Introduction to Poisons

WHAT ARE TOXINS?

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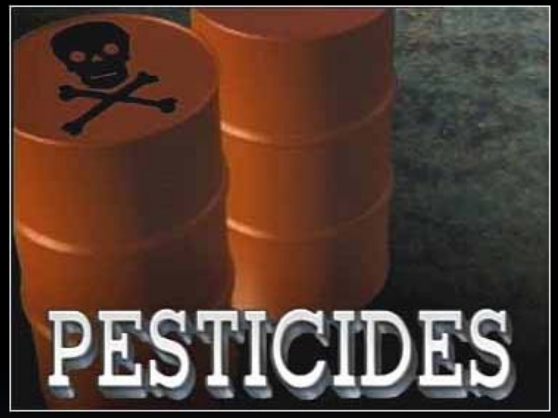
MARCH 2010

Part 1: Toxins and poisons

Explaining the differences, uses and applications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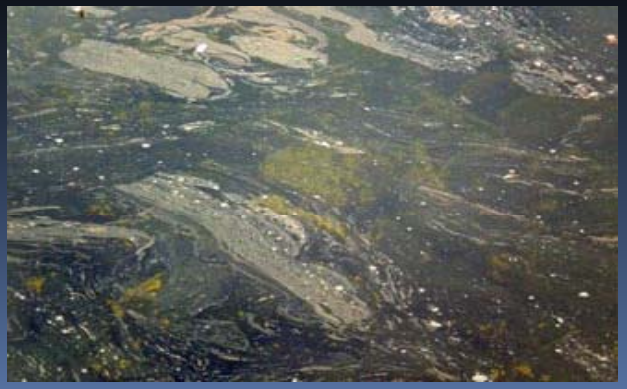
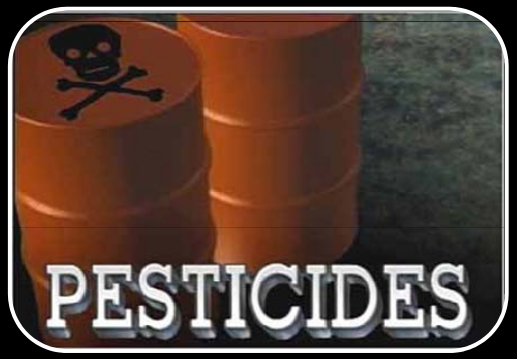
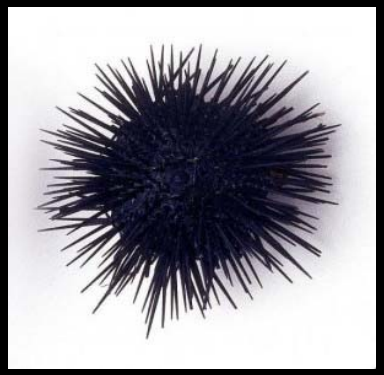




What Did

You See?


Bleach
Toilet Bowl Cleaner
Household Cleaner
Pain
Caution




DANGER
POISON


GAS
PAINT

What

Did

You

See

This time?

Key words to highlight

Key vocabulary words
Antidote
Arsenic
Chemotherapy
Dose
Poisonous
Radiation therapy
Remedy
Severity
Toxin
Venomous

Toxins versus poisons?

Toxins

A toxin is a poisonous substance produced by living cells or organisms that is active at very low concentrations and are capable of causing disease on contact or absorption with body tissues. Toxins vary greatly in their severity, ranging from usually minor and acute (as in a bee sting) to almost immediately deadly, as with Sea Anemone.

Poisons

Poisons are substances that can cause damage, illness, or death to organisms, usually by chemical reaction or other activity on the molecular scale, when a sufficient quantity is absorbed by an organism.

Toxins and Poisons

Remember.....

Legally and in hazardous chemical labeling, poisons are especially toxic substances; less toxic substances are labeled "harmful", "irritant", or not labeled at all.

Venomous versus poisonous?

Venomous

Venomous refers to animals that inject venom into their prey when hunting or as a self-defense mechanism.

Poisonous

Poisonous describes plants or animals that are harmful when consumed or touched.

Poisons and remedies

"All substances are poisons;
there is none which is not a poison.
The right dose differentiates a poison
from a remedy."

Paracelsus (1493-1541)

Poisons and remedies

"The sensitivity of the individual differentiates a poison from a remedy. The fundamental principle of toxicology is the individual's response to a dose."

S. G. Gilbert (1997)

Poisons and remedies

Poison as an antidote

The venom of the Chilean Rose tarantula contains a protein that can help stop heart attacks.

Poisons and remedies

A good understanding of how the body works is required before one can confidently introduce poison into a human being as a means to cure illness. Experimenting with different poisons as antidotes results in extensive deaths among a test subject population. Trial and error, in other words, isn't a good means of identifying which poisons can also serve as a cure.

Poisons and remedies

The venom from another menacing arachnid is being used to help treat cancer. Researchers, have found that venom of the Israeli yellow scorpion may destroy types of cancerous cells found in **gliomas**, brain cancer that's particularly difficult to treat.

Poisons and remedies Chemotherapy

The first use of drugs to treat cancer, however, was in the early 20th century, although it was not originally intended for that purpose. Mustard gas was used as a chemical warfare agent during World War I and was studied further during World War II. During a military operation in World War II, a group of people were accidentally exposed to mustard gas and were later found to have very low white blood cell counts. It was reasoned that an agent that damaged the rapidly-growing white blood cells might have a similar effect on cancer.

Poisons and remedies

In the 1940s, several patients with advanced lymphomas (cancers of certain white blood cells) were given the drug by vein, rather than by breathing the irritating gas. Their improvement was remarkable which led researchers to look for other substances that might have similar effects against cancer.

Poisons and remedies

Chemotherapy, in its most general sense, is the treatment of disease by chemicals especially by killing micro-organisms or cancerous cells., an arsenic compound discovered in 1909.

Poisons and remedies

Most commonly, chemotherapy acts by killing cells that divide rapidly, one of the main properties of cancer cells. This means that it also harms cells that divide rapidly under normal circumstances: cells in the bone marrow, digestive tract and hair follicles; this results in the most common side effects of chemotherapy decreased production of blood cells, inflammation of the lining of the digestive tract and alopecia (hair loss).

Poisons and remedies

Radiation therapy

Radiation therapy works by damaging the DNA of cells. The damage is caused by a photon, electron, proton, neutron, or ion beam directly or indirectly on the atoms which make up the DNA chain. Because cells have mechanisms for repairing DNA damage, breaking the DNA on both strands proves to be the most significant technique in modifying cell characteristics. Cancer cells reproduce more, and have a diminished ability to repair damage to their cells compared to most healthy cells. The DNA damage is inherited through cell division, accumulating damage to the cancer cells, causing them to die or reproduce more slowly.

Toxin inventory assignment

As we start preparing for warmer days ahead, there are more opportunities to be exposed to toxic substances, such as weed killer, bug sprays, left over anti-freeze, etc. The rational for this assignment is for the student to become familiar with common household harmful substances and be aware if they are safely stowed away in the house.

Key vocabulary words learned so far…

Key vocabulary words
Antidote
Arsenic
Chemotherapy
Dose
Poisonous
Radiation therapy
Remedy
Severity
Toxin
Venomous

End of Part 1: Toxins and poisons

Part 2: Food poisoning

Key words…

Key vocabulary words
Antimony
Contaminated
Heavy metals
Incubation
Ingested
Microbial
Nausea
Pesticides
Salmonella
Zince

Food borne diseases

Diseases brought about by eating harmful contaminated food

Symptoms

- diarrhea
- abdominal pain
- nausea and vomiting
- mild fever and chills

Salmonella

Food borne diseases

May manifest themselves in a mild form or as a serious condition that can lead to death

How sick you may become depends on:

- Type of bacteria, amount of bacteria or toxin ingested
- Age of the person
- Incubation period = time interval between eating and the onset of symptoms

Food borne diseases

Causes:

- Microbial infection
- Naturally occurring toxins
- Chemicals, heavy metals, pesticides
- Allergic or sensitivity reaction to certain foods

Food borne diseases

Majority of food poisoning are caused by bacteria

- Multiply on food and cause spoilage
- Releases toxins

Food borne diseases

Certain plants naturally contain substances which are harmful to human beings such as peas, beans and cassava

Food borne diseases

Raw and undercooked red kidney beans

Food borne diseases

Chemical food poisoning

- Food contaminated by chemicals due to mishandling of chemicals
- Food contaminated by chemicals during processing, e.g., pesticides

Food borne diseases

Chemical food poisoning

- Zinc poisoning
- Antimony poisoning

Food borne diseases

- Zinc poisoning

  Zinc is a very abundant element, appearing as a bluish white metal in its pure state. Zinc is also highly adaptable and has many uses, including rust resistant coating, blending with other metals, and use in wood preservatives.

  A small amount of zinc is necessary for a balanced human diet. However, being exposed to more than 10 times the amount of recommended zinc can result in zinc poisoning. Zinc poisoning can be deadly if not caught and treated quickly.

Food borne diseases

Antimony poisoning

Antimony is increasingly being used in the semiconductor industry in the production of diodes, infrared detectors, and Hall-effect devices. As an alloy, this metalloid greatly increases lead's hardness and mechanical strength. The most important use of antimony is as a hardener in lead for storage batteries.

Food borne diseases

Food poisoning symptoms may begin soon after eating or within a day

<u>When you see</u>

- ✓ Nausea and vomiting, signs of abdominal pain or cramps
- ✓ Diarrhea, possibly with blood
- ✓ Headache and fever

Food borne diseases

Food poisoning symptoms may begin soon after eating or within a day

Do this first

- ✓ Have the victim rest lying down
- ✓ Give the victim lots of fluids
- ✓ Seek medical attention

Food borne diseases

Food borne diseases

Prevention of food poisoning

- Proper cleaning
  - Use clean utensils
  - Use hot soapy water to clean cutting boards, knives and equipment after handling raw food

Keep all surfaces that come in contact with food absolutely clean

Food borne diseases

Prevention of food poisoning

- Proper cooking
- Avoid "undercooked" portions especially meat and poultry should be properly thawed before cooking!
- Avoid reheating food—it must be thoroughly reheated in all parts

Food borne diseases

Prevention of food poisoning

- Proper storage
- Store perishable food in the refrigerator or in the freezer for longer storage
- Do not crowd the refrigerator or freezer—cold air should circulate
- Do not store food near cleaning products and chemicals

Food borne diseases

Important!

Keep food at the right temperature

Key vocabulary words learned so far…

Key vocabulary words
Antidote
Arsenic
Chemotherapy
Dose
Poisonous
Radiation therapy
Remedy
Severity
Toxin
Venomous

End of Part 2: Food borne diseases

Part 3: Persistent chemical pollution

Persistent chemical pollution

What does persistence mean?

Key vocabulary words

Key vocabulary words
Trophic
Consumer
Persistent
Decomposer
Food chain
Predator
Producer
Food web
Prey
Bio-accumulate

Persistent chemical pollution

Persistent chemical pollution

Persistent chemical pollution

What does persistence mean?

Existing for a long or longer than usual time or continuously: as continuing without change in function or structure

Persistent chemical pollution

Which persistent future do we strive for?

or

Persistent chemical pollution

- Toxic to humans and animals
- Persist in the environment
  - Do not break down
- Bio-accumulate in animals becoming part of the food chain
- Tend to be widespread

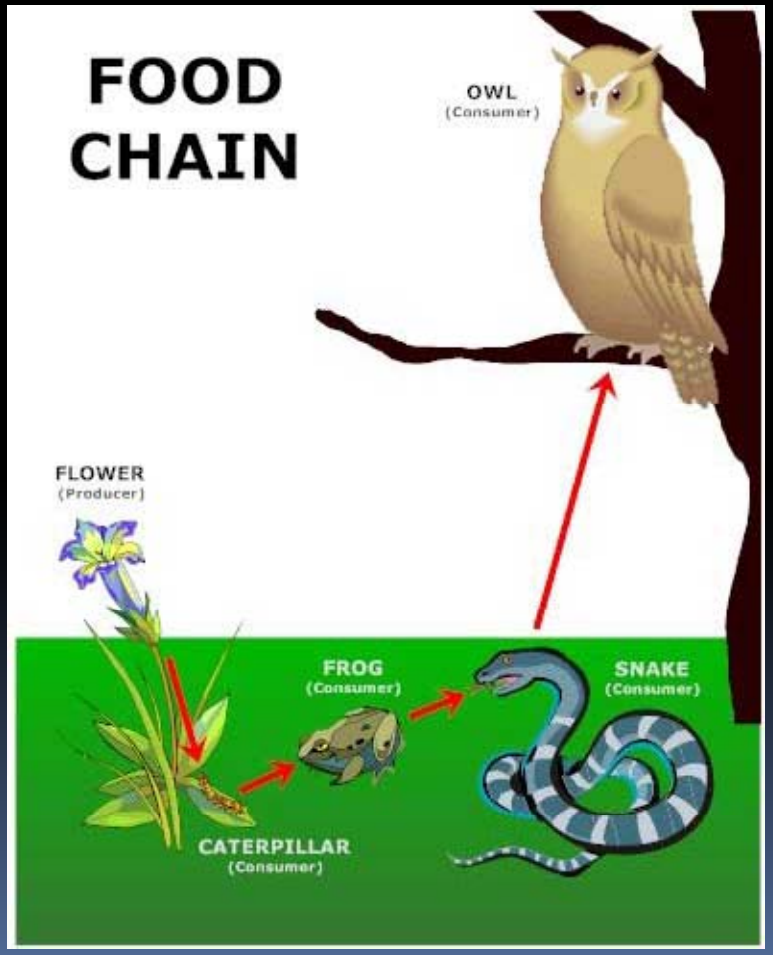
Persistent chemical pollution

“These (British Columbia, Canada & Washington, U.S.) killer (Orca) whales can now be considered among the most contaminated marine mammals in the world”

Persistent chemical pollution

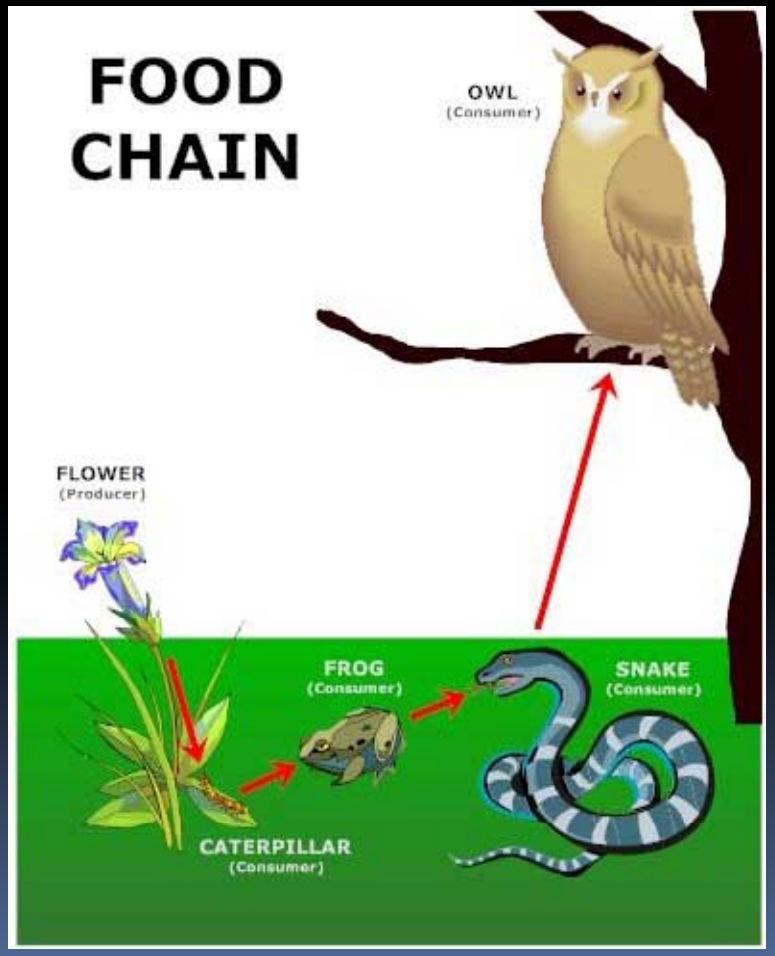
- Toxic to humans and animals
- Persist in the environment
  - Do not break down
- Bio-accumulate in animals becoming part of the food chain
- Tend to be widespread

Persistent chemical pollution



What is the food chain?

