STATE MUSSEL WATCH PROGRAM

1995-97

DATA REPORT

Prepared By
Del Rasmussen
Division of Water Quality

State Water Resources Control Board
California Environmental Protection Agency

ACKNOWLEDGEMENTS

The State Water Resources Control Board wishes to acknowledge the contributions of the following individuals to the 1995-97 State Mussel Watch Program:

Department of Fish and Game
Moss Landing and Water Pollution Control Laboratories

Project Director:	Mark Stephenson
Field Support:	Gary Ichikawa Jon Goetzl
Laboratory Support:	Dave Crane Autumn Bonnema James McCall Abdou Mekebri Gary Munoz Kim Paulson Mark Pranger Kathleen Regalado Laurie Smith

State Water Resources Control Board

Graphic Support:	Dale Oliver

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF APPENDICES (continued)

LIST OF TABLES

LIST OF ABBREVIATIONS

DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DDMS	Dichlorodiphenylmonochlorosaturatedethane
DDMU	Dichlorodiphenylmonochlorounsaturatedethane
DFG	Department of Fish and Game, California
EDL(s)	Elevated Data Level(s)
USFDA or FDA	United States Food and Drug Administration
HCH	Hexachlorocyclohexane
MIS(s)	Median International Standard(s)
MTRL(s)	Maximum Tissue Residue Level(s)
NAS	National Academy of Sciences
PAH(s)	Polynuclear Aromatic Hydrocarbon(s)
PCB(s)	Polychlorinated Biphenyl(s)
PCP	Pentachlorophenol
PCT	Polychlorinated Terphenyl
ppb	Parts Per Billion (ng/g)
ppm	Parts Per Million (µg/g)
RWQCB(s)	Regional Water Quality Control Board(s)
SMWP	State Mussel Watch Program
SWRCB	State Water Resources Control Board
TCP	Tetrachlorophenol
TBT	Tributyltin
USEPA	United States Environmental Protection Agency

1. STATE MUSSEL WATCH PROGRAM 1995 - 1997

Introduction

The California State Mussel Watch Program (SMWP), initiated in 1977 by the State Water Resources Control Board (SWRCB), was organized to provide a uniform statewide approach to the detection and evaluation of toxic substances in the waters of California's bays, harbors, and estuaries. This is accomplished through the analysis of resident and transplanted mussels and clams. The SMWP primarily targets areas with known or suspected impaired water quality and is not intended to give an overall water quality assessment. The SWRCB provides funding to the California Department of Fish and Game (DFG) under an ongoing interagency agreement for the collection and analysis of SMWP samples. Sampling stations are selected primarily by the six coastal Regional Water Quality Control Boards (RWQCBs), which are identified on the inside back cover.

The DFG reports sampling results to the SWRCB, which distributes the information to the coastal RWQCBs and to other federal, State, and local agencies through annual preliminary data reports. These preliminary data reports are also routinely transmitted to the Office of Environmental Health Hazard Assessment of the California Environmental Protection Agency, which has responsibility for issuing sport fish and shellfish consumption advisories if needed. This is the formal report presenting the results of the 1995-96 and 1996-97 sampling and analysis programs. Some 1994-95 data not previously reported are also included in this report.

Information collected in the SMWP is used by the SWRCB, RWQCBs, and other agencies to identify waters impacted by toxic pollutants. Through the SWRCB's statewide Water Quality Assessment, SMWP results are used to help classify water bodies from good to impaired water quality relative to each other. SMWP results are also used in the normal regulatory activities of the RWQCBs and other State agencies such as the Department of Pesticide Regulation.

Summary

Appendix A shows map locations for sampling stations included in this report. Appendix B contains station location information such as latitude and

longitude, county, and the region. A total of 51 samples (44 stations) were collected and analyzed in 1995-96, and 57 samples (54 stations) were collected and analyzed in 1996-97 (Appendix C). Six archive samples (5 stations) collected from San Francisco Bay in 1981 and 1982 were analyzed in 1996-97 (Appendix C). Also included in this report are PAH data from 16 samples (7 stations) collected in 1994-95 and not previously reported (Appendix C). These 16 samples from 1994-95 and 18 PAH samples from 1995-96 were analyzed under the SWRCB's Bay Protection and Toxic Cleanup Program (BPTCP). Samples analyzed under the BPTCP, from Regions 1 and 2, are identified in Appendix C. Sample analysis includes trace elements (metals), organic chemicals (pesticides and PCBs), and polynuclear aromatic hydrocarbons (PAHs).

Of the 130 samples included in this report 87 are California mussel (*Mytilus californianus*) samples, 67 transplanted and 20 resident mussel samples. Ten samples were resident bay mussels (*Mytilus edulis*) from Regions 1, 2, 4, and 9. Freshwater clams (*Corbicula fluminea*) were analyzed from four waterbodies (seven samples) from Region 2. One oyster sample (*Crassostrea gigas*) was analyzed from the Mad River Slough in Region 1. Three new sample types were analyzed under the BPTCP in Region 1. Five shore crab samples (*Pachygrapsus crassipes*) were collected from Arcata Bay and Humboldt Bay. Three Sand Worm samples (*Glycera spp.*) and one Abalone Jingle (*Pododesmus cepio*) were also collected from Humboldt Bay. In addition to tissue analysis, sixteen sediment samples were analyzed from Region 1 and 2. A complete station sampling history of the SMWP from 1978 to 1997 is provided in Appendix D.

