Health Consultation

EXAMINATION OF CONTAMINATION IN FISH
OF THE NEW RIVER AT WESTMORLAND

WESTMORLAND, IMPERIAL COUNTY, CALIFORNIA

FEBRUARY 18, 2000

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BACKGROUND AND STATEMENT OF ISSUES

The purpose of this health consultation is to evaluate the levels of chemical contamination in fish from the New River, as measured in a recent binational environmental monitoring program, and to estimate the potential public health effects, if any, of that contamination.

The California Department of Health Services (CDHS) Environmental Health Investigations Branch (EHIB), under cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), is conducting health assessment activities for the communities that lie along the New River in Imperial County, California. As a part of these activities, CDHS has prepared a series of health consultations that evaluate the public health implications of the chemical contamination in the water column, suspended and bottom sediments in the New River and the Colorado River (28 – 31). This health consultation evaluates the public health implications of eating contaminated fish from the New River, and a future document will address the same issues for fish from the Colorado River. All of these health consultations are based upon data obtained from a Binational Study Group, commissioned by the United States (U.S.) and Mexican governments, for the purpose of studying water quality issues at the U.S./Mexican Border (1).

Site Description

The New River flows northward, from the Colorado River in Baja California, Mexico, for about 20 miles, to the International Border, and on to the Salton Sea in the U.S. On the Mexican side of the border, it passes through the city of Mexicali. On the U.S. side of the border, it passes through the city of Calexico. The New River flows for approximately 60 more miles through Imperial County, passing near or through several other towns, including Seely, El Centro, Brawley, and Westmorland, where it terminates at the Salton Sea (Figures 1,2) (3). At the Salton Sea, approximately one third of the total flow is of Mexican origin, and includes agricultural runoff, untreated and partially treated sewage, and industrial wastewater. The remaining flow comes mainly from agricultural runoff and irrigation return flow on the U.S. side of the border (2,3).

The city of Mexicali has a population of approximately 600,000 and is growing at an annual rate of 1.7 percent. The New River flows through the urban part of Mexicali. Approximately 200 industrial facilities are located in Mexicali. Among these are facilities called *maquiladoras*, which are foreign-owned manufacturing facilities that are operated in Mexico (2).

Imperial County is predominately agricultural, with a population spread among numerous small towns and cities. After passing through the U.S. city of Calexico, the New River passes through predominately agricultural land as it flows to the south side of the Salton Sea (3).

In addition to the New River, the Whitewater River flows into the Salton Sea from the north and the Alamo River flows into the Salton Sea from the south. There is, however, no outlet from the Salton Sea. Thus, there is the potential for buildup of contamination in the Salton Sea.

Site History and ATSDR Involvement

For over 50 years, the New River has been a concern for both the U.S. and Mexican governments. As far back as 1944, both governments have been promising to clean up the river, but aside from upgrades to the Mexicali sewage system, little has been accomplished.

In November 1993, the Board of Supervisors of Imperial County, California, petitioned ATSDR to evaluate the public health impact of the New River. In response, ATSDR prepared a petitioned health consultation (3). The petitioned health consultation evaluated environmental data for the New River, collected from 1969 to 1994, from sampling stations at the International Boundary and along the New River, up to the Salton Sea. These samples were collected as a part of an ongoing water quality monitoring program. Agencies involved with this program include the U.S. Geological Survey, Region 7 of the California Regional Water Quality Control Board, the California Department of Fish and Game, and the State Water Resources Control Board.

The petitioned health consultation concluded that the primary threat to public health was fecal streptococci and other pathogens found in surface water and in the foam, which is often seen floating on the river surface. While some chemical contaminants were present in the water at concentrations higher than comparison values, the authors concluded that adverse health effects (noncancer and cancer) were unlikely to occur. In addition, New River fish did contain some chemical contamination. The levels of contamination were such that people could probably consume small amounts of fish without adverse health effects. However, based upon the risks posed by biological contamination, the authors recommended against eating any fish.

Based upon these conclusions, the petitioned health consultation recommended that access to the New River be restricted where possible, and that warning signs should be posted or improved; coordination and cooperation between the U.S. and Mexican governments be promoted; awareness of contamination issues in the New River be raised for residents and government officials on both sides of the border; and area residents be advised of the potential dangers of eating aquatic animals from the New River and to avoid contact with the foam (3).

As mentioned above, the data examined for the petitioned health consultation covered the period of 1969 to 1994. When evaluating these data for potential adverse health effects, the worst case data were used, which in some cases were 15 to 20 years old. Thus, when the petitioned health consultation was presented to the public, there was concern about the relevance of some of these data. Because of this concern, CDHS decided to evaluate more recent environmental data in this and other health consultations. In addition to these health consultations, CDHS conducted an educational program for health care providers from both sides of the border in April 1997.

Demographics

Based upon 1990 Census data, the majority of the population of Imperial County lies in a corridor along the New River, extending approximately five miles to the west of the New River, and approximately 10 miles to the east of the New River, and running from the U.S.-Mexico Border to the Salton Sea (Figure 2). The total population in this corridor is approximately 102,000 people. The population is 48.9% male and 51.1% female. The racial composition of the

population is: 26.6% white non-Hispanic; 2.3% black non-Hispanic; 0.3% Native American non-Hispanic; 0.1% other non-Hispanic; and 69.1% Hispanic. The ages of the population break down as follows: 0 – 18 years old, 37.3%; 19 – 29 years old, 16.1%; 30 – 39 years old, 15.5%; 40 – 49 years old, 11.0%; 50 – 59 years old, 7.8%; 60 – 69 years old, 7.0%; and greater than 70 years old, 5.4%.

Community Concerns

As discussed above in **Site History**, the New River has been a source of concern for area residents for many years. Residents complain about odors, as well as insects such as flies and mosquitoes, that come from the river. County public health officials have expressed great concern about workers, especially emergency response workers, coming into contact with the water of the New River. In addition, area physicians have expressed concerns about the findings in the 1996 petitioned health consultation which documents biological contamination, including fecal streptococci and coliforms, and pathogens capable of causing diseases such as polio, typhoid, cholera, tuberculosis, and encephalitis.

Area residents are also concerned about chemical contamination in the New River, and the effects of that contamination on fish in the New River. The petitioned health consultation, however, cited data that were in some cases almost 20 years old. Thus, people were somewhat skeptical about the relevance of these data, and were very interested in a governmental agency collecting and evaluating more current data.

Environmental Contamination

In June 1995 and April 1996, the Binational Study Group collected fish from the New River at Westmorland, near the location where the New River flows into the Salton Sea. Five fish of two types were collected: three carp, and two channel cat fish. A carp and a channel cat fish were collected in early June 1995, a carp was collected in late June 1995, and a carp and a channel catfish were collected in April 1996. The fillet portions were analyzed for organic and inorganic species (Table 1). No data were available regarding levels of chemical contamination in whole fish, nor was there any information regarding the size and approximate age of the fish, or on the method used to obtain the fish.

Thirty-three out of 42 total organic target chemicals were detected among the various fish fillet samples. The primary organic chemicals detected in all five fish fillet samples include total chlordane, 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane (DDT), toxaphene, and polychlorinated biphenyls (PCBs). Hexachlorobenzene was detected in four fish fillet samples. Other organic chemicals were detected in a few, but not all, of the fish fillet samples. All five inorganic target chemicals were detected in all five fish fillet samples. The primary inorganic chemicals detected were mercury, arsenic, and selenium.

One factor to consider in evaluating contamination in fish is whether the chemical in question occurs naturally in the fish's environment or in the fish itself. All of the organic species are man-made chemicals, and thus there is no naturally occurring level. Any level of these chemicals measured in the environment or in fish tissue is a result of pollution due to human activity. Some

of these organic chemicals tend to accumulate in the fatty tissues of fish. However, the inorganic species being measured in this study can occur naturally in the environment, and as a result of human activities.

Fish Species Studied in this Project

Two species of fish, carp and channel catfish, were caught from the New River at Westmorland.

