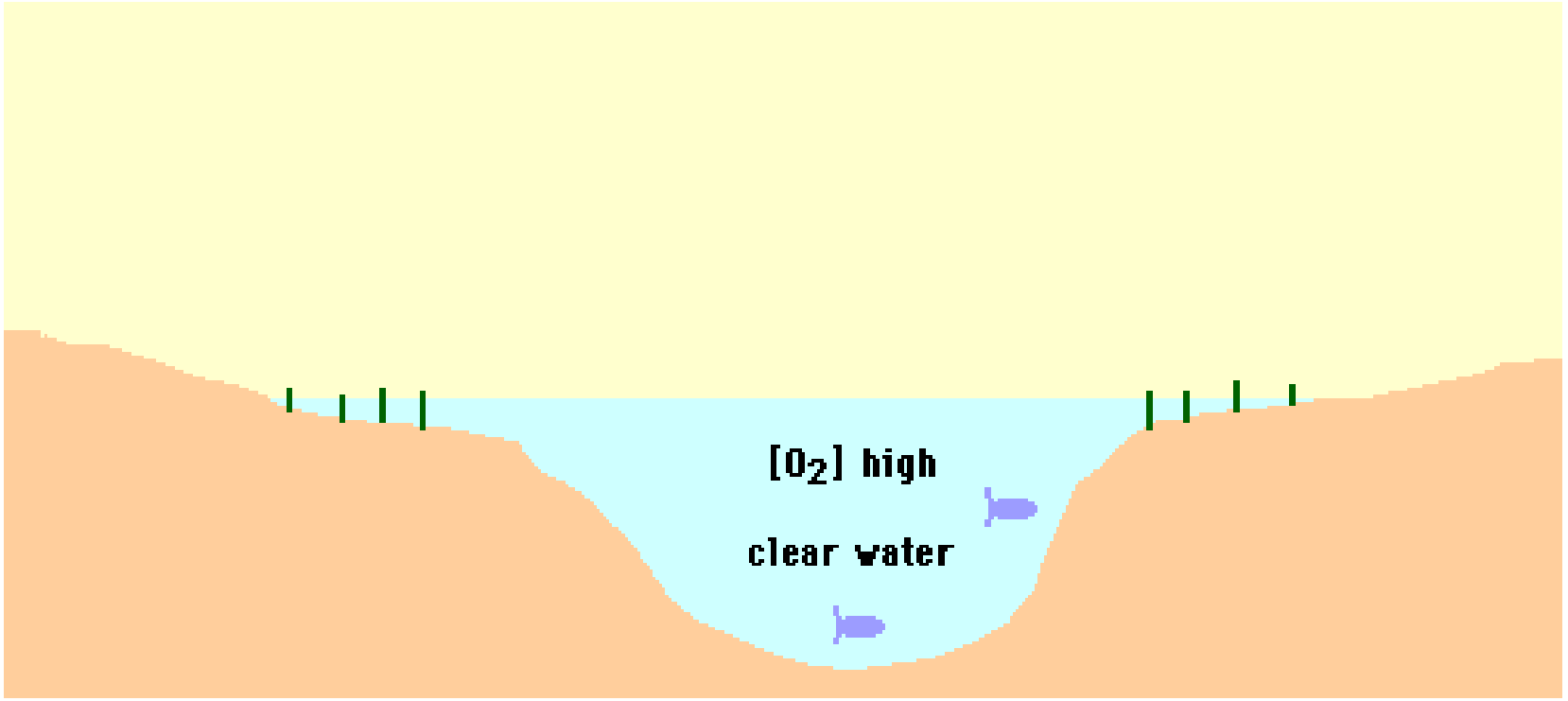

EUTROPHICATION

- **Eutrophication** (Greek: *eutrophia* – healthy, adequate nutrition, development; German: *Eutrophie*) or more precisely **hypertrophication**, is the ecosystem response to the addition of artificial or natural substances,mainly phosphates,through detergents, fertilizers, or sewage, to an aquatic system. One example is the "bloom" or great increase of phytoplankton in a water body as a response to increased levels of nutrients. Negative environmental effects include hypoxia, the depletion of oxygen in the water, which may cause death to aquatic animals.

