Ecotoxicology

Ecotoxicological studies explore the mechanisms and processes whereby the environmental chemicals exert their effects on ecosystems and their impact on the populations and communities.

Ecotoxicological concepts and applications

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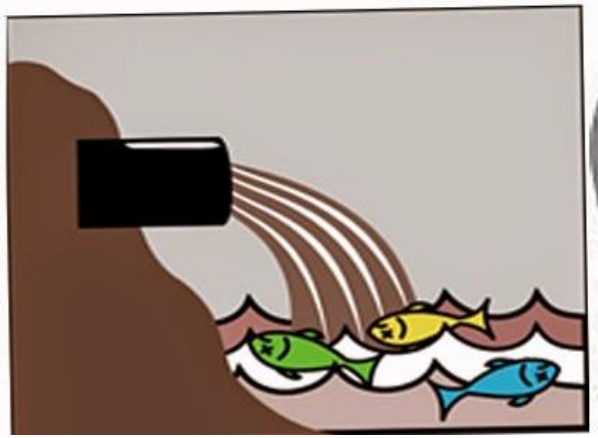
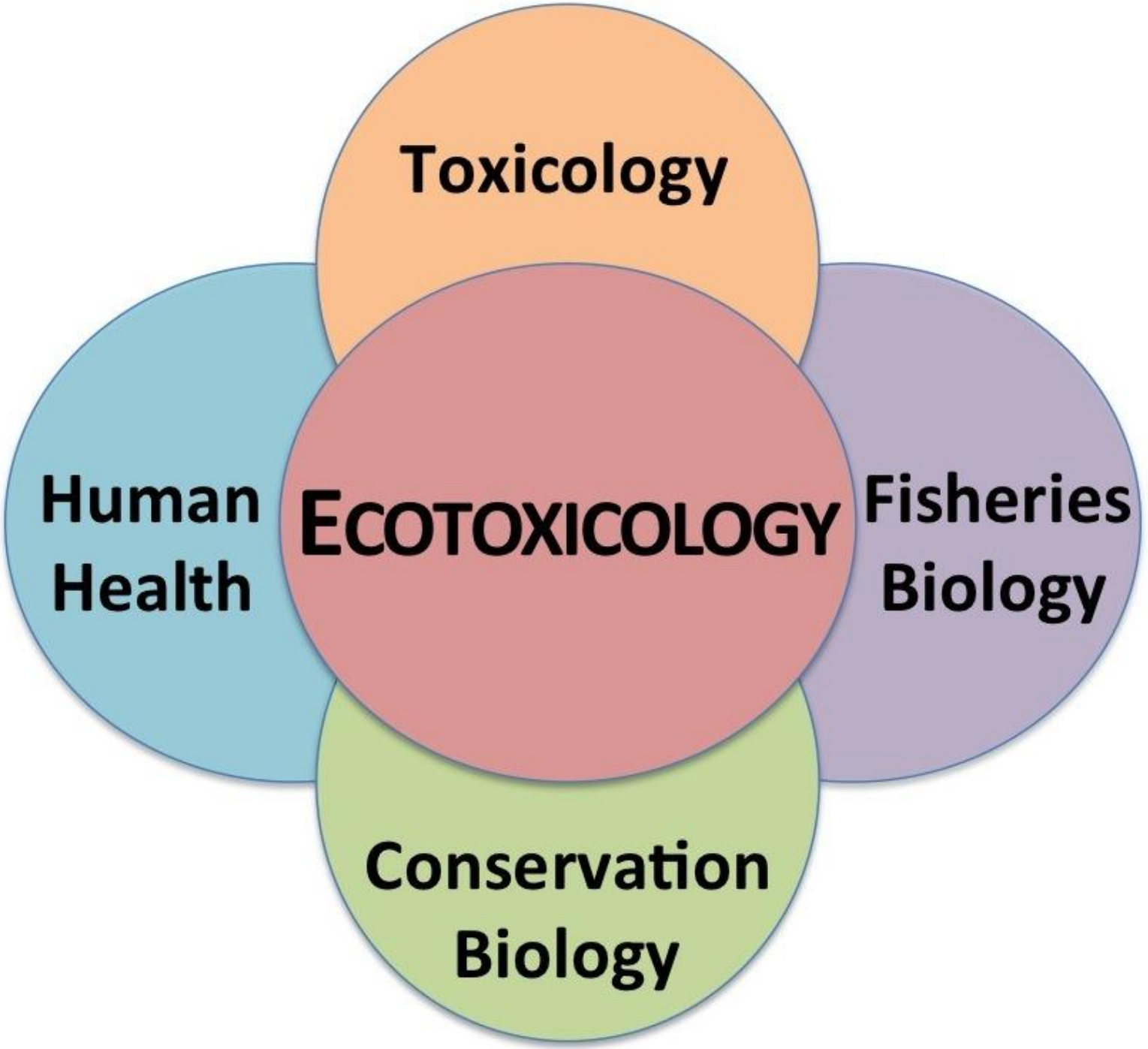


