

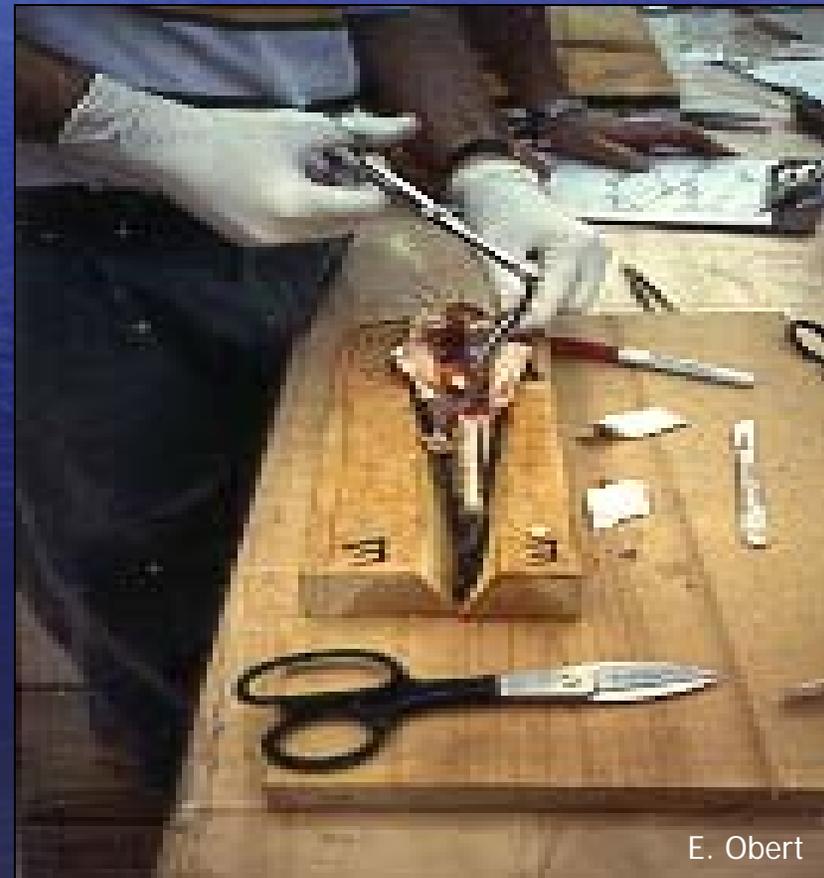


Great Lakes Fishery Leadership Institute

Contaminant Issues Relevant to Great Lakes Fisheries



E. Obert



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Contaminants

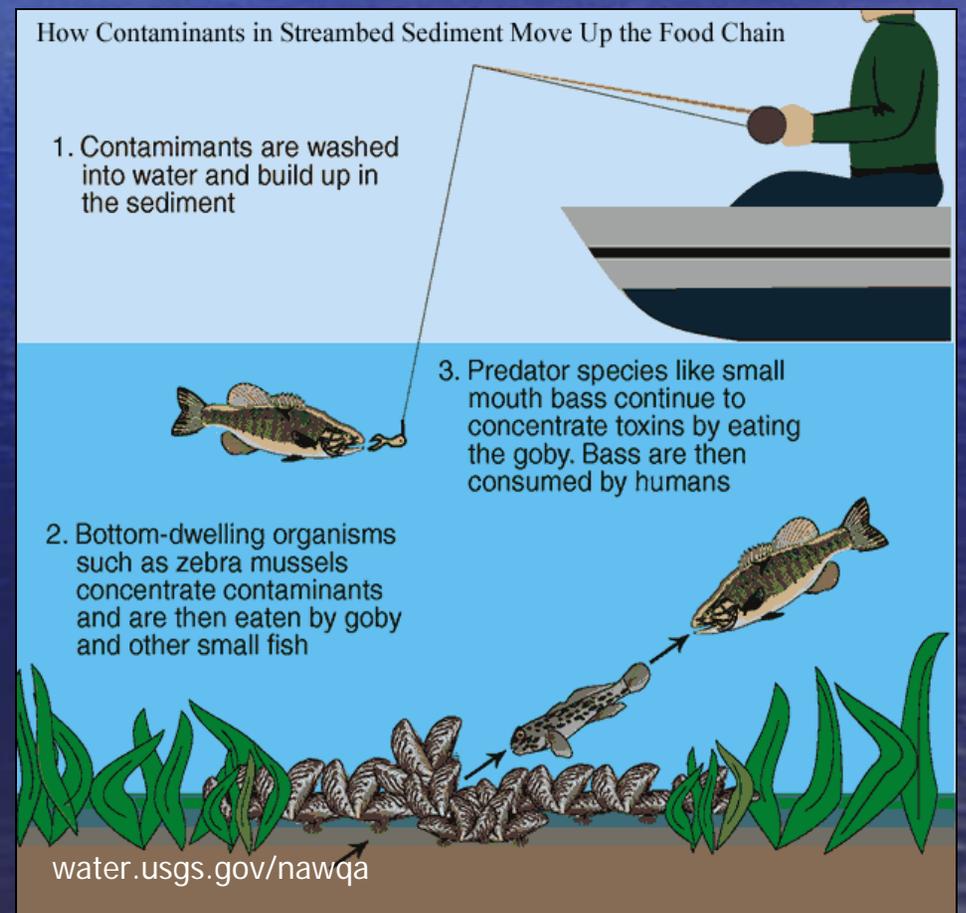


National Park Service, Indiana Dunes National Lake Shore

- Polluted many of the sediments in our rivers, lakes and oceans.
- Many are bioaccumulative.
- Estrogenic substances, metals, organic contaminants, and fire retardants.

Potential Effects of Contaminants on Aquatic Life

- kills benthic organisms and reduces the food available to larger organisms such as fish.
- contaminants are taken up by benthic organisms and become concentrated in higher and higher amounts in a process called bioaccumulation.
- toxins move up the food chain in increasing concentrations in a process known as biological amplification
- Leads to a reduction of the biodiversity.



Potential Effects of Contaminants on Aquatic Life (cont.)