Wet weight tissue results were compared to the following criteria: U.S. Food and Drug Administration (FDA) criteria, Maximum Tissue Residue Levels (MTRLs), Median International Standards (MISs), and Elevated Data Levels (EDLs). Data were not compared to the National Academy of Sciences (NAS) recommended guidelines for predator protection since freshwater clams were only analyzed for trace metals not included in the NAS guidelines for shellfish. A discussion of each criterion can be found in Section 3, Administrative and Comparative Criteria, on Page 6. The MTRL criterion was developed from water quality objectives from the 1997 *California Ocean Plan* (SWRCB 1997) and the from the California Toxic Rule (40 CFR Part 131, May 18, 2000) as established in the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SWRCB 2000).

Only one sample exceeded FDA criteria (Appendix E). Transplanted California mussels collected in 1997 from San Diego Bay/Harbor Island/East Basin/Storm Drain contained 6,741 ppb PCBs, which exceeded the FDA tolerance level of 2,000 ppb for PCBs. This station has periodically exceeded the FDA level for PCBs since 1982. The 1997 PCB concentration is by far the highest level found at this station at more than 1.5 times higher than the previous high of 3,792 ppb found in 1982. MTRL criteria for ocean waters were exceeded in 17 samples from 11 stations (Appendix F). MTRLs for enclosed bays and estuaries were exceeded in 59 samples from 45 stations (Appendix G) including all six archive samples from five stations in Region 2. The MIS for trace elements were exceeded in 59 samples from 51 stations (Appendix H). Samples exceeding EDLs for trace elements and organic chemicals can be found in Appendices I and E.

Tabular summaries of all chemistry data are provided in Appendices J through T. Summaries of all trace element data in tissue are provided in Appendix J (wet weight) and Appendix K (dry weight). Trace element data in sediment are contained in Appendix L (dry weight). Summaries of all organic chemical data in tissue are provided in Appendix M (wet weight), Appendix N (dry weight), and Appendix O (lipid weight). Organic chemical data in sediment are contained in Appendix P (dry weight). PAH data summaries in tissue can be found in Appendix Q (wet weight), Appendix R (dry weight), and Appendix S (lipid weight). PAH data in sediment are contained in Appendix T (dry weight).

2. FIELD AND LABORATORY OPERATIONS

The presence of many toxic substances in the State's waters is determined by analyzing tissues from aquatic organisms. Concentrations of these substances in water are often too low or transitory to be reliably detected through the more traditional methods of analysis of water samples. Also, many toxic substances are not water soluble, but can be found associated with sediment or organic matter. Aquatic organisms are sampled because they bioaccumulate and bioconcentrate toxic substances to levels which may be many hundreds of times the levels actually in the water. This concentration factor facilitates detection of toxic pollutants. Mussels are excellent subjects for this purpose because they (1) are sessile, (2) are long-lived, (3) can be successfully transplanted to and maintained in areas where they do not naturally occur, and (4) readily concentrate toxic pollutants from the water. The following is a general overall discussion of field and laboratory procedures. A detailed discussion is provided in Appendix U.

Substances Measured

Samples are regularly analyzed for up to 13 trace elements (Table U-1) and approximately 45 synthetic organic chemicals including pesticides and PCBs (Table U-4). Not every sample is analyzed for all trace elements or organic chemicals. Each sample at each station is handled individually. The RWQCBs will specify the type of analysis for each sample. The following are analyzed on a request basis only: arsenic, nickel, selenium, polynuclear aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), and tetrachlorophenol (TCP), and tributyltin (TBT).

Sample Size and Collection

Forty-five mussels or clams are composited and analyzed for organic chemicals. Three analytical replicates of 15 individuals each of mussels or clams are analyzed for trace elements (trace element results reported herein are mean values). Concentrations in bivalves of certain trace elements and organic chemicals can be directly correlated with several variables such as size of the animal, location of habitation within the tidal zone, and season of collection (Stephenson et al. 1987). In the SMWP, mussels of 55 to 65 mm in length are collected whenever possible in order to reduce size-related effects. In an attempt to minimize variability introduced by location of

collection within the intertidal zone, mussels are collected from the highest point in the zone where adequate numbers occur.

Mussels are transplanted where a suitable resident population does not exist and where sampling can be accomplished using scuba equipment. One of the following three mussel transplant systems is used in the SMWP; 1) A bottom anchored submerged buoy system in an area of deep water and no structures; 2) A polypropylene line which may be tied between two pilings or a line hung beneath a dock in areas with structures (i.e. pilings, floating docks, etc.); 3) Samples may be placed on PVC or wooden stakes that are pounded into the substrate in areas of shallow water. A two month transplant period is adequate in most cases where pollutant uptake rates are expected to be high, but for trace elements in less contaminated environments a six month interval may be necessary for an adequate sample (Stephenson et al. 1980). A four to six month transplant interval is used for organic chemicals to be consistent with transplant periods for trace elements. Transplanted mussels (M. californianus) were collected from Trinidad Head and Bodega Head.