Definition of Ecotoxicology

- **The study of the ecological consequences of polluting the environment with various substances and radiation, released by human activity.**


Toxicology
Human Health
ECOTOXICOLOGY
Fisheries Biology
Conservation Biology

Human Activities

Human activities affect ecosystems by:

1) polluting them with substances that do not occur there naturally

or

2) by significantly increasing concentrations of substances already present.

Contaminant

- “an agent that causes changes in the physical, chemical or biological properties of an environment or an organism”

4 main classes of contaminants:

- Inorganic
- Organic
- Microbial
- Radioactive

Class of Contaminant	Examples
Inorganic	Lead _____ Arsenic Mercury _____ Nitrogen Oxides _____ Phosphorus _____
Organic	Insecticides Pesticides Polychlorinated biphenyls _____ Benzene
Microbial	Viruses and harmful bacteria
Radioactive	Uranium _____ Plutonium _____ Radon _____

Toxicity

When a contaminant effectively harms an organism it is toxic!!!

Toxicity depends on:

- Concentration
- The type of organism it comes in contact with
- Length of exposure

Concentration

- The higher the concentration the greater the risk.

  e.g. ≥ 0.01 ppm or 0.01 mg/L lead in water

Type of Organism

- Certain contaminants are toxic to some organisms and not others.

  e.g. an herbicide toxic to broad-leaved weeds

  e.g. chocolate or raisins for dogs

Length of Exposure

- The longer an organism is in contact with the contaminant the worse the effects.

  e.g. cigarette smoke and lung cancer

Toxicity Threshold

- “the minimum concentration of a substance that produces a significant harmful effect in an organism (mg/kg of the organism’s mass)”

Toxicity Threshold

- The WHO (World Health Organization) has set the average toxicity threshold of sulfur dioxide gas _____ for plants at ≥ 30 ug/m^3 of air.
- There can be many different effects on human health e.g. red patches or vomiting.
- Scientists determine limits called Lethal Doses.

Lethal Doses

- From the Latin letalis = deadly!

- the amount of contaminant necessary in a single dose to cause the death of the organism

Lethal Doses

- Within a species, some individuals have a higher resistance to a contaminant.
- Lethal Dose 50 = LD_{50}
- LD_{50} is the dose that causes death among 50 % of individuals.

Bioaccumulation or Bioconcentration of Contaminants

- Many contaminants that result from human activities resist natural degradation and can pollute ecosystems for years.

Bioaccumulation

- Toxins can mix with water and then are ingested.
- Heavy metal, PCBs (substances with insulating properties) and DDT (a powerful insecticide) cannot be eliminated.
- Accumulation in the tissues of living organisms is called bioaccumulation
- “the process by which a contaminant from the environment or food supply accumulates in an organism”

Bioconcentration:

- A special case of bioaccumulation that occurs in water

- “a special case of bioaccumulation by which an organism accumulates a contaminant through direct contact with its environment specifically a water environment”

Bioamplification/Biomagnification

- The phenomenon by which the concentration of a contaminant in the tissues of living organisms tends to increase with each trophic level i.e. as you go up a food chain.
- To amplify or to magnify is to make bigger
- Humans are no exception—the top of the food chain means more contamination

Biotechnology to the Rescue

- Environmental problems are due to the discharge of contaminants from industry, cars and household waste.
- It is difficult to remove contaminated earth and water from a polluted site.
- Living organisms can be used to either limit discharge or to break it down.

Decontaminating Soil through Pollutant Biodegradation

Biodegradation

- The breaking down of organic matter into inorganic matter by microorganisms
- Various types of bacteria and microscopic fungi can live in highly toxic environments and feed on contaminants and degrade them
- The transformation of pollutants into harmless matter is called bio-remediation

Bioremediation

- a biotechnology for cleaning up a polluted site, using microorganisms that **decompose** contaminants

Phytoremediation

A biotechnology that uses plants or algae to eliminate contaminants from a site

- e.g. cabbages are grown to remove heavy metals from soil

Phytoremediation

- Plants can decontaminate too
- Plants absorb the contaminants then the plants are harvested
- Contaminants are recovered and destroyed
- The **cabbages do not degrade** the metals