Persistent chemical pollution

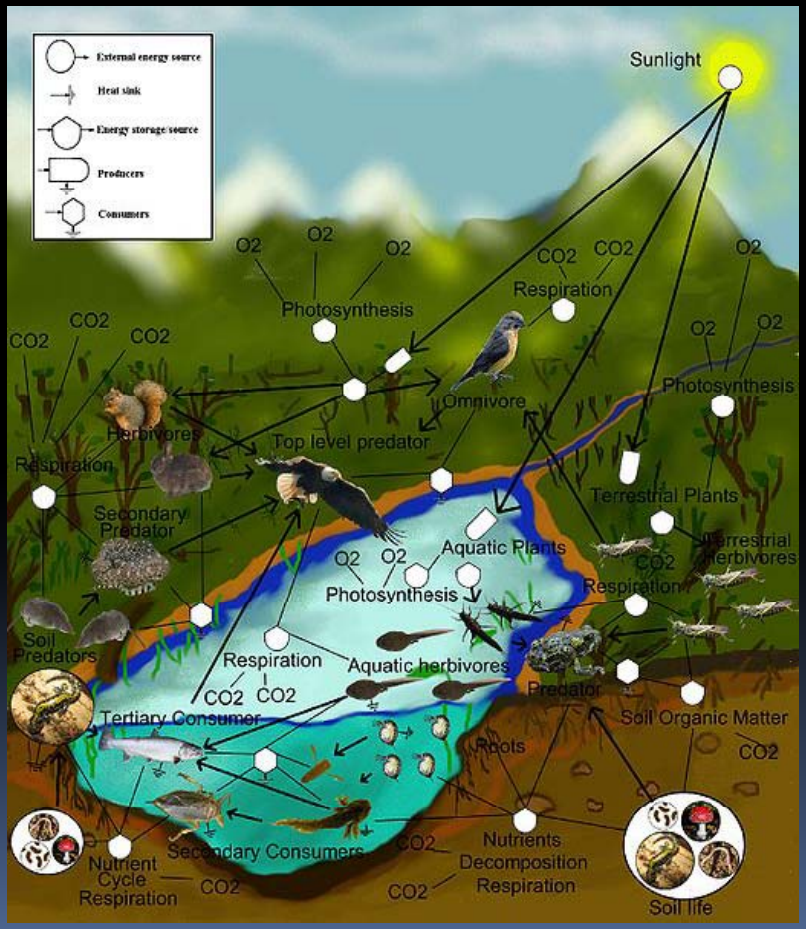


In this food chain:

1. Caterpillar eats flower
2. Frog eats caterpillar
3. Snake eats frog
4. Owl eats snake

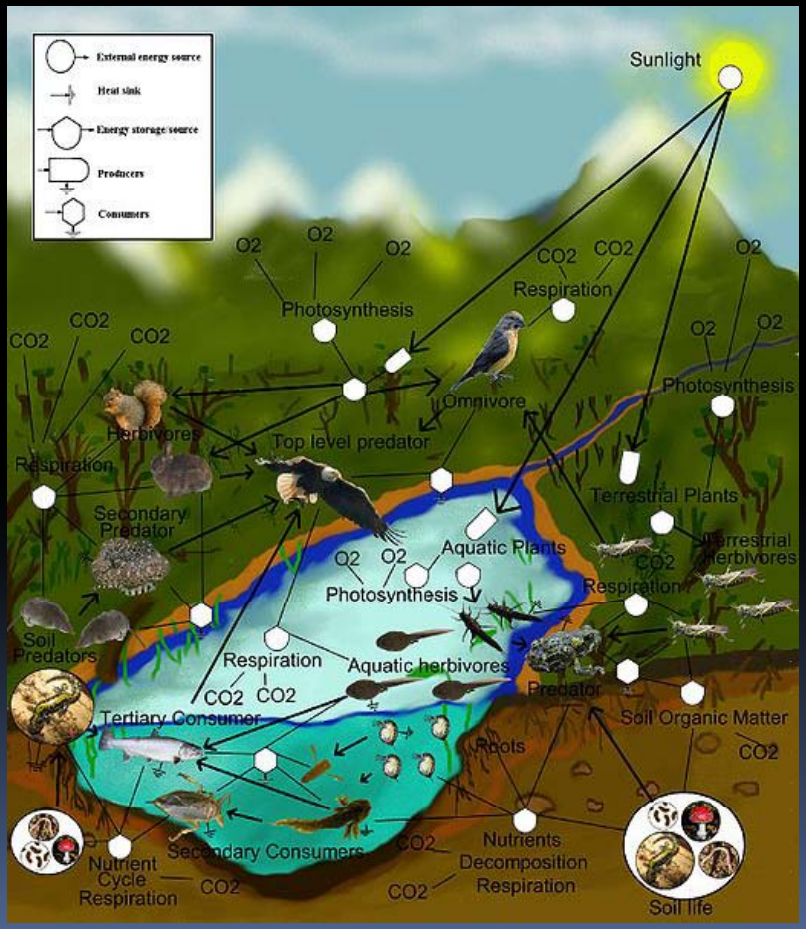
There are many kinds of food chains!

Persistent chemical pollution



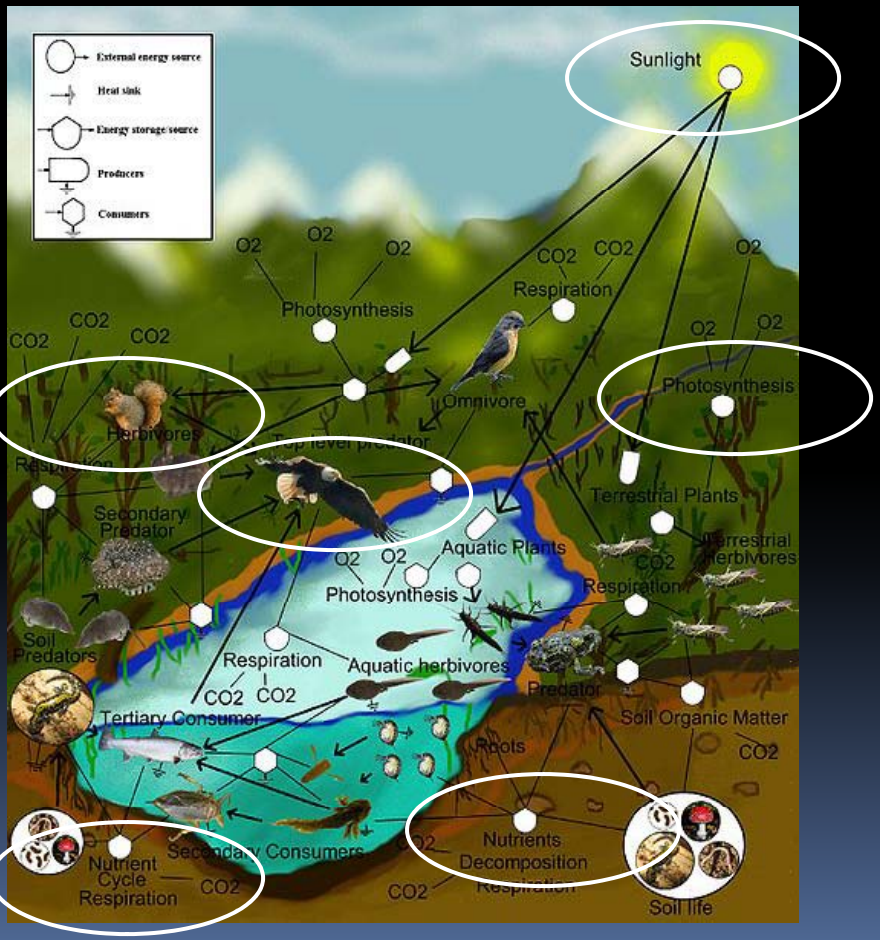
A food web is more complicated, but more realistic to nature!

Persistent chemical pollution



Lets looks closely at the relationships within the food web

Persistent chemical pollution



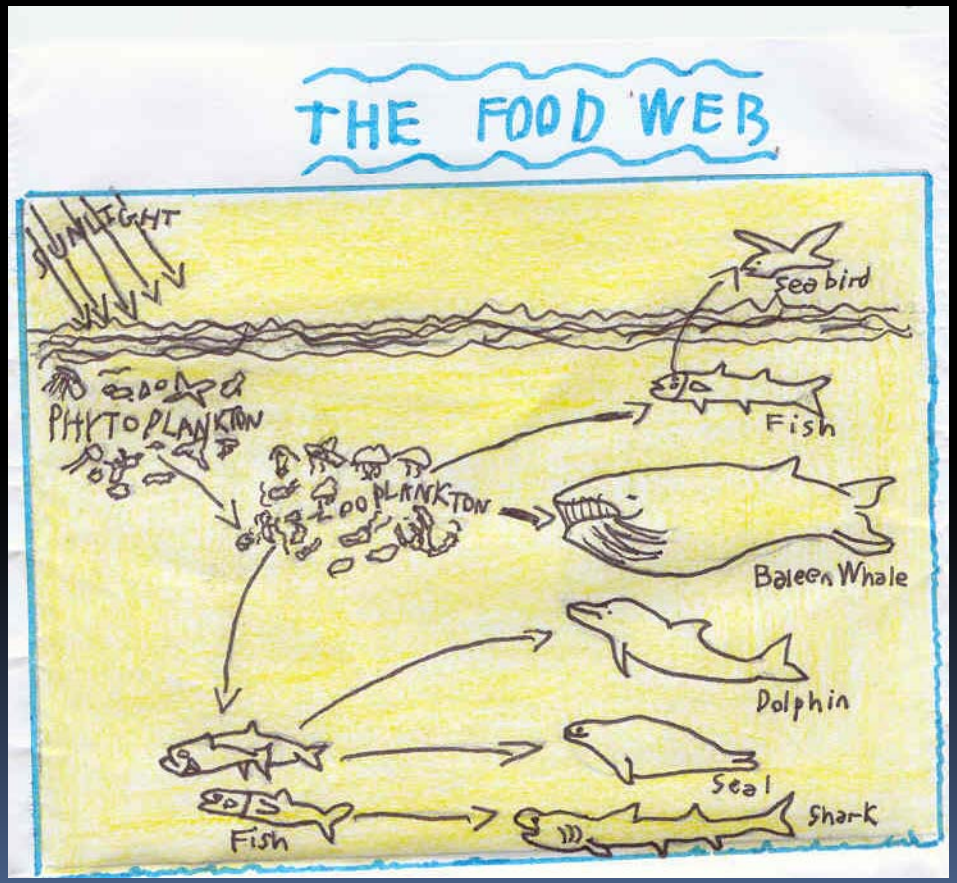
The sun powers the process!

Photosynthesis produces the plants

Smaller organisms eats the plants

Larger animals such as birds eat the smaller organisms

Persistent chemical pollution



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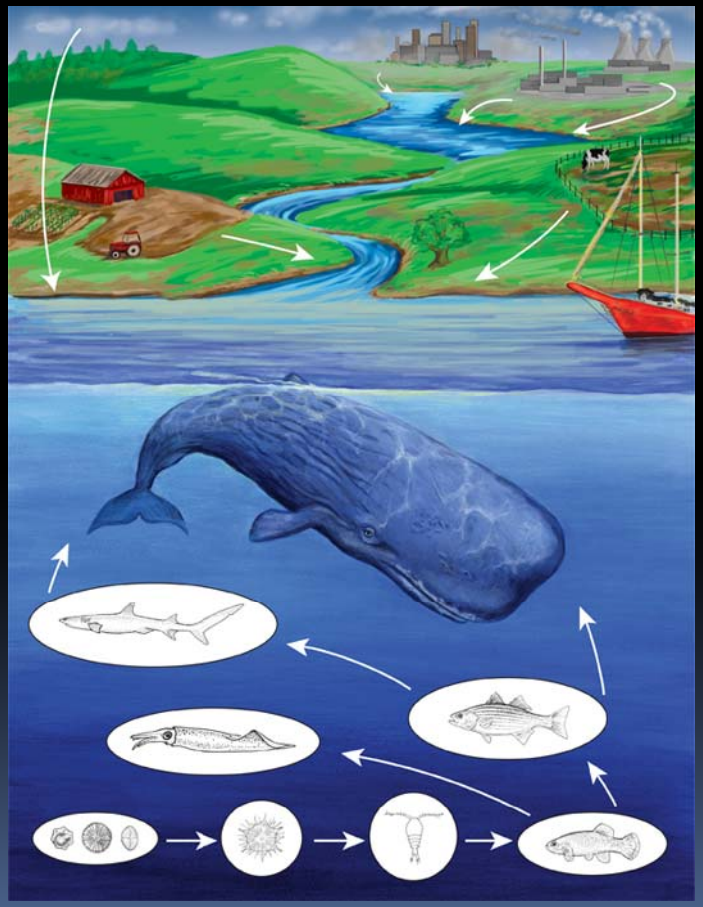


Can you find the sources of pollution?

Key vocabulary words

Key vocabulary words
Trophic
Consumer
Persistent
Decomposer
Food chain
Predator
Producer
Food web
Prey
Bio-accumulate

End of Part 3: Persistent chemical pollution

Part 4: Arsenic

Key vocabulary words

Key vocabulary words
Constriction
Excreted
Imported
Gangrene
Paresthesia
Peripheral
Perspiration
Pigmentation
Smelting
Susceptibility
Therapeutic

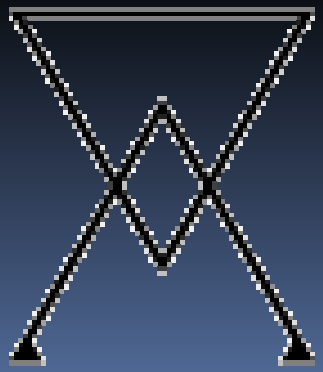
Arsenic

A therapeutic agent and poison 2400 Years Ago In Greece and in Rome

Arsenic

They put arsenic in his meat
And stared aghast to watch him eat;
They poured strychnine in his cup
And shook to see him drink it up

A.E. (Alfred Edward) Housman (1859–1936)



Arsenic

For many years arsenic was used to treat common diseases such as dysentery…but caused skin cancer in patients treated with arsenic chemicals

Arsenic

- By product of smelting for cooper, lead, zinc
- Last smelter in Tacoma Washington closed in 1985 – still dealing with pollution issues
- Annual use 20,000 tons imported

Arsenic

- Use is dropping because of toxicity
- 90% used as wood preservative (although this too is being phased out)
- Silicon based computer chips
- Feed additive (poultry and swine)
- Cotton fields
- Chemotherapeutic

Arsenic

Health effects

- Bound to red blood cells
- Distributes to liver
- Binds to proteins
- Concentrates in the hair and fingernails

Arsenic

Health effects

- 3-5 days
- Excreted
  - Urine majority of the time
  - Skin cells
  - Sweat

Arsenic

Health effects

- Constriction of the throat with difficulty in swallowing
- Severe intestinal pain
- Vomiting, diarrhea
- Muscle cramps
- Severe thirst
- Coma and death

Arsenic

Chronic exposure (drinking water)

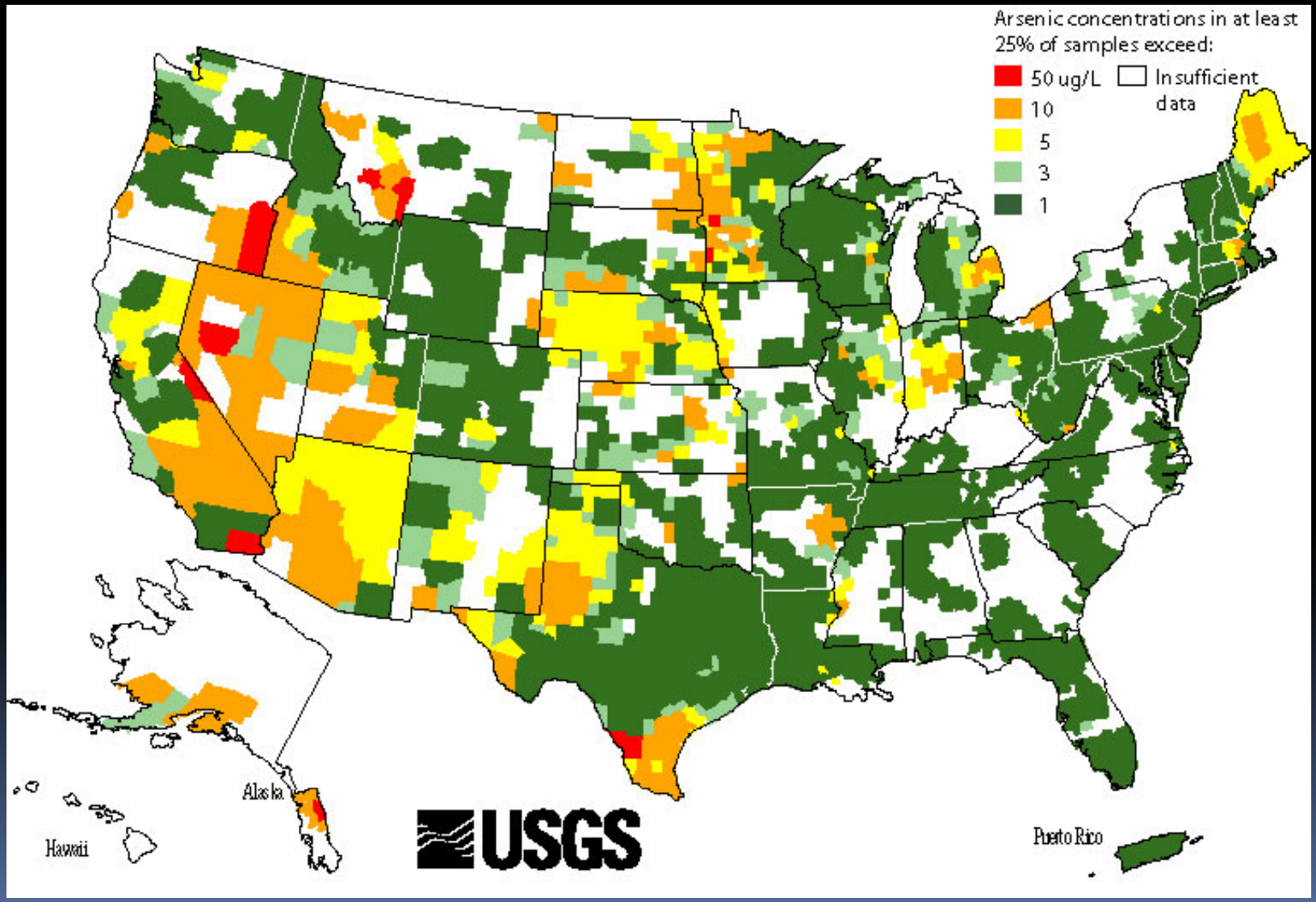
- Skin cancer (recognized 100 years ago)
- Garlic odor on breath
- Excessive perspiration
- Muscle tenderness and weakness
- Changes in skin pigmentation
- Paresthesia abnormal sensations such as burning, tingling, or a "pins-and-needles" feeling in hands and feet
- Peripheral vascular disease
- Gangrene of feet – Blackfoot disease

