STATE MUSSEL WATCH PROGRAM

1987 - 1993

DATA REPORT

94-1WQ

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Field and Laboratory Operations Conducted by the
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STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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State Mussel Watch Program - 1987-93 Data Report

TABLE OF CONTENTS

	Page
Acknowledgements	ii
List of Appendices	v
List of Tables	vi
List of Abbreviations	viii
1. 1987 - 1993 PROGRAM	
Introduction	1
Summary	1
2. FIELD AND LABORATORY OPERATIONS	3
Substances Measured	3
Sample Size and Collection	3
Dry, Wet, and Lipid Weight Measurements	4
3. ADMINISTRATIVE AND COMPARATIVE CRITERIA	5
FDA Action Levels and NAS Guidelines	5
Maximum Tissue Residue Levels (MTRLs)	5
Median International Standards (MIS) for Trace Elements	6
Elevated Data Levels (EDLs)	6
4. LITERATURE CITED	21

State Mussel Watch Program - 1987-93 Data Report

APPENDICES

		Page
Appendix A -	Maps Showing 1987-93 Station Locations	A-1
Appendix B -	1987-93 Sampling Stations - Latitude and Longitude	B-1
Appendix C -	1987-93 Sample Information	C-1
Appendix D -	Station Sampling History	D-1
Appendix E -	List of Station Name Changes	E-1
Appendix F -	Summary of 1987-93 Data: Organic Chemicals Exceeding Selected Criteria (ppb, wet weight)	F-1
Appendix G -	Summary of 1987-93 Data: Organic Chemicals Exceeding Maximum Tissue Residue Levels (MTRLs) in Ocean Waters (ppb, wet weight).	G-1
Appendix H -	Summary of 1987-93 Data: Organic Chemicals Exceeding Maximum Tissue Residue Levels (MTRLs) in Enclosed Bays and Estuaries (ppb, wet weight)	H-1
Appendix I -	Summary of 1987-93 Data: Trace Elements and Organic Chemicals Exceeding Maximum Tissue Residue Levels (MTRLs) in Inland Surface Waters (ppb, wet weight)	I-1
Appendix J -	Summary of 1987-93 Data: Trace Elements Exceeding the Median International Standards (MIS) (ppm, wet weight)	J-1
Appendix K -	Summary of 1987-93 Data: Trace Elements Exceeding Elevated Data Levels (EDLs) (ppm, wet weight)	K-1
Appendix L -	Summary of 1987-93 Data: Trace Elements in Mussels, Clams, and Sediment (ppm, wet weight)	L-1
Appendix M -	Summary of 1987-93 Data: Trace Elements in Mussels, Clams, and Sediment (ppm, dry weight)	M-1

State Mussel Watch Program - 1987-93 Data Report

APPENDICES (continued)

		Page
Appendix N -	Summary of 1987-93 Data: Organic Chemicals in Mussels, Clams, and Sediment (ppb, wet weight)	N-1
Appendix O -	Summary of 1987-93 Data: Organic Chemicals in Mussels, Clams, and Sediment (ppb, dry weight)	O-1
Appendix P -	Summary of 1987-93 Data: Organic Chemicals in Mussels, Clams, and Sediment (ppb, lipid weight)	P-1
Appendix Q -	Summary of 1987-93 Data: PCP and TCP in Mussels and Sediment (ppb: wet, dry, and lipid weight)	Q-1
Appendix R -	Summary of 1987-93 Data: PAHs in Mussels, Clams, and Sediment (ppb, wet weight)	R-1
Appendix S -	Summary of 1987-93 Data: PAHs in Mussels, Clams, and Sediment (ppb, dry weight)	S-1
Appendix T -	Summary of 1987-93 Data: PAHs in Mussels, Clams, and Sediment (ppb, lipid weight)	T-1
Appendix U -	Summary of 1987-93 Data: PCB Congeners 5 - 101 in Mussels, Clams, and Sediment (ppb, wet weight)	U-1
Appendix V -	Summary of 1987-93 Data: PCB Congeners 105 - 207 in Mussels, Clams, and Sediment (ppb, wet weight)	V-1
Appendix W -	Summary of 1987-93 Data: PCB Congeners 5 - 101 in Mussels, Clams, and Sediment (ppb, dry weight)	W-1
Appendix X -	Summary of 1987-93 Data: PCB Congeners 105 - 207 in Mussels, Clams, and Sediment (ppb, dry weight)	X-1
Appendix Y -	Summary of 1987-93 Data: PCB Congeners 5 - 101 in Mussels and Clams (ppb, lipid weight)	Y-1
Appendix Z -	Summary of 1987-93 Data: PCB Congeners 105 - 207 in Mussels and Clams (ppb, lipid weight)	Z-1