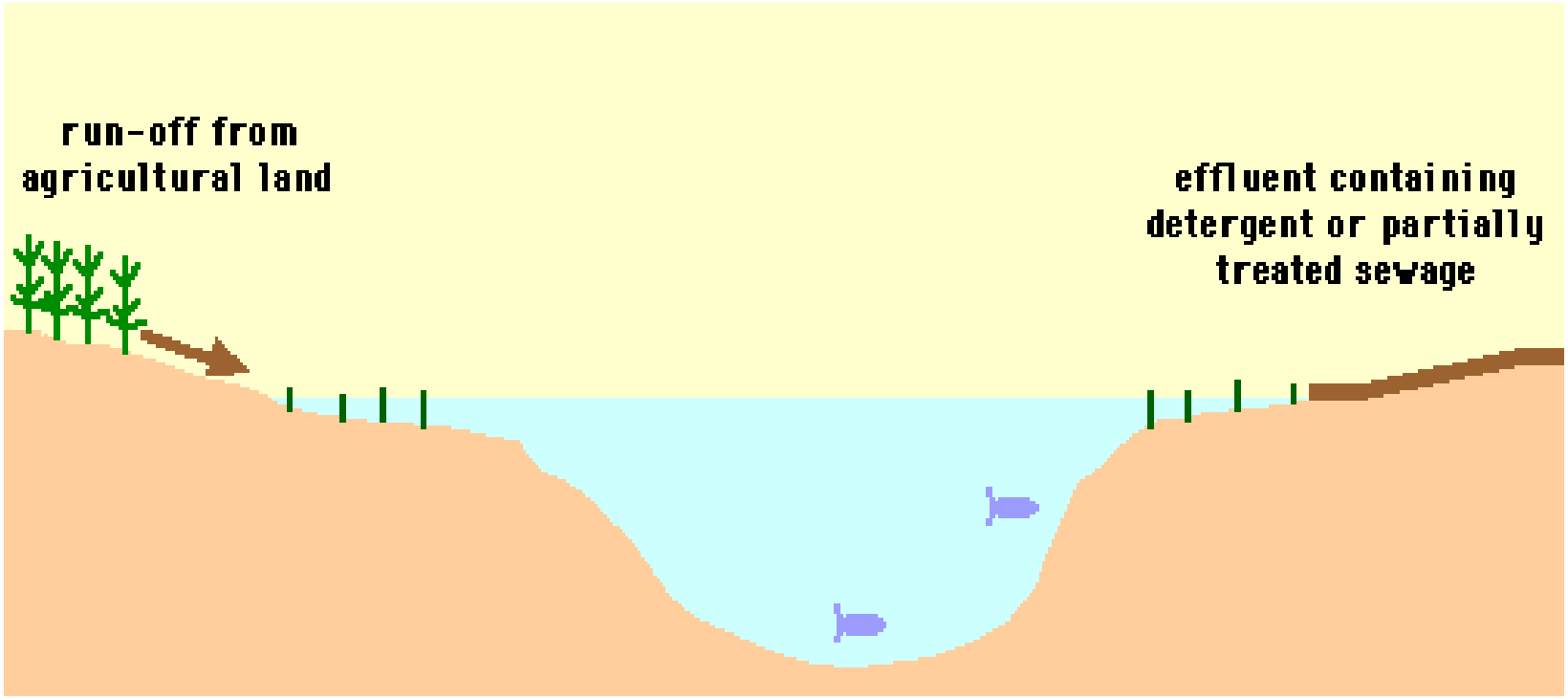
- “Eutrophication - an increase in the rate of supply of organic matter to an ecosystem.
- Scott Nixon (1995)”
- Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess **nutrients** that stimulate excessive plant growth (algae, periphyton attached algae, and plants weeds).
- This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die

- Nutrients can come from many sources, such as fertilizers applied to agricultural fields, golf courses, and suburban lawns; deposition of nitrogen from the atmosphere; erosion of soil containing nutrients; and sewage treatment plant discharges.