Arsenic

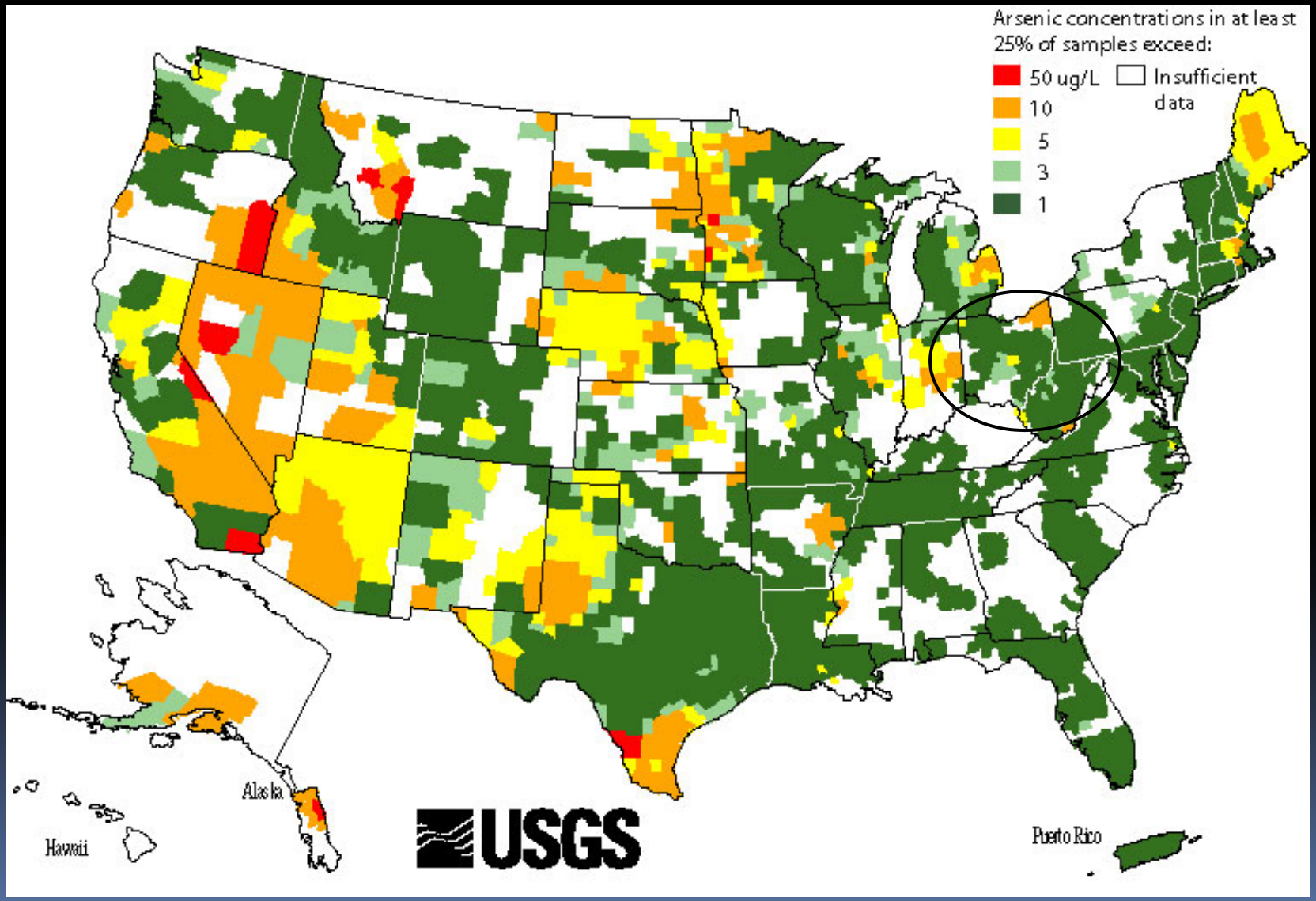
Exposure

- Drinking water
- Burning arsenic treated wood
- Handling treated wood

Arsenic


Arsenic concentrations in at least 25% of samples exceed:
50 ug/L
10
5
3
1
Insufficient data
Alaska
Hawaii
USGS
Puerto Rico

Arsenic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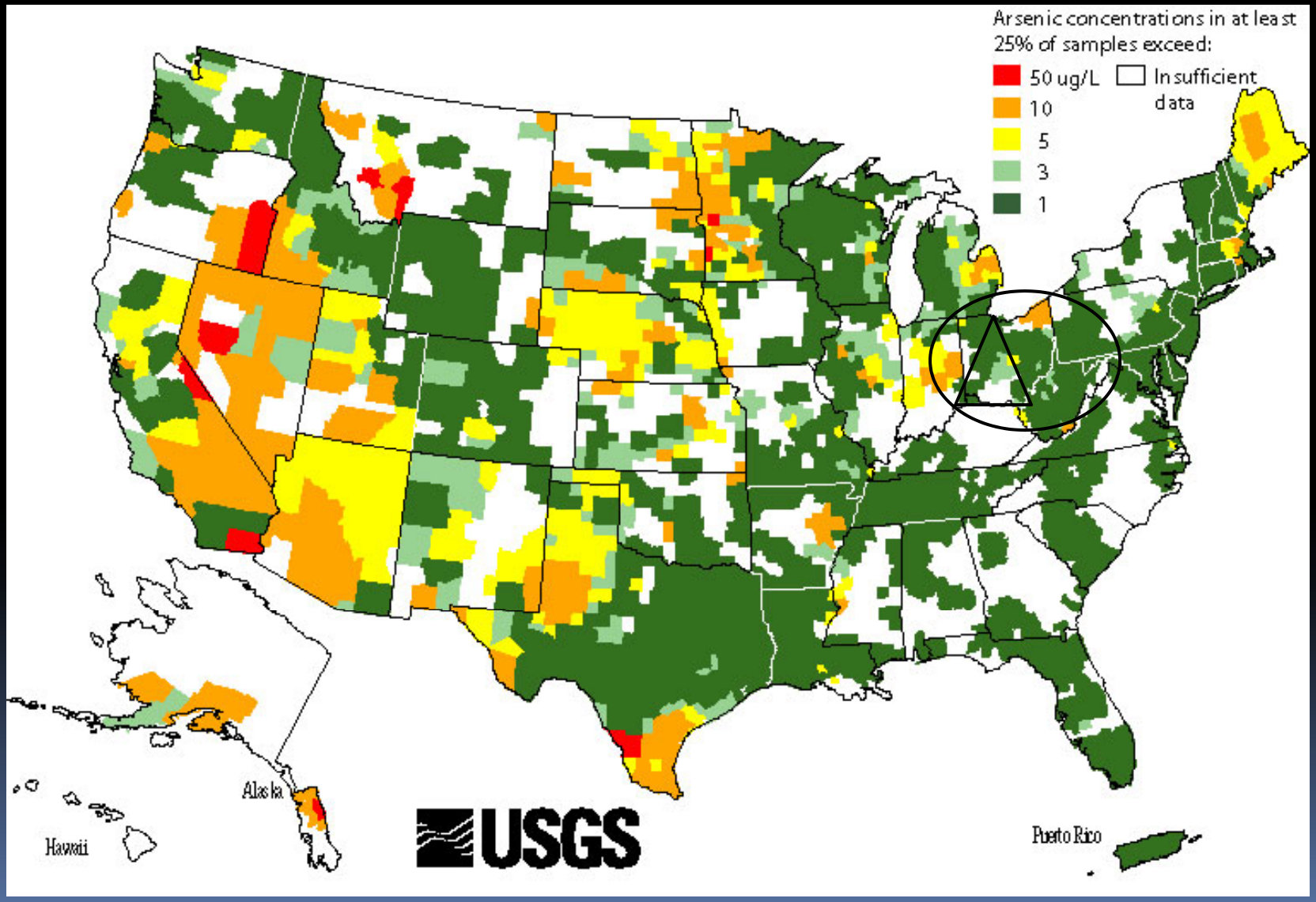
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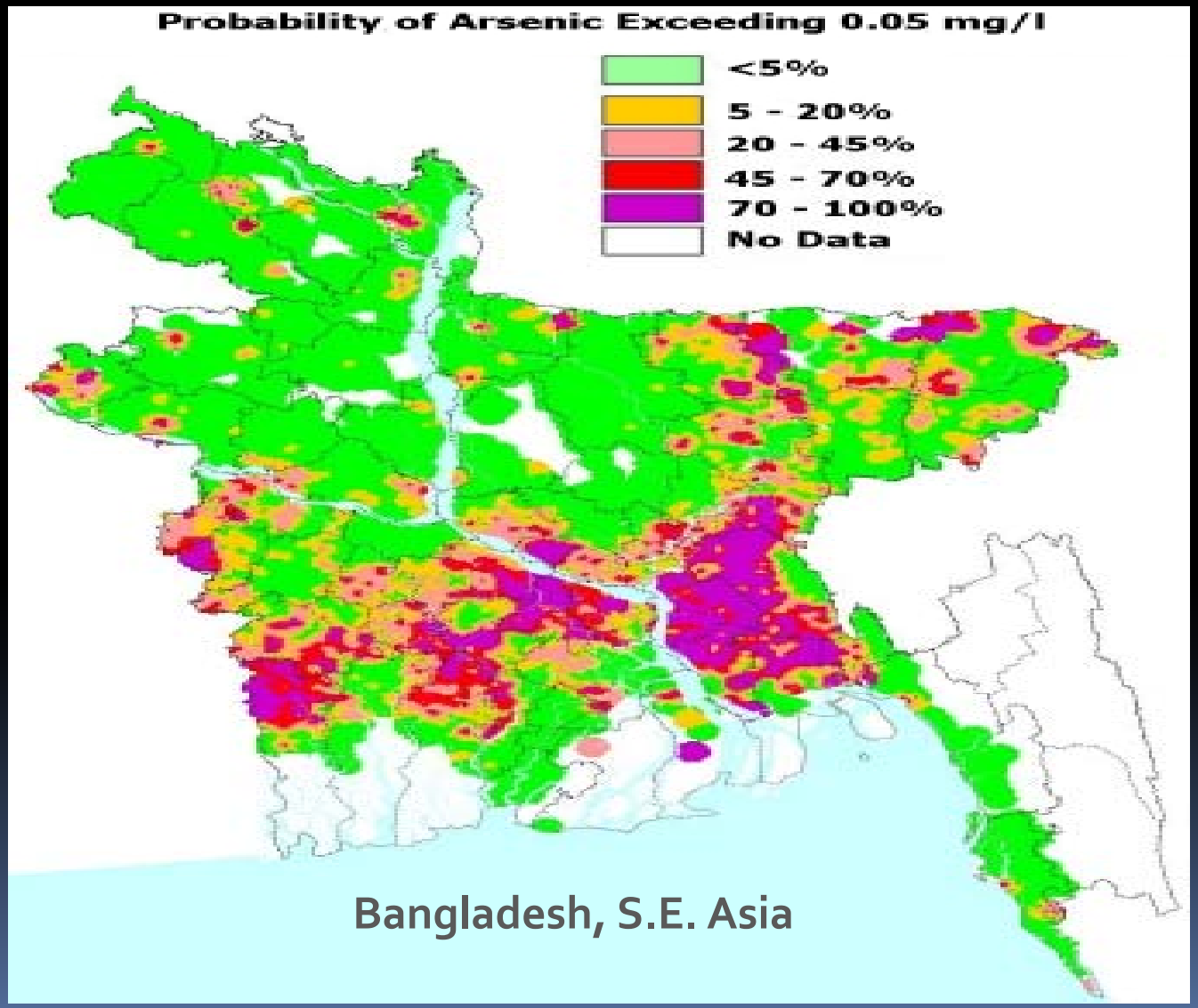
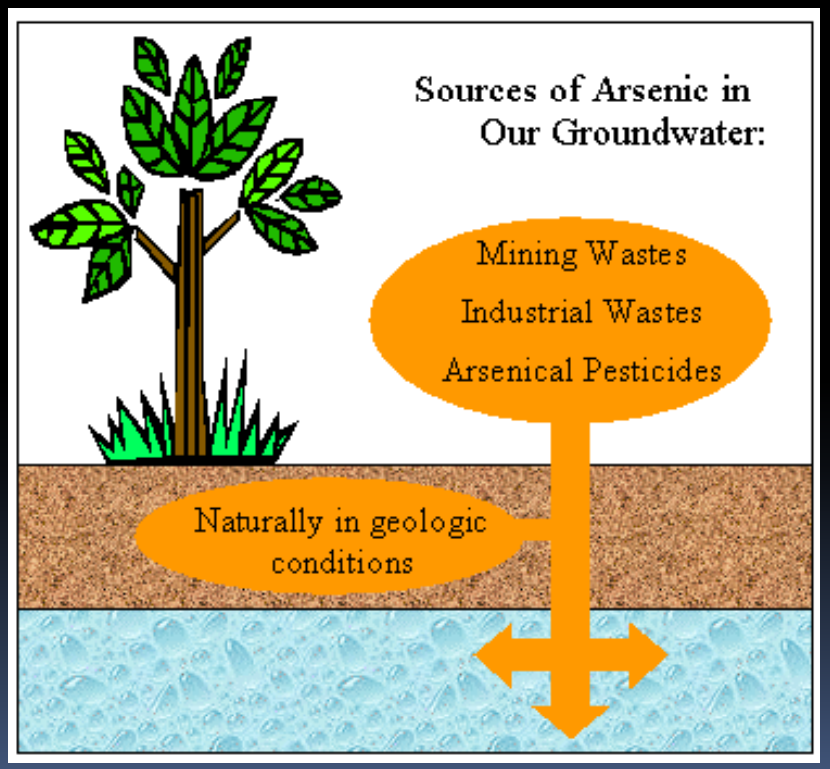

Probability of Arsenic Exceeding 0.05 mg/l
<5%
5 - 20%
20 - 45%
45 - 70%
70 - 100%
No Data
Bangladesh, S.E. Asia

Arsenic

Susceptibility

Children – small size, higher water consumption for size

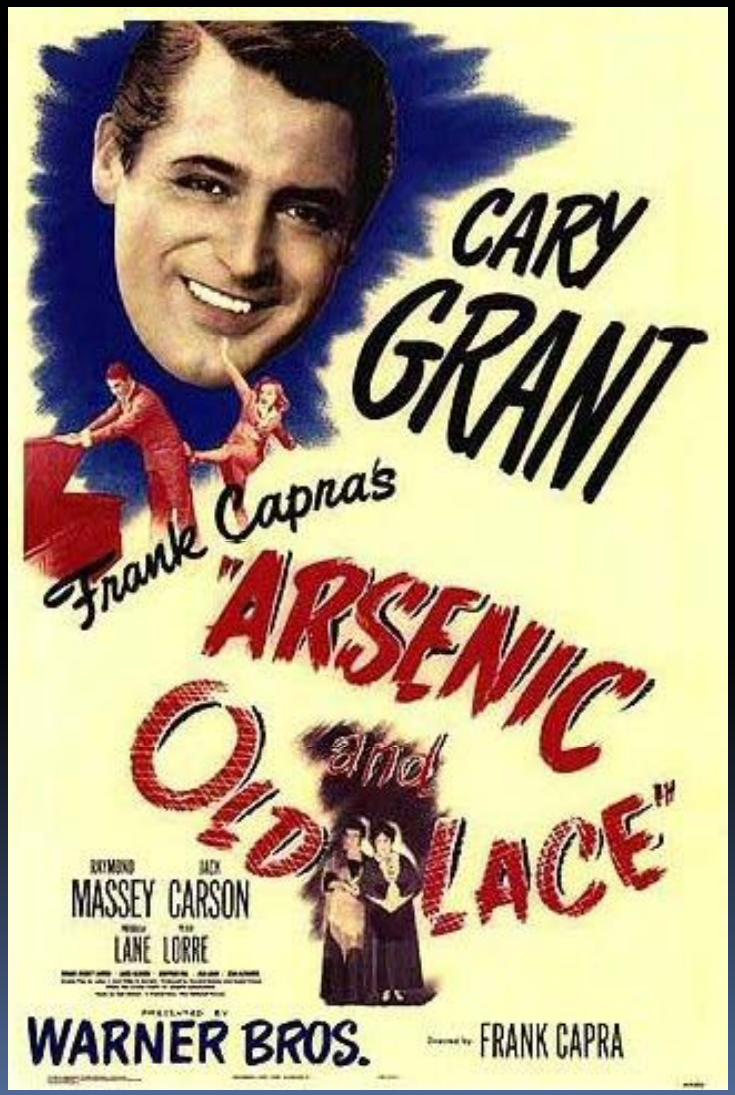


Arsenic

Reducing exposure

- Avoid (do not use treated lumber)
- Test drinking water
- Stop smoking

Arsenic



Since 1939, "Arsenic and Old Lace" has been a popular comedy play, including Canal Winchester High School's adaptation a few years ago!

Key vocabulary words

Key vocabulary words
Constriction
Excreted
Imported
Gangrene
Paresthesia
Peripheral
Perspiration
Pigmentation
Smelting
Susceptibility
Therapeutic

End of Part 4: Arsenic

Part 5: Lead

What do you know about lead?

True or False
1. Lead is a safe substance?
2. Lead was used to make paint?
3. Lead was added to gasoline a few years ago?
4. Lead can lead to learning disabilities?
5. Lead has been around for a long time?

Historical background…what really "lead" to the Fall of the Roman Empire?

- **6500 BC. - Lead discovered in Turkey, first mine.**
- **500 BC-300 AD.- Roman lead smelting produces dangerous emissions.**
- **100 BC. - Greek physicians give clinical description of lead poisoning.**

Historical background…what really "lead" to the Fall of the Roman Empire?

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What does the word "smelting" mean?

- **500 BC-300 AD.- Roman lead smelting produces dangerous emissions.**

Historical background…what really "lead" to the Fall of the Roman Empire?

Did lead poison the Roman Empire?

Lead's discovery dates back to 3500 BC. Lead artifacts have been found throughout the ancient world, and some researchers have suggested that lead poisoning was a major factor in the downfall of the Roman Empire.

Well-to-do Romans painted their walls a rich Pompeian red, which owed its color to a salt of lead or mercury. Lead was used for water pipes, cups, toys, statues, cosmetics, coffins, and roofs, but the most significant source may have been the wine of the wealthy class.

S. Columba Gilfillan proposed a theory for Roman decay in 1965 that involved "poisons esteemed as delicious by the ancient well-to-do." Spoilage was a problem in ancient Rome, and vintners discovered that wine tasted better and lasted longer if it was mixed with a concentrated grape syrup called sapa. The best sapa was boiled in lead pots, allowing lead to leach into the syrup. When sapa was mixed with wine, it sweetened it and also poisoned the microorganisms that cause fermentation and souring. Sapa was also used in fruit and honey drinks, and as a food preservative.

Historical background…what really "lead" to the Fall of the Roman Empire?

Josef Eisinger estimated a Roman consuming a liter of wine a day would ingest about 20 mg of lead per day, which he said was more than enough to produce chronic lead poisoning.

A cultural shift at the height of the Roman Empire made it socially acceptable for wives to drink wine, to which Gilfillan attributed a declining birth rate and a low rate of surviving children among the wealthy. Today, the reproductive effects of lead are well established, as are the effects on childhood development and learning disabilities.

Gilfillan hypothesized that the diet of the poor was not so badly poisoned as that of the rich. Although they drank the same water, they lacked the luxuries of cosmetics, lead paint, wine, fruit and honey drinks, or preserved foods.

What role did lead play in decline of the Roman Empire? We may never know for certain, but the evidence is intriguing.

