**	NA
1282	SAN FRANCISCO PIER #7	5 White Croaker	**0.289**	**79.63**	**2.704**	**18.39**	**613.44**	**1.00**
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	**0.162**	11.16	0.577	2.03	**88.79**	NA
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	**0.146**	9.49	ND	1.88	**119.76**	NA
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	0.102	10.19	ND	1.66	**65.43**	NA
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	**0.444**	36.35	**2.31**	10.60	**191.40**	**0.50**
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	**0.202**	33.20	**1.935**	7.41	**93.60**	NA
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	**0.257**	41.14	**1.543**	8.38	**181.64**	NA
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	**0.245**	49.27	**3.057**	10.64	**71.82**	**0.51**
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	**1.24**	8.49	ND	1.44	**41.23**	0.12
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	**0.398**	6.04	ND	1.19	**44.21**	NA
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	**0.529**	4.91	ND	0.50	**16.53**	NA
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	**1.01**	25.93	0.614	2.98	**112.40**	**0.23**
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	**0.617**	5.24	ND	0.50	**16.85**	NA
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	**0.820**	9.12	ND	1.03	**50.40**	NA
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	**1.26**	17.80	ND	2.62	**60.85**	0.13
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	**0.845**	16.18	ND	2.27	**118.33**	NA
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	**0.562**	13.22	ND	2.22	**147.75**	NA
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	**0.197**	7.58	ND	1.29	**54.47**	0.12
1336	VALLEJO-MARE ISLAND	5 White Croaker	**0.414**	**156.01**	**4.241**	**36.10**	**528.96**	**1.04**
1337	VALLEJO-MARE ISLAND	5 White Croaker	**0.280**	**128.43**	**3.502**	**30.70**	**567.18**	NA
1338	VALLEJO-MARE ISLAND	5 White Croaker	**0.255**	**82.76**	**3.243**	**20.67**	**259.42**	NA
1339	VALLEJO-MARE ISLAND	3 Striped Bass	**0.308**	51.37	1.077	11.92	**126.75**	NA
	ND - not detected NA - not analyzed							
		SCREENING VALUE (PS-SV)	**0.14 ppm**	**69 ppb**	**1.5 ppb**	**18 ppb**	**3 ppb**	**0.15 ppt**

1248, 1254 and 1260.

The PS-SV of 3 ppb for total PCBs, based on the sum of Aroclors, was exceeded in all sixty-six tissue composite samples analyzed in this study. The PS-SV was exceeded by a factor of ten in 97% of the samples and by a factor of one hundred in 20% of the samples. In contrast, only one sample (for Dioxin-TEQ) exceededthe PS-SV by a factor of ten for any of the other contaminants. Total Aroclor levels were highest (638 ppb) at stations nearest San Francisco and Vallejo-Mare Island, particularly in fish with higher tissue lipid contents, such as white croaker (Fig. 2). For comparative purposes, PCB levels (as Aroclor 1254) in tissue of white croaker from two other regional studies, in southern California and Monterey Bay are reported here. White croaker collected in a comprehensive study in southern California coastal waters had tissue concentrations of total PCBs (sum of Aroclors 1254 & 1260) that ranged from 1 ppb at Dana Point to 757 ppb at Malibu (Pollock *et al.*, 1991). White croaker collected near several wastewater outfalls in Monterey Bay exhibited no tissue levels above the detection limit of 40 ppb (Pollock *et al.*, 1992). White croaker from San Francisco Bay had measured Aroclor 1254 levels which fell between these two extremes and ranged from 16-382 ppb. Stations nearest Oakland's and San Francisco's industrial areas exhibited the highest PCB values in the Bay area, with stations in the North and South Bay following closely (Figures 3, 4 & 5), depending on fish species.

MERCURY

Mercury, in both its inorganic and organic forms, is considered to be a neurotoxicant. The screening value for mercury given in Table 5 is for the organic form, methylmercury, since most mercury in fish tissue is in this form and the compound of greatest concern for human health (NAS, 1991; Tollefson, 1989). Due to high analytical cost of measuring methylmercury, the EPA recommends that total mercury be determined for screening purposes and the conservative assumption be made that all mercury present is in the form of methylmercury (U.S. EPA, 1993).

Total mercury was analyzed in sixty-six tissue samples and forty of these exceeded the PS-SV of 0.14 ppm. Mercury levels were found to be the highest in large leopard sharks (1.2 ppm), with leopard sharks from all three regions of the Bay demonstrating mercury levels in excess of 1 ppm. Brown smoothhound sharks had mercury levels above 0.5 ppm in six of seven samples with the highest value (0.84 ppm) being reported from Pt. Molate. (Figures 6 & 7). Mercury levels in tissues of sharks are often elevated (National Fisheries Institute, 1992) and have been reported as high as 2.7 ppm in larger open ocean sharks of the Pacific (Hawaii Department of Health, 1991). Shark samples were not collected during either the southern California or the Monterey Bay fish contaminant studies, so direct comparisons with other west coast shark samples cannot be made. The Food and Drug Administration currently recommends that shark and swordfish be consumed no more than once a week (7 ounces) for the general population and no more than once a month for pregnant women and women of childbearing age who might become pregnant (FDA, 1994).

TOTAL AROCLOR IN SAN FRANCISCO BAY FISH

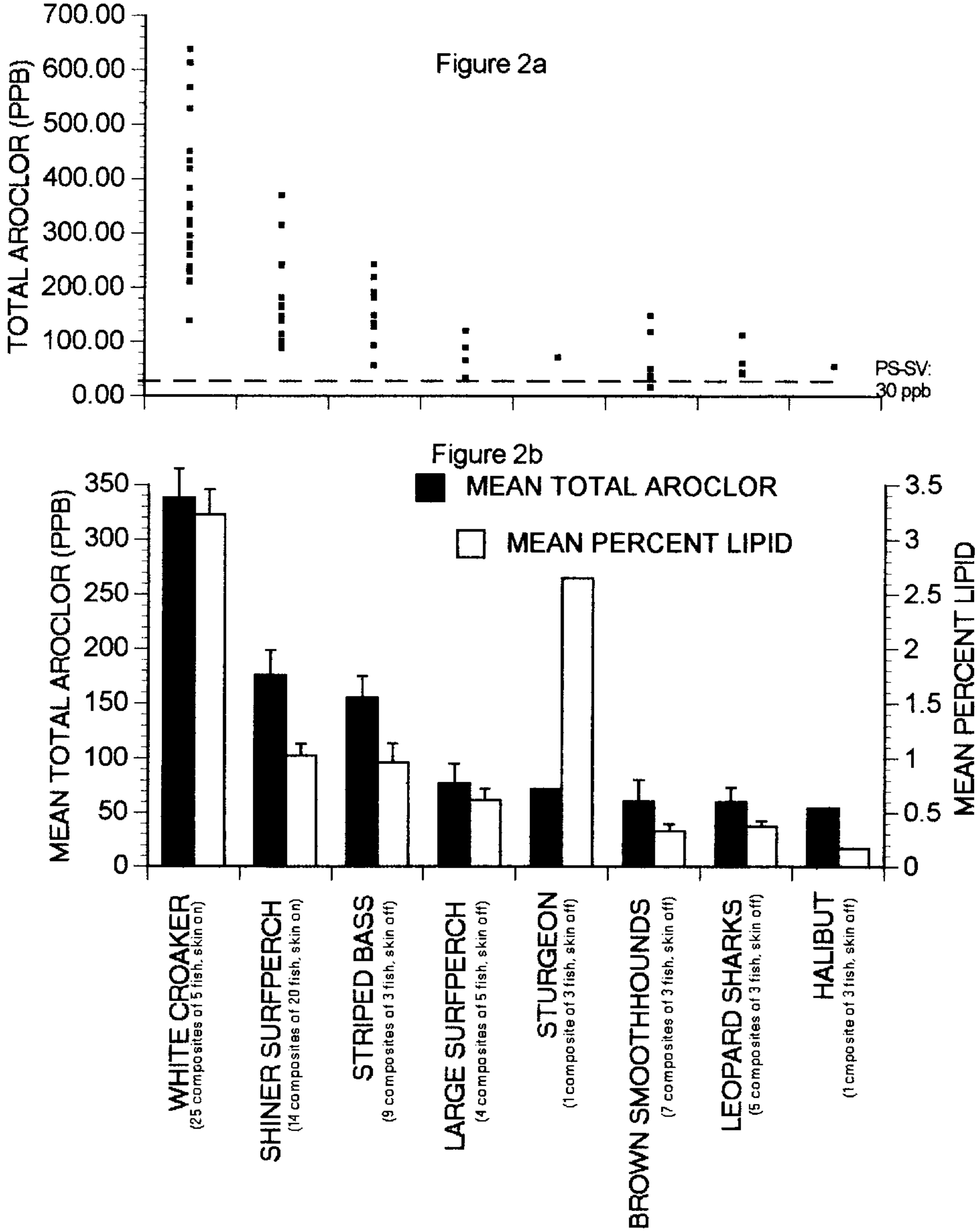
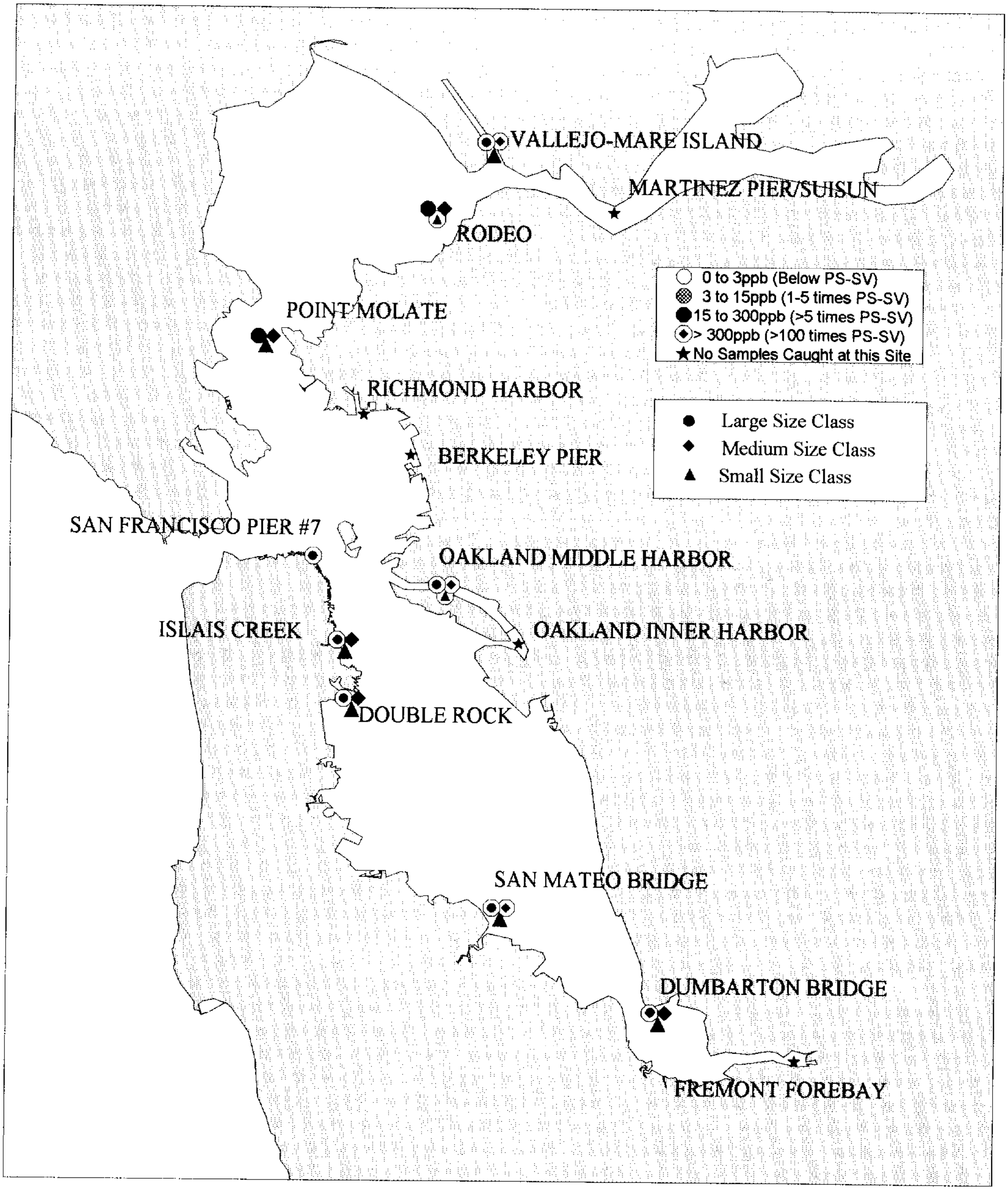


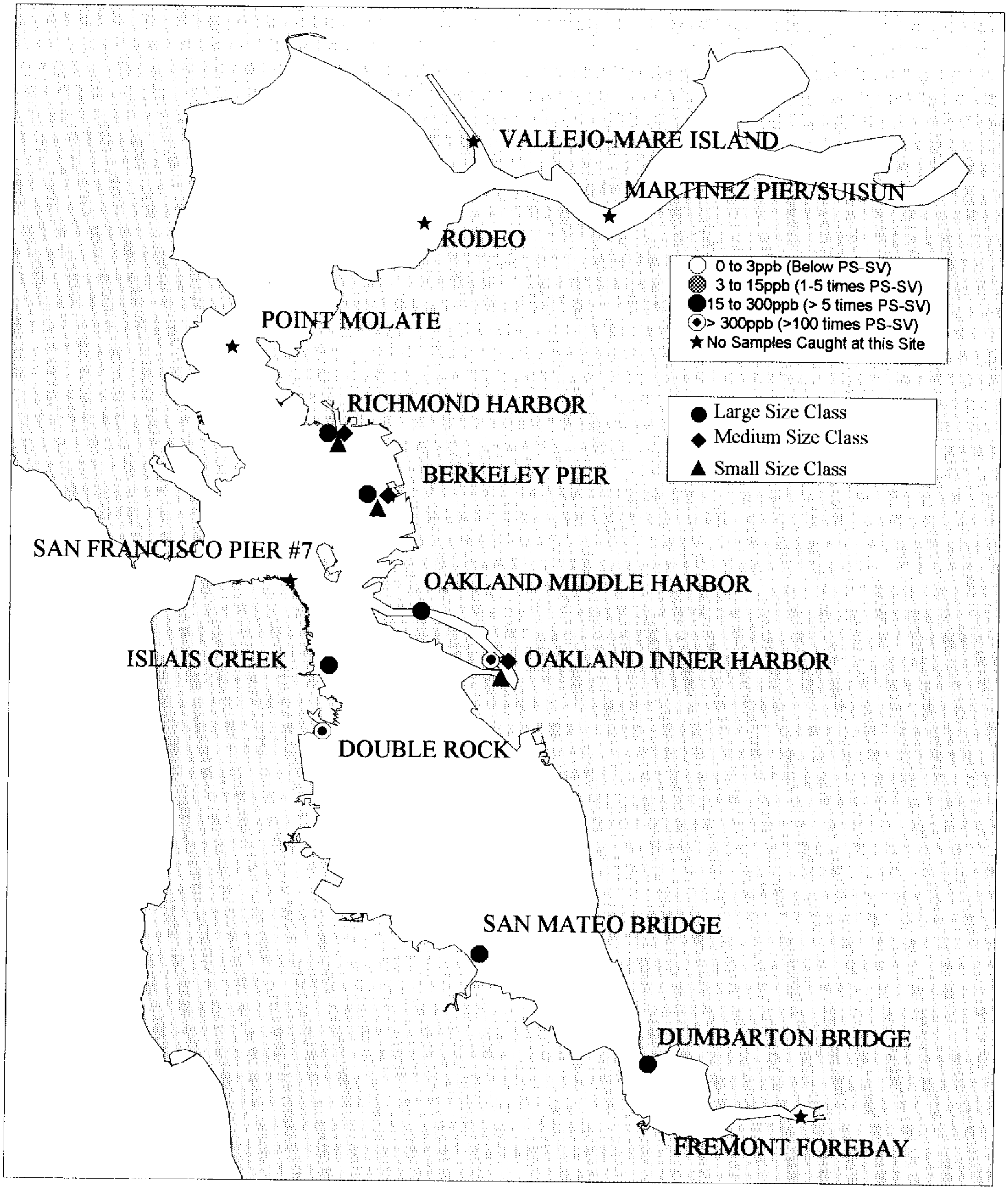
Figure 2. Total Aroclor in parts per billion in fish tissue. Figure 2a shows raw data in relation to the screening level. Each data point represents one composite of fish. Figure 2b shows mean values for total aroclor and percent lipid content for each species. Error bars reflect one standard error.

Figure 3
Total Aroclor Concentration in White Croaker from San Francisco Bay



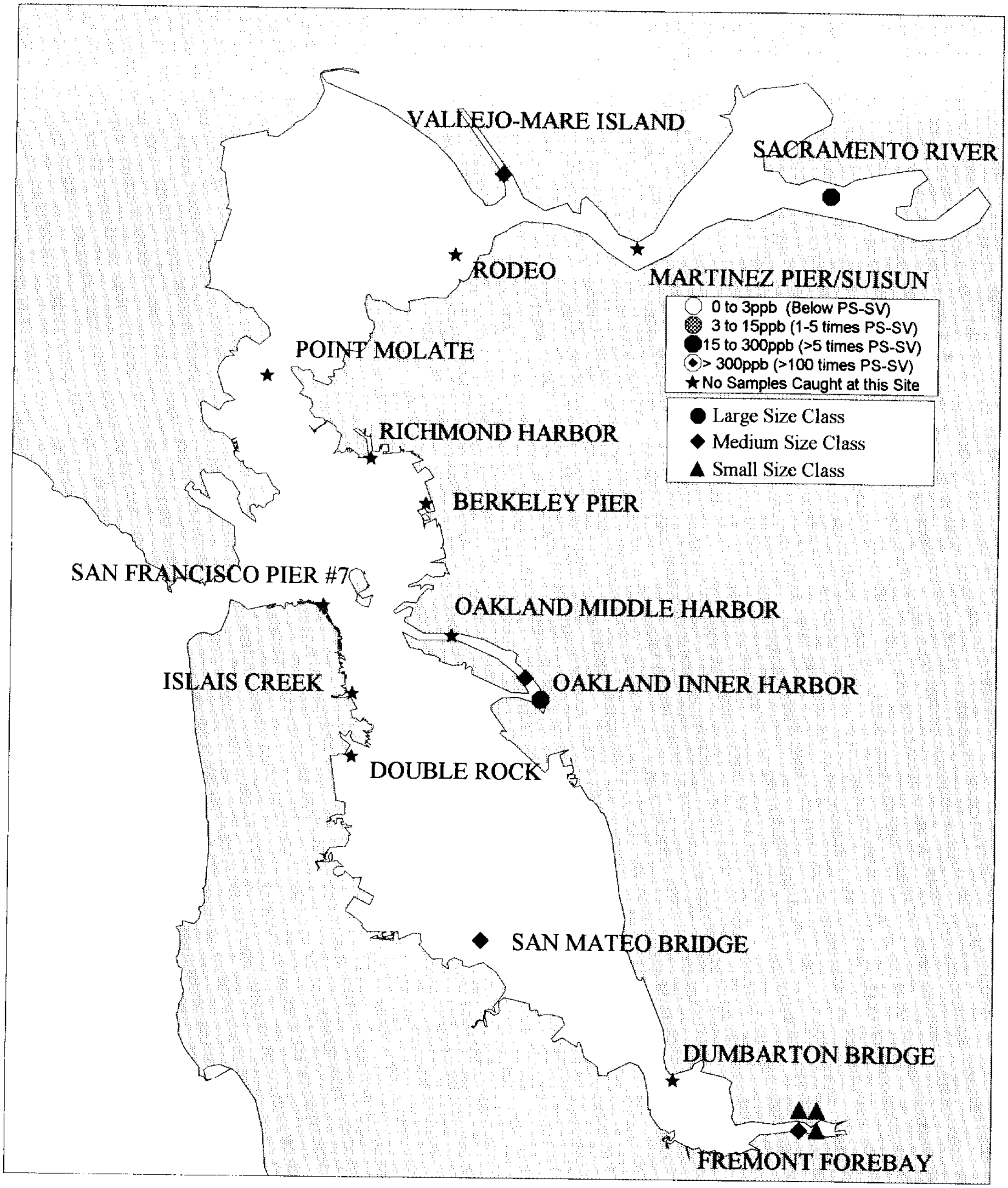
Size Classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for total aroclor is 3 ppb.

Figure 4
Total Aroclor Concentration in Shiner Surf Perch from San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for total aroclor is 3 ppb.

Figure 5
Total Aroclor Concentration in Striped Bass from San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for total aroclor is 3 ppb.

