TOXIC POLLUTION
OF THE
SAN JOAQUIN RIVER:
THE PESTICIDE PROBLEM

Report prepared by:

Trygve B. Sletteland
428 Harborview Dr. SE #122
Bainbridge Island, WA 98110

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FOREWORD

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The author, however, is solely responsible for its content.

Trygve B. Sletteland

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INTRODUCTION

Reviewing the book San Joaquin: A River Betrayed before it was published in 1992, Fresno State University professor Roger Tatarian wrote that author Gene Rose reminds us that few American rivers have been so shamefully abused and exploited. "Dammed time after time in its upper reaches for power generation, the San Joaquin's waters have been so massively diverted for use by distant farmers that it has become a ghost of a river in its lower reaches." (1)

Much of this water is exported to the Tulare Basin via the Friant-Kern Canal. The Tulare Basin shares several characterisitcs with the westside San Joaquin Valley that are important from a water quality standpoint. Each lacks a natural drainage outlet, has similar soil conditions, and suffers from build-up of selenium and other poisonous salts and trace minerals due to poor irrigation practices.

It has been estimated that in recent years just five to six percent of the San Joaquin's average annual runoff has been allocated to help sustain life in the river and estuary. (2) Before the creation of Millerton Reservoir by construction of Friant Dam and the Friant-Kern and Madera canals, the stretch of the river above the Mendota Pool (see map 1) once provided about one-third of the total San Joaquin runoff reaching the south Sacramento-San Joaquin Delta. Last year was the first in seven that there was any water flowing between Friant and the Mendota Pool, and it has been estimated that historically about 98 percent of the San Joaquin has been diverted from the river, mostly for agricultural use. (3,4)

But it is not only hydropower projects and diversion of 98 percent of its water that have destroyed the San Joaquin's once abundant salmon runs. "By the time it reaches the Delta, it is little more than a public sewer -- a fouled, controlled drain for agriculture and municipal waste water." (4)

This report summarizes some current knowledge about toxic pollution of the San Joaquin River. This problem results from a variety of sources, including polluted runoff from urban areas, dairy waste, and accumulation of salts and trace minerals. While this last problem is briefly described below, this report focuses on a fourth critical source: pesticides.

SALTS AND TRACE MINERALS

Soils on the western side of the San Joaquin Valley result from marine sediments and are high in salts and trace elements that occur in marine environments. Nearly all commercial crops grown on the westside require irrigation, which has dissolved the salts and trace minerals and accelerated their movement into the shallow groundwater. (5) Water tables are high and agricultural drains are necessary throughout much of the westside and Tulare Basin, and drainage water frequently contains toxic concentrations of arsenic, boron, copper, chromium, molybdenum, nickel and -- last, but certainly not least -- selenium. (6) The Tulare Basin, which occupies roughly the southern half of the San Joaquin Valley as shown on map 2, is a hydrologically closed area that is drained by the San Joaquin River only in extremely wet years. Under more normal or drier conditions, the San Joaquin River drains only the northern half of the valley.

Inadequate drainage and accumulating salts have been a persistent problem in the western and southern parts of the San Joaquin Valley for more than a century, making some land unusable for agriculture as far back as the 1880s. (7) In 1983, the discovery of deformed and dead waterfowl at Kesterson Reservoir (see map 3), a designated national wildlife area, dramatically increased public awareness of westside San Joaquin drainage problems.

Kesterson was built as a regulating reservoir for the San Luis Drain, which was intended to collect and transport irrigation drainage from 300,000 acres of westside farmland to the Sacramento-San Joaquin River Delta. Because of concerns about impacts on water quality in the San Francisco Bay-Delta estuary, the drain has never been completed. In 1990 it was estimated that between 35,000 and 56,000 acre feet of collected subsurface agricultural drainage water was being discharged to the San Joaquin River. (6)

PESTICIDES

State Board Studies

To provide a uniform statewide approach to the detection and evaluation of the occurence of toxic substances in the fresh and estuarine waters of California, the State Water Resources Control Board (State Board) began its Toxic Substances Monitoring Program in 1976. The TSMP data is collected by the Department of Fish and Game, which gathers and analyzes fish and other aquatic organisms. The sampling stations in the San Joaquin and Tulare basins are shown on map 2.

