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## Despite end to direct piping of sewage, pollution worse now than 30 years ago

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The not-so-halcyon days when San Francisco Bay reeked like a festering garbage dump are over.

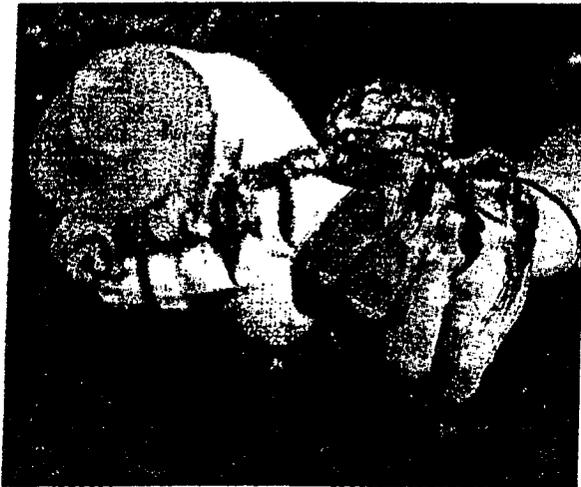
Municipal sewage and industrial waste no longer pour directly into the estuary. Today, thanks to tough environmental regulations enacted during the past 30 years, bay waters are relatively clear and sweet-smelling.

But many species of fish and wildlife are in steep decline. The big cleanup has done little to improve their fortunes. Indeed, the bay was far richer in fish 30 years ago — when it stank to high heaven — than it is now.

The problem, scientists say, is that the bay is suffering from millions of tiny, diffuse sources of pollution. Considered separately, each is small, even inconsequential. But collectively, they are doing serious damage.

Oil and gas spilled on streets, pesticides from farm fields and backyard lawns, polychlorinated biphenyls and dioxin buried in soil at thousands of small, contaminated sites — they all flow downhill with the winter rains, ending up in estuaries and the ocean.

And as the population expands, the problem worsens. These phantom sources of pollution have emerged as one of the most



Cristina Grosso (background) and a colleague from the San Francisco Estuary Institute found a green crab at Robert Crown State Beach in Alameda. Once a month, researchers collect specimens from the tidal flats to determine the health of the ecosystem.

serious threats to San Francisco Bay, and scientists say that traditional pollution controls may be inadequate to deal with them.

"San Francisco Bay is a catch basin for a huge area, from Redding in the north on the Sacramento River to Fresno in the south on the San Joaquin River," said Stanley "Jeep" Rice, a senior toxicologist with the National Marine Fisheries Service.

"Then you have this incredibly urbanized area immediately around the bay and Delta," Rice said. "Every time you have a rain, you get a huge pulse of petrochemicals into the system."

The policy wonk's term for the problem is "nonpoint" pollution. Basically, that is any toxic substance that does not originate directly from a pipe.

Rainer Hoenicke, an environmental scientist with the San Francisco Estuary Institute, an East Bay organization that monitors the health of the bay-Delta system, said "point" sources of water pollution — pipe discharges — have been regulated to the degree that additional controls would provide little benefit.

"Our concern has basically shifted to nonpoint," said Hoenicke, "and that covers a very wide area. It's all the urban runoff

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# Millions of Solutions to <sup>(2)</sup>

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\* **immediately around the bay, all the pesticides and herbicides from both homes and farms. It includes aerial deposition of chemicals. It's all the sources that don't lend themselves to easy control or regulation."**

Although nonpoint sources are diffuse by their very definition, their cumulative effect can be huge.

Rice and a group of his fellow fisheries service scientists determined that the average American annually puts a little more than a quart of petroleum products on roads and parking lots from leaky crankcases and exhaust emissions.

That means that the 11 million people who live in the 31 counties that border San Francisco Bay or the rivers that ultimately flow into it collectively, if indirectly, dump about 2.97 million gallons of oil a year into the the watersheds that feed the bay-Delta system. (By comparison, the Exxon Valdez oil spill was about 11 million gallons.)