Dry, Wet, and Lipid Weight Measurements

Metal data are presented in parts per million (ppm) while organic chemical data are presented in parts per billion (ppb). Tissue concentrations of trace elements and organic chemicals are measured on a dry weight basis to reduce data variability due to moisture content. Wet and lipid weight basis data are back calculated from dry weight and lipid measurements. Wet weight basis data are used to compare to wet weight or fresh weight criteria listed in this report (see Section 3, Administrative and Comparative Criteria). In addition, organic chemicals are expressed on a lipid weight basis. Lipid weight measurements offer several advantages. Because chlorinated hydrocarbons are much more soluble in lipids (fat tissues) than in water, they partition into lipid-rich tissues of aquatic organisms (Stout and Beezhold 1981). Animals with higher proportions of lipid in their tissue usually have higher concentrations of chlorinated hydrocarbon pollutants (Phillips 1980). Factors such as season, water temperature, health of the organism, stress on the organism, and type of species can affect the lipid levels of samples collected for analysis and can, therefore, cause variability in results. Use of lipid weight basis measurements may reduce this source of variability, although disadvantages have also been noted (Phillips 1980). As a result, lipid weight based values may represent a more realistic measure of environmental availability of chlorinated hydrocarbons

than wet weight based values. Wet weight based measures, however, remain the preferred data for most readers because all criteria for human health and for predator protection are based on wet weight based measures. Also, wet weight based measures better reflect the exposure of predators or humans to the actual concentration in fresh mussels or clams.

3. ADMINISTRATIVE AND COMPARATIVE CRITERIA

In this report the term "criteria" is used to refer to the criteria against which a particular trace element or organic chemical is being compared. More than one criterion may apply to any one metal or organic compound. Human health-related criteria, FDA action levels, Maximum Tissue Residue Levels (MTRLs), and Median International Standards (MISs) are considered more important or critical. Following human health criteria are NAS guidelines for predator protection and Elevated Data Levels (EDLs). All five criteria are discussed below.

In interpreting the SMWP data by any of the criteria provided, it is important to note that there is no simple relationship between concentrations of toxic substances observed in tissue samples and actual concentrations in water. Different aquatic organisms tend to bioaccumulate a given toxic substance in water to different levels; however, these differences usually do not prevent a general interpretation of the data. It should also be noted that the limited number of samples obtained and analyzed at each station in a single year is generally too small to provide a statistically sound basis for making absolute statements on toxic substance concentrations. The values reported herein should be accepted as indicators of relative levels of toxic pollution in water, and not as absolute values. In this sense, trends over time and ranking values of a toxic substance provide only an indication of areas where mussels are evidently accumulating toxicants at concentrations which are above normal.

FDA Action Levels and NAS Guidelines

The FDA has established maximum concentration levels for some toxic substances in human foods (USFDA 1985). The levels are based on specific assumptions of the quantities of food consumed by humans and the frequency of their consumption. The FDA limits are intended to protect humans from the chronic effects of toxic substances consumed in foodstuffs. The National Academy of Sciences (NAS) has established recommended maximum concentrations of toxic substances in animals (NAS 1973). They were established not only to protect the organisms containing the toxic compounds, but also to protect the species that consume these contaminated organisms. The NAS has set guidelines for marine fish but not for marine shellfish. Only two guidelines apply to freshwater clams. The FDA limits and NAS guidelines are shown in Table 1.

Maximum Tissue Residue Levels (MTRLs)

The MTRLs were developed by SWRCB staff from human health water quality objectives in the 1997 *California Ocean Plan* (SWRCB 1997) and from the California Toxic Rule (40 CFR Part 131, May 18, 2000) as established in the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SWRCB 2000). The objectives represent levels that protect human health from consumption of fish, shellfish, and water (freshwater only) that contain substances at levels which could result in significant human health problems. The MTRLs are used as alert levels or guidelines indicating water bodies with potential human health concerns and are an assessment tool and not compliance or enforcement criteria. Tables 2 and 3 list MTRLs for those substances monitored in ocean waters and enclosed bays and estuaries. The MTRLs for a number of substances listed as carcinogens in the MTRL tables are below the current tissue detection limit for those substances. Detection limits can be found in Tables U-1, U-4, and U-13 in Appendix U.

The MTRLs were calculated by multiplying the human health water quality objectives by the bioconcentration factor (BCF) for each substance as recommended in the USEPA Draft Assessment and Control of Bioconcentratable Contaminants in Surface Waters (USEPA 1991). BCFs were taken from the USEPA 1980 Ambient Water Quality Criteria Documents for the priority pollutants. MTRLs were not calculated for objectives that are based on drinking water Maximum Contaminant levels (MCLs) or taste and odor criteria.

Median International Standards (MISs) for Trace Elements

The MIS is an in-house criterion developed from a United Nations Food and Agriculture Organization publication of a survey of health protection criteria used by member nations (Nauen 1983). A description of how the MISs were compiled by SWRCB staff is provided in Appendix V. These criteria vary somewhat in the tissues to be analyzed or the level of protection desired but may be compared qualitatively. Table 4 summarizes these standards as an indication of what other countries have determined to be unsafe levels of trace elements. Though the standards do not apply within the United States, they provide an indication of what other nations consider to be an elevated concentration of trace elements in shellfish.

Elevated Data Levels

The "elevated data level" (EDL) was introduced by SWRCB staff in 1983 as an internal comparative measure which ranks a given concentration of a particular substance with previous SMWP data. The EDL is calculated by ranking all of the results for a species and exposure condition (resident or transplant) and a given chemical from the highest concentration measured down to and including those records where the chemical was not detected. From this, a cumulative distribution is constructed and percentile rankings are calculated. For example, the 50th percentile corresponds to the median or "middle" value rather than to the mean. With a large number of records, the median can be approximately compared to the mean.