Areas where pesticide levels were found in high concentrations over many years include the San Joaquin River and its three principal tributaries, the Merced, Tuolumne and Stanislaus rivers (see map 1). The Vernalisstation near the mouth of the most downstream of these rivers -- the Stanislaus -- had the most exceedances of U.S. Food and Drug Administration (FDA) standards during the period 1978 through 1987, with six occurring in 1983, 1984, and 1986. (8)

The FDA has established maximum concentrations for toxic substances in human foods. The levels are based on specific assumptions about the quantities of food consumed by humans and on the the frequency of their consumption. The FDA limits are intended to protect humans from the chronic effects of toxic substances contained and consumed in their food.

The hazardous chemicals detected by the State Board in fish and other organisms from the San Joaquin River and its tributaries included carbaryl, carbofuran, chlordane, chlorpyrifos, diazinon, DDT, dimethoate, diuron, endosulfan, fonofos, HCB, methidathion, methomyl, oxamyl, parathion, and toxaphene. The use and abuse of each of these chemicals is discussed below.

Carbaryl

This pesticide is widely used on cotton, soybeans, corn, other vegetables and fruit. It was introduced by Union Carbide Corporation (now Rhone-Poulenc Ag Co.), which manufactured 55 million pounds in 1971. In 1990, over 800,000 pounds were applied to 42 crops in Central Valley counties. Tulare, Kern and Fresno were the top three users. (9)

The National Academy of Sciences (NAS) recommends a maximum concentration of 0.02 ppb (parts per billion) in order to protect crustaceans, amphibians, molluscs, fishes, and other life forms from carbaryl toxicity (9). Carbaryl was detected in concentrations ranging from 0.6 to 8.4 ppb in San Joaquin Basin surface waters in 1991-92. (10) This represents a factor of 30 to 420 times the NAS recommended maximum concentration.

Carbofuran

The 1990 San Joaquin Basin plan was amended by the Central Valley Regional Water Quality Control Board to include a regulatory limit for carbofuran of 0.4 ppb (11). In 1990, this performance goal was exceeded one to two-fold at five locations on the San Joaquin River between river mile 89 (above the mouth of the Tuolumne River) and river mile 125 (above the mouth of the Merced River. (12)

Over 326,000 pounds of carbofuran were applied to crops in California in 1991, including 46,280 pounds to rice in Merced County, 126,908 pounds to grapes, and 133,419 pounds to alfalfa. (13) Data is presently sorely lacking on the acute and chronic toxicity of carbofuran.

Chlordane

Used for termite control, chlordane is a known carcinogen listed by the state, as required by the 1986 Safe Drinking Water and Toxic Enforcement Act. Prior to being prohibited from use in 1988, its use statewide peaked at 639,529 pounds in 1987. However, many pesticides have long half-lives and will continue to be found in the environment for many more years. (8)

Chlorpyrifos

The use of this insecticide increased from 55,000 pounds in 1978 to 1,700,000 pounds in 1988. In the latter year, its primary use was to control pests on cotton and alfalfa. Chlorpyrifos was by far the most widely used of the pesticides monitored in the State Water Resources Control Board's Toxic Substances Monitoring Program since 1984. (8,14) In 1990, 1,427,341 pounds were applied to 27 crops in Central Valley counties, with Tulare, Fresno and Kern using the most. (9)

Chlorpyrifos is considered extremely toxic to fish, birds and other wildlife, and has been implicated in fish kills. (15) The U.S. EPA has established a freshwater 4-day criteria for chlorpyrifos of 0.041 ppb. (10) In 1991-92, the chemical was detected 180 times in the San Joaquin basin. Concentrations ranged as high as 39 times the EPA criteria, which "...is not sufficiently protective to prevent acute toxicity to organisms such as the opposum shrimp, *Mysidopsis bahia.*" 10: 51)

During the period 1988 through 1990, chlorpyrifos was found in the New Jerusalem Drain, well below the confluence of the San Joaquin and Stanislaus rivers, at levels 146 to 212 times greater than the Environmental Protection Agency (EPA) recommended criteria to protect freshwater aquatic life. (16)

Diazinon

665,124 pounds of diazinon were applied to 32 crops in the Central Valley in 1990. Fresno, Kern and Merced counties were the top three users; crops included cotton, alfalfa, fruit and nuts. (9)

The recommended maximum concentration is 0.009 ppb, but diazinon was detected 210 times in the San Joaquin Basin in 1991-92 in concentrations ranging from 0.01 to 2.6 ppb, exceeding the criteria by a factor of up to 288. (10)