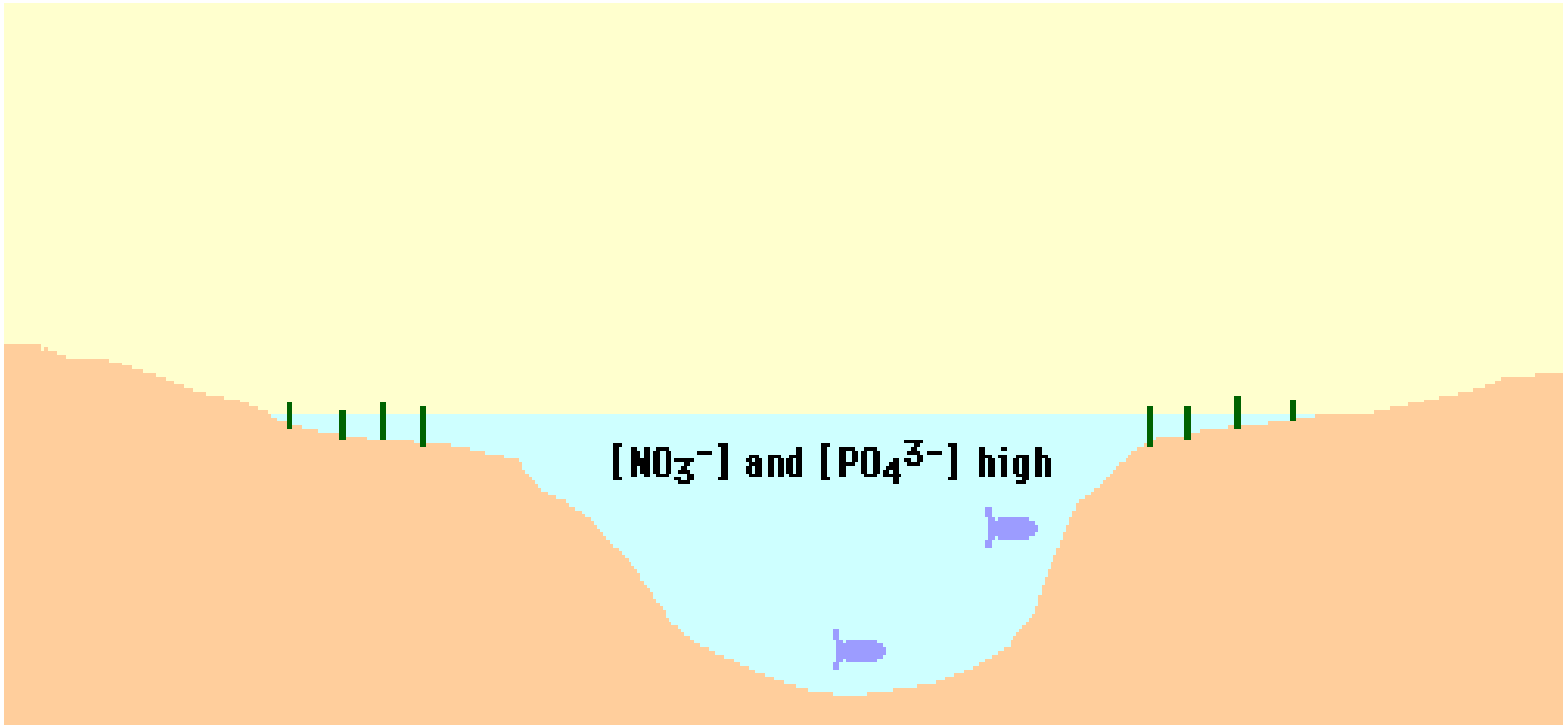
STEP BY STEP EUTROPHICATION PROCESS



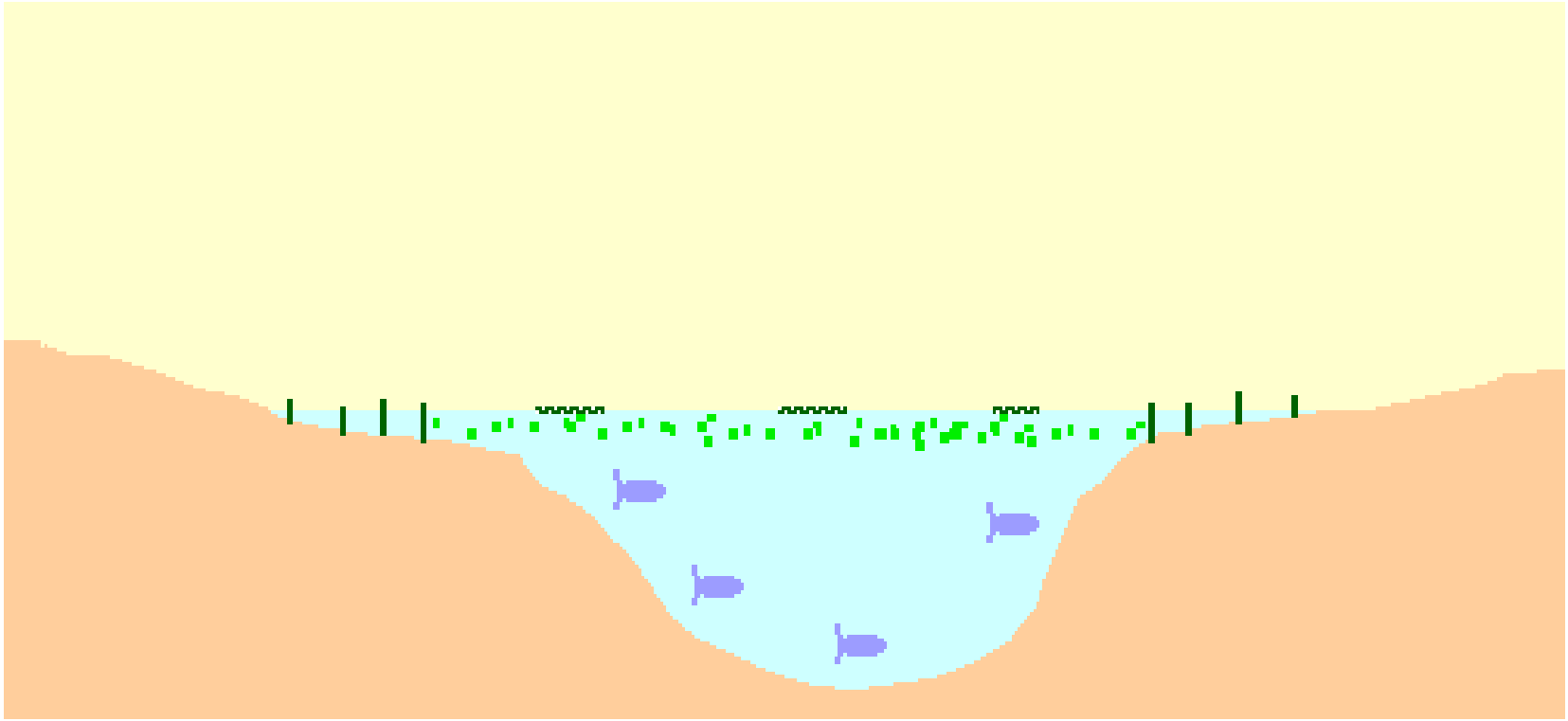
Oligotrophic lake with a low level of nutrients.



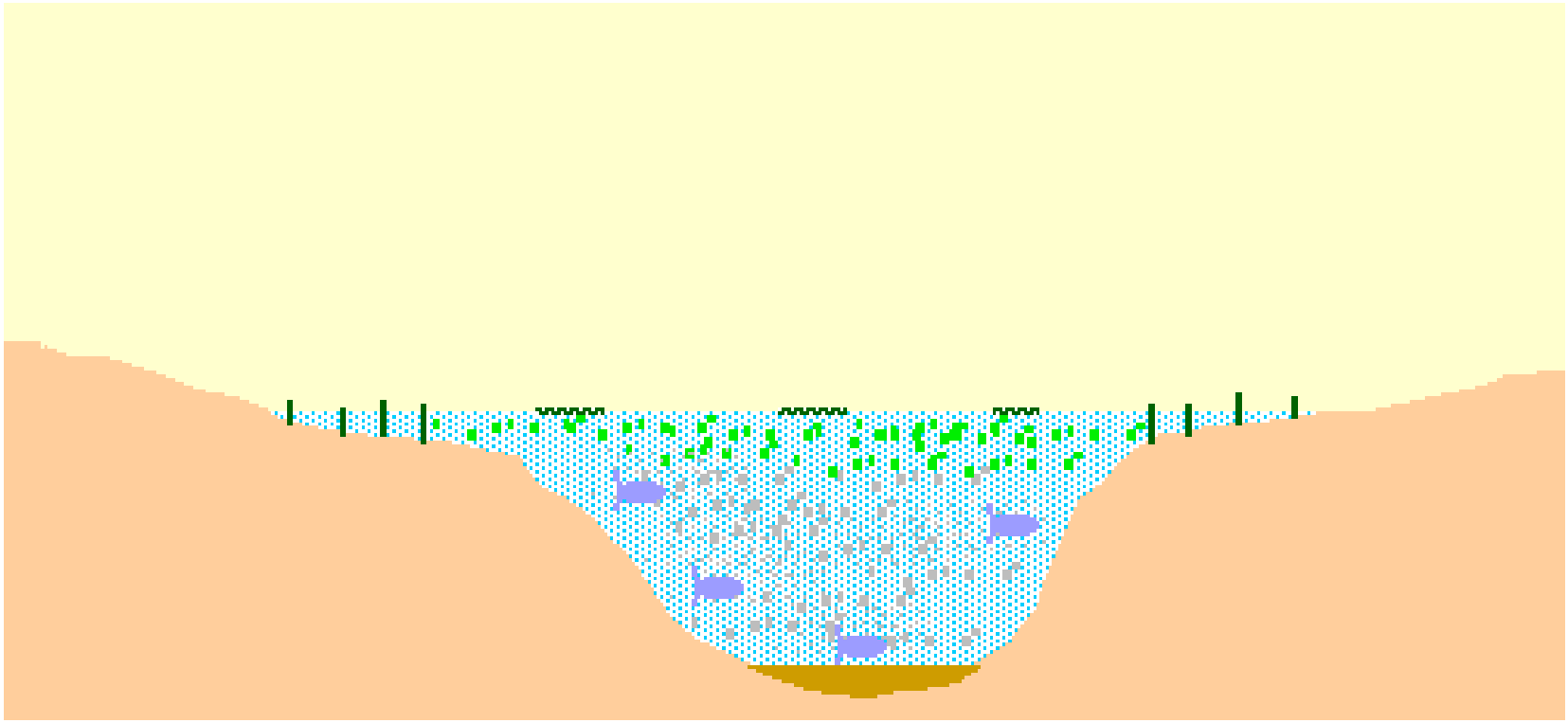
Artificial input of nutrients from run-off and discharge of effluent.