- Toxic chemicals may lead to the death of aquatic organisms
- Some of contaminants are believed to induce tumors in wild fish populations
- Contaminants cause fish deformities and reproductive problems



Efforts to Restore Contaminated Habitats

- International Joint Commission
- Designation of Great Lakes Areas of Concern
- Remedial Action Plans



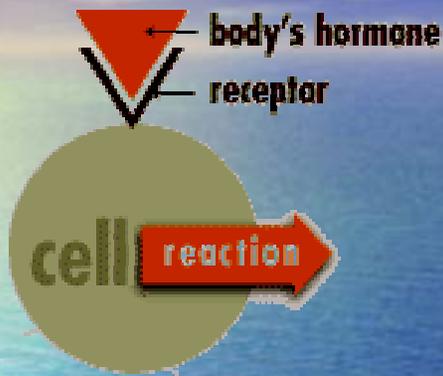
Estrogenic Substances

- Chemical compounds that have serious effects on sexual development.
- These endocrine disrupting compounds are found in the environment and include mercury, polychlorinated biphenyls (PCBs), and pesticides such as DDT.
- Endocrine disruptors are chemicals that interfere with the normal function of the endocrine system.
- An endocrine system is a hormonal pathway made up of glands that release their products (hormones) into the bloodstream.



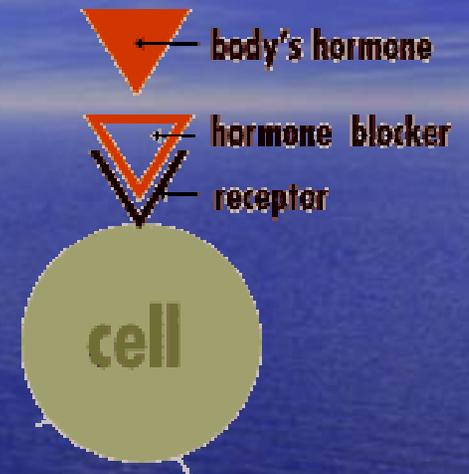
Endocrine Disrupting Activity

normal



← Normal hormone activates the receptor at the appropriate level
Hormone blocker interferes ⇒ with the signal from the body hormones

blocked



excessive



← Hormone disrupters give a signal stronger than the body's hormone (and at the wrong time)
Hormone disrupter gives a ⇒ signal weaker than normal, also at the wrong time.

insufficient



Credits: The Why Files Staff, University of Wisconsin-Madison.

Effects of Estrogenic Substances

- ✓ Thyroid dysfunction in birds and fish
- ✓ Decreased fertility in birds, fish, shellfish, and mammals
- ✓ Decreased hatching success in birds, turtles, and fish
- ✓ Gross birth deformities in birds, fish, and turtles
- ✓ Male fish, birds, and mammals that are feminized
- ✓ Female fish, birds, and mammals that are masculinized
- ✓ Compromised immune systems in birds and mammals



Metals

- Slightly elevated metal levels may cause sub-lethal effects in aquatic organisms.
 - ✓ Histological or morphological changes in tissues
 - ✓ Physiological changes
 - ✓ Biochemical changes
 - ✓ Behavioral changes
 - ✓ Reproductive changes
- Bivalves as an indicator.

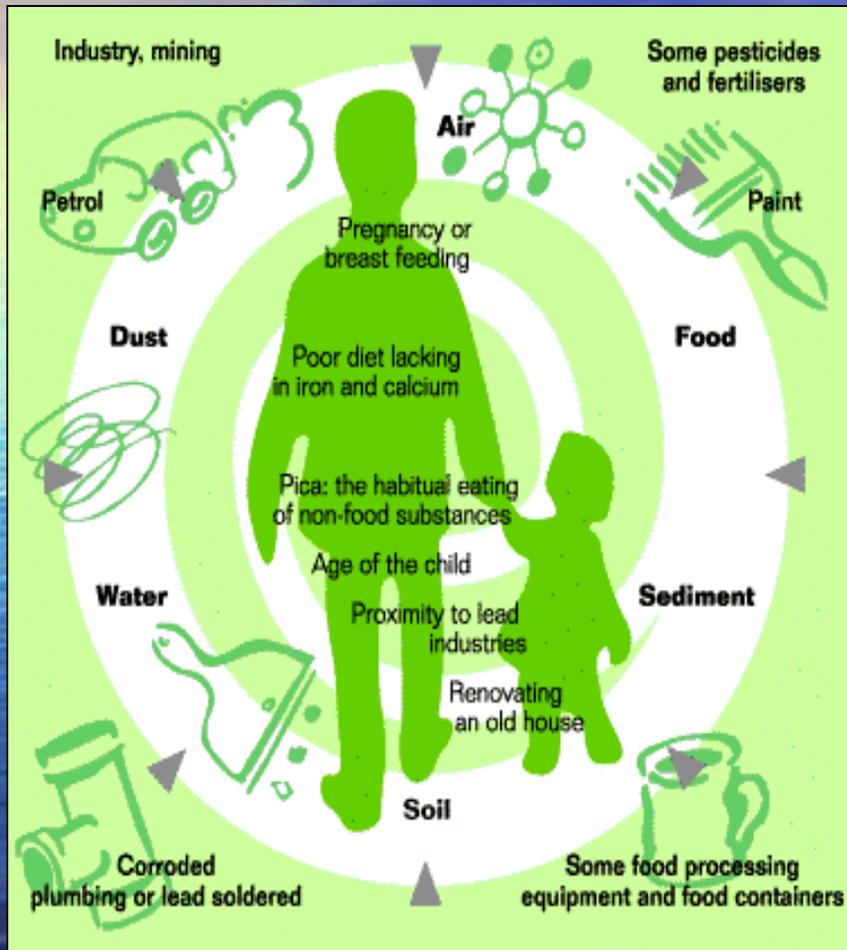


Metals (cont.)

- Metals may be adsorbed by aquatic organisms via three main pathways:
 - Free metal ions that are absorbed through gills are readily diffused into the blood stream.
 - Free metal ions that are adsorbed onto body surfaces are passively diffused into the blood stream.
 - Metals that are absorbed onto food and particulates may be ingested.



