Mercury in the Bay Educator Guide
A resource for using QUEST video, audio and blogs in the classroom

QUEST MEDIA FOR TEACHING ABOUT MERCURY IN THE BAY

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Watch “Mercury in the Bay - Part 1”
http://www.kqed.org/quest/television/view/855
- Did you know that mercury extracts gold out of rock? Mercury mined during the gold rush has left a toxic legacy in California, particularly in the San Francisco Bay, where the metal is still found in its mud and fish.

Listen to “Mercury in the Bay - Part 2”
- QUEST discusses the problem of mercury in San Francisco Bay with local fisherman at the Berkeley Marina, a leading doctor who diagnoses “fish fog” mercury poisoning in her patients and a bay ecologist who studies the ways mercury affects human life.

Watch “Mercury in San Francisco Bay”
- Examine the multibillion-dollar plan to clean up the mercury in San Francisco Bay.

TOPIC BACKGROUND

Mercury is an extremely toxic pollutant. It can occur naturally or be introduced as a contaminant. One of the dangers of mercury is its potential to create toxicity in areas that may not on the surface seem polluted. In such places, as well as in visibly contaminated areas, mercury can be a great hazard to the health of humans and wildlife.

The toxic effects of mercury vary depending on the chemical form it takes and the way a person or animal is exposed to it. The most dangerous form of mercury is methylmercury. Methylmercury causes problems with the immune system and damages a person's nervous system, creating issues with coordination and the senses of touch, taste and sight. It is particularly toxic for pregnant women, because developing embryos are much more sensitive to methylmercury than adults are. Generally, exposure to methylmercury comes through food. When methylmercury is ingested, it is readily absorbed and excreted very slowly, so that most of it stays in a person's system. Eating contaminated fish and other organisms at the top of the aquatic food chain is the most common way that humans are exposed to methylmercury. A 2000 report by the National Research Council stated that an estimated 60,000 children are born every year with the possibility of neurological damage due to exposure to methylmercury while in the womb. Wildlife is also at risk of damage due to methylmercury exposure. However, scientists have trouble proving how much risk this pollutant poses, as it is difficult to remove other factors from the environment. Studies conducted on certain birds show that protective enzymes do not work properly after a bird has been exposed to mercury. And high mercury concentrations in eggs have been found to affect the chick populations in certain areas.

Additional background resources:
USGS: Water Quality of San Francisco Bay http://sfbay.wr.usgs.gov/access/wqdata/
**INTRODUCTORY QUESTIONS**

- What kinds of things create water pollution?
- How does mining impact the environment?
- What do you know about mercury and mercury poisoning?

**FOCUS QUESTIONS**

- What are some challenges to the mercury cleanup process in San Francisco Bay?
- Why do apex predators in the marine food chain (like halibut and other large fish) have the highest mercury levels?
- How does mercury in the watershed affect humans? How does it affect wildlife?
- Where does mercury in the San Francisco Bay come from?

For all media see:


**LESSON PLANS and RESOURCES from PBS, NPR and MORE**

NOTE: Resources from the Teachers' Domain collection require a fast and free registration.

**Weighing the Risks and Benefits of Eating Fish** NPR
In this January 16, 2009, edition of *Talk of the Nation*, health experts discuss mercury poisoning and whether the potential risks of eating fish outweigh the benefits.

**Fish FAQ: What You Need to Know About Mercury** NPR
This October 17, 2006, story answers the questions of what mercury is, how methylmercury gets into the food chain and why this toxic compound is so dangerous, among other questions.

**The Mercury Story** PBS
This article from *NOW* discusses the facts about the uses and hazards of mercury, including information about mercury in fish and mercury emission standards from the Environmental Protection Agency.

**Contaminating the Rockies** Teachers' Domain
This video segment adapted from *NOVA* explores the contamination left behind by abandoned mines in the Rocky Mountains. With more than 15,000 abandoned mines in the area, the rivers of the Rockies are becoming laden with heavy metals.

**Human Impact on Water Quality** Teachers' Domain
How do human activities affect our water supplies? In this lesson, students will examine the causes of water pollution in their watershed and consider ways to avoid further pollution.
Why Use Multimedia in Science Education
- Read about the importance of using multimedia in the 21st century science classroom.

How to Use Science Media for Teaching and Learning
- A collection of tips, activities and handouts to actively engage students with multimedia.

Science Multimedia Analysis
- Give your students the tools to recognize the purposes and messages of science multimedia.

Create Online Science Hikes with Google Maps
- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

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The Bay Institute
www.bay.org

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www.calacademy.org

Chabot Space and Science Center
www.chabotspace.org

East Bay Regional Park District
www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of Northern California
www.girlscoutsnorcal.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

The J. David Gladstone Institutes
www.gladstone.ucsf.edu

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Monterey Bay Aquarium
www.mbayaq.org

Monterey Bay Aquarium Research Institute
www.mbari.org

Oakland Zoo
www.oaklandzoo.org

The Tech Museum of Innovation
www.thetech.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

U.S. Geological Survey
www.usgs.gov

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OLD TAPE: Almaden, California. A western community that is famous. Famous for
the curious metal mined in the mountains.