APPENDICES (continued)

Page

Appendix AA - Field and Laboratory Operations AA-1

Appendix BB - Median International Standards BB-1

Appendix CC - Elevated Data Levels CC-1

Appendix DD - Corrected Phenol Data from 1984-85 and 1986-87 ..... DD-1

LIST OF TABLES

Table 1. NAS Guidelines and FDA Action Levels For Toxic Chemicals in Shellfish (wet weight) 7

Table 2. Maximum Tissue Residue Levels (MTRLs) For Carcinogens in Ocean Waters 8

Table 3. Maximum Tissue Residue Levels (MTRLs) in Enclosed Bays and Estuaries 9

Table 4. Maximum Tissue Residue Levels (MTRLs) in Inland Surface Waters 10

Table 5. Median International Standards for Trace Elements (edible portion, ppm, wet weight) 11

Table 6. SMWP EDL 85 and EDL 95 for Trace Elements in California Mussels (*Mytilus californianus*). Calculated Using 1977-1993 Data (ppm, wet weight) 12

Table 7. SMWP EDL 85 and EDL 95 for Trace Elements in Bay Mussels (*Mytilus edulis*) Calculated Using 1977-1993 Data (ppm, wet weight) 13

LIST OF TABLES (continued)

		Page
Table 8.	SMWP EDL 85 and EDL 95 for Trace Elements in Freshwater Clams (*Corbicula fluminea*) Calculated Using 1977-1993 Data (ppm, wet weight)	14
Table 9.	SMWP EDL 85 and EDL 95 for Organic Chemicals in Resident California Mussels (*Mytilus californianus*). Calculated Using 1977-1993 Data (ppb, wet weight)	15
Table 10.	SMWP EDL 85 and EDL 95 for Organic Chemicals in Transplanted California Mussels (*Mytilus californianus*). Calculated Using 1977-1993 Data (ppb, wet weight)	16
Table 11.	SMWP EDL 85 and EDL 95 for Organic Chemicals in Resident Bay Mussels (*Mytilus edulis*) Calculated Using 1977-1993 Data (ppb, wet weight)	17
Table 12.	SMWP EDL 85 and EDL 95 for Organic Chemicals in Resident Freshwater Clams (*Corbicula fluminea*) Calculated Using 1977-1993 Data (ppb, wet weight)	18
Table 13.	SMWP EDL 85 and EDL 95 for Organic Chemicals in Transplanted Freshwater Clams (*Corbicula fluminea*) Calculated Using 1977-1993 Data (ppb, wet weight)	19

State Mussel Watch Program - 1987-93 Data Report

LIST OF ABBREVIATIONS

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

1. STATE MUSSEL WATCH PROGRAM
1987 - 1993

Introduction

The California State Mussel Watch Program (SMWP) was initiated in 1977 by the California State Water Resources Control Board (SWRCB). The SMWP was organized to provide a uniform statewide approach to the detection and evaluation of the occurrence of toxic substances in the waters of California's bays, harbors, and estuaries through the analysis of 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 California Department of Fish and Game (DFG) carries out the statewide SMWP for the SWRCB by collecting and analyzing samples. The SWRCB provides funding under an ongoing interagency agreement with the DFG. Sampling stations are selected primarily by the six coastal Regional Water Quality Control Boards (RWQCB) which are identified on the inside back cover.

The DFG reports annual 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 evaluating pollutant levels based on human health concerns and issuing consumption health advisories if indicated. This report is the formal report presenting the results of the 1987-93 sampling and analysis programs.

Information collected in the SMWP is used by the SWRCB, RWQCB, and other agencies to identify waters impacted by toxic pollutants. Through the SWRCB's statewide Water Quality Assessment/Clean Water Strategy, SMWP results are used to help classify water bodies from good to impaired water quality relative to each other and ranked according to this classification and resource value. For example, water bodies that exceed human health criteria are considered more impaired than water bodies that only exceed environmental protection criteria. SMWP results are also used in the SWRCB's Bay Protection Program in helping identify "Toxic Hot Spots". Lastly, SMWP results are used in the normal regulatory activities of the RWQCBs and other State agencies such as the Department of Pesticide Regulation.