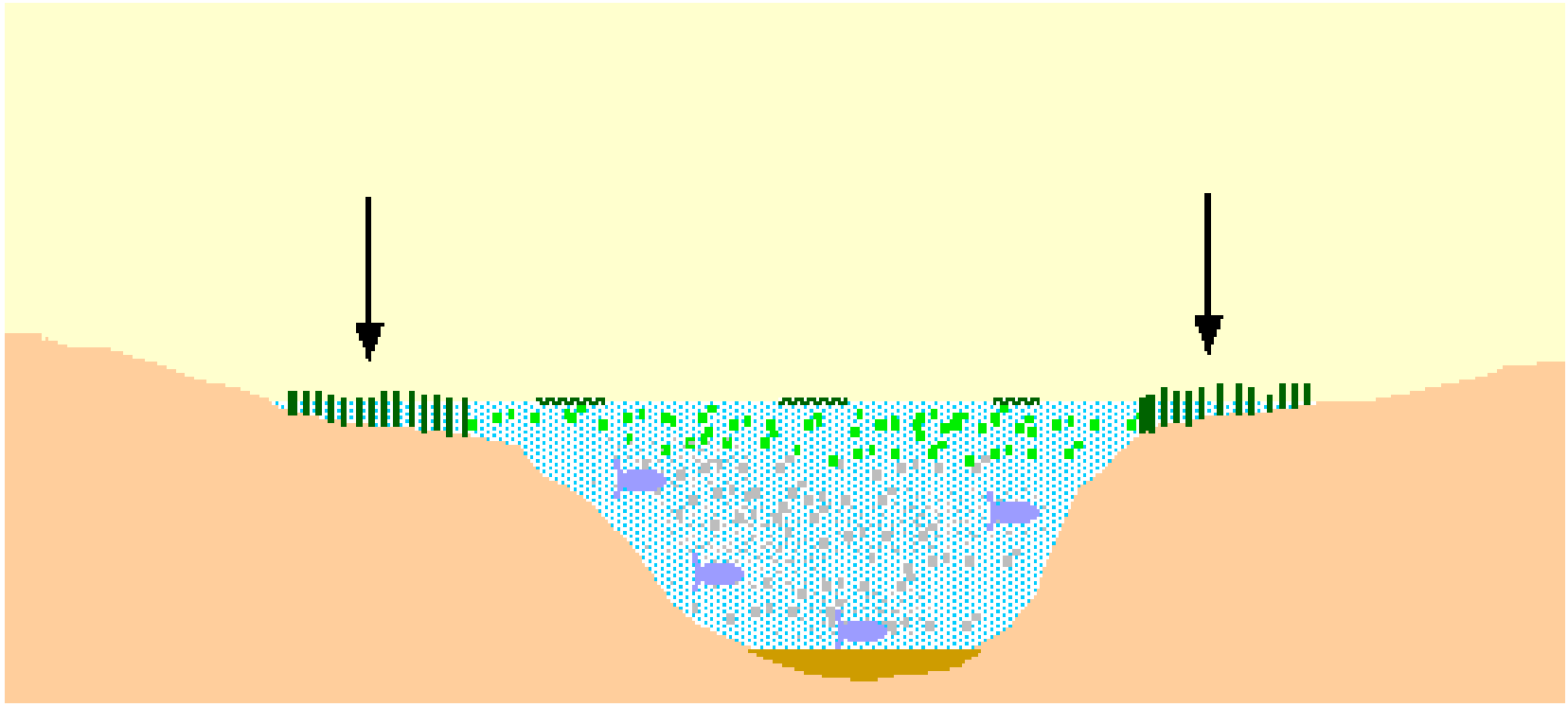
Eutrophic lake with a high level of nutrients. Phosphorus is usually the



