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Dioxins in San Francisco Bay: Questions and Answers

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EPA has been contributing to state, local and nongovernmental efforts to study and reduce dioxin levels in San Francisco Bay and human exposure to these toxics. These questions and answers provide some information on these efforts and links to other resources.

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Why is EPA interested in dioxins in San Francisco Bay?

In 1994, the California Office of Environmental Health Hazard Assessment (OEHHA) issued a fish consumption advisory for San Francisco Bay [\[EXIT Disclaimer\]](#) due to the presence of pollutants in fish, including dioxins. It has been recognized and documented (San Francisco Bay Seafood Consumption Study, March 2001, San Francisco Estuary Institute and California Department of Health Services) that some Bay Area residents consume fish from the Bay for subsistence. The Seafood Consumption Study found that one in ten of these consumers eats more than the recommended amount of fish. Among ethnic groups, Asians stand out as a group at risk because they consume large numbers of fish and often eat parts of the fish, like skin and organs, which concentrate pollutants.

As a result of the OEHHA advisory, the Bay was listed in 1999 under section 303(d) of the Clean Water Act as a water body that fails to meet water quality standards for dioxins. This listing requires EPA and California's Water Quality Control Boards to establish and implement measures to achieve the [total maximum daily load \(TMDL\)](#) to maintain water quality. At the time of listing, EPA committed to undertake several multimedia studies to determine the extent of the dioxin problem in the Bay (see [Question 3](#) for the results of these studies).

What are the risks to people who routinely catch and eat fish from San Francisco Bay?

Variables that can affect a person's risk of accumulating dioxin through Bay fish include the type and amount of fish eaten (for example, white croaker samples have shown higher overall concentrations than other fish species), and what parts of the fish are eaten (higher concentrations of dioxin can be found in the organs and fattier parts of the fish). OEHHA's screening value (recommended safety threshold) is equivalent to a 1 in 100,000 risk of cancer from consuming two fish meals a month at the 0.3 parts per trillion Toxicity Equivalent (TEQ, which takes into account the toxic potency of different dioxins and dioxin-like compounds - see [Question 7](#)) of dioxin in the edible portion of the fish.

Table 1 shows the associated dioxin risk level from consuming only the specific fish species over a lifetime at both average and high-end consumption rates. The average dioxin concentration is based on fillets, a limited number of composites and number of fish per composite presented. Also, the March 2001 San Francisco Estuary Institute/Department of Health Services report found that while no groups consumed one species exclusively, 50% of all fishers consumed striped bass and, among some ethnic subgroups, white croaker was often eaten.

Table 1. Risk levels associated with San Francisco Bay fish from 2000 sampling

Fish Species	number of composites	number of fish per composite	average TEQ _{DF} ppt*	average TEQ _{DFP} ppt*	average consumption lifetime risk (assuming 16.5 g/day**)	high end consumption lifetime risk (assuming 108 g/day)
White Croaker	14	5	1.6	6.7	2 in 10,000	1 in 1,000
Shiner surfperch	8	20	1.4	6.4	2 in 10,000	1 in 1,000
Striped bass	9	3	0.2	1.2	4 in 100,000	3 in 10,000

Table 1. Risk levels associated with San Francisco Bay fish from 2000 sampling

Jacksmelt	1	5	0.2	NA	--	--
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*pptr = parts per trillion DF=dioxins and furans

**g/day = grams per day DFP = dioxins, furans, and PCBs

Note: This table is based on current dioxin risk levels; EPA's Dioxin Reassessment Public Review Draft has increased the cancer slope (risk) factor six-fold.

Overall, the average level of dioxin in fish for all species sampled may not be elevated compared to other marine water bodies, but several species in the Bay have elevated average dioxin levels. In these species, the white croaker and the shiner surfperch, there is a larger percentage contribution from PCBs to the total dioxin TEQ. Thus, if a fisher's catch is predominantly white croaker and shiner surfperch, their risk from dioxin is higher; over a lifetime for someone who eats 15 servings per month, their cancer risk is 1 in 1,000.

Source: San Francisco Bay Seafood Consumption Study, March 2001

For more information see: [Fact Sheets from Seafood Consumption Study](#), [EXIT Disclaimer](#), or contact [Dan Stralka \(straalka.daniel@epa.gov\)](mailto:straalka.daniel@epa.gov), EPA Region 9 Superfund Division, Risk Assessment.