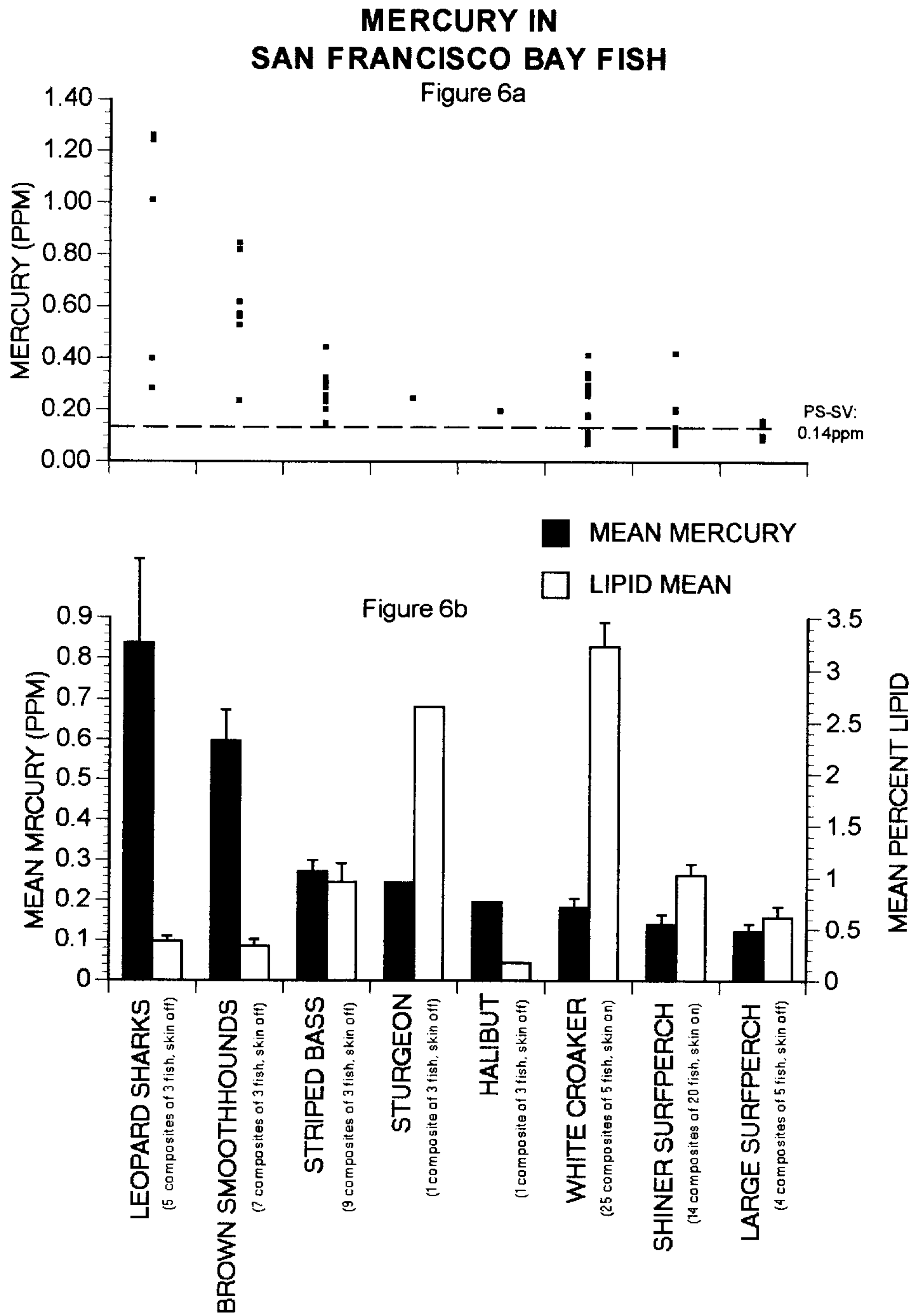
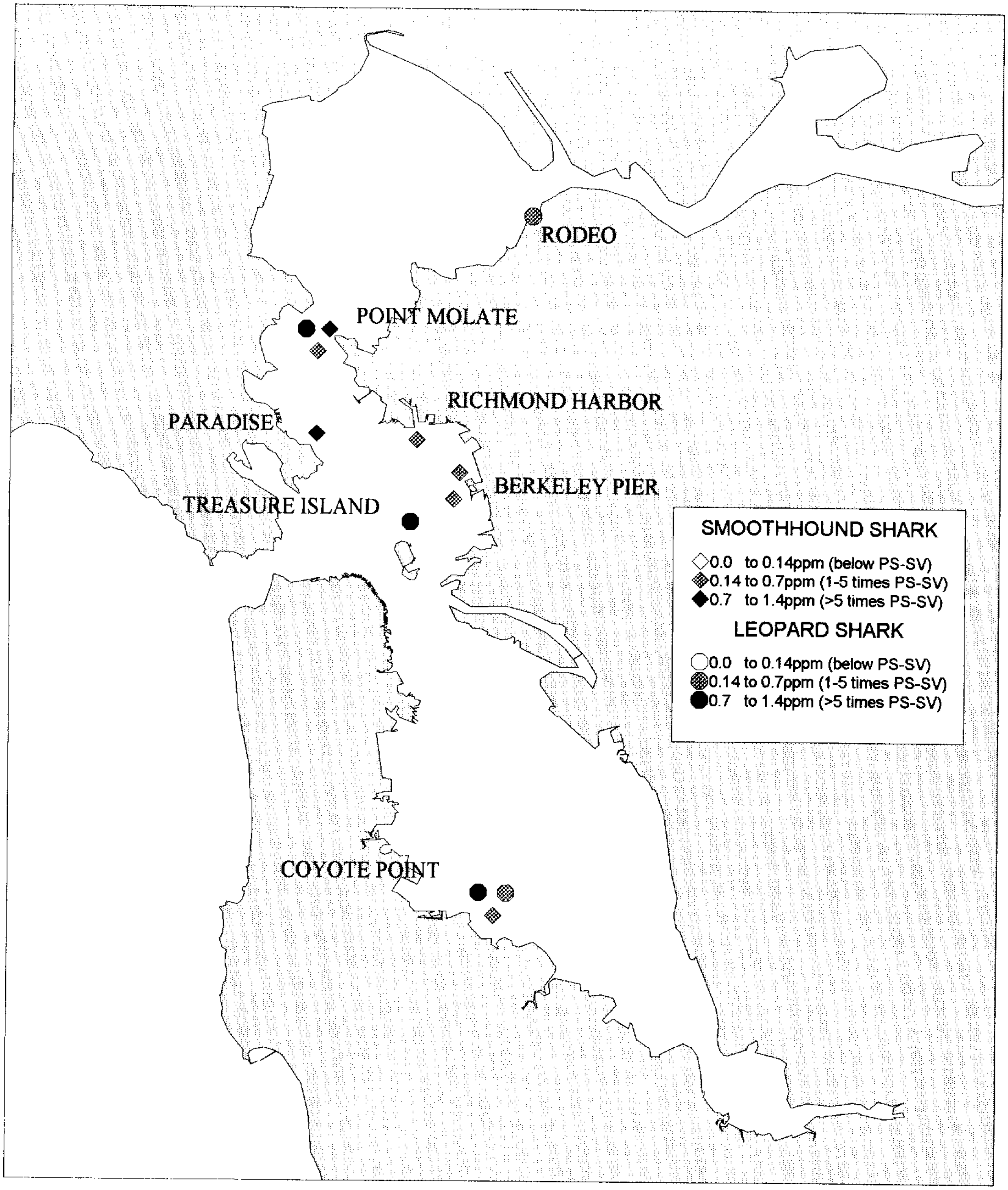


Figure 6. Mercury in parts per million in fish tissue. Figure 6a shows raw data in relation to the screening level. Each data point represents one composite of fish. Figure 6b shows mean values for mercury and percent lipid content for each species. Error bars reflect one standard error.

Figure 7
Mercury Concentration in Leopard Sharks and Smoothhound Sharks from San Francisco Bay



Species are not ranked by size classes due to low sample size. Multiple symbols for a species at a single station indicates separation of the species at that site. The pilot study screening value (PS-SV) for mercury is 0.14 ppm.

Mercury was also found to be elevated in white croakers, again with larger fish exhibiting greater contamination. The North Bay stations at Vallejo-Mare Island and Rodeo showed the highest mercury (0.4 ppm) concentrations in this species (Figure 8). Mercury levels in white croaker collected during the southern California study were lower than seen from San Francisco Bay. Only one sample collected from Dana Point (Pollock *et al.*, 1991) had mercury levels (0.44 ppm) as high as those found in white croaker from the Vallejo-Mare Island and Rodeo stations.

Mercury concentrations in striped bass were also elevated above screening levels, although at a lower level than sharks, with the Oakland Inner Harbor and Vallejo-Mare Island stations showing the highest mercury concentrations (Figure 9). A health advisory has been issued on consumption of striped bass, due to tissue mercury levels, since the early 1970s. An advisory was again issued in October, 1993, by the Office of Environmental Health Hazard Assessment, reiterating the concern regarding consumption of this species.

As opposed to other organic chemicals, methylmercury tends to bioaccumulate more as a function of age than lipid content. Although fish in this study were not aged, this relationship is inferred from the strong correlation between mercury and size in certain species (Fig. 10). It seems clear in this study that larger predatory fish are more heavily contaminated with mercury and exhibit bioaccumulation of this metal.

DIELDRIN

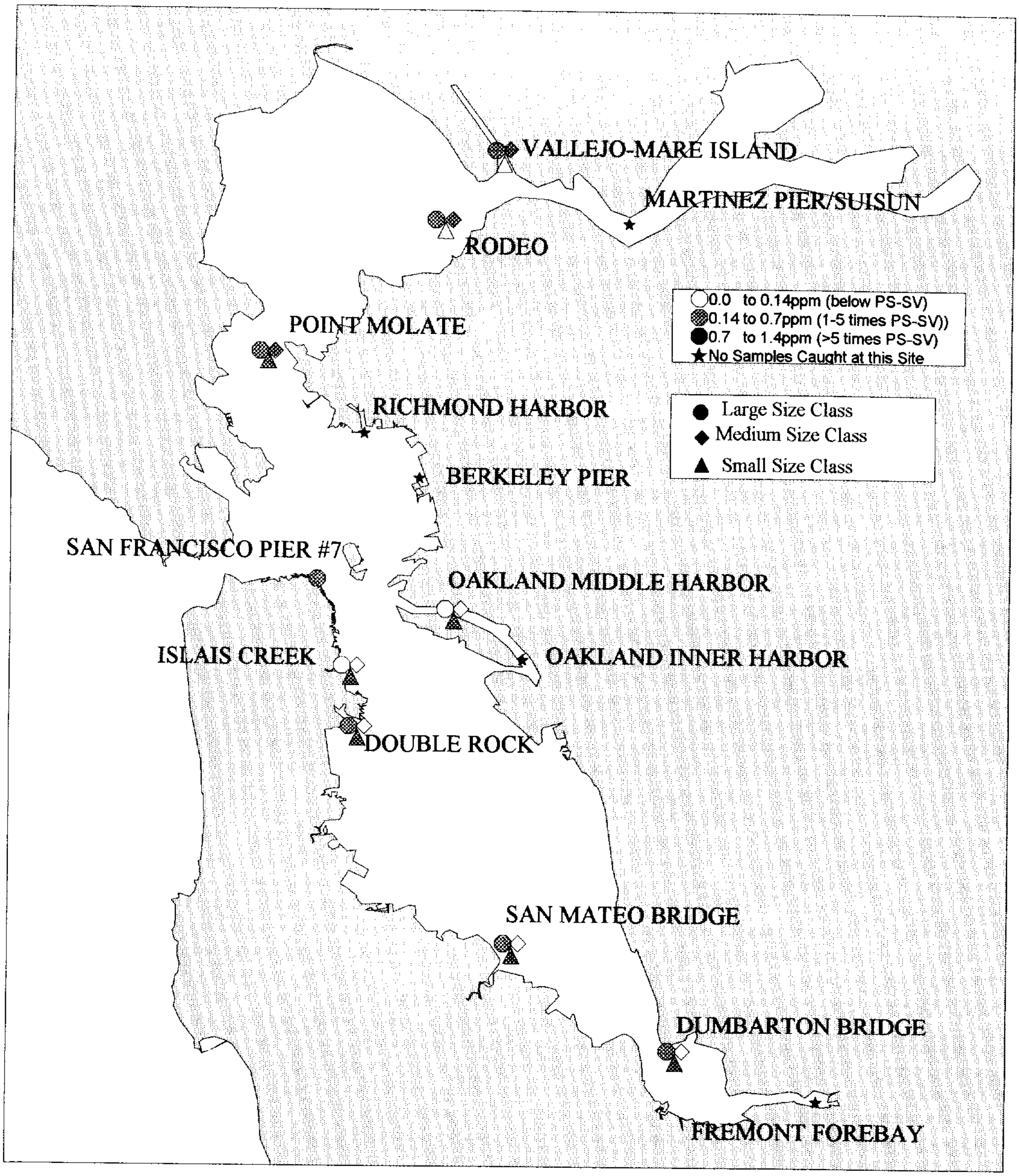
Dieldrin is a chlorinated cyclodiene pesticide used in the U.S. until 1987 for the control of soil dwelling insects. Because it is a metabolite of aldrin, environmental concentrations of dieldrin most likely represent the cumulative use of both aldrin and dieldrin. It has long term persistence in the environment and has been identified as a human neurotoxin (ATSDR, 1987a) and a probable carcinogen (IRIS, 1992). Since these lipid soluble compounds are not easily metabolized or excreted, they are easily stored in fatty tissues and can readily bioaccumulate in fish tissue with high lipid content.

Thirty-five of sixty-six tissue samples analyzed for dieldrin exceeded the PS_SV of 1.5 ppb. Concentrations of this pesticide were highest (4.2 ppb) in white croakers (Fig. 11) and exceedences were found at stations throughout the Bay (Fig. 12). Striped bass and shiner surf perch also exhibited exceedences throughout the Bay (Fig. 13). As was seen with other organic compounds, except methylmercury, the highest dieldrin levels were found in white croaker, the fish with highest lipid content. Sharks, the fish with the lowest lipid content, accumulated some of the lowest levels of dieldrin. The relationship between lipid and dieldrin is statistically significant, as will be discussed later.

DDT

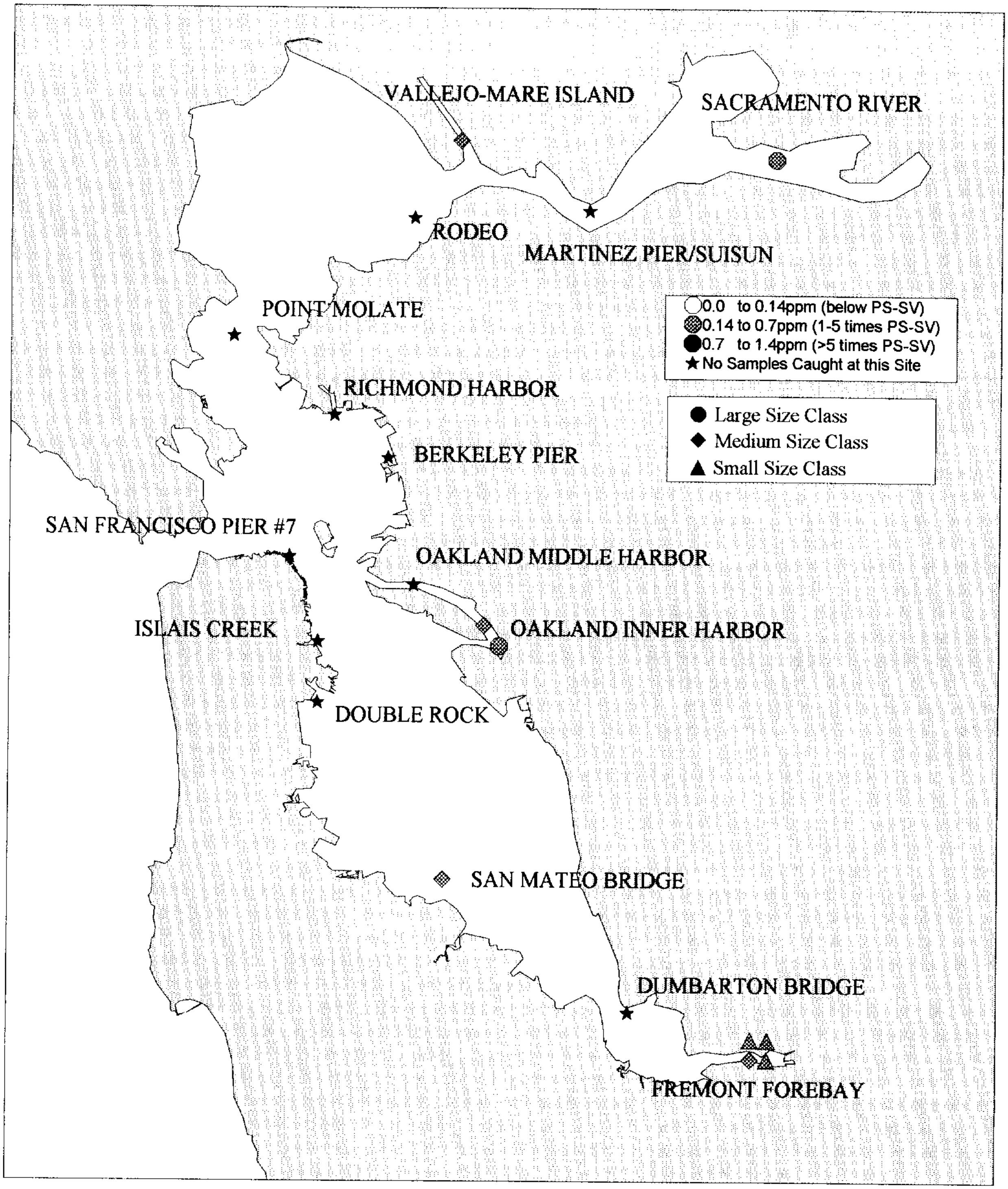
The use of the pesticide DDT ended in the U.S. by 1972, but persistence of DDT, and its DDD and DDE metabolites, in the

Figure 8
Mercury Concentrations in White Croaker of San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for mercury is 0.14 ppm.

Figure 9
Mercury Concentration in Striped Bass from San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for mercury is 0.14 ppm.

FIGURE 10
MERCURY CONCENTRATION vs. MEAN LENGTH

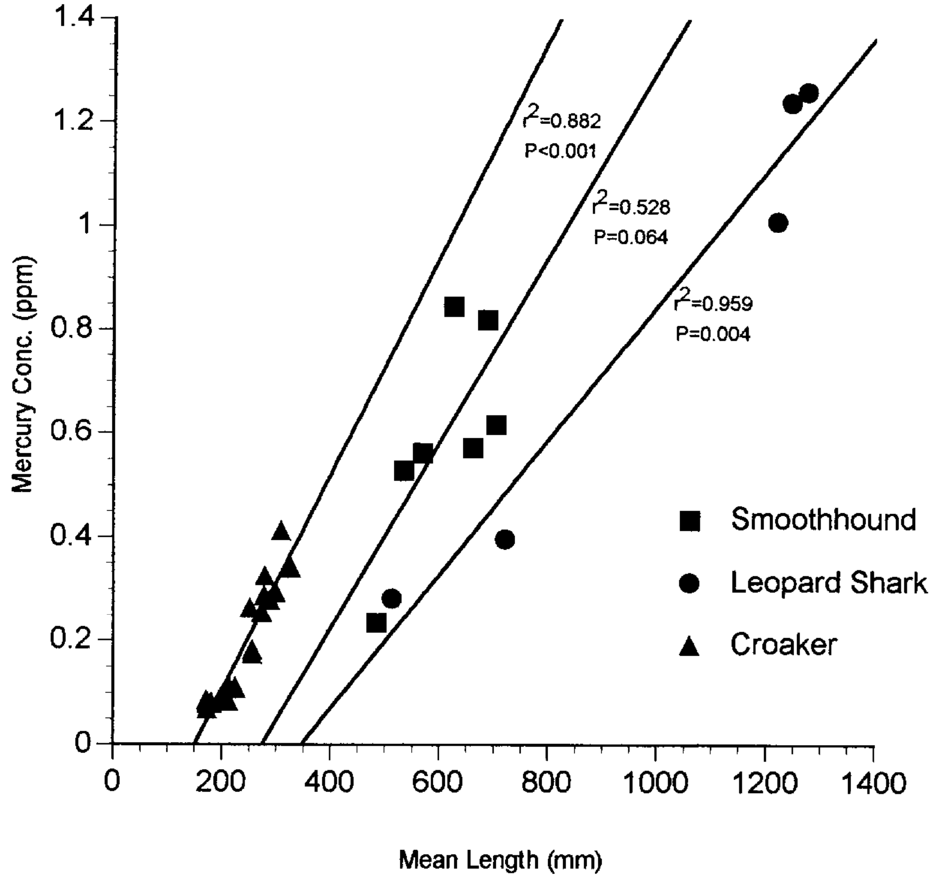


Figure 10. Mercury concentration to mean length comparison for three fish species caught in San Fransico Bay. Linear regression r^2 values presented for Smoothhound Sharks, Leopard Sharks, and White Croaker.

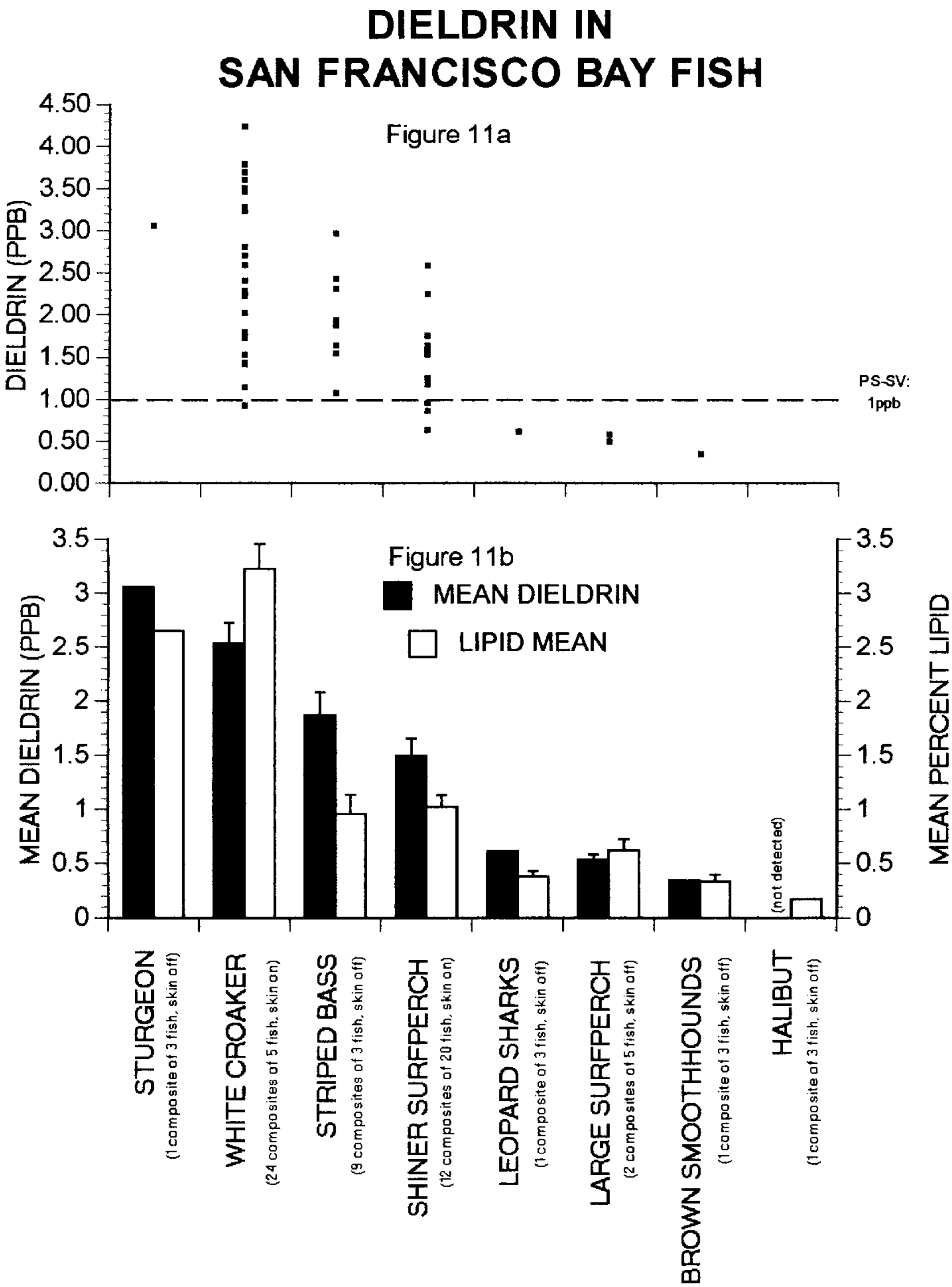
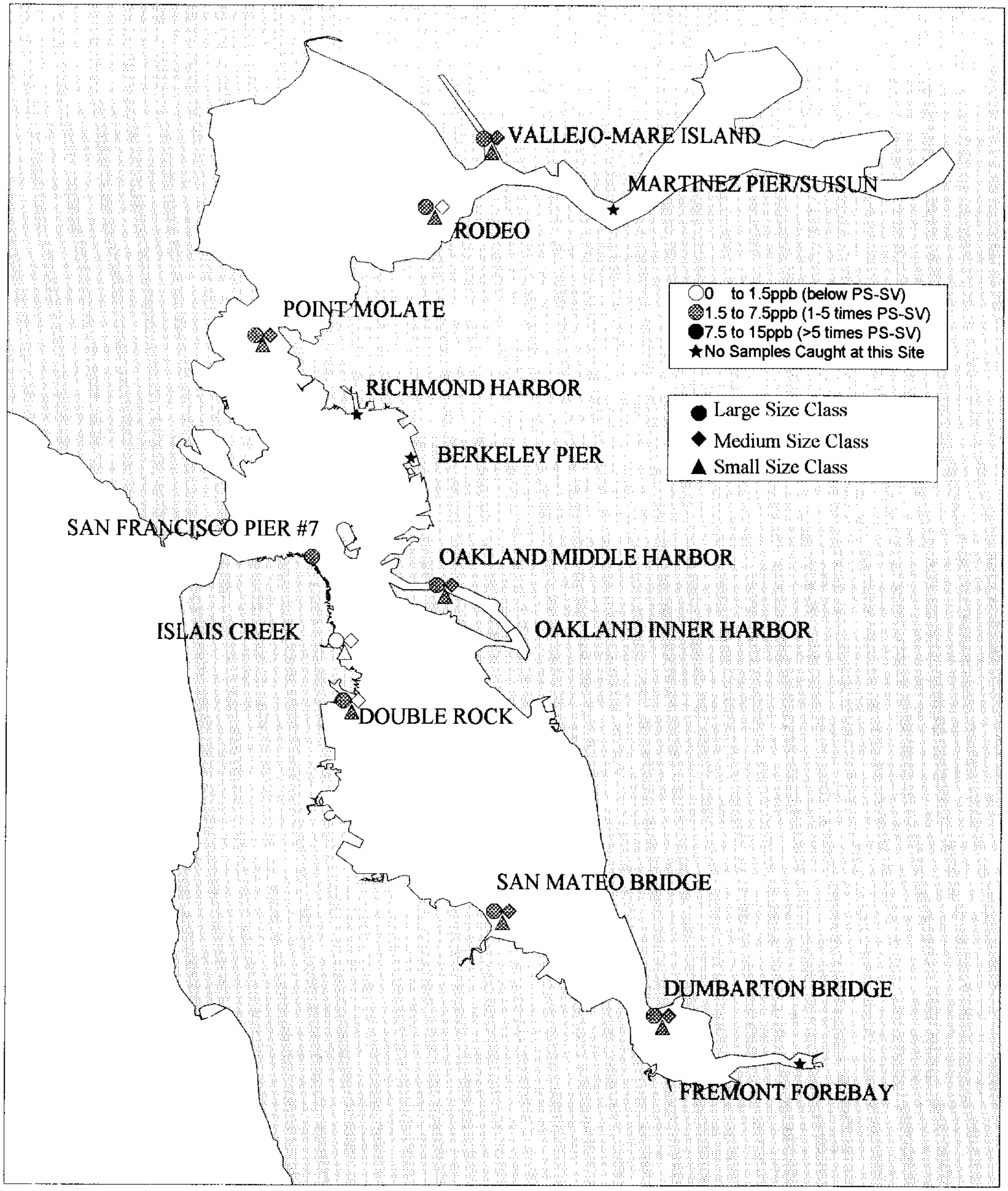