Carp

The carp (Cyprinus carpio, family Cyprinidae), is an omnivorous feeder, with invertebrates such as mollusks, crustaceans, and insect larvae, as well as filamentous green algae and aquatic plants, forming a large part of its diet. When feeding, the carp often takes up bottom sediment, extracts the invertebrate or plant food material, and rejects the sediment material. This practice, called "grubbing", muddies the water in which the carp is feeding, and also destroys the habitat of fish species that require clear water. Carp are prolific breeders with abundant populations in most areas throughout California. Their rapid reproduction, as well as their feeding habits, has had a deleterious effect on many native species. The carp's popularity as a sport fish has been on the increase, especially in areas in which there is a heavy influence of Asian culture (6–8).

Channel Catfish

The channel catfish (Ictalurus punctatus, family name Ictaluridae) is one of the larger species of the catfish family. It feeds on a variety of aquatic life, including other fish, insects, and crustaceans. The channel catfish tends to stay in deep holes under banks or root tangles when not feeding, and also spawns in such areas. Many California reservoirs lack this type of habitat, and must be restocked from hatchery-raised channel catfish. Adult channel catfish are highly migratory, especially when spawning. They are considered by some sport fishers to be superior to other members of the catfish family because of its excellent food and sportfish value (7,8).

DISCUSSION

Pathways Analysis

For a receptor population to be exposed to environmental contamination, there must be a mechanism by which that contamination comes into direct contact with that population. An exposure pathway is the description of that mechanism. An exposure pathway consists of five elements: a source of contamination; an environmental medium and transport mechanism; a point of exposure; a route of exposure; and a receptor population.

Exposure pathways are classified as completed, potential, or eliminated. A completed exposure pathway is one in which all five elements are present. A potential pathway is one in which one or more elements are missing, but might be present later. A pathway may also be described as a potential pathway if information on one of the elements of the pathway is missing. An eliminated pathway is one in which one or more of the elements is missing and will not be present in the future. For a population to be exposed to an environmental contaminant, a completed exposure pathway must exist (all five elements must be present). If any one or more of these elements is

missing, then there is no exposure, though the presence of contamination may still be significant and require clean up. This is especially true if there is a possibility of an incomplete exposure pathway becoming complete in the future.

Completed Exposure Pathways

CDHS determined that there is one completed exposure pathway, that of the receptor population eating contaminated fish caught from the New River (Table 2). CDHS considers this to be a completed exposure pathway because it has been reported that people in the area do eat New River fish.

CDHS divided the receptor population into four subgroups: high-end sport fishers, typical sport fishers, and the children of high-end and typical sport fishers. Sport fishers are assumed to be adults weighing 70 kilograms (kg) (approximately 154 pounds) and who are greater than 18 years of age (Table 3). High-end sport fishers are assumed to consume an average of 107 grams per day (g/day) of sport (noncommercial) fish (24). This is the equivalent of eating about 14 eight-ounce meals of sport fish per month. Typical sport fishers are assumed to consume an average of 21 g/day of sport fish (24). This is equivalent to eating about three eight-ounce meals of sport fish per month.

These consumption rates were obtained from the *Santa Monica Bay Seafood Consumption Study*, published in June 1994 (24). The objectives of this study were to "... describe the demographic characteristics of recreational anglers that fish in the Santa Monica Bay, California, to assess their seafood consumption, and to determine the species that are being caught and consumed at the highest rates." The consumption rate of 107 g/day is the amount of fish consumed by the highest 10% of fishers studied. The consumption rate of 21 g/day is the median consumption rate of fishers studied in this report.

Children of sport fishers are assumed to eat the same number of meals per month as their high-end sport fishing parents or typical sport fishing parents (14 and 3, respectively), to weigh 17 kg (a little over 37 pounds) and to consume approximately 28 g per 10 kg body weight per meal (approximately 1.7 oz fish per meal) (8a) (Table 3). This results in an average daily fish ingestion rate of 22 g/day for children of high-end sport fishers and an average ingestion rate of 4.8 g/day for children of typical sport fishers.

Public Health Implications

In order to assess the potential health effects of environmental contamination on a nearby population, one must first identify those contaminants that are present at high enough concentration to possibly cause adverse health effects. Those contaminants so identified are called contaminants of concern. In this document, contaminants of concern are identified as described below.

Noncancer Adverse Health Effects

Chemicals with similar noncancer toxicological effects were evaluated as a group according to the following procedure: the hazard quotient was calculated for each chemical. The hazard

quotient is the ratio of the actual dose of the chemical to the Minimum Risk Level (MRL) or Reference Dose (RfD) for that chemical. If the hazard quotient is greater than one, then there is a potential for adverse health effects. If the hazard quotient is less than or equal to one, then adverse health effects are considered unlikely. Once the hazard quotient is calculated for each detected chemical, then the hazard quotient for each chemical with a similar toxicological end point (neurological effects, kidney or liver toxicity, etc.) is added together to create a hazard index. If the hazard index is greater than one, even if the hazard quotients of the individual chemicals are less than one, then the combined effect of all of the chemicals might cause adverse health effects. If the hazard index is less than or equal to one, then adverse health effects are considered unlikely, and these chemicals are not considered further. If only one chemical causing a particular effect is detected, then that chemical is evaluated individually (9).

The MRL or RfD is the dose of a chemical, calculated by ATSDR and the U.S. Environmental Protection Agency (EPA), respectively, below which a person exposed at these levels would be unlikely to suffer adverse health effects. These reference doses have uncertainty factors built into them to account for several factors, including, but not limited to the extrapolation of conclusions from animal studies to humans, and for the variability in the human population.

MRLs and RfDs may be calculated for oral or inhalation exposures. Inhalation exposures will not be considered here. MRLs are classified as acute, intermediate, or chronic. An acute MRL is the dose of a chemical to which a person could be exposed for a up to 14 days; intermediate MRLs for exposures of between 15 and 364 days; and chronic MRL for exposures of greater than 365 days. An RfD, by definition, is a chronic exposure dose.

ATSDR's Child's Health Initiative

An additional consideration in evaluating adverse health effects is the effect of a chemical on children. Children are not little adults. Their bodies are not fully developed, and may not respond to a specific chemical in the same manner as an adult. Depending upon their age and the chemical, they may be more sensitive to a chemical's effects than an adult. However, very few chemicals have been evaluated for toxicity in children.

To accommodate this lack of information regarding toxicity in children when evaluating noncancer adverse health effects, an additional uncertainty factor will be applied to the reference dose. Language in the "Food Quality Protection Act of 1996" and the National Academy of Sciences "Pesticides in the Diet of Infants and Children," indicates that an "... additional safety factor of up to ten-fold, if necessary, to account for uncertainty in data relative to children" may be used (10). CDHS opted to be very conservative and used 10 as the additional uncertainty factor. Therefore, when evaluating children exposed to chemical contamination, those chemicals or groups of chemicals with hazard quotients or indices greater than 0.1 will be evaluated for noncancer adverse health effects. However, this additional factor of 10 increases the uncertainty associated with the MRL or RfD for that chemical. This will be taken into account when evaluating the noncancer adverse health effects of those chemicals or groups of chemicals with a hazard quotient/index of between 0.1 and 1.

Carcinogenic Adverse Health Effects

To evaluate the cancer risk posed by some chemicals, the increased lifetime cancer risk was calculated. This risk is called an increased risk because the value that is calculated represents an increase in the number of expected cases of cancer over and above the normal background cancer rate in the general population, which is in the range of 25% to 35% (250,000 to 350,000 cancers per 1,000,000 people). Assuming a 25% background rate, an increased lifetime cancer risk of 1 in 1,000,000 (or 1×10^{-6}) means that in 1,000,000 people, 250,001 cases of cancer would be expected, with the extra 1 case being caused by the specific chemical exposure.

The increased lifetime cancer risk is calculated from the oral slope factor for that chemical. The oral slope factor, in turn, is calculated from the slope of the dose-response curve for the chemical in question. The increased lifetime cancer risk from exposure to a given chemical is calculated by multiplying the daily dose of the chemical by the oral slope factor. The total increased lifetime cancer risk is calculated by adding together the cancer risk for the individual chemicals. If the total increased lifetime cancer risk is less than 1×10^{-6}, then it is considered to be an insignificant increased risk and will not be considered further.

Limitations of Toxicological Evaluation

One problem frequently encountered during the evaluation process is that of incomplete data. Only a relatively few chemicals of the many thousands of commonly used industrial chemicals have been thoroughly evaluated for toxicity. For most chemicals, there are data gaps. For example, there may be information available on the noncancer health effects of a particular chemical, but no information available on its potential for carcinogenicity. Or, there may be information regarding the toxicity of a chemical at high levels of exposure for short periods of time, but little information on the effects of long term exposure at low levels. In such situations, the health implications of exposure to these chemicals cannot be fully addressed.

