

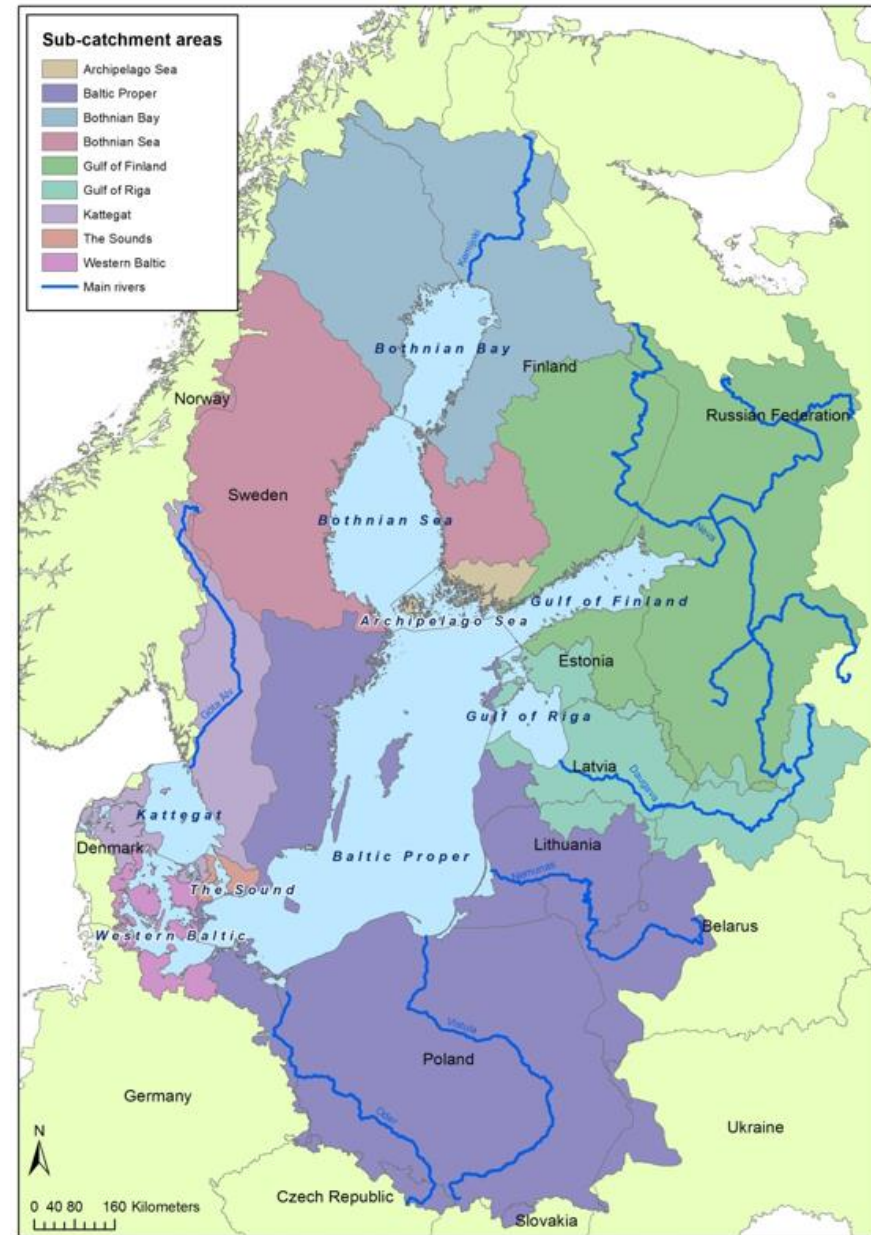
# Reducing nutrient load from catchments

1. Catchment area and nutrients

# 1.1 Catchment area

- The catchment area is an area from which all rain and surface water runs towards a common outlet, to the same watercourse
- Characteristics of the catchment area affect the water quality of a water body

[Learn more:](#)



The catchment area of the Baltic Sea, with sub-catchment areas. ([HELCOM 2015](#))

# 1.2. Nutrients

- Many different kinds of minerals and nutrients, are needed for plants to grow and reproduce
- Limiting factor: that essential element that is in the shortest supply and limits the growth of the plant (can be light, CO<sub>2</sub>, nutrients...)
- The factor limiting the primary production in Finnish freshwaters is usually **phosphorus**. Sometimes in the Baltic coast waters, coastal rivers and some very eutrophicated lakes, **nitrogen** is the limiting factor
- The element that is the limiting factor in certain circumstances, depends on the production cycle – nitrogen might be limiting the production in the growing period

- N:P:C-ratio (mass) in a plant cell is usually:

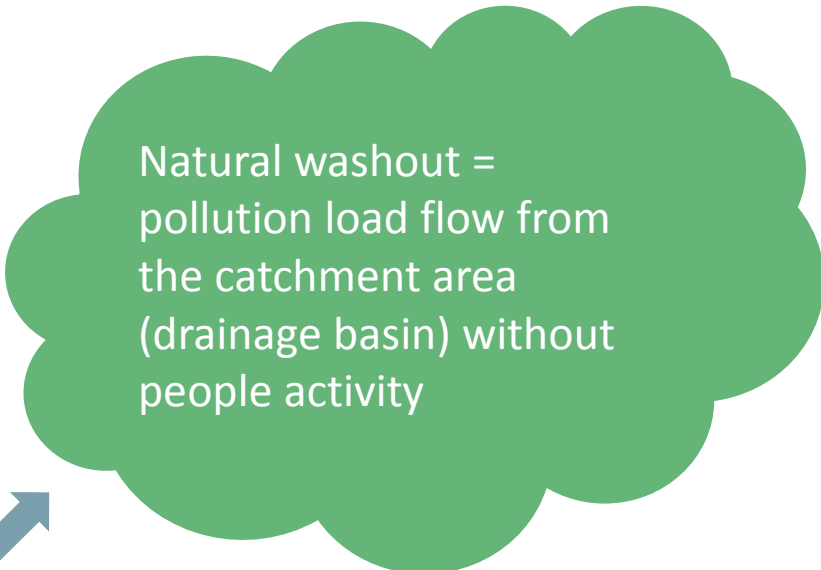
N	P	C
1	7	42

What is a limiting factor?



# 1.2.1. Phosphorus (P)

- Phosphorus is required for all organisms to live and grow
- It is an essential component of e.g. ATP (“cells energy storage”) and cellular membranes and the structural framework in DNA and RNA
- Phosphorus exists in water as phosphate,  $\text{PO}_4^{3-}$  and as particulate phosphorus (contained in particles, plants, animals,...)
- Dissolved phosphate is the form, in which phosphate is available for algae and plants, only part of particulate phosphorus is usable for them
- In natural washout only 5-10 % of P is dissolved phosphate
- In wastewaters most of the P (> 90 %) is dissolved phosphate



Natural washout =  
pollution load flow from  
the catchment area  
(drainage basin) without  
people activity

[Learn about the  
phosphorus cycle:](#)



## 1.2.2. Nitrogen (N)

- All organisms need nitrogen to grow and live
- Nitrogen (N) is an essential component of DNA, RNA and proteins
- In very eutrophicated lakes, where a lot of phosphorus is available, nitrogen can be the limiting factor for production
- Nitrogen exists in water as dissolved, gas and solid:
  - $N_2$  (main form, but less important as source for plants)
  - **$NH_4^+$  (ammonium) important as source**
  - $NH_3$
  - **$NO_3^-$  (nitrate, important as source)**
  - $NO_2^-$  (nitrite)
  - $CO(NH_2)_2$  (urea)
  - And as dissolved organic compounds
- Nitrate  $NO_3^-$ 
  - Moves easily in soil and will easily be washed out from land
  - Most common form of inorganic nitrogen in rivers and lakes
  - Useful for plants, but nitrate reduction is needed (and therefore energy)
- Ammonium  $NH_4^+$ 
  - Water plants prefer to use ammonium (no reductase needed)
  - Aquatic organisms excrete mainly ammonium (which is quickly uptaken by plants)
  - The percentage of un-ionized ammonia (toxic) rises by rising temperature and pH, sometimes a problem in eutrophicated lakes and rivers

# Ammonia - Ammonium



Ammonia + water

Ammonium + hydroxyl

- Ammonia in water is either un-ionized ammonia or the ammonium ion.
- Ammonia ( $\text{NH}_3$ ) is toxic to many water organisms
- The toxic form, ammonia, predominates when pH is high and non-toxic ammonium when pH is low
- Also the temperature affects the balance: at any pH, more ammonia is present in warmer water than in colder water

Learn the nitrogen cycle!



# 1.2.3. Photosynthesis and respiration

Plants (phytoplankton, algae and aquatic plants) are producers. Instead of consuming food to get energy, they produce their own by photosynthesis. During the process of photosynthesis, plants take in energy from sunlight and convert it into chemical energy stored in carbohydrates.

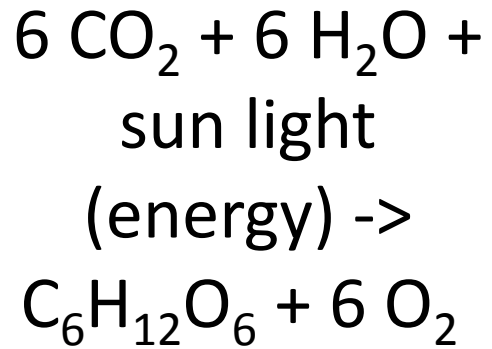
Plants use the sugar made during photosynthesis for growth, development, reproduction and repair. The simple sugars produced in photosynthesis bond to form more complex starches such as cellulose that provide structure to plants. Photosynthesis removes carbon dioxide from the environment and replenishes oxygen.

Plants need:

- $\text{CO}_2$  and light in photosynthesis
- $\text{O}_2$  in respiration, to get energy out of sugar (carbohydrates) - but in addition to energy, plants also need nutrients to grow, reproduce and develop.