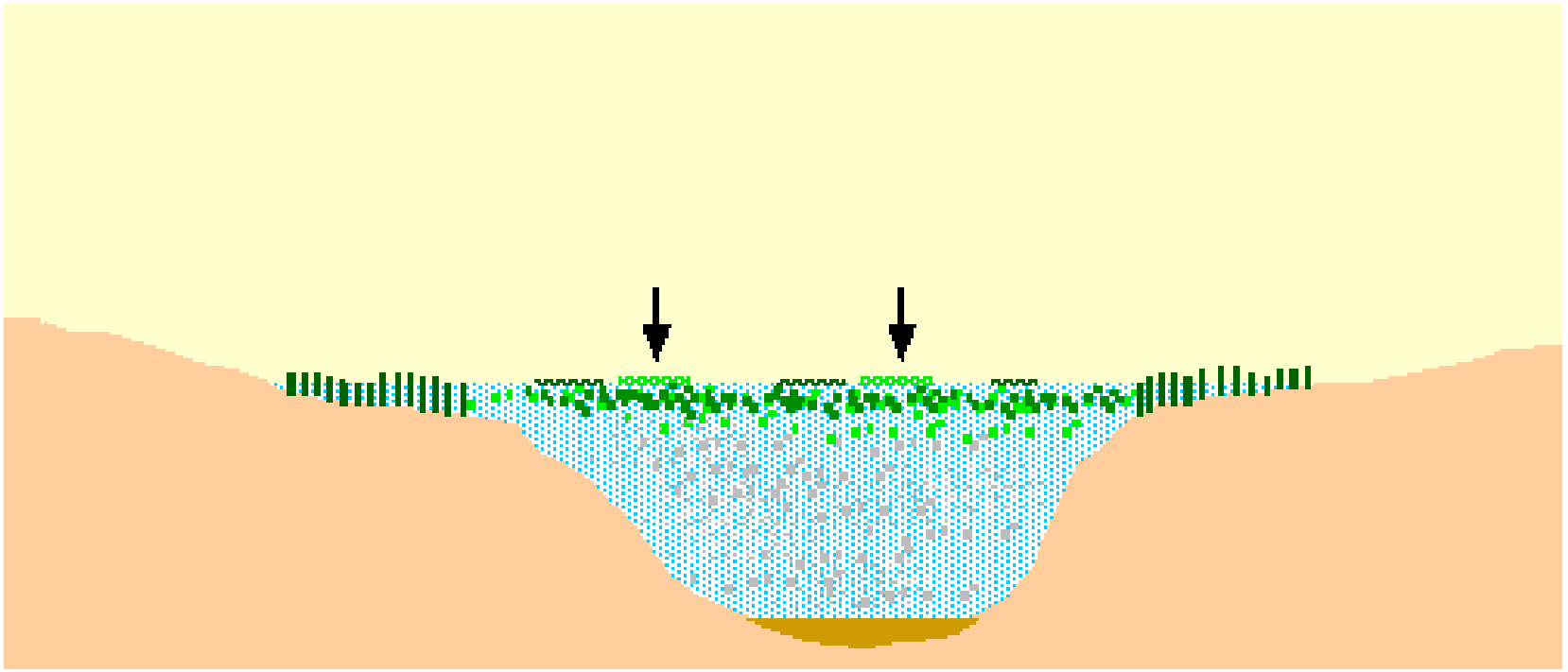
Rapid growth of algae and other biomass resulting in a decrease in the concentration of dissolved oxygen.



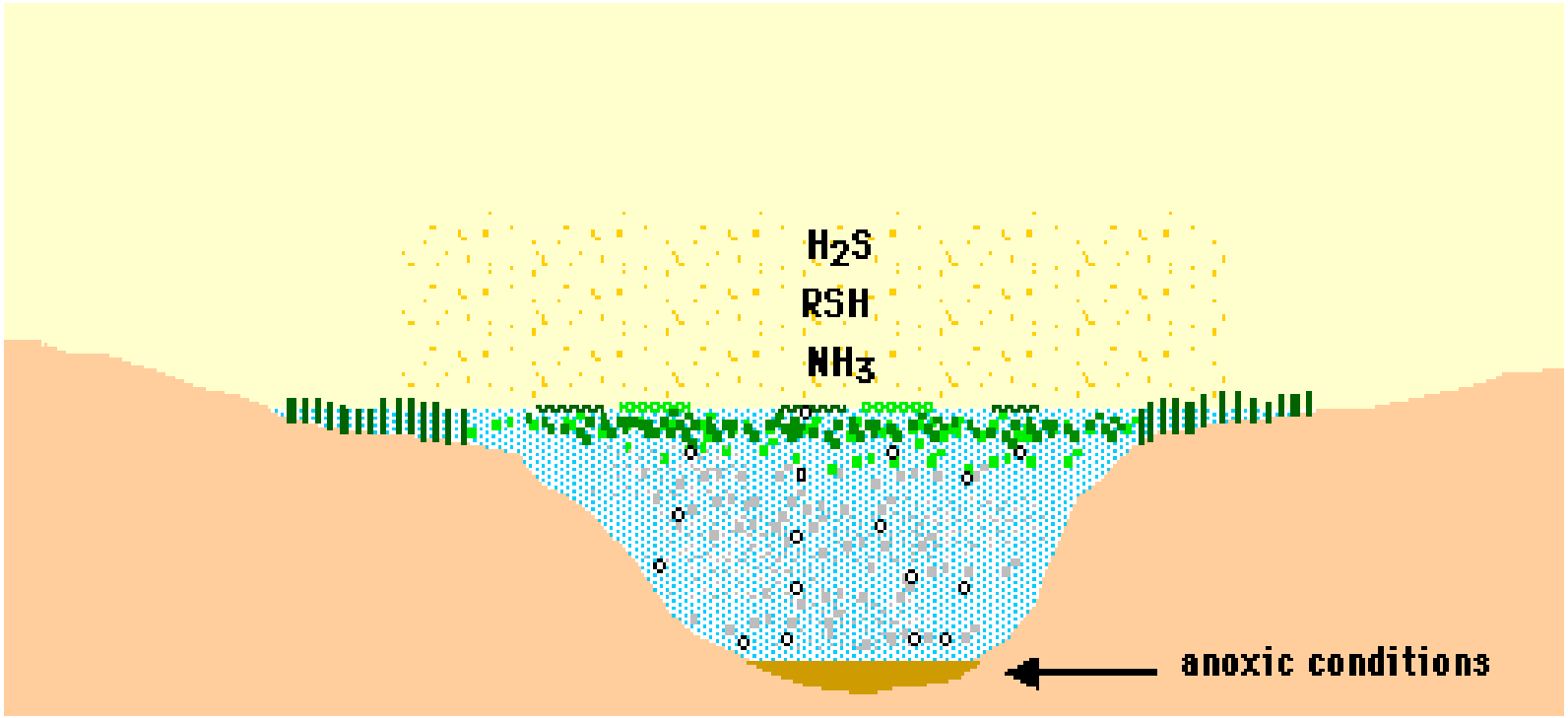
Turbidity (cloudiness) of water increases as does rate of sedimentation.