In addition to gaps in information on specific chemicals, there are data gaps in the fish data obtained from the Binational Study Group that limit the usefulness of the data in estimating potential adverse health effects. First, there are no data concerning concentration of chemical contamination in whole fish; there are only data for contamination in fish fillets. However, it is important to have whole body data because people from certain cultures and ethnic groups eat the whole fish, not just the fillet portion. Second, only five fish were collected over a period of just under one year. Ideally, more fish would be collected and analyzed. Third, there are no data concerning the size or approximate age of the fish that were collected. This is important because older, larger fish tend to have higher levels of contamination than younger, smaller fish. It is sometimes recommended that only fish below a certain size be eaten.

Toxicological Effects of Contaminants of Concern in Completed Exposure Pathway

In this section, background information and information on the toxicological effects of the contaminants of concern are discussed. These chemicals are categorized by noncancer toxicological effect: hepatic (liver) adverse health effects, immunological (immune system) adverse health effects, developmental (learning, growth rate, motor skill development) adverse

health effects, and dermal (skin) adverse health effects. Information on the carcinogenicity of each chemical is also listed. Only those chemicals that constitute a significant fraction of the total hazard index or the total increased lifetime cancer risk are discussed.

Chemicals Causing Hepatic Adverse Health Effects

Chlordane (11, 12)

- Man-made chlorinated pesticide, banned from use in the U.S. in 1988
- Is persistent in the environment
- Is a mixture consisting primarily of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, alpha chlordene, gamma chlordene, and oxychlordane
- The term "total chlordane" used in this document refers to the sum of the concentration of each of these species
- Animal and human studies of lower dose exposures over a long period of time show chlordane can cause changes in liver function
- Chronic oral MRL = 6×10^{-4} mg/kg/day (uncertainty factor = 100)
- Probable Human Carcinogen, based on data showing that chlordane causes cancer in animals, and inadequate data as to whether chlordane causes cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 1.3 (mg/kg/day)-1

Aldrin and Dieldrin (11, 13)

- Man-made chlorinated pesticides, banned from use in the U.S. in 1987
- Both are chemically similar, both used as primary product, but aldrin will convert to dieldrin in the environment and when ingested
- Highly persistent in the environment
- Animal studies of lower dose exposures over long periods of time show dieldrin can cause liver damage
- Chronic oral MRL = 5×10^{-5} mg/kg/day (uncertainty factor = 100)
- Probable Human Carcinogen, based on data showing that dieldrin causes cancer in animals, and inadequate data as to whether dieldrin causes cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 16 $(mg/kg/day)^{-1}$

1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane (DDT), 1,1-dichloro-2.2-bis(p-chlorophenyl)ethane (DDD), 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene (DDE), and 1-chloro-2,2-bis(p-chlorophenyl)ethylene (DDMU) (11, 15)

- Man-made chlorinated pesticide, banned from use in the U.S. in 1972, and also banned in other, but not all, countries
- Very widely used around the world at one time on crops and for control of disease-carrying insects
- Very persistent in the environment, DDT or breakdown products can still be found in humans and animals, and in the environment many years after application, even in areas where its use has been banned
- DDT or breakdown products frequently found in humans and animals

- DDD is a related compound used as a pesticide, also a breakdown product of DDT
- Other related chemicals and breakdown products of DDT include DDE and DDMU
- Term "total DDT" refers to the sum of the concentrations of each of the following: *o,p'*-DDD, *p, p'*-DDD, *o,p'*-DDE, *p,p'*-DDE, *p,p'*-DDMU, *o,p'*-DDT, and *p,p'*-DDT
- Animals studies of low dose exposures over long periods of time show DDT can cause hepatic health effects
- RfD = 5×10^{-4} mg/kg/day (uncertainty factor =100)
- Probable Human Carcinogen, based on data showing that DDT causes cancer in animals, and inadequate data as to whether DDT causes cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 0.34 $(mg/kg/day)^{-1}$

Hexachlorobenzene (11, 16)

- Man-made chlorinated pesticide, also a by-product of several industrial processes, banned from use in the U.S. in 1965
- Persistent in the environment
- Animal and human studies of low dose exposures over a long period of time show that hexachlorobenzene can cause hepatic health effects.
- Chronic oral MRL = 2×10^{-5} mg/kg/day (uncertainty factor =100)
- Probable Human Carcinogen, based on data showing that hexachlorobenzene causes cancer in animals, and inadequate data as to whether hexachlorobenzene causes cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 1.6 $(mg/kg/day)^{-1}$

Alpha-Hexachlorocyclohexane (11, 25)

- Man-made chlorinated pesticide, banned from use in the U.S.
- Alpha form is one of eight structurally related forms of hexachlorocyclohexane
- Animal studies of the effects of oral exposure to alpha hexachlorocyclohexane show it causes convulsions and liver and kidney effects
- No reference dose or minimal risk level available
- Probable Human Carcinogen, based on data showing that hexachlorobenzene causes cancer in animals, and inadequate data as to whether hexachlorobenzene causes cancer in humans (U.S. EPA Classification B2): Cancer oral Slope factor = 6.3 $(mg/kg/day)^{-1}$

Toxaphene (11, 17)

- Man-made chlorinated pesticide, banned from use in the U.S. in 1982
- Highly persistent in the environment
- Is a mixture of over 670 different chemicals
- No studies of low dose, long term exposures found
- Intermediate level exposures can cause hepatic adverse health effects
- Intermediate oral MRL = 1×10^{-3} mg/kg/day (uncertainty factor = 100)
- Probable Human Carcinogen, based on data showing that toxaphene causes cancer in animals, and no data as to whether toxaphene causes cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 1.1 $(mg/kg/day)^{-1}$

Heptachlor Epoxide (11, 18)

- Breakdown product of heptachlor, a man-made chlorinated pesticide, banned from use in the U.S. in 1988
- Heptachlor converted to heptachlor epoxide by bacterial activity in environment, and when ingested by humans
- Animal studies of low dose exposures over long periods of time show heptachlor can cause hepatic health effects
- RfD = 1.3×10^{-5} mg/kg/day (uncertainty factor = 1000)
- Probable Human Carcinogen, based on data showing that heptachlor epoxide causes cancer in animals, and inadequate data as to whether heptachlor epoxide causes cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 9.1 $(mg/kg/day)^{-1}$

Chemicals Causing Immunological Adverse Health Effects

Polychlorinated Biphenyl (PCBs) (11, 19)

- Man-made chlorinated industrial chemicals frequently in electrical equipment, manufacture halted in 1977
- Consists of 209 individual chemicals called congeners
- Produced as mixtures of various congeners, mixtures called Araclors
- Very persistent in the environment
- Animal studies of low dose exposures over long periods of time show PCBs can cause immunological health effects
- Chronic oral MRL = 2×10^{-5} mg/kg/day (uncertainty factor = 300)
- Probable Human Carcinogen, based on data showing that PCBs cause cancer in animals, and inadequate data as to whether PCBs cause cancer in humans (U.S. EPA Classification B2): Cancer oral slope factor = 2 $(mg/kg/day)^{-1}$

Chemicals Causing Neurological Adverse Health Effects

Diazinon (11, 26)

- Man-made organophosphorous pesticide
- Human studies of lower levels of exposure over longer periods of time show that diazinon causes headache, dizziness, weakness, feelings of anxiety, constriction of the pupils, and poor vision
- Intermediate oral MRL = 0.0002 mg/kg/day (uncertainty factor = 100)
- Has not been shown to cause cancer in animals or humans

Chemicals Causing Developmental Adverse Health Effects

Organic Mercury (11, 20)

- Mercury is a naturally occurring element, also occurs in environment due to human activity