Summary

Appendix A shows area map locations for each station sampled from August 1987 through March 1993. Appendix B contains station location information such as latitude and longitude and county identification. From 1987 to 1993 a total of 863 samples from 315 stations were collected and analyzed (Appendix C) including 776 samples of California mussel (*Mytilus californiaus*), bay mussel (*Mytilus edulis*), and freshwater clam (*Corbicula fluminea*), and 87 sediment samples. Two archive samples of California mussels from Point Pinole and the Dumbarton Bridge at Channel Marker 14 collected in 1981 and 1982, respectively, were also analyzed in 1989 upon special request. Samples were analyzed for trace elements (metals), organic chemicals (pesticides and PCBs), polynuclear aromatic hydrocarbons (PAHs), and tributyltin (TBT). Transplanted California mussels made up 62% of the tissue samples followed by resident California mussels (24%), transplanted freshwater clams (11%), resident bay mussels (2%), and resident freshwater clams (1%). A complete station sampling history of the SMWP from 1978 to 1993 is provided in Appendix D. Recently, station names were reviewed and updated to more accurately describe the location of the sampling site. These changes are listed in Appendix E by old station name.

Wet weight sampling results were compared to the following criteria: U.S. Food and Drug Administration (FDA) criteria, Maximum Tissue Residue Levels (MTRLs), Median International Standards (MIS), the National Academy of Sciences (NAS) recommended guidelines for predator protection, and Elevated Data Levels (EDLs). A discussion of each criterion can be found in Section 3, Administrative and Comparative Criteria on Page 5. The MTRL is a new criterion developed from water quality objectives from the 1990

California Ocean Plan (SWRCB 1990a), the *Draft November 26, 1990 Functional Equivalent Document - Development of Water Quality Plans For: Inland Surface Waters of California and Enclosed Bays and Estuaries of California* (SWRCB 1990b), and the *Draft April 9, 1991 Supplement to the Functional Equivalent Document* (SWRCB 1991). Only three samples collected from 1987 to 1993 exceeded FDA criteria (Appendix F). Two samples exceeded the FDA action level for dieldrin of 300 ppb. Transplanted California mussels collected in 1988 from the Lauritzen Canal/End contained 602 ppb dieldrin and freshwater clams from Salinas/Reclamation Canal 4 collected the same year contained 396 ppb. The FDA tolerance level for PCBs (2,000 ppb) was exceeded in only one sample. Transplanted California mussels from San Diego Bay/Harbor Island/East Basin/Storm Drain also collected in 1988 contained 2,738 ppb PCBs. A total of 500 tissue samples from 216 stations exceeded the MTRLs for ocean waters (Appendix G), enclosed bays and estuaries (Appendix H), and inland surface waters (Appendix I). The NAS guideline for DDT (1,000 ppb) was exceeded in five transplanted freshwater clam samples from four stations (Appendix F). Two samples collected in 1988 from Salinas/Reclamation Canal 4 and Revolon Slough contained 2,556 and 3,845 ppb, respectively. A sample from Revolon Slough again exceeded the NAS for DDT in 1989 with 2,507 ppb. More recently, a sample from Salinas River Lag 2 station in 1992 contained 1,068 ppb while a 1993 sample from Watsonville Slough/Bridge station contained 1,058 ppb. The MIS for trace elements were exceeded in 528 samples from 203 stations from 1987 to 1993 (Appendix J). Samples exceeding EDLs for trace elements and organic chemicals can be found in Appendices K and F.

Tabular summaries of all chemistry data are provided in Appendices L through P. Summaries of all trace element data are provided in Appendix L (wet weight) and Appendix M (dry weight). Summaries of all organic chemical data are provided in Appendix N (wet weight), Appendix O (dry weight), and Appendix P (lipid weight). A separate table containing PCP and TCP results is located in Appendix Q. PAH data summaries can be found in Appendix R (wet weight), Appendix S (dry weight), and Appendix T (lipid weight). From 1987 to 1990 samples were analyzed for a large number of PCB congeners. These data can be found in Appendix U and V (wet weight), Appendix W and X (dry weight), and Appendix Y and Z (lipid weight).

Appendix DD is an errata sheet containing corrected phenol data from 1984-85 and 1986-87.

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 and clams 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) reliably 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 AA.