Increased growth of rooted plants such as reeds.



Algal blooms during the Summer months. Note that dissolved oxygen levels are at their lowest at night when plants respire rather than photosynthesis.



Development of anoxic conditions and release of noxious gases such as hydrogen sulphide, thioalcohols and ammonia.

EUTROPHICATION TYPES

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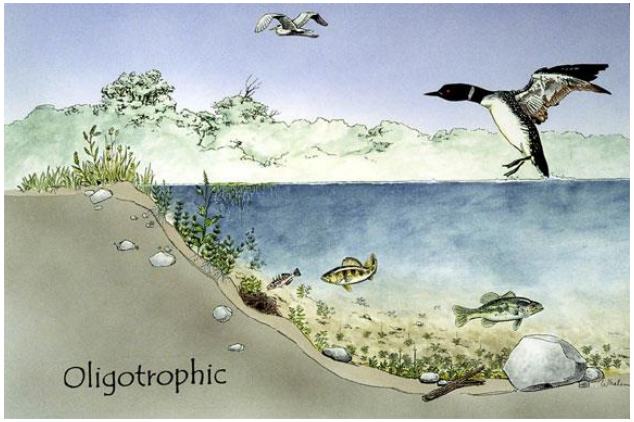
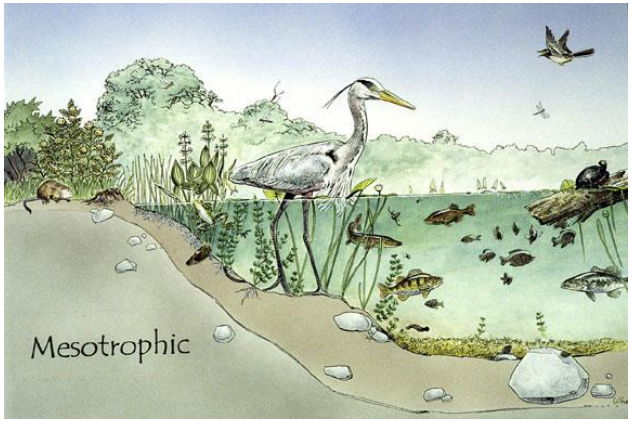
- Natural Eutrophication -- a process that occurs as a lake or river ages over a period of hundreds or thousands of years.
- Cultural Eutrophication -- a process that occurs when humans release excessive amounts of nutrients; it shortens the rate of aging to decades.

Natural Eutrophication

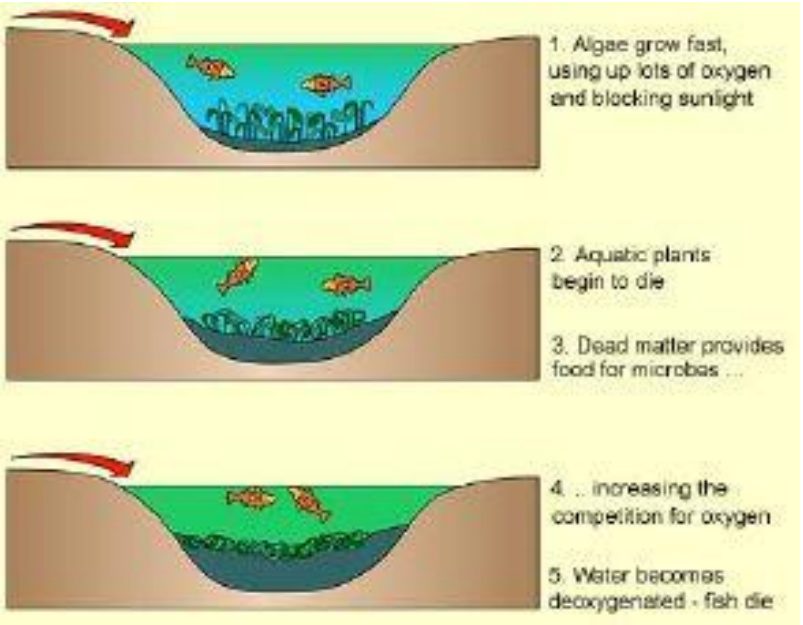




Lake classification based on nutrient content and production of organic matter. Oligo- nutrient poor; meso- middle nutrient; eu- nutrient rich.

Cultural Eutrophication

- The addition of excess nutrients from a variety of sources results in the rapid aging of aquatic ecosystems.
- During this process the species composition of the aquatic community changes.



When lakes, streams and estuaries are over fertilized, excessive production of aquatic organic matter can become a water quality problem and as a result the eutrophication process can be enhanced!

Before Eutrophication

After Eutrophication

– Sources of Eutrophication

Point sources are directly attributable to one influence. In point sources the nutrient waste travels directly from source to water. Point sources are relatively easy to regulate.

– Sources of Eutrophication

Nonpoint source pollution (also known as 'diffuse' or 'runoff' pollution) is that which comes from ill-defined and diffuse sources. Nonpoint sources are difficult to regulate and usually vary spatially and temporally (with season, precipitation, and other irregular events).
It has been shown that nitrogen transport is correlated with various indices of human activity in watersheds, including the amount of development. Ploughing in agriculture and development are activities that contribute most to nutrient loading.