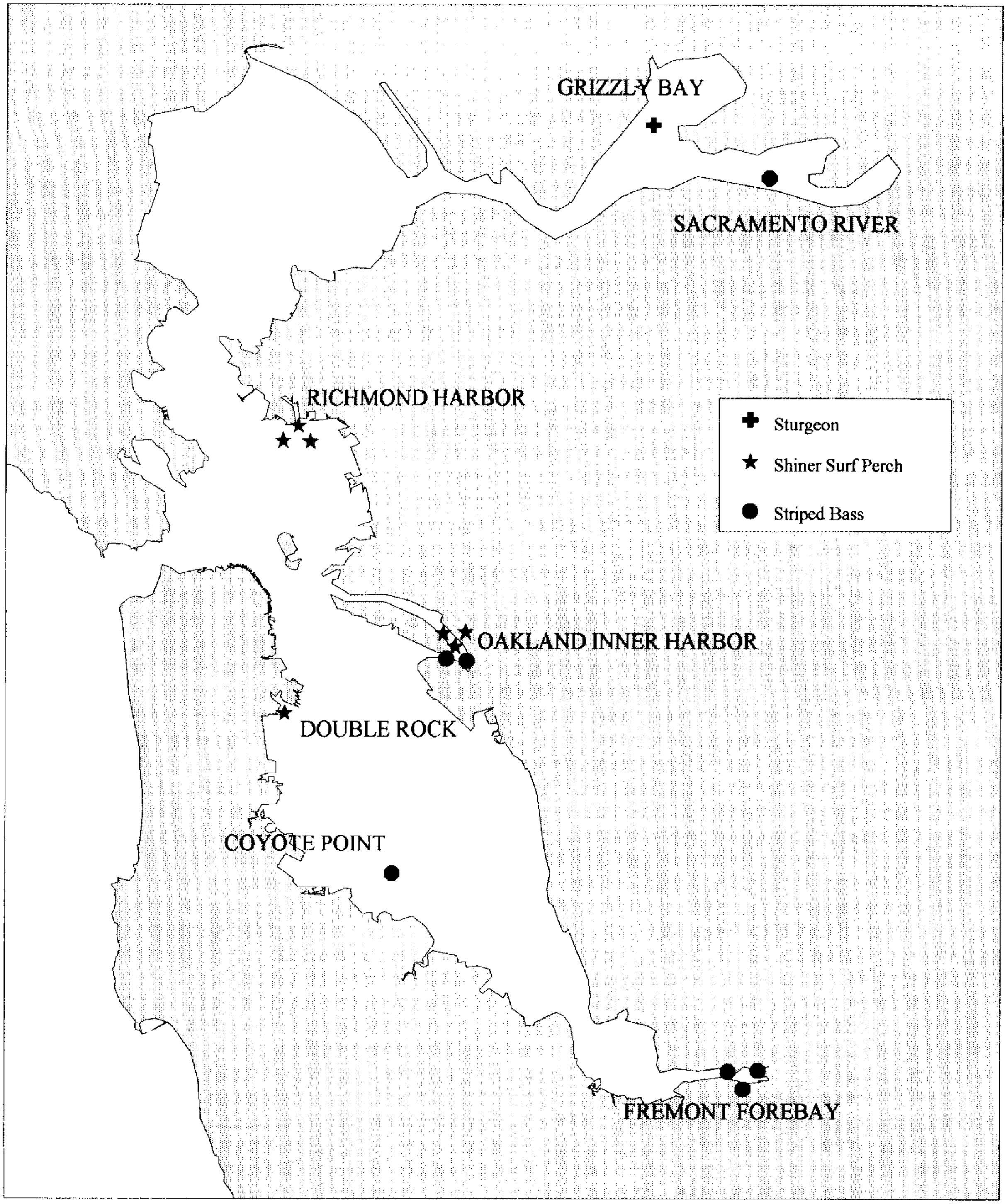
Figure 11. Dieldrin in parts per billion in fish tissue. Figure 11a shows raw data in relation to the screening level. Each data point represents one composite of fish. Figure 11b shows mean values for dieldrin and percent lipid content for each species. Error bars reflect one standard error.

Figure 12
Dieldrin Concentration in White Croaker from San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for dieldrin is 1.5 ppb.

Figure 13
Sturgeon, Striped Bass & Shiner Perch with Dieldrin Concentrations that Exceed Pilot Study Screening Values



Species are not ranked by size classes due to low sample size. Multiple symbols for a species at a single station indicates separation of the species at that site. The pilot study screening value (PS-SV) for dieldrin is 1.5ppb.

environment continues to make this a common chemical of concern. These chemicals bioaccumulate and are listed as probable human carcinogens (Ware, 1978: IRIS, 1992). Total DDT reported in this study is the summation of the six isomers o,p'-DDT, p,p'- DDT, o,p'-DDE, p,p'- DDE, o,p'-DDD and p,p'- DDE. When concentrations of a particular isomer were reported as below the method detection limit (MDL - Table 2) in a sample, as was common for o,p'-DDE, a value of one half the MDL was used for the summation of total DDT for that sample.

Nine of sixty-six tissue samples analyzed for total DDT exceeded the PS-SV of 69 ppb. Concentrations of this pesticide were found to be highest (156 ppb) in white croakers (Fig. 14) from the North Bay station at Vallejo-Mare Island, although levels were also elevated in white croaker composites from Rodeo (83 ppb), Dumbarton Bridge (79 ppb), San Francisco Pier #7 (79 ppb), Double Rock (71 ppb) and San Mateo Bridge (69 ppb)(Fig. 15). Shiner surf perch collected from Oakland Inner Harbor had one composite that exceeded the screening value (73 ppb) and was significantly higher than other shiner surf perch samples taken from the Bay. Although no white croaker were collected from this station, there should still be some concern, since total DDT levels were always higher in the larger size classes of white croaker compared to shiner surf perch, when both were collected from the same station. This probably is due to higher lipid content in white croaker's tissue. The above listed stations should be examined more thoroughly in future studies which evaluate fish contaminants.

In comparison, the highest reported total DDT value in white croakers from the Monterey Bay study was 31 ppb (Pollock *et al.*, 1992). In southern California, where DDT residue levels can be extremely elevated in sediments, reported mean tissue values ranged from as low as 6 ppb at Dana Point to as high as 2641 ppb at Pt. Vicente (Pollock *et al.*, 1991), near the White's Point sewage outfall. The highest concentration for an individual composite was 8052 ppb and was reported from Cabrillo Beach, in Los Angeles Harbor. Although tissue samples from San Francisco Bay are generally much lower than samples from Southern California, the DDT levels in white croaker should be of concern, particularly from stations in the North Bay and possibly Oakland Inner Harbor, where the highest tissue levels of this pesticide are found.

CHLORDANE

Chlordane is another of the organochlorine pesticides which is not easily degraded or metabolized in the environment. It is like DDT and dieldrin in that it is lipophilic and tends to accumulate in fatty tissues. It is similar in structure to dieldrin and has been classified as a probable human carcinogen (IRIS, 1992; Worthing, 1991). Total chlordane is the summation of major constituents of technical grade chlordane (cis-chlordane, trans-chlordane, cis-nonachlor, and trans-nonachlor) and the major metabolite (oxychlordane). As with total DDT, when concentrations of a particular isomer were reported as below the method detection limit (MDL - Table 2) in a sample, a value of one half

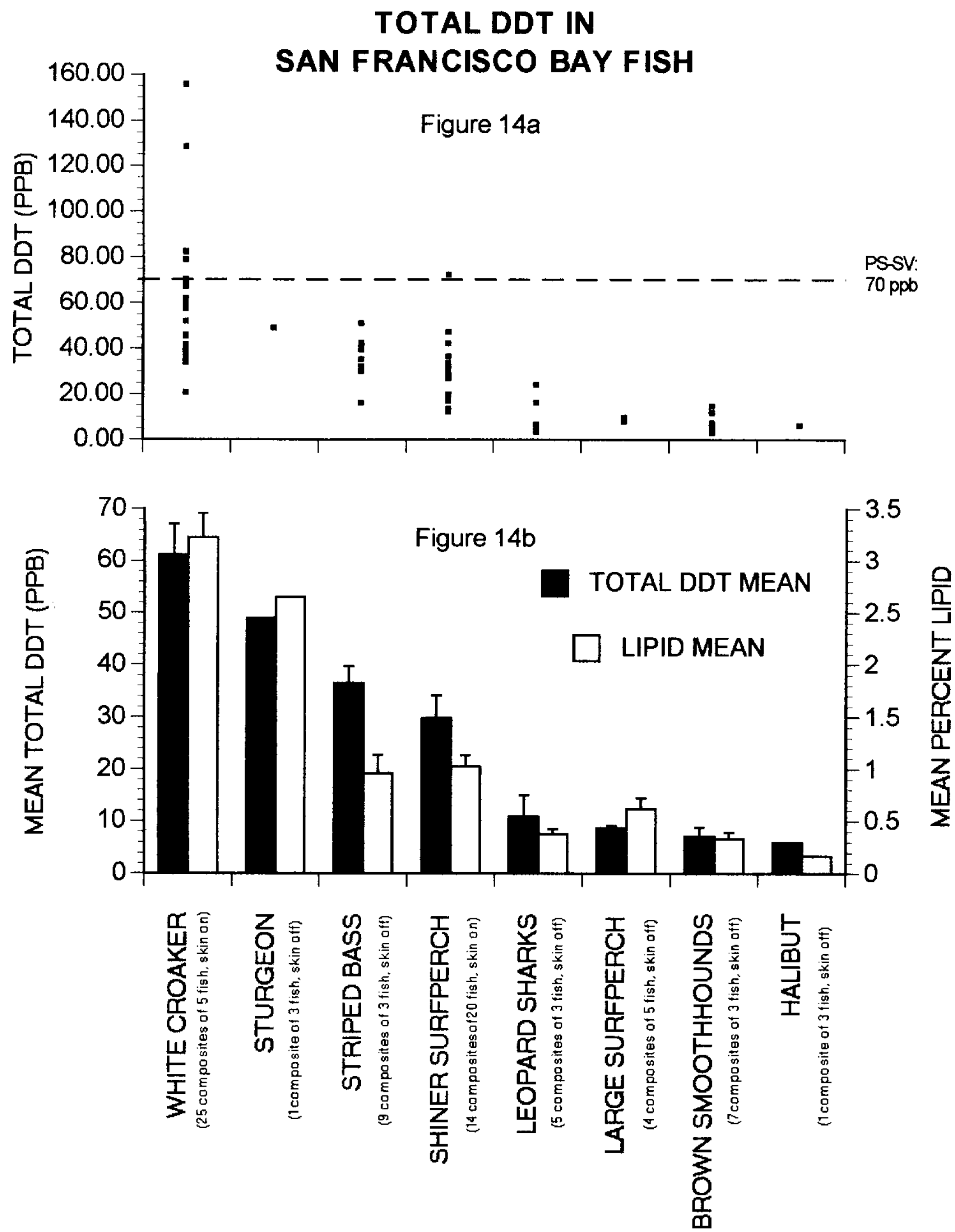
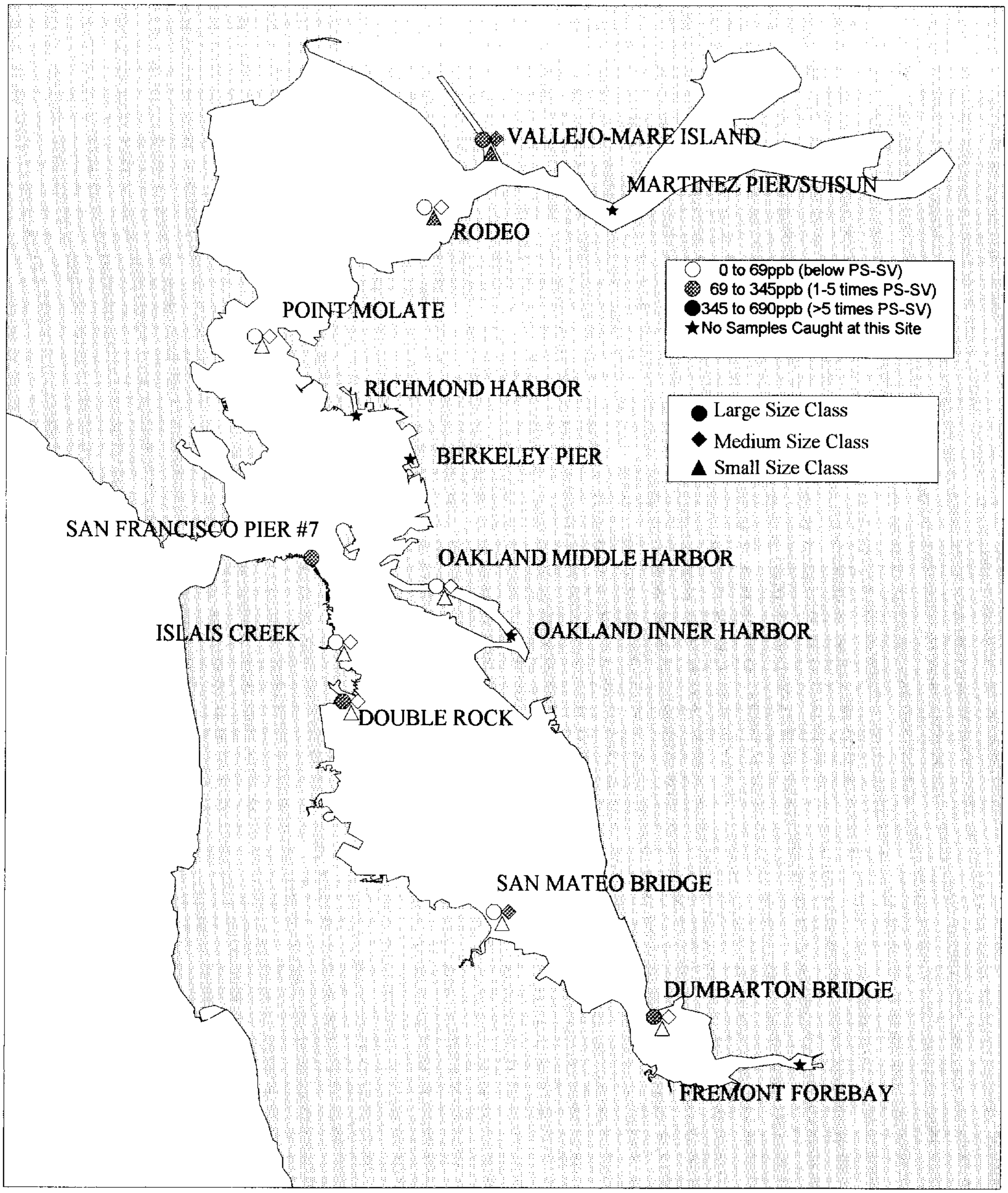


Figure 14. Total DDT in parts per billion from fish tissue. Figure 14a shows raw data in relation to the screening level. Each data point represents one composite of fish. Figure 14b shows mean values for each species for DDT and percent lipid content. Error bars reflect one standard error.

Figure 15
Total DDT Concentration in White Croaker from San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for DDT is 69 ppb.

the MDL was used for the summation of total chlordane for that sample. Seven samples of sixty-six analyzed exceeded the total chlordane PS-SV of 18 ppb (Fig. 16). Of these seven, the three highest levels occurred in white croaker at the north Bay Vallejo-Mare Island station (Fig. 17) with a maximum value of 36 ppb found in the largest size class.

In comparison, white croaker caught near the Monterey Regional wastewater outfall had total chlordane tissue levels of 3.2 ppb (Pollock *et al.*, 1992), while only the Malibu station from the southern California study (Pollock *et al.*, 1991) reported a chlordane value in white croaker (30 ppb) near the higher levels seen at Vallejo-Mare Island. Most samples from the Monterey Bay and southern California studies were below the MDL (3 ppb) while over half of the samples from San Francisco Bay exceeded this level. High levels of chlordane in the sediments of streams flowing into San Francisco Bay were reported in the seventies (Law and Goerlitz, 1974) and fish tissue levels from this study illustrate its persistence today. This chemical should continue to be monitored, particularly in white croaker from the North Bay.

DIOXINS/FURANS

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDFs) are released into the environment primarily as by-products of thermal processes (incineration of municipal and chemical wastes and combustion of PCBs) and chemical manufacturing processes (paper pulp chlorine bleaching, oil refining and manufacturing of pesticides). Except as laboratory standards, these chemicals are not intentionally manufactured. Of 75 possible PCDDs and the 135 PCDFs, 17 congeners with chlorines at the 2,3,7 and 8 positions are considered the most important toxicologically. The dioxin isomer 2,3,7,8-TCDD is the most potent animal carcinogen evaluated by the EPA and is considered a probable human carcinogen (U.S. EPA, 1987d). International Toxic Equivalency Factors (I-TEFs) have been developed (Barnes and Bellin, 1989) to assess risks posed by mixtures of PCDD/PCDFs. This is done by converting specific congener concentrations to equivalent concentrations (I-TEQs) of 2,3,7,8-TCDD, the most toxic and extensively studied congener. In this study, all 17 2,3,7,8- substituted congeners were measured and the dioxin-TEQs calculated (Appendix I - Section VI). In addition, 5 dioxin-like coplanar PCBs were measured and a PCB-TEQ (APPENDIX III) value was calculated using the proposed PCB Toxic Equivalents (Ahlborg *et al.*, 1994). It should be acknowledged though that this method, as well as the toxicological significance of different concentrations of coplanar PCB's, is a matter of controversy at this time. Whenever any congener was below the method detection limit, one half the detection limit was used in the TEQ calculations.

Due to the high costs of the PCDD/PCDF analysis, only nineteen of sixty-six tissue samples were analyzed. The largest size class from the most abundant species at each station was analyzed, as well as the largest composite from each of the shark, striped bass, sturgeon and halibut samples. Sixteen of nineteen

TOTAL CHLORDANE
IN SAN FRANCISCO BAY FISH

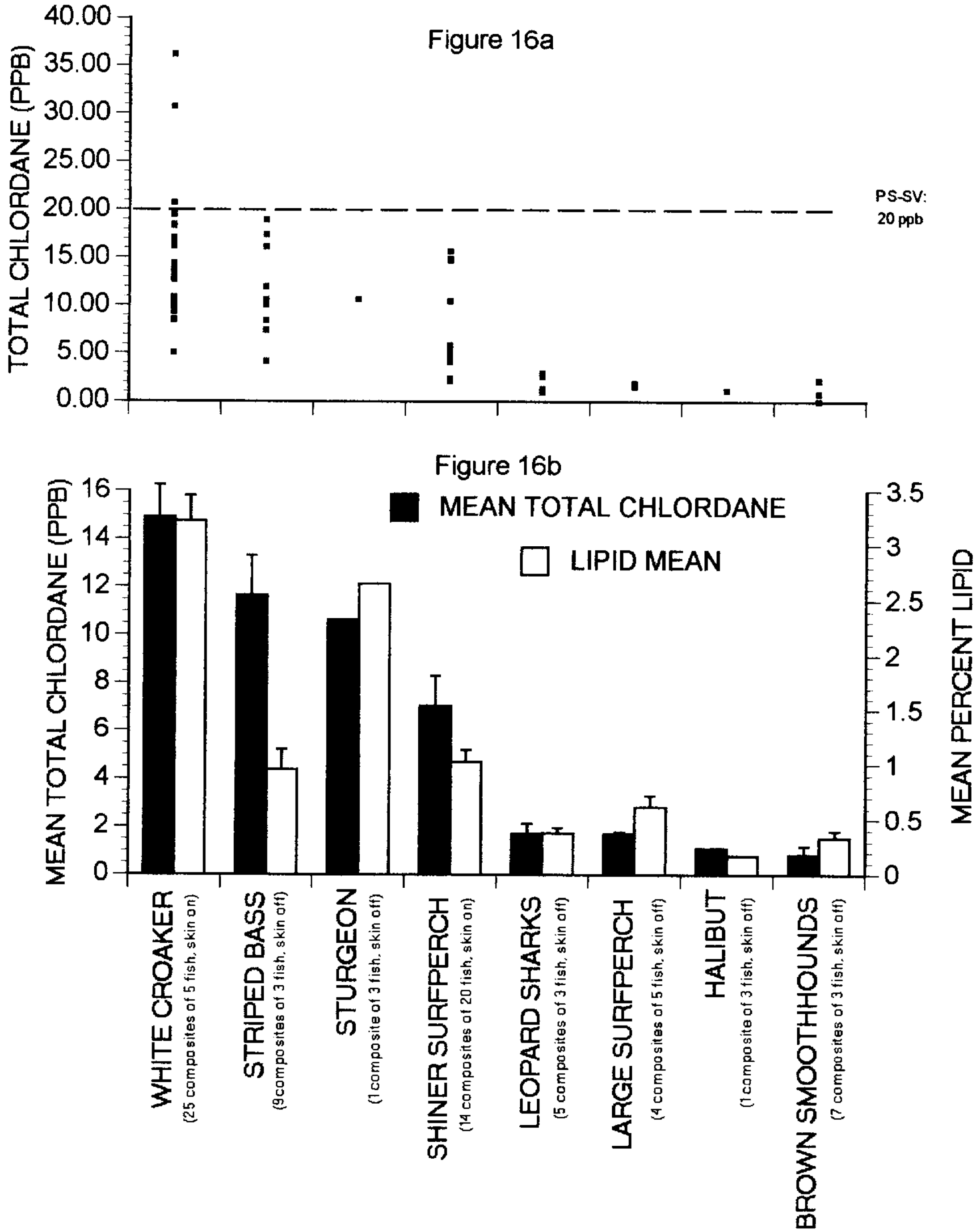
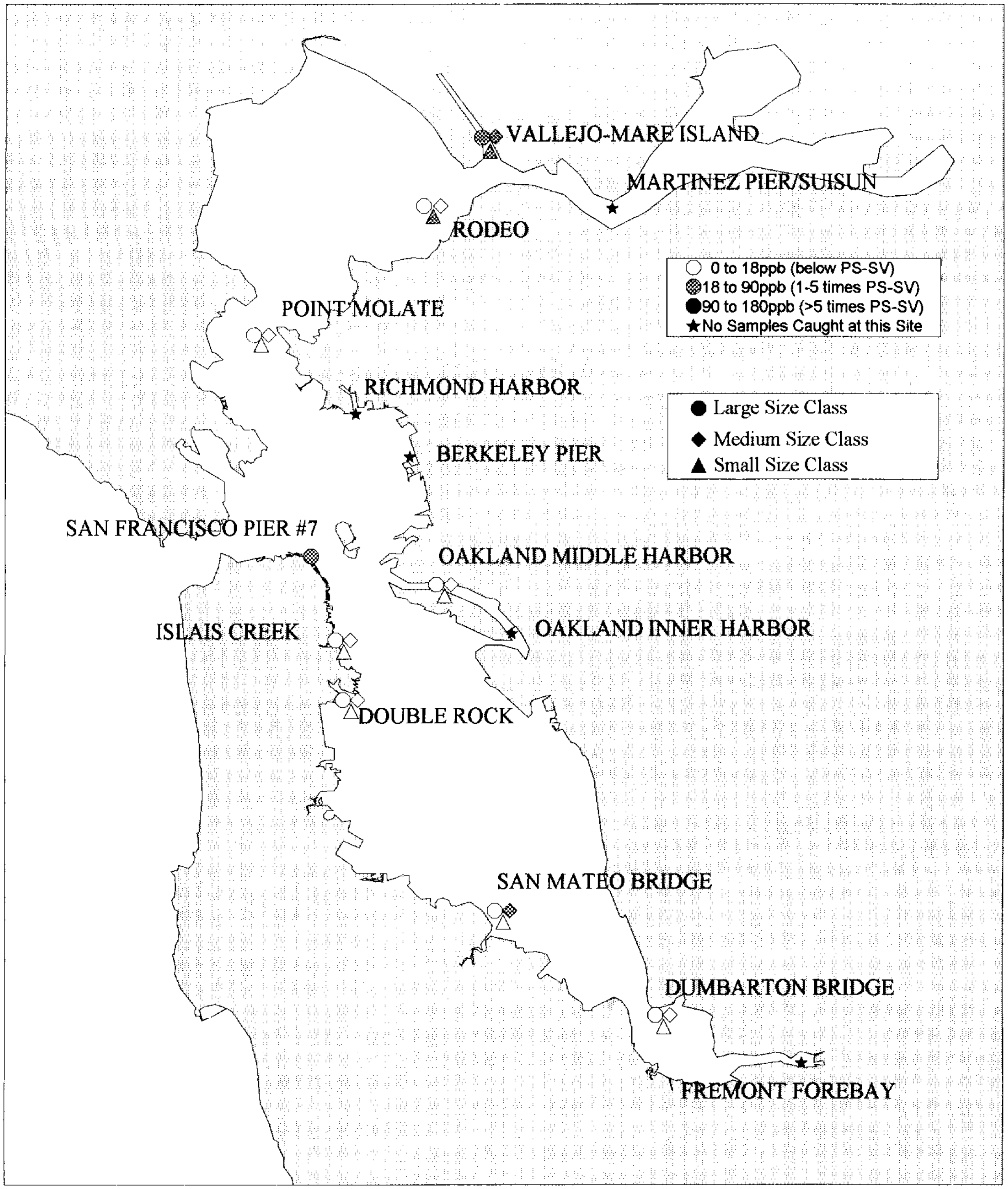


Figure 16. Total chlordane in parts per billion in fish tissue. Figure 16a shows raw data in relation to the screening level. Each data point represents one composite of fish. Figure 16b shows mean values for total chlordane and percent lipid content in each species. Error bars reflect one standard error.