- In the environment, typically occurs as mercury salts (inorganic mercury), but biological activity such as microbial action in sediment can convert inorganic mercury to organic mercury (commonly methyl mercury)
- Both forms of mercury are toxic, but fish and other animals can take up organic mercury, accumulate it in their bodies, and pass it further up the food chain, including humans
- All mercury in fish is assumed to be organic mercury
- Studies of accidentally exposed humans who have ingested both high doses of organic mercury over short periods of time, and intermediate doses of organic mercury over moderate periods of time, show that children exposed to organic mercury often show developmental health effects, such as delayed walking
- RfD = 1×10^{-4} mg/kg/day (uncertainty factor = 10)
- Possible Human Carcinogen, based on limited data showing that organic mercury causes cancer in animals, and inadequate data as to whether organic mercury causes cancer in humans (U.S. EPA Classification C)

Chemicals Causing Dermal Adverse Health Effects

Inorganic Arsenic (4a, 4b, 11, 21, 22)

- Naturally occurring element, commonly found in surface and ground waters of California, also occurs in the environment as a result of human activities
- Used in some pesticides, but not in any target species in this study
- Can occur in organic or inorganic form
- Most arsenic found in fish (approximately 90% or more) is the organic form, which is considered to have very low toxicity
- Conservatively, approximately 10% of arsenic in fish is considered to be inorganic arsenic, which is highly toxic
- Animal and human studies of low dose exposures over long periods of time show inorganic arsenic can cause darkening of the skin and skin lesions, which can become cancerous
- Chronic oral MRL = 3×10^{-4} mg/kg/day (uncertainty factor = 3)
- Known Human Carcinogen (U.S. EPA classification A): Cancer oral slope factor = 1.5 $(mg/kg/day)^{-1}$

Selenium (11, 23)

- Naturally occurring element, widely distributed in environment, also occurs in environment as a result of human activities
- Occurs in inorganic form or in organic form in plants
- Is an essential element in the diet
- Studies of human populations exposed for long periods of time at moderate or low doses show that selenium causes brittle hair and deformed nails
- Chronic oral MRL = 5×10^{-3} mg/kg/day (uncertainty factor = 3)
- Not classifiable as to carcinogenicity in humans (U.S. EPA Weight of Evidence Classification = D).

Toxicological Evaluation of Completed Exposure Pathways

CDHS has identified one completed exposure pathway, that of the receptor population being exposed to contamination through the ingestion of contaminated fish caught from the New River. The toxicological evaluation of this completed exposure pathway will consider four sub-groups of the receptor population, adult high-end sport fishers, typical adult sport fishers, and children of high-end and typical sport fishers.

The completed exposure pathways for adult sport fishers will be evaluated for both noncancer and cancer adverse health effects. The completed exposure pathways for children of sport fishers will be evaluated for noncancer adverse health effects. When evaluating noncancer adverse health effects, all chemicals with a similar toxicological effect are evaluated as a group. This allows for the possibility that there may be an adverse health effect from this group of chemicals, even though the dose of each individual chemical is less than its respective reference dose. In the case of these fish caught from the New River, only chemicals causing adverse health effects to the liver (hepatic effects) fall into this category. The other chemicals being evaluated for adverse health effects are single chemicals.

The chemicals that are evaluated in each exposure pathway are selected by their hazard index or hazard quotient. The hazard quotient, discussed in the **Public Health Implications** – *Noncancer Adverse Health Effects* section, is the ratio of the calculated dose of the chemical to the reference dose of the chemical. The hazard index is the sum of the hazard quotients for chemicals with similar toxicological effects. If the hazard quotient is greater than one (calculated dose is greater than reference dose), or if the hazard index is greater than one, then that chemical(s) is evaluated for potential adverse health effects. Chemicals whose hazard quotient is less than one (calculated dose less than reference dose), or whose hazard index is less than one, are not evaluated for adverse health effects.

Only five fish were collected over the course of the sampling period. Because of this small sample size and because many of the contaminants were measured at relatively low levels, the average concentration of the contaminant is not a reliable measurement. Thus, CDHS performed a log-transformation of the data and calculated the upper 95% confidence interval for the concentration on this transformed data (27). This upper-end concentration estimate was then used to calculate the daily dose of that contaminant to the receptor population.

In addition to using the upper 95% confidence interval for the concentration of each contaminant, CDHS deliberately used assumptions regarding factors such as body weight and consumption rates that yield conservative exposure scenarios (Table 3). By doing so, one can be more certain that if a chemical is present at less than a comparison value, then the risk of adverse health effects is considered very low. Should a chemical be present at a level that exceeds its comparison value, then it must be evaluated more thoroughly to determine the potential for adverse health effects.

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities in their water, soil, air, or food. This sensitivity is a result of a number of factors. Children are more likely to be exposed to soil or surface water because they play outdoors and

often bring food into contaminated areas. For example, children may come into contact with and ingest soil particles at higher rates than do adults; also, some children with a behavior trait known as "pica" are more likely to ingest soil and other non-food items. Children are shorter than adults, which means that they can breathe dust, soil, and any vapors close to the ground. Also, they are smaller, resulting in higher doses of chemicals per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Because children depend completely upon adults for risk identification and management decisions, ATSDR is committed to evaluating their special interest at applicable sites as a part of the ATSDR Child Health Initiative.

Toxicological Evaluation of Adult High-End Sport Fishers Who Consume Fish from the New River at Westmorland

Noncancer Adverse Health Effects

The total hazard index for chemicals causing hepatic adverse health effects in adult high-end sport fishers who consume fish from the New River at Westmorland is 6.1, with the hazard quotient for total DDT comprising the majority of the hazard index. The hazard quotient for total DDT is 3.6, which corresponds to a total daily dose of DDT that is approximately 30 times less than the dose of DDT shown in animal studies to cause hepatic adverse health effects. The total daily dose of each of the other chemicals that cause hepatic adverse health effects is well over 100 times less than the respective dose shown in studies to cause hepatic adverse health effects. Thus, it is unlikely that adult high-end sport fishers who consume fish from the New River at Westmorland would experience hepatic adverse health effects.

The hazard quotient for total PCBs in adult high-end sport fishers who consume fish from the New River at Westmorland is 26. This corresponds to a total daily dose of PCBs that is approximately 12 times less than the dose of PCBs shown in animal studies to cause immunological adverse health effects. Healthy high-end sport fishers who consume fish from the New River at Westmorland would probably not experience immunological adverse health effects. However, some individuals, such as those who use sport fish as a significant supplement to their families' diets, those who are in poor health, pregnant women, and women who are nursing children, may be more sensitive to the effects of PCBs, and thus may be more likely to experience immunological adverse health effects.

The hazard quotient for organic mercury for adult high-end sport fishers who consume fish from the New River at Westmorland is 5.3. This corresponds to a total daily dose of organic mercury that is only two times less than the dose of organic mercury shown in studies of accidentally exposed humans to cause developmental adverse health effects in children of exposed adults. High-end sport fishers might possibly experience adverse health effects. In addition, some individuals, such as those who use sport fish as a significant supplement to their families' diets, pregnant women, and women who are nursing children, may be more sensitive to the effects of organic mercury, and thus may be more likely to experience developmental adverse health effects.

Cancer Adverse Health Effects

The total increased lifetime cancer risk for high-end adult sport fishers who consume fish from the New River at Westmorland 3.5×10^{-3}. This is considered to be a moderate increased risk. The chemicals with the greatest contribution to the total increased lifetime cancer risk are total chlordane, dieldrin, total DDT, toxaphene, and total PCBs.

Toxicological Evaluation of Children of Adult High-End Sport Fishers Who Consume Fish from the New River at Westmorland

Noncancer Adverse Health Effects

The total hazard index for chemicals causing hepatic adverse health effects in children of high-end sport fishers who consume fish from the New River at Westmorland is 5.2, with the hazard quotient for total DDT comprising the majority of the contribution to the hazard index. The hazard quotient for total DDT is 3.1, which corresponds to a daily dose of DDT that is approximately 30 times less than the dose of PCBs shown in animal studies to cause hepatic adverse health effects. The daily doses of each of the other chemicals causing hepatic adverse health effects are all over 140 times less than the dose of the respective chemical shown in studies to cause hepatic adverse health effects. Children of high-end sport fishers who consume fish from the New River at Westmorland are unlikely to experience hepatic adverse health effects.

The hazard quotient for total PCBs for children of high-end sport fishers who consume fish from the New River at Westmorland is 22. This corresponds to a total daily dose of PCBs that is approximately 14 times less than the dose of PCBs shown in animal studies to cause immunological adverse health effects. Children of high-end sport fishers who consume fish from the New River at Westmorland would probably not experience immunological adverse health effects.