The 85th percentile (EDL 85) was chosen as an indication that a chemical is markedly elevated from the median. The 85th percentile corresponds to measures used by the U.S. Fish and Wildlife Service in its National Contaminant Biomonitoring Program and would represent approximately one and one-half standard deviations from the mean, if the data were normally distributed. The 95th percentile (EDL 95) was chosen to indicate values that are highly elevated above the median. The 95th percentile would represent two standard deviations from the mean, if the data were normally distributed. When used along with other information, these measures provide a useful guideline to determine if a chemical has been found in unusually high concentrations. A more detailed description of EDL rankings is provided in Appendix W. It should be noted that EDLs are not directly related to potentially adverse human or animal health effects; they are only a way to compare findings in a particular area with the larger data base of findings from all over the state. The 1977-97 EDLs and the number of data points used to calculate each EDL are provided in Tables 5 through 12.

TABLE 1

NAS Guidelines and FDA Action Levels for Toxic Chemicals in Shellfish (wet weight)

Chemical	NAS[a] Recommended Guideline for Freshwater Shellfish µg/g (ppm)	ng/g (ppb)	FDA[b] Action Level for Freshwater and Marine Shellfish µg/g (ppm)	ng/g (ppb)
Mercury	-	-	1.0[c]	1,000
DDT (total)	1.0	1,000	-	-
PCB (total)	0.5	500	2.0[d]	2,000
Aldrin	-	-	0.3	300
Dieldrin	-	-	0.3	300
Endrin	-	-	0.3	300
Heptachlor	-	-	0.3	300
Heptachlor epoxide	-	-	0.3	300

a National Academy of Sciences-National Academy of Engineering. 1973. Water Quality Criteria, 1972 (Blue Book). U.S. Environmental Protection Agency, Ecological Research Series.

b U. S. Food and Drug Administration. 1984. Shellfish Sanitation Interpretation: Action Levels for Chemical and Poisonous Substances, June 21, 1984. U.S.F.D.A., Shellfish Sanitation Branch, Washington, D.C.

c As methyl mercury.

d A tolerance, rather than an action level, has been established for PCBs (21CFR 109, published May 29, 1984). An action level is revoked when a regulation establishes a tolerance for the same substance and use.

TABLE 2

Maximum Tissue Residue Levels (MTRLs) in Ocean Waters

Carcinogens [a]

Chemical	Water Quality Objective [b] (µg/l)	BCF [c] (l/kg)	MTRL [d] (µg/kg) (ppb, wet weight)
Aldrin	0.000022	**e**	0.1
Chlordane (total)	0.000023	14100	0.32
DDT (total)	0.00017	53600	9.1
Dieldrin	0.00004	4670	0.2
Heptachlor	0.00072	11200	8.1
Hexachlorobenzene (HCB)	0.00021	8690	2.0
PAHs (total)	0.0088	30	0.26
PCBs (total)	0.000019	31200	0.6
Toxaphene	0.00021	13100	2.75

a. The SMWP does not analyze for any of the non-carcinogens listed in the human health section of Table B of the 1997 Ocean Plan.
b. From Table B, Objectives for Human Health, "*California Ocean Plan*" (SWRCB 1997).
c. Bioconcentration Factors taken from the USEPA 1980 Ambient Water Quality Criteria Documents for each substance.
d. MTRLs were calculated by multiplying the Water Quality Objective by the BCF, except for aldrin.
e. Aldrin MTRL is derived from a combination of aldrin and dieldrin risk factors and BCFs as recommended in the USEPA 1980 "*Ambient Water Quality Criteria for Aldrin/Dieldrin*" (USEPA 1980).

TABLE 3

Maximum Tissue Residue Levels (MTRLs) in Enclosed Bays and Estuaries

Carcinogens

Chemical	Water Quality Objective [a] (µg/l)	BCF [b] (l/kg)	MTRL [c] (µg/kg) (ppb, wet weight)
Aldrin	0.00014	**d**	0.33
Chlordane (total)	0.00059	14100	8.3
p,p′ DDT	0.00059	53600	32.0
p,p′ DDE	0.00059	53600	32.0
p,p′ DDD	0.00084	53600	45.0
Dieldrin	0.00014	4670	0.7
Heptachlor	0.00021	11200	2.3
Heptachlor epoxide	0.00011	11200	1.2
Hexachlorobenzene (HCB)	0.00077	8690	6.7
Hexachlorocyclohexane (HCH), alpha	0.0013	130	1.7
Hexachlorocyclohexane (HCH), beta	0.046	130	6.0
Hexachlorocyclohexane (HCH), gamma	0.063	130	8.2
PCBs (total)	0.00017	31200	5.3
Pentachlorophenol (PCP)	8.2	11	90.0
Toxaphene	0.00075	13100	9.8

Non-carcinogens

Chemical	Water Quality Objective [a] (mg/l)	BCF [b] (l/kg)	MTRL [c] (mg/kg) (ppm, wet weight)
endosulfan I	0.240	270	64.8 (64,800 ppb)
endosulfan II	0.240	270	64.8 (64,800 ppb)
endosulfan sulfate	0.240	270	64.8 (64,800 ppb)
Endrin	0.00081	3970	3.2 (3,200 ppb)
Mercury	0.000051	7342 [e]	0.37
Nickel	4.6	47	220.0

a. From the California Toxic Rule (40 CFR Part 131, May 18, 2000) as established in the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SWRCB 2000).

b. Bioconcentration Factors taken from the USEPA 1980 Ambient Water Quality Criteria Documents for each substance.

c. MTRLs were calculated by multiplying the Water Quality Objective by the BCF, except for aldrin.

d. Aldrin MTRL is derived from a combination of aldrin and dieldrin risk factors and BCFs as recommended in the USEPA 1980 "*Ambient Water Quality Criteria for Aldrin/Dieldrin*" (USEPA 1980).

e. Weighted Average Practical BCF as calculated in the California Toxic Rule.