Substances Measured

Samples are regularly analyzed for up to 14 trace elements (Table AA-1) and approximately 45 synthetic organic chemicals including pesticides and PCBs (Table AA-3). Arsenic, nickel, selenium, polynuclear aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), and tetrachlorophenol (TCP), and tributyltin (TBT) are looked for on a request basis only. Not every sample is analyzed for all trace elements or organic chemicals. Each sample at each station is handled individually. The requesting agency, usually the RWQCBs, will specify the type of analysis for each sample.

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. Clams size is limited to 20 to 30 mm in length. In an attempt to minimize variability introduced by location of collection within the inter-tidal zone, mussels are collected from the highest point in the zone where adequate numbers occur.

Mussels and clams are transplanted where a suitable resident population does not exist and where sampling can be accomplished using scuba equipment. The mussel transplant system, consisting of a bottom anchored float buoy used in water up to 40 m depth, is shown in Appendix AA, Figure AA-1. Bags of freshwater clams are usually tied to plastic stakes placed off the bottom or are attached to submerged structures. 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 for the Humboldt Bay survey, from Montana de Oro for the Diablo Canyon survey, and from Bodega Head for all other transplants. Transplanted freshwater clams (C. fluminea) were collected from Lake San Antonio up to mid-1990. Because drought conditions at Lake San Antonio prevented further collections, clams were obtained from the Rio Vista area (Solano County) from 1990 through mid-1992. Clams collected from the Rio Vista area were held in Aptos Creek until transplanted. In 1992-93 clams were collected from Lake Isabella.

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 data are back calculated from dry weight measurements. Wet weight 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 had 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 measurements may reduce this source of variability, although disadvantages have also been noted (Phillips 1980). As a result, lipid weight values may represent a more realistic measure of environmental availability of chlorinated hydrocarbons than wet weight values. Wet weight measures, however, remain the preferred measure for most readers because all criteria for human health and for predator protection are based on wet weight measures. Also, wet weight 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. In general, FDA action levels, Maximum Tissue Residue Levels (MTRLs), and Median International Standards (MIS), all human health-related criteria, 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, the reader is cautioned 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, the differences usually do not prevent a general interpretation of the data. The reader is cautioned 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, 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 and clams are evidently accumulating 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 used in this report are shown in Table 1.

Maximum Tissue Residue Levels (MTRLs)

MTRLs were developed by SWRCB staff from human health water quality objectives in the *1990 California Ocean Plan* (SWRCB 1990a), the *Draft November 26, 1990 Functional Equivalent Document - Development of Water Quality Plans For: Inland Surface Waters of California and Enclosed Bays and Estuaries of California* (SWRCB 1990b), and the *Draft April 9, 1991 Supplement to the Functional Equivalent Document* (SWRCB 1991). The objectives represent concentrations in water that protect against consumption of fish, shellfish, and water (freshwater only) that contain substances at levels which could result in significant human health problems. 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, 3, and 4 lists MTRLs for those substances monitored in the SMWP. 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 AA-1, AA-3, and AA-4 in Appendix AA.

The MTRLs were calculated by multiplying the human health water quality objectives in 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 each substance. MTRLs were not calculated for objectives that are based on maximum contaminant levels (MCLs) or taste and odor criteria.

Median International Standards (MIS) for Trace Elements

The MIS is an in-house criterion developed from a Food and Agriculture Organization of the United Nations publication of a survey of health protection criteria used by member nations (Nauen 1983). A description of how the Median International Standards were compiled by SWRCB staff is provided in Appendix BB. These criteria vary somewhat in the tissues to be analyzed or the level of protection desired, but may be compared qualitatively. Table 5 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 data from the SMWP. 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 50^{th} 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 85^{th} percentile (EDL 85) was chosen as an indication that a chemical is markedly elevated from the median. The 85^{th} 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 95^{th} percentile (EDL 95) was chosen to indicate values that are highly elevated above the median. The 95^{th} 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 CC. The reader is cautioned 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 1977-93 EDLs and the number of data points used to calculate each EDL are provided in Tables 6 through 13.