The hazard quotient for diazinon for children of high-end sport fishers who consume fish from the New River is 0.2. This corresponds to a total daily dose of diazinon that is approximately 500 times less than the dose of diazinon shown in studies of accidentally exposed humans to cause neurological adverse health effects. Children of high-end sport fishers who consume fish from the New River at Westmorland would not be expected to experience neurological adverse health effects.

The hazard quotient for selenium for children of high-end sport fishers who consume fish from the New River at Westmorland is 0.4. This corresponds to a daily dose of selenium that is approximately eight times less than the dose of selenium shown in human studies to cause dermal adverse health effects. Children of high-end sport fishers who consume fish from the New River at Westmorland might experience dermal adverse health effects.

The hazard quotient for organic mercury for children of high-end sport fishers who consume fish from the New River at Westmorland is 4.5. This corresponds to a total daily dose of organic mercury that is approximately two times less than the dose of organic mercury shown in studies

of accidentally exposed humans to cause developmental adverse health effects. Children of high-end sport fishers who consume fish from the New River at Westmorland might experience developmental adverse health effects.

Toxicological Evaluation of Typical Adult Sport Fishers Who Consume Fish from the New River at Westmorland

Noncancer Adverse Health Effects

The total hazard index for chemicals causing hepatic adverse health effects in adult high-end sport fishers who consume fish from the New River at Westmorland is 1.2, with the hazard quotient for total DDT comprising the majority of the hazard index. The hazard quotient for total DDT is 0.7, which corresponds to a total daily dose of DDT that is approximately 140 times less than the dose of DDT shown in animal studies to cause hepatic adverse health effects. The total daily dose of the other chemicals that cause hepatic adverse health effects is well over 570 times less than the respective dose shown to cause hepatic adverse health effects. Thus, it is unlikely that typical adult sport fishers who consume fish from the New River at Westmorland would experience hepatic adverse health effects.

The hazard quotient for total PCBs for typical adult sport fishers who consume fish from the New River at Westmorland is 5.2. This corresponds to a total daily dose of PCBs that is approximately 60 times less than the dose of PCBs shown in animal studies to cause immunological adverse health effects. Thus, it is unlikely that adult high-end sport fishers would experience immunological adverse health effects. However, some individuals, such as those who use sport fish as a significant supplement to their families' diets, those in poor health, pregnant women, and women who are nursing children, may be more sensitive to the effects of organic mercury, and thus may be more likely to experience developmental adverse health effects.

The hazard quotient for organic mercury for typical adult sport fishers who consume fish from the New River at Westmorland is 1.1. This corresponds to a total daily dose of organic mercury that is approximately nine times less than the dose of organic mercury shown in studies of accidentally exposed humans to cause developmental adverse health effects in the children of exposed adults. Typical sport fishers might experience developmental adverse health effects. In addition, some individuals such as those who use sport fish as a significant supplement to their families' diets, pregnant women, and women who are nursing children, may be more sensitive to the effects of organic mercury, and thus may be more likely to experience developmental adverse health effects.

Cancer Adverse Health Effects

The total increased lifetime cancer risk for typical adult sport fishers who consume fish from the New River at Westmorland is 7.0×10^{-4} which is considered to be a low increased risk. The chemicals with the greatest contribution to the total increased lifetime cancer risk are total chlordane, dieldrin, total DDT, toxaphene, and total PCBs.

Toxicological Evaluation of Children of Typical Adult Sport Fishers Who Consume Fish from the New River at Westmorland

Noncancer Adverse Health Effects

The total hazard index for chemicals causing hepatic adverse health effects for children of typical sport fishers who consume fish from the New River at Westmorland is 1.1, with the hazard quotient of total DDT comprising the majority of the hazard index. The hazard quotient for total DDT is 0.7. This corresponds to a daily dose of total DDT that is over 150 times less than the dose of DDT shown in animal studies to cause hepatic adverse health effects. The daily dose of the other chemicals causing hepatic adverse health effects are all over 620 times less than the individual dose of each chemical shown in studies to cause hepatic adverse health effects. Thus, children of typical sport fishers who consume fish from the New River at Westmorland would not be expected to experience adverse health effects.

The hazard quotient for total PCBs for children of typical sport fishers who consume fish from the New River at Westmorland is 4.8. This corresponds to a daily dose of PCBs that is approximately 62 times less than the dose of PCBs shown in animal studies to cause immunological adverse health effects. It is unlikely that children of typical sport fishers who consume fish from the New River at Westmorland would experience adverse health effects.

The hazard quotient for organic mercury for children of typical sport fishers who consume fish from the New River at Westmorland is 1.0, which is approximately 10 times less than the dose of organic mercury shown in studies of accidentally exposed humans to cause developmental adverse health effects. Children of typical sport fishers who consume fish from the New River at Westmorland might experience developmental adverse health effects.

CONCLUSIONS

While a relatively large number of chemicals were detected in these fish collected from the New River at Westmorland, only a few were detected at levels that could potentially cause noncancer adverse health effects. These include total DDT, total PCBs, and organic mercury. Several chemicals that can cause cancer are present at concentrations that could potentially cause a significant increase in the lifetime cancer risk. These include total chlordane, dieldrin, total DDT, toxaphene, and total PCBs.

High-end adult sport fishers are assumed to consume 14 eight-ounce meals of fish per month, and their children are assumed to eat 14 fish meals per month, each meal being about 1.7 ounces. Typical adult sport fishers are assumed to eat three eight-ounce meals of fish per month, and their children are assumed to eat three fish meals per month, each meal being about 1.7 ounces.

For both high-end and typical adult sport fishers and their children, the doses of contaminants in these fish samples are below the dose of the respective chemical that has been shown in scientific studies to cause adverse health effects. However, in adult high-end sport fishers and their children, the dose of total PCBs and organic mercury is close to the dose that causes adverse health effects, thus raising the potential for adverse health effects in sensitive sub-populations

such as those in poor health, or women of child-bearing age. Adult high-end sport fishers who consume fish from the New River at Westmorland that are contaminated at levels comparable to these fish samples face a moderate increased lifetime cancer risk.

With the exception of organic mercury, the doses of contamination in fish is well below the dose of the respective chemical in typical adult sport fishers and their children that causes noncancer adverse health effects. The dose of organic mercury is close to the dose that causes developmental adverse health effects. Thus, typical adult sport fishers and their children, and sensitive populations such as those in poor health, women of child-bearing age, and those who use sport fish as a significant supplement for their family's diet, might experience developmental adverse health effects. There is a low increase in the lifetime cancer risk for typical adult sport fishers who consume fish from the New River at Westmorland that are contaminated at levels comparable to these samples.

The potential for adverse health effects increases in both high and typical sport fishers and their children if they eat the whole fish. This is because certain organic contaminants such as DDT, PCBs, chlordane, dieldrin, hexachlorocyclohexane, and hexachlorobenzene (to name a few), collect in the fat portions of the fish to a greater extent than in the fillet portion. Thus, CDHS recommends that everyone should eat only the fillet portion of the fish.

Based upon these findings, CDHS concludes that the consumption of fish from the New River at Westmorland constitutes a public health threat for adult high-end sport fishers and their children. This conclusion is based upon the moderate increased lifetime cancer risk, and upon the possibility of adverse health effects in the most sensitive sub-population due to exposure to PCBs, organic mercury, and to a lesser extent, to total DDT. Consumption of fish from the New River at Westmorland by typical sport fishers and their children also constitutes a public health threat due to the low increased lifetime cancer risk and the possibility of developmental adverse health effects in sensitive populations due to organic mercury. Thus, CDHS recommends that sport fishers either not consume fish caught from the New River, or minimize the amount of such fish that they eat. In addition, CDHS recommends that children, pregnant women, and women who are nursing children not consume fish that have been caught from the New River.

These conclusions and recommendations are based upon the evaluation of contamination in fish only, and does not consider other sources of contamination. In addition, the small number of fish analyzed in this study also limits the usefulness of these data. This report is based upon data available at the time this report was written. If necessary, CDHS will review any new data that become available, and may revise these recommendations, if needed. These conclusions and the recommendations made below are specific to this site only, and do not necessarily apply to other situations or sites.