Lead toxicology history

Investigator	Date	Blood	Findings
Dioscerides	2nd BC	100	"Lead makes the mind give way."
B. Franklin	1763	100	"Dry gripes"
A.J. Tuner	1894	80	Childhood plumbism
R. Byers	1943	80	Long-term sequelae
CDC	1973	40	Undue lead exposure
CDC	1975	30	Undue lead exposure
CDC	1985	25	Undue lead exposure
WHO	1986	20	Undue lead exposure
EPA	1986	15	Undue lead exposure
Fulton et al.	1987	15	IQ Deficits
Hansen et al.	1987	15	IQ Deficits
CDC	1990	10	Undue lead exposure

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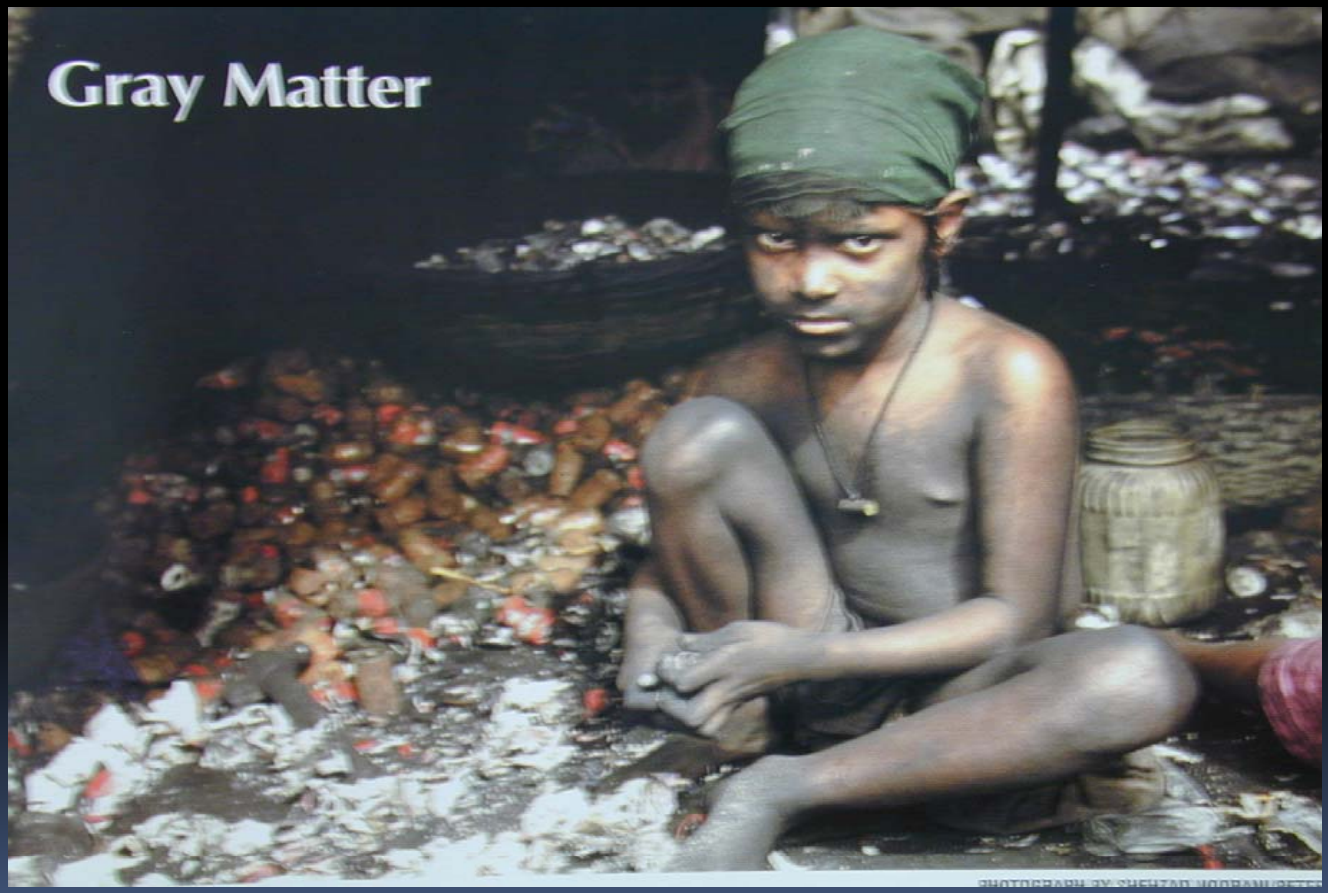
Historical awareness

"If we were to judge of the interest excited by any medical subject by the number of writings to which it has given birth, we could not but regard the poisoning by lead as the most important to be known of all those that have been treated of, up to the present time."

…Orfila, 1817

Example of recycling lead



Lead and IQ

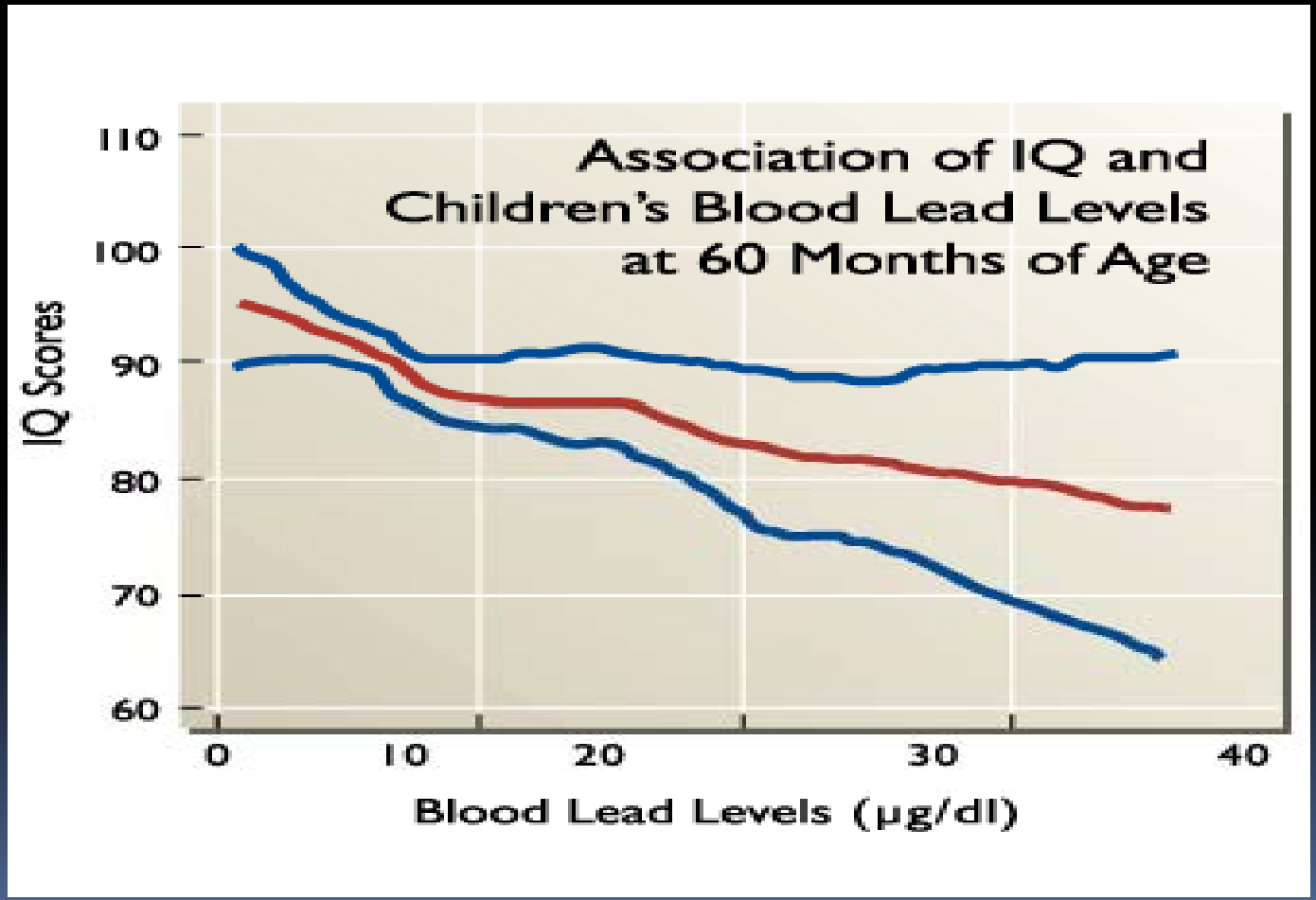
"Lead makes the mind give way." Greek Dioscerides - 2nd BC

Lead and IQ

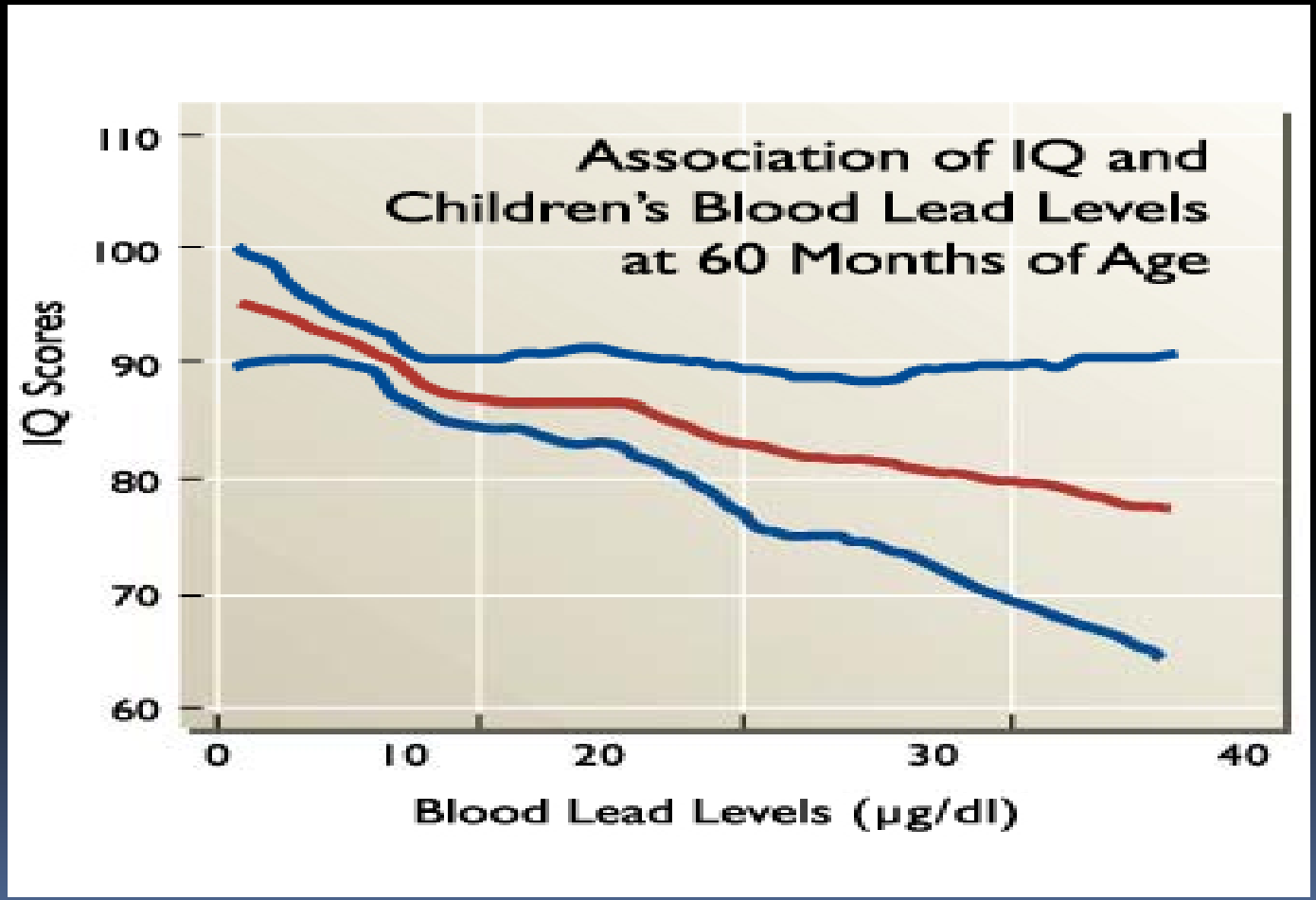
"Blood lead concentrations are associated with children's IQ scores at three and five years of age, and associated declines in IQ are greater at these concentrations than at higher concentrations.

These findings suggest that more U.S. children may be adversely affected by environmental lead than previously estimated."

IQ and blood levels



IQ and blood levels…what is the trend?



A lead pipe cinch?

Plumbing is derived from plumbun, Latin for lead

Review of terms

Dose / Response

Hazard + Exposure = Risk

Individual Susceptibility

Environmental hazard in the home

What does the child appear to have in her mouth? And where did she get it from?

Environmental hazard in the home

"Lead Poisoning remains the most common and societal devastating environmental disease of young children."…Public Health Service - L. Sullivan, 1991

Environmental hazard in the home

Sources of lead in the home…a few years ago

Lead based paint history

1887 - US medical authorities diagnose childhood lead poisoning

1904 - Child lead poisoning linked to lead-based paints

1909 - France, Belgium and Austria ban white-lead interior paint

1914- Pediatric lead-paint poisoning death from eating crib paint is described

1921 - National Lead Company admits lead is a poison

1922 - League of Nations bans white-lead interior paint; US declines to adopt

1943- Report concludes eating lead paint chips causes physical and neurological disorders, behavior, learning and intelligence problems in children

1971- Lead-Based Paint Poisoning Prevention Act passed

Lead in gasoline history

1854 - Tetraethyl lead discovered by German chemist

1921 - Midgley discovers that tetraethyl lead curbs engine knock

1922 - Public Health Service warns of dangers of lead production, leaded fuel

1923 - Leaded gasoline goes on sale in selected markets

1936 - 90 percent of gasoline sold in US contains Ethyl

1972 - EPA gives notice of proposed phase out of lead in gasoline.

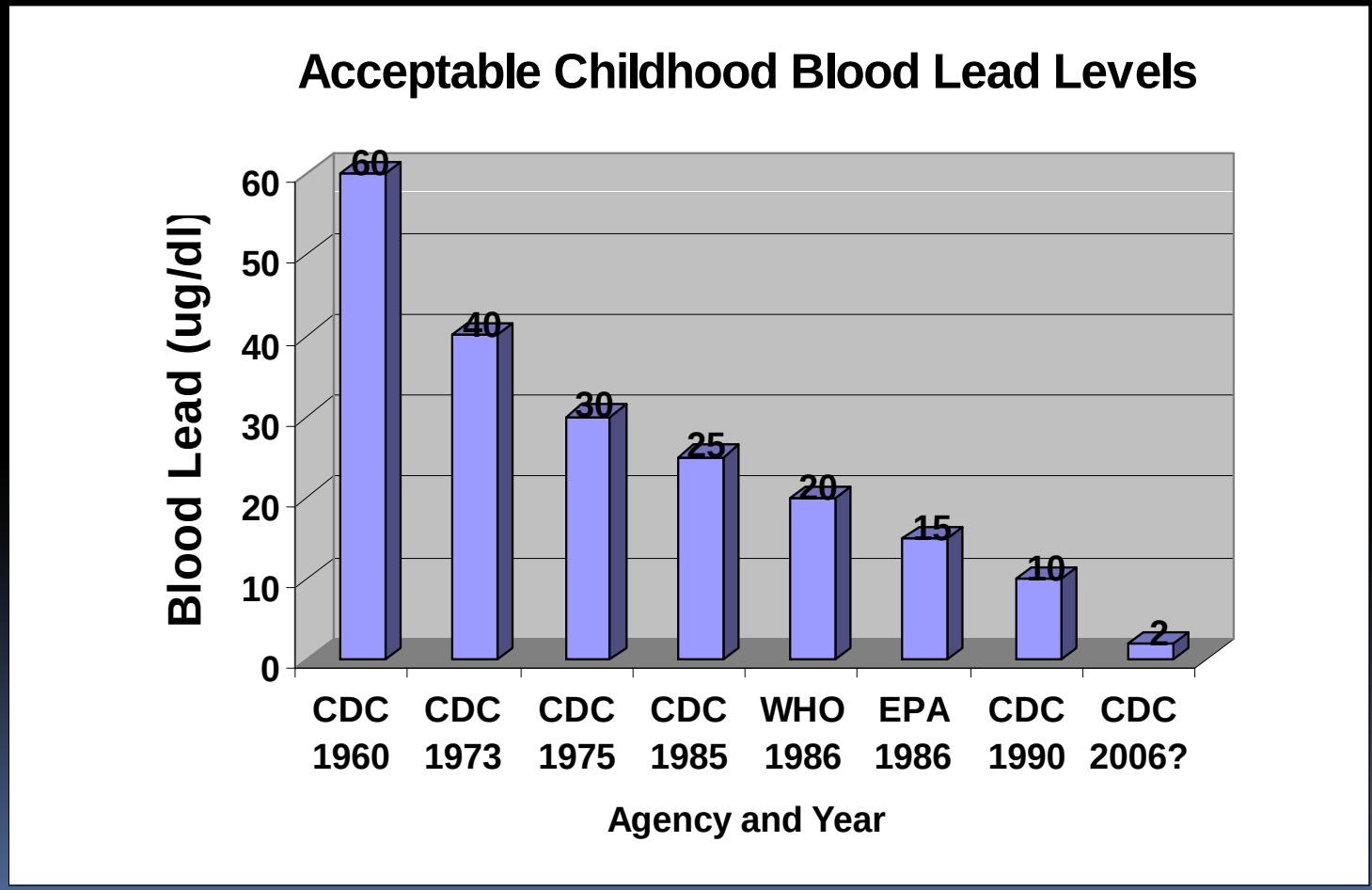
1986 - Primary phase out of leaded gas in US completed

1994 - Study shows that US blood-lead levels declined by 78 percent from 1978 to 1991

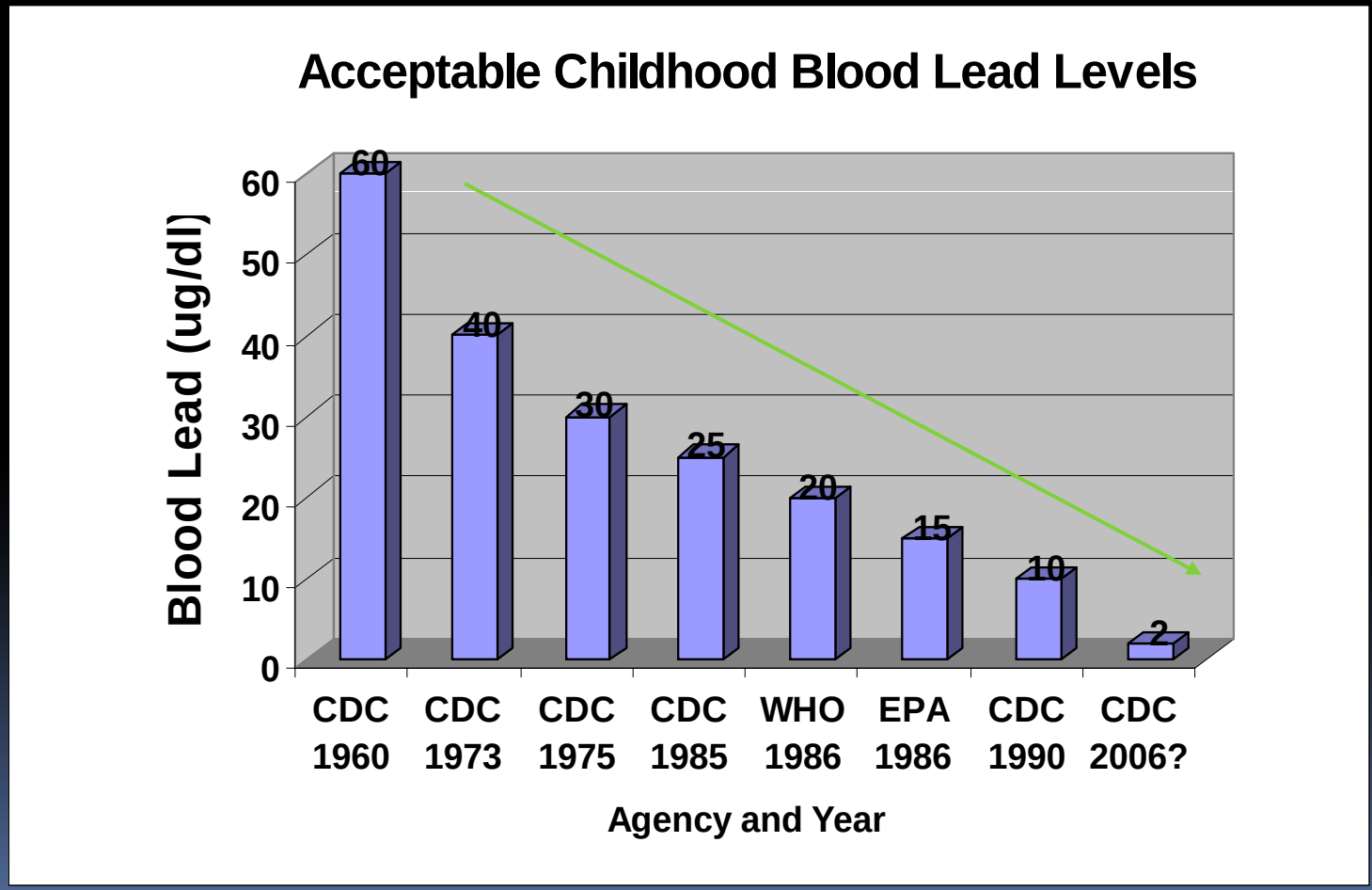
2000 - European Union bans leaded gasoline

Why screen for lead exposure?
Lead in jewelry

Acceptable blood lead levels by agency



What is the general trend?