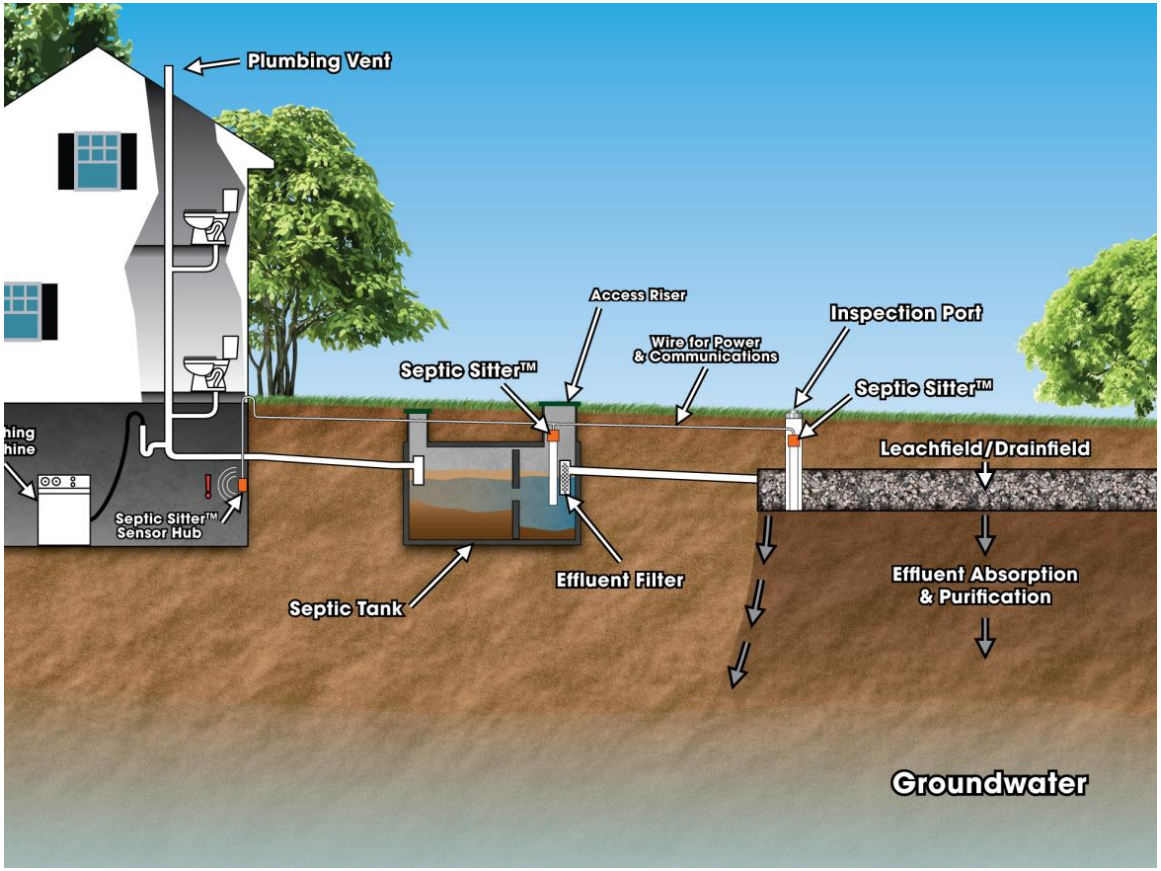
Wastewater Treatment

- There are treatment methods to limit the discharge of pollutants

- Wastewater is water that is discharged after household or industrial use and that is polluted as a result of human activities.

Waste Water Contaminants

- Sand and suspended particles
- Pathogens (microorganisms that cause disease)
- Decomposing organic waste
- Nutrients that stimulate the excessive growth of algae, cyanobacteria and aquatic plants