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]

Substance	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 1990 Ocean Plan.
b. From Table B, Objectives for Human Health, "*California Ocean Plan*" (SWRCB 1990a).
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

Substance	Water Quality Objective [a] (µg/l)	BCF [b] (l/kg)	MTRL [c] (µg/kg, ppb)
aldrin	0.00014	**d**	0.33
chlordane (total)	0.000081	14100	1.2
DDT (total)	0.0006	53600	32.0
dieldrin	0.00014	4670	0.7
heptachlor	0.00017	11200	1.9
heptachlor epoxide	0.00007	11200	0.8
hexachlorobenzene (HCB)	0.00069	8690	6.0
hexachlorocyclohexane (HCH), alpha	0.0013	130	1.7
hexachlorocyclohexane (HCH), beta	0.046	130	6.0
hexachlorocyclohexane (HCH), gamma	0.062	130	8.1
PAHs (total)	0.031	30	0.93
PCBs (total)	0.00007	31200	2.2
pentachlorophenol (PCP)	8.2	11	90.0
toxaphene	0.00069	13100	9.0

Non-carcinogens

Substance	Water Quality Objective [a] (mg/l)	BCF [b] (l/kg)	MTRL [c] (mg/kg, ppm)
endosulfan (total)	0.002	270	0.5 (500 ppb)
endrin	0.0008	3970	3.2 (3,200 ppb)
mercury	0.000025	**e**	1.0
nickel	4.6	47	220.0

a. From the *Draft November 26, 1990 Functional Equivalent Document - Development of Water Quality Plans For: Inland Surface Waters of California and Enclosed Bays and Estuaries of California* (SWRCB 1990b), the *Draft April 9, 1991 Supplement to the Functional Equivalent Document* (SWRCB 1991).

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 and mercury.

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. The MTRL for mercury is the FDA action level. The water quality objective for mercury in the Enclosed Bays and Estuaries Plan is based on the FDA action level as recommended in the USEPA 1985 "*Ambient Water Quality Criteria for Mercury*" (USEPA 1985).

TABLE 4

Maximum Tissue Residue Levels (MTRLs) in Inland Surface Waters

Carcinogens

Substance	Water Quality Objective [a] (µg/l)	BCF [b] (l/kg)	MTRL [c] (µg/kg, ppb)
aldrin	0.00013	**d**	0.05
arsenic	5.0 [e]	44	200.0 (0.2 ppm)
chlordane (total)	0.00008	14100	1.1
DDT (total)	0.00059	53600	32.0
dieldrin	0.00014	4670	0.65
heptachlor	0.00016	11200	1.8
heptachlor epoxide	0.00007	11200	0.8
hexachlorobenzene (HCB)	0.00066	8690	6.0
hexachlorocyclohexane (HCH), alpha	0.0039	130	0.5
hexachlorocyclohexane (HCH), beta	0.014	130	1.8
hexachlorocyclohexane (HCH), gamma	0.019	130	2.5
PAHs (total)	0.0028	30	0.08
PCBs (total)	0.00007	31200	2.2
pentachlorophenol (PCP)	0.28	11	3.1
toxaphene	0.00067	13100	8.8

Non-carcinogens

Substance	Water Quality Objective [a] (mg/l)	BCF [b] (l/kg)	MTRL [c] (mg/kg, ppm)
cadmium	0.01	64	0.64
endosulfan (total)	0.0009	270	0.25 (250 ppb)
endrin	0.0008	3970	3.0 (3,000 ppb)
mercury	0.000012	**f**	1.0
nickel	0.6	47	28.0

a. From the *Draft November 26, 1990 Functional Equivalent Document - Development of Water Quality Plans For: Inland Surface Waters of California and Enclosed Bays and Estuaries of California* (SWRCB 1990b), the *Draft April 9, 1991 Supplement to the Functional Equivalent Document* (SWRCB 1991)

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, arsenic, and mercury.

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. Arsenic MTRL was calculated from the formula NSRL ÷ (WI/BCF) + FC = MTRL. [NSRL (California's No Significant Risk Level for arsenic) = 10 µg/d, WI (Water Intake) = 2 l/d, FC (daily fish consumption) = 0.0065 kg/d].

f. The MTRL for mercury is the FDA action level. The water quality objective for mercury in the Inland Surface Waters Plan is based on the FDA action level as recommended in the USEPA 1985 "*Ambient Water Quality Criteria for Mercury*" (USEPA 1985).

TABLE 5

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

Freshwater Element	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. C., Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products, Food and Agriculture Organization of the United Nations, 1983.