"And that happens year in and year out," said Rice.

Worries about nonpoint pollution sharpened recently with a study led by Rice that found minute quantities of oil can devastate fish eggs and larvae. The study was initiated to determine the long-term effects of the 1989 Exxon Valdez oil spill on Alaska's Prince William Sound, but the startling results may be more relevant to urban estuaries such as San Francisco Bay.

"We found that long-term exposure to oil in the parts per billion range produced significantly more egg mortality, more deformities in the fry and less adult survival than (fish) raised in an oil-free environment," Rice said.

"That was very surprising, be-

cause we were dealing with levels of oil on three orders of magnitude less than were previously considered toxic. Until our study, it was assumed you'd need oil in the parts per million range to see real problems."

Rice said San Francisco Bay is under unrelenting pressure from pe-

troleum pollutants, and that the substances causing the most problems are polyaromatic hydrocarbons, or PAHs. These are the heavier compounds left from fuels and motor oil after lighter compounds such as benzene and toluene have evaporated.

"PAHs are resistant to bacterial



MICHAEL MALONEY / The Chronicle

Fishers headed out to the end of the Berkeley Pier to try their luck despite warning signs cautioning them against the increasing toxicity of fish in San Francisco Bay.

# Reclaiming Polluted S.F. Bay

degradation, they are quite toxic, and they are not very soluble in water," said Rice. "But they are lipid (fat) soluble, and animals take them up in their fat. PAHs concentrate in marine organisms when those organisms are almost pure fat and at their most vulnerable — the egg and larval stages."

Bob Spies, a Livermore marine biologist who was the former chief scientist for the Exxon Valdez Oil Spill Trustee Council, said he finds the fisheries service report troubling, particularly in regard to estuaries near urban areas.

"It essentially supports work I did in the 1980s on starry flounder in San Francisco Bay, where we found that fish that had high levels of an enzyme associated with PAH exposure had reduced egg fertility and increased (fry) mortality," said Spies. "Since that study, other scientists I talk to tell me starry flounder have become rare in the bay. They once were very common."

It is not only PAHs that are a nonpoint pollution problem — polychlorinated biphenyls, or PCBs, and dioxin are also poisoning the bay.

PCBs are long-lasting compounds that are solid in their pure state but easily soluble in fats, oils or solvents. Banned in the 1970s, polychlorinated biphenyls were widely used for insulation in electrical transformers and capacitors. Soils have been contaminated with PCBs in myriad spots around the Bay Area, and the compounds wash easily into rivers and estuaries.

"PCBs are a real concern because they're slow to break down," said Spies. "Not too many of them are released into the environment these days, but the ones that are already out there represent a significant quantity."

Like PAHs, PCBs have been asso-

ciated with decreased fertility in fish, said Spies.

Dioxin is another worry. One of the most toxic compounds known, minute amounts can cause cancer and reproductive disorders. Several species of San Francisco Bay fish contain enough dioxin — as well as other contaminants — to make their consumption a public health concern.

Dioxin is a byproduct of the manufacture of certain pesticides. It is also formed in combustion processes involving fuel that contains both chlorine and carbon. The burning of diesel fuel, coal or wood results in the formation of dioxin.

In the past, much of the dioxin that got into the bay probably came from now-banned pesticides and industrial waste discharges. Today, most comes from diesel exhaust.

Recently, the Oakland City Council and the San Francisco Board of Supervisors voted to support a regional plan calling for the complete elimination of dioxin discharges into the bay. But given current sources of the compound, achieving such a goal will be difficult.

As with polychlorinated biphenyls, not much dioxin is estimated to flow into the bay — about three grams a year. But like PCBs, dioxin is extremely long-lasting and can move about freely in the environment.

"Intuitively, that doesn't seem like much," said Brian Bateman, the air toxics manager for the Bay Area Air Quality Management District. "But it's extremely toxic, and we also have to deal with 'reservoir' sources — the dioxin that got into the bay years ago."