PUBLIC HEALTH RECOMMENDATIONS AND ACTIONS

The Public Health Recommendations and Action Plan (PHRAP) for this site contains a description of actions taken, to be taken, or under consideration by ATSDR and CDHS at and near the site. The purpose of the PHRAP is to ensure that this health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and

prevent adverse human health effects resulting from exposure to hazardous substances in the environment. CDHS and ATSDR will follow up on this plan to ensure that actions are carried out.

The conclusions and recommendations in this document are based upon data available to CDHS at the time this document was written. Recommendations enumerated here are specific to the New River at Westmorland, and do not necessarily apply to other situations or sites. If needed, CDHS will review additional data on this site as they become available, and remains available for consultation.

Actions Completed

Health consultations documenting potential adverse health effects due to exposure to pollutants in the water column of the New River and in the bottom and suspended sediments of the New River have been prepared.

Recommendations for Further Actions

1. CDHS staff is evaluating the need for community-wide educational programs to provide information to the community regarding the New River.

2. CDHS staff is working with local school districts to include information on the New River into their curricula, and to use the New River as a research topic for science and social studies classes.

3. CDHS will review other data on contaminants in fish as they become available.

4. CDHS will continue to work with other national, state, county, and local agencies on health-related issues at the New River, the Salton Sea, and the U.S./Mexico border area.

5. CDHS will work with other agencies to examine the feasibility of conducting a more thorough study of contamination in fish in the New River. This study should evaluate both chemical and biological contamination in New River fish.

6. CDHS recommends that people not eat fish caught from the New River. However, if people do eat New River fish, they should minimize the amount that they eat, and they should eat only the fillet portion of the fish (skinned and defatted).

7. CDHS recommends that children, pregnant women, and women who are nursing children not eat any fish caught from the New River.

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APPENDICES

Figures

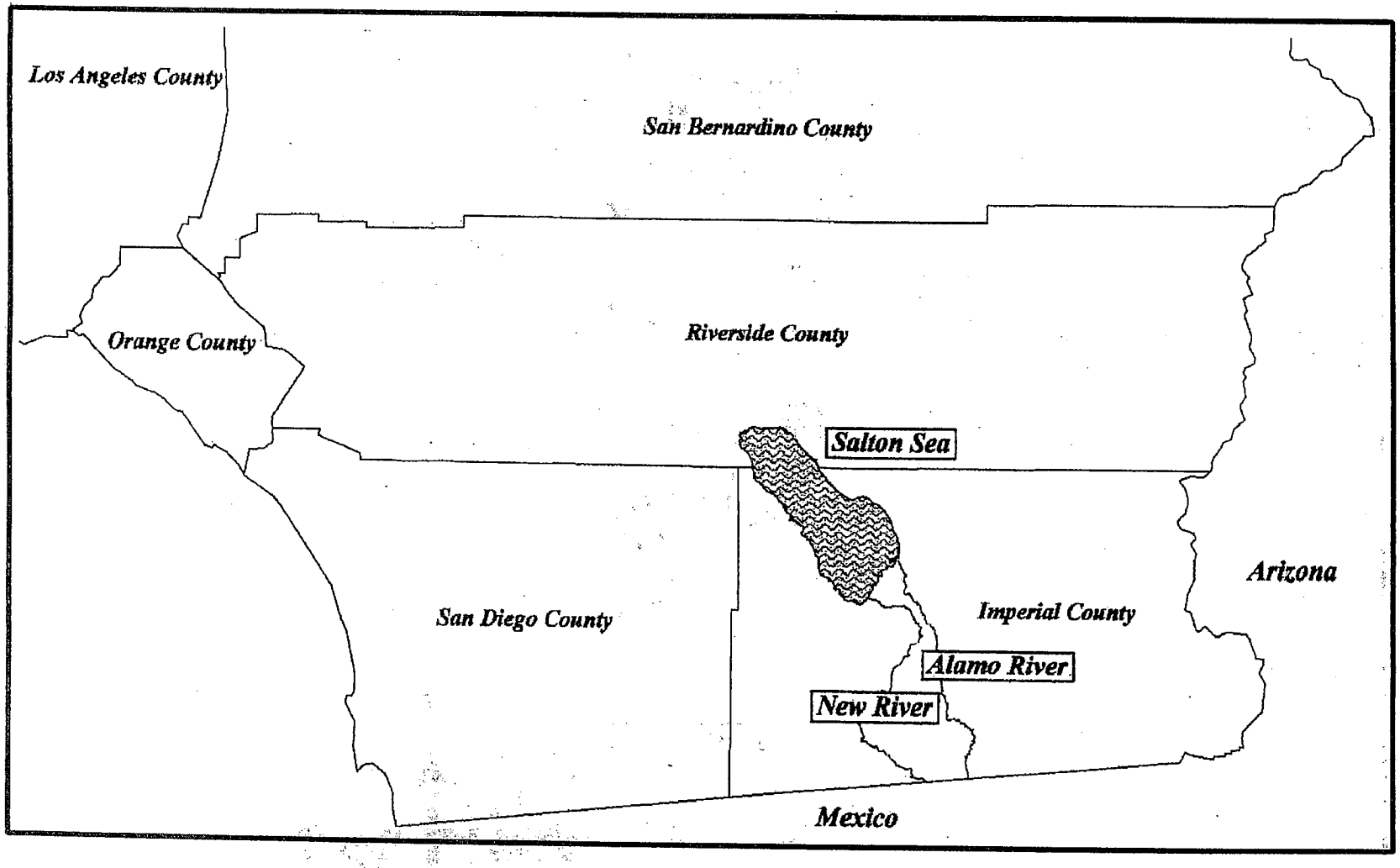

Figure 1. Southern California showing location of Imperial County, the New River, and the Salton Sea.

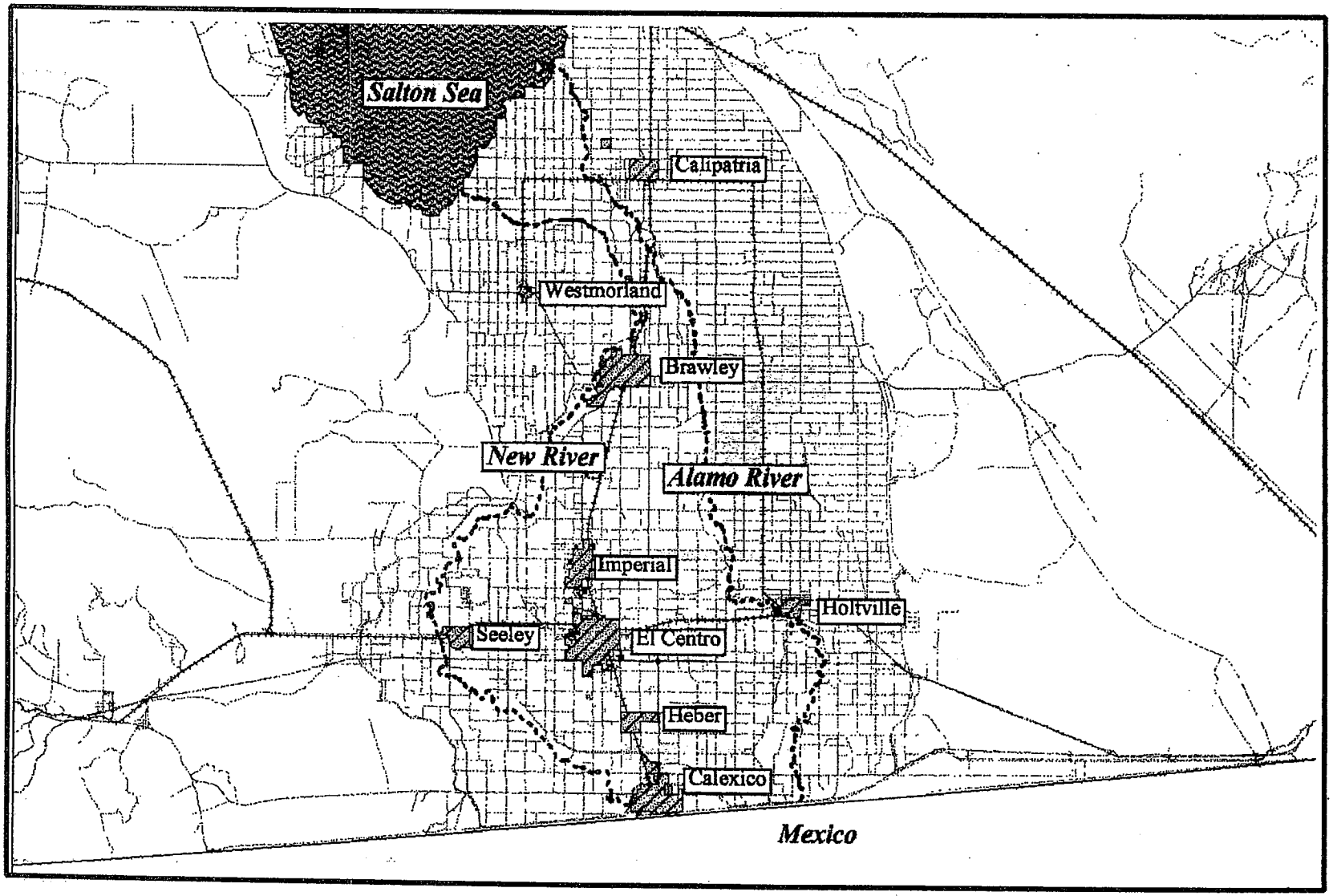

Figure 2. Imperial County showing location of the New River, the Salton Sea, and main cities and towns.