TABLE 6
State Mussel Watch Program
EDL 85 and EDL 95 for Trace Elements in California Mussels (*Mytilus californianus*)
Calculated Using 1977 - 1993 Data
(ppm, wet weight)

Resident

Element	EDL 85	EDL 95	Number of Samples
Aluminum	73.15	110.00	574
Arsenic	3.81	4.95	129
Cadmium	1.50	2.03	574
Chromium	0.52	0.80	574
Copper	1.52	1.99	574
Manganese	1.92	2.70	574
Mercury	0.06	0.11	571
Nickel	0.62	0.79	271
Lead	0.99	2.46	574
Selenium	0.51	0.56	41
Silver	0.45	1.63	574
Titanium	5.71	9.95	167
Zinc	33.63	38.86	574

Transplanted

Element	EDL 85	EDL 95	Number of Samples
Aluminum	120.19	206.73	867
Arsenic	2.29	3.51	196
Cadmium	1.56	1.92	867
Chromium	0.62	1.19	867
Copper	4.79	11.81	867
Manganese	4.40	6.00	867
Mercury	0.06	0.08	857
Nickel	0.72	0.95	193
Lead	1.57	2.72	876
Selenium	0.63	0.91	112
Silver	0.10	0.19	867
Titanium	7.55	14.65	139
Zinc	52.86	73.94	867

TABLE 7
State Mussel Watch Program
EDL 85 and EDL 95 for Trace Elements in Bay Mussels (*Mytilus edulis*)
Calculated Using 1977 - 1993 Data
(ppm, wet weight)

Resident

Element	EDL 85	EDL 95	Number of Samples
Aluminum	122.87	183.71	86
Arsenic	IS	IS	5
Cadmium	1.02	1.25	86
Chromium	0.52	0.95	86
Copper	1.92	3.87	86
Manganese	5.01	6.64	86
Mercury	0.05	0.09	85
Nickel	0.75	0.97	21
Lead	1.92	4.42	86
Selenium	IS	IS	5
Silver	0.05	0.15	86
Titanium	IS	IS	1
Zinc	43.29	54.22	86

IS = Insufficient number of samples to calculate an EDL.

TABLE 8
State Mussel Watch Program
EDL 85 and EDL 95 for Trace Elements in Freshwater Clams (*Corbicula fluminea*)
Calculated Using 1977 - 1993 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
Manganese	6.68	9.35	18
Mercury	0.04	0.05	18
Nickel	IS	IS	2
Lead	0.12	0.21	18
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
Manganese	9.55	16.90	84
Mercury	0.04	0.05	81
Nickel	1.00	1.40	20
Lead	0.21	0.39	84
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 9
State Mussel Watch Program
EDL 85 and EDL 95 for Organic Chemicals in Resident California Mussels (*Mytilus californianus*)
Calculated Using 1977 - 1993 Data
(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	ND	51
Chlordene, alpha	ND	ND	122
Chlordene, gamma	ND	ND	121
cis-Chlordane	1.6	3.0	151
cis-Nonachlor	0.2	0.4	127
Oxychlordane	0.2	0.4	151
trans-Chlordane	1.3	2.3	151
trans-Nonachlor	1.1	2.3	151
Total Chlordane	4.2	7.1	161
Chlorbenside	ND	0.5	124
Chlorpyrifos	ND	ND	150
Dacthal	ND	0.4	150
DDD, o,p'	1.1	2.0	273
DDD, p,p'	3.0	7.5	273
DDE, o,p'	4.3	11.3	154
DDE, p,p'	24.1	102.8	273
DDMS, p,p'	ND	2.4	154
DDMU, p,p'	2.6	8.6	154
DDT, o,p'	0.5	1.1	273
DDT, p,p'	1.7	3.3	273
Total DDT	33.2	122.5	283
Diazinon	ND	ND	124
Dichlorobenzophenone, p,p'	ND	ND	66
Dicofol	ND	ND	40
Dieldrin	1.6	2.5	150
Endosulfan I	0.5	1.4	151
Endosulfan II	ND	ND	54
Endosulfan Sulfate	ND	ND	54
Total Endosulfan	0.5	1.4	161
Endrin	ND	ND	151
Ethion	ND	ND	66
HCH, alpha	1.3	1.7	151
HCH, beta	ND	1.2	150
HCH, delta	ND	ND	150
HCH, gamma	0.2	0.3	150
Heptachlor	ND	ND	151
Heptachlor Epoxide	ND	ND	150
Hexachlorobenzene	ND	0.03	151
Methoxychlor	ND	ND	150
Oxadiazon	ND	ND	40
Parathion, ethyl	ND	ND	123
Parathion, methyl	ND	ND	123
PCB 1248	ND	ND	377
PCB 1254	13.2	32.3	377
PCB 1260	ND	ND	377
Total PCB	13.8	32.3	377
PCT 5460	ND	ND	54
Pentachlorophenol	1.2	2.7	14
Phenol	0.3	0.4	14
Tetrachlorophenol	1.1	3.0	14
Tetradifon	ND	ND	123
Toxaphene	ND	ND	151
Tributyltin	ND	8.5	18

ND = EDL lies below the detection limit.