TABLE 4

Median International Standards for Trace Elements[a]
(edible portion, ppm, wet weight)

Element	Freshwater Fish	Shellfish	Range	Number of Countries with Standards
Arsenic	1.5	1.4	0.1 to 5.0	11
Cadmium	0.3	1.0	0.05 to 2.0	10
Chromium	1.0	1.0	1.0	1
Copper	20.0	20.0	10 to 100	8
Lead	2.0	2.0	0.5 to 10.0	19
Mercury	0.5	0.5	0.1 to 1.0	28
Selenium	2.0	0.3	0.3 to 2.0	3
Zinc	45.0	70.0	40 to 100	6

a. Based on: Nauen, C. E., Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products, Food and Agriculture Organization of the United Nations, 1983.

TABLE 5

State Mussel Watch Program
EDL 85 and EDL 95 for Trace Elements in
California Mussels *(Mytilus californianus)*
Calculated Using 1977 - 1997 Data
(ppm, wet weight)

Resident

Element	EDL 85	EDL 95	Number of Samples
Aluminum	80.23	130.00	605
Arsenic	3.74	4.94	137
Cadmium	1.50	2.03	605
Chromium	0.55	1.04	604
Copper	1.59	2.12	605
Lead	0.92	2.42	604
Manganese	2.11	2.90	605
Mercury	0.06	0.11	602
Nickel	0.63	0.82	281
Selenium	0.53	0.82	55
Silver	0.44	1.45	605
Titanium	5.71	9.95	167
Zinc	33.64	38.87	605

Transplanted

Element	EDL 85	EDL 95	Number of Samples
Aluminum	138.43	240.00	952
Arsenic	2.20	3.26	239
Cadmium	1.59	1.91	952
Chromium	0.73	1.70	951
Copper	5.30	11.93	952
Lead	1.57	2.79	964
Manganese	4.60	6.24	952
Mercury	0.06	0.08	942
Nickel	0.83	1.10	238
Selenium	0.59	0.85	159
Silver	0.09	0.19	952
Titanium	7.55	14.65	139
Zinc	55.78	77.84	952

TABLE 6

State Mussel Watch Program
EDL 85 and EDL 95 for Trace Elements in Bay Mussels *(Mytilus edulis)*
Calculated Using 1977 - 1997 Data
(ppm, wet weight)

Resident

Element	EDL 85	EDL 95	Number of Samples
Aluminum	170.00	220.00	95
Arsenic	IS	IS	8
Cadmium	0.99	1.24	95
Chromium	0.73	1.60	95
Copper	2.28	4.28	95
Lead	1.61	4.26	95
Manganese	5.11	6.98	95
Mercury	0.05	0.09	94
Nickel	0.78	1.06	24
Selenium	IS	IS	9
Silver	0.05	0.16	95
Titanium	IS	IS	1
Zinc	42.92	52.60	95

IS = Insufficient number of samples to calculate an EDL.

TABLE 7

State Mussel Watch Program
EDL 85 and EDL 95 for Trace Elements in
Freshwater Clams *(Corbicula fluminea)*
Calculated Using 1977 - 1997 Data
(ppm, wet weight)

Resident

Element	EDL 85	EDL 95	Number of Samples
Aluminum	56.29	78.17	18
Arsenic	IS	IS	4
Cadmium	1.26	1.74	18
Chromium	0.99	1.51	18
Copper	8.61	10.68	18
Lead	0.12	0.21	18
Manganese	6.68	9.35	18
Mercury	0.04	0.04	18
Nickel	IS	IS	2
Selenium	IS	IS	7
Silver	0.03	0.04	18
Titanium	IS	IS	1
Zinc	17.05	18.17	18

Transplanted

Element	EDL 85	EDL 95	Number of Samples
Aluminum	206.33	446.00	84
Arsenic	0.90	0.93	28
Cadmium	0.92	1.26	84
Chromium	2.00	3.07	84
Copper	8.78	15.00	84
Lead	0.21	0.39	84
Manganese	9.55	16.90	84
Mercury	0.04	0.10	88
Nickel	1.00	1.40	20
Selenium	0.43	0.46	28
Silver	0.03	0.04	84
Titanium	IS	IS	5
Zinc	19.39	25.12	84

IS = Insufficient number of samples to calculate an EDL.