What studies does EPA have to better understand the fate of dioxins in San Francisco Bay?

Fish Tissue Study

In the summer of 2000, EPA Region 9 coordinated with the San Francisco Estuary Institute (SFEI) to fund the analysis of [dioxins and dioxin-like compounds \(furans and co-planar PCBs\)](#) in fish collected as part of the Regional Monitoring Program (RMP). This study built on past fish sampling surveys, but included a larger number of samples and fish types tested. The fish sampled were those most likely to be consumed by Bay fishers-- white croaker, shiner surfperch, striped bass and jacksmelt. Samples were collected and grouped into six areas of the Bay: the South Bay, Oakland, San Leandro Bay, San Francisco Waterfront, Berkeley, and San Pablo Bay.

The fish tissue samples for the study were collected in the summer of 2000. The sampling results confirm preliminary data from 1994 and 1997 that levels of dioxins and dioxin-like PCBs in three species of fish (white croaker, shiner surfperch, striped bass) caught from the Bay exceed a fish advisory screening level established by OEHHA. The fish data suggest that 50-80% of the dioxin TEQ is due to dioxin-like PCBs. Similar results spanning 1994, 1997 and 2000 suggest that dioxin levels are neither increasing nor decreasing. Though the concentrations in fish are very low, the toxicity of dioxin and dioxin-like PCBs is so potent, that even these levels exceed the health advisory.

When dioxins and furans were analyzed alone, the results were less conclusive, with two fish samples (white croaker, shiner surfperch) above the screening level, and two fish samples (striped bass, jacksmelt) below it. The study results did indicate that for shiner surfperch, the concentrations were significantly higher at the Oakland Harbor than at the San Francisco Waterfront or Berkeley.

For more information see: [Fact Sheet for Fish Tissue Study \(PDF\)](#) (1 pp., 22 K, [About PDF](#))

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Sediment Study

In the summer of 2000, EPA's Environmental Monitoring and Assessment program (EMAP), in coordination with the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends Program, conducted an extensive analysis of dioxin in San Francisco Bay sediments. Ninety-nine sampling stations were selected to provide an unbiased estimate of the concentrations of dioxin-like compounds for the entire Bay.

The levels of dioxin-like PCBs, dioxins and furans in San Francisco Bay sediments were found to be quite low compared to other bays near large metropolitan areas, such as the Hudson-Raritan Estuary, Newark Bay, and the northwestern Mediterranean Sea, all of which had higher concentrations in their sediments than those found in San Francisco Bay. Lake Ontario and Lake Michigan sediments also contain higher levels of dioxin TEQs than the Bay. The San Francisco Bay sediment samples measured close to detection limits. However, within the Bay, the Oakland Harbor sediment site contained somewhat elevated levels.

For more information see: [Fact Sheet for Sediment Study \(PDF\)](#) (1pp., 15 K, [About PDF](#))

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Air Monitoring Study

EPA is working with the Bay Area Air Quality Management District (BAAQMD) and the California Air Resources Board (CARB) to measure ambient dioxin levels in Bay Area air. Through the combined efforts of these agencies, seven monitoring sites have been established throughout the Bay Area. BAAQMD and EPA established a monitoring station upwind of most of the Bay Area on the coast, just north of the Golden Gate Bridge. BAAQMD and CARB have established stations in San Francisco, Oakland, Richmond, Crockett, San Jose and Livermore. The aim of this monitoring network is to characterize ambient levels spatially and seasonally and could highlight unforeseen sources of dioxin. The first year of air monitoring data is currently being analyzed and is planned for release in the fall of 2003.

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Dioxin from Fireplaces and Woodstoves Study

Emissions from residential fireplaces and woodstoves burning wood fuels and artificial logs in the San Francisco Bay Area were sampled for dioxins and hazardous pollutants. In a first-of-its-kind study in the U.S. sponsored by EPA, California oak and pine, and commercially available artificial logs, were tested in a fireplace and a woodstove. Limited testing showed dioxin and furans emissions ranged from 0.25 to 1.4 ng toxic equivalency (TEQ)/kg of natural wood burned, and 2.4 ng/kg for artificial logs. Some of these values are actually lower than had been previously estimated in EPA's Dioxin Reassessment for residential wood burning sources. This

report has been published by the journal Environmental Science and Technology (Vol. 37, No. 9, 2003).