TABLE 10

State Mussel Watch Program

EDL 85 and EDL 95 for Organic Chemicals in Transplanted California Mussels (*Mytilus californianus*)

Calculated Using 1977 - 1993 Data

(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	ND	511
Chlordene, alpha	0.5	1.1	457
Chlordene, gamma	0.1	0.4	457
cis-Chlordane	7.7	13.8	514
cis-Nonachlor	2.0	3.7	464
trans-Chlordane	6.3	10.1	514
trans-Nonachlor	5.5	10.2	514
Total Chlordane	21.9	36.5	523
Chlorbenside	ND	1.7	423
Chlorpyrifos	ND	1.4	509
Dacthal	0.7	6.0	490
DDD, o,p'	6.0	12.5	535
DDD, p,p'	24.1	67.7	535
DDE, o,p'	6.1	10.4	535
DDE, p,p'	97.7	163.8	535
DDMS, p,p'	3.4	6.2	535
DDMU, p,p'	6.5	10.4	535
DDT, o,p'	2.3	8.4	535
DDT, p,p'	7.7	32.4	535
Total DDT	153.0	301.9	544
Diazinon	ND	ND	409
Dichlorobenzophenone, p,p'	ND	ND	250
Dicofol	ND	ND	167
Dieldrin	6.3	18.2	491
Endosulfan I	1.3	24.7	495
Endosulfan II	3.9	18.0	239
Endosulfan Sulfate	10.2	29.0	240
Total Endosulfan	1.8	47.1	504
Endrin	ND	1.4	488
Ethion	ND	ND	250
HCH, alpha	0.6	1.1	506
HCH, beta	ND	ND	490
HCH, delta	ND	ND	489
HCH, gamma	0.4	0.7	489
Heptachlor	ND	ND	506
Heptachlor Epoxide	0.1	0.5	506
Hexachlorobenzene	ND	0.1	506
Methoxychlor	ND	ND	491
Oxadiazon	1.1	2.4	150
Parathion, ethyl	ND	ND	388
Parathion, methyl	ND	ND	388
PCB 1248	ND	28.1	675
PCB 1254	173.9	375.7	675
PCB 1260	ND	ND	675
Total PCB	179.7	421.9	675
PCT 5460	ND	ND	158
Pentachlorophenol	22.5	33.8	91
Phenol	0.5	0.9	37
Tetrachlorophenol	2.0	5.4	91
Tetradifon	ND	ND	394
Toxaphene	ND	81.9	514
Tributyltin	1560.0	2694.0	136

ND = EDL lies below the detection limit.

TABLE 11

State Mussel Watch Program

EDL 85 and EDL 95 for Organic Chemicals in Resident Bay Mussels (Mytilus edulis)

