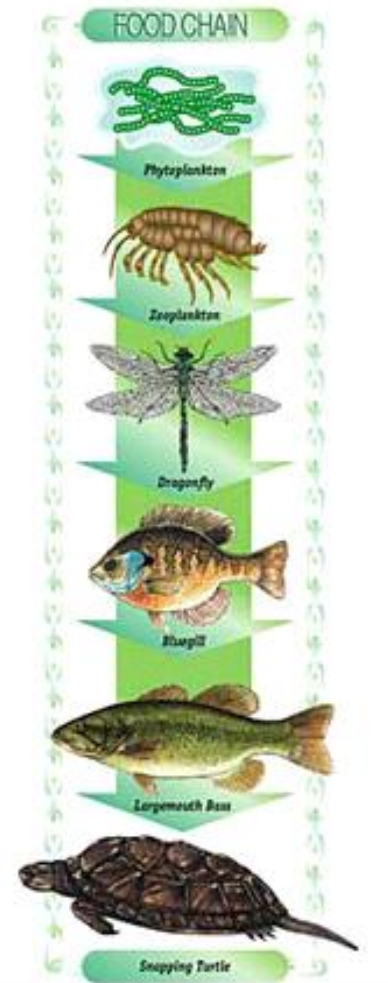


BIO AMPLIFICATION



BIOLOGICAL AMPLIFICATION

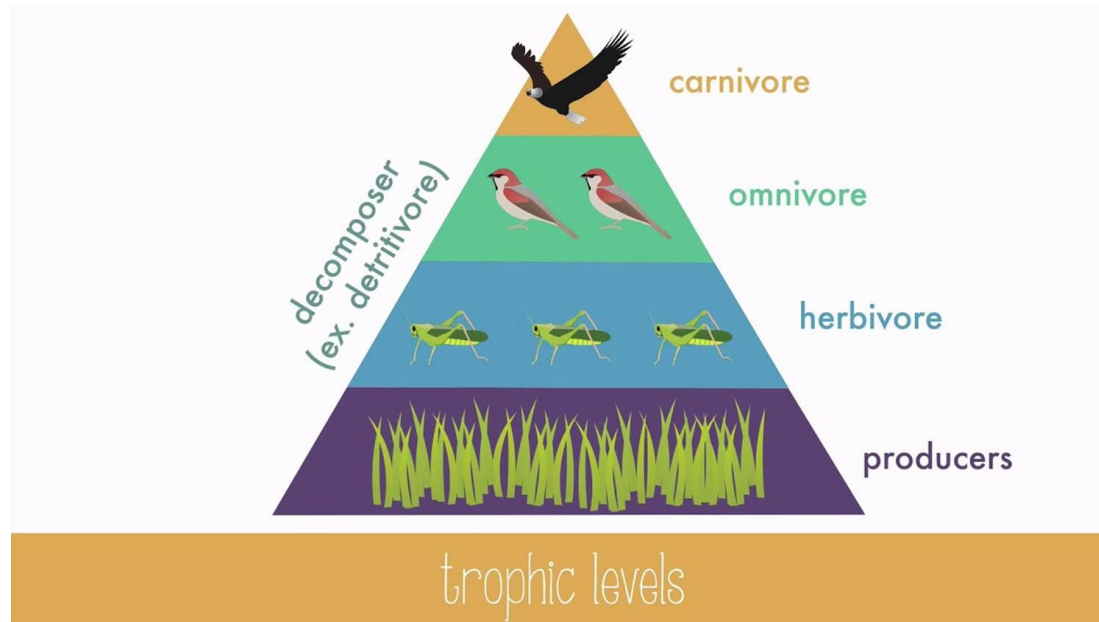
- Toxic pollutants enter the ecosystem that are absorbed or ingested by organisms. Some substances accumulate in organism's tissue over time.