Figure 17
Total Chlordane Concentration in White Croaker from San Francisco Bay



Size classes (small, medium, and large) are relative to individual station size ranges of each species and may overlap in different regions of the bay. The pilot study screening value (PS-SV) for total chlordane is 18 ppb.

samples exceeded the dioxin-TEQ PS-SV of 0.15 ppt with the highest levels (1.3 - 1.75 ppt) found in white croaker from the South Bay (Fig. 18 & 19). Interestingly, stations with high dioxin-TEQ levels corresponded to stations with high PCB levels with overall correlation between concentrations of the two groups of chemicals highly significant (r^2 = 0.72; p<0.001)(Fig. 20). PCDD/PCDFs, like other lipophilic compounds demonstrate a strong tendency to accumulate in lipid rich tissues. Correlation between lipids and dioxins in the 19 samples is highly significant (r^2 = 0.72; p=0.001). The lowest PCDD/PCDFs levels were found in two shark samples and one halibut sample, all three of which had low lipid levels in the muscle tissue.

In a recent study undertaken by the EPA, fish were sampled from over 300 sites throughout the U.S. and analyzed for dioxin concentrations (U.S.EPA, 1992). On the basis of these samples, 34 sites were considered to be uncontaminated and to represent background levels for dioxin, with a TEQ mean of 1.16 ± 1.21 parts per trillion. For consistency, the same method was used to calculate TEQs for both the EPA study and the pilot study reported here. All of the dioxin-TEQ values from the San Francisco Bay area samples fell well within the reported background range of EPA values. The EPA does express concern that even these background levels may be too high, considering the extreme toxicity these chemicals can exhibit. The EPA Office of Research and Development is currently reevaluating the potency of dioxins and the methods of calculating TEQs and screening values. When that reevaluation is complete, interpretation of the above dioxin/furan data will be more valid and scientifically based. Since the draft document (U.S.EPA, 1994-draft) that discusses this re-evaluation does not specifically address the toxicological significance of concentrations of coplanar PCBs, no conclusions can be reached at this time on the significance of levels measured in San Francisco Bay. These chemicals are suspected though of having properties similar to the dioxins and furans.

STATISTICAL ANALYSES

Statistical analyses were performed for the six chemicals of concern to identify contaminant bioaccumulation or bioconcentration trends in different species and at different stations. Chemistry values used for statistical purposes were a mean of the three composite samples, unless otherwise noted. Dioxin chemical analyses were performed on only 19 of 66 samples, so statistical comparisons were restricted to white croaker composites and excluded from the majority of statistical analyses. During statistical analysis, non-detected values (ND or -8) were given a numerical value of zero, except for dioxin/furans or unless otherwise noted.

Differences Between Sites Within a Single Species

Only white croaker and shiner surf perch were sufficiently abundant for comparisons of pesticide and PCB concentrations between sites, so data for each species were analyzed separately. For the chemical constituents, normality was tested using Kolmogorov-Smirnov goodness-of-fit analysis. Homogeneity of

DIOXIN-TEQ IN SAN FRANCISCO BAY FISH

Figure 18a

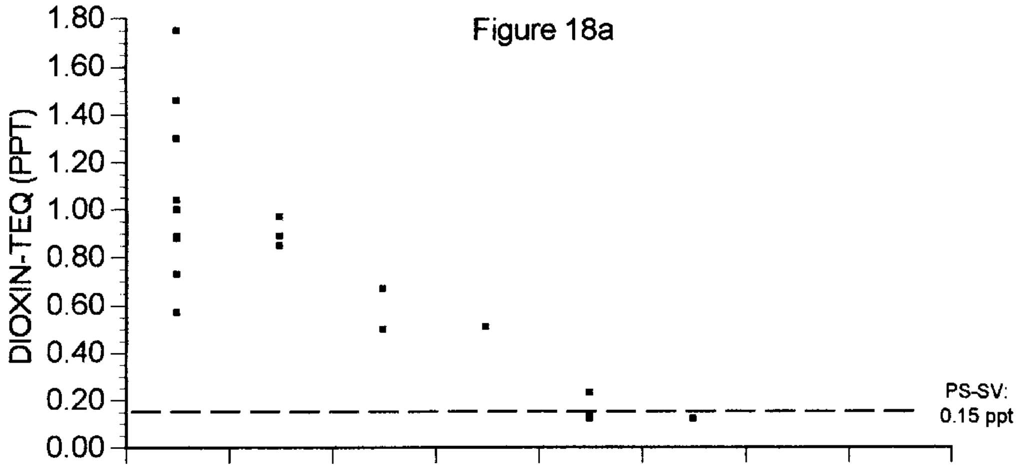


Figure 18b

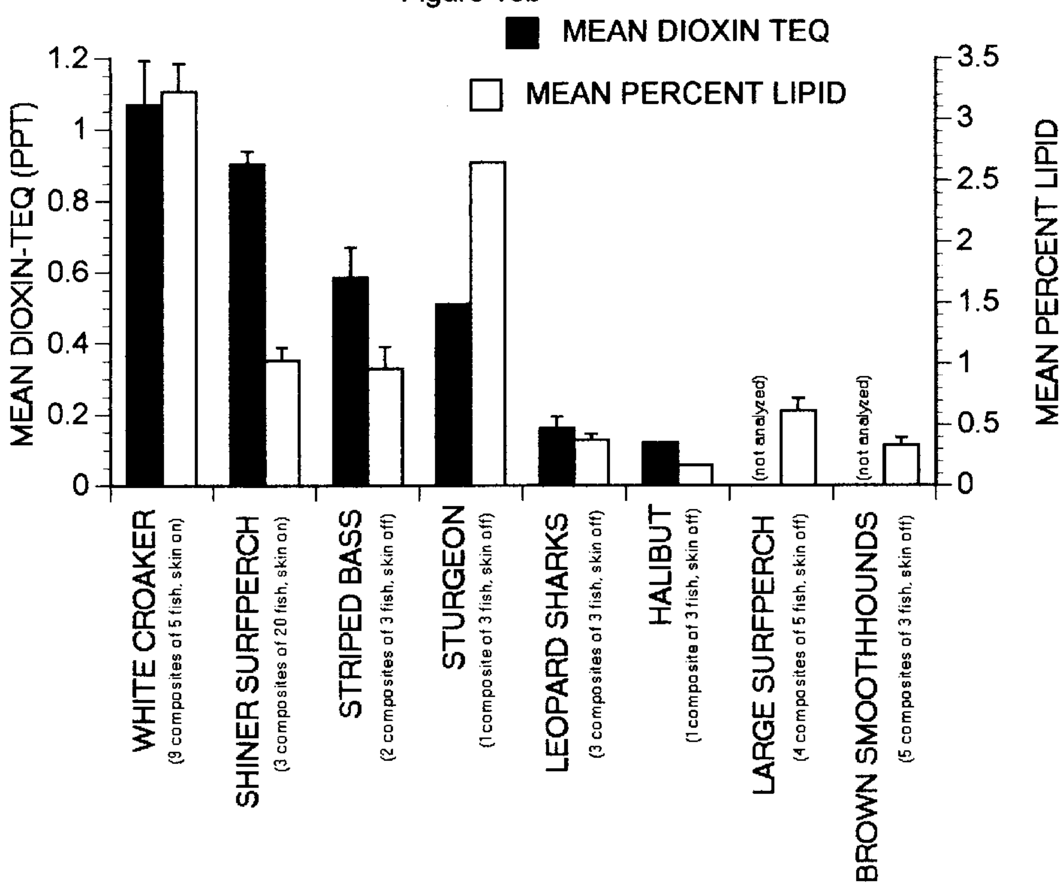
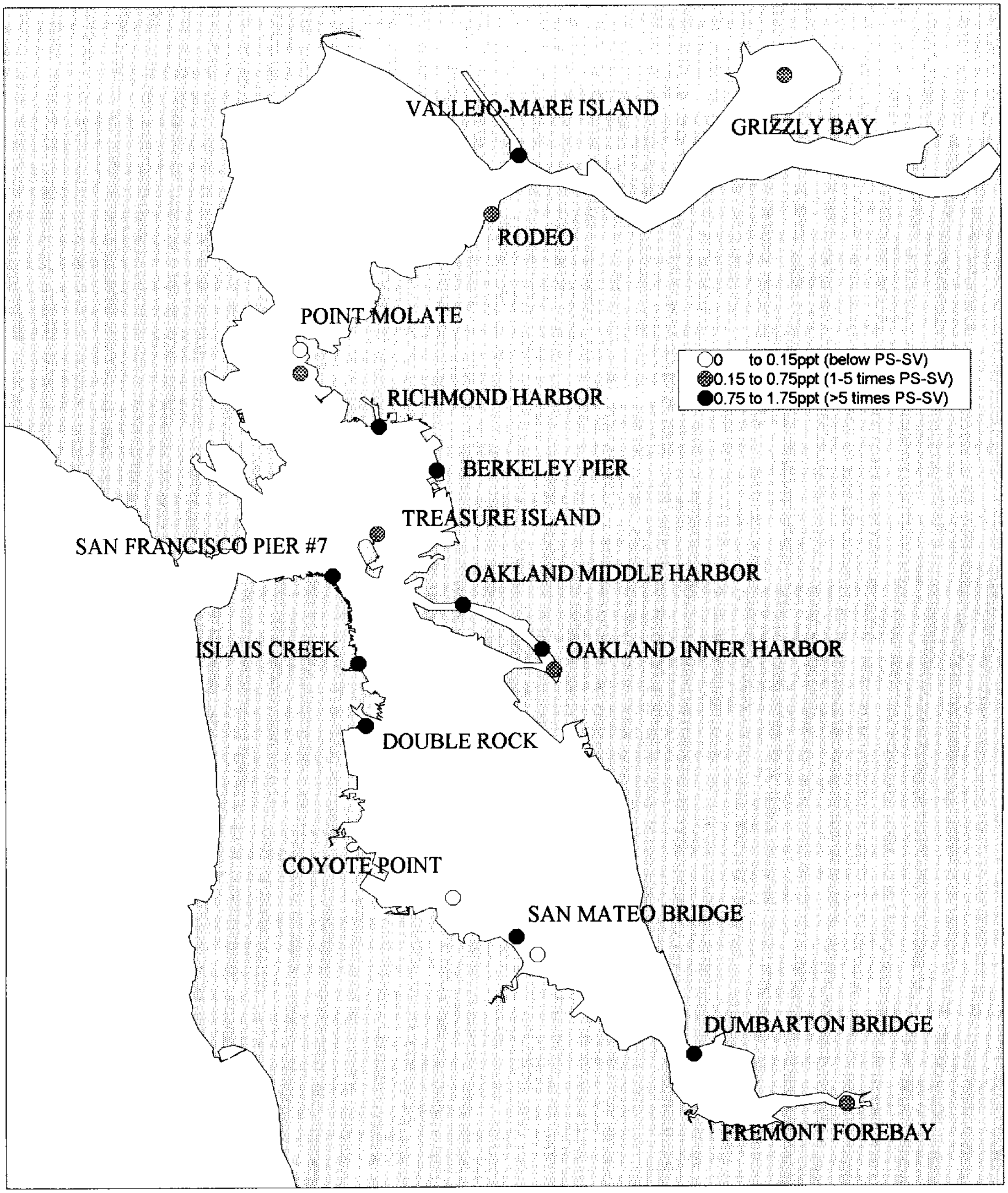


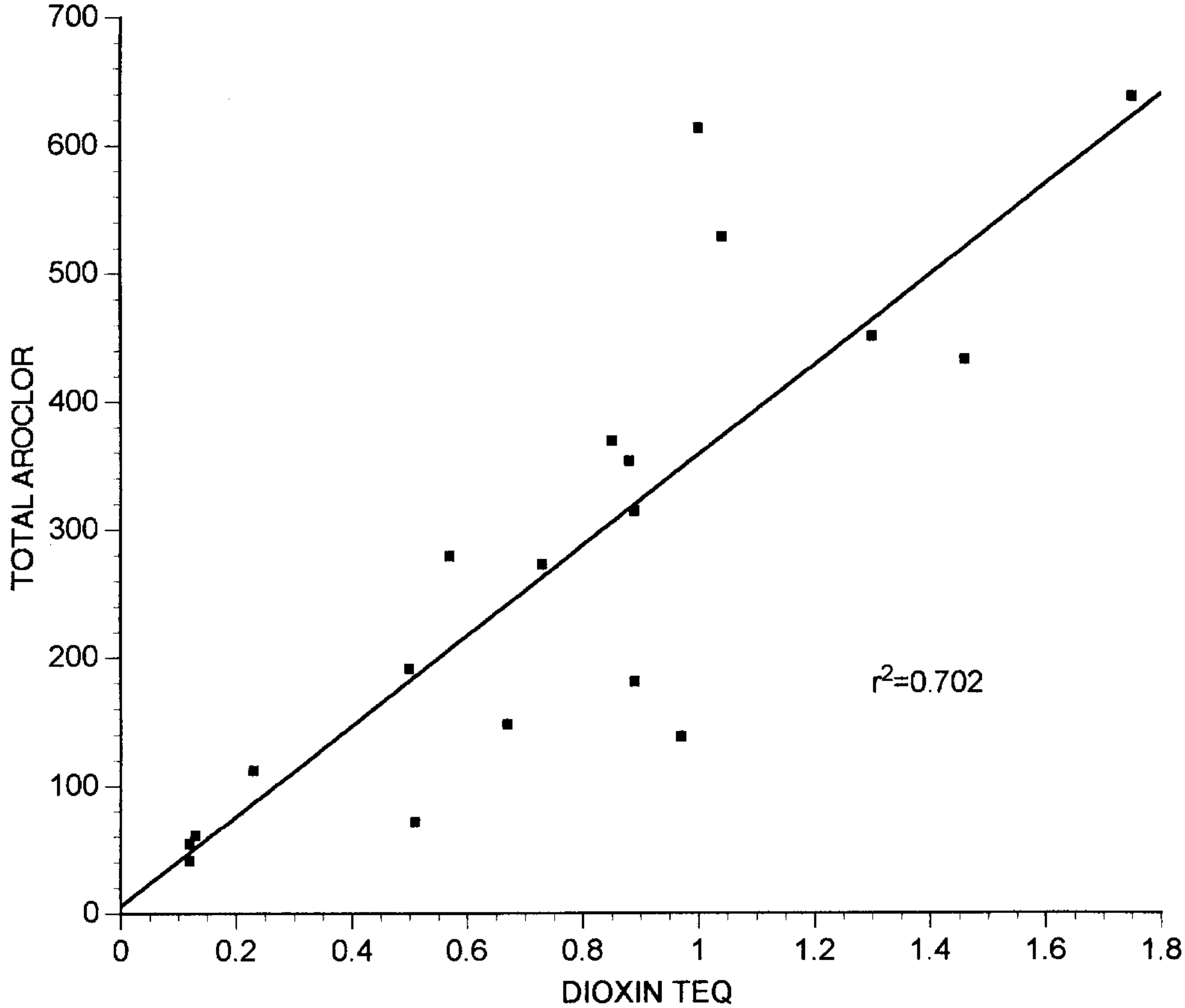
Figure 18. Dioxin TEQ in parts per trillion in fish tissue. Figure 18a shows raw data in relation to the screening level. Each data point represents one composite of fish. Figure 18b shows mean values for Dioxin TEQ and percent lipid content for each species. Error bars reflect one standard error.

Figure 19
Dioxin-TEQ in All Fish Species Throughout San Francisco Bay



Each of the nineteen samples analyzed for dioxin-TEQ is represented.
The pilot study screening value (PS-SV) for dioxin-TEQ is 0.15 ppt.

FIGURE 20
DIOXIN TEQ vs. TOTAL AROCLOR



Dioxin TEQ vs Total Aroclor. Regression is significant ($p<0.001$)

variances was tested using Cochran's test. Variances for all levels of each measured variable were homogeneous. Differences in concentrations of lipids, mercury, PCBs, and pesticides were tested separately using single factor analysis of variance (ANOVA) for all constituents. Although mercury was not normally distributed, Zar (1984) notes that ANOVAs remain robust even with substantial deviations from normal. Using ANOVAs for all analyses allowed for a posteriori comparisons (Tukey multiple comparison tests) to isolate significant differences.

A) White Croaker
All measured variables were normally distributed with the exception of mercury and DDT. DDT was not significantly different from normal when data were transformed (log(x+1)). Sample size was three composites for all sample locations with the exception of San Francisco Pier #7 (n=1). No white croaker samples were collected from Richmond Harbor, Berkeley Pier or Oakland Inner Harbor. It is worth noting that mean length of fish was significantly different ($p=0.039$) between Rodeo and Islais Creek.

• Lipids $p<0.001$
Vallejo-Mare Island was significantly greater than Double Rock, Islais Creek, Oakland-Middle Harbor, Point Molate, and Rodeo.
San Mateo Bridge was significantly greater than Islais Creek, Point Molate, and Rodeo.
Dumbarton Bridge was significantly greater than Islais Creek, Point Molate, and Rodeo.
Point Molate was significantly greater than Islais Creek.

• Mercury $p=0.017$
Vallejo was significantly greater than Islais Creek and Oakland Inner Harbor.
Rodeo was significantly greater than Islais Creek.

• Total DDT $p=0.016$
Vallejo was significantly greater than Double Rock and Islais Creek.

• Dieldrin $p=0.013$
Vallejo was significantly greater than Islais Creek.

• Total Chlordane $p=0.002$
Vallejo was greater than all sites except San Francisco Pier #7.

• Total Aroclor $p=0.395$
Differences in total Aroclor among sites were not significant.

Rankings of chemical means for white croaker composites collected at each station are given in Table 6. Means were ranked in order of their concentrations so the lowest rank numbers indicate stations with highest chemical concentrations.

B) Shiner Surf Perch
Normality and homogeneity of variances were tested again with Kolomogorov-Smirnov and Cochran's tests. Differences between means were tested with single factor ANOVAs. All measured

Table 6. Mean Lipid and Chemical Concentration in White Croaker

STATION NAME	n		% Lipid	R	Hg (ppm)	R	TTLDDT (ppb)	R	Dieldrin (ppb)	R	TTLCLOR(ppb)	R	TTLARO(ppb)	R
Double Rock	3	mean	3.22	5	0.171	5	46.2	8	2.22	6	11.6	9	372.8	3
		sd	0.68		0.110		20.7		1.05		4.1		190.0	
Dumbarton Bridge	3	mean	4.26	3	0.124	7	50.5	7	2.90	4	13.0	6	299.3	6
		sd	0.45		0.047		17.4		1.19		3.4		115.8	
Islais Creek	3	mean	2.37	8	0.086	9	33.7	9	0.86	9	8.3	9	228.6	9
		sd	0.50		0.006		11.3		0.76		2.9		86.6	
Oakland Middle Harbor	3	mean	3.21	6	0.100	8	52.2	6	2.94	3	14.0	5	341.4	4
		sd	0.57		0.017		7.1		0.61		0.3		15.4	
Point Molate	3	mean	2.39	7	0.197	4	61.0	4	2.20	7	11.9	7	262.0	8
		sd	0.67		0.093		6.1		0.44		2.3		41.5	
Rodeo	3	mean	1.53	9	0.297	2	62.0	3	1.65	8	14.8	4	312.4	5
		sd	0.73		0.044		23.2		0.66		5.7		97.9	
San Francisco Pier	1	mean	3.30	4	0.289	3	78.9	2	2.70	5	18.4	2	616.4	1
		sd												
San Mateo Bridge	3	mean	4.31	2	0.148	6	55.2	5	2.95	2	15.4	3	286.3	7
		sd	0.47		0.102		17.6		1.03		4.0		231.7	
Vallejo	3	mean	4.83	1	0.316	1	122.1	1	3.66	1	29.2	1	454.9	2
		sd	0.47		0.086		37.0		0.52		7.8		167.7	

Table 7. Mean Lipid and Chemical Concentration in Surfperch

STATION NAME	n		% Lipid	R	Hg (ppm)	R	TTLDDT (ppb)	R	Dieldrin (ppb)	R	TTLCLOR (ppb)	R	TTLARO(ppb)	R
Berkeley Pier	3	mean	0.52	8	0.102	6	15.1	8	0.50	7	2.813	8	108.6	6
		sd	0.18		0.027		4.1		0.45		1.092		28.7	
Double Rock	1	mean	1.58	2	0.104	5	31.6	4	2.25	1	10.396	2	317.5	1
		sd												
Dumbarton Bridge	1	mean	1.00	6	0.124	2.5	16.9	7	1.18	5	4.505	7	101.1	8
		sd												
Islais Creek	1	mean	1.16	4	0.080	7	18.8	5	0.00	8	5.414	4	103.7	7
		sd												
Oakland Inner Harbor	3	mean	1.10	5	0.274	1	42.6	2	1.98	2	15.060	1	287.0	2
		sd	0.12		0.126		25.7		0.53		0.532		74.2	
Oakland Middle Harbor	1	mean	1.34	3	0.124	2.5	47.1	1	0.96	6	5.818	3	167.0	3
		sd												
Richmond Harbor	3	mean	0.86	7	0.113	4	37.3	3	1.64	3	4.745	5	166.9	4
		sd	0.03		0.015		4.4		0.11		0.460		16.8	
San Mateo Bridge	1	mean	1.84	1	0.068	8	17.5	6	1.25	4	4.508	6	114.0	5

Chemical concentrations represent mean values of composites. Numbers to the right of each set of values are ranking order (R) for that analyte. Lowest rank numbers indicate stations with the highest chemical concentration. See text for fish composites included in means.

variables were distributed normally with the exception of mercury and total chlordane, and total chlordane was not significantly different from normal when data were log transformed. Variances for all levels of each measured variable were homogeneous. Sample sizes were three for the Richmond Harbor, Berkeley Pier, and Oakland Inner Harbor sites. All other sample sizes were one. There was no significant difference in the mean length of fish caught at each site (p=0.207).