Calculated Using 1977 - 1993 Data

(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	0.4	61
Chlordene, alpha	0.4	1.1	40
Chlordene, gamma	0.5	1.2	40
cis-Chlordane	12.0	17.9	62
cis-Nonachlor	2.6	4.7	51
Oxychlordane	0.5	0.9	62
trans-Chlordane	13.3	17.2	62
trans-Nonachlor	11.5	16.6	62
Total Chlordane	39.5	56.3	62
Chlorbenside	ND	5.9	54
Chlorpyrifos	ND	0.7	62
Dacthal	9.6	21.6	60
DDD, o,p'	12.2	24.3	81
DDD, p,p'	45.8	84.6	81
DDE, o,p'	8.1	15.9	74
DDE, p,p'	176.5	330.5	81
DDMS, p,p'	3.1	5.3	74
DDMU, p,p'	7.0	11.3	74
DDT, o,p'	7.3	23.3	81
DDT, p,p'	32.3	97.0	81
Total DDT	315.3	500.0	81
Diazinon	ND	ND	52
Dichlorobenzophenone, p,p'	ND	ND	14
Dicofol	IS	IS	7
Dieldrin	12.6	22.4	59
Endosulfan I	94.6	126.4	62
Endosulfan II	54.3	74.6	25
Endosulfan Sulfate	51.0	74.8	24
Total Endosulfan	126.9	232.1	62
Endrin	2.4	4.1	60
Ethion	ND	ND	14
HCH, alpha	0.4	0.5	61
HCH, beta	ND	0.3	60
HCH, delta	ND	ND	60
HCH, gamma	0.3	0.5	60
Heptachlor	0.2	0.6	61
Heptachlor Epoxide	0.2	0.5	61
Hexachlorobenzene	0.1	0.2	61
Methoxychlor	ND	ND	60
Oxadiazon	ND	0.9	10
Parathion, ethyl	ND	ND	52
Parathion, methyl	ND	ND	52
PCB 1248	ND	14.7	86
PCB 1254	128.1	194.0	86
PCB 1260	ND	ND	86
Total PCB	132.0	194.0	86
PCT 5460	ND	ND	10
Pentachlorophenol	IS	IS	1
Phenol	IS	IS	0
Tetrachlorophenol	IS	IS	1
Tetradifon	ND	ND	51
Toxaphene	116.7	242.8	64
Tributyltin	IS	IS	5

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 Resident Freshwater Clams (*Corbicula fluminea*)

Calculated Using 1977 - 1993 Data

(ppb, wet weight)

Chemical	EDL 85	EDL 95	Number of Samples
Aldrin	ND	ND	16
Chlordene, alpha	ND	ND	16
Chlordene, gamma	ND	ND	16
cis-Chlordane	1.6	3.6	16
cis-Nonachlor	ND	0.4	16
Oxychlordane	ND	ND	16
trans-Chlordane	1.4	3.0	16
trans-Nonachlor	0.9	4.1	16
Total Chlordane	4.5	10.6	16
Chlorbenside	ND	ND	15
Chlorpyrifos	ND	ND	16
Dacthal	2.3	3.3	16
DDD, o,p'	1.8	13.7	16
DDD, p,p'	7.9	51.9	16
DDE, o,p'	0.8	8.2	16
DDE, p,p'	14.9	139.7	16
DDMS, p,p'	ND	ND	16
DDMU, p,p'	1.2	6.6	16
DDT, o,p'	ND	ND	16
DDT, p,p'	3.0	48.1	16
Total DDT	26.9	290.0	16
Diazinon	ND	ND	15
Dichlorobenzophenone, p,p'	IS	IS	8
Dicofol	IS	IS	7
Dieldrin	1.2	1.5	16
Endosulfan I	ND	6.9	16
Endosulfan II	ND	ND	15
Endosulfan Sulfate	ND	ND	15
Total Endosulfan	ND	18.1	16
Endrin	ND	ND	16
Ethion	IS	IS	8
HCH, alpha	0.3	0.5	16
HCH, beta	ND	ND	16
HCH, delta	ND	ND	16
HCH, gamma	ND	0.4	16
Heptachlor	ND	ND	16
Heptachlor Epoxide	ND	ND	16
Hexachlorobenzene	0.3	0.5	16
Methoxychlor	ND	ND	16
Oxadiazon	IS	IS	1
Parathion, ethyl	ND	ND	15
Parathion, methyl	ND	ND	15
PCB 1248	ND	ND	18
PCB 1254	14.3	65.2	18
PCB 1260	ND	ND	18
Total PCB	14.3	65.2	18
PCT 5460	IS	IS	3
Pentachlorophenol	IS	IS	0
Phenol	IS	IS	0
Tetrachlorophenol	IS	IS	0
Tetradifon	ND	ND	15
Toxaphene	ND	ND	16
Tributyltin	IS	IS	0

ND = EDL lies below the detection limit.

IS = Insufficient number of samples to calculate an EDL.

TABLE 13

State Mussel Watch Program

EDL 85 and EDL 95 for Organic Chemicals in Transplanted Freshwater Clams (*Corbicula fluminea*)

Calculated Using 1977 - 1993 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
Chlorpyrifos	40.0	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
DDMS, p,p'	ND	7.8	111
DDMU, p,p'	15.1	34.4	111
DDT, o,p'	41.9	126.2	111
DDT, p,p'	217.4	665.1	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	11
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	11
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
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
Pentachlorophenol	IS	IS	0
Phenol	IS	IS	3
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.

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