DDT

The use of DDT and the related compound DDE have been prohibited in the U.S. since the early 1970s because of their destructive effects on wildlife, carcinogenicity, and persistence in the environment. In general, levels of DDT in fish have yet to show a decline with cancellation of its use. (8)

Dimethoate

Dimethoate is classified in toxicity category I, defined as highly toxic to mammals and requiring the signal words "danger-poison" on labels. Nearly 600,000 pounds were applied to 21 crops in Central Valley counties in 1990, with Tulare, Kern and Fresno using the most. Crops to which it was applied included alfalfa, fruits and vegetables. (9)

Dimethoate was found in San Joaquin Basin surface waters 44 times in 1991-92 in concentrations ranging from 0.05 to 1.05 ppb. Maximum concentration recommendations have not yet been made for this chemical, presumably because "[m]ore studies are needed describing the effects of chronic exposure to dimethoate." (9: 82)

Diuron

During 1990, nearly 600,000 pounds of diuron were applied to 20 crops in Central Valley counties. Those using the most were Tulare, Fresno, Kern and San Joaquin counties. It is also used for weed control and as a pre-emergent herbicide on crops such as cotton, citrus and other fruits. (9)

While "[m]uch more research is needed on the acute toxicity of diuron to all taxa", the recommended maximum for diuron in waters is 1.6 ppb. (9:114, 5) Diuron was found in Central Valley surface waters 23 times in 1992. The mean concentration at which it was detected was 6.09 ppb. (18)

Endosulfan

This insecticide is extremely toxic to aquatic organisms and also acutely toxic to mammals. While the Department of Food and Agriculture restricted the use of endosulfan in 1973, nearly 340,000 pounds of the chemical were used in California in 1991. The top five crops on which it was used were cotton, alfalfa, grapes, cantaloupe and head lettuce. (13) Scientists recently provided testimony (before the House Energy and Commerce subcommittee on health and the

environment) linking endosulfan and other estrogenic chemicals with breast cancer in women. When approving their use on crops, EPA does not screen pesticides for chemical properties that imitate the human reproductive hormone estrogen. (17)

Fonofos

Over 33,000 pounds of fonofos were applied to Central Valley crops in 1990. These included tomatoes, corn, beans, asparagus and peppers. Leading counties in use were San Joaquin, Sacramento and Stanislaus. (9)

Fonofos is classified as highly toxic to mammals and requires the words "danger-poison" on product labels. However, no criteria have been promulgated as yet to protect freshwater aquatic organisms. In 1991-92, fonofos was detected in San Joaquin Basin surface waters 43 times in concentrations between 0.01 and 0.54 ppb. (9)

HCB

Hexachlorbenzene is no longer used nationwide because of its high soil pesistence and known carcinogenicity. Commercial production was discontinued in 1976, yet as late as 1989 it was found at levels exceeding FDA criteria in the San Joaquin River at Vernalis and Paradise Cut near Tracy. (8,14)

Methidathion

Over 330,000 pounds of methidathion were applied to Central Valley crops in 1990. Those counties using the most were Tulare, Fresno, Kings and Kern. Crops dusted included alfalfa, fruit and nuts. (9)

Methidathion is classified as "moderately" toxic to mammals and requires the word "warning" on product labels. One teaspoon taken orally could cause death. "The extremely limited acute toxicity data indicate that crustaceans and fishes are the most sensitive to methidathion." (9:103)

No criteria have been published as yet for this chemical. Concentrations of methidation ranging from 0.14 to 15.1 ppb were detected 11 times in Central Valley surface waters in 1992. (18)

Methomyl

Nearly 540,000 pounds of methomyl were applied to 33 crops in the Central Valley in 1990. Counties using the most were Fresno, Kern and Tulare. Crops included alfalfa, vegetables and fruit. (9)

Methomyl is classed as highly toxic to mammals and requires the words "danger-poison" on product labels. It was found 59 times in San Joaquin Basin waters during 1991-92 at concentrations between 2.6 and 5.4 ppb; however, freshwater aquatic organisms are not being protected because no maximum allowable concentrations have been identified as yet. (9)

Oxamyl

Nearly 12,000 pounds of oxamyl were applied to 21 crops in Central Valley counties in 1990. These included melons, peppers, apples, cucumbers and tomatoes. San Joaquin, Merced and Stanislaus counties used the most. (9)