- Lipids p=0.001

San Mateo was significantly greater than Richmond, Oakland Inner Harbor, Dumbarton, and Berkeley Pier.
Berkeley Pier was significantly less than Double Rock, Islais Creek, Oakland Inner Harbor, Oakland Middle Harbor and San Mateo.
Double Rock was significantly less than Richmond.

- Mercury p=0.385

Differences for mercury were not significant.

- Total DDT p=0.255

Differences for total DDT were not significant.

- Dieldrin p=0.056

A posteriori tests did not indicate significant differences among sites.

- Total Chlordane p=0.001

Oakland Inner Harbor was significantly greater than all other sites except Double Rock.
Double Rock was significantly greater than Berkeley Pier.

- Total Aroclor p=0.058

A posteriori tests did not indicate significant differences among sites.

Rankings of chemical means for shiner surf perch composites collected at each station are given in Table 7. Means were ranked in order of their concentrations so lowest rank numbers indicate stations with highest chemical concentrations.

Differences Between Sites For All Species

Single factor ANOVAs were run to test for differences between species regardless of site. Species showing significant differences were dropped from analysis of site. To evaluate each site, regardless of fish species, all species showing no significant difference in the constituent of interest were grouped.

A) Differences Between Species

Fish species caught in small numbers at only one sample location were excluded from analyses (South Bay-San Mateo/Halibut, Grizzly Bay/Sturgeon, and Point Molate/Walleye Surf Perch). Normality and homogeneity of variances were tested with Kolmogorov-Smirnov goodness-of-fit analyses and Cochran's tests for multiple variances. No measured variable was distributed normally, although when log transformed, differences between distribution of data for lipids and total Aroclor were not significantly different from normal. Single factor ANOVAs were used for all analyses despite deviations from normality.

- Lipid $p<0.001$

Lipid was significantly greater in white croaker than all other fish species.
Lipid was significantly greater in shiner surf perch than brown smoothhound sharks.

- Mercury $p<0.001$

Leopard sharks and brown smoothhounds sharks were significantly higher in mercury than shiner perch, striped bass, white croaker, and white surf perch.

- Total DDT $p<0.001$

White croaker were significantly greater than all other species.

- Dieldrin $p<0.001$

White croaker were significantly greater than all other species.

- Total Chlordane $p<0.001$

White croaker were significantly greater than shiner perch, smoothhound, leopard sharks, and white surf perch.
Striped bass were significantly greater than the two shark species.

- Total Aroclor $p<0.001$

White croaker were significantly greater than all other species.

Rankings of chemical means for species collected throughout the Bay are given in Table 8. Means were ranked in order of their concentrations so lowest rank numbers indicate the species tested with highest chemical concentrations.

B) Differences Between Sites

If a species was significantly different and dropped, analysis of differences between all thirteen sites may not have been possible. Single factor ANOVAs were conducted comparing the following chemical constituents between all possible sites:

- LIPID $p=0.062$

Lipid was not significantly different between sites

- Mercury $p=0.001$

Islais creek was significantly lower than Rodeo and Vallejo.

- Total DDT $p<0.001$

Vallejo was greater than all sites except Point Molate.

- Dieldrin $p<0.001$

Fremont Forebay was significantly greater than Berkeley Pier, San Francisco Pier #7, and Vallejo.
Oakland Inner Harbor was significantly greater than San Francisco Pier #7 and Vallejo.

Table 8. Mean Length, Lipid and Chemical Concentration by species

FISH TYPE	n		leng.	% Lipid	R	Hg (ppm)	R	TTLDDT (ppb)	R	Dieldrin (ppb)	R	TTLCLOR (ppb)	R	TTLARO (ppb)
shiner perch	14	mean	96.3	1.026	2	0.141	5	29.8	3	1.283	3	7.035	3	177.9
		sd		0.397		0.090		16.3		0.753		4.755		87.2
striped bass	9	mean	453.9	0.958	3	0.272	3	36.5	2	1.871	2	11.644	2	157.1
		sd		0.539		0.084		9.9		0.627		4.916		59.0
smoothound	7	mean	607.8	0.333	6	0.597	2	7.1	6	0.049	6	0.824	6	63.9
		sd		0.165		0.203		4.4		0.129		0.962		51.3
leopard sharks	5	mean	994	0.376	5	0.838	1	10.8	4	0.123	5	1.706	4	63.0
		sd		0.108		0.467		9.0		0.275		0.922		30.4
white croaker	25	mean	238	3.266	1	0.184	4	61.1	1	2.433	1	14.913	1	331.6
		sd		1.154		0.105		29.9		1.056		6.850		147.6
white surf perch	3	mean	256.4	0.580	4	0.137	6	8.7	5	0.192	4	1.657	5	94.3
		sd		0.235		0.031		0.8		0.333		0.186		27.3

Table 9. Mean Lipid and Chemical Concentration by site

STATION NAME	n		% Lipid	R	Hg(ppm)	R	TTLDDT(ppb)	R	Dieldrin(ppb)	R	TTLCLOR(ppb)	R	TTLARO(ppb)
Berkeley Pier	63	mean	0.59	3	0.10	13	12.4	13	0.37	10	2.3	8	91.7
		sd			0.03		6.4		0.44		1.4		41.1
Double Rock	35	mean			0.15	8	42.5	7	2.25	1	10.4	3	317.5
		sd			0.12		18.5						
Dumbarton Bridge	35	mean			0.12	10	42.1	8	1.18	7	4.5	6	101.1
		sd			0.04		22.0						
Fremont Forebay	13	mean	0.98	2	0.23	4	34.9	10	2.03	2			146.8
		sd	0.17		0.06		12.7		0.84				74.7
Islais Creek	35	mean			0.17	7	43.3	6	1.75	4	15.7	1	372.7
		sd			0.17		21.4						
Oakland Inner Harbor	63	mean	1.37	1	0.29	3	39.4	9	1.95	3	15.1	2	270.6
		sd			0.11		21.9		0.44		0.5		68.9
Oakland Middle Harbor	35	mean			0.11	12	50.9	3	0.96	9	5.8	4	167.0
		sd			0.02		6.3						
Point Molate	20	mean			0.20	5	61.0	2					
		sd			0.09		6.1						
Richmond Harbor	23	mean	0.30	6	0.11	11	29.4	11	1.31	5	3.6	7	135.0
		sd			0.02		16.2		0.65		2.4		65.3
Rodeo	18	mean	0.46	5	0.29	2	47.3	4	0.00	12	0.9	10	44.3
		sd			0.04		35.0						
San Francisco Pier #7	20	mean	0.58	4	0.17	6	26.2	12	0.19	11	1.7	9	94.3
		sd	0.24		0.08		35.1		0.33		0.2		27.3
San Mateo	35	mean			0.13	9	45.8	5	1.25	6	4.5	5	114.0
		sd			0.09		23.7						
Vallejo	18	mean	0.09	7	0.31	1	104.3	1	1.08	8			129.8
		sd			0.07		46.6						

Chemical concentrations represent mean values of composites. Numbers to the right of each set of values are ranking order (R) for that analyte. Lowest rank numbers indicate stations with the highest chemical concentration. See text for fish composites included in means.

• Total Chlordane $p<0.001$
Oakland Inner Harbor was significantly greater than all sites other than Double Rock.
Double Rock was significantly greater than Berkeley Pier, Richmond, Rodeo, San Francisco Pier #7, and San Mateo Bridge.

• Total Aroclors $p=0.003$
Oakland Inner Harbor was significantly greater than Berkeley Pier and San Francisco Pier #7.We attempted to address total contaminant concentrations at different sites around the Bay. Since not all species were found at all sites, species-specific factors affecting contaminant load had to be isolated. By comparing mean contaminant concentration between species for each of the pesticides and PCBs, significant differences between species could be isolated. For example, the two shark species had significantly greater mercury concentrations than all other species collected. This is probably representative of species-specific physiological or biological processes rather than concentrations specific to the collection site. To evaluate the total contamination of a site, it was necessary to separate these biases. For each contaminant, all fish species were statistically compared. Fishes that were significantly different were excluded from comparisons among sites, and fishes that were not significantly different were pooled. White croaker were excluded from comparisons of lipids, total DDT, dieldrin, total chlordane and total Aroclors among sites. Smoothhound and leopard sharks were excluded from comparisons of mercury, shiner surf perch were excluded from comparisons of lipids, and striped bass were excluded from comparisons of total chlordane. These exclusions were necessary to make comparisons between stations, but holes are left in the data subset. These exclusions make the analysis conservative with the potential of not identifying all the differences among species. Rankings resulting from this limited comparison of stations collected from the Bay are given in Table 9. Missing standard deviations indicate only one sample for that case. Means were ranked in order of their concentrations so lowest rank mean numbers indicate species tested with highest chemical concentrations.

OTHER CHEMICALS
Although arsenic is not currently an analyte given a screening value by the EPA, there should be some mention of arsenic levels found in the tissue of San Francisco Bay sharks. Arsenic, like methylmercury, has a strong potential to biomagnify in the upper trophic levels of the food chain (Suedal *et al.*,1994). Some of the highest reported arsenic values in marine fish are from sharks (4.6 ppm-LeBlanc and Jackson, 1973 & 30 ppm-U.S. Dept. of the Interior, 1988), and may be related to specific feeding behaviors. Levels seen in this study in sharks from San Francisco Bay ranged from 1.08 to 5.95 ppm, with the highest level found in brown smoothhounds from the Central Bay. Arsenic is predominantly present in edible tissue as an organoarsenical, arsenobetaine, which is less toxic than the carcinogenic inorganic forms (U.S. Dept. of the Interior, 1988). Since speciation of arsenic was not attempted for this study there can be no assessment of the organic-inorganic relationship. It should be noted though that

arsenic levels in sharks from the Bay were significantly higher than in the other species collected and deserve attention in this and future tissue contaminant studies.

The PAH analysis done in this study indicates that hydrocarbon levels were near or below method detection limits in all samples measured. The EPA guidance document does not currently recommend a screening value for these compounds. For these reasons, it is not necessary to target this group of chemicals as a special concern at this time. As more quantitative data becomes available concerning carcinogenic risks of individual PAHs, this may need to be revisited.

Although there were a number of chemicals of concern found in fish throughout the Bay, a number of chemicals measured in this study fell below the pilot study screening values and based on the results of this report these chemicals are not a concern for humans consuming fish from the Bay at this time. This is true of cadmium, selenium, endosulfan, endrin, heptaclor epoxide, hexachlorobenzene, mirex, toxaphene and chlorpyrifos. Seemingly low tissue levels observed for these and the remainder of the other analytes, for which there are currently no screening values, should serve as baseline data for future studies and should be reviewed when new screening levels are established by the EPA.

It is useful at this point to add some historical perspective to the impact these study results may have on public perception, monitoring policy and future research. The only long term monitoring program that has been implemented in the bay is the California State Mussel Watch program, which has been in existence for over 15 years. Mussels have been collected from stations at Point Pinole, Treasure Island, Oakland Inner Harbor and Dumbarton Bridge and their tissues measured for a wide range of metal and organic contaminants. Analysis of Mussel Watch data can help put our present findings in perspective. Long term trends measured for DDTs, dieldrin, chlordanes and PCBs indicate that these contaminants have steadily and significantly declined since the beginning of the program (CA. State Mussel Watch Program, 1988, CA. State Mussel Watch Program, 1994, and Stephenson *et al.*, 1994). Chlordane and DDT levels were approximately four times higher in the early 1980s while dieldrin levels were approximately twice as high as currently seen. PCB levels at the same time were four to seven times higher than those currently observed. Mercury levels in mussel tissues have remained at essentially the same level over the duration of the program. Dioxins were not measured by the Mussel Watch Program. This indicates that at least for some of the organic contaminants the water quality in the Bay has been improving. It follows that levels of contaminants in the tissues of species other than mussels, which are also influenced by bioconcentration and biomagnification factors, also would exhibit a corresponding decrease over time. If this is true, the PCB and pesticide levels seen in fish tissues from this study may represent relatively lower levels than those in the past, and can be used to assess any changes or trends we may see in the future.

CONCLUSIONS

The major conclusions of the pilot study are:

1) The EPA guidance document, Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories- Volume 1- Fish Sampling And Analysis (EPA 823-R-93-002, 1993), was an effective tool for designing the pilot study and analyzing data collected from the San Francisco Bay study.

2) Based on calculated pilot study screening values (PS-SVs), six chemicals or chemical groups are identified as potential chemicals of concern in San Francisco Bay. They are PCBs, mercury, dieldrin, total DDT, total chlordane and the dioxin/furans.

3) High levels of the pesticides dieldrin, total DDT and total chlordane were found most often in fish from the North Bay.

4) Levels of PCBs, mercury and the dioxin/furans were found at concentrations exceeding the pilot study screening values throughout the Bay.

5) Fish with high lipid content (croaker and shiner surfperch) in their tissue samples generally exhibited higher organic contaminant levels, with the exception of methyl mercury. Fish with low lipid levels (halibut and shark) generally exhibited lower organic contaminant levels. It should be noted though that skin on/skin off sampling differences may have magnified lipid differences between species in this study.

6) Of the Bay fish collected, white croaker consistently exhibited the highest tissue lipid concentrations. Lipophilic PCBs and pesticides concentrated to the highest levels in the tissue of this fish.

7) Mercury levels were found to be highest in two shark species collected; leopard shark and brown smoothhound shark. Leopard sharks and white croaker exhibited increasing mercury concentration with increasing fish size, suggesting bioaccumulation of this metal in Bay area fish.

8) Vallejo-Mare Island is the sampling location from which fish most often exhibited high levels of chemical contaminants. Oakland Inner Harbor also exhibited a high incidence of tissue contamination.

9) A comprehensive study of the potential chemicals of concern, and accumulation of these chemicals in fish and invertebrate tissues is recommended for the San Francisco Bay area and its tributaries.

Although the study design worked well in meeting the goals of the pilot study, a number of limitations and questions remain to be addressed in a more comprehensive study. When designing future studies, the following limitations in the pilot study data set should be considered:

1) Not all species which are caught and consumed from the Bay were collected in this study. This is particularly apparent with the absence of one of the prioritized species, jacksmelt, from samples collected.

2) Analyses were not performed for all chemicals for which the EPA currently has recommended screening values. Samples were not analyzed for the following eight pesticides: dicofol, lindane, carbophenothion, diazanon, disulfoton, ethion, terbufos and

oxyfluorfen. Due to the costs of the special analytical procedures, and the fact that these pesticides were not found at elevated levels in the southern California or Monterey Bay studies, these chemicals were not analyzed. Future research should evaluate these compounds. Diazanon is used extensively in California's central valley and may deserve particular attention in future studies.
3) Chemical analysis was performed on composites of fish rather than individual fish so the variability of contamination in individual fish can not be addressed.
4) The same number of fish were not used for all composites, with numbers of fish per composite ranging from 3 to 20. The small sample size of fish used to complete some composites may not accurately represent the population.
5) Size classes within species were not the same at all stations. Size differences make age/accumulation relationships difficult to assess.
6) Sampling occurred over a one month period during the spring. This design does not address changing species composition at stations throughout the year or changing contaminant load due to reproductive cycle or other variables.
7) All species of fish were not caught at all stations so rigorous statistical analysis between stations is compromised.
8) Some fish(white croaker and shiner surf perch) were analyzed with skin on while others were analyzed with skin off. Although this is the way these fish are most commonly eaten, it confounds the chemical comparisons between species.

As mentioned earlier, this report was not meant to evaluate the human health risks associated with consumption of particular fish. This question will be addressed in detail by the Office of Environmental Health Hazard Assessment, with input from the Department of Health Services. Recommendations or warnings concerning the consumption of fish caught from San Francisco Bay will be made as a result of that assessment.

SUGGESTED RESEARCH

Results of this study have raised additional questions which were not addressed in the pilot study design. These concerns involve levels of contaminants in species not sampled, seasonality of contaminant loading and additional chemical analysis.

High levels of mercury in sharks points to the need for research into bioaccumulation issues for different age groups and species. This should be expanded to include other elasmobranchs, such as bat rays, which are consumed by some fishing populations. The source of mercury to sharks is also of concern since common food items in the shark's diet such as crabs, shrimp and other fish (Russo, 1975) also are consumed by people. Trophic level transfer of mercury to other higher level marine species also may constitute a concern in the continuing movement of mercury up the food chain. Ebert (1989) found that sevengill sharks, collected in the S.F. Bay, fed heavily on brown smoothhounds. Larger species of shark may bioaccumulate mercury to more extreme levels than the two smaller species which were sampled in this study. This was evident in sharks from Hawaiian waters, weighing over

150 pounds, where mercury levels exceeded 2.5 ppm (Hawaii Dept. of Health, 1992).

Not all species which are caught and consumed from the Bay were collected in this study. Jacksmelt, which were not collected in sufficient numbers to complete a composite, need to be targeted again since this is the most commonly caught fish in San Francisco Bay, with over 10 million pounds reportedly landed in 1992 (CDFG, 1993). As mentioned earlier, there is also a need to measure the other sharks, rays and invertebrates. Considering the variability in contaminant loading for various species seen in this study, it seems clear that an evaluation of additional species which are caught and consumed from the Bay is needed.

Since white croaker were the most consistently contaminated fish from the Bay, additional analysis should be performed with this species. In particular, to assist in comparisons between different Bay species, croaker muscle tissue also should be analyzed with the skin off to eliminate biases created through skin on/skin off lipid differences. Also to better evaluate differences between sites, white croaker of similar size should be collected from all sites in the future.

One aspect of tissue biochemistry not well addressed in this pilot study is the seasonality of contaminant levels. Studies of white croaker in southern California indicate that lipid content of female liver tissue is dependent on the seasonal reproductive cycle (SCCWRP, 1986). Significantly higher levels of DDT and chlordane were found in muscle tissue of white croakers during summer months, while the highest PCB levels were found during winter months (Pollock *et al.*, 1991). This relationship between contaminant body burdens and seasonal lipid variability needs to be better understood when assessing the loading of lipid soluble contaminants such as PCBs and pesticides. A more comprehensive study should include sampling at other times of the year to address this issue.

Of additional interest is the relationship between contaminant levels in organ tissues, such as the liver and gonads, and their lipid content. These organs are very high in lipids and may be reservoirs for lipophilic compounds. Sharks which have extremely high liver lipid levels may concentrate these contaminants in the organs rather than the muscle tissue, thus explaining some of the seemingly low organic contaminant loading in these species. Gonadal tissue analysis would also help identify patterns in seasonal contaminant levels for species such as croaker and surf perch in which tissue lipid levels are influenced by reproductive cycles.

Future studies also should include the analysis for chemicals not measured in this study. This might include additional pesticides of interest, such as diazinon, or other chemicals for which screening values can be developed using EPA guidelines.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR) (1987a) Draft Toxicological Profile for Aldrin/Dieldrin. U.S. Public Health Service, Washington, DC.

Ahlborg U.G., G.C. Becking, L.S. Birnbaum *et al.* (1993) Toxic equivalency factors for dioxin-like PCBs. Report on a WHO_ECEH and IPCSA consulation. Chemosphere 28: 1049-1067, 1994.

Barnes, D.G. and J.S. Bellin (1989) Interim Procedures For Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs). Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, D.C.

California State Mussel Watch Program (1988) Ten Year Data Summary 1977-1987. Water Quality Monitoring Report No. 87-3. Division of Water Quality. State Water Resources Control Board.

California State Mussel Watch Program (1994) 1987-93 Data Report Draft. Water Quality Monitoring Report No. 94-1WQ. State Water Resources Control Board. California Environmental Protection Agency.

Ebert, D. A. (1989) Life history of the sevengill shark, *Notorynchus depedianus* Peron, in two northern California bays. California Fish and Game 75(2): 102-112.

Food and Drug Administration (1994) Mercury in Fish; Cause for Concern?. Judith Faulke, FDA Consumer, Sept. 1994

Forsythe, B.L., F.C. Bailey and S.J. Klaine (1994) Interactive Effect of Selenium and Mercury on Development and Mortality of Brine Shrimp, *Artemia sp.* Society of Environmental Toxicology and Chemistry 15th Annual Meeting.

Hodges, L. (1977) Environmental Pollution. Holt, Rinehart and Winston, New York, NY.

Gunther, A.J., J.A. Davis and D.J.H.Phillips (1987) An Assessment of the Loading of Toxic Contaminants to the San Francisco Bay-Delta, Aquatic Habitat Institute, Richmond, CA.

Hazardous Materials Laboratory (1992) Analysis of Dioxins and Furans; Method 880.

IRIS (Integrated Risk Information System) (1992) U.S. Environmental Protection Agency, Duluth, MN.

LeBlanc, P.J. and A.L. Jackson (1973) Arsenic in Marine Fish and Invertebrates. Marine Pollution Bulletin, 4, 88-90.

Luoma, S.N. and D.J.H. Phillips (1988) distribution, Variability, and Impacts of Trace Elements in San Francisco Bay. Marine Pollution Bulletin, 19(9), 413-425.

NAS (National Academy of Sciences) (1991) Seafood Safety. Committee on Evaluation of the Safety of Fishing Products, National Academy Press, Washington, DC.

NOAA (National Oceanic and Atmospheric Administration) (1989b) Standard analytical procedures of the NOAA National Analytical Facility. 2nd ed. NOAA Tech. Mem. NMFS F/NWC-92, 1985-86. National Status and Trends Program, U.S. Department of Commerce, Rockville, MD.

Nichols F.H., J.E. Cloern, S.N. Luoma and D.H. Peterson (1986) The Modification of an Estuary. Science, 231, 561-573.

Phillips, D.J.H. (1987) Toxic Contaminants In The San Francisco Bay-Delta And Their Possible Effects. Aquatic Habitat Institute.

Pollock, G.A., I.J. Uhuaa, A.M. Fan, J.A. Wisniewski and I. Witheral (1991) A study of Chemical Contamination of Marine Fish from Southern California. II. Comprehensive Study. Office of Environmental Health hazard Assessment. Sacramento, CA

Pollock, G.A., I.J. Uhuaa, A.M. Fan, J.A. Wisniewski and I. Witheral (1992) Monterey Bay Marine Environmental Health Survey, Health Evaluation. Office of Environmental Health hazard Assessment. Sacramento, CA

Russo, R.A. (1975) Observations on the Food Habits of Leopard Sharks (*Triakas semifasciata*) and Brown Smoothhounds (*Mustelus henlei*). Cal. Fish and Game, 61(2):95-103.

SCCWRP (Southern California Coastal Water Research Project) (1986) Annual Report.

Stephenson, M.D., M. Martin and R.S. Tjeerdema (1994) Long-term Trends in DDTs, Polychlorinated Biphenyls and Chlordanes in California Mussels. Archives of Environmental Contamination & Toxicology (in press).

Suedal, B.C., J.A. Boraczek, R.K. Peddicord, P.A. Clifford and T.M. Dillon (1994) Trophic Transfer and Biomagnification Potential of Contaminants in Aquatic Ecosystems. Reviews of Environmental Contamination and Toxicology, 136, 21-89.