Lead

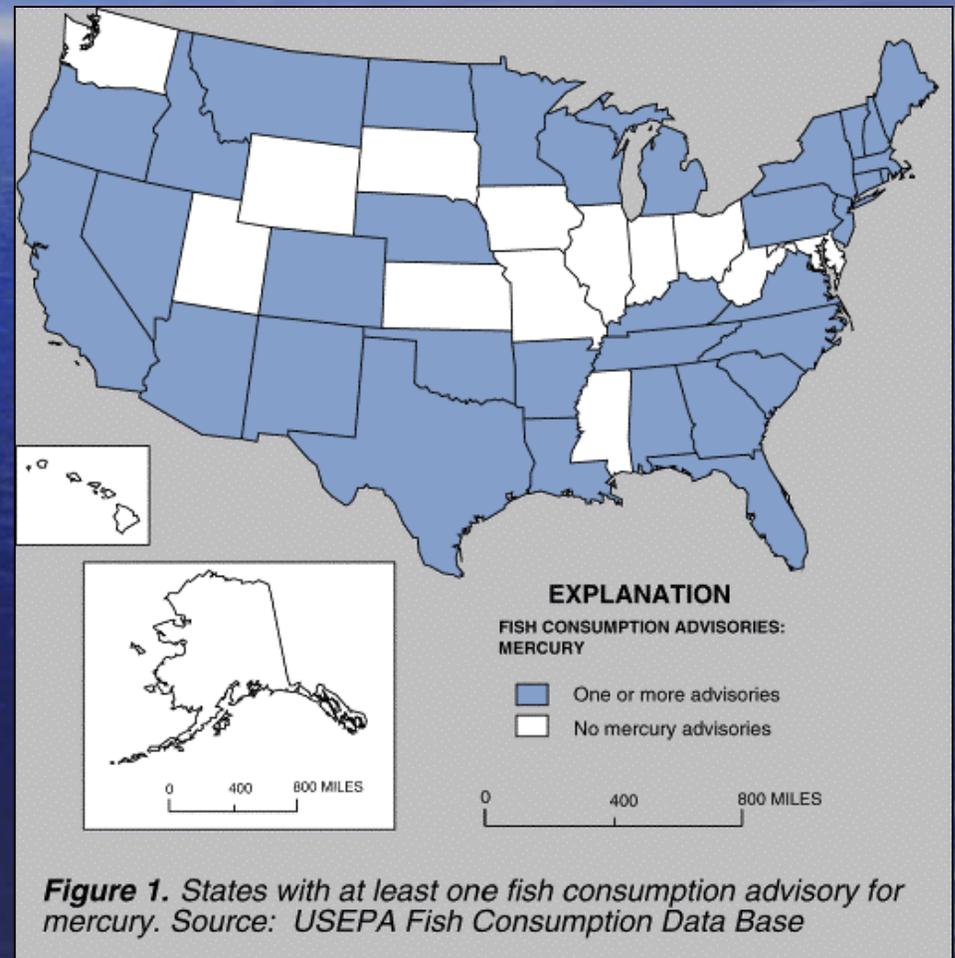


<http://www.epa.nsw.gov.au/leadsafe/sources.gif>

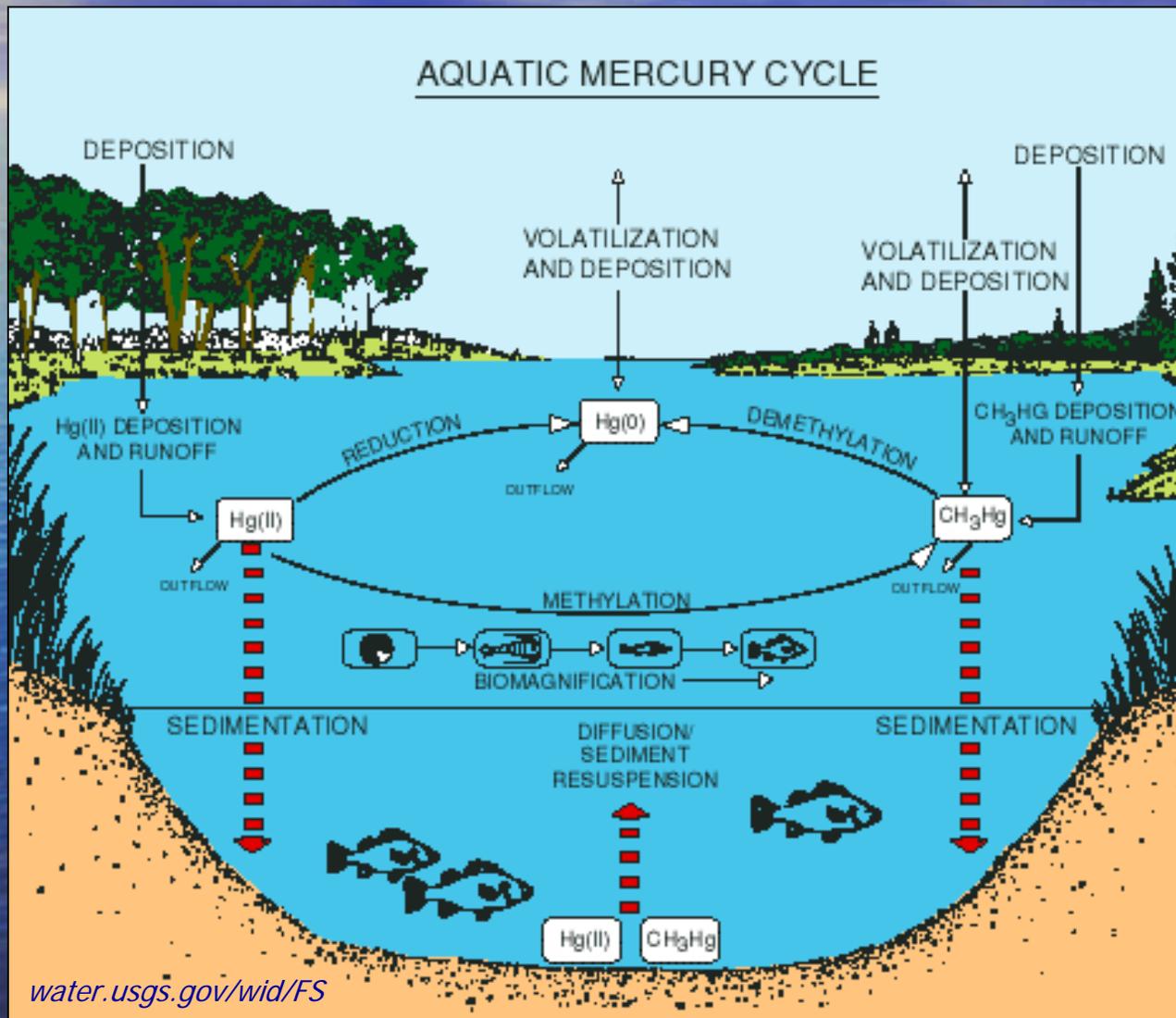
- Highly toxic, produces a variety of effects.
- Can substitute for calcium and be included in bone.
- May lead to nephrotoxicity, neurotoxicity, and hypertension.
- Waterfowl affected by lead poisoning will experience physical and behavioral changes such as loss of balance, gasping, tremors, and impaired ability to fly.