Source: Pennsylvania Fish and Boat Commission

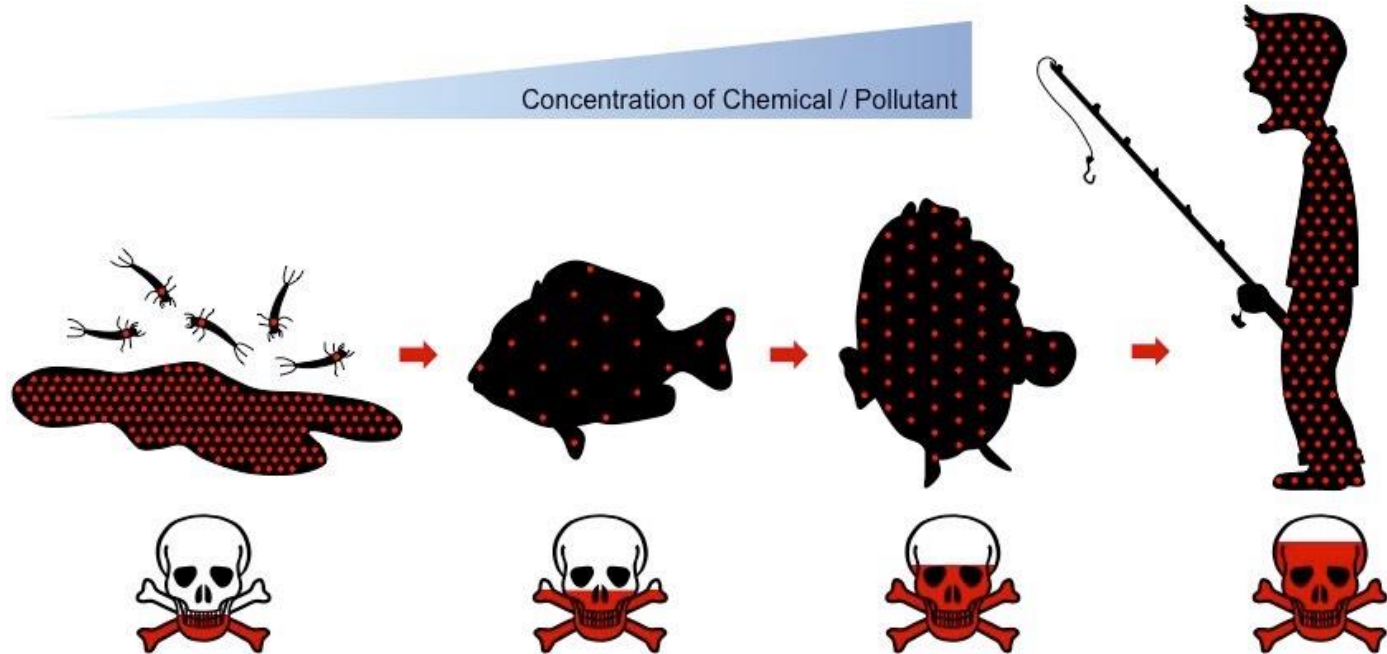
BIOACCUMULATION

- An increase in the concentration of a pollutant in a biological organism compared to its concentration in the environment
- It is how pollutants enter a food chain



BIOMAGNIFICATION

- Increase in the concentration of a pollutant as it passes from one trophic level to the next
- Small amount in environment → Large concentration at top of food chain

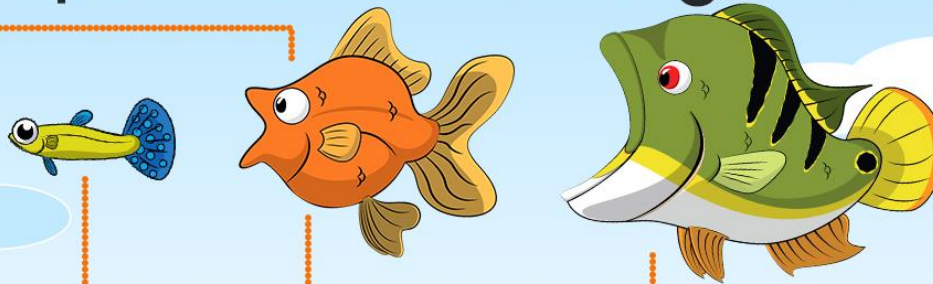


BIOACCUMULATION VS BIOMAGNIFICATION

Bioaccumulation

Buzzle.com

Increase in concentration of a pollutant in an organism.



Biomagnification

Increase in concentration of a pollutant in a food chain.

WHY SHOULD WE CARE?

- Because the two processes together mean that when we release even small amounts of pollutants into the environment, eventually they build-up in organisms to toxic dosages



WHERE DO POLLUTANTS COME FROM?

- Coal burning power plants
- Factories
- Farms, lawns, and gardens.

