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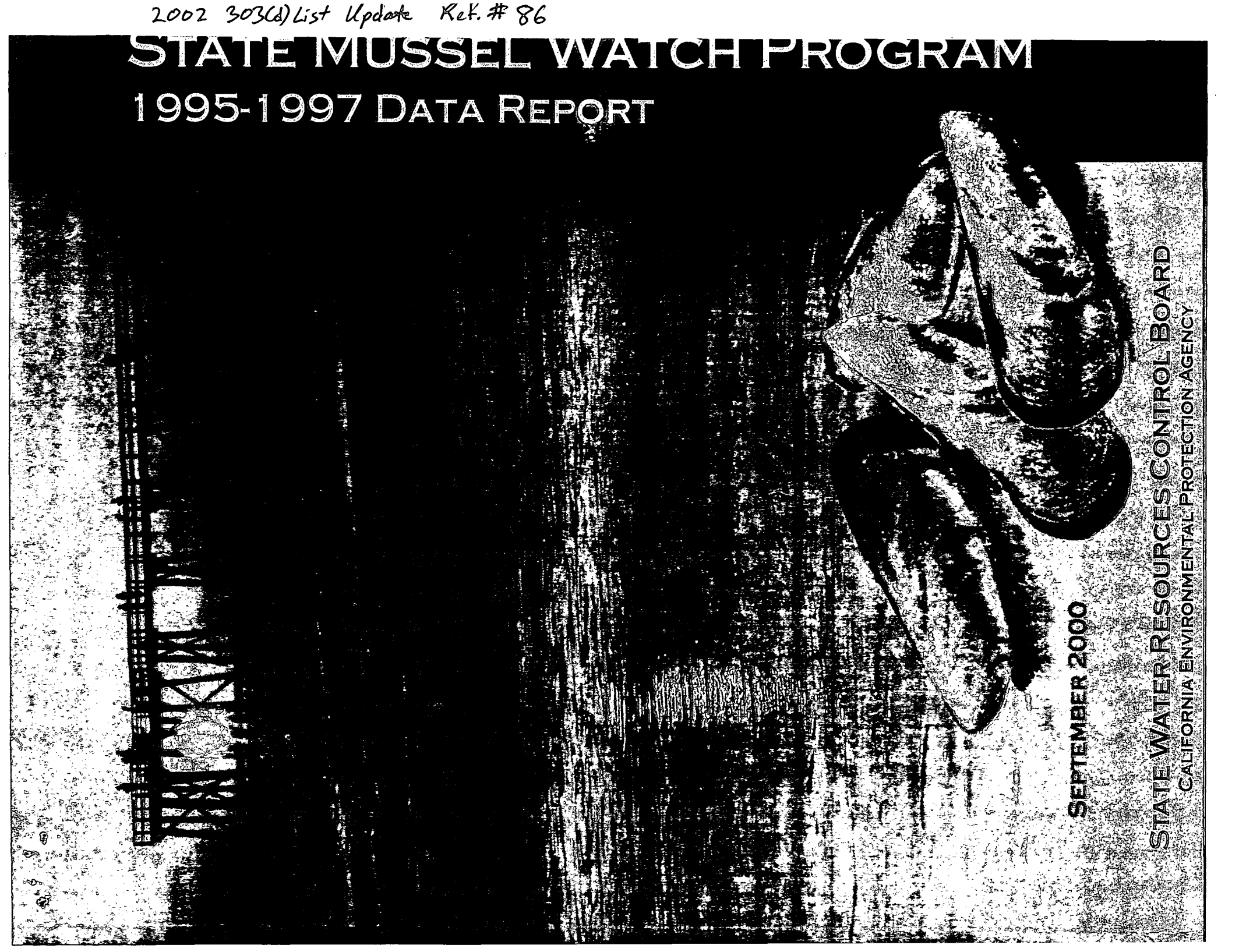
STATE MUSSEL WATCH PROGRAM

1995-1997 DATA REPORT



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STATE WATER RESOURCES CONTROL BOARD

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

STATE MUSSEL WATCH PROGRAM

1995-97

DATA REPORT

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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 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)
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)
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.