Mercury

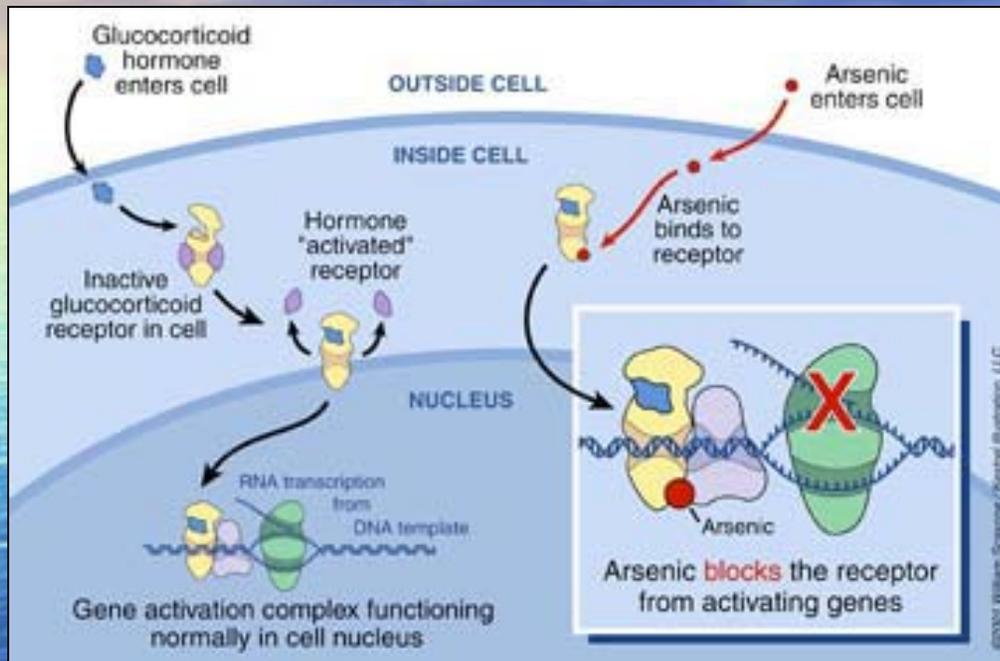
- Upon entering the water mercury is transformed into methyl-mercury, which is more toxic.
- In 2001, the EPA issued a national consumption advisory for women who are or may become pregnant, nursing mothers, and young children.
- Bioaccumulation by aquatic life.



Mercury Cycle



Arsenic



<http://www.ourstolenfuture.org/NewScience/oncompounds/2001kaltreideretal.htm>

- Many common arsenic compounds can dissolve in water; therefore, arsenic can get into lakes, rivers, and underground water by dissolving in rain or snow, or through the discharge of industrial wastes.
- Cannot be destroyed in the environment; it can only change forms.
- Although some fish and shellfish take in arsenic, which can build up in their tissues, most of this arsenic is in a form often called "fish arsenic" that is less harmful.

Chromium

- Naturally occurring element found in several different forms.
 - Chromium enters the air, water, and soil mostly in the chromium (III) and chromium (VI) forms.
 - Chromium IV known as a human carcinogenic.
- Chromium can strongly attach to soil and only a small amount can dissolve in water and move deeper in the soil to underground water.

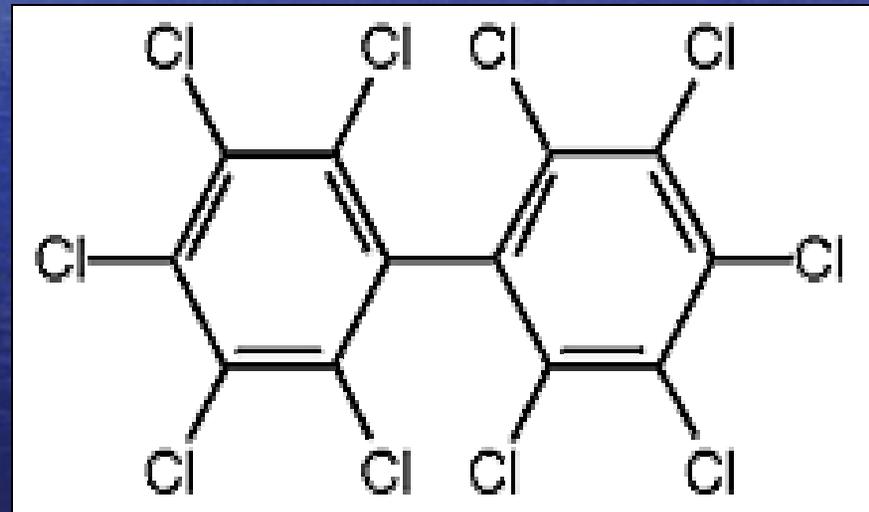


Paul Lioy

Environmental Health Perspectives V.108, N.9, Sep00

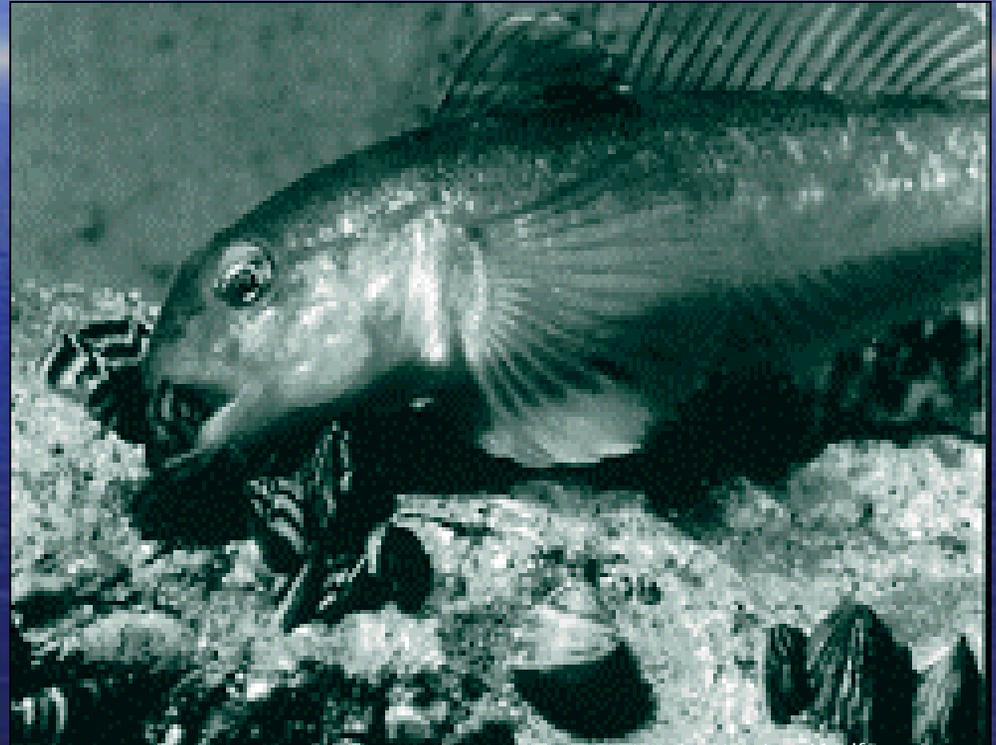
Organic Contaminants

- ✓ Polychlorinated biphenyls (PCBs)
- ✓ Polycyclic aromatic hydrocarbons (PAHs)
- ✓ Dioxin
- ✓ Atrazine
- ✓ Dichlorodiphenyltrichlorethane (DDT)