Everyone knows about California’s Gold Rush: Sutter’s Mill, the ‘49ers, the birth of a
new state. But what made it all possible was another, less well-known, mining rush. It
happened here, in the hills on San Jose’s southern edges.

SANISLO: Our mines were bigger than the biggest gold mines.

Terri Sanislo is an interpreter at the New Almaden Mining Museum in San Jose.

SANISLO: And ultimately, we made more money selling mercury than the biggest
gold mine did selling gold.

So everyone talks about the gold rush, but financially, at least, it was the...

SANISLO: A mercury rush. A mercury rush. One hundred and fifty years ago there
were nine saloons on this little street, serving miners from as far away as Mexico,
China, and England. They dug 40 miles of mining tunnels through the hills above
town, and pulled out thousands of pounds of cinnabar—a rock that contains mercury.
But, there wouldn’t have been a mercury rush without the gold rush.

OLD TAPE: During the gold rush days, miners used mercury to help them refine their
gold.

Mercury has an almost magical property: it can extract gold out of rock. In its peak
years between 1850 and 1890, the New Almaden Mine sold mercury to gold miners
in the Sierra foothills who spread it over their gold ore. When that mixture of gold and
mercury was heated in smelters, the mercury vaporized.

SANISLO: And when you open their cooker pots, left in the bottom was the powdery
rock, and sitting on top was, you hoped, pure 24 carat sponge gold.

But mercury has other special properties as well, and while it was godsend for gold
miners, it’s left a toxic legacy here in the Bay Area, one that scientists are still trying
to understand.

We’re inside a complex of labs and office buildings at the US Geological Survey in
Menlo Park, meeting with scientist Mark Marvin Di Pasquale. In one hand, he’s
holding a reddish rock, about the size of a golf ball. In the other, a small glass bottle
containing a pea-sized drop of elemental mercury, like what you’d find in an old
thermometer.

DI PASQUALE: Cinnabar. Mercury. It’s not a lot of it, but we try to actually stay away
from big balls of mercury around here.
Di Pasquale works with tiny amounts of mercury, not teaspoons or ounces, but picograms. That’s a trillionth of a gram.

DI PASQUALE: A globule like this would really contaminate a laboratory for years.

Elemental mercury is not safe to handle. But what’s even more dangerous is a form of the metal called methyl mercury. It’s what happens to mercury when it gets eaten by bacteria in the dirt and starts making its way up the food chain.

DI PASQUALE: And that’s where it becomes problematic, is it moves from the sediments to the water column. It begins to accumulate in phytoplankton and consumed by the very tiny organisms that we call zooplankton and then by smaller fish and larger fish and so on up the food chain.

Less than a teaspoon of methyl mercury can poison thousands of fish. When children or pregnant women eat that fish, the methyl mercury can cause brain damage and developmental delays. So the goal is to remove the mercury before it even hits the water.

That’s what’s happening here, just downstream of the former New Almaden Mercury mines, which are now a county park.

DRURY: This is a before. I’ve been showing you afters, here’s a before. So if you could follow me.

Dave Drury is an engineer with the Santa Clara Valley Water District, in charge of cleaning up old mining waste. We’re standing on a creek bank covered in what looks like concrete.

DRURY: You notice there’s not much growing on it? Remember that other spot, we had nice tall grass and trees and stuff? Nothing grows in this, it grows on the edges. This is a deposit of mining waste.

After miners extracted most of the mercury from the rocks, they dumped the waste rock into nearby streams. These rocks are harmless; you can’t get mercury poisoning from handling them, or from walking around the old mines. But over time, they can slowly leech mercury and, eventually, methyl mercury into the water.

Scientists say about 200 pounds of mercury flow out of these streams every year and end up in the San Francisco Bay. It’s an enormous amount, given the toxicity of the metal. This is just one of the sources of mercury in the Bay, but it’s also one of the simplest to clean up.

DRURY: So, the way to reduce methyl mercury in fish is to prevent it from getting in the water in the first place because that’s where your money is best spent. That’s where you’re going to make the biggest difference.
Meanwhile, the Bay is conducting its own clean up, as the tides slowly flush water and mercury out through the Golden Gate. At the current rate, that’ll take a century or more until the Bay’s mercury levels are safe. Unless, that is, state officials succeed in their plan to speed up the process. We’ll hear about that next week.

For QUEST, I’m Amy Standen, KQED Radio News.
You wouldn’t know it just by looking at the surface, but San Francisco Bay is still feeling the effects of the Gold Rush. Nineteenth-century mining left thousands of pounds of toxic mercury in the Bay’s mud. And every year, local industry and city residents are adding even more mercury—leaving many fish in the Bay unsafe to eat. But now, as Amy Standen reports, local officials are taking big steps toward cleaning up the mercury pollution in San Francisco Bay.