CHARACTERISTICS OF POLLUTANTS:

- In order for biomagnification to happen, substance must be:
 - Long lived (takes a long time to break down)
 - Soluble in fat (breakdown in fat)
 - Mobile (can move from organism to organism)
 - Biologically active (have an effect on the organism)

CHARACTERISTICS OF POLLUTANTS:

- Putting it into perspective:
 - Only some substances biomagnify
 - Most substances are water soluble and are excreted into the water
 - Many breakdown quickly
 - Many are not biologically active

POLLUTANTS THAT UNDERGO BIOMAGNIFICATION

- Mercury
- Persistent organic pollutants (POPs)

MERCURY

- Source: Emissions from coal-burning power plants, metal processing, medical and other waste
- Made bioavailable by bacteria
 - Inorganic mercury → Organic form of mercury that is biologically active

MERCURY

- Elementary Mercury (Hg)
- Methylmercury (CH_3Hg) – most toxic form
 - Form ingested by consuming fish
 - Concentrated in muscle tissue
 - More in older fish than younger fish
- Note – changed from Hg to this form by bacteria

IMPACTS OF WILDLIFE



- Loons – diet of fish
 - Decrease in chicks in areas of high mercury
 - Large concentration of mercury in eggs
- Great Egrets – study in Everglades indicates behavior of juveniles is affected
- Deformities in developing animals

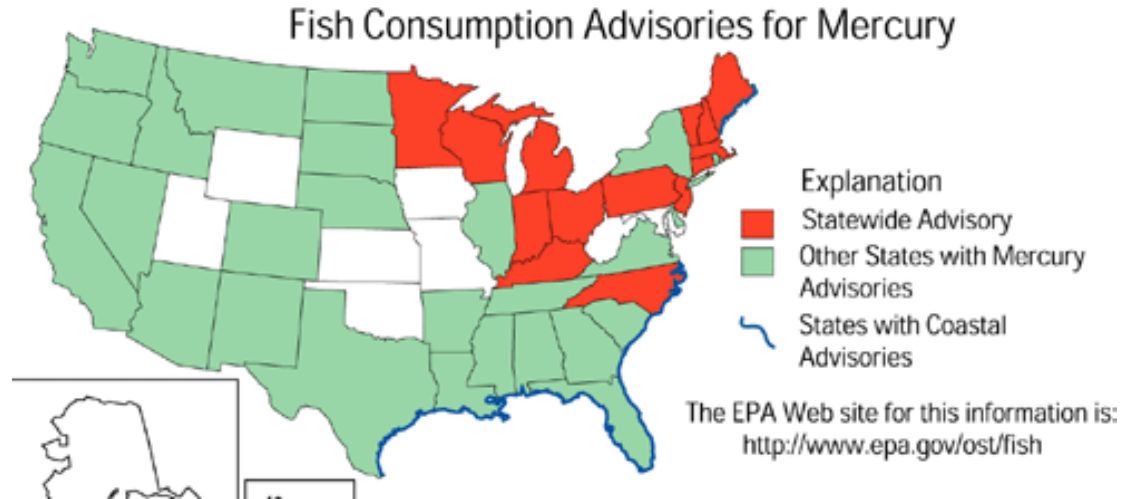


RISK TO PEOPLE

- Exposed by eating contaminated fish
- Pregnant women and children most at risk
 - 60,000 children born annually suffering from neurodevelopmental problems due to in utero exposure to mercury



FISH ADVISORIES



13 states have state wide advisories for fish from rivers and lakes

40 states have advisories on selected bodies of water

Parts of Eastern Coast and Gulf of Mexico have advisories

CONCERNED ABOUT THE FISH YOU EAT?

Recommendations per the FDA

- Avoid shark, swordfish, king mackerel and tilefish = all are high in Mercury
- 12 oz can be consumed a week of a variety of fish and shellfish that are lower in mercury.
- Fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.
 - Note, albacore tuna has more mercury than canned light tuna. You may eat up to 6 oz of it in a week.

ORIGINS OF THE TERM “MAD AS A HATTER”

$\text{Hg}(\text{NO}_3)_2$ Mercury is a compound that was used to soften fur in the making of felt hats.

The phrase “Mad as a Hatter”, and the Mad Hatter of Alice in Wonderland -- both refer to the toxic effect of mercury on the central nervous system of the hat makers, producing mental effects and "hatter's shakes".