Polychlorinated biphenyls (PCBs)

- Flame resistance made them ideal for industrial and household use.
- Toxic and accumulate in fatty tissues of animals and fish.
- Bioaccumulate in the food web.
- Chronic effects from PCBs may include shortened lifespan, reproductive problems, lower fertility, and changes in appearance or behavior.



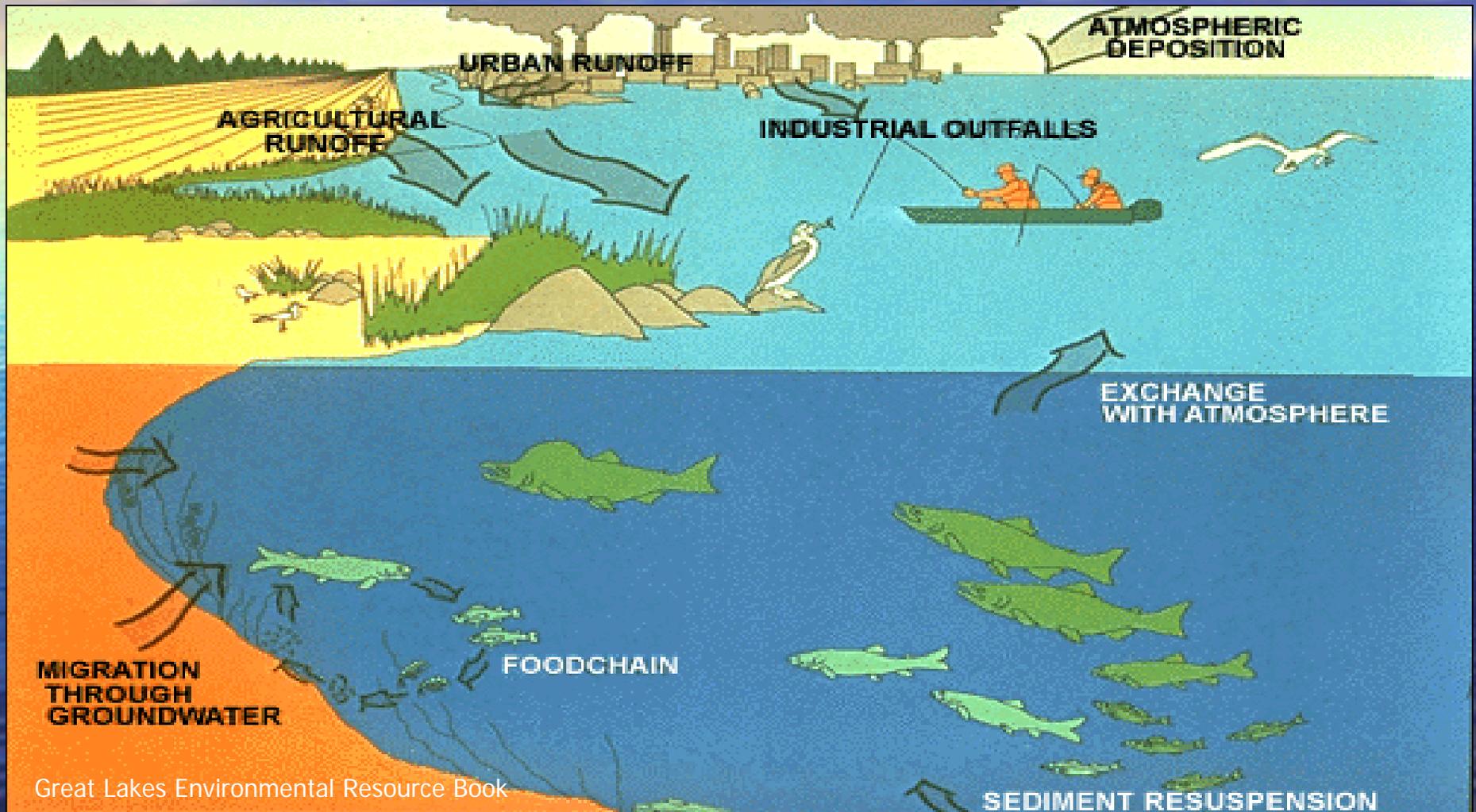
PCBs can increase or biomagnify with each trophic level before being consumed by humans or animals. New Ohio Sea Grant research reports levels of PCBs in round gobies after eating PCB-contaminated zebra mussels to range from 200 to 800 ppb. After eating these gobies, smallmouth bass' PCB concentrations increase with ranges from 1100 to 1800 ppb.

Polycyclic Aromatic Hydrocarbons (PAHs)

- Organic compounds that are formed during incomplete combustion of coal, oil, gas, garbage, tobacco, and charbroiled meats.
- Insoluble in water, they tend to bind to particles and settle into the sediment.
- Bottom feeding fish and crustaceans are likely to ingest PAHs, causing tumors and lesions to the animals.