On a Sunday morning in late April, at the Berkeley Marina, dozens of anglers are casting their fishing rods over the pier, hoping for a bite.

BERKELEY FISHERMEN: Well, we’re doing some halibut fishing. Yeah, halibut if they’re biting. That’s what’s in here right now. This is halibut season, so… We tried to get halibut!

That last voice belongs to Tu Van, who’s here today with her husband Lam Chan. The two emigrated from Vietnam 33 years ago. Now that they’re retired, they come out to fish in the Bay about once a week.

Do you ever hear about mercury in the fish?

TU VAN: Yeah, we hear but not too much in Bay. Not much mercury.

Halibut not a problem?

TU VAN: Not a problem.

Fisherman Dave Hurwatt isn’t too worried either.

HURWATT: I heard a long time ago that if you, when you’re cleaning the fish, if you trim the red meat off and just leave nice white meat and don’t eat the meat off the head, that’s pretty much, that’s where it’s all located. So, you know, I don’t worry too much.

But halibut does contain mercury, and it’s present throughout the fish. Levels aren’t as high as they are in other Bay dwellers, like striped bass and sturgeon. Still, health officials advise against eating any fish caught in the Bay more than twice a month.

Herwatt and Tu Van highlight a basic problem of mercury poisoning. Despite warning signs posted near fishing piers, it’s a difficult toxin to understand.

SWANSON: If you eat a fish that’s contaminated with mercury you won’t taste it, you won’t see it.

Tina Swanson is an ecologist with the Bay Institute, an environmental group based in Novato.
SWANSON: You can’t cook it out because much of the mercury accumulates in the muscles of the fish that we eat. Nor would you feel particularly sick after you’d consumed it, or days later. It’s just not that kind of a contaminant.

Instead, mercury contamination builds up over time, particularly in those who eat a lot of it. A 2001 study by the San Francisco Estuary Institute found that many Southeast Asian immigrants eat Bay fish almost daily.

Pregnant women are particularly at risk. Mercury can cause brain defects in a developing fetus. In children, high levels of mercury can cause learning disabilities. Among adults, the symptoms can be much more subtle.

Dr Jane Hightower runs her medical practice at California Pacific Medical Center in San Francisco—a long way from the fishing piers of Berkeley or Richmond.

HIGHTOWER: I have a Pacific Heights practice. They’re not fishing in Martinez; okay, you know, they’re fishing at Bryans and Whole Foods and the like.

Still, store-bought fish caught in the ocean can be just as high in mercury as fish caught in the San Francisco Bay, which is how Dr. Hightower came to be one of the first physicians to start diagnosing mercury poisoning in her patients.

HIGHTOWER: I thought, you know, I’m getting a lot of people in my office in the last year or two that I really can’t figure out what’s wrong with them. I thought of those folks first and I started calling them up and asking, well, what’s for dinner. What are you eating for lunch?

Hightower’s patients’ symptoms were vague. She calls it fish fog.

HIGHTOWER: Fish fog is troubles thinking, fatigue, headache, muscle and joint pains, little bit of stomach upset.

Initially, Hightower took hair samples to see how high her patients’ mercury levels were. But eventually, her diagnostic methods became much simpler.

HIGHTOWER: Look it’s not rocket science. If you eat a poison and you don’t feel well, stop eating poison and see if you feel better. And sure enough, people started feeling better.

The good news, here in the Bay at least, is that we are finally doing something about mercury pollution. It’s a multi-billion dollar clean-up project, began last year, by the San Francisco Bay Regional Water Quality Control Board. Manager Will Bruhns says that cleaning up mercury in the Bay is not as simple as the kinds of problems his agency once tackled.
BRUHNS: There’s no bad actor. There’s no factory in some city that’s dumping out the tons of mercury that if we just could make them clean up their act, all of the problems would be solved. There isn’t any.

Mercury comes from many sources. Hundreds of pounds every year flow from old mercury and gold mines in the Sierra and San Jose. Hundreds more run off city streets from things like broken thermometers and other urban waste. Airborne mercury drifts over from coal-fired power plants in Asia. Meanwhile, the Bay Area’s five oil refineries and a cement kiln pump over a thousand pounds of mercury into the air a year, some of which ends up in the Bay. So the clean up has to happen on many fronts, all at once.

BRUHNS: It’s a different kind of problem; that’s what new here. And it’s hard to deal with.

Over the next 20 years, the clean up will include hauling away mining waste from creek beds that lead to the Bay. Cities will be required to clean up their streets. Refineries will have to account for their mercury waste. Meanwhile, the Bay is cleaning itself, flushing mercury out through the Golden Gate. Still, scientists believe it will be at least a century before all Bay fish are safe to eat.

For Quest, I’m Amy Standen. KQED Radio News.