While oxamyl is classed as having high mammalian toxicity, no criteria exist for protecting freshwater aquatic organisms. The chemical was detected three times in San Joaquin Basin surface waters in 1991-92. (9)

Parathion

Ethyl parathion use in California peaked at 1,100,000 pounds in 1988, primarily on almonds. Methyl parathion, used primarily on alfalfa and rice, reached a peak application of 413,000 pounds in 1978. (14) Since it was banned by the U.S. EPA as a result of human health concerns, parathion is no longer used on crops in California. (20)

Toxaphene

A carcinogenic insecticide, toxaphene has been used widely over the years in California, primarily on cotton. It has also been applied to alfalfa and a variety of vegetables. The State Board has found it to present "by far the most serious pesticide problem" in the San Joaquin drainage. (8:83) There has been a great decrease in its use statewide, which went from over a million pounds in 1978 to under a thousand pounds in 1987. In the latter year, 96 percent was applied to cotton and alfalfa. As of 1987, no evidence had been found to suggest a decrease in the detection levels of toxaphene, even though its use had decreased dramatically by that time. (8)

Regional Board Studies

The Basin Plan adopted by the Central Valley Regional Water Quality Control Board (Regional Board) requires that "all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in...aquatic life." (18:ix) The Inland Surface Waters Plan adopted by the State Board in 1991 requires that there shall be no chronic toxicity in receiving waters and that attainment shall be measured in freshwater by use of the EPA 3-species bioassay test. The plan also directs Regional Boards to conduct follow-up studies in waters with chronic toxicity to determine the source of the pollution and insure that those responsible take all reasonable actions to eliminate it.

From 1988 to 1990, to assess water quality in the basin, the Regional Board conducted surveys of the San Joaquin watershed. The study found a 43-mile stretch of the San Joaquin between the confluence of the Merced and Stanislaus rivers that was toxic forty to fifty percent of the time to the invertebrate component of the 3-species test. "The primary cause of the toxicity appeared to be pesticides entering the River in rain and tailwater runoff from row, field, and orchard crops. Two agricultural practices that contribute to pesticide residues in the San Joaquin River in winter and early spring are the application of dormant sprays to orchards and the application of weevil control insecticides to alfalfa." (18:ix)

RECOMMENDATIONS

1. Criteria to protect freshwater aquatic organisms should be established by the U.S. EPA or National Academy of Sciences for: dimethoate (9:82), fonofos (9:94), methidathion (9:103), methomyl (9:27), and oxamyl (9:40).

2. The National Academy of Sciences should establish a recommended maximum concentration for the degradation products of diuron. (9:114)

3. More data should be gathered on the acute toxicity to aquatic organisms and other taxa of: dimethoate (9:82), diuron (9:114), fonofos (9:94), and oxamyl (9:40).

4. More data should be gathered on the chronic toxicity to organisms of: diuron (9:114), fonofos (9:94), and oxamyl (9:40).

5. Research should be done on the acute and chronic toxicity to aquatic organisms of the degradation products of: carbofuran (19:iii), chlorpyrifos (9:51), diazinon (9:66), dimethoate (9:82), diuron (9:114), fonofos (9:94), and oxamyl (9:40).

6. More studies should be done on the effects of chronic exposure to dimethoate. (9:82)

7. Research should be done on the persistence on crops of: carbaryl (9:5), methomyl (9:26), and oxamyl (9:40).

8. Research should be done on the persistence of the following chemicals in natural waters and/or soils: carbaryl (9:5) dimethoate (9:82), diuron (9:114), fonofos (9:94), methidathion (9:103), methomyl (9:40), and oxamyl (9:40).

9. Research should be done to identify the degradation products and pathways of: carbaryl (9:5), chlorpyrifos (9:51), dimethoate (9:82), diuron (9:114), fonofos (9:94), methidathion (9:103), methomyl (9:27), and oxamyl (9:40).

10. Research should be done on bioconcentration of: carbaryl (9:5), dimethoate (9:82), diuron (9:114), fonofos (9:94), methidathion (9:103), methomyl (9:27), and oxamyl (9:40).

LITERATURE CITED

(1) Tatarian, Roger, *A river scums through it*, Hayward Review, Hayward, California, December 1, 1992.