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Are fish caught in the Bay more contaminated than fish in other areas in the country?

As part of EPA's dioxin reassessment (see [background information: EPA's Dioxin Report](#)), existing dioxin data on fish tissue samples were compiled to provide background levels of TEQ for dioxins and furans (TEQDF). The average value from this data set, which included estuarine and freshwater fish, was 1.6 ppt TEQDF. The San Francisco Bay fish tissue study results are typical of or below this national average (see Table 1 in Question 2). For one species, the striped bass, the results can be directly compared, where the national average TEQDF is 1.2 and the San Francisco TEQDF is 0.2.

The effort to compile data for a total TEQ that included PCB's (TEQDFP) found that there was insufficient data to provide meaningful results at a national level. By including TEQDFP in the sampling of San Francisco Bay fish, we have started filling in this data gap. There were two regional studies that were available for comparison to the San Francisco Bay fish data, one conducted in the Columbia River and the other in Delaware. The Columbia River data, which was analyzed for TEQDFP, was similar to the San Francisco levels. In comparison to the Delaware data, the TEQDFP in San Francisco Bay fish tissue was somewhat lower. In summary, the San Francisco Bay fish tissue results indicate that while we are similar to national levels for dioxins and furans, the TEQ levels that include PCBs are higher and point to historical sources of PCBs that are known to exist in the Bay Area.

There are other studies that can be used for comparison to San Francisco Bay fish results. EPA's National Fish Tissue Survey has accumulated its first year of data. The purpose of this study is to conduct a screening-level study to estimate the national distribution of selected persistent, bioaccumulative and toxic chemical residues in fish tissue from lakes and reservoirs of the continental United States. This four-year study is intended to define national background levels for 265 chemicals in fish, establish a baseline to track progress of pollution control activities, and identify areas where contaminant levels are high enough to warrant further investigation. EPA is working with partner agencies over a four-year period to collect fish from 500 randomly selected lakes and reservoirs of the estimated 260,000 lakes and reservoirs in the continental U.S. This study will be useful for comparison because it is analyzing data for TEQDF as well as total TEQDFP; however, at a species level there may not be many opportunities for direct comparison, given that the study is focusing solely on freshwater fish species.

Should I stop eating particular foods?

Fish sold in supermarkets and served in restaurants generally are not caught in San Francisco Bay. If you fish in San Francisco Bay, EPA recommends that you follow the OEHHHA health advisory. This advisory recommends that adults limit their consumption of San Francisco Bay fish to no more than two meals a month. Adults also should not eat striped bass over 35 inches in length because larger fish often contain more chemicals, and striped bass contains more mercury than most fish. Women who are pregnant, breastfeeding, or may become pregnant should not eat more than one meal per month. In addition, they should not eat any meals of striped bass over 27 inches, or shark over 24 inches. Children under the age of six should eat no more than one meal per month. The advisory also recommends cooking and preparing fish in ways that reduce the amounts of contaminants.

For more information, see [FDA's Questions and Answers about Dioxin: Food Safety](#).

What are sources of dioxin in San Francisco Bay?

In the Bay Area, there is only preliminary data regarding the sources of dioxin and the relative contribution of these sources. There are a number of source categories nationally and in the Bay Area that are not well characterized. The following is a summary of source information provided by a 1998 San Francisco Bay Regional Water Quality Control Board (RWQCB or Regional Board) report.²

Refinery effluent discharges are not thought to be a major source of dioxins and dioxin-like PCBs in the Bay. Most refineries do not have detectable levels in their discharges. For other water sources, conventional treatment is very efficient at removing dioxins since they tend to bind to sediments, and are removed during the waste treatment process.

The following figure shows the Regional Board's estimate (Survey of Storm Water Runoff for Dioxins in the San Francisco Bay Area, February 1997) of the mass contribution from industrial and municipal wastewater discharges, storm water, and direct atmospheric deposition.