Tollefson, Linda (1989) Methylmercury in fish: Assessment of risk for U.S. consumers. In: The Risk Assessment of Environmental and Human Health Hazards : A Textbook of Case Studies. Dennis J. Paustenback (ed.) John Wiley & Sons, New York,NY.

U.S. Department of the Interior, Fish and Wildlife Service (1988) Arsenic Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.12) Contaminant Hazard Reviews Report No. 12

U.S. Environmental Protection Agency (1987d) National Dioxin Study. Tiers 3,5,6 and 7. EPA-440/4-87-003. Office of Water Regulations and Standards, Washington, DC.

U.S. Environmental Protection Agency (1990a) Exposure Factors Handbook. EPA-600/8-89/043. Office of Health and Environmental Assessment. Washington, D.C.

U.S. Environmental Protection Agency (1992) National Study of Chemical Residues in Fish. EPA-823-R-02-008. Office of Science and Technology, Washington, D.C.

U.S. Environmental Protection Agency (1993) Guidance for Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 1. Fish Sampling and Analysis. EPA 823-R-93-002. Office of Water, Washington D.C.

U.S. Environmental Protection Agency (1993c) Workshop Report on Developmental Neurotoxic Effects Associated With Exposure to PCBs. September 14-15, 1992, Research Triangle Park, NC. Risk Assessment Forum, Washington, DC.

U.S. Environmental Protection Agency (1994-draft) Estimating Exposure to Dioxin-Like Compounds. EPA-600/6-88/005Ca. Office of Research and Development, Washington, D.C.

U.S. Food and Drug Administration (1994) Shellfish Sanitation Interpretation: Action Levels for Chemical and Poisonous Substances.

Ware, G.W. (1978) The Pesticide Book. W.H. Freeman and Company, San Francisco, CA.

Worthing, C.R. (1991) The Pesticide Manual: A World Compendium. 9th edition. British Crop Protection Council, Croydon, England.

Zar, J.H. (1984) Biostatistical Analysis Second Edition, Prentice Hall, Englewood Cliffs, New Jersey .

APPENDIX I

ANALYTICAL RESULTS & DATA BASE DESCRIPTION

Analytical Results & Data Base Description

Results from the study are presented here in tabular form: All trace metal chemistry data is presented in units of parts per million (ppm-wet weight). Organic chemistry is presented in units of part per billion (ppb-wet weight). Dioxin and furan data is presented in units of part per trillion (ppt-wet weight). Data is presented in the following sections:

Section I - Sampling Data
Section II - Trace Metal Analysis
Section III - PCB Analysis
Section IV - Pesticide Analysis
Section V - PAH Analysis
Section VI - Dioxin and Furan Analysis
Section VII - Data Base Description

Section I - Sampling Data

IDORG #	STATION NAME	FISH TYPE	STATION	DATE	SAMPLERS	COMP#	SIZE RANGE	MN LENGTH
1234	SAN MATEO BRIDGE	5 White Croaker	24001.0	5/3/94	RF,EJ,KT	1	253-242 mm	250
1235	SAN MATEO BRIDGE	5 White Croaker	24001.0	5/3/94	RF,EJ,KT	2	242-199 mm	224
1236	SAN MATEO BRIDGE	5 White Croaker	24001.0	5/3/94	RF,EJ,KT	3	180-154 mm	172
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	24001.0	5/3/94	RF,EJ,KT	4	136-103 mm	117
1238	DUMBARTON BRIDGE	5 White Croaker	24002.0	5/2/94	RF,EJ,KT	1	286-231 mm	255
1239	DUMBARTON BRIDGE	5 White Croaker	24002.0	5/2/94	RF,EJ,KT	2	230-220 mm	224
1240	DUMBARTON BRIDGE	5 White Croaker	24002.0	5/2/94	RF,EJ,KT	3	201-157 mm	179
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	24002.0	5/2/94	RF,EJ,KT	4	157-102 mm	121
1242	FREMONT FOREBAY	3 Striped Bass	24003.0	5/20/94	RF,EJ,JD,LK	1	445-406 mm	423
1243	FREMONT FOREBAY	3 Striped Bass	24003.0	5/20/94	RF,EJ,JD,LK	2	406-387 mm	396
1244	FREMONT FOREBAY	3 Striped Bass	24003.0	5/20/94	RF,EJ,JD,LK	3	362-356 mm	358
1245	FREMONT FOREBAY	4 Striped Bass	24003.0	5/20/94	RF,EJ,JD,LK	4	381-343 mm	362
1246	RICHMOND HARBOR	20 Shiner Surf Perch	24004.0	5/10/94	RF,EJ	1	121-98 mm (s.l.)	104
1247	RICHMOND HARBOR	20 Shiner Surf Perch	24004.0	5/10/94	RF,EJ	2	96-87 mm (s.l.)	91
1248	RICHMOND HARBOR	20 Shiner Surf Perch	24004.0	5/10/94	RF,EJ	3	87-77 mm (s.l.)	83
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	24004.0	5/10/94	RF,EJ	4	711-559 mm	660
1250	BERKELEY PIER	20 Shiner Surf Perch	24005.0	5/9/94	RF,EJ	1	119-98 mm (s.l.)	108
1251	BERKELEY PIER	20 Shiner Surf Perch	24005.0	5/9/94	RF,EJ	2	97-88 mm (s.l.)	92
1252	BERKELEY PIER	20 Shiner Surf Perch	24005.0	5/9/94	RF,EJ	3	87-77 mm (s.l.)	83
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	24005.0	5/9/94	RF,EJ	4	508-457 mm	483
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	24006.0	5/6/94	RF,EJ	1	119-94 mm (s.l.)	104
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	24006.0	5/6/94	RF,EJ	2	94-87 mm (s.l.)	91
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	24006.0	5/6/94	RF,EJ	3	87-81 mm (s.l.)	83
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	24006.0	5/6/94	RF,EJ	4	469-460 mm	466
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	24007.0	5/4/94	EJ,SL	1	348-227 mm	278
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	24007.0	5/4/94	EJ,SL	2	220-185 mm	202
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	24007.0	5/4/94	EJ,SL	3	184-165 mm	171
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	24007.0	5/4/94	EJ,SL	4	147-105 mm	94
1262	ISLAIS CREEK	5 White Croaker	24008.0	5/4/94	EJ,SL	1	229-202 mm	211
1263	ISLAIS CREEK	5 White Croaker	24008.0	5/4/94	EJ,SL	2	202-192 mm	197
1264	ISLAIS CREEK	5 White Croaker	24008.0	5/4/94	EJ,SL	3	183-161 mm	172
1265	ISLAIS CREEK	20 Shiner Surf Perch	24008.0	5/4/94	EJ,SL	4	116-102 mm	85
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	24009.0	5/5/94	RF,EJ	1	242-217 mm	225
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	24009.0	5/5/94	RF,EJ	2	215-202 mm	209
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	24009.0	5/5/94	RF,EJ	3	200-166 mm	180
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	24009.0	5/5/94	RF,EJ	4	147-98 mm	93
1270	POINT MOLATE	5 White Croaker	24010.0	5/11/94	RF,EJ	1	323-280 mm	297
1271	POINT MOLATE	5 White Croaker	24010.0	5/11/94	RF,EJ	2	279-233 mm	255
1272	POINT MOLATE	5 White Croaker	24010.0	5/11/94	RF,EJ	3	231-179 mm	212
1273	POINT MOLATE	5 Walleye Surf Perch	24010.0	5/11/94	RF,EJ	4	232-195 mm	215
1274	RODEO	5 White Croaker	24011.0	5/12/94	EJ,JD	1	340-300 mm	326
1275	RODEO	5 White Croaker	24011.0	5/12/94	EJ,JD	2	300-282 mm	297
1276	RODEO	5 White Croaker	24011.0	5/12/94	EJ,JD	3	275-270 mm	273
1277	RODEO	3 Leopard Sharks	24011.0	5/12/94	EJ,JD	4	559-470 mm	512
1282	SAN FRANCISCO PIER #7	5 White Croaker	24013.0	5/9/94	RF,EJ	1	305-251 mm	276
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	24013.0	5/9/94	RF,EJ	2	280-264 mm	270
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	24013.0	5/9/94	RF,EJ	3	263-255 mm	260
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	24013.0	5/9/94	RF,EJ	4	250-219 mm	238
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass		5/6/94	RF,EJ	1	501-478 mm	489
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass		5/14/94	EJ,SL	2	486-477 mm	480
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass		6/10/94	EJ,SL,JD	3	686-610 mm	644
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon		6/4/94	EJ,SL,JD	1	1346-1092 mm	1202
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks		5/3/94	RF,EJ	1	1321-1194 mm	1245
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks		5/14/94	RF,EJ	2	813-660 mm	720
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks		5/14/94	RF,EJ	3	584-457 mm	533
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks		5/9/94	RF,EJ	1	1295-1143 mm	1219
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks		5/9/94	RF,EJ	2	711-686 mm	703
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks		5/13/94	RF,EJ	3	711-635 mm	686
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks		5/11/94	RF,EJ	1	1346-1245 mm	1274
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks		5/11/94	RF,EJ	2	711-610 mm	623
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks		5/11/94	RF,EJ	3	584-533 mm	567
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut		5/3/94	RF,EJ	1	953-660 mm	758
1336	VALLEJO-MARE ISLAND	5 White Croaker	24014.0	6/1/94	EJ,SL	1	312-301 mm	307
1337	VALLEJO-MARE ISLAND	5 White Croaker	24014.0	6/1/94	EJ,SL	2	300-277 mm	288
1338	VALLEJO-MARE ISLAND	5 White Croaker	24014.0	6/1/94	EJ,SL	3	282-263 mm	271
1339	VALLEJO-MARE ISLAND	3 Striped Bass	24014.0	6/1/94	EJ,SL	4	514-425 mm	468

Section II - Trace Metal Analysis

IDORG #	STATION NAME	FISH TYPE	% MOIST	ALUMINUM	ARSENIC	CADMIUM	CHROMIUM	COPPER
1234	SAN MATEO BRIDGE	5 White Croaker	70.2	-8	0.775	-8	-8	0.296
1235	SAN MATEO BRIDGE	5 White Croaker	73.7	4.65	0.722	-8	-8	0.273
1236	SAN MATEO BRIDGE	5 White Croaker	72.7	4.76	0.826	-8	-8	0.317
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	78.1	5.70	0.564	0.00219	3.84	0.265
1238	DUMBARTON BRIDGE	5 White Croaker	69.7	-8	0.723	0.00303	9.41	0.0536
1239	DUMBARTON BRIDGE	5 White Croaker	74.2	-8	0.775	0.00361	-8	0.233
1240	DUMBARTON BRIDGE	5 White Croaker	75.2	4.64	0.698	0.00248	-8	0.258
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	78.6	4.71	0.514	-8	4.43	0.332
1242	FREMONT FOREBAY	3 Striped Bass	73.7	-8	0.0788	-8	-8	0.305
1243	FREMONT FOREBAY	3 Striped Bass	73.3	5.82	0.414	-8	-8	0.321
1244	FREMONT FOREBAY	3 Striped Bass	75.8	-8	0.454	-8	-8	0.268
1245	FREMONT FOREBAY	4 Striped Bass	78.4	4.74	0.556	-8	-8	0.205
1246	RICHMOND HARBOR	20 Shiner Surf Perch	77.1	-8	0.490	-8	-8	0.226
1247	RICHMOND HARBOR	20 Shiner Surf Perch	79.0	-8	0.539	-8	10.3	0.420
1248	RICHMOND HARBOR	20 Shiner Surf Perch	77.2	4.77	0.596	0.00228	-8	0.267
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	74.0	-8	2.55	0.00390	0.0884	0.157
1250	BERKELEY PIER	20 Shiner Surf Perch	77.0	-8	0.632	-8	0.0234	0.206
1251	BERKELEY PIER	20 Shiner Surf Perch	75.9	-8	0.554	-8	-8	0.222
1252	BERKELEY PIER	20 Shiner Surf Perch	78.2	-8	0.533	-8	8.21	0.32
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	75.4	-8	2.90	-8	-8	0.169
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	77.6	-8	0.480	-8	4.24	0.251
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	76.6	-8	0.373	-8	-8	0.212
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	75.6	-8	0.584	-8	-8	0.259
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	77.8	-8	0.353	0.00289	-8	0.227
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	71.8	-8	0.823	-8	-8	0.333
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	73.6	5.64	0.609	-8	2.12	0.377
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	70.1	-8	0.784	-8	-8	0.320
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	76.3	-8	0.489	-8	0.0498	0.240
1262	ISLAIS CREEK	5 White Croaker	73.8	-8	0.527	-8	2.3	0.341
1263	ISLAIS CREEK	5 White Croaker	74.9	4.84	0.743	-8	-8	0.369
1264	ISLAIS CREEK	5 White Croaker	73.3	4.76	0.556	-8	-8	0.393
1265	ISLAIS CREEK	20 Shiner Surf Perch	75.1	-8	0.561	-8	-8	0.257
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	73.1	-8	0.716	-8	-8	0.269
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	75.2	-8	0.862	-8	-8	0.226
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	76.7	5.86	0.775	-8	-8	0.216
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	71.6	9.37	0.429	-8	15.8	0.690
1270	POINT MOLATE	5 White Croaker	76.5	4.79	1.22	-8	3.71	0.333
1271	POINT MOLATE	5 White Croaker	80.1	-8	0.878	-8	7.55	0.401
1272	POINT MOLATE	5 White Croaker	74.9	-8	0.74	-8	8.83	0.457
1273	POINT MOLATE	5 Walleye Surf Perch	75.4	-8	0.489	-8	-8	0.119
1274	RODEO	5 White Croaker	76.9	-8	1.10	-8	0.0785	0.242
1275	RODEO	5 White Croaker	75.8	-8	1.01	-8	2.15	0.256
1276	RODEO	5 White Croaker	74.4	-8	1.23	-8	-8	0.169
1277	RODEO	3 Leopard Sharks	72.3	19.7	1.76	-8	-8	0.218
1282	SAN FRANCISCO PIER #7	5 White Croaker	71.6	13.4	1.01	-8	1.82	0.403
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	78.0	-8	0.396	-8	0.0532	0.116
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	78.2	-8	0.283	-8	0.0442	0.134
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	80.0	-8	0.206	-8	-8	0.133
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	72.6	-8	0.313	-8	-8	0.378
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	73.5	-8	0.515	-8	-8	0.589
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	80.7	-8	0.697	-8	-8	0.252
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	70.6	-8	0.842	-8	0.063	0.237
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	75.0	-8	1.32	0.00974	0.802	0.287
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	75.4	-8	3.74	-8	-8	0.233
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	71.4	-8	4.43	0.00314	-8	0.226
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	67.3	-8	1.91	0.00849	-8	0.266
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	69.6	5.20	4.04	0.00486	2.65	0.104
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	73.5	-8	5.95	-8	-8	0.220
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	71.9	-8	1.08	0.00281	2.31	0.164
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	71.9	-8	4.49	-8	-8	0.264
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	73.8	5.34	3.82	0.00340	0.824	0.213
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	72.8	9.13	0.31	-8	-8	0.104
1336	VALLEJO-MARE ISLAND	5 White Croaker	68.1	4.49	0.87	0.00446	5.99	0.0328
1337	VALLEJO-MARE ISLAND	5 White Croaker	69.5	-8	0.832	-8	0.053	0.232
1338	VALLEJO-MARE ISLAND	5 White Croaker	70.3	-8	0.708	-8	-8	0.189
1339	VALLEJO-MARE ISLAND	3 Striped Bass	75.8	-8	0.725	-8	0.142	0.269

S.F. Bay Fish Contaminant Study TM Concentrations (ug/g wet weight)

IDORG #	STATION NAME	FISH TYPE	IRON	LEAD	MANGANESE	MERCURY	SELENIUM	SILVER	TIN
1234	SAN MATEO BRIDGE	5 White Croaker	7.54	-8	0.384	0.264	0.384	-8	-8
1235	SAN MATEO BRIDGE	5 White Croaker	5.57	-8	0.441	0.112	0.278	-8	-8
1236	SAN MATEO BRIDGE	5 White Croaker	5.06	-8	0.451	0.0692	0.426	-8	0.052
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	17.7	-8	0.708	0.0676	0.219	0.00395	0.04
1238	DUMBARTON BRIDGE	5 White Croaker	41.8	-8	1.10	0.175	0.321	-8	0.027
1239	DUMBARTON BRIDGE	5 White Croaker	5.08	-8	0.453	0.113	0.273	-8	-8
1240	DUMBARTON BRIDGE	5 White Croaker	5.56	-8	0.315	0.0825	0.340	-8	-8
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	21.8	0.021	0.831	0.124	0.242	-8	0.039
1242	FREMONT FOREBAY	3 Striped Bass	3.76	-8	0.318	0.150	0.559	-8	-8
1243	FREMONT FOREBAY	3 Striped Bass	4.51	-8	0.329	0.286	0.473	-8	-8
1244	FREMONT FOREBAY	3 Striped Bass	4.37	-8	0.445	0.232	0.534	-8	-8
1245	FREMONT FOREBAY	4 Striped Bass	2.53	-8	0.322	0.245	0.385	-8	0.0390
1246	RICHMOND HARBOR	20 Shiner Surf Perch	4.28	-8	0.375	0.130	0.238	-8	-8
1247	RICHMOND HARBOR	20 Shiner Surf Perch	41.1	-8	1.02	0.109	0.292	0.00378	0.025
1248	RICHMOND HARBOR	20 Shiner Surf Perch	5.07	-8	0.452	0.100	0.219	-8	-8
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	2.55	-8	-8	0.572	0.117	0.00260	-8
1250	BERKELEY PIER	20 Shiner Surf Perch	4.46	-8	0.455	0.133	0.312	-8	-8
1251	BERKELEY PIER	20 Shiner Surf Perch	3.78	-8	0.323	0.0903	0.323	-8	-8
1252	BERKELEY PIER	20 Shiner Surf Perch	34.8	-8	0.823	0.0827	0.253	-8	0.026
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	3.79	-8	-8	0.236	0.231	-8	0.039
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	19.8	-8	0.779	0.420	0.285	-8	-8
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	3.75	-8	0.382	0.206	0.229	-8	-8
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	3.69	-8	0.440	0.197	0.300	-8	-8
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	3.87	-8	-8	0.327	0.289	-8	0.053
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	6.32	-8	-8	0.327	0.372	-8	-8
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	15	-8	0.509	0.0999	0.332	-8	-8
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	4.49	-8	0.326	0.0871	0.353	-8	-8
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	3.68	-8	0.313	0.104	0.187	-8	-8
1262	ISLAIS CREEK	5 White Croaker	15.6	-8	0.692	0.0847	0.315	-8	-8
1263	ISLAIS CREEK	5 White Croaker	6.17	-8	0.454	0.0926	0.351	-8	-8
1264	ISLAIS CREEK	5 White Croaker	7.29	-8	0.767	0.0799	0.358	-8	-8
1265	ISLAIS CREEK	20 Shiner Surf Perch	3.76	-8	0.396	0.0800	0.252	-8	-8
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	5.58	-8	0.391	0.109	0.312	-8	-8
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	6.13	-8	0.452	0.110	0.387	-8	0.04
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	4.98	-8	0.523	0.0800	0.367	-8	-8
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	74.1	-8	2.07	0.124	0.277	-8	-8
1270	POINT MOLATE	5 White Croaker	22	-8	0.706	0.296	0.359	-8	0.052
1271	POINT MOLATE	5 White Croaker	34.4	-8	1.05	0.183	0.409	-8	0.042
1272	POINT MOLATE	5 White Croaker	39.4	-8	1.12	0.111	0.341	-8	0.04
1273	POINT MOLATE	5 Walleye Surf Perch	2.37	-8	0.622	0.0865	0.349	-8	0.0860
1274	RODEO	5 White Croaker	6.74	-8	0.353	0.342	0.554	-8	0.095
1275	RODEO	5 White Croaker	13.0	-8	0.457	0.295	0.483	-8	0.065
1276	RODEO	5 White Croaker	4.91	-8	0.322	0.255	0.478	-8	0.09
1277	RODEO	3 Leopard Sharks	3.13	-8	-8	0.283	0.515	-8	0.091
1282	SAN FRANCISCO PIER #7	5 White Croaker	14.7	-8	0.644	0.289	0.502	-8	-8
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	2.46	-8	0.585	0.162	0.273	-8	0.04
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	1.85	-8	0.390	0.146	0.312	0.00523	-8
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	1.81	-8	0.380	0.102	0.278	0.00260	0.0500
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	4.91	-8	-8	0.444	0.414	-8	-8
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	3.71	-8	-8	0.202	0.300	-8	-8
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	3.6	-8	-8	0.257	0.263	-8	-8
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	3.59	-8	0.315	0.245	1.04	-8	-8
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	7.74	-8	0.375	1.24	0.0874	-8	-8
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	3.07	-8	0.322	0.398	nd	-8	-8
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	3.03	-8	-8	0.529	nd	-8	-8
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	5.03	-8	-8	1.01	nd	-8	-8
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	15.1	-8	0.392	0.617	0.149	-8	-8
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	3.31	-8	-8	0.820	0.157	-8	-8
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	16.4	-8	0.475	1.26	0.155	-8	-8
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	3.31	-8	-8	0.845	0.289	-8	-8
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	6.41	-8	0.332	0.562	0.165	-8	-8
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	1.98	-8	-8	0.197	0.196	-8	-8
1336	VALLEJO-MARE ISLAND	5 White Croaker	30.5	-8	0.876	0.414	0.398	-8	-8
1337	VALLEJO-MARE ISLAND	5 White Croaker	5.36	-8	0.347	0.280	0.381	-8	-8
1338	VALLEJO-MARE ISLAND	5 White Croaker	4.46	-8	0.330	0.255	0.348	-8	-8
1339	VALLEJO-MARE ISLAND	3 Striped Bass	5.21	0.027	0.337	0.308	0.298	-8	-8

IDORG #	STATION NAME	FISH TYPE	ZINC	TMDATAQC
1234	SAN MATEO BRIDGE	5 White Croaker	6.08	-4
1235	SAN MATEO BRIDGE	5 White Croaker	5.07	-4
1236	SAN MATEO BRIDGE	5 White Croaker	5.66	-4
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	8.47	-4
1238	DUMBARTON BRIDGE	5 White Croaker	5.66	-4
1239	DUMBARTON BRIDGE	5 White Croaker	5.20	-4
1240	DUMBARTON BRIDGE	5 White Croaker	5.99	-4
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	9.80	-4
1242	FREMONT FOREBAY	3 Striped Bass	5.59	-4
1243	FREMONT FOREBAY	3 Striped Bass	4.81	-4
1244	FREMONT FOREBAY	3 Striped Bass	5.12	-4
1245	FREMONT FOREBAY	4 Striped Bass	4.70	-4
1246	RICHMOND HARBOR	20 Shiner Surf Perch	11.9	-4
1247	RICHMOND HARBOR	20 Shiner Surf Perch	11.6	-4
1248	RICHMOND HARBOR	20 Shiner Surf Perch	11.3	-4
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	4.26	-4
1250	BERKELEY PIER	20 Shiner Surf Perch	12.3	-4
1251	BERKELEY PIER	20 Shiner Surf Perch	12.2	-4
1252	BERKELEY PIER	20 Shiner Surf Perch	10.2	-4
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	5.63	-4
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	12.3	-4
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	8.86	-4
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	11.0	-4
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	4.80	-4
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	7.53	-4
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	5.11	-4
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	5.75	-4
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	10.5	-4
1262	ISLAIS CREEK	5 White Croaker	4.93	-4
1263	ISLAIS CREEK	5 White Croaker	6.55	-4
1264	ISLAIS CREEK	5 White Croaker	6.44	-4
1265	ISLAIS CREEK	20 Shiner Surf Perch	11.8	-4
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	4.36	-4
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	5.79	-4
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	5.12	-4
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	12.7	-4
1270	POINT MOLATE	5 White Croaker	6.45	-4
1271	POINT MOLATE	5 White Croaker	4.43	-4
1272	POINT MOLATE	5 White Croaker	5.14	-4
1273	POINT MOLATE	5 Walleye Surf Perch	7.67	-4
1274	RODEO	5 White Croaker	5.93	-4
1275	RODEO	5 White Croaker	4.37	-4
1276	RODEO	5 White Croaker	5.06	-4
1277	RODEO	3 Leopard Sharks	6.65	-4
1282	SAN FRANCISCO PIER #7	5 White Croaker	7.21	-4
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	7.26	-4
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	7.26	-4
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	6.36	-4
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	6.50	-4
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	4.35	-4
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	2.81	-4
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	4.24	-4
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	5.59	-4
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	5.06	-4
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	5.00	-4
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	4.87	-4
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	4.86	-4
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	5.82	-4
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	6.52	-4
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	4.38	-4
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	4.24	-4
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	3.64	-4
1336	VALLEJO-MARE ISLAND	5 White Croaker	5.74	-4
1337	VALLEJO-MARE ISLAND	5 White Croaker	7.37	-4
1338	VALLEJO-MARE ISLAND	5 White Croaker	4.94	-4
1339	VALLEJO-MARE ISLAND	3 Striped Bass	5.04	-4