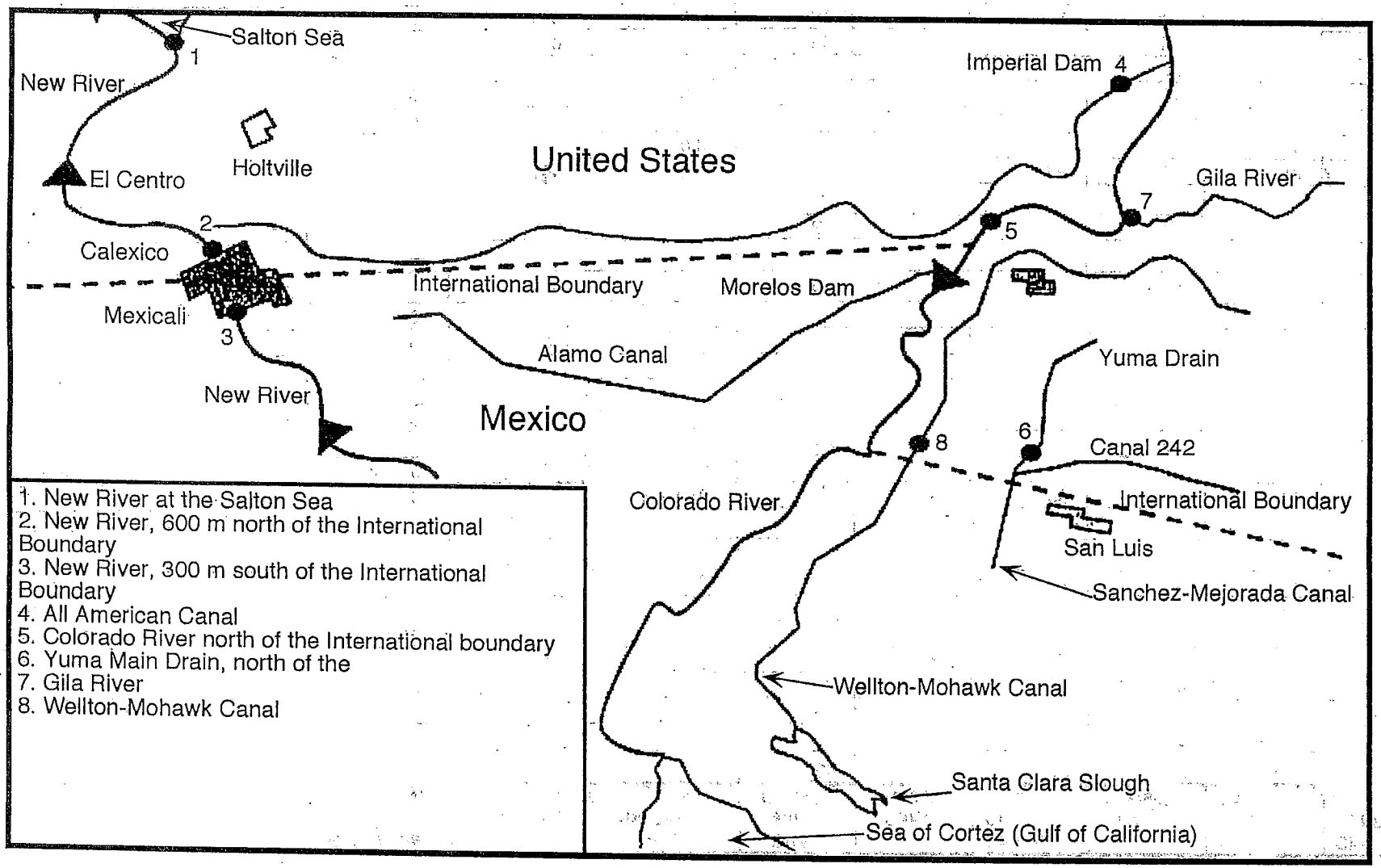

Figure 2.

Figure 3. Map of U.S./Mexico border zone showing sampling locations.

Tables

Table 1. List of chemicals detected and their concentrations in flesh of fish collected from the New River near Westmorland.

Chemical Contaminant	MQL[1]	Reference Dose (mg/kg/day)[2]	Uncertainty Factor	Cancer Oral Slope Factor (mg/kg/day)$^{-1}$ [1,2]	EPA Cancer Class[3]	Carp 6/16/95[4,5]	Channel Cat Fish 6/16/95[4,5]	Carp 6/28/95[4,5]	Carp 4/10/96[4,5]	Channel Cat Fish 4/10/96[4,5]
Aldrin	5	5×10^{-3}	1000	17	B2		0.19	1.7	0.32	
cis-Chlordane	5	6×10^{-4}	100	13	B2	3.3	19	39	13	11
trans-Chlordane	5	6×10^{-4}	100	13	B2	2.9	14	32	10	8.3
cis-Nonachlor	5	6×10^{-4}	100	—	B2	1.2	10	12	7.3	5.5
trans-Nonachlor	5	6×10^{-4}	100	—	B2	4.6	24	29	14	13
alpha Chlordene	5	6×10^{-4}	100	—	B2		1.4	5	0.78	1.1
gamma Chlordene	5	6×10^{-4}	100	—	B2		2.1	8.7	1.5	2
Chlorpyrifos	10	3×10^{-3}	10	—	—	2.9	17	46	4.4	8
Dicofol	100	—	—	—	—					
Dichlorobenzophenone	30	—	—	—	—					
Dacthal	5	1×10^{-2}	100	1.5×10^{-3}	C	6.5	25	5.9	98	120
Diazinon	50	2×10^{-4}	100	—	—			65		14
Dieldrin	5	5×10^{-5}	100	16	B2	6.2	32	7.8	14	27
Endosulfan I	5	2×10^{-3}	100	—	—	6.8	37	2.2	63	110
Endosulfan II	35	1	100	—	—	3.2	14		39	58
Endosulfan sulfate	40	—	—	—	—	2.5	3.6		29	31
Endrin	15	3×10^{-4}	100	—	D		4.5		1.8	2.7
Ethion	20	5×10^{-4}	100	—	—		15		8	14
alpha HCH	2	—	—	6.3	B2			0.33		
beta HCH	10	—	—	1.8	C					
gamma HCH	2	4×10^{-5}	300	—	B2			4.2		0.46
delta HCH	5	—	—	—	D					
o,p'-DDD	10	5×10^{-4}	100	—	B2	3	5.8	20	14	8.6
p,p'-DDD	10	5×10^{-4}	100	0.24	B2	15	61	94	58	41
o,p'-DDE	10	5×10^{-4}	100	—	B2	2.5	7	5.3	8	6.3
p,p'-DDE	5	5×10^{-4}	100	0.34	B2	830	1100	180	710	740
p,p'-DDMU	15	5×10^{-4}	100	—	B2	6.5	16	13	16	11
o,p'-DDT	10	5×10^{-4}	100	—	B2		1.4	1.4	2	1.6
p,p'-DDT	10	5×10^{-4}	100	0.34	B2		19	4.8	6.4	16
Heptachlor	5	5×10^{-4}	300	4.5	B2					