TABLE 8

State Mussel Watch Program
EDL 85 and EDL 95 for Organic Chemicals in
Resident California Mussels *(Mytilus californianus)*
Calculated Using 1977 - 1997 Data
(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	ND	184
Chlordene, alpha	ND	ND	155
Chlordene, gamma	ND	ND	154
cis-Chlordane	1.5	3.0	184
cis-Nonachlor	0.3	0.7	160
Oxychlordane	0.2	0.3	184
trans-Chlordane	1.3	2.2	184
trans-Nonachlor	1.3	2.3	184
Total Chlordane	4.4	7.2	194
Chlorbenside	ND	0.5	130
Chlordene	ND	ND	64
Chlorpyrifos	ND	ND	183
Dacthal	ND	0.4	183
DDD, o,p'	1.2	2.2	306
DDD, p,p'	3.3	7.5	306
DDE, o,p'	5.8	12.4	187
DDE, p,p'	31.4	105.5	306
DDT, o,p'	0.4	1.1	306
DDT, p,p'	1.8	3.3	306
DDMS, p,p'	ND	2.4	153
DDMU, p,p'	4.6	9.0	187
Total DDT	48.8	129.0	316
Diazinon	ND	ND	157
Dichlorobenzophenone, p,p'	ND	ND	99
Dicofol	ND	ND	61
Dieldrin	1.6	2.5	183
Endosulfan I	0.3	1.2	184
Endosulfan II	ND	ND	88
Endosulfan Sulfate	ND	ND	82
Total Endosulfan	0.3	1.3	194
Endrin	ND	ND	184
Ethion	ND	ND	99
HCH, alpha	1.2	1.7	184
HCH, beta	ND	1.1	183
HCH, delta	ND	ND	183
HCH, gamma	0.2	0.3	183
Heptachlor	ND	ND	184
Heptachlor Epoxide	ND	ND	183
Hexachlorobenzene	ND	0.03	184
Methoxychlor	ND	ND	183
Oxadiazon	ND	ND	74
Parathion, ethyl	ND	ND	156
Parathion, methyl	ND	ND	156
Phenol	0.3	0.4	14
Pentachlorophenol	1.2	2.7	14
PCB 1248	ND	ND	410
PCB 1254	14.7	33.3	410
PCB 1260	ND	ND	410
Total PCB	15.1	35.2	410
PCT 5460	ND	ND	69
Ronel	ND	ND	69
Tetrachlorophenol	1.1	3.0	14
Tetradifon	ND	ND	156
Toxaphene	ND	ND	184
Tributyltin	ND	ND	23

ND = EDL lies below the detection limit.

TABLE 9

State Mussel Watch Program
EDL 85 and EDL 95 for Organic Chemicals in
Transplanted California Mussels *(Mytilus californianus)*
Calculated Using 1977 - 1997 Data
(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	ND	584
Chlordene, alpha	0.4	1.0	530
Chlordene, gamma	0.2	0.4	530
cis-Chlordane	6.9	13.0	587
cis-Nonachlor	2.1	3.7	537
Oxychlordane	0.4	0.8	587
trans-Chlordane	5.6	9.5	587
trans-Nonachlor	4.9	9.4	587
Total Chlordane	20.0	34.5	596
Chlorbenside	ND	1.7	437
Chlordene	ND	ND	240
Chlorpyrifos	0.6	1.5	582
Dacthal	0.6	6.2	563
DDD, o,p'	5.7	12.4	608
DDD, p,p'	22.7	65.3	608
DDE, o,p'	5.9	10.2	608
DDE, p,p'	94.7	170.1	608
DDT, o,p'	2.1	8.6	608
DDT, p,p'	7.6	33.8	608
DDMS, p,p'	3.4	6.2	533
DDMU, p,p'	6.4	10.2	608
Total DDT	145.1	308.5	617
Diazinon	ND	ND	482
Dichlorobenzophenone, p,p'	ND	ND	323
Dicofol	ND	ND	215
Dieldrin	5.7	18.2	564
Endosulfan I	1.0	20.0	568
Endosulfan II	ND	13.4	314
Endosulfan Sulfate	1.3	26.6	297
Total Endosulfan	1.3	40.9	577
Endrin	ND	1.4	561
Ethion	ND	ND	323
HCH, alpha	0.6	1.0	579
HCH, beta	ND	ND	563
HCH, delta	ND	ND	562
HCH, gamma	0.4	0.6	562
Heptachlor	ND	ND	579
Heptachlor Epoxide	0.1	0.4	579
Hexachlorobenzene	ND	0.1	579
Methoxychlor	ND	ND	564
Oxadiazon	1.2	2.7	225
Parathion, ethyl	ND	ND	461
Parathion, methyl	ND	ND	461
Phenol	0.5	0.9	37
Pentachlorophenol	22.6	34.0	90
PCB 1248	ND	28.2	748
PCB 1254	161.9	368.4	748
PCB 1260	ND	2.1	748
Total PCB	171.3	420.0	748
PCT 5460	ND	ND	189
Ronel	ND	0.3	134
Tetradifon	ND	ND	467
Toxaphene	ND	83.2	587
Tributyltin	1474.5	2639.3	150
Tetrachlorophenol	2.0	5.4	90

ND = EDL lies below the detection limit.