Septic Tanks

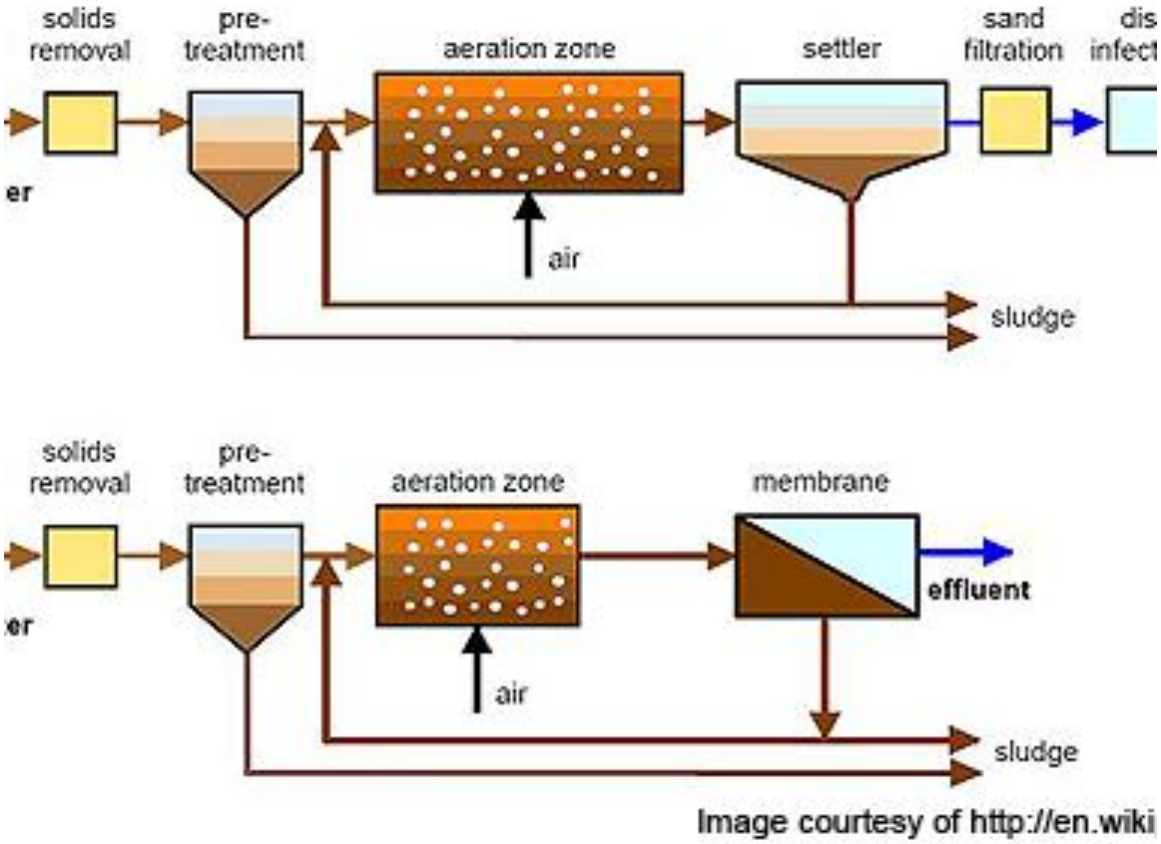
Found in areas that do not have sewage pipes e.g. Baie D'Urfe

Septic Tanks

- Wastewater is drained into a container
- Solid waste settles at the bottom = sludge
- Collect the sludge and treat it
- Liquid part drains out of tank into surrounding land i.e. Drainage field
- Can use microorganisms to treat the liquids in the water or the soil

Wastewater Treatment Plants

- Expensive to build
- Usually in urban areas
- Where sewer systems exist



Waste Water Treatment Plants

3 Major Processes of Waste Water Treatment

1)Primary or Physical Treatment

Involves sedimentation of solid waste within the **water**. This is done after filtering out larger contaminants within the **water**. Wastewater is passed through several tanks and filters that separate **water** from contaminants

2) Secondary or Biological Treatment

Removes dissolved and suspended biological matter

3) Disinfection

Chemically or physically

https://www.youtube.com/watch?v=i9L45sC20qk

Primary Treatment

During primary treatment, wastewater is temporarily held in a settling tank where heavier solids sink to the bottom while lighter solids float to the surface.
Once settled, these materials are held back while the remaining liquid is discharged or moved through to the more rigorous secondary phase of wastewater treatment.
These large tanks are also often equipped with mechanical scrapers that continually drive collected sludge in the base of the tank to a hopper which pumps it to sludge treatment facilities.

Secondary Treatment

Secondary treatment of wastewater works on a deeper level than primary and is designed to substantially degrade the biological content of the waste through aerobic biological processes. It is done in one of three ways:

Biofiltration

Biofiltration uses sand filters, contact filters or trickling filters to ensure that any additional sediment is removed from the wastewater.

Aeration

Aeration is a lengthy process which increases oxygen saturation by introducing air to wastewater. Typically, the aeration process can last for up to 30 hours, but it is very effective.

Oxidation ponds

Typically used in warmer climates, this method utilises natural bodies of water such as lagoons, allowing wastewater to pass through for a set period before being retained for two to three weeks.

Completing secondary wastewater treatment allows for safer release into the local environment, reducing common biodegradable contaminants down to safe levels.

Ternary Treatment

The aim of tertiary wastewater treatment is to raise the quality of the water to domestic and industrial standards, or to meet specific requirements around the safe discharge of water. In the case of water treated by municipalities, tertiary treatment also involves the removal of pathogens, which ensures that water is safe for drinking purposes.