MERCURY ACTIVITY!

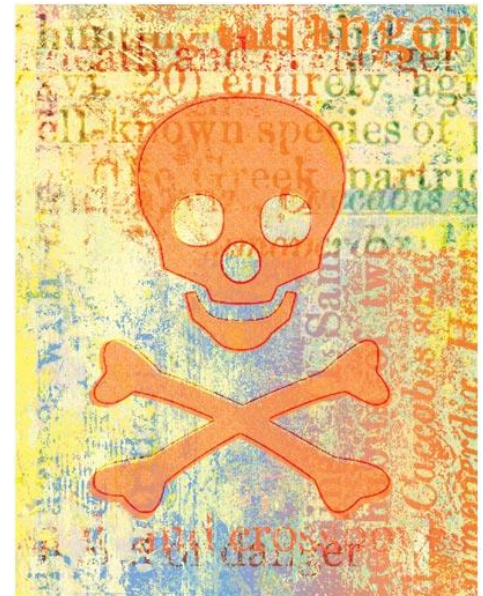


PERSISTENT ORGANIC POLLUTANTS (POPS)

- Also called organochlorines
- Synthetic organic chemicals that persist in the environment and biomagnify through the food web
- Poses a risk to human health and the environment
- Sources:
 - Pesticides, some plastics, paints, industrial chemicals, bleaching, burning garbage
- Examples: DDT, PCBs, dioxin

BAN ON POPS

- 1995 UN estimated 20,000+ substances with properties of POPs
- Stockholm Convention 2004, banned 12 worst
 - “The Dirty Dozen”
 - U.S. signed in 2001 but as of last year, Congress still has not ratified the change.



STOCKHOLM CONVENTION TREATY

The Dirty Dozen

1. DDT - pesticide
2. PCBs - Industrial
3. Dioxin - waste
4. Furans - waste
5. Aldrin - pesticide
6. Chlordane - pesticide
7. Dieldrin - pesticide
8. Endrin - pesticide
9. HCB – pest/ waste
10. Heptachlor - pesticide
11. Mirex - pesticide
12. Toxaphane - pesticide



EXPOSURE

Environmental exposure – many will stay in soil or water for decades

- Slow to breakdown

Humans consume toxins via fish, meat and dairy

DDT (DICHLORO-DIPHENYL-TRICHLOROETHANE)

- Insecticide used to control malaria and typhus by killing mosquitoes and lice.
- Commonly used after WWII
 - Inventor received Noble Prize
- Overused on crops as a pesticide



U.S. Department of Agriculture

In World War II, troops and refugees were dusted with DDT powder to kill the lice that carried typhus.



DDT PROBLEMS

- Eggshell thinning
- DDT interferes with metabolism of calcium
- Result - thin shells in predator birds such as osprey, bald eagles, brown pelicans
- Birds unable to brood (aka sit on) their eggs without breaking them



DDT PROBLEMS (CONT'D)

- Feminization
 - Acts as a hormone disrupter, mimics estrogen
 - Has impacted sex ratio in some birds

DDT - IT'S A LONG TERM PROBLEM

It has a half life of 15 year;
it takes 15yrs for its quantity
to be $\frac{1}{2}$ its original

Ex. If we start with 100 kg,
we will still have ~ 1 kg
after 100 yrs

Year	Amount Remaining
0	100 kg
15	50 kg
30	25 kg
45	12.5 kg
60	6.25 kg
75	3.13 kg
90	1.56 kg
105	0.78 kg

DDT CURRENT USE

- Banned in US in 1972
- Still used overseas to prevent malaria
 - Estimated it save millions of lives annually in Africa

POPS ARE EVERYWHERE!

Even Polar Bears have POPs in their system

- Top predator
- All toxins in prey is transferred to them, stored in fat

Concentration increases 5 – 10x each trophic level



HEALTH IMPACT OF POPS

- Some cause cancer, damage nervous system
- Some act like hormones (estrogens) leads to:
 - Developmental changes, birth defects
 - Reproductive and Behavioral problems
- Toxins can be passed to young

SOLUTIONS TO TOXIC POLLUTION

- Worst ones are banned or no longer used in U.S.
- Still need to eliminate/reduce the processes that create toxins (i.e. burning coal)

POPS ACTIVITY