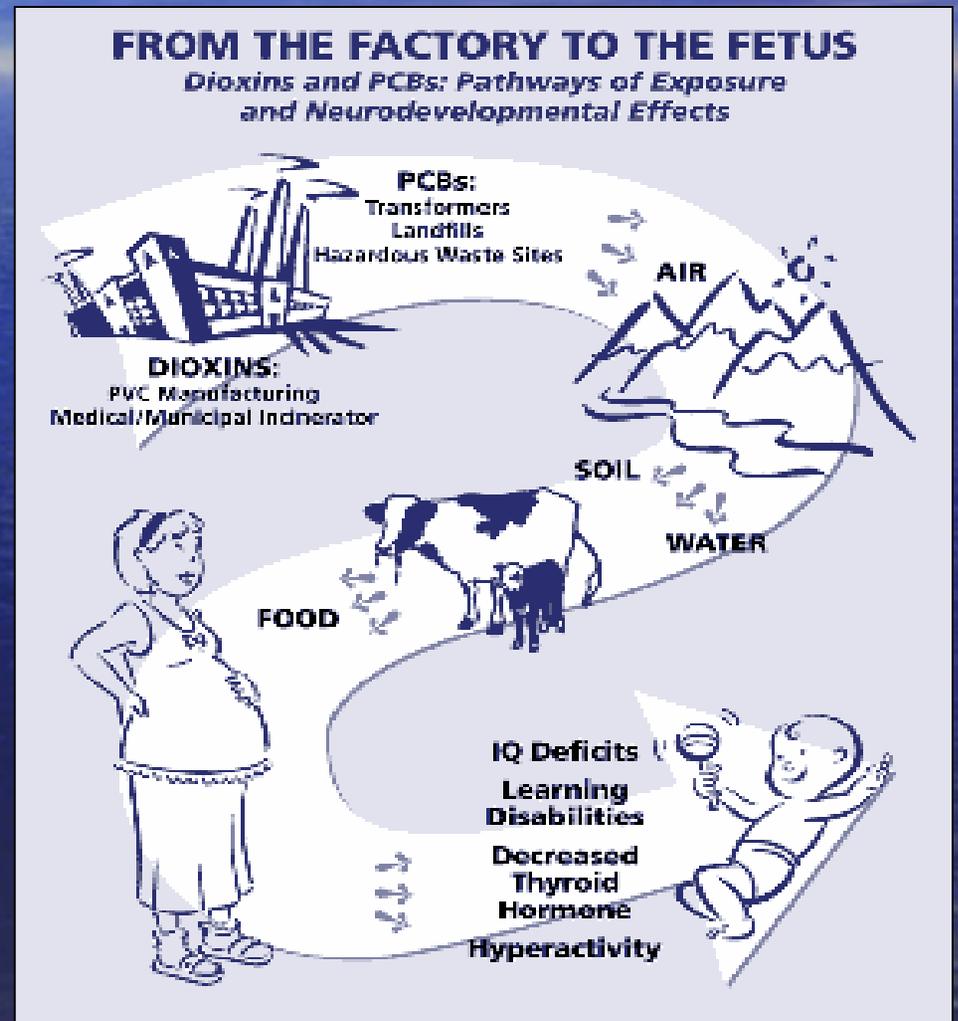
Cycling of PAH and Other Contaminants



Great Lakes Environmental Resource Book

Dioxin

- One of the most toxic man-made chemicals ever produced.
- Dioxins, furans, and PCBs collectively known as “dioxin”.
- Heating converts PCBs to more toxic dioxins and furans.



Atrazine



J. Harshbarger

- Widely used as a herbicide.
- Can bind to particles in the soil, but tends to escape into the ground water.
- Endocrine disrupting toxin.

Frog With Polydactyly

Dichlorodiphenyl-trichlorethane (DDT)



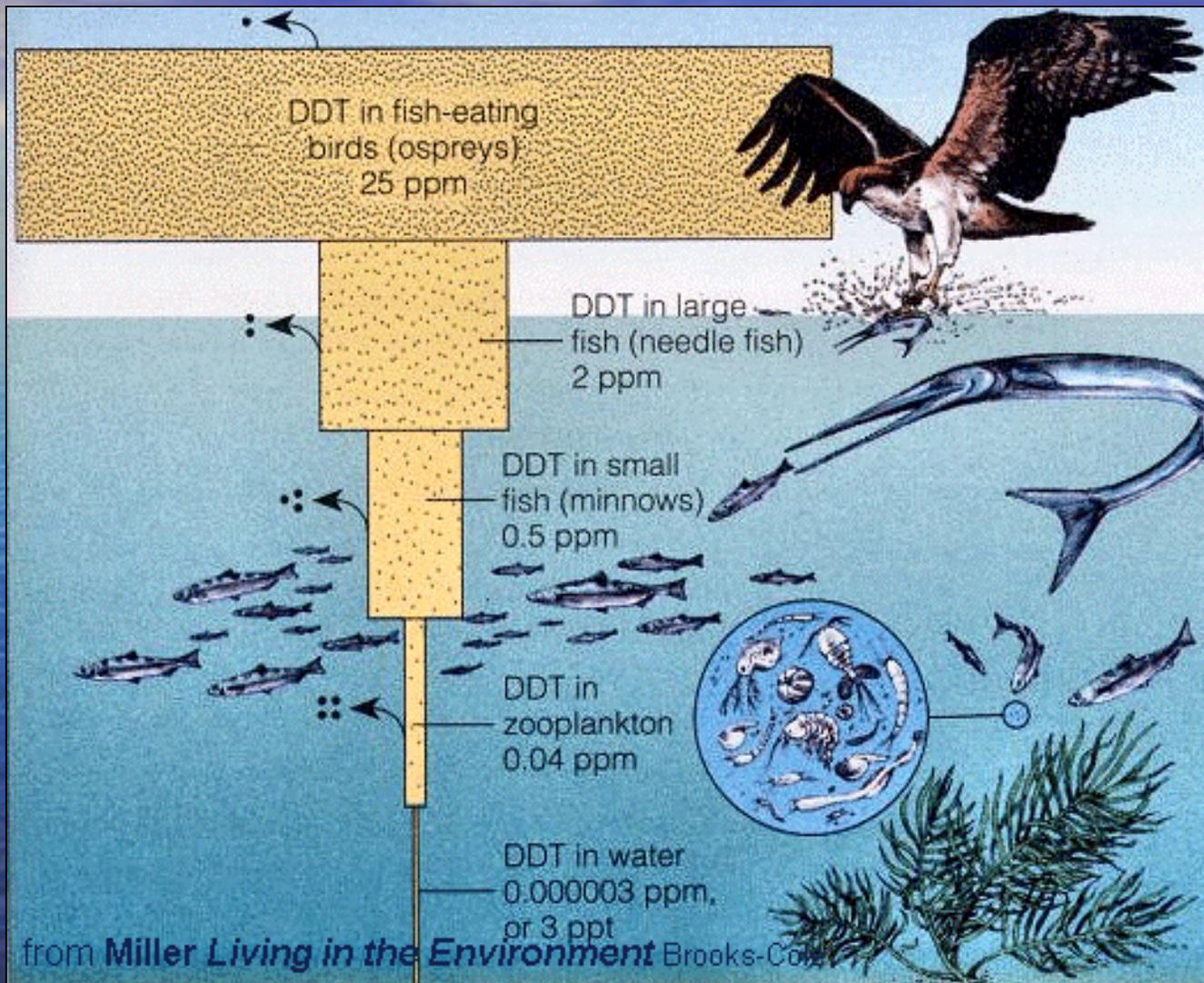
<http://www.baldeagleinfo.com/eagle/eagle4.html>