Table 1 (Continued)

Chemical Contaminant	MQL[1]	Reference Dose (mg/kg/day)[2]	Uncertainty Factor	Cancer Oral Slope Factor (mg/kg/day)$^{-1}$ [2]	EPA Cancer Class[3]	Carp 6/16/95[4]	Channel Cat Fish 6/16/95[4]	Carp 6/28/95[4]	Carp 4/10/96[4]	Channel Cat Fish 4/10/96[4]
Heptachlor epoxide	5	1.3×10^{-5}	000	9.1	B2			0.45		
Hexachlorobenzene	2	2×10^{-5}	100	1.6	B2	0.97		10	3.9	4.2
Methoxychlor	15	2×10^{-4}	1000	—	D		3.1			2.2
Oxadiazon	5	5×10^{-3}	100	—	—					
Ethyl parathion	10	—	—	—	—					
Methyl parathion	10	2.5×10^{-4}	100	—	—					
PCB 1248	50	2×10^{-5}	300	2.0	B2			180	45	36
PCB 1254	50	2×10^{-5}	300	2.0	B2	43	45	98	110	17
PCB 1260	50	2×10^{-5}	300	2.0	B2	120	79	45	250	91
Tetradifon	10	—	—	—	—					
Toxaphene	100	1×10^{-3}	300	1.1	B2	100	750	120	270	290
Mercury (organic)	20	1×10^{-4}	10	—	C	280	180	310	280	80
Selenium	50	5×10^{-3}	3	—	—	1500	580	1000	1500	800
Arsenic (inorganic)	50	3×10^{-4}	3	1.5	A	60	40	60	110	60
Cadmium	10	7×10^{-4}	3	—	B1	3	9	ND	3	ND
Nickel	100	2×10^{-2}	300	—	—	17	18	11	11	ND

[1] MQL = Method Quantitation Limit

[2] = value not found or no value has been determined

[3] EPA Cancer Classification

Class	Interpretation
A	Known Human Carcinogen
B1	Probable human carcinogen, based upon limited human data and sufficient animal studies
B2	Probable human carcinogen, based upon inadequate human data and sufficient animal data
C	Possible human carcinogen, based upon limited animal data and no human data
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity

[4] Concentration of contaminant in fish in µg/kg (ppb). Empty cell means non-detect

Table 2. Completed Exposure Pathway

Pathway Name	Source	Environmental Medium	Point of Exposure	Route of Exposure	Exposed Population	Time
Fish Consumption	Fish	New River	Homes of people eating fish	Ingestion of contaminated fish	High and typical sport fishers and their children	Past Present Future

Table 3. List of default values for receptor population.

Parameter	Adult High-End Sport Fishers	Children of High-End Sport Fishers	Typical adult Sport Fishers	Children of Typical Sport Fishers
Body Weight (kg)	70	17	70	17
Age	> 18 years old	3 – 6 years old	> 18 years old	3 – 6 years old
Ingestion Rate (kg/day) of Sport Fish	0.107	0.022[1]	0.021	0.0048[1]
Corresponding Number of Meals/Month	14 (8 ounce meals)	14 (1.7 ounce meals)*	3 (8 ounce meals)	3 (1.7 ounce meals)*

1 Based upon children eating the same number of fish meals per month as their parents, and eating approximately 1 oz of fish (28.3 g) per 10 kg body weight.

Table 4. Hazard index/hazard quotient for adult high-end sport fishers and their children who consume fish from the New River at Westmorland.

COMPOUND	# Fish	Geometric Mean ppb (ng/g)	Upper 95% Conf Int ppb (ng/g)	HiEndAdlt DailyDose[1] mg/kg/d	HiEndChld DailyDose[1] mg/kg/d	HiEndAdult HazIndx	HiEndChld HazIndx	Target Organ System
Total Chlordane	5	46.7	107.2	1.6e-4	1.4e-4	0.273	0.231	Hepatic
dieldrin	5	14.2	28.5	4.4e-5	3.7e-5	0.871	0.737	Hepatic
Total DDT	5	739.8	1189.7	1.8e-3	1.5e-3	3.637	3.079	hepatic
hexachlorobenzene	5	2.4	7.6	1.2e-5	9.8e-6	0.581	0.492	Hepatic
toxaphene	5	234.2	504.2	7.7e-4	6.5e-4	0.771	0.653	Hepatic
						6.133	5.192	Hepatic HI
Total PCBs	5	207.1	341.2	5.2e-4	4.4e-4	26.080	22.080	Immunological
diazinon	5	12.6	31.5	4.8e-5	4.1e-5	0.241	0.204	Neurological
Selenium	5	1008.6	1491.7	2.3e-3	1.9e-3	0.456	0.386	Dermal
Mercury (Org)	5	203.6	348.1	5.3e-4	4.5e-4	5.321	4.505	Developmental

[1] Based upon upper 95% confidence interval concentration

Table 5. Hazard quotient/hazard index for typical adult sport fishers and their children who consume fish from the New River at Westmorland

COMPOUND	# Fish	Geometric Mean ppb (ng/g)	Upper 95% Conf Int ppb (ng/g)	LoEndAdlt DailyDose[1] mg/kg/d	LoEndChld DailyDose[1] mg/kg/d	LoEndAdult HazIndx	LoEndChld HazIndx	Target Organ System
Total Chlordane	5	46.7	107.2	3.3e-5	3.0e-5	0.055	0.050	Hepatic
dieldrin	5	14.2	28.5	8.7e-6	8.0e-6	0.174	0.161	Hepatic
Total DDT	5	739.8	1189.7	3.6e-4	3.4e-4	0.727	0.672	hepatic
hexachlorobenzene	5	2.4	7.6	2.3e-6	2.1e-6	0.116	0.107	Hepatic
toxaphene	5	234.2	504.2	1.5e-4	1.4e-4	0.154	0.142	Hepatic
						1.227	1.133	Hepatic HI
Total PCBs	5	207.1	341.2	1.0e-4	9.6e-5	5.216	4.817	Immunological
diazinon	5	12.6	31.5	9.6e-6	8.9e-6	0.048	0.045	Neurological
Selenium	5	1008.6	1491.7	4.6e-4	4.2e-4	0.091	0.084	Dermal
Mercury (Org)	5	203.6	348.1	1.1e-4	9.8e-5	1.064	0.983	Developmental

[1] Based upon upper 95% confidence interval concentration

Table 6. Increased lifetime cancer risk for adult high and typical sport fishers who consume fish from the New River at Westmorland

COMPOUND	# Fish	Geometric Mean ppb (ng/g)	Upper 95% Conf.Int ppb (ng/g)	HiEndAdlt DailyDose[1] mg/kg/d	LoEndAdlt DailyDose[1] mg/kg/d	HiEndAdult Cancer Risk	LoEndAdult Cancer Risk
Arsenic (Inorg)	5	6.2	8.8	1.3e-5	2.7e-6	2.0E-05	4.0E-06
aldrin	5	0.2	0.8	1.2e-6	2.4e-7	2.0E-05	4.0E-06
Total Chlordane	5	46.7	107.2	1.6e-4	3.3e-5	2.1E-04	4.3E-05
dieldrin	5	14.2	28.5	4.4e-5	8.7e-6	7.0E-04	1.4E-04
Total DDT	5	739.8	1189.7	1.8e-3	3.6e-4	6.2E-04	1.2E-04
hexachlorobenzene	5	2.4	7.6	1.2e-5	2.3e-6	1.9E-05	3.7E-06
toxaphene	5	234.2	504.2	7.7e-4	1.5e-4	8.5E-04	1.7E-04
heptachlor epoxide	5	0.3	0.3	5.3e-7	1.1e-7	4.8E-06	9.7E-07
Total PCBs	5	207.1	341.2	5.2e-4	1.0e-4	1.0E-03	2.1E-04
alpha HCH	5	0.2	0.2	3.6e-7	7.2e-8	2.3E-06	4.6E-07
					Total Increased Lifetime Cancer Risk	3.5E-03	7.0E-04

[1] Based upon upper 95% confidence interval concentration

CERTIFICATION

This Health Consultation for the Nitrate Contamination and Methemoglobinemia in the State of California was prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated.

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this Health Consultation and concurs with its findings.

for Chief, SPS, SSAB, DHAC, ATSDR