SOURCES- point & non point

- Point Sources

❖*Waste water effluent (municipal and industrial)*
❖*Runoff and leachate from waste disposal systems*
❖*Runoff and infiltration from animal feedlots*
❖*Runoff from mines, oil fields, unsewered industrial sites*
❖*Overflows of combined storm and sanitary sewers. Runoff from construction sites less than 20000 sq. mtr.*
❖ *Untreated Sewage*

- Non-point Sources

❖*Runoff from agriculture/irrigation*
❖*Runoff from pasture and range*
❖*Urban runoff from unsewered areas*
❖*Septic tank leachate*
❖*Runoff from construction sites> 20000 sq. mtrs*
❖*Runoff from abandoned mines*
❖*Atmospheric deposition over a water surface*
❖*Other land activities generating contaminants.*

EUTROPHICATION SOURCES

– Major Sources of Eutrophication

- Major sources of excess nutrients are agricultural fertilizers, domestic sewage and livestock wastes.
- Agricultural fertilizers provide inorganic nutrients.
- Sewage and wastes provide both inorganic and organic nutrients.

Eutrophication is a natural process!

However, humans in their everyday activities can exacerbate the process:

Point sources (can locate the cause)

- Sewage treatment plant discharges
- Storm sewer discharges
- Industrial discharges

Non-point sources (can't locate the cause, it's everywhere)

- Atmospheric deposition
- Agricultural runoff (fertilizer, soil erosion)
- Septic systems

Eutrophication process in 6 stages

ADDITION OF NITRATES

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GROWTH OF PLANTS

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DEATH OF PLANTS

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GROWTH OF BACTERIA

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LACK OF OXYGEN

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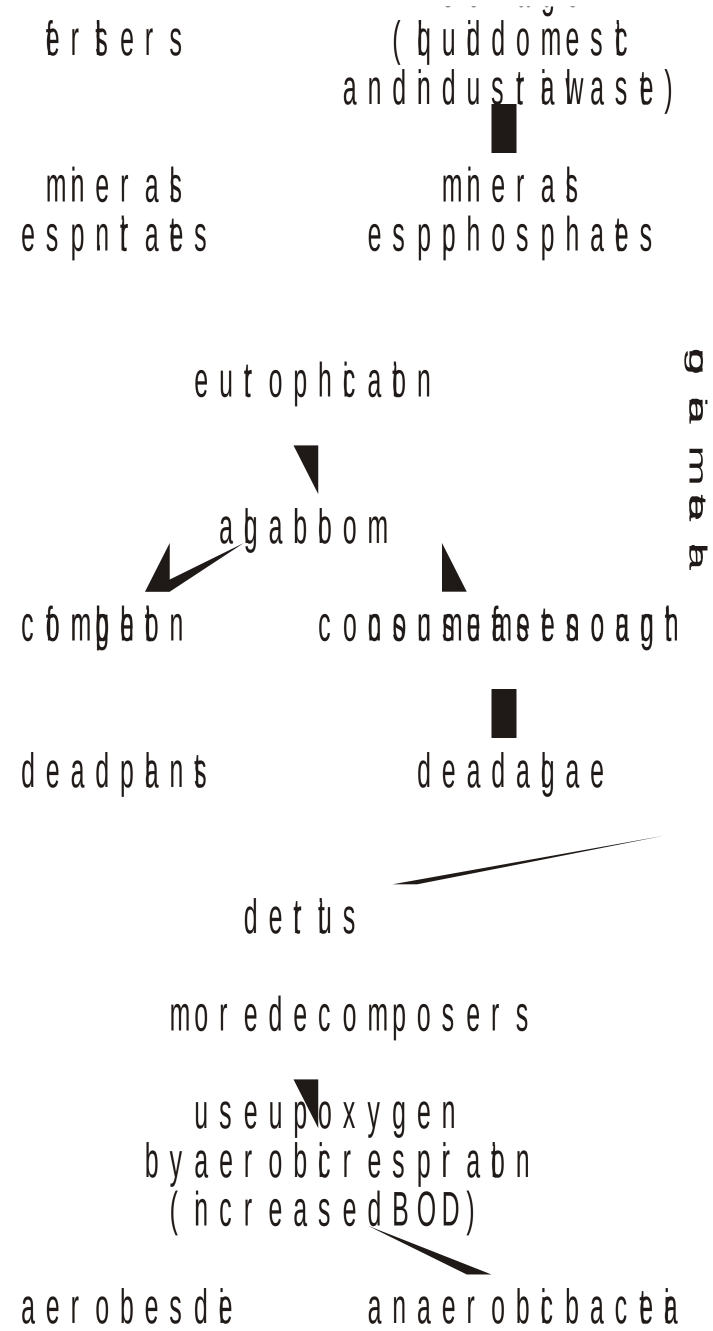
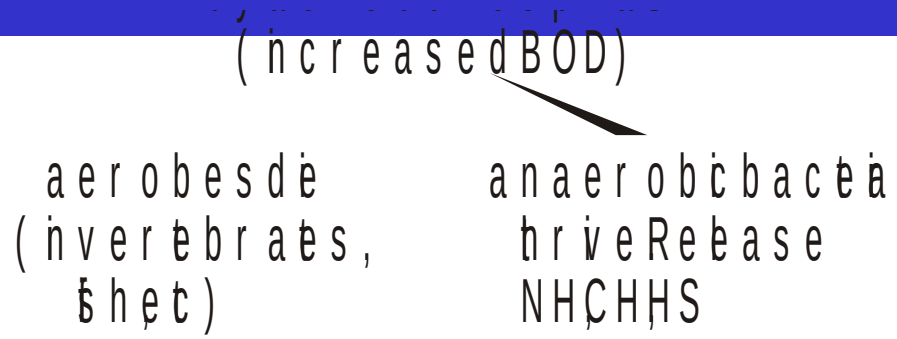
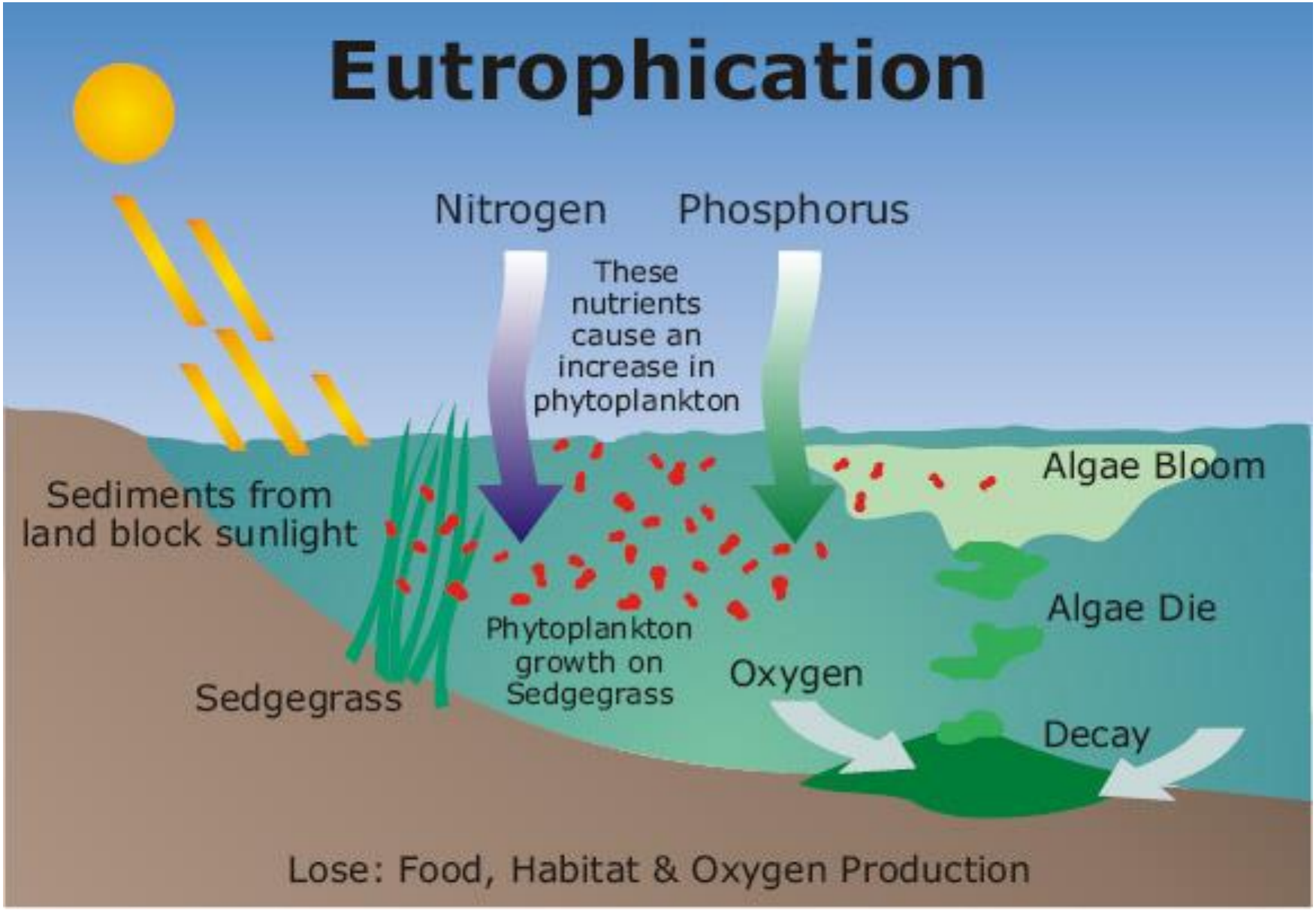
SUFFOCATION