Sources of lead

- **Lead Paint**
- **Dust, Soil**
- **Water**
- **Industry**
- **Hobbies**
- **Traditional Ethnic Remedies**

Sources of lead
The bio-accumulative effect

- 25 DAYS -- BLOOD
- 40 DAYS -- SOFT TISSUE
- 20 YEARS -- BONE

What does the word bio-accumulative effect mean?

CHILDREN are more vulnerable to exposure than ADULTS

Size

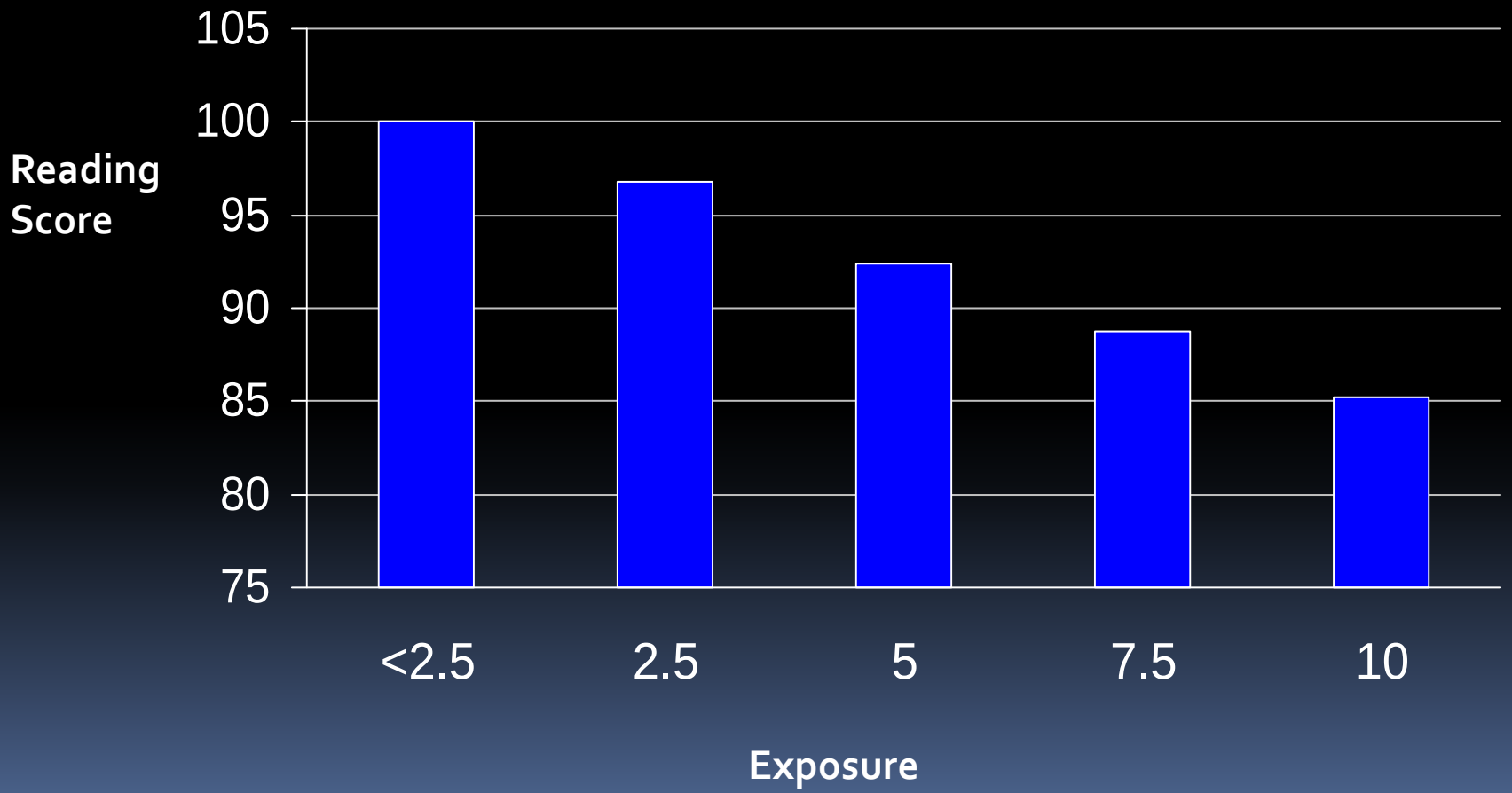
Consume More Food

Inhale More Air

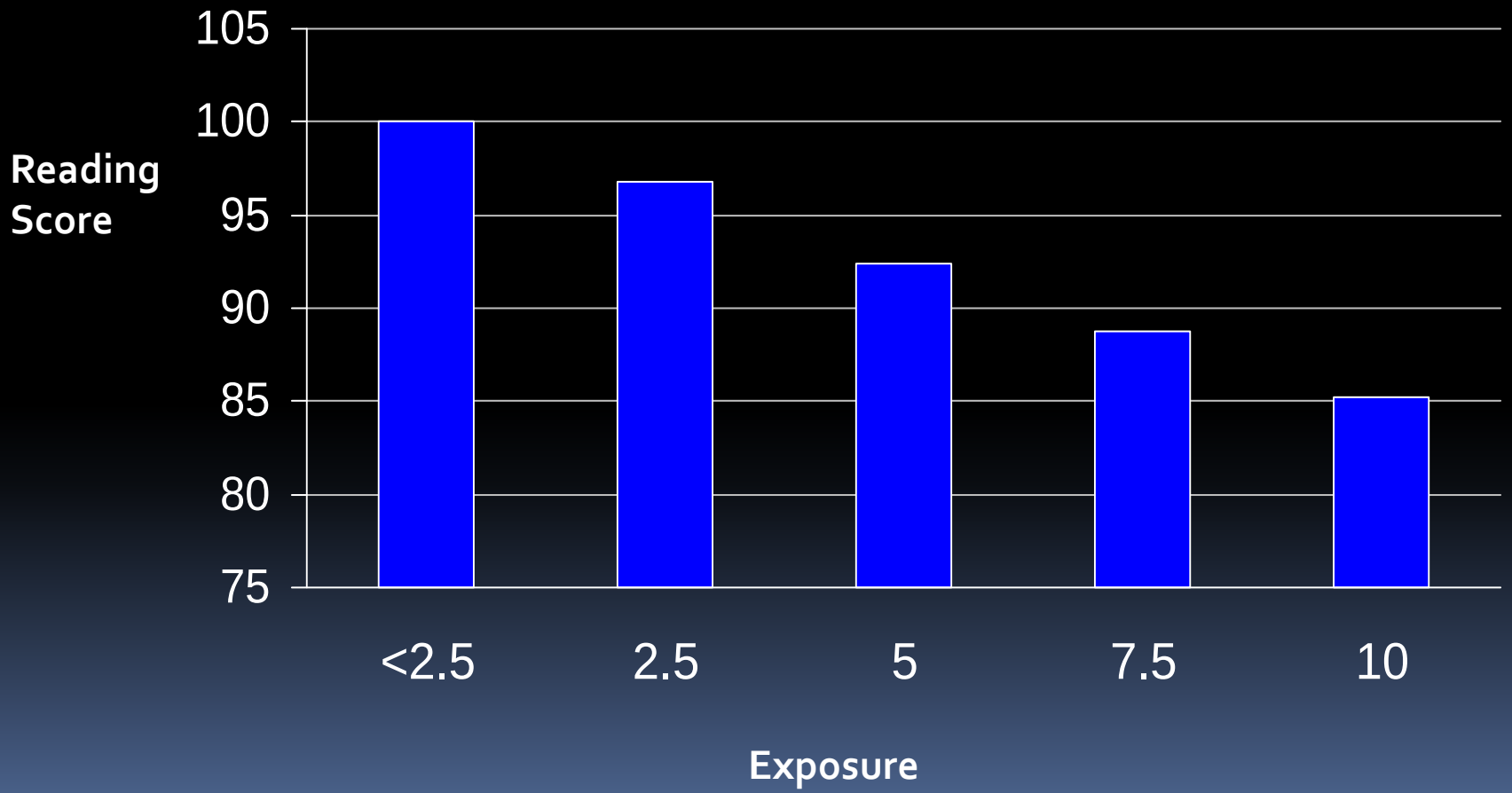
Developing Nervous System

Increased need for Calcium

Lead exposure and reading scores in U.S.



What is the trend between lead exposure the reading score?



Long term effects on children…

- LOW GRADES
- ABSENTEEISM
- READING DISABILITY
- HIGH SCHOOL DROP OUT

Academic & social effects of lead exposure

- Increased risk of not graduating from high school
- Poorer reading scores
- Increased evidence of depression
- Higher rate of hard drug use
- Increased risk for attention deficit disorder
- Increased risk for antisocial behavior

Why screen for lead exposure?

- Test siblings
- Find the source
- Reduce risky behaviors
- Education about the hazards
- Education about nutrition

Why screen for lead exposure? Precautionary principle

"When an activity raises threats of harm to human health or the environment, precautionary measures should be take even if some cause and effect relationships are not fully established scientifically."

Wingspread Conference, 1998.

Why screen for lead exposure?
Precautionary principle

"How long a useful truth
may be known and exist,
befort it is generally
receiv'd and practis'd on"

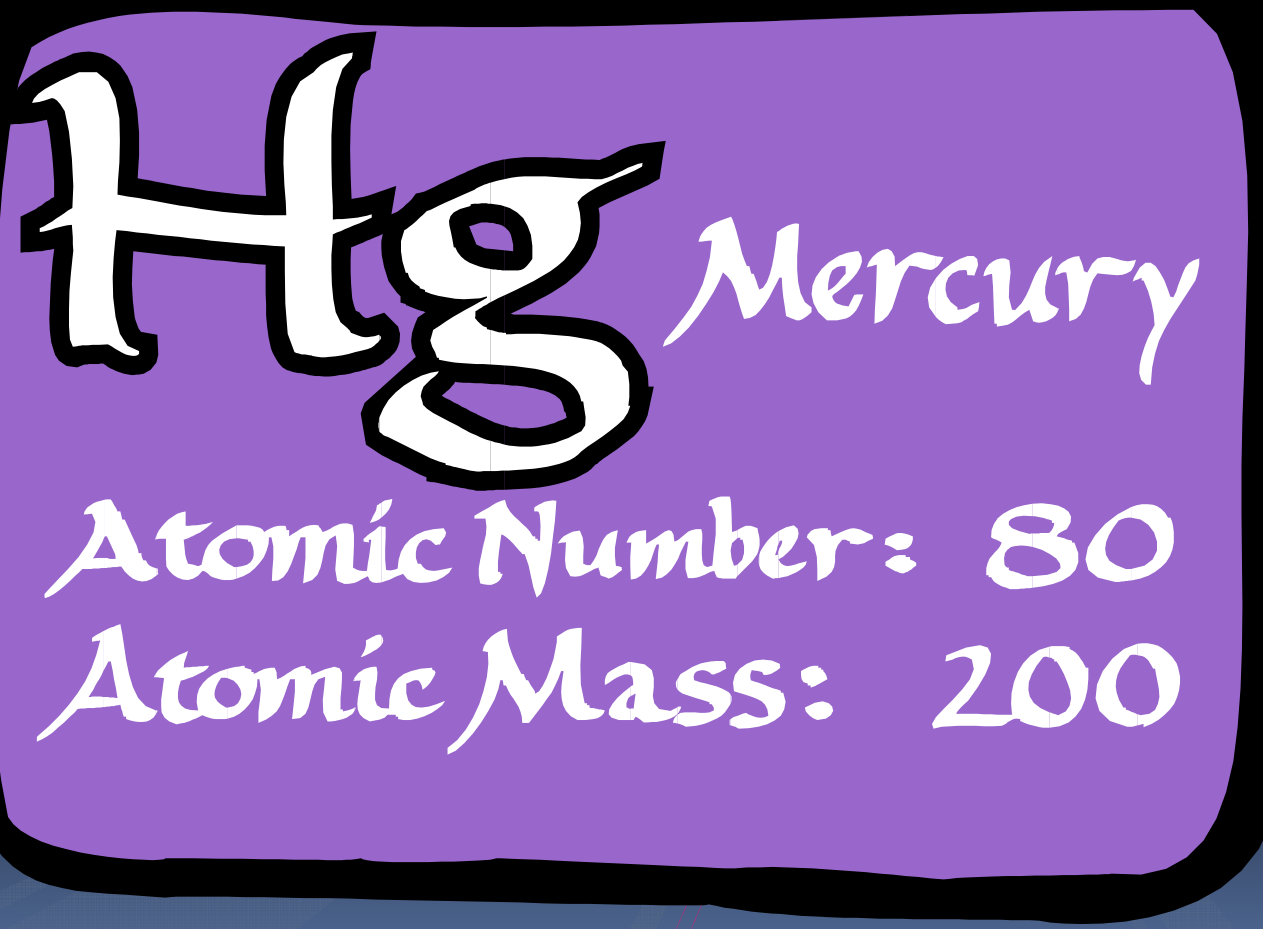
Benjamin Franklin

What do you know about lead?

True or False
1. Lead is a safe substance?
2. Lead was used to make paint?
3. Lead was added to gasoline a few years ago?
4. Lead can lead to learning problems or disabilities?
5. Lead has been around for a long time?
6. Lead has been known to be a health hazard for a long time?
7. Children exposed to lead can develop some behavioral problems?
8. Children exposed to lead usually have no reading problems?
9. Children exposed to lead have no school or social problems?
10. Lead was recently discovered in toys and jewelry?

End of Part 5: Lead

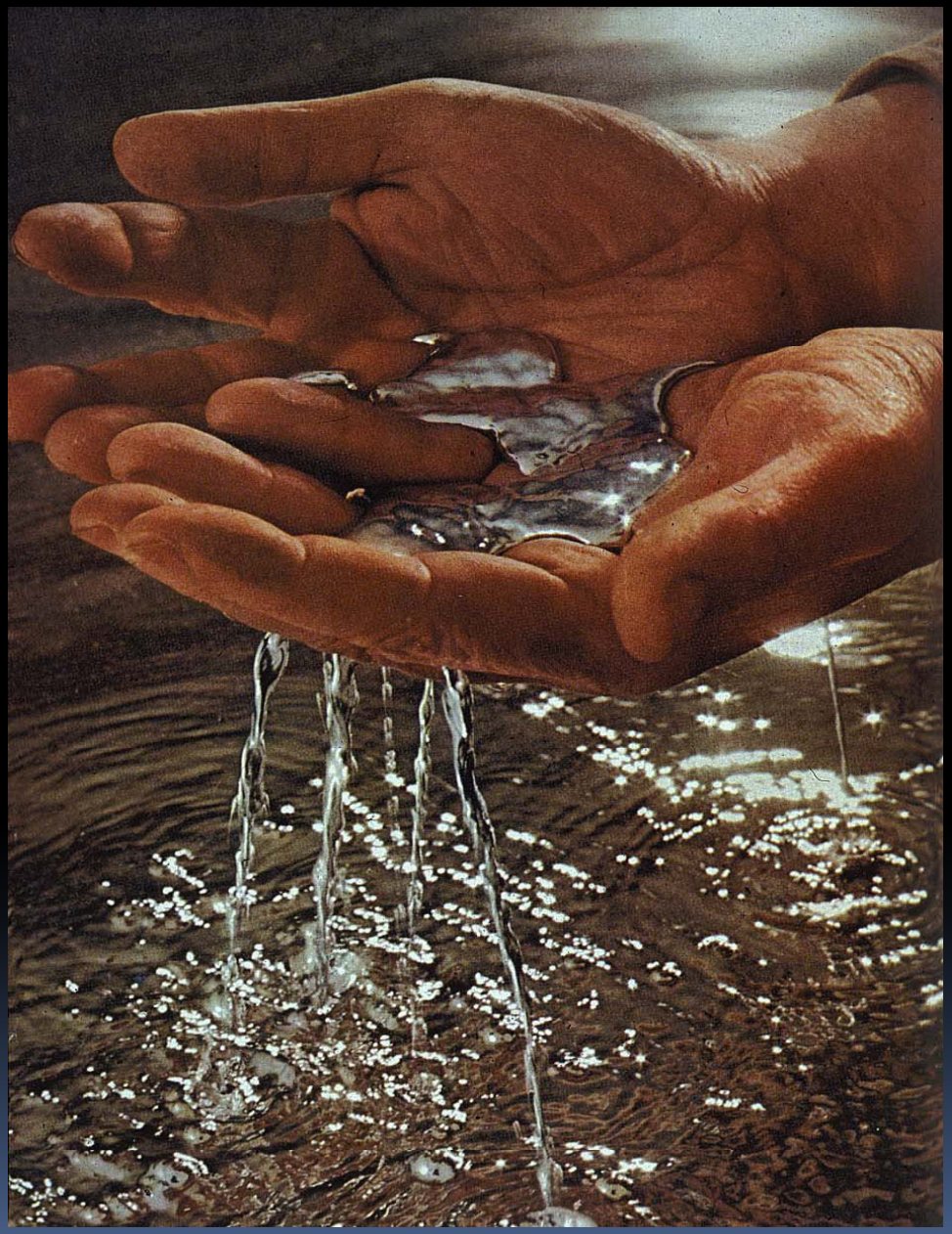
Part 6: Mercury



Hg… FAST FACTS

- Quicksilver
- 13.6 times the weight of water
- Evaporates at room temperature
- Bacteria change to Methylmercury
- Amalgam
- Many Industrial uses (thermometers, chemical reactions, gold mining)

Hg… Flows like water



Occupational Exposure

Gold mining.