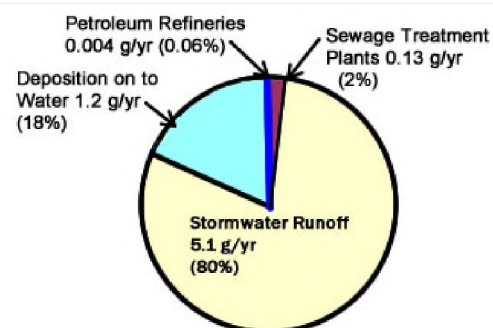


Figure 1. Sources of Discharge to San Francisco Bay

For the largest categories of direct deposition and storm water runoff, the Regional Board suspects air emissions from diffuse sources or from "reservoir sources" to be the ultimate source due to uniformity of concentrations throughout the region independent of industrial activity. The current known air sources are on- and off-road mobile sources (motor vehicles, including diesel), and residential wood burning (e.g., home fireplaces) (BAAQMD, Air Emissions of Dioxin in the Bay Area, March 1996). Dioxin legacy sources may include over 20 medical waste incinerators and other combustion sources that operated historically in the Bay Area. The RWQCB 1997 inventory indicated two sewage sludge incinerators (Central Contra Costa County Sanitary District and Palo Alto's sewage treatment plant) and one medical waste incinerator (Integrated Environmental Systems, Oakland; now closed) in the Bay Area. EPA has conducted tests of wood normally burned as firewood in California to improve emission estimates from wood burning. The California Air Resources Board (CARB) and EPA are conducting source tests for dioxins at selected sites in the Bay Area and Los Angeles. (See [Question 3](#).)

In the municipal water discharge category, the suspected sources are also diffuse, including laundry gray-water, storm water inflow, shower water, human waste, bleached toilet paper, food waste, and industrial sources. Of these, the predominant one appears to be laundry gray-water (EIP Associates, Palo Alto Regional Water Quality Control Plant. Dioxins Source Identification, September 1997). Dioxins in gray-water may come from pentachlorophenol-treated cotton from overseas, chloranil-based dyes in the fabric, fabric bleaching, soil and human skin.

For the industrial category, the only documented source of dioxins in the Bay Area is from petroleum refineries. Within the industrial process, the specific source is the wash waters from catalyst regeneration reformers. Further studies have shown that the refineries' treatment systems remove these dioxins to below detection limits prior to discharge (Tosco Corp., 1997). These studies also suggest that the dioxins that remain in the discharge are primarily due to storm water runoff from areas surrounding the refineries. This runoff is comparable to the urban runoff from areas far away from any refinery (RWQCB 1997).

* "Dioxin in the Bay Environment -- A Review of the Environmental Concerns, Regulatory History, Current Status, and Possible Regulatory Options" by Ron Gervason and Lila Tang, San Francisco Bay Regional Water Quality Control Board. February 1998.

Do all dioxin compounds pose the same amount of danger?

No. The term dioxin is commonly used to refer to a family of toxic chemicals that all share a similar chemical structure and a common mechanism of toxic action, but the different dioxin compounds can have different toxicities. Dioxins are most often found in mixtures rather than as single compounds in the environment, and the chemical family includes, as mentioned above, chlorinated dibenzo-p-dioxins (CDDs), chlorinated dibenzofurans (CDFs) and certain polychlorinated biphenyls (PCBs). The most toxic forms of dioxin are 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD. Scientists use a shorthand method for comparing the toxicity of different types or mixtures of dioxins to the toxicity of 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD. This method is called the "Toxicity Equivalence" or TEQ. EPA is currently following the 1996 World Health Organization (WHO) TEQ protocol.

CDDs and CDFs are not commercial chemical products but trace level unintentional byproducts of most forms of combustion (which is why forest fires and wood-burning stoves will appear on listings of dioxin sources) and several industrial chemical processes. PCBs were produced commercially in large quantities until production was stopped in 1977. Dioxin levels in the environment have been declining since the early 1970's and have been the subject of a number of federal and state regulations and cleanup actions; nevertheless, current exposure levels still remain a concern.

For more information, see FDA's [Questions and Answers About Dioxin](#).

Has the pollution prevention (P2) approach been applied to reduce dioxin levels in the Bay Area?

EPA Region 9 has supported several dioxin pollution prevention projects in the Bay Area. EPA is a partner with state and local efforts to reduce waste generated at hospitals, including waste sent for incineration. A pilot project involving six Bay Area hospitals demonstrated opportunities to significantly reduce medical waste. One hospital reduced the amount of plastic sent for incineration by 13 tons per year by implementing a reusable sharps container program. Project partners included the California Department of Health Services, California Integrated Waste Management Board, California Department of Toxic Substances Control, Alameda County Department of Health, Contra Costa County Health Services Department, and the Center for Environmental Health, a liaison for nonprofits such as Healthcare Without Harm, Commonweal and Green Action. EPA Region 9 also has supported the Association of Bay Area Governments' Dioxins Pollution Prevention Project. This project is coordinated by a task force of local governments working to implement pollution prevention strategies for dioxins at the municipal level. For more information, contact [John Katz](#) (katz.john@epa.gov) of EPA Region 9's Waste Management Division.