The process of Eutrophication



The process of Eutrophication cont.




Eutrophication
Nitrogen
Phosphorus
These nutrients cause an increase in phytoplankton
Sediments from land block sunlight
Algae Bloom
Algae Die
Phytoplankton growth on Sedgegrass
Oxygen
Sedgegrass
Decay
Lose: Food, Habitat & Oxygen Production

The primary limiting factor for eutrophication is phosphate." The availability of phosphorus generally promotes excessive plant growth and decay, favouring simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality. Phosphorus is a necessary nutrient for plants to live, and is the limiting factor for plant growth in many freshwater ecosystems. Phosphate adheres tightly to soil, so it is mainly transported by erosion. Once translocated to lakes, the extraction of phosphate into water is slow, hence the difficulty of reversing the effects of eutrophication

Lakes and Rivers

When algae die, they decompose and the nutrients contained in that organic matter are converted into inorganic form by microorganisms. This decomposition process consumes oxygen, which reduces the concentration of dissolved oxygen. The depleted oxygen levels in turn may lead to fish kills and a range of other effects reducing bio-diversity. Nutrients may become concentrated in an anoxic zone and may only be made available again during autumn turn-over or in conditions of turbulent flow.

Cont…

- Enhanced growth of aquatic vegetation or phytoplankton and algal blooms disrupts normal functioning of the ecosystem, causing a variety of problems such as a lack of oxygen needed for fish and shellfish to survive. The water becomes cloudy, typically coloured a shade of green, yellow, brown, or red. Eutrophication also decreases the value of rivers, lakes and aesthetic enjoyment. Health problems can occur where eutrophic conditions interfere with drinking water treatment.

MAIN CULPRIT

- Phosphorus is often regarded as the main culprit in cases of eutrophication in lakes subjected to "point source" pollution from sewage pipes. The concentration of algae and the trophic state of lakes correspond well to phosphorus levels in water. Studies conducted in the Experimental Lakes Area in Ontario have shown a relationship between the addition of phosphorus and the rate of eutrophication. Humankind has increased the rate of phosphorus cycling on Earth by four times, mainly due to agricultural fertilizer production and application.

- Although eutrophication is commonly caused by human activities, it can also be a natural process, particularly in lakes. Eutrophy occurs in many lakes in temperate grasslands, for instance. Paleolimnologists now recognise that climate change, geology, and other external influences are critical in regulating the natural productivity of lakes. Some lakes also demonstrate the reverse process (meiotrophication), becoming less nutrient rich with time. The main difference between natural and anthropogenic eutrophication