Hatters in the felt industry.

The “Mad Hatter”

The Legacy Lives On

After learning about the Danbury hatmaking history, Varekamp sampled surface mud surrounding the former Mallory Factory, and found very high mercury levels still there67,000 parts per billion (ppb), compared to a state cleanup standard of 20,000 ppb.) A nearby park where children play had levels of 25,000 ppb. Typical levels elsewhere are around 400-600 ppb. Much of the mercury has found its way to the nearest rivers, particularly the Still River, where it can accumulate in fish.

The mercury has dissipated and sunk into the sediments, but the Still and Housatonic Rivers are both prone to catastrophic flooding. Varekamp says severe storms such as the memorable hurricanes of 1938 and 1955 stir up river sediments, remobilizing buried contaminants. The sediments and their mercury burden can be transported into Long Island Sound. "It's only a matter of time before another major hurricane happens, and flushes out more mercury." Varekamp says. Varekamp's research is funded by Connecticut Sea Grant and the Connecticut Department of Environmental Protection.

Discharge in Minamata Bay, Japan

Mercury poisoning of thousands confirmed

Thirty years on, the victims of Japan's worst case of industrial pollution are getting support from scientists and the courts - but not the state

For Yasuko Tanaka, it started when the village cats turned into demons. One year, they were sleepy pets; the next, they were hyperactive monsters - screeching, scratching and jumping around as if possessed.

That was when she drew the connection between Japan's worst case of industrial pollution in nearby Minamata and the splitting headaches, tunnel vision and shaking hands that she and several other villagers had been suffering.

Yesterday, more than 30 years later, researchers presented evidence that the mercury poisoning of Minamata bay in the 50s and 60s lasted longer, spread further and affected tens of thousands more people than previously believed.

The study by doctors at Kumamoto University could cost the Japanese government billions of yen (millions of pounds) as thousands of claimants seek recognition as having Minamata Disease - the nerve disorder caused by eating seafood from the polluted bay or nearby waters.

Symptoms of spasms, blurred vision and hearing loss were first recognised in the 50s when the ailment was called "itaiitabyo" (ouch ouch disease), but it was not until 1968 that the government blamed the nearby Chisso chemical corporation for pumping mercury waste into the bay.

More than 900 victims died in agony. Many babies in the area were born with knarled limbs. Thousands of victims were ostracised, first out of a mistaken fear that the disease might be contagious, and later, because their legal suits drew unwanted attention to the invisible pollution in this picturesque region.
In 1996, the government offered sufferers a modest settlement of about £1,500 in damages from Chisso and £120 a month in medical expenses from public funds.
But since then it has only certified 2,264 victims, 1,435 of whom are already dead.
Another 17,128 have applied for recognition.

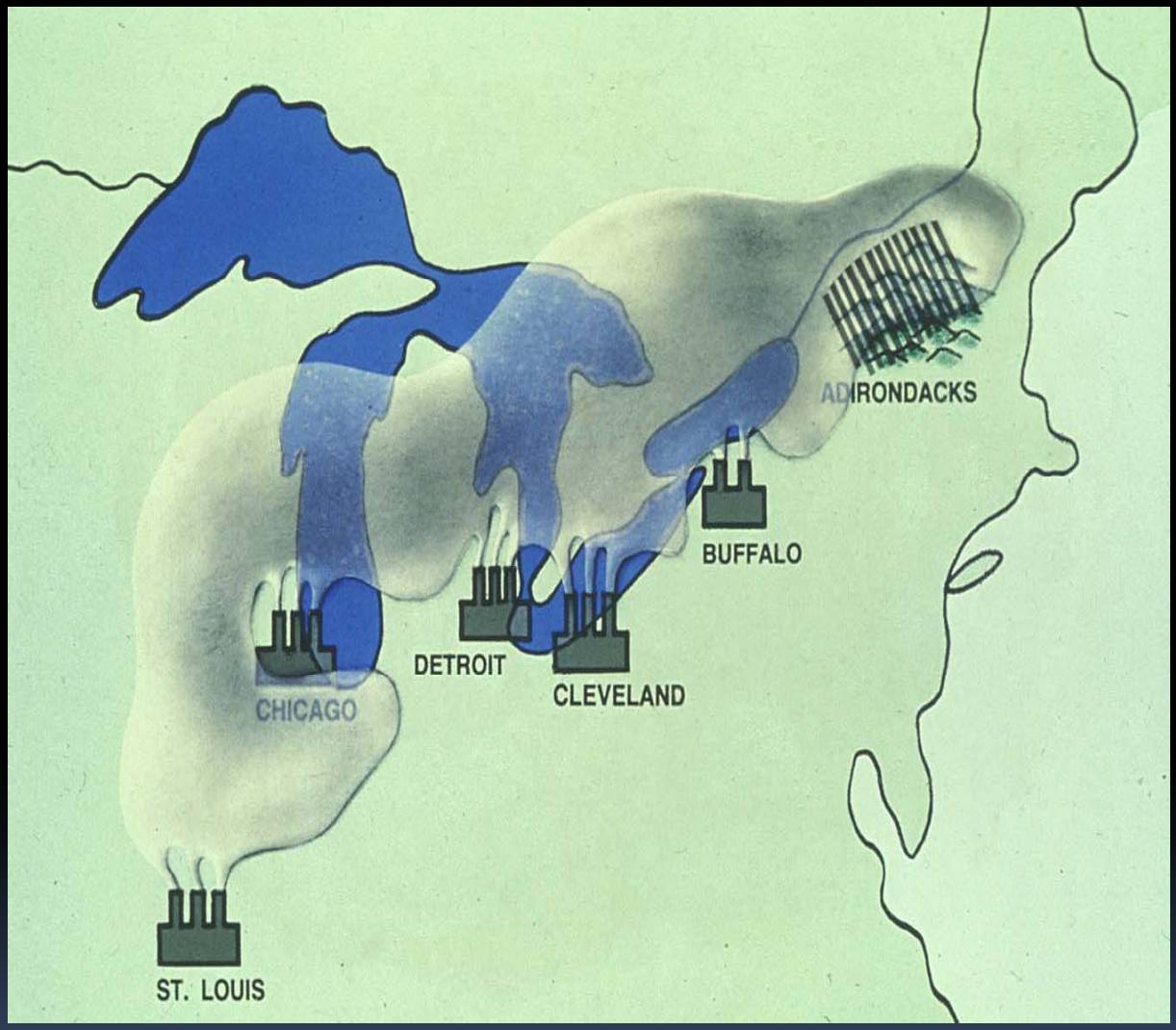
According to the Kumamoto University research team, which is presenting its findings at a conference on mercury poisoning that started in Minamata yesterday, at least another 20,000 people are likely to be eligible.
By comparing levels of mercury and sensory disruption in residents on the far coast from Minamata with a control group from outside the area, the researchers found that harmful levels of pollution spread beyond Minamata Bay and lasted until 1970, 10 years longer than government estimates.

They found that mercury damaged the central nervous system and impaired sight, hearing, smell, taste and touch when present at the level of just 10 parts per million in hair and umbilical cords. This is five times lower than the level recognised as harmful by the government.

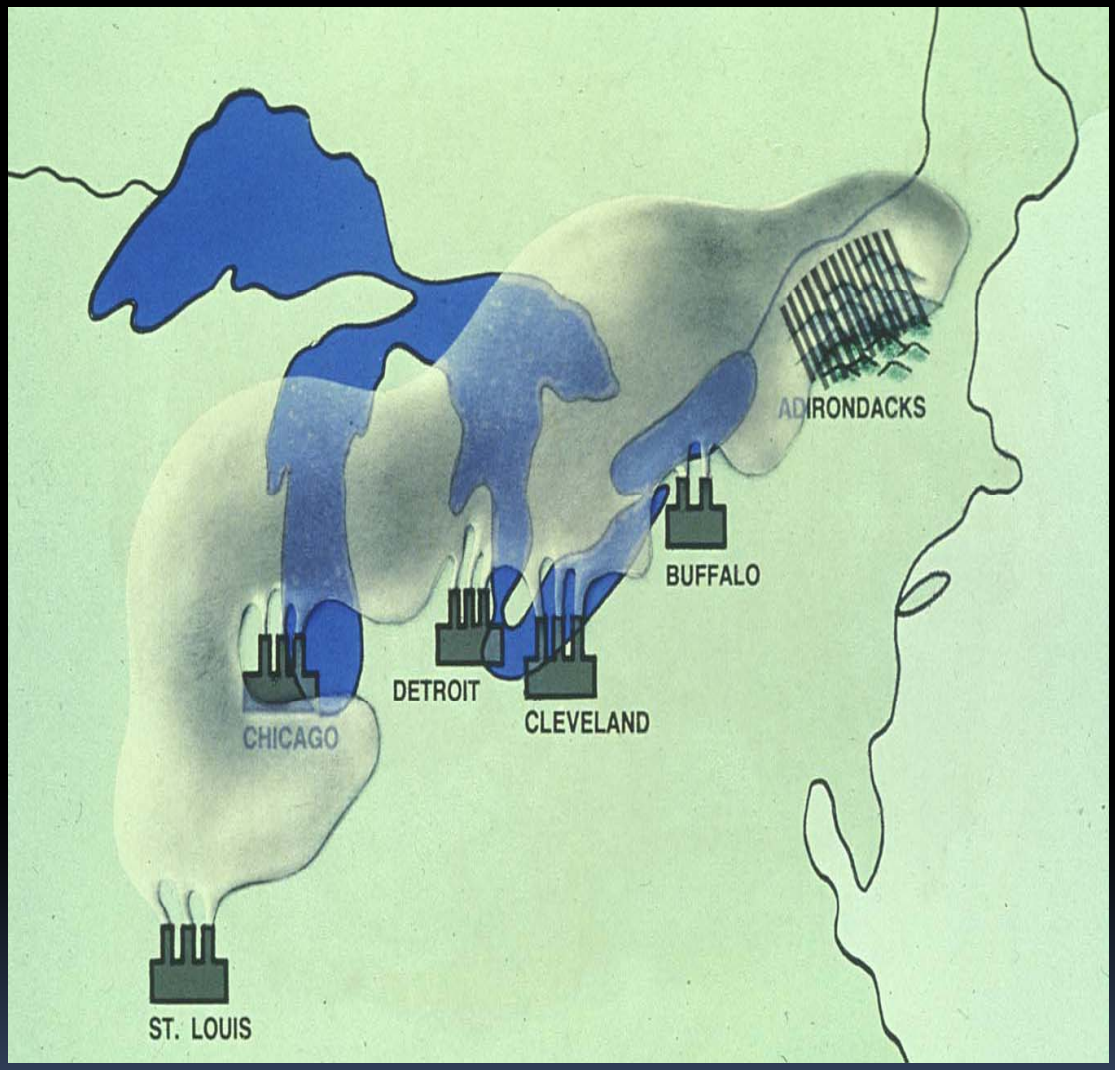
Campaigners for the rights of Minamata disease sufferers said the findings indicated that as many as 2m people might have eaten enough contaminated fish to suffer from such lesser, but still painful, side effects of mercury poisoning as constant headaches, loss of hearing and an inability to distinguish hot from cold. The government, which has been accused of colluding with Chisso Corporation to cover up the environmental disaster, has never attempted to find out how many people were affected by Minamata disease. Instead, it has asked victims to come forward, which many are reluctant to do because they fear discrimination.
"The problem is that the government has not launched a detailed epidemiological study," said Shigeo Ekino, the professor who led the research. "They are afraid of looking into the wider area."

In May, after Professor Ekino presented his initial findings, the Osaka high court ordered the government to recognise the claims of victims who had been refused certification. The government has appealed.
Environment agency officials were unavailable for comment.

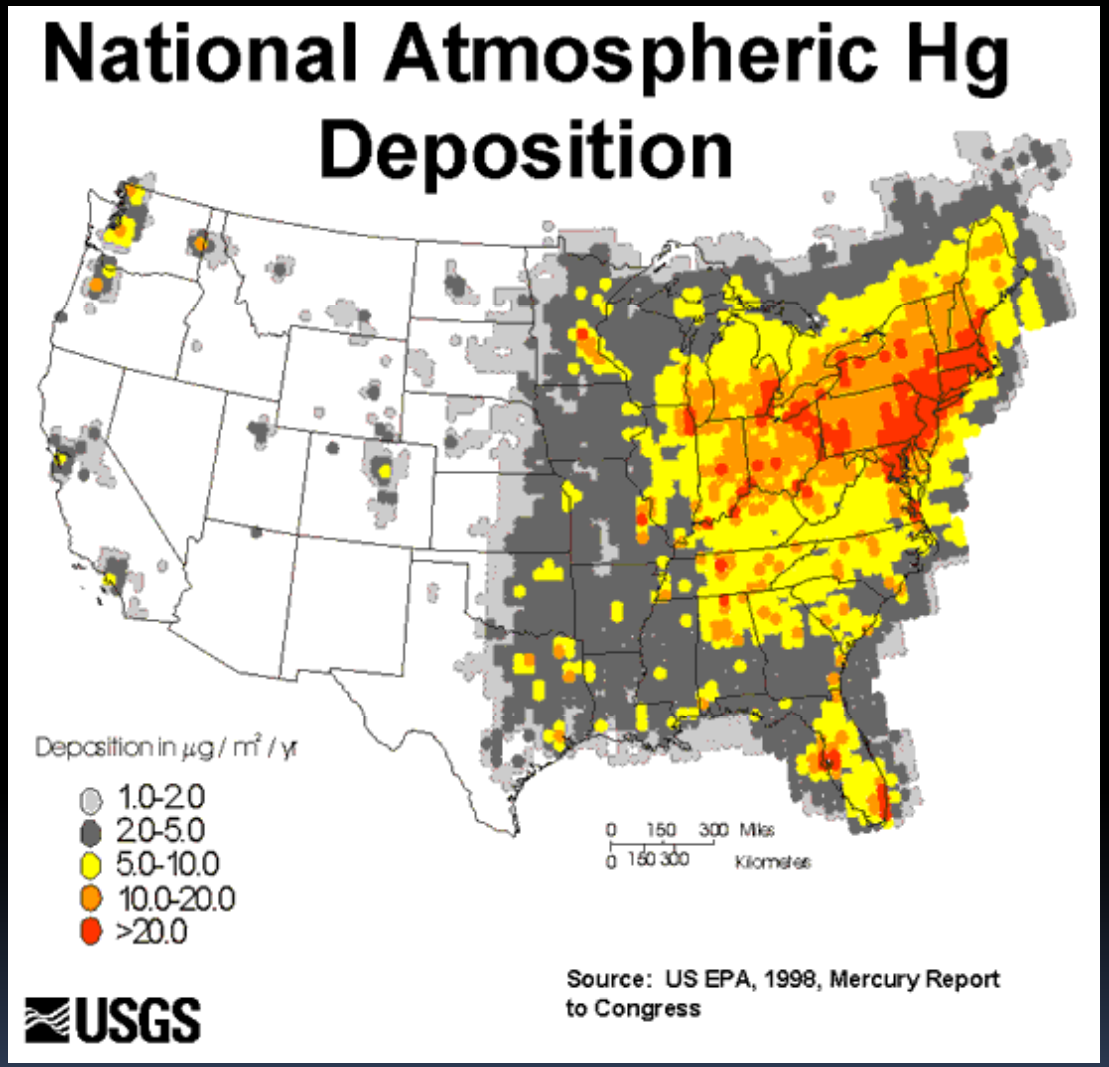
Coal fired plants, Hg emissions



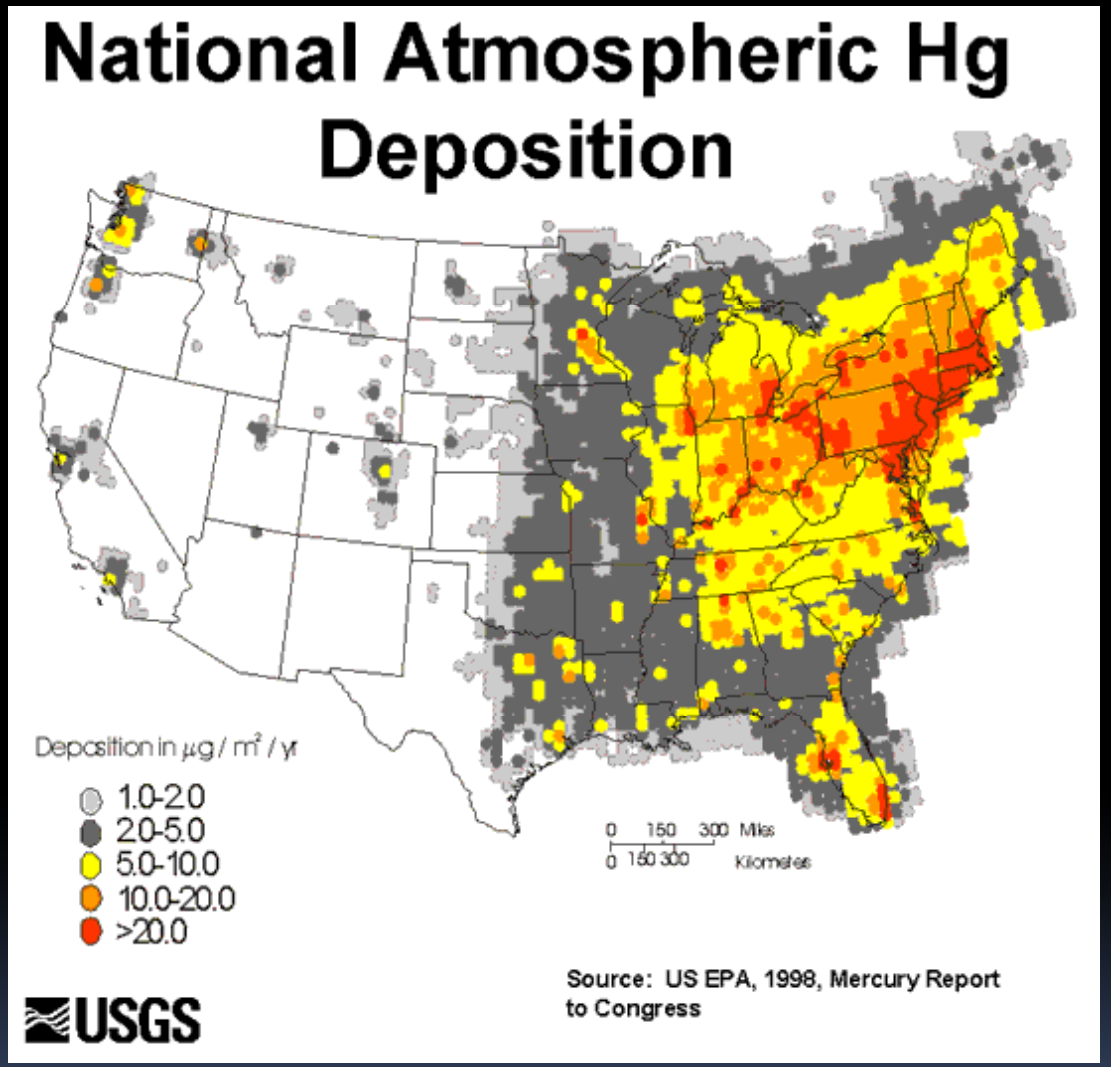
50-75% mercury of released in the environment related to human activities