Mercury is another contaminant that has had a long and troublesome history in the bay. The element is profoundly harmful to both human

beings and wildlife.

During the 19th century, huge quantities of it were flushed into the estuary from the Sierra, where it was used to separate ore from gold. This "legacy" mercury is still tainting San Francisco area fish and wildlife. And environmentalists say the heavy metal continues to seep into the bay on a continuing basis from myriad sources.

"There are more than 300 inactive mercury mines in the coastal foothills that have large exposed tailings piles," said Michael Belliveau, the director of Just Economics for Environmental Health, a San Francisco group concerned with Bay Area mercury contamination.

"Mercury leaches from them continually," Belliveau said. "It's also released from fuel combustion in cars and at refineries, cement kilns and power plants. It's in silver amalgam fillings, so it gets into the sewage system from dentists' offices. It's in fluorescent lights, camera and watch batteries and certain electrical switches."

Bad as it is, the quantity of mercury seeping into San Francisco Bay has been reduced since the late 1800s. PCB and dioxin flows have also been cut.

But the same cannot be said of pesticides.

DDT and dieldrin, which have been banned for decades, continue to pollute bay fish. Both compounds — known as chlorinated hydrocarbon pesticides — are extremely stable and take decades to degrade. Yet DDT tissue levels in local fish appear to be gradually decreasing.

Of greater concern these days are organophosphate pesticides. Organophosphates replaced the earlier pesticides, promoted as short-lived compounds that would break down

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# Bay in Worse Shape Than

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quickly when exposed to sunlight and soil.

Tons of organophosphate poisons get into the bay each year — not just from farms in the Central Valley, but from golf courses and the lawns and gardens of the thousands of homes ringing the estuary. Experts say pesticides are often applied more heavily in and around homes than on commercial crops.

But "some of the organophosphates don't break down as quickly as promoted," said Spies. "At least one, Diazinon, is a serious contaminant in the bay. It's used in agriculture and around the home to control fleas and ants."

Spies explained that organophosphates kill insects by interfering with an enzyme that aids in the transmission of nerve impulses. "Unfortunately, shrimp and numerous other marine animals are biologically similar to insects, so it affects them as well," he said.

A 1993 study by the U.S. Geological Survey concluded that large "pulses" of Diazinon flow through San Francisco Bay from the Sacramento and San Joaquin rivers after major storms.

Concentrations of the pesticide in bay water can be alarmingly high during such events — as much as 199 nanograms per liter. Although a nanogram is only one-billionth of a gram, the National Academy of Sciences has issued guidelines stipulating that maximum Diazinon concentrations should not exceed nine nanograms per liter of water if aquatic life is to thrive.

Ultimately, the problem is not simply PAHs or PCBs or Diazinon or dioxin, say scientists. It is probably all of them combined, each working in malign concert with the other.

Unfortunately, research is scant on the cumulative effects of the various toxic compounds circulating in urban estuaries.

"A lot of the available research money is going to the examination of short-term impacts" of specific chemicals, said Spies. "We're not looking at the long-range implications of the entire soup of com-

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pounds out there in the bay."

One thing is clear about San Francisco Bay: For whatever reason, marine life has been greatly reduced. Rice thinks "compound soups" may gradually depress fish populations to the point of no return.

"You don't see the huge fish kills that you used to get in the old days from sewage spills or big industrial releases of chemicals," he said. "But these compounds appear to be acting at the larval and egg stages, so you get less and less recruitment with each generation of fish. They just kind of fade away. And then fishermen suddenly start wondering why they aren't catching anything."

What can be done to restore fish populations? Rice thinks healthy wetlands are essential in reducing the effects of polluted runoff.

"Wetlands are filters," he said. "They remove and degrade all sorts of toxic compounds. The more wetlands you have around a bay, the more filtration you get."

That line of thinking is gaining ground. Recently, a federal and state

task force called for creating 60,000 acres of new tidal marshlands to revitalize bay ecosystems.