Section III - PCB Analysis

IDORG #	STATION NAME	FISH TYPE	PCB5	PCB8	PCB15	PCB18	PCB27	PCB28	PCB29	PCB31	PCB44
1234	SAN MATEO BRIDGE	5 White Croaker	-8	-8	-8	0.614	-8	0.631	-8	1.751	1.028
1235	SAN MATEO BRIDGE	5 White Croaker	-8	2.282	-8	3.519	-8	-8	-8	7.712	0.822
1236	SAN MATEO BRIDGE	5 White Croaker	0.605	-8	-8	-8	-8	0.557	-8	-8	0.609
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	-8	-8	-8	-8	-8	-8	-8	0.808	-8
1238	DUMBARTON BRIDGE	5 White Croaker	-8	-8	-8	1.093	-8	1.1	-8	1.427	1.748
1239	DUMBARTON BRIDGE	5 White Croaker	-8	-8	-8	0.825	-8	0.519	-8	1.364	0.698
1240	DUMBARTON BRIDGE	5 White Croaker	0.557	-8	-8	0.813	-8	0.424	-8	1.983	0.547
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	-8	-8	-8	-8	-8	-8	-8	-8	-8
1242	FREMONT FOREBAY	3 Striped Bass	-8	-8	-8	1.132	-8	0.83	-8	2.948	3.136
1243	FREMONT FOREBAY	3 Striped Bass	-8	-8	-8	1.093	-8	1.509	0.66	3.731	1.797
1244	FREMONT FOREBAY	3 Striped Bass	-8	-8	-8	-8	-8	0.561	-8	2.337	1.117
1245	FREMONT FOREBAY	4 Striped Bass	-8	-8	-8	-8	-8	0.289	-8	-8	0.317
1246	RICHMOND HARBOR	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.885	-8	0.994	1.451
1247	RICHMOND HARBOR	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.508	-8	1.092	1.112
1248	RICHMOND HARBOR	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.681	-8	1.553	1.562
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1250	BERKELEY PIER	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.208	-8	0.644	0.549
1251	BERKELEY PIER	20 Shiner Surf Perch	-8	-8	-8	-8	-8	-8	-8	-8	-8
1252	BERKELEY PIER	20 Shiner Surf Perch	-8	-8	-8	-8	-8	-8	-8	-8	-8
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.83	-8	1.493	1.275
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.717	-8	1.746	0.974
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.556	-8	2.38	0.903
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	-8	-8	-8	-8	-8	0.706	-8	1.81	0.519
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	-8	-8	-8	0.693	-8	0.796	-8	4.039	2.271
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	-8	4.103	-8	-8	-8	0.571	-8	0.735	1.028
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	0.783	-8	-8	1.619	-8	0.798	-8	1.381	1.062
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.378	-8	1.85	1.029
1262	ISLAIS CREEK	5 White Croaker	-8	-8	-8	1.579	-8	3.385	-8	2.577	3.101
1263	ISLAIS CREEK	5 White Croaker	-8	-8	-8	-8	-8	0.334	-8	1.949	0.699
1264	ISLAIS CREEK	5 White Croaker	-8	-8	-8	-8	-8	0.21	-8	-8	0.727
1265	ISLAIS CREEK	20 Shiner Surf Perch	-8	-8	-8	-8	-8	0.29	-8	1.707	0.511
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	-8	-8	-8	-8	-8	0.781	-8	1.845	1.652
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	-8	-8	-8	2.254	-8	0.663	-8	3.868	1.494
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	-8	-8	-8	0.988	-8	0.53	-8	1.532	1.481
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	-8	-8	-8	1.449	-8	0.318	-8	1.485	0.412
1270	POINT MOLATE	5 White Croaker	-8	-8	-8	-8	-8	-8	-8	-8	0.801
1271	POINT MOLATE	5 White Croaker	-8	-8	-8	0.756	-8	0.266	-8	-8	0.902
1272	POINT MOLATE	5 White Croaker	-8	-8	-8	-8	-8	0.342	-8	0.611	0.717
1273	POINT MOLATE	5 Walleye Surf Perch	-8	-8	-8	-8	-8	-8	-8	-8	-8
1274	RODEO	5 White Croaker	-8	-8	-8	-8	-8	-8	-8	-8	0.883
1275	RODEO	5 White Croaker	-8	-8	-8	0.848	-8	-8	-8	-8	0.351
1276	RODEO	5 White Croaker	-8	-8	-8	-8	-8	-8	-8	0.353	0.833
1277	RODEO	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1282	SAN FRANCISCO PIER #7	5 White Croaker	-8	-8	-8	-8	-8	0.525	-8	1.106	1.595
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	-8	-8	-8	0.533	-8	-8	-8	-8	-8
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	-8	-8	-8	-8	-8	0.255	-8	0.429	-8
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	-8	-8	-8	-8	-8	-8	-8	-8	-8
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	-8	-8	-8	-8	-8	0.491	-8	0.796	0.869
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	-8	1.764	-8	-8	-8	0.234	-8	-8	0.517
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	-8	-8	-8	0.465	-8	0.208	-8	-8	0.547
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	-8	-8	-8	1.127	-8	-8	-8	-8	0.456
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	-8
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	-8	-8	-8	-8	-8	-8	-8	-8	-8
1336	VALLEJO-MARE ISLAND	5 White Croaker	-8	-8	-8	-8	-8	0.47	-8	1.5	1.671
1337	VALLEJO-MARE ISLAND	5 White Croaker	-8	-8	-8	-8	-8	0.293	-8	1.297	1.378
1338	VALLEJO-MARE ISLAND	5 White Croaker	-8	-8	-8	-8	-8	0.377	-8	1.364	0.956
1339	VALLEJO-MARE ISLAND	3 Striped Bass	-8	-8	-8	-8	-8	0.228	-8	-8	0.59

IDORG #	STATION NAME	FISH TYPE	PCB49	PCB52	PCB66	PCB70	PCB74	PCB87	PCB95	PCB97	PCB99
1234	SAN MATEO BRIDGE	5 White Croaker	1.499	2.737	3.403	0.797	1.166	2.03	10.14	2.688	10.04
1235	SAN MATEO BRIDGE	5 White Croaker	0.631	2.506	3.88	0.899	1.827	2.434	9.905	2.868	9.953
1236	SAN MATEO BRIDGE	5 White Croaker	-8	2.06	2.275	0.846	1.101	1.431	6.259	1.911	5.858
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	-8	0.798	0.746	-8	0.464	0.898	4.38	0.432	2.56
1238	DUMBARTON BRIDGE	5 White Croaker	2.674	4.33	4.732	1.706	2.011	3.36	12.66	3.336	11.03
1239	DUMBARTON BRIDGE	5 White Croaker	0.514	1.661	2.239	0.623	0.8	1.113	5.574	1.552	5.076
1240	DUMBARTON BRIDGE	5 White Croaker	0.497	2.154	2.462	0.991	1.092	1.408	6.175	1.659	5.472
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	-8	0.619	0.609	-8	0.356	-8	1.345	0.26	2.003
1242	FREMONT FOREBAY	3 Striped Bass	1.302	2.092	2.499	1.238	1.408	0.898	2.712	1.224	3.207
1243	FREMONT FOREBAY	3 Striped Bass	2.133	3.795	3.838	2.358	1.805	1.702	5.553	1.977	5.317
1244	FREMONT FOREBAY	3 Striped Bass	1.117	1.994	2.938	1.638	1.683	0.953	3.05	1.166	3.495
1245	FREMONT FOREBAY	4 Striped Bass	0.37	0.825	0.867	-8	0.342	0.225	1.363	0.351	1.271
1246	RICHMOND HARBOR	20 Shiner Surf Perch	1.797	3.923	2.858	2.914	2.148	2.111	5.268	1.313	6.426
1247	RICHMOND HARBOR	20 Shiner Surf Perch	1.157	2.991	2.066	2.184	1.541	1.602	4.133	0.941	4.782
1248	RICHMOND HARBOR	20 Shiner Surf Perch	0.751	3.999	2.243	2.201	1.741	2.006	5.417	1.437	5.565
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	-8	0.365	-8	-8	-8	-8	-8	0.548
1250	BERKELEY PIER	20 Shiner Surf Perch	0.335	1.064	1.045	0.745	0.616	0.436	2.676	0.396	3.151
1251	BERKELEY PIER	20 Shiner Surf Perch	-8	0.613	0.334	0.432	0.304	0.703	1.5	-8	1.891
1252	BERKELEY PIER	20 Shiner Surf Perch	-8	0.649	0.386	0.361	0.365	-8	1.472	-8	2.087
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.57
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	2.716	5.344	3.031	2.19	1.945	3.066	8.077	1.84	10.67
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	1.93	3.652	2.289	1.323	1.294	2.043	5.922	1.587	7.227
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	0.895	3.529	2.401	1.547	1.354	2.023	9.357	1.562	7.059
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	0.531	2.887	2.838	0.822	1.247	1.829	6.623	1.943	6.938
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	3.155	5.401	3.8	3.035	1.647	5.832	20.77	5.043	15.3
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	1.268	3.552	2.36	0.706	0.856	1.149	7.853	1.76	5.515
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	1.375	2.681	2.575	0.864	1.064	1.509	8.427	2.041	6.256
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	1.175	3.079	1.725	2.446	1.144	3.342	9.413	1.8	8.474
1262	ISLAIS CREEK	5 White Croaker	2.796	5.045	5.023	2.839	2.184	2.075	8.627	2.228	6.137
1263	ISLAIS CREEK	5 White Croaker	0.65	2.233	2.2	1.042	0.961	1.651	8.437	1.717	4.67
1264	ISLAIS CREEK	5 White Croaker	0.507	1.507	1.411	0.459	0.574	0.803	4.276	1.004	3.27
1265	ISLAIS CREEK	20 Shiner Surf Perch	-8	1.288	0.959	0.388	0.596	0.626	2.444	0.429	2.485
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	1.7	4.015	3.971	2.457	1.757	2.655	10.25	2.984	7.986
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	1.545	3.713	3.448	2.013	1.456	2.652	9.967	2.917	7.293
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	1.8	3.24	3.517	2.265	1.574	3.124	10.21	2.8	7.706
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	0.427	1.571	0.996	-8	0.72	0.994	2.465	0.69	3.28
1270	POINT MOLATE	5 White Croaker	0.993	1.549	1.818	0.801	0.683	1.286	5.768	1.431	4.993
1271	POINT MOLATE	5 White Croaker	1.046	2.156	2.17	0.815	0.813	1.765	6.691	1.955	6.291
1272	POINT MOLATE	5 White Croaker	0.747	1.332	1.64	0.97	0.721	1.408	5.047	1.323	4.505
1273	POINT MOLATE	5 Walleye Surf Perch	0.261	0.617	0.343	-8	-8	-8	1.038	-8	1.078
1274	RODEO	5 White Croaker	1.079	2.035	2.092	0.715	0.783	1.174	6.487	1.866	6.418
1275	RODEO	5 White Croaker	0.457	1.052	1.212	-8	0.354	0.746	3.232	1.053	4.429
1276	RODEO	5 White Croaker	0.929	1.455	2.652	0.708	0.984	2.28	7.584	2.017	9.031
1277	RODEO	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.538
1282	SAN FRANCISCO PIER #7	5 White Croaker	1.874	3.044	3.499	1.72	1.479	3.249	12.18	3.113	12.45
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	0.245	1.091	0.575	0.617	0.444	0.273	0.643	-8	2.241
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	0.409	1.13	0.737	0.906	0.603	0.637	0.892	-8	2.794
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	0.289	0.828	0.39	-8	0.318	0.262	0.582	-8	1.6
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	1.371	2.354	2.123	0.572	0.796	0.997	5.038	1.606	5.126
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	0.555	1.03	1.081	0.515	0.3	0.934	2.785	0.793	2.048
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	0.585	1.397	1.303	-8	0.469	0.774	3.553	1.325	3.812
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	0.287	1.098	0.704	-8	0.226	0.205	2.216	0.23	1.855
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.699
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.663
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.337
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	-8	-8	-8	-8	-8	-8	-8	-8	2.035
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.266
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	0.68
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	-8	-8	0.508	-8	-8	-8	-8	-8	1.18
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	-8	1.756
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	-8	-8	-8	-8	-8	-8	-8	0.593	2.57
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	-8	-8	-8	-8	-8	-8	0.553	-8	0.974
1336	VALLEJO-MARE ISLAND	5 White Croaker	2.28	4.036	4.583	1.658	1.564	2.918	12.93	3.466	12.77
1337	VALLEJO-MARE ISLAND	5 White Croaker	1.8	2.762	3.576	1.265	1.191	3.28	11.94	2.885	11.86
1338	VALLEJO-MARE ISLAND	5 White Croaker	1.167	2.167	2.474	0.689	0.745	1.167	6.557	1.727	6.245
1339	VALLEJO-MARE ISLAND	3 Striped Bass	0.568	1.501	1.479	0.902	0.406	0.857	2.383	1.208	2.941

S.F. Bay Fish Contaminant Study PCB Analysis (ppb-ng/g)

IDORG #	STATION NAME	FISH TYPE	PCB101	PCB105	PCB110	PCB118	PCB128	PCB132	PCB137	PCB138
1234	SAN MATEO BRIDGE	5 White Croaker	14.327	3.403	10.752	12.873	4.044	5.376	0.905	25.893
1235	SAN MATEO BRIDGE	5 White Croaker	15.087	3.446	10.291	13.279	4.507	5.085	0.86	27.233
1236	SAN MATEO BRIDGE	5 White Croaker	8.385	1.757	6.448	7.251	2.296	3.449	0.404	14 574
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	4.12	1.078	2.06	3.68	0.854	0.73	0.254	6.52
1238	DUMBARTON BRIDGE	5 White Croaker	16.515	4.685	13.344	14.835	4.377	5.134	0.963	24.843
1239	DUMBARTON BRIDGE	5 White Croaker	7.365	1.799	5.325	6.526	1.885	2.583	0.381	11.942
1240	DUMBARTON BRIDGE	5 White Croaker	9.011	2.086	6.652	7.63	2.337	3.464	0.547	15.186
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	3.005	0.865	1.641	2.8	0.717	0.576	-8	5.498
1242	FREMONT FOREBAY	3 Striped Bass	4.763	1.299	5.093	3.961	0.969	1.005	-8	6.249
1243	FREMONT FOREBAY	3 Striped Bass	8.812	2.487	7.633	6.325	1.825	1.96	0.459	9.905
1244	FREMONT FOREBAY	3 Striped Bass	5.387	1.99	4.363	5.276	1.382	1.206	0.247	8.303
1245	FREMONT FOREBAY	4 Striped Bass	2.079	0.697	1.818	1.875	0.542	0.619	-8	2.998
1246	RICHMOND HARBOR	20 Shiner Surf Perch	10.237	3.512	7.79	9.602	1.696	1.055	0.56	10.069
1247	RICHMOND HARBOR	20 Shiner Surf Perch	7.301	2.814	6.101	8.069	1.429	0.968	0.612	8.207
1248	RICHMOND HARBOR	20 Shiner Surf Perch	8.951	3.47	7.872	8.993	1.513	1.162	0.592	8.845
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	-8	-8	1.071	0.285	-8	-8	1.654
1250	BERKELEY PIER	20 Shiner Surf Perch	4.638	1.391	2.478	4.222	1.08	0.65	0.406	7.809
1251	BERKELEY PIER	20 Shiner Surf Perch	2.553	0.921	1.42	2.435	0.597	0.438	0.21	4.635
1252	BERKELEY PIER	20 Shiner Surf Perch	2.828	1.026	1.517	2.789	0.618	0.431	0.213	4.797
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	0.623	-8	0.392	0.967	0.36	-8	-8	1.911
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	18.571	4.503	9.145	15.593	3.154	2.172	0.872	25.229
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	12.998	3.311	7.492	11.049	2.138	1.833	0.609	16.158
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	12.558	3.304	8.208	10.691	2.031	1.98	0.583	16.047
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	12.712	3.033	8.03	10.189	2.353	2.397	0.56	15.332
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	27.485	5.354	20.841	19.861	6.764	11.998	1.121	42.781
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	8.978	2.157	6.684	6.861	2.36	3.309	0.525	14.604
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	10.363	2.405	7.448	8.065	2.575	3.852	0.498	16.471
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	15.943	3.604	8.911	11.968	3.32	3.625	0.57	24.461
1262	ISLAIS CREEK	5 White Croaker	11.029	2.73	8.146	8.19	2.11	3.494	0.574	14.567
1263	ISLAIS CREEK	5 White Croaker	8.189	1.712	6.159	6.678	1.807	2.888	0.521	12.092
1264	ISLAIS CREEK	5 White Croaker	5.68	1.402	4.213	4.548	1.163	1.958	0.319	7.378
1265	ISLAIS CREEK	20 Shiner Surf Perch	4.252	1.097	2.711	3.163	0.682	0.963	-8	5.874
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	13.164	2.699	10.641	10.092	3.313	4.585	0.838	19.483
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	13.304	2.343	9.812	10.122	3.028	4.928	0.785	17.857
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	13.213	2.615	11.153	10.853	3.378	5.021	0.639	19.692
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	5.089	1.455	1.024	5.189	1.163	0.793	0.366	7.853
1270	POINT MOLATE	5 White Croaker	7.948	1.918	6.073	6.542	2.425	2.609	0.465	15.244
1271	POINT MOLATE	5 White Croaker	9.636	2.226	6.809	8.105	2.733	3.322	0.61	16.61
1272	POINT MOLATE	5 White Croaker	7.169	1.696	5.177	6.606	2.318	2.383	0.503	13.299
1273	POINT MOLATE	5 Walleye Surf Perch	1.451	0.491	0.914	1.485	0.399	0.321	-8	2.475
1274	RODEO	5 White Croaker	9.423	2.299	6.578	7.875	2.64	3.186	0.717	16.387
1275	RODEO	5 White Croaker	6.447	1.676	3.899	5.968	2.052	1.967	0.508	12.962
1276	RODEO	5 White Croaker	12.319	3.441	8.527	12.823	4.428	4.231	0.918	27.4
1277	RODEO	3 Leopard Sharks	-8	0.281	-8	0.992	0.315	-8	-8	2.313
1282	SAN FRANCISCO PIER #7	5 White Croaker	18.585	5.407	14.95	17.949	6.066	6.43	1.327	34.307
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	2.347	1.366	0.977	3.805	0.626	-8	0.353	5.031
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	3.752	2.176	0.782	5.848	1.094	-8	0.391	7.325
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	2.105	0.871	0.654	2.518	0.502	-8	-8	3.426
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	8.602	2.332	6.248	7.282	1.687	1.998	0.433	11.044
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	3.58	0.796	3.136	2.714	0.718	1.252	-8	4.797
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	6.247	1.731	4.451	5.429	2.076	1.928	0.457	11.537
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	2.483	0.642	4.042	1.303	0.886	0.932	-8	4.843
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	-8	-8	-8	0.924	0.263	-8	-8	2.809
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	0.249	-8	1.168	0.258	-8	-8	2.596
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	-8	-8	-8	0.567	-8	-8	-8	0.994
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	-8	0.547	-8	3.004	0.486	-8	0.297	8.721
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	-8	-8	-8	0.613	0.225	-8	-8	1.311
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	-8	-8	-8	1.03	0.472	-8	-8	3.12
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	-8	0.39	-8	1.686	0.508	-8	-8	3.915
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	0.685	0.424	0.536	2.533	0.882	-8	0.382	6.622
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	1.801	0.771	1.892	4.21	1.49	-8	0.415	8.359
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	1.44	0.487	0.904	1.391	0.37	0.246	-8	2.649
1336	VALLEJO-MARE ISLAND	5 White Croaker	17.146	4.309	13.178	16.028	5.016	5.814	1.213	30.324
1337	VALLEJO-MARE ISLAND	5 White Croaker	18.643	3.995	12.897	15.388	5.992	7.768	1.068	37.483
1338	VALLEJO-MARE ISLAND	5 White Croaker	8.311	2.267	6.606	7.807	2.618	2.978	0.658	15.925
1339	VALLEJO-MARE ISLAND	3 Striped Bass -	4.867	1.342	4.276	4.157	1.284	1.136	0.345	7.014