(2) Loudermilk, William, *The ambulatory San Joaquin*, Bay on Trial, newsletter of the Bay Institute of San Francisco, vol. V, no. 2, spring, 1993.

(3) Rose, Gene, personal communication, letter dated September 1, 1993.

(4) Rose, Gene, *San Joaquin: A River Betrayed*, Linrose Publishing Co., Fresno, California, 1992.

(5) Gilliom, R.J., et al, *Preliminary Assessment of Sources, Distribution, and Mobility of Selenium in the San Joaquin Valley, California*, U.S. Geological Survey, Water-Resource Investigation Report No. 88-4186, 1989.

(6) U.S. Department of the Interior and California Resources Agency, *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*, Final Report of the San Joaquin Valley Drainage Program, September, 1990.

(7) Ogden, G.R., *Agricultural Land Use and Wildlife in the San Joaquin Valley, 1769-1930: An Overview*, SOLO Heritage Research, Report Prepared for the San Joaquin Valley Drainage Program, Sacramento, March, 1988.

(8) Rasmussen, Del and Heide Blethrow, *Toxic Substances Monitoring Program, Ten Year Summary Report 1978-1987*, 90-1 WQ, Division of Water Quality, Water Resources Control Board, Environmental Protection Agency, State of California, Sacramento, August, 1990.

(9) Sheipline, Robert, *Background Information on Nine Selected Pesticides*, Staff Report of the California Regional Water Quality Control Board, Central Valley Region, April, 1993.

(10) Foe, Christopher, in preparation.

(11) Regional Water Quality Control Board, Central Valley Region, *Water Quality Control Plan for the Sacramento River, Sacramento-San Joaquin Delta, and San Joaquin River Basins*, Resolution No. 90-028, Sacramento, January 26, 1990.

(12) Regional Water Quality Control Board, Central Valley Region, *Detection of Pesticides in the San Joaquin River on 27 March and 24 April, 1990*, Memorandum, Sacramento, June 25, 1990.

(13) California EPA, *Summary of Pesticide Use Report Data, Annual 1991*, Department of Pesticide Regulation, Information Services Branch, Sacramento, January, 1993.

(14) Rasmussen, Del and Heide Blethrow, *Toxic Substances Monitoring Program, 1988-89*, 91-1 WQ, Division of Water Quality, Water Resources Control Board, Environmental Protection Agency, State of California, Sacramento, June 1991.

(15) Pait, A.S., A.E. De Souza, and D.R.G. Farrow, *Agricultural Pesticide Use in Coastal Areas: A National Summary*, National Oceanic and Atmospheric Administration, Rockville, Maryland, 1992.

(16) Foe, Christopher and Valerie Connor, *San Joaquin Watershed Bioassay Results, 1988-90*, Regional Water Quality Control Board, Central Valley Region, State of California, Sacramento, July, 1991.