- Widely used as a pesticide from 1946 to 1972.
- Banned due to its ability to cause reproductive failures in wildlife.
- Bioaccumulative



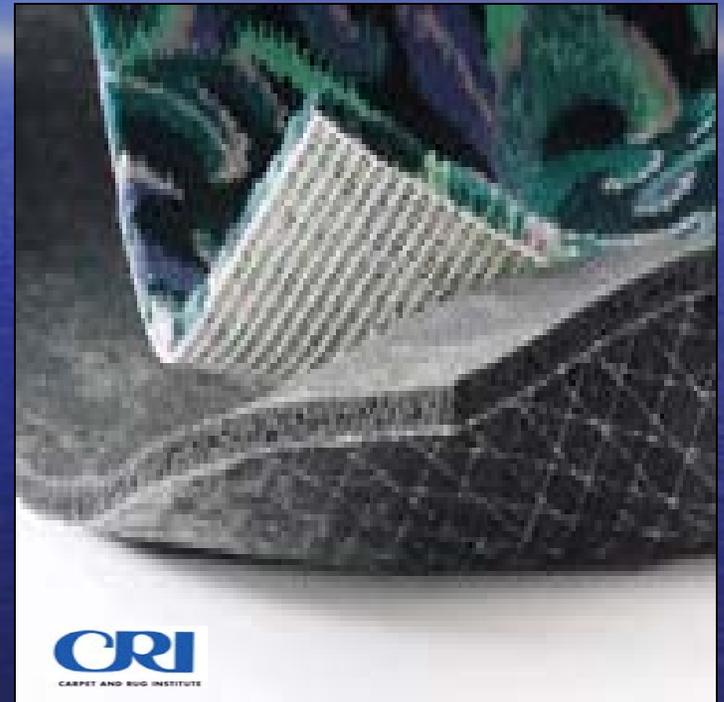
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Bioaccumulation of DDT



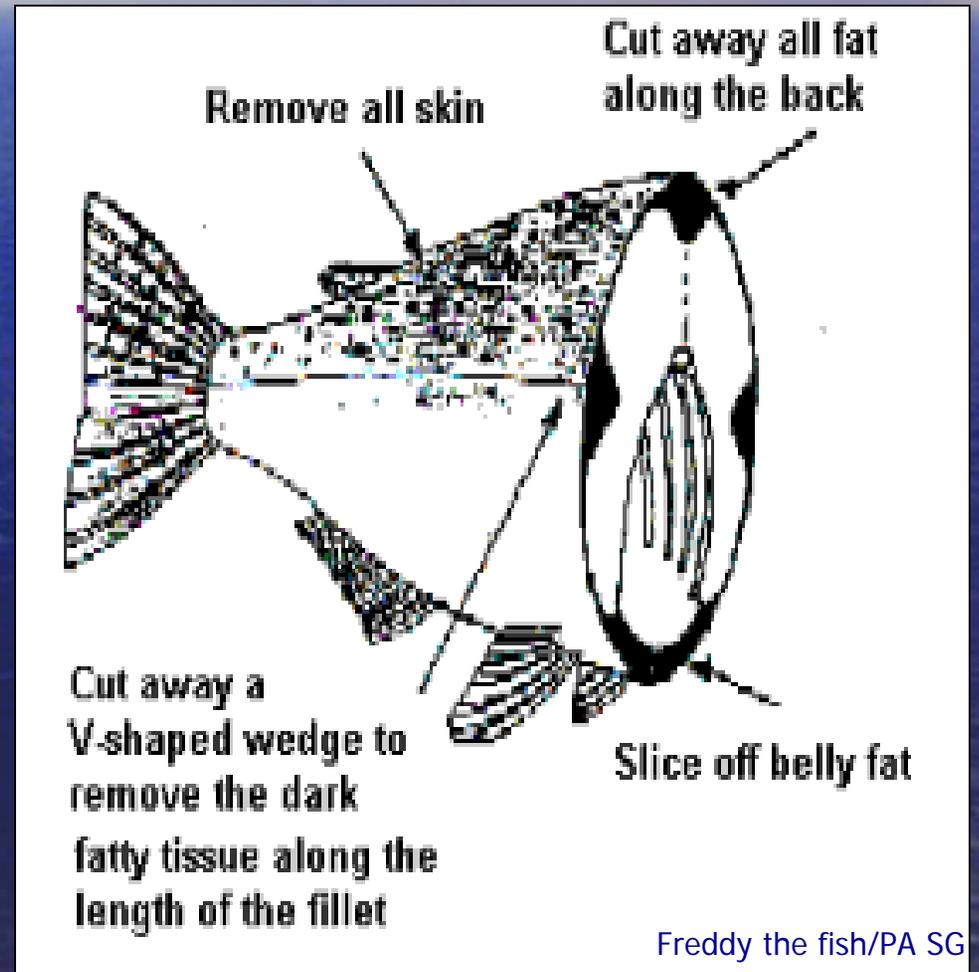
Fire Retardants

- Mirex
 - ✓ Widely used as a pesticide and flame retardant.
 - ✓ degrades slowly in the environment, and may persist for years in soil and water.
- Polybrominated biphenyls (PBBs)
 - ✓ mixed into plastics, they can dissipate and enter the environment.
 - ✓ The effects of PBBs are found to be essentially the same as PCBs
- Polybrominateddiphenyl ethers (PBDEs)
 - ✓ Persistent bioaccumulative chemicals.



Fish Consumption Advisory

- Great Lakes and surrounding watersheds contain chemicals that could pose health risks.
- Contaminants bioaccumulate in aquatic organisms via their diet and become concentrated at levels that are much higher than in the water itself.
- At risk populations:
 - ✓ Pregnant and nursing mothers
 - ✓ Women of child-bearing age
 - ✓ Young children and babies
 - ✓ People who regularly eat fish from contaminated areas.



Risk Assessments

- Each state is responsible for developing its own fish advisories to meet the health needs of its citizens.
- Toxic endpoints used for assessment are subtle.
- Awareness to reduce exposure.
 - ✓ Exposure to detrimental levels of environmental contaminants can cause a variety of negative health effects.
 - ✓ The precise level of contaminant exposure that is detrimental to an individual is going to vary with his/her age, sex, genetics, current physical condition, and previous exposure of that individual.
 - ✓ Individuals within a population will vary in their sensitivities to environmental contaminants.