TABLE 10

State Mussel Watch Program
EDL 85 and EDL 95 for Organic Chemicals in
Resident Bay Mussels *(Mytilus edulis)*
Calculated Using 1977 - 1997 Data
(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	0.3	69
Chlordene, alpha	0.4	1.1	48
Chlordene, gamma	0.4	1.2	48
cis-Chlordane	11.8	17.6	70
cis-Nonachlor	2.5	4.1	59
Oxychlordane	0.5	0.8	70
trans-Chlordane	12.3	17.0	70
trans-Nonachlor	10.6	15.9	70
Total Chlordane	37.7	55.9	70
Chlorbenside	ND	5.8	55
Chlordene	ND	ND	27
Chlorpyrifos	ND	0.9	70
Dacthal	7.4	20.2	68
DDD, o,p'	11.7	21.8	89
DDD, p,p'	44.2	79.5	89
DDE, o,p'	7.4	14.8	82
DDE, p,p'	167.0	295.7	89
DDT, o,p'	7.0	22.6	89
DDT, p,p'	31.8	96.0	89
DDMS, p,p'	3.1	5.3	74
DDMU, p,p'	7.0	11.2	82
Total DDT	263.6	487.6	89
Diazinon	ND	ND	59
Dichlorobenzophenone, p,p'	ND	ND	22
Dicofol	ND	ND	11
Dieldrin	10.5	21.8	67
Endosulfan I	89.8	124.5	70
Endosulfan II	48.2	73.3	33
Endosulfan Sulfate	46.8	68.2	30
Total Endosulfan	102.5	230.6	70
Endrin	2.2	4.0	67
Ethion	ND	ND	22
HCH, alpha	0.4	0.5	69
HCH, beta	ND	0.3	68
HCH, delta	ND	ND	68
HCH, gamma	0.3	0.4	68
Heptachlor	0.1	0.6	69
Heptachlor Epoxide	0.2	0.5	69
Hexachlorobenzene	0.1	0.2	69
Methoxychlor	ND	ND	68
Oxadiazon	0.5	1.5	17
Parathion, ethyl	ND	ND	59
Parathion, methyl	ND	ND	59
Phenol	IS	IS	0
Pentachlorophenol	IS	IS	1
PCB 1248	ND	13.6	94
PCB 1254	127.0	188.8	94
PCB 1260	ND	ND	94
Total PCB	128.7	188.8	94
PCT 5460	ND	ND	13
Ronel	ND	0.6	34
Tetrachlorophenol	IS	IS	1
Tetradifon	ND	ND	58
Toxaphene	82.1	226.7	72
Tributyltin	IS	IS	5

ND = EDL lies below the detection limit.
IS = Insufficient number of samples to calculate an EDL.

TABLE 11

State Mussel Watch Program
EDL 85 and EDL 95 for Organic Chemicals in
Resident Freshwater Clams *(Corbicula fluminea)*
Calculated Using 1977 - 1997 Data
(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	ND	17
Chlordene, alpha	ND	ND	17
Chlordene, gamma	ND	ND	17
cis-Chlordane	1.6	3.2	17
cis-Nonachlor	ND	0.4	17
Oxychlordane	ND	ND	17
trans-Chlordane	1.3	2.8	17
trans-Nonachlor	0.8	3.6	17
Total Chlordane	4.3	9.4	17
Chlorbenside	ND	ND	16
Chlordene	ND	ND	11
Chlorpyrifos	ND	ND	17
Dacthal	1.9	3.3	17
DDD, o,p'	1.7	13.4	17
DDD, p,p'	7.5	51.7	17
DDE, o,p'	0.7	6.4	17
DDE, p,p'	14.2	110.5	17
DDT, o,p'	ND	4.8	17
DDT, p,p'	4.2	39.8	17
DDMS, p,p'	ND	ND	17
DDMU, p,p'	1.1	6.0	17
Total DDT	26.6	250.4	17
Diazinon	ND	ND	16
Dichlorobenzophenone, p,p'	IS	IS	9
Dicofol	IS	IS	8
Dieldrin	1.2	1.5	17
Endosulfan I	ND	6.0	17
Endosulfan II	ND	ND	15
Endosulfan Sulfate	ND	ND	15
Total Endosulfan	0.5	14.1	17
Endrin	ND	ND	17
Ethion	IS	IS	9
HCH, alpha	0.3	0.5	17
HCH, beta	ND	ND	17
HCH, delta	ND	ND	17
HCH, gamma	ND	0.4	17
Heptachlor	ND	ND	17
Heptachlor Epoxide	ND	ND	17
Hexachlorobenzene	0.2	0.3	17
Methoxychlor	ND	ND	17
Oxadiazon	IS	IS	1
Parathion, ethyl	ND	ND	16
Parathion, methyl	ND	ND	16
Phenol	IS	IS	0
Pentachlorophenol	IS	IS	0
PCB 1248	ND	ND	19
PCB 1254	13.7	63.3	19
PCB 1260	ND	ND	19
Total PCB	13.7	63.3	19
PCT 5460	IS	IS	3
Ronel	IS	IS	4
Tetrachlorophenol	IS	IS	0
Tetradifon	ND	ND	16
Toxaphene	ND	ND	17
Tributyltin	IS	IS	0

ND = EDL lies below the detection limit.
IS = Insufficient number of samples to calculate an EDL.