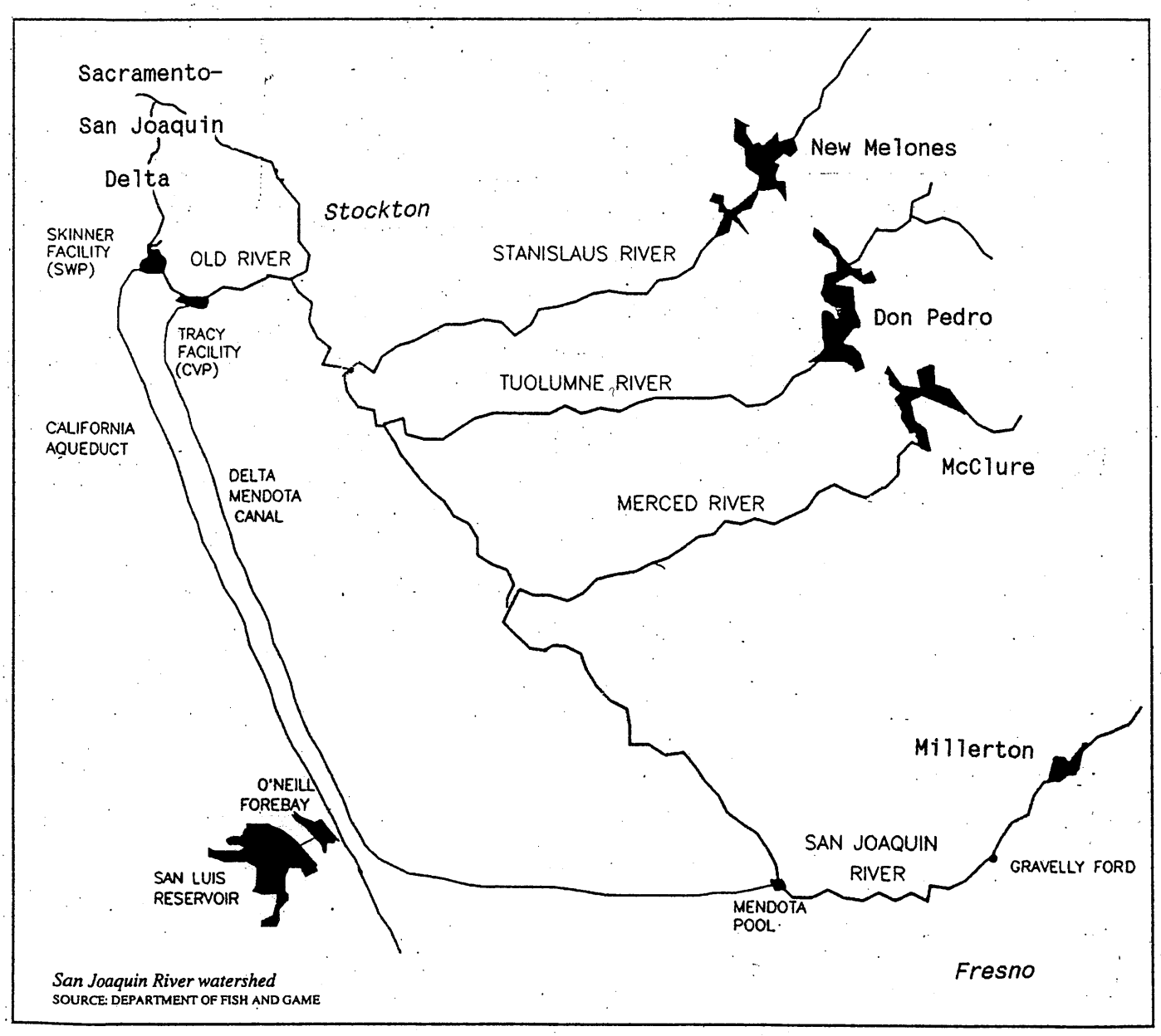
(17) *Scientists Link Pesticide to Breast Cancer*, San Francisco Chronicle, October 22, 1993.

(18) Foe, Christopher and Robert Sheipline, Pesticides in Surface *Water from Applications on Orchards and Alfalfa During the Winter and Spring of 1991-92*, Regional Water Quality Control Board, Central Valley Region, State of California, Sacramento, February, 1993.

(19) California Department of Fish and Game, *Hazard Assessment of the Insecticide Carbofuran to Aquatic Organisms in the Sacramento River System*, Environmental Services Division, Administrative Report 92-3, Sacramento, 1992.

(20) Foe, Christopher, personal communication, letter dated October 4, 1993.