IDORG #	STATION NAME	FISH TYPE	PCB149	PCB151	PCB153	PCB156	PCB157	PCB158	PCB170	PCB174
1234	SAN MATEO BRIDGE	5 White Croaker	19.038	7.225	46.361	1.78	1.487	3.181	8.952	4.981
1235	SAN MATEO BRIDGE	5 White Croaker	18.967	6.603	42.657	1.424	1.448	3.133	6.965	4.941
1236	SAN MATEO BRIDGE	5 White Croaker	11.078	3.614	22.226	0.694	0.673	1.727	4.039	2.433
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	2.72	1.9	13.28	0.562	0.39	0.808	2.2	0.346
1238	DUMBARTON BRIDGE	5 White Croaker	17.958	6.152	42.351	2.063	1.472	3.052	6.199	4.495
1239	DUMBARTON BRIDGE	5 White Croaker	9.109	3.082	21.278	0.678	0.603	1.477	4.124	2.515
1240	DUMBARTON BRIDGE	5 White Croaker	11.521	3.891	24.849	0.991	0.68	1.825	3.64	2.786
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	2.024	1.421	10.445	0.435	0.225	0.67	1.578	-8
1242	FREMONT FOREBAY	3 Striped Bass	3.631	1.273	11.083	0.556	-8	0.67	1.804	0.745
1243	FREMONT FOREBAY	3 Striped Bass	7.461	2.659	17.731	1.053	0.551	1.312	2.187	1.445
1244	FREMONT FOREBAY	3 Striped Bass	4.586	1.434	12.176	1.563	0.45	0.979	1.621	0.819
1245	FREMONT FOREBAY	4 Striped Bass	2.317	0.857	6.314	-8	-8	0.313	0.77	0.48
1246	RICHMOND HARBOR	20 Shiner Surf Perch	3.026	1.705	14.757	1.154	0.467	1.349	1.831	-8
1247	RICHMOND HARBOR	20 Shiner Surf Perch	2.578	1.364	11.631	1.069	0.378	1.13	1.429	-8
1248	RICHMOND HARBOR	20 Shiner Surf Perch	3.47	1.566	13.056	1.242	0.466	1.198	1.657	0.284
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	-8	3.673	-8	-8	0.254	0.568	-8
1250	BERKELEY PIER	20 Shiner Surf Perch	2.715	2.081	14.746	0.739	0.517	0.898	2.696	0.313
1251	BERKELEY PIER	20 Shiner Surf Perch	1.687	1.202	8.799	0.473	0.318	0.593	1.907	-8
1252	BERKELEY PIER	20 Shiner Surf Perch	1.622	1.322	9.048	0.603	0.306	0.62	1.695	-8
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	0.632	-8	4.149	-8	-8	0.241	0.583	-8
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	9.233	5.764	42.924	2.[illegible]2	1.822	3.048	7.288	0.867
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	7.19	3.387	26.488	1.538	1.13	2.081	4.579	0.878
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	7.223	3.632	26.471	1.648	1.196	2.114	4.391	0.864
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	10.383	3.275	22.61	0.856	0.997	1.951	3.954	1.803
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	37.284	13.934	87.474	3.513	2.749	5.33	16.013	7.505
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	11.802	4.015	25.59	1.335	0.966	1.754	5.581	3.64
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	13.045	4.384	27.664	1.426	0.828	1.93	5.448	3.554
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	13.235	6.639	41.278	2.337	1.055	3.014	8.146	1.594
1262	ISLAIS CREEK	5 White Croaker	12.274	4.215	25.99	1.374	0.791	1.797	5.788	3.778
1263	ISLAIS CREEK	5 White Croaker	10.784	3.61	21.364	0.866	0.715	1.581	4.647	2.865
1264	ISLAIS CREEK	5 White Croaker	6.56	2.264	13.917	0.69	0.425	1.046	2.704	1.794
1265	ISLAIS CREEK	20 Shiner Surf Perch	3.266	1.801	11.194	0.394	0.327	0.789	2.259	0.448
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	16.828	5.661	30.716	0.873	1.455	2.413	5.99	4.256
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	17.105	5.503	29.393	1.646	1.222	2.387	5.834	4.597
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	16.406	5.484	31.702	1.555	1.125	2.279	5.068	3.633
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	2.823	1.763	12.147	0.441	-8	1.101	1.962	0.334
1270	POINT MOLATE	5 White Croaker	11.148	4.035	30.366	1.586	1.747	1.594	6.032	2.751
1271	POINT MOLATE	5 White Croaker	13.217	4.948	29.686	0.589	1.107	1.92	4.877	3.228
1272	POINT MOLATE	5 White Croaker	9.487	3.119	22.526	1.215	0.901	1.393	3.726	2.134
1273	POINT MOLATE	5 Walleye Surf Perch	1.531	0.693	5.03	-8	-8	0.331	0.541	-8
1274	RODEO	5 White Croaker	12.632	4.848	32.547	1.773	1.293	1.944	4.506	2.822
1275	RODEO	5 White Croaker	8.618	3.506	26.676	0.652	0.744	1.536	4.514	2.069
1276	RODEO	5 White Croaker	16.944	6.905	53.704	2.122	1.708	3.091	7.869	4.209
1277	RODEO	3 Leopard Sharks	-8	-8	4.691	-8	-8	0.274	0.707	-8
1282	SAN FRANCISCO PIER #7	5 White Croaker	23.629	9.179	69.069	4.067	2.772	4.067	13.973	6.861
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	0.461	0.765	9.344	0.748	0.22	0.602	1.503	-8
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	0.493	0.834	10.339	1.23	0.343	0.906	1.485	-8
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	0.491	0.588	6.254	0.287	-8	0.452	0.875	-8
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	8.162	2.794	21.296	1.047	0.766	1.399	3.63	1.729
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	4.961	1.619	10.975	0.36	0.307	0.629	1.792	1.287
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	8.283	3.154	22.156	0.509	0.711	1.347	4.172	1.996
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	4.001	1.488	10.917	0.616	0.484	0.591	0.7	0.302
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	-8	-8	4.94	0.233	-8	0.247	1.04	-8
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	-8	5.334	-8	-8	0.29	0.866	-8
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	-8	-8	2.617	-8	-8	-8	0.378	-8
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	-8	-8	19.38	0.391	0.289	0.766	4.361	-8
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	-8	-8	2.757	-8	-8	-8	0.431	-8
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	-8	-8	6.14	-8	-8	0.306	0.982	-8
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	-8	-8	7.112	0.271	-8	0.399	1.167	-8
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	0.666	-8	15.549	0.436	0.276	0.754	2.387	-8
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	0.882	-8	17.67	0.506	0.326	1.077	2.793	-8
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	1.491	0.669	5.554	0.248	-8	0.335	0.929	0.288
1336	VALLEJO-MARE ISLAND	5 White Croaker	23.712	9.439	58.596	0.96	2.177	3.625	10.967	4.993
1337	VALLEJO-MARE ISLAND	5 White Croaker	28.112	11.861	74.72	4.192	2.713	4.932	15.092	7.941
1338	VALLEJO-MARE ISLAND	5 White Croaker	11.722	4.66	29.304	0.673	1.153	1.847	4.131	2.344
1339	VALLEJO-MARE ISLAND	3 Striped Bass	4.833	1.876	13.588	-8	0.544	0.794	1.96	0.919

IDORG #	STATION NAME	FISH TYPE	PCB177	PCB180	PCB183	PCB187	PCB189	PCB194	PCB195	PCB201
1234	SAN MATEO BRIDGE	5 White Croaker	10.209	28.852	8.088	21.676	-8	3.995	1.194	5.203
1235	SAN MATEO BRIDGE	5 White Croaker	7.471	21.714	7.688	20.34	-8	3.591	1.123	4.555
1236	SAN MATEO BRIDGE	5 White Croaker	7.96	9.991	3.637	10.369	-8	1.755	0.446	2.121
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	2.6	6.64	1.832	4.98	-8	0.688	-8	0.87
1238	DUMBARTON BRIDGE	5 White Croaker	7.003	23.447	6.932	17.674	-8	3.052	0.88	4.022
1239	DUMBARTON BRIDGE	5 White Croaker	4.577	10.696	3.716	10.582	-8	1.824	0.508	2.243
1240	DUMBARTON BRIDGE	5 White Croaker	6.275	10.793	4.167	12.148	-8	1.898	0.472	2.42
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	2.902	4.395	1.774	4.742	-8	0.576	-8	0.76
1242	FREMONT FOREBAY	3 Striped Bass	1.087	4.339	1.37	4.009	-8	0.943	0.363	0.757
1243	FREMONT FOREBAY	3 Striped Bass	4.331	8.49	2.701	6.818	-8	0.896	0.309	1.173
1244	FREMONT FOREBAY	3 Striped Bass	-8	4.385	1.785	5.075	-8	0.659	0.278	0.799
1245	FREMONT FOREBAY	4 Striped Bass	1.191	2.254	0.853	2.679	-8	0.336	-8	0.491
1246	RICHMOND HARBOR	20 Shiner Surf Perch	1.44	5.324	1.455	3.773	-8	0.544	-8	0.65
1247	RICHMOND HARBOR	20 Shiner Surf Perch	1.824	3.68	1.269	2.972	-8	0.407	0.24	0.49
1248	RICHMOND HARBOR	20 Shiner Surf Perch	2.137	4.295	1.475	3.386	-8	0.512	-8	0.601
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	2.017	0.554	1.235	-8	-8	-8	-8
1250	BERKELEY PIER	20 Shiner Surf Perch	2.359	8.067	2.299	6.223	-8	0.979	-8	1.177
1251	BERKELEY PIER	20 Shiner Surf Perch	1.87	5.303	1.522	4.046	-8	0.593	-8	0.821
1252	BERKELEY PIER	20 Shiner Surf Perch	1.989	4.017	1.385	3.803	-8	0.478	-8	0.725
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	0.509	1.979	0.587	1.615	-8	-8	-8	-8
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	4.625	20.323	5.571	13.841	0.244	2.225	0.704	2.418
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	3.292	13.339	3.595	8.722	-8	1.285	0.327	1.461
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	3.94	12.763	3.345	8.372	-8	1.313	0.304	1.354
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	4.779	10.844	3.105	8.054	-8	1.172	0.323	1.48
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	17.041	47.322	13.408	32.026	0.574	5.76	2.024	6.19
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	4.368	16.986	4.522	11.559	-8	2.581	0.788	2.934
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	4.66	12.981	4.724	12.151	-8	2.149	0.585	2.681
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	7.578	20.53	5.962	13.716	0.227	2.167	0.858	1.789
1262	ISLAIS CREEK	5 White Croaker	4.412	17.734	4.717	11.335	-8	2.424	0.649	2.817
1263	ISLAIS CREEK	5 White Croaker	5.82	12.092	3.903	8.979	-8	2.145	0.575	2.346
1264	ISLAIS CREEK	5 White Croaker	3.458	6.623	2.201	4.968	-8	1.1	0.235	1.411
1265	ISLAIS CREEK	20 Shiner Surf Perch	4.457	5.607	1.99	4.231	-8	0.737	-8	0.83
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	7.569	22.379	6.034	14.941	0.239	2.896	0.823	3.686
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	9.923	21.967	5.834	13.724	0.243	2.696	0.846	3.205
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	12.935	18.697	4.998	13.259	-8	2.407	0.764	2.777
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	4.91	3.121	2.127	4.692	-8	0.712	-8	0.757
1270	POINT MOLATE	5 White Croaker	6.644	21.399	5.156	15.224	-8	3.22	0.813	4.117
1271	POINT MOLATE	5 White Croaker	6.667	20.191	5.89	15.903	-8	2.686	0.763	3.605
1272	POINT MOLATE	5 White Croaker	7.819	11.761	3.596	9.769	-8	1.975	0.539	2.231
1273	POINT MOLATE	5 Walleye Surf Perch	1.18	1.77	0.671	1.782	-8	-8	-8	0.277
1274	RODEO	5 White Croaker	6.259	19.073	5.963	16.956	-8	2.64	1.131	3.687
1275	RODEO	5 White Croaker	5.045	15.989	4.6	13.526	-8	2.001	0.634	2.462
1276	RODEO	5 White Croaker	8.636	32.222	8.834	24.331	-8	3.661	1.206	4.844
1277	RODEO	3 Leopard Sharks	0.317	2.127	0.63	1.18	-8	0.27	-8	0.278
1282	SAN FRANCISCO PIER #7	5 White Croaker	11.973	47.258	11.655	29.99	0.35	6.816	2.24	8.134
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	1.615	4.439	1.37	2.664	-8	0.59	-8	0.359
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	1.144	4.172	1.214	2.295	-8	0.611	-8	0.321
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	2.229	2.601	0.815	1.839	-8	0.341	-8	0.31
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	3.146	8.888	3.014	8.58	-8	1.192	0.251	1.61
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	1.692	5.522	1.762	5.195	-8	0.894	-8	1.165
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	4.331	10.419	3.932	11.038	0.234	1.249	0.808	2.156
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	1.892	2.811	1.566	5.171	-8	0.363	-8	0.521
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	1.723	3.008	0.787	1.359	-8	0.319	-8	0.269
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	2.454	0.754	0.915	-8	0.345	-8	-8
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	0.276	1.478	0.396	1	-8	-8	-8	-8
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	0.234	12.132	3.023	1.847	-8	1.376	0.421	0.43
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	0.465	1.244	0.391	1.013	-8	-8	-8	-8
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	0.308	3.08	1.008	2.4	-8	0.368	-8	0.452
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	0.676	2.965	1.004	1.913	-8	0.395	-8	0.393
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	0.903	10.276	2.823	5.584	-8	1.163	0.367	1.219
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	0.712	8.116	2.591	5.485	-8	1.079	0.399	1.186
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	0.927	2.456	0.788	2.243	-8	0.389	-8	0.54
1336	VALLEJO-MARE ISLAND	5 White Croaker	10.921	36.252	11.195	30.552	0.321	4.446	1.436	6.384
1337	VALLEJO-MARE ISLAND	5 White Croaker	14.549	50.06	13.341	32.305	0.402	5.696	2.042	7.373
1338	VALLEJO-MARE ISLAND	5 White Croaker	6.509	14.1	5.405	14.748	-8	2.006	0.745	2.978
1339	VALLEJO-MARE ISLAND	3 Striped Bass	1.675	5.442	2.062	5.425	-8	0.791	-8	0.987

IDORG #	STATION NAME	FISH TYPE	PCB203	PCB206	PCB209	TTLPCB	ARO1248	ARO1254	ARO1260
1234	SAN MATEO BRIDGE	5 White Croaker	2.589	1.741	0.764	154.1	36.99	246.6	167.688
1235	SAN MATEO BRIDGE	5 White Croaker	2.253	1.417	0.617	-9	-8	236.18	147.01
1236	SAN MATEO BRIDGE	5 White Croaker	0.98	0.673	0.265	-9	-8	136.996	73.222
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	0.502	-8	-8	-9	-8	84	30
1238	DUMBARTON BRIDGE	5 White Croaker	1.855	1.218	0.587	152.2	42.588	260.26	130.13
1239	DUMBARTON BRIDGE	5 White Croaker	1.142	0.757	0.281	-9	33.99	122.364	77.044
1240	DUMBARTON BRIDGE	5 White Croaker	-8	0.761	-8	-9	-8	148.09	80.32
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	0.431	0.217	-8	-9	-8	69.496	28.616
1242	FREMONT FOREBAY	3 Striped Bass	0.927	-8	-8	45.5	37.728	75.456	35.37
1243	FREMONT FOREBAY	3 Striped Bass	0.834	0.332	-8	-9	85.76	111.488	45.024
1244	FREMONT FOREBAY	3 Striped Bass	0.83	0.245	-8	-9	-8	102.396	31.164
1245	FREMONT FOREBAY	4 Striped Bass	0.302	-8	-8	-9	-8	38.268	18.709
1246	RICHMOND HARBOR	20 Shiner Surf Perch	0.362	-8	-8	69.2	-8	155.044	26.152
1247	RICHMOND HARBOR	20 Shiner Surf Perch	0.338	-8	-8	-9	-8	125.952	21.648
1248	RICHMOND HARBOR	20 Shiner Surf Perch	0.334	-8	-8	-9	-8	139.656	23.276
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	-8	-8	-9	-8	24.486	11.798
1250	BERKELEY PIER	20 Shiner Surf Perch	0.525	0.309	-8	48.3	-8	97.118	41.622
1251	BERKELEY PIER	20 Shiner Surf Perch	0.365	-8	-8	-9	-8	60.884	27.496
1252	BERKELEY PIER	20 Shiner Surf Perch	0.25	-8	-8	-9	-8	66.3	23.4
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	-8	-8	-8	-9	-8	26.572	11.446
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	1.857	0.589	0.296	150.5	-8	280.32	89.352
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	0.942	0.289	-8	-9	-8	187.308	54.868
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	0.852	0.275	-8	-9	-8	184.68	55.404
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	0.953	0.408	-8	-9	-8	164.968	53.372
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	4.422	1.747	0.719	269.4	35.85	382.4	219.88
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	1.418	0.838	0.377	-9	-8	136.772	99.27
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	1.415	0.828	0.292	-9	-8	144.704	93.632
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	1.544	0.323	-8	-9	-8	240.24	74.256
1262	ISLAIS CREEK	5 White Croaker	1.422	0.823	0.275	109.3	80.808	133.224	100.464
1263	ISLAIS CREEK	5 White Croaker	1.297	0.799	0.257	-9	33.84	110.544	85.728
1264	ISLAIS CREEK	5 White Croaker	0.681	0.386	-8	-9	-8	81.744	56.592
1265	ISLAIS CREEK	20 Shiner Surf Perch	0.501	-8	-8	-9	-8	67.782	32.864
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	2.216	1.158	0.555	120.9	50.462	177.714	125.058
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	2.157	0.877	0.469	-9	70.72	154.7	121.55
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	1.752	0.75	0.299	-9	34.71	194.376	94.874
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	0.656	-8	-8	-9	33.796	99.4	33.796
1270	POINT MOLATE	5 White Croaker	2.303	1.365	0.858	96.9	-8	142.66	130.432
1271	POINT MOLATE	5 White Croaker	1.93	1.204	0.521	-9	28.272	150.784	115.444
1272	POINT MOLATE	5 White Croaker	1.421	0.695	0.318	-9	-8	138.624	73.644
1273	POINT MOLATE	5 Walleye Surf Perch	-8	-8	-8	-9	-8	33.932	-8
1274	RODEO	5 White Croaker	2.151	1.343	0.628	100.5	-8	159.32	120.628
1275	RODEO	5 White Croaker	1.56	0.826	0.354	-9	17.1	129.96	85.5
1276	RODEO	5 White Croaker	2.915	1.473	0.587	-9	-8	263.04	155.632
1277	RODEO	3 Leopard Sharks	-8	-8	-8	-9	-8	27.846	13.495
1282	SAN FRANCISCO PIER #7	5 White Croaker	5.544	2.658	1.225	223.1	-8	340.8	272.64
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	0.541	-8	-8	-9	-8	65.534	23.254
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	0.489	-8	-8	-9	-8	95.808	23.952
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	0.312	-8	-8	-9	-8	49.536	15.893
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	0.81	0.361	0.231	71.3	-8	132	59.4
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	0.632	0.283	-8	-9	-8	56.16	37.44
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	1.597	0.699	0.273	-9	-8	111.776	69.86
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	0.49	0.232	-8	28	-8	49.248	22.572
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	0.235	-8	-8	13	-8	27.888	13.346
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	-8	-8	-9	-8	28.392	15.818
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	-8	-8	-8	-9	-8	16.531	-8
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	0.789	0.252	-8	48.6	-8	71.706	40.698
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	-8	-8	-8	-9	-8	16.85	-8
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	0.334	-8	-8	-9	-8	32	18.4
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	0.353	-8	-8	18.3	-8	42.636	18.217
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	0.893	0.26	-8	-9	-8	70.584	47.748
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	0.862	0.289	-8	-9	-8	103.224	44.528
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	0.312	-8	-8	15.3	-8	34.176	20.292
1336	VALLEJO-MARE ISLAND	5 White Croaker	3.785	2.241	0.992	191.2	-8	319.2	209.76
1337	VALLEJO-MARE ISLAND	5 White Croaker	5.351	2.128	1.063	-9	-8	320.58	246.6
1338	VALLEJO-MARE ISLAND	5 White Croaker	1.845	1.148	0.5	-9	-8	160.934	98.482
1339	VALLEJO-MARE ISLAND	3 Striped Bass	0.798	0.368	0.174	-9	-8	87.88	38.87

IDORG #	STATION NAME	FISH TYPE	ARO5460	TTLARO	PCBBATCH
1234	SAN MATEO BRIDGE	5 White Croaker	-8	451.278	73.4
1235	SAN MATEO BRIDGE	5 White Croaker	-8	386.190	73.4
1236	SAN MATEO BRIDGE	5 White Croaker	-8	213.218	73.42
1237	SAN MATEO BRIDGE	20 Shiner Surf Perch	-8	117.000	73.4
1238	DUMBARTON BRIDGE	5 White Croaker	-8	432.978	73.4
1239	DUMBARTON BRIDGE	5 White Croaker	-8	233.398	73.41
1240	DUMBARTON BRIDGE	5 White Croaker	-8	231.410	73.42
1241	DUMBARTON BRIDGE	20 Shiner Surf Perch	-8	101.112	73.42
1242	FREMONT FOREBAY	3 Striped Bass	-8	148.554	73.43
1243	FREMONT FOREBAY	3 Striped Bass	-8	242.272	73.44
1244	FREMONT FOREBAY	3 Striped Bass	-8	136.560	73.45
1245	FREMONT FOREBAY	4 Striped Bass	-8	59.977	73.46
1246	RICHMOND HARBOR	20 Shiner Surf Perch	-8	184.196	73.4
1247	RICHMOND HARBOR	20 Shiner Surf Perch	-8	150.600	73.41
1248	RICHMOND HARBOR	20 Shiner Surf Perch	-8	165.932	73.42
1249	RICHMOND HARBOR	3 Brown Smoothhound Sharks	-8	39.284	73.4
1250	BERKELEY PIER	20 Shiner Surf Perch	-8	141.740	73.4
1251	BERKELEY PIER	20 Shiner Surf Perch	-8	91.380	73.41
1252	BERKELEY PIER	20 Shiner Surf Perch	-8	92.700	73.42
1253	BERKELEY PIER	3 Brown Smoothhound Sharks	-8	41.018	73.4
1254	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	-8	372.672	73.4
1255	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	-8	245.176	73.41
1256	OAKLAND INNER HAR. (FRUITVALE)	20 Shiner Surf Perch	-8	243.084	73.42
1257	OAKLAND INNER HAR. (FRUITVALE)	3 Striped Bass	-8	221.340	73.4
1258	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	-8	638.130	73.43
1259	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	-8	239.042	73.41
1260	DOUBLE ROCK (CANDLESTICK)	5 White Croaker	-8	241.336	73.41
1261	DOUBLE ROCK (CANDLESTICK)	20 Shiner Surf Perch	-8	317.496	73.45
1262	ISLAIS CREEK	5 White Croaker	-8	314.496	73.41
1263	ISLAIS CREEK	5 White Croaker	-8	230.112	73.42
1264	ISLAIS CREEK	5 White Croaker	-8	141.336	73.42
1265	ISLAIS CREEK	20 Shiner Surf Perch	-8	103.646	73.42
1266	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	-8	353.234	73.47
1267	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	-8	346.970	73.44
1268	OAKLAND MIDDLE HARBOR PIER	5 White Croaker	-8	323.960	73.45
1269	OAKLAND MIDDLE HARBOR PIER	20 Shiner Surf Perch	-8	166.992	73.46
1270	POINT MOLATE	5 White Croaker	-8	276.092	73.43
1271	POINT MOLATE	5 White Croaker	-8	294.500	73.44
1272	POINT MOLATE	5 White Croaker	-8	215.268	73.45
1273	POINT MOLATE	5 Walleye Surf Perch	-8	37.932	73.46
1274	RODEO	5 White Croaker	-8	282.948	73.47
1275	RODEO	5 White Croaker	-8	232.560	73.44
1276	RODEO	5 White Croaker	-8	421.672	73.45
1277	RODEO	3 Leopard Sharks	-8	44.341	73.46
1282	SAN FRANCISCO PIER #7	5 White Croaker	-8	616.440	73.43
1283	SAN FRANCISCO PIER #7	5 White Surf Perch	-8	91.788	73.44
1284	SAN FRANCISCO PIER #7	5 White Surf Perch	-8	122.760	73.45
1285	SAN FRANCISCO PIER #7	5 White Surf Perch	-8	68.429	73.46
1286	STRIPED BASS (OAKLAND INNER)	3 Striped Bass	-8	194.400	73.41
1287	STRIPED BASS (COYOTE POINT)	3 Striped Bass	-8	96.600	73.41
1288	STRIPED BASS (SACRAMENTO. R.)	3 Striped Bass	-8	184.636	73.44
1289	STURGEON (GRIZZLY BAY)	3 Sturgeon	-8	74.820	73.44
1292	SHARK-SOUTH BAY (S.M., COYOTE)	3 Leopard Sharks	-8	44.234	73.43
1293	SHARK-SOUTH BAY (COYOTE)	3 Leopard Sharks	-8	47.210	73.47
1294	SHARK-SOUTH BAY (COYOTE)	3 Brown Smoothhound Sharks	-8	20.531	73.41
1295	SHARK-MID BAY (TREASURE IS.)	2 Leopard Sharks	-8	115.404	73.43
1296	SHARK-MID BAY (BERKELEY)	3 Brown Smoothhound Sharks	-8	20.850	73.44
1297	SHARK-MID BAY (PARADISE)	3 Brown Smoothhound Sharks	-8	53.400	73.45
1298	SHARK-NORTH BAY (PT. MOLATE)	3 Leopard Sharks	-8	63.853	73.45
1299	SHARK-NORTH BAY (PT. MOLATE)	3 Brown Smoothhound Sharks	-8	121.332	73.46
1300	SHARK-NORTH BAY (Pt. MOLATE)	3 Brown Smoothhound Sharks	-8	150.752	73.45
1301	HALIBUT-SOUTH BAY (SAN MATEO)	3 Halibut	-8	57.468	73.46
1336	VALLEJO-MARE ISLAND	5 White Croaker	-8	531.960	73.47
1337	VALLEJO-MARE ISLAND	5 White Croaker	-8	570.180	73.43
1338	VALLEJO-MARE ISLAND	5 White Croaker	-8	262.416	73.46
1339	VALLEJO-MARE ISLAND	3 Striped Bass	-8	129.750	73.44