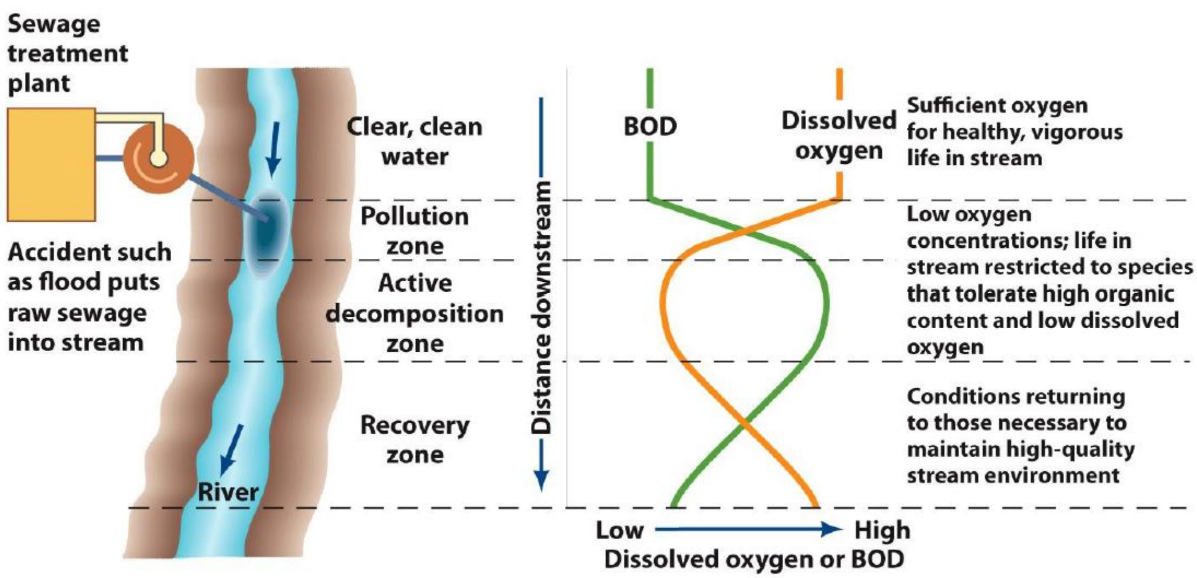
Chlorofluorocarbons

Chlorofluorocarbons (CFCs) are inert, stable compounds that have been used in spray cans as aerosol propellants and in refrigerators. The rate of increase of CFCs in the atmosphere in the recent past was about 5% per year, and it has been estimated that approximately 15% to 25% of the anthropogenic greenhouse effect may be related to CFCs.

Because they affect the stratospheric ozone layer and also play a role in the greenhouse effect, the United States banned their use as propellants in 1978. In 1987, 24 countries signed the Montreal Protocol to reduce and eventually eliminate production of CFCs and accelerate the development of alternative chemicals.

Potential global warming from CFCs is considerable because each CFC molecule may absorb hundreds or even thousands of times more infrared radiation emitted from the surface than is absorbed by a molecule of carbon dioxide. Furthermore, because CFCs are highly stable, their residence time in the atmosphere is long. Even though their production was drastically reduced, their concentrations in the atmosphere will remain significant

The relationship between dissolved oxygen and biochemical oxygen demand (BOD) for a stream after the input of sewage.



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Carbon 14 and sunspots

- Radioactive carbon 14 (14C) is produced in the upper atmosphere by the collision of cosmic rays and nitrogen 14 (14N).
- Cosmic rays come from outer space; those the Earth receives are predominantly from the sun.
- The abundance of cosmic rays varies with the number of sunspots, so-called because they appear as dark areas on the sun.
- As sunspot activity increases, more energy from the sun reaches Earth. There is an associated solar wind, which produces ionized particles consisting mostly of protons and electrons, emanating from the sun.
- The radioactive 14C is taken up by photosynthetic organisms—green plants, algae, and some bacteria—and stored in them.
- The record of 14C in the atmosphere has been correlated with tree ring chronology. Each ring of wood of known age contains carbon, and the amount of 14C can be measured.

Acid Rain's Effects on Forest Ecosystems

Studies in Germany led scientists to cite acid rain and other air pollution as the cause of death for thousands of acres of evergreen trees in Bavaria

Appalachian Mountains of Vermont (where many soils are naturally acidic) suggest that in some locations half the red spruce trees have died in past years

The acid rain does not directly kill trees; rather, it weakens them as essential nutrients are leached from soils or stripped from leaves by acid fog. Acidic rainfall also may release toxic chemicals, such as aluminum, that damage trees

Acid Mine Drainage

- Refers to water with high concentration of **sulfuric acid** that drains from mines
- Coal mines— **pyrite** (iron sulfide), (Cu, Z & Pb)
  - When pyrite comes into contact with oxygen and water it creates sulfuric acid
- Water runs through the **mine tailings**
  - This acidic water then runs off into natural waterways or the groundwater
- In addition, pyrite is associated with **metallic sulfide deposits**, which, when **weathered** (worn by long exposure to the atmosphere), also produce sulfuric acid.
- The acid is produced when surface water or shallow (little depth) groundwater runs through or moves into and out of mines or tailings

Acid Mine Drainage

If the **acidic water runs off to a natural stream**, pond, or lake, significant pollution and ecological damage may result.

The acidic water is **toxic** to the plants and animals of an aquatic ecosystem; it damages biological productivity, and fish and other aquatic life may die.

Acidic water can also **seep** into and pollute groundwater.

Even abandoned mines can cause serious problems.

$$4\ FeS_2 + 15\ O_2 + 14\ H_2O \rightarrow 4\ Fe\ (OH)_3\ 8\ H_2SO_4$$

Pyrite + Oxygen + Water → Ferric Hydroxide + Sulfuric Acid

Ultraviolet Radiation and Ozone
UVA, UVB & UVC -0.1 and 0.4 µm

The ozone layer in the stratosphere is often called the **ozone shield** because it absorbs most of the potentially hazardous ultraviolet radiation that enters Earth's atmosphere from the sun.

Ultraviolet radiation with a wavelength of less than about 0.3 µm can be very hazardous to life.

Ultraviolet C (UVC) has the ***shortest wavelength*** and is the ***most energetic*** of the three types.

It has enough energy to break down diatomic oxygen (O_2) in the stratosphere into two oxygen atoms, each of which may **combine with an O_2 molecule** to create ozone.

Ultraviolet C is strongly absorbed in the stratosphere, and negligible amounts reach Earth's surface.

Ultraviolet A (UVA) radiation has the longest wavelength and ***the least energy*** of the three types.

UVA can cause some damage to living cells, ***is not affected by stratospheric ozone***, and is transmitted to the surface of Earth.

Ultraviolet B (UVB) radiation is ***energetic and strongly absorbed*** by stratospheric ozone. **In fact, ozone is the only known gas that absorbs UVB**.

Thus, depletion of ozone in the stratosphere allows more UVB to reach the Earth.

Because UVB radiation is known to be hazardous to living things, this increase in UVB is the hazard we are talking about when we discuss the problem of ozone depletion in the stratosphere