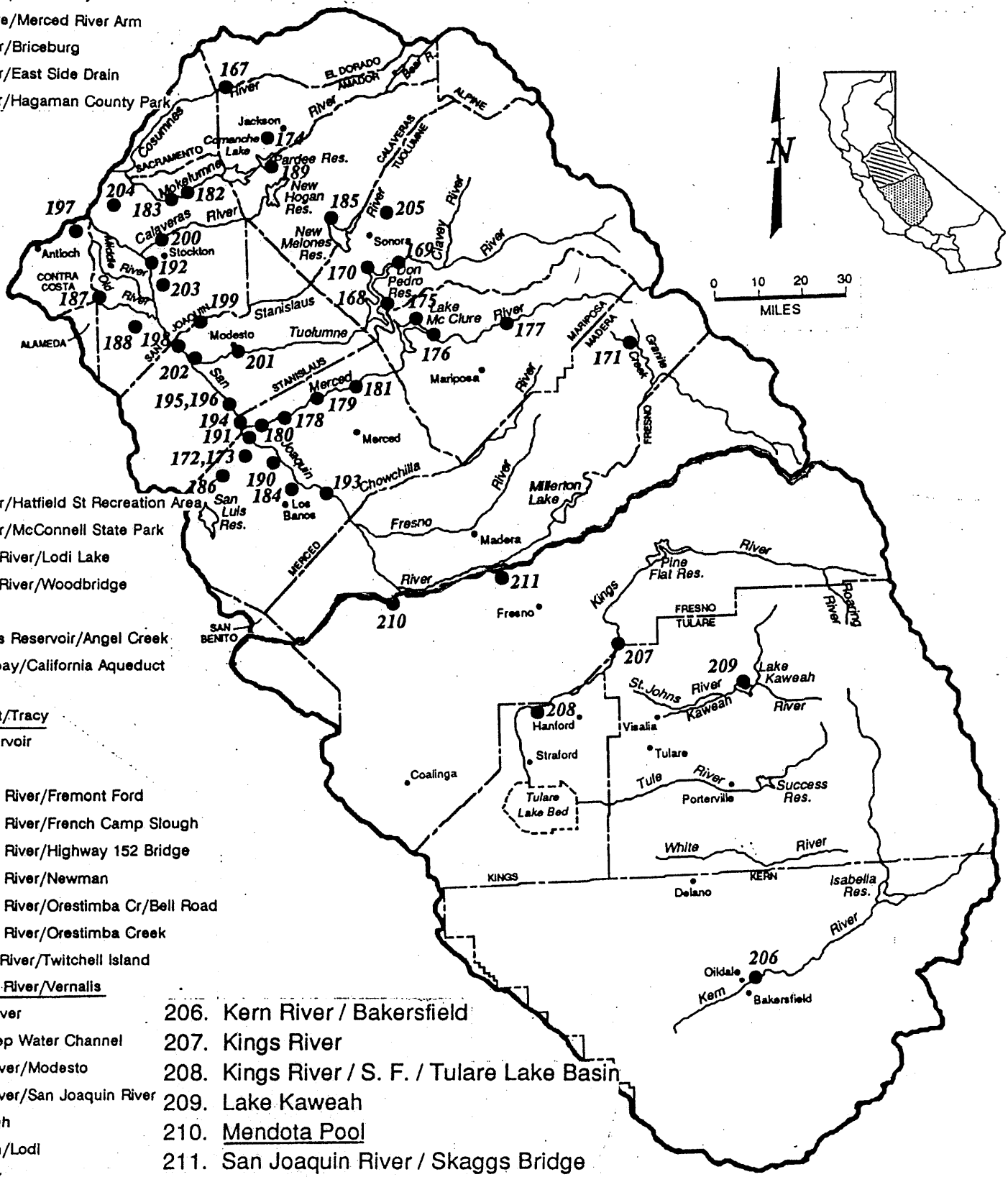
MAP 1
San Joaquin River
Major Tributaries & Reservoirs