Fish Tumors

- Indicator of environmental degradation of the aquatic ecosystem and a measure of health impairments to fish populations.
- Can be induced genetically, virally, and chemically.

Mouth tumor on brown bullhead



Lymphocystis in walleye



Fish Tumors (cont.)

- Tumors in wild fish populations, and the presence of contaminants provides evidence that chemical carcinogenesis is occurring in the Great Lakes.
- For tumor formation to occur, several chemicals require the need for metabolic activity before they can induce neoplasia.
- PAHs, benzo(a)pyrene, and dimethylbenthracene, induce liver cancers in fish.

Gross Cholangiocarcinoma liver tumor



PAHs in bile of gallbladder



Fish Tumors (cont.)



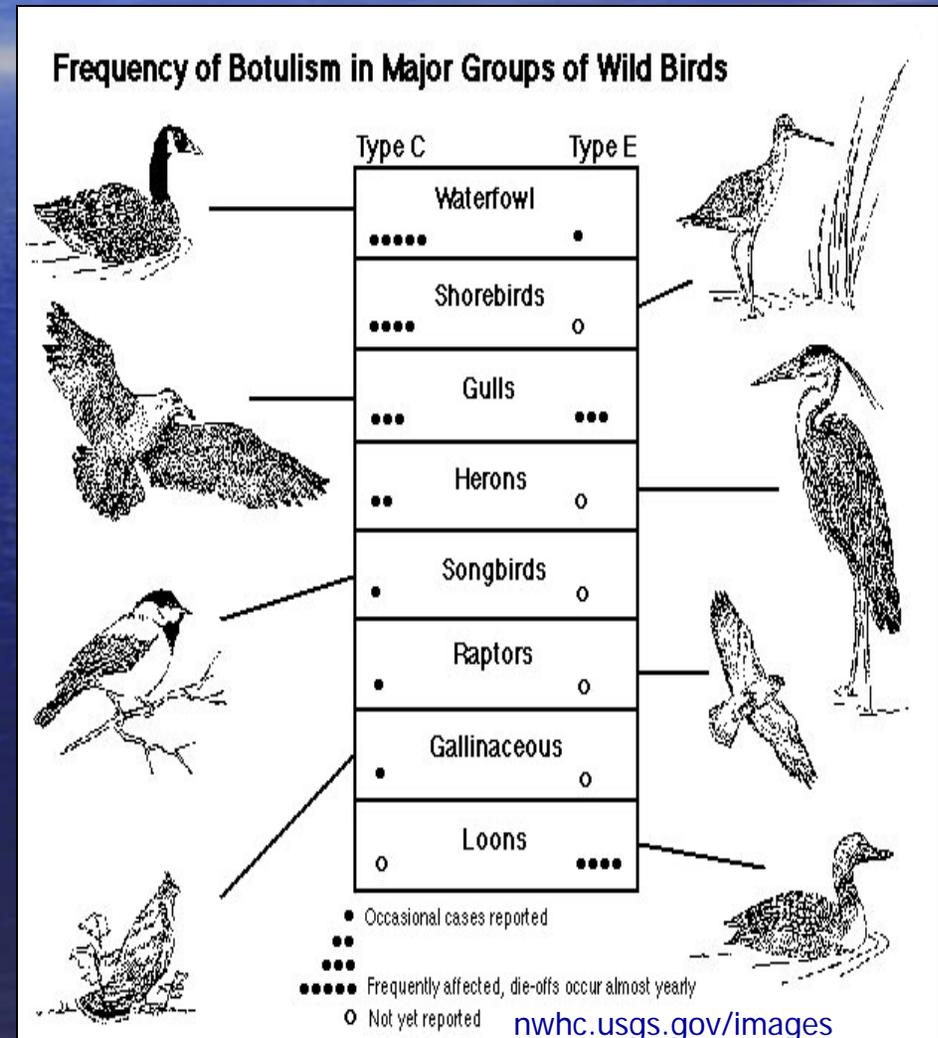
J. Harsbarger

Lymphoma on a Northern Pike

- The International Joint Commission (IJC) characterized fish tumors and other deformities as beneficial use impairments.
- Viruses or viral-chemical action can cause many benign and malignant tumors in Great Lakes fish.
- Other tumors believed to be virally induced include lymphocystis and dermal sarcomas in walleye, papillomas in carp, and possibly lip and body papillomas in white suckers.

Avian Botulism

- The bacterium is classified into seven types (A-G) by using characteristics of the neurotoxins that are produced.
- Type C is the major cause of mortality in migratory birds.
- Type E is mainly restricted to fish-eating birds.



Botulism (cont.)

- Spores of both type C and type E botulism are found in anaerobic habitats.
- Botulism toxin is only produced during vegetative growth, not when the bacterium is in its spore stage.



E.Obert



L. Smith/PAPGC

Human Health Considerations

The cycle of avian botulism

Avian botulism is an often-fatal disease in birds resulting from ingestion of toxins produced by bacteria. The disease causes birds to lose their ability to fly and use their legs, and eventually leads to respiratory failure if they don't drown first.



WHAT TO DO IF YOU FIND DEAD BIRDS

- | | | | |
|---|---|--|--|
| 1) Record the location, type of bird and number of carcasses found. | 2) Report the information to the Game Commission at (814) 432-3187. | 3) Dispose of birds in a hole 2 to 3 feet deep or place birds in a plastic garbage bag and deposit the bag in a trash container. | 4) If bare hands touch a dead bird, wash the contacted skin immediately with soap and hot water. |
|---|---|--|--|

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CHRIS SIGMUND/For The Times-News

- Human botulism is typically caused by eating improperly canned or stored foods and involves types A and B botulism toxins.
 - ✓ Proper cooking of fish and waterfowl will kill bacteria found in food items.
 - ✓ When canning or smoking fish or waterfowl, methods should be used that incorporate sufficient heat to insure that any toxins will be killed off.
- Anglers and hunters should avoid harvesting sick or dying fish or waterfowl.
- Proper disposal of dead fish and birds from beach areas may prevent increased wildlife mortality through the maggot botulism cycle.

Human Health Considerations (cont.)

- In case of a die-off, individuals are urged to contact local agencies responsible for fish and wildlife management to notify them of fish and bird mortalities.
 - ✓ It is important to record the location, type of birds or fishes, and number of carcasses found.
 - ✓ If birds are to be collected, they should be placed in heavy plastic bags to avoid the spread of botulism-containing maggots.



E. Obert/PASG

The End

- For more information please contact your local Sea Grant Office.