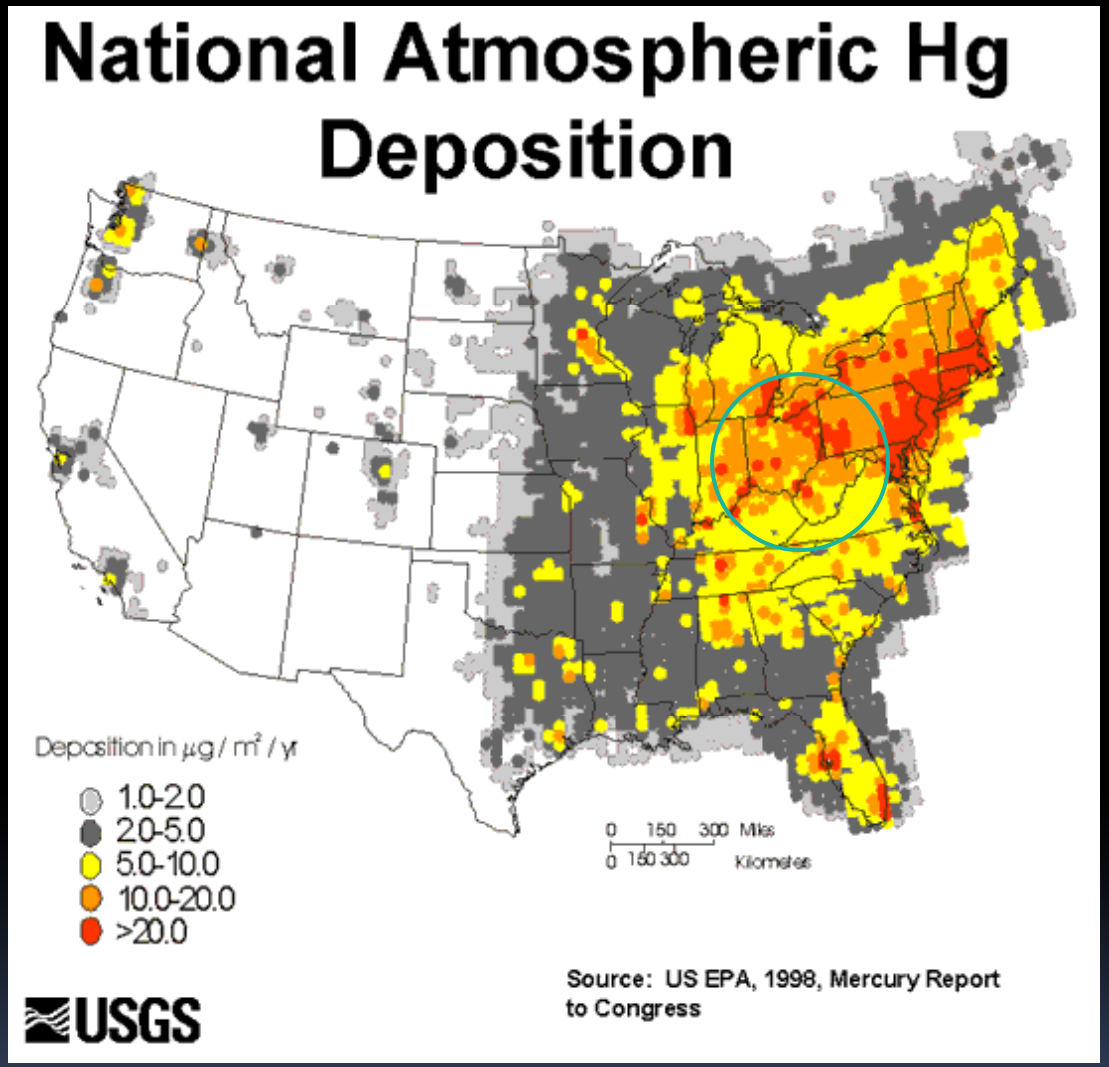
Hg and the atmosphere



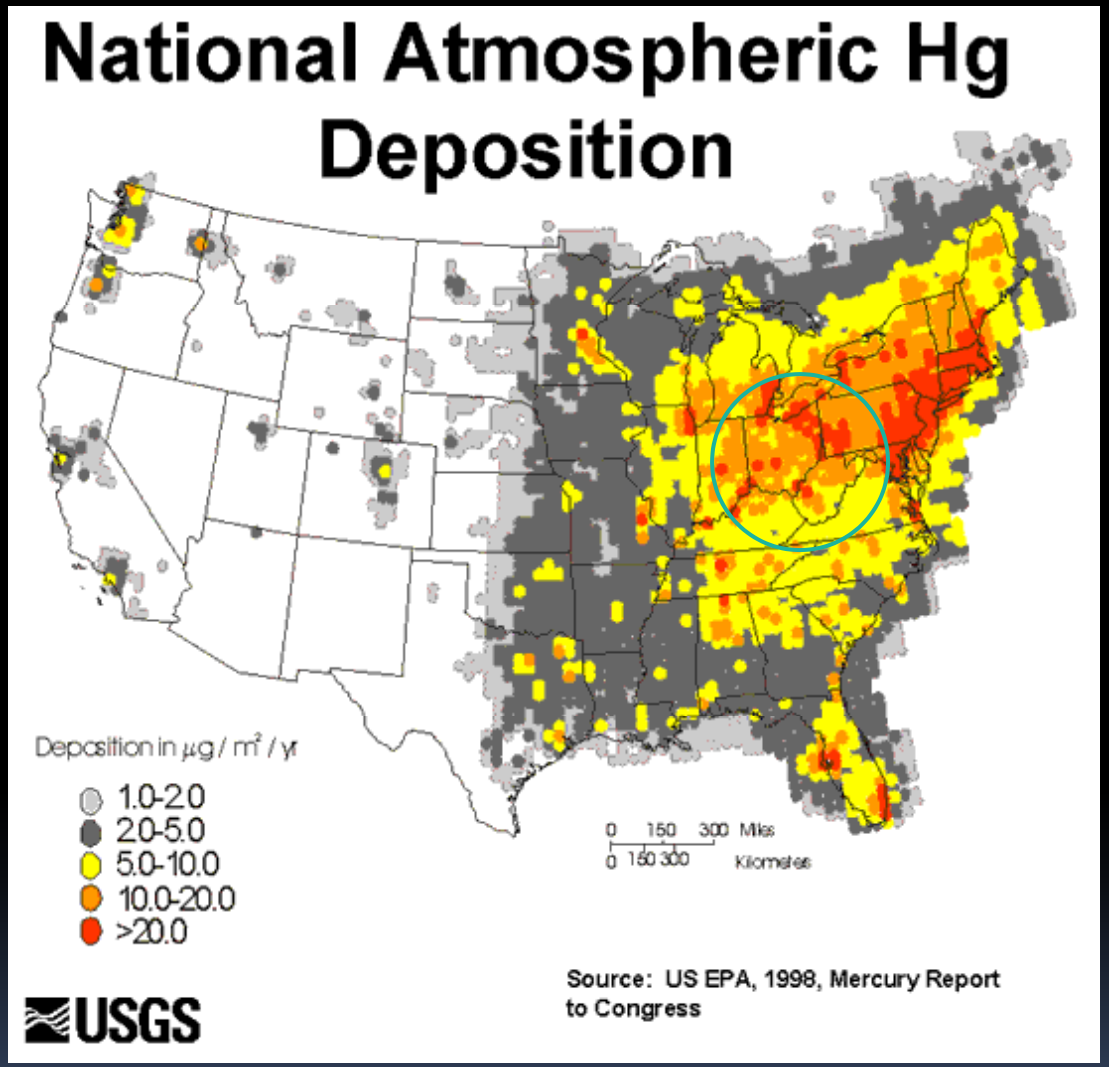
How does Ohio "stack" up?



How does Ohio "stack" up?

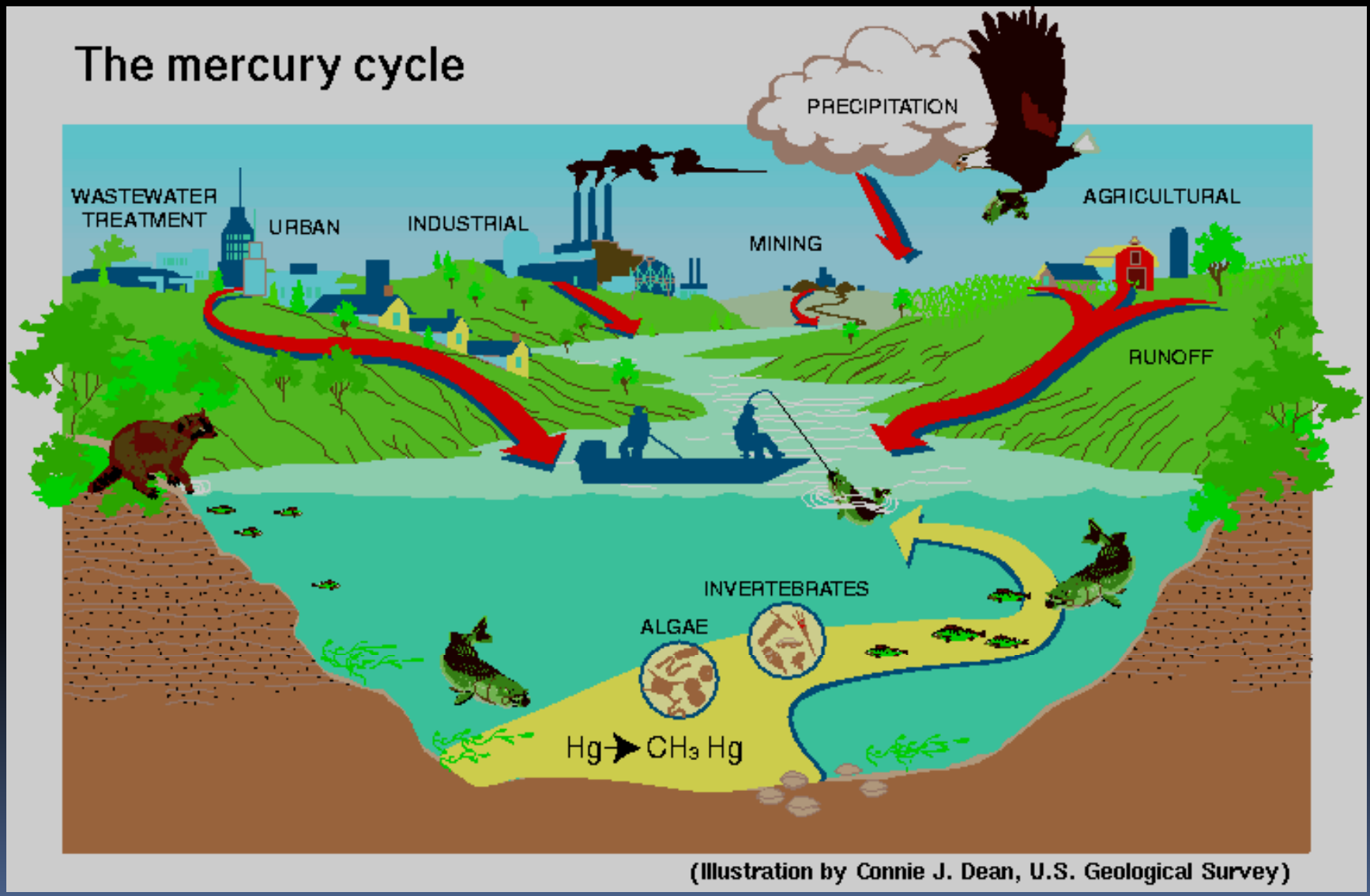


How does Ohio "stack" up?

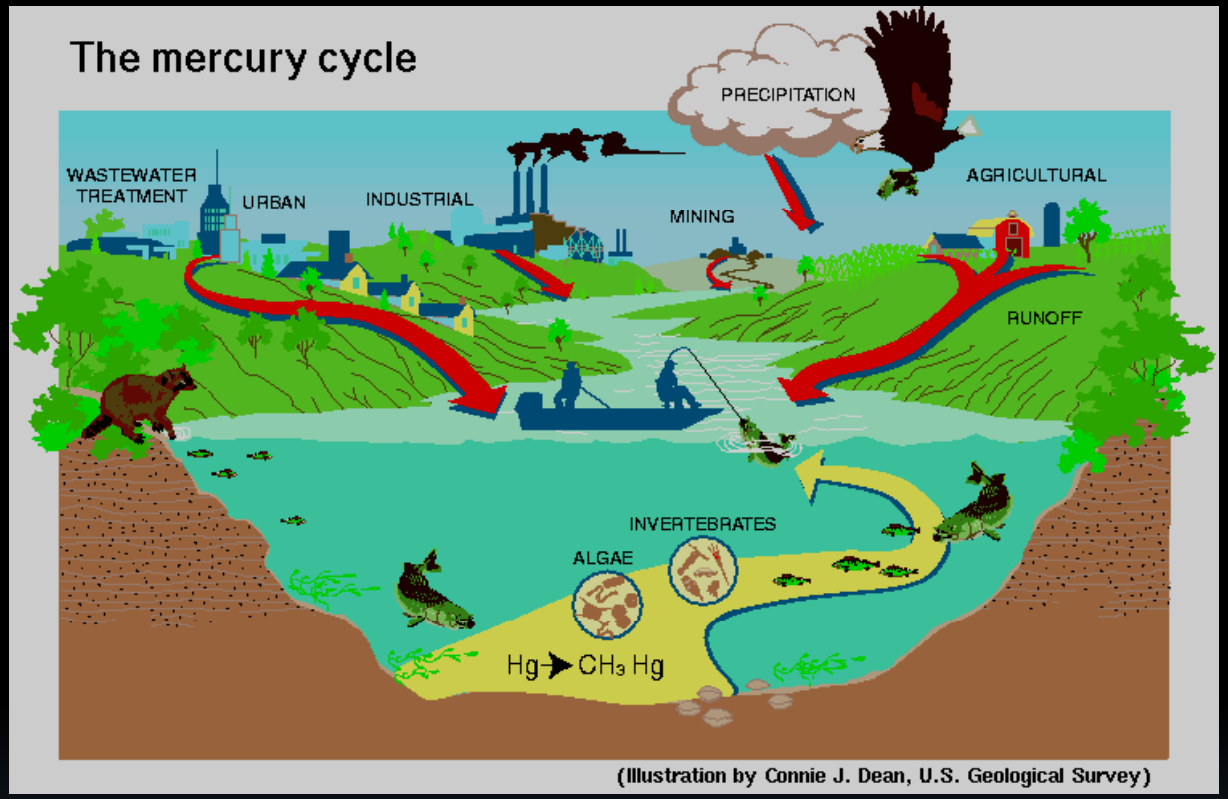


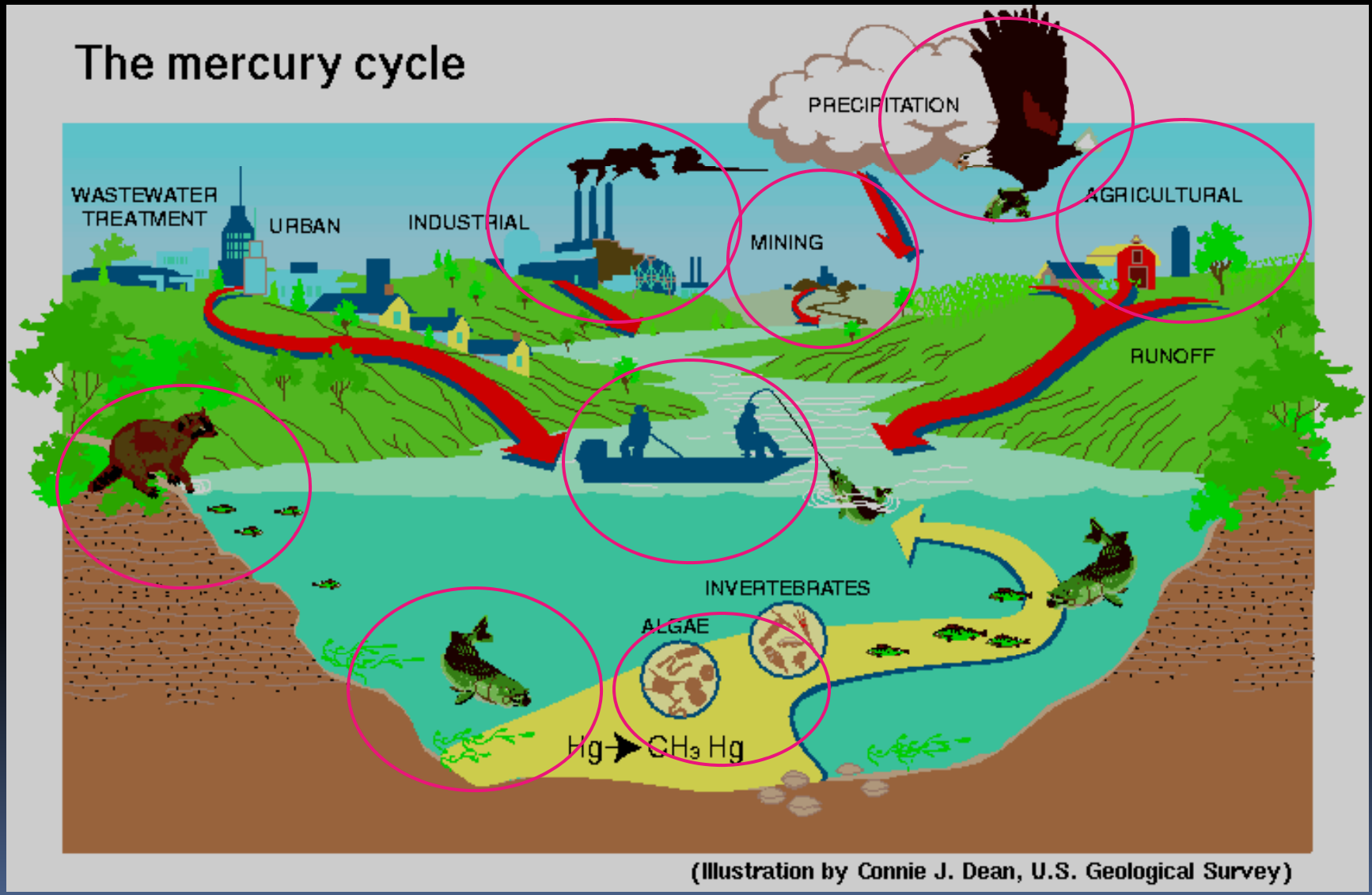
Environmental sources of mercury

- Natural Degassing of the earth
- Combustion of fossil fuel
- Industrial Discharges and Wastes
- Incineration & Crematories
- Dental amalgams


The mercury cycle
PRECIPITATION
WASTEWATER TREATMENT
URBAN
INDUSTRIAL
MINING
AGRICULTURAL
RUNOFF
INVERTEBRATES
ALGAE
Hg → CH3 Hg
(Illustration by Connie J. Dean, U.S. Geological Survey)

What does this illustration remind you of?