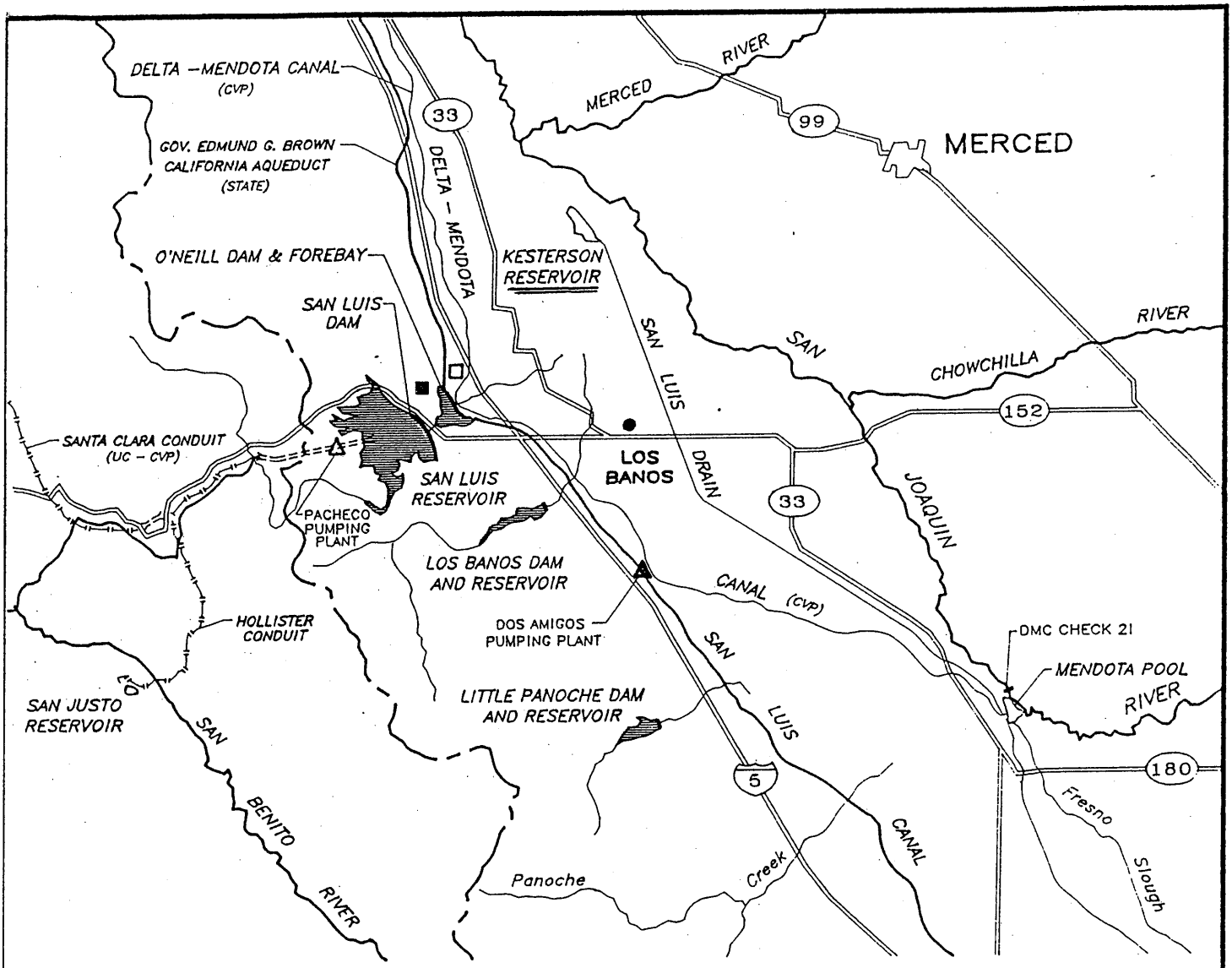
Station Identification List

167. Cosumnes River
168. Don Pedro Reservoir/Moccasin Creek
169. Don Pedro Reservoir/Tuolumne River
170. Don Pedro Reservoir/Woods Creek
171. Granite Creek/W.F.
172. Kesterson N.W.R./Pond 2
173. Kesterson N.W.R./Pond 5
174. Lake Amador
175. Lake McClure/Main Body
176. Lake McClure/Merced River Arm
177. Merced River/Briceburg
178. Merced River/East Side Drain
179. Merced River/Hagaman County Park
180. Merced River/Hatfield St Recreation Area
181. Merced River/McConnell State Park
182. Mokelumne River/Lodi Lake
183. Mokelumne River/Woodbridge
184. Mud Slough
185. New Melones Reservoir/Angel Creek
186. O'Neill Forebay/California Aqueduct
187. Old River
188. Paradise Cut/Tracy
189. Pardee Reservoir
190. Salt Slough
191. San Joaquin River/Fremont Ford
192. San Joaquin River/French Camp Slough
193. San Joaquin River/Highway 152 Bridge
194. San Joaquin River/Newman
195. San Joaquin River/Orestimba Cr/Bell Road
196. San Joaquin River/Orestimba Creek
197. San Joaquin River/Twitchell Island
198. San Joaquin River/Vernalis
199. Stanislaus River
200. Stockton Deep Water Channel
201. Tuolumne River/Modesto
202. Tuolumne River/San Joaquin River
203. Walker Slough
204. White Slough/Lodi
205. Woods Creek

MAP 2
Toxic Substance Monitoring Stations, 1978-87
San Joaquin & Tulare Lake Basins
[Figs. 7b, 7c in citation (8), this report]



206. Kern River / Bakersfield
207. Kings River
208. Kings River / S. F. / Tulare Lake Basin
209. Lake Kaweah
210. Mendota Pool
211. San Joaquin River / Skaggs Bridge



MAP 3

Central Valley Project, W. San Joaquin & San Felipe Divisions
(Fig. 13 in CVP-OCAP, U.S. Bureau of Reclamation, 10/92)