What is the status of the dioxin Total Maximum Daily Load (TMDL) for San Francisco Bay?

EPA is committed to continuing to develop necessary multi-media information on dioxin sources and strategies for pollution prevention. This information will be helpful in the development of a TMDL. The Regional Board is responsible for preparing TMDLs and will release a draft TMDL for PCBs soon. Since PCBs are the most significant contributor to the total TEQ of dioxin-like chemicals in Bay fish, the PCB TMDL is a high priority. San Francisco Bay remains on the Regional Board's 303(d) list of impaired waters for its dioxin levels. See [California's TMDL and 303\(d\) list contacts](#) for more information.

What is the federal government doing to reduce dioxin levels?

EPA has taken aggressive actions to reduce and control dioxins in all environmental media by placing strict regulatory controls on all of the major industrial sources of dioxins. By 2004, the known, quantifiable industrial emissions will be reduced by more than 90% from their levels in the 1980's as a result of EPA's efforts, along with efforts by state government and private industry.

In the long term, efforts to reduce dioxin in the environment should also reduce dioxin levels in the food supply. Federal agencies have been monitoring the levels in foods and conducting an investigation whenever a particular food has dioxin levels detected over the background levels in that food. If the investigation determines a specific source of the increased dioxins, the Food and Drug Administration (FDA) and the Food Safety Inspection Service (FSIS) are poised to take action to remove that source.

Further, under the direction of the Interagency Working Group on Dioxin, FDA and the FSIS have initiated a National Academy of Sciences study to examine potential opportunities for reducing dioxin input into the food supply while maintaining the benefits of a balanced, healthy diet. The results of this study are expected in 2003.

What is the status of EPA's dioxin risk reassessment?

At this time, EPA has submitted the draft dioxin reassessment to the Interagency Working Group on Dioxin (IWG) for review. The Dioxin IWG is made up of federal agencies that address health, food, and the environment. EPA will consider the comments from this consultation in determining the next steps for the reassessment document. If comments by the IWG indicate that additional scientific review of some issues would be beneficial, the EPA is prepared to request such a review by the National Academy of Sciences (NAS) or some other independent scientific organization. In addition, NAS has completed an evaluation of the possible impacts of dioxin in the food supply. That report is available on the Internet at [National Academies Press](#) [\[EXIT Disclaimer\]](#).

In summary, what steps will EPA take in the future to address dioxin issues?

- Nationally, EPA is reviewing dioxin's toxicity. A [draft risk reassessment](#) was circulated in 2002. As of July 2003, a final risk assessment is pending (see [Question 11](#) above).
- EPA is working to further analyze data on air emissions in the Bay Area.
- EPA is supporting the following actions by the San Francisco Bay Regional Water Quality Control Board:
 - Review of NPDES permit limits for dioxins and dioxin-like PCBs
 - Developing a TMDL for PCBs which may address dioxin-like PCBs
 - Developing more sensitive detection methods for compounds such as dioxins where current levels of detection are above water quality criteria
 - Review of effluent dioxin data being collected by all major NPDES permit holders to study to what extent dioxin from point sources is an issue
- EPA has several projects and partnerships underway to reduce pollutant loadings and educate people fishing from the San Francisco Bay:
 - Hospital Waste Pollution Prevention (P2) project
 - Grant to California Department of Health Services for a Seafood Consumption Outreach project to reduce consumption levels in at-risk populations

Web Sites for Reference/Follow-up**FDA's Background Information on Dioxin**

- [General Questions](#)
- [Food Safety Questions](#)
- [EPA's Dioxin Report](#)

California's Office of Environmental Health Hazard Assessment [EXIT Disclaimer](#)

[San Francisco Estuary Institute](#) [EXIT Disclaimer](#)

[CDC's Second National Report on Human Exposure to Environmental Chemicals](#) [EXIT Disclaimer](#)

Local EPA Contacts**Sediment/fish tissue studies:**

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