TABLE 12

State Mussel Watch Program
EDL 85 and EDL 95 for Organic Chemicals in
Transplanted Freshwater Clams *(Corbicula fluminea)*
Calculated Using 1977 - 1997 Data
(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	0.7	1.5	111
Chlordene, alpha	1.5	2.8	111
Chlordene, gamma	1.1	3.1	111
cis-Chlordane	13.0	26.7	111
cis-Nonachlor	2.8	12.2	111
Oxychlordane	0.7	1.7	111
trans-Chlordane	9.5	18.4	111
trans-Nonachlor	9.2	18.5	111
Total Chlordane	35.1	79.0	111
Chlorbenside	ND	ND	80
Chlordene	ND	ND	49
Chlorpyrifos	4IS	72.0	111
Dacthal	137.5	378.0	111
DDD, o,p'	46.0	120.6	111
DDD, p,p'	165.0	396.4	111
DDE, o,p'	9.2	20.8	111
DDE, p,p'	376.9	1019.8	111
DDT, o,p'	41.9	126.2	111
DDT, p,p'	217.4	665.1	111
DDMS, p,p'	ND	7.8	111
DDMU, p,p'	15.1	34.4	111
Total DDT	911.0	2493.7	111
Diazinon	ND	23.2	80
Dichlorobenzophenone, p,p'	ND	4.6	67
Dicofol	40.1	107.4	37
Dieldrin	110.4	196.9	111
Endosulfan I	22.7	190.5	111
Endosulfan II	24.9	111.4	94
Endosulfan Sulfate	37.8	88.3	94
Total Endosulfan	74.6	294.4	111
Endrin	17.0	29.3	111
Ethion	ND	ND	66
HCH, alpha	0.1	0.4	111
HCH, beta	ND	ND	107
HCH, delta	ND	ND	107
HCH, gamma	0.6	0.9	107
Heptachlor	ND	0.3	111
Heptachlor Epoxide	0.6	2.6	111
Hexachlorobenzene	1.3	2.9	111
Methoxychlor	ND	ND	107
Oxadiazon	26.2	61.6	44
Parathion, ethyl	ND	ND	76
Parathion, methyl	ND	ND	76
Phenol	IS	IS	3
Pentachlorophenol	IS	IS	0
PCB 1248	4.1	13.4	111
PCB 1254	59.8	151.6	111
PCB 1260	ND	9.4	111
Total PCB	78.0	151.6	111
PCT 5460	ND	ND	41
Ronel	ND	ND	11
Tetrachlorophenol	IS	IS	0
Tetradifon	ND	ND	77
Toxaphene	603.2	2374.4	111
Tributyltin	IS	IS	0

ND = EDL lies below the detection limit.
IS = Insufficient number of samples to calculate an EDL.

4. LITERATURE CITED

(DFG) Department of Fish and Game. 1990. Laboratory Quality Assurance Program Plan (October 12, 1992 update). Environmental Services Division, California Department of Fish and Game. Sacramento, California.

Goldberg, E.D. 1980. The International Mussel Watch. National Academy of Sciences Publ., Washington, D.C.

(NAS) National Academy of Sciences-National Academy of Engineering. 1973. Water Quality Criteria 1972 (Blue Book). EPA Ecological Research Series. EPA-R3-73-033. U.S. Environmental Protection Agency, Washington, D.C.

Nauen, C.E. 1983. Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products, Circular No. 764. FIRI/C764, Food and Agricultural Organization of the United Nations.

Phillips, D.J.H. 1980. Quantitative Aquatic Biological Indicators. Applied Science Publishers Ltd, Ripple Road, Barking, Essex, England. Pages 38-90.

Risebrough, R.W., B.W. deLappe, E.F. Letterman, J.L. Lane, M. Firestone-Gilles, A.M. Springer, and W. Walker II. 1980. California State Mussel Watch 1977-1978. Volume III. Organic Pollutants in Mussels, Mytilus californianus and Mytilus edulis, along the California Coast. Water Quality Monitoring Report No. 79-22. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California.

(SWRCB) State Water Resources Control Board. 2000. Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Phase 1 of the Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan). March 2, 2000. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California.

(SWRCB) State Water Resources Control Board. 1997. California Ocean Plan - Water Quality Control Plan, Ocean Waters of California. July 23, 1997. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California.

Stephenson, M.D., D. Smith, G. Ichikawa, J. Goetzl, W. Laurendine, and M. Martin. 1987. State Mussel Watch Program Preliminary Data Report 1986-1987. California Department of Fish and Game, Monterey, California.

Stephenson, M.D., S.L. Coale, M. Martin, and J. H. Martin. 1980. California State Mussel Watch 1979-1980. Trace metal concentrations in the California mussel, Mytilus californianus, and the Bay Mussel, Mytilus edulis, along the California coast and selected harbors and bays. Water Quality Monitoring Report No. 79-22. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, California

Stout, V.F. and F.L. Beezhold. 1981. Chlorinated hydrocarbon levels in fishes and shellfishes of the northeastern Pacific Ocean including the Hawaiian Islands. Mar. Fish. Rev. 43:1:1-12.

(USEPA) U.S. Environmental Protection Agency. 1991. "Draft" Assessment and Control of Bioconcentratable Contaminants in Surface Waters. March 1991. Office of Water, U.S. EPA, Washington, D.C.

LITERATURE CITED (continued)

(USEPA) U.S. Environmental Protection Agency. 1985. Ambient Water Quality Criteria for Mercury. EPA 440/5-84-026. U.S. EPA, Office of Water Regulations and Standards, Washington, D.C.

(USEPA) U.S. Environmental Protection Agency. 1980. Ambient Water Quality Criteria for Aldrin/Dieldrin. EPA 440/5-80-019. U.S. EPA, Office of Water Regulations and Standards, Washington, D.C.

(USFDA) U.S. Food and Drug Administration, Bureau of Foods. 1985. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed. USFDA, Washington, D.C.

(USFDA) U. S. Food and Drug Administration. 1984. Shellfish Sanitation Interpretation: Action Levels for Chemical and Poisonous Substances, June 21, 1984. U.S.F.D.A., Shellfish Sanitation Branch, Washington, D.C.