Local pollution experts suggest other remedies as well.

"Education is the first step," said Geoff Brosseau, executive director of the Bay Area Stormwater Management Agencies Association, a regional organization of 90 city, county and special district jurisdictions that promotes programs to reduce nonpoint pollution to the bay.

"We're dedicated to raising public awareness," said Brosseau. "Basically, this is a matter of 6 million little pollution sources — every one of us who lives around the bay contributes to the problem, and we'll only solve it when we each do our part."

Minimizing driving and keeping cars maintained to reduce crankcase drips and exhaust emissions are crucial, said Brosseau, as is curtailing excessive pesticide, herbicide and fertilizer use around homes and gardens.

Changes in basic infrastructure could also help significantly, said Brosseau. "We need to plan for water quality when we develop," he

# 30 Years Ago

said. "Wherever possible, storm drains should be directed to bypasses."

Bypasses are areas of open land where runoff is diverted. Although they are typically employed for flood control, they can also be used to improve water quality. When contained in shallow impoundments of standing water, toxic compounds tend to degrade.

"We can designate open areas in cities and suburbs as small bypasses," said Brosseau. "Freeway medians should be concave instead of convex, so water will collect rather than run off. This allows microbes and sunlight to degrade toxic compounds before they get into the bay."

Wil Bruhn, a senior engineer with the San Francisco Bay Regional Water Quality Board, said the problem of nonpoint pollution is confounding simply because it is caused by millions of people involved in the daily, mundane process of living their lives — driving their cars, caring for their lawns, consuming products.

"For example, we've determined that the biggest source of copper —

a serious pollutant in the bay — is now coming from brake pad dust," Bruhn said. "It used to be industry that was the biggest source. And when it was industry causing the problem, it was easy to regulate — we issued discharge standards. But regulating millions of brake pads is much harder."

After 30 years of hard work, environmentalists and regulators alike hoped that there would be a big payoff for the bay — that the fish and wildlife would return to waters that no longer stank, that were no longer mottled by mysterious slicks and scum.

But the payoff never happened — and a growing number of scientists think the reason is small but persistent quantities of toxic compounds. And they believe that a completely new approach to pollution control is necessary to address them.

"The whole toxic paradigm has changed," Rice said. "It's not a matter of all or nothing. If you have trace levels of compounds in the water that are killing 5 to 10 percent of the eggs and young fish each year, you're still going to come to a point when you have no fish. You'll still end up with an empty system."

## REDUCING POLLUTION

*Pollution in San Francisco Bay has several million causes — it exists because of the activities of the several million people who live around it. So it requires several million solutions. The problem seems daunting, but environmental authorities insist that individual and community action can make a significant, positive difference. Among their recommendations:*

- Bring your car to a certified dealership or garage for oil changes, or return used oil to established recycling centers if you perform your own maintenance.
- Have your car checked periodically to make sure it is not dripping oil or producing excessively dirty exhaust.
- Ride a bike or walk whenever possible.
- Use the minimum amount of pesticide necessary for your home and garden. Garden organically whenever possible.
- Compost garden and kitchen waste. Compost can be used as a fertilizer, reducing nitrate runoff from artificial fertilizers. Composting also saves landfill space.
- Do not overwater lawns and gardens. Overwatering can flush large quantities of pesticides and fertilizer directly into storm drains.
- Wash your car at commercial car washes. They use less water than is typically used at home, and the water is usually contained for treatment.
- Use manual or electric lawn mowers and garden tools whenever possible. Gas-powered lawn mowers, chain saws and hedge trimmers contribute to short-term air pollution, and their combustion byproducts contain nasty toxic substances that can eventually settle into waterways.
- Purchase products that are low in toxic elements such as mercury.
- Encourage your city to purchase buses and service vehicles that use clean fuels such as propane, rather than diesel.
- Promote community and county zoning regulations that require new developments to construct minibypasses and settling areas that slow water discharge into rivers and estuaries.

— Glen Martin