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Hg → CH3 Hg
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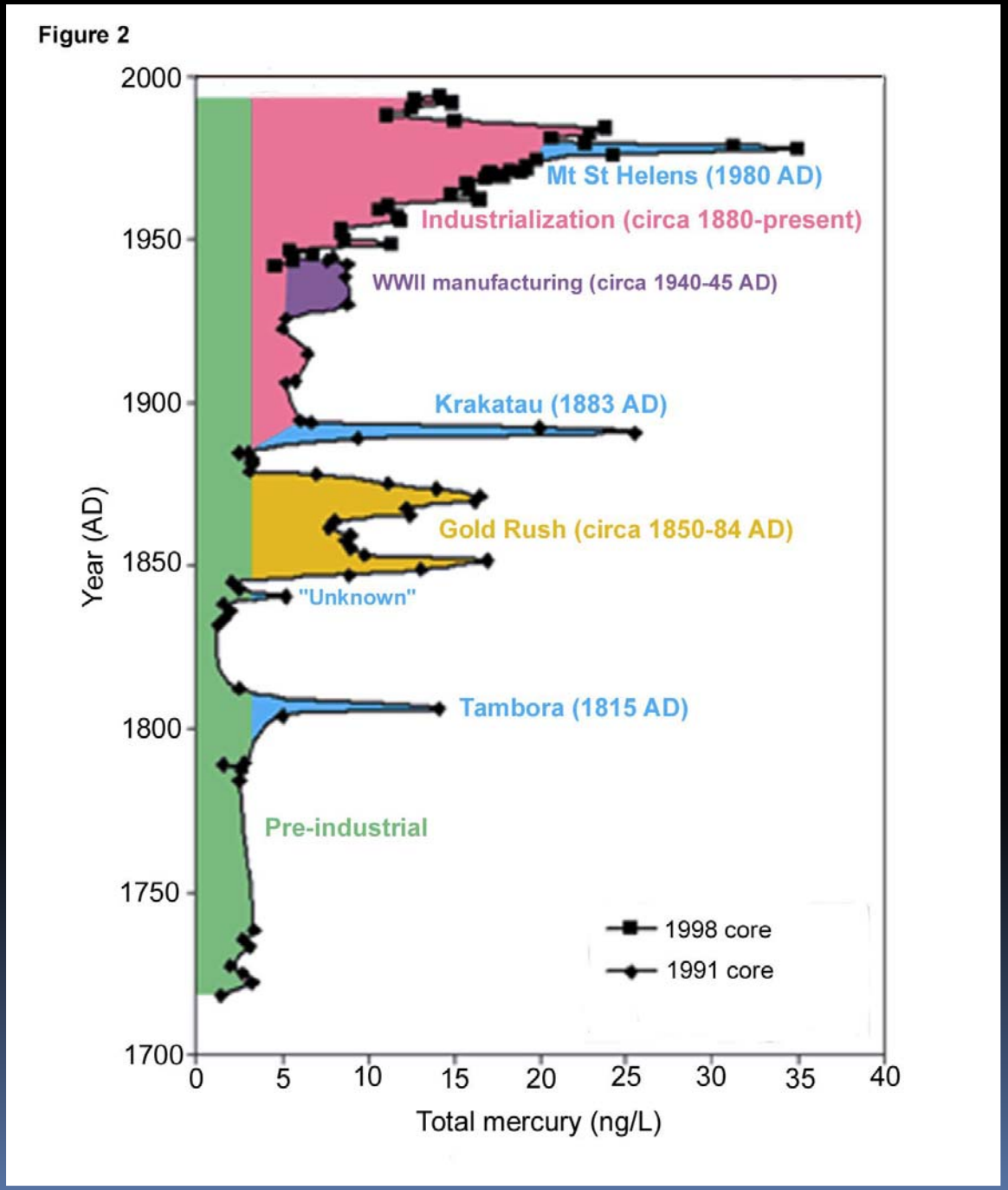
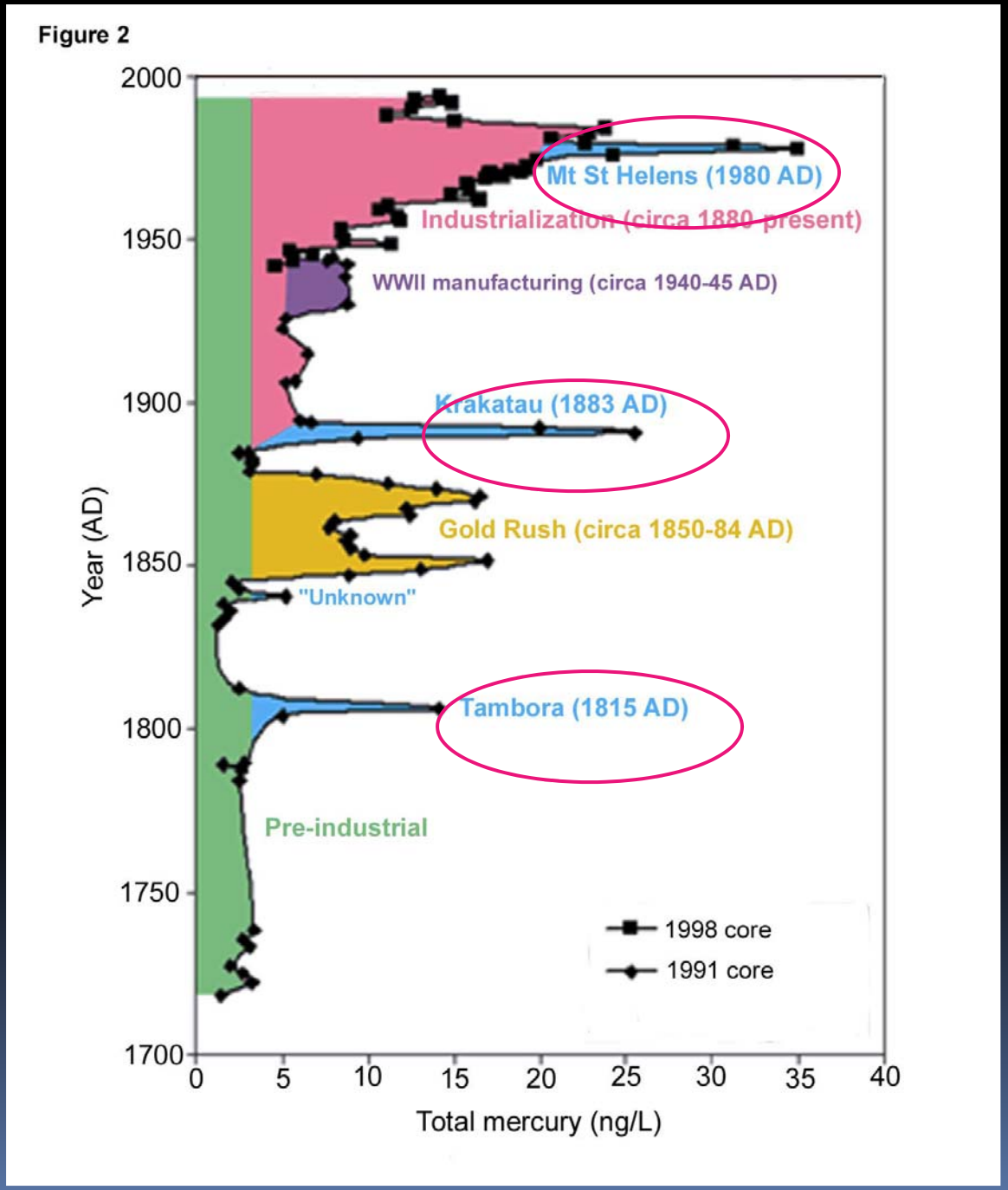
Natural Degassing of the earth?

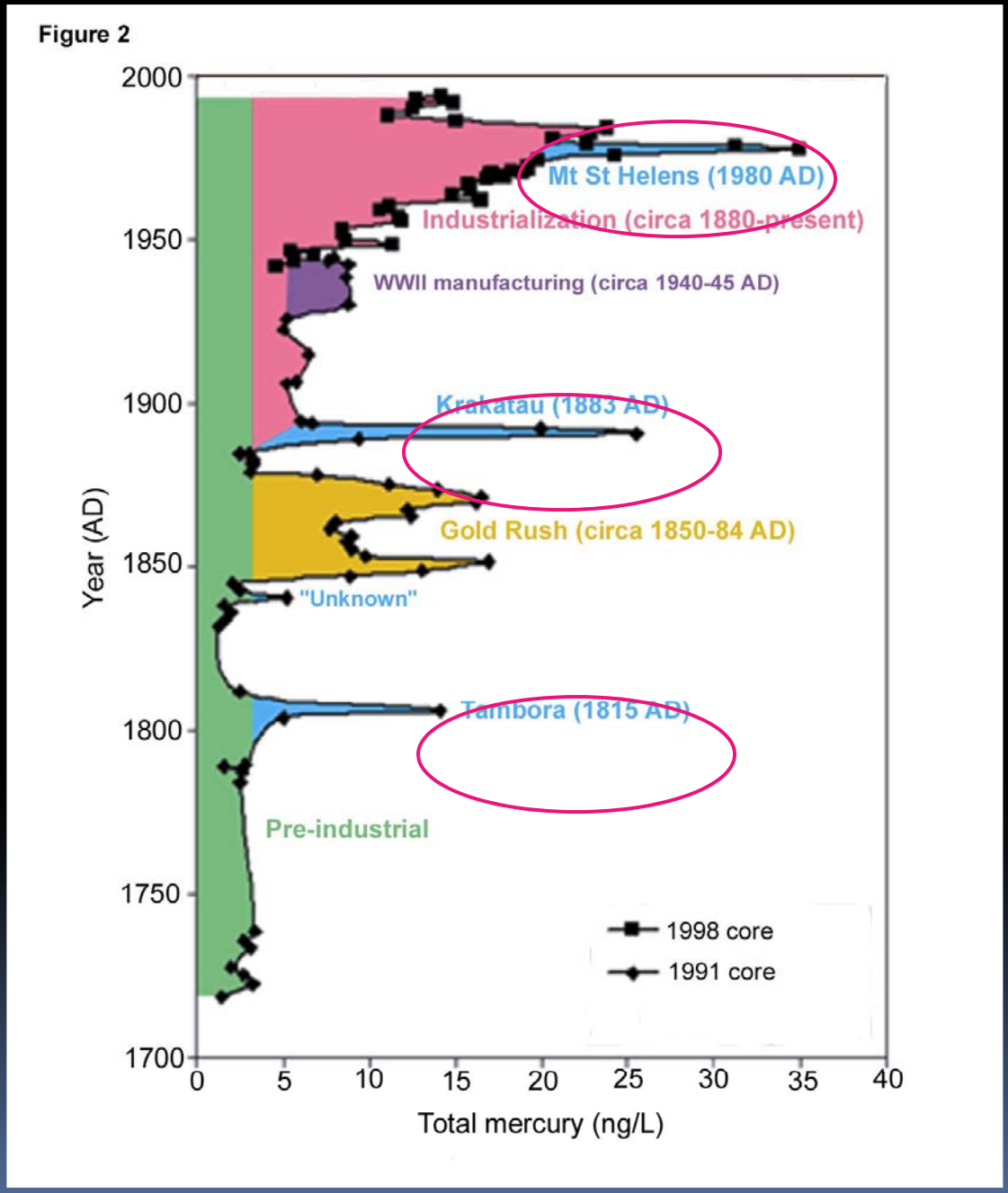


"Natural Degassing" of the earth? What can you say about volcanic eruptions and mercury in the atmosphere?



Major atmospheric releases

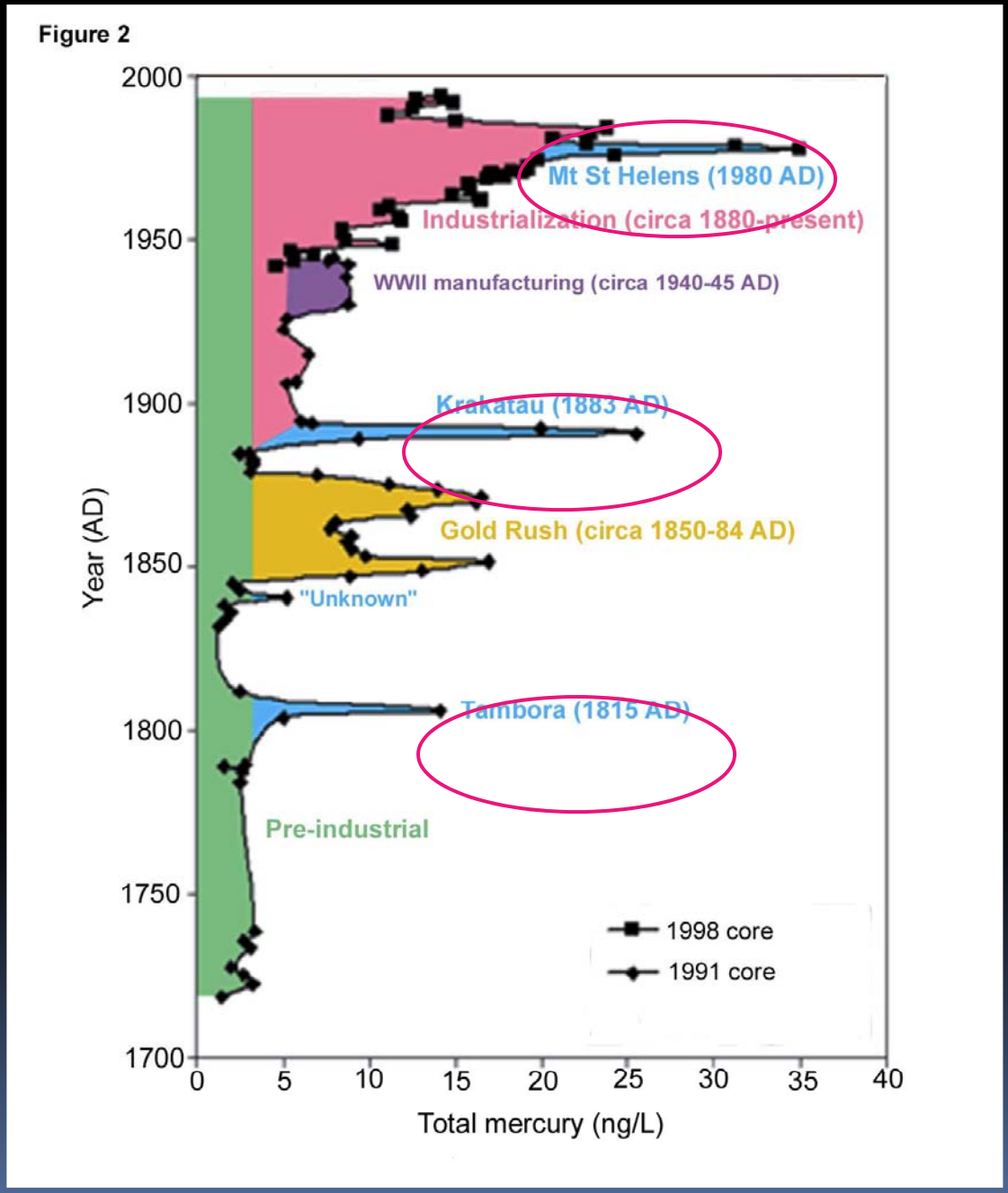
- Natural
  - Background (42%)
  - Volcanic (6%)
- Human (52%)
  - Gold rush
  - WWII
  - Industrialization



Significantly

The last 100 years
Human sources: 70%

The last 10 years
an apparent decline



Neuro-behavioral effects of Hg exposure

- Blindness - Deafness
- Cerebral Palsy - Seizures
- Abnormal reflexes & muscle tone
- Visual and Auditory Deficits
- Delayed motor development

Neuro-behavioral effects of Hg exposure

- Decrease in Brain Size
- Cell loss
- Disorganization of cells
- Cell migration failures

Hg exposure in fish

- In 2000, 41 States have over 2000 fish consumption advisories
- An increase from 27 in 1993
- Pregnant women, nursing mothers, women who intend to have children, and children under 15

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"Everything's got a moral, if you can only find it"

Lewis Carroll in Alice's Adventures in Wonderland

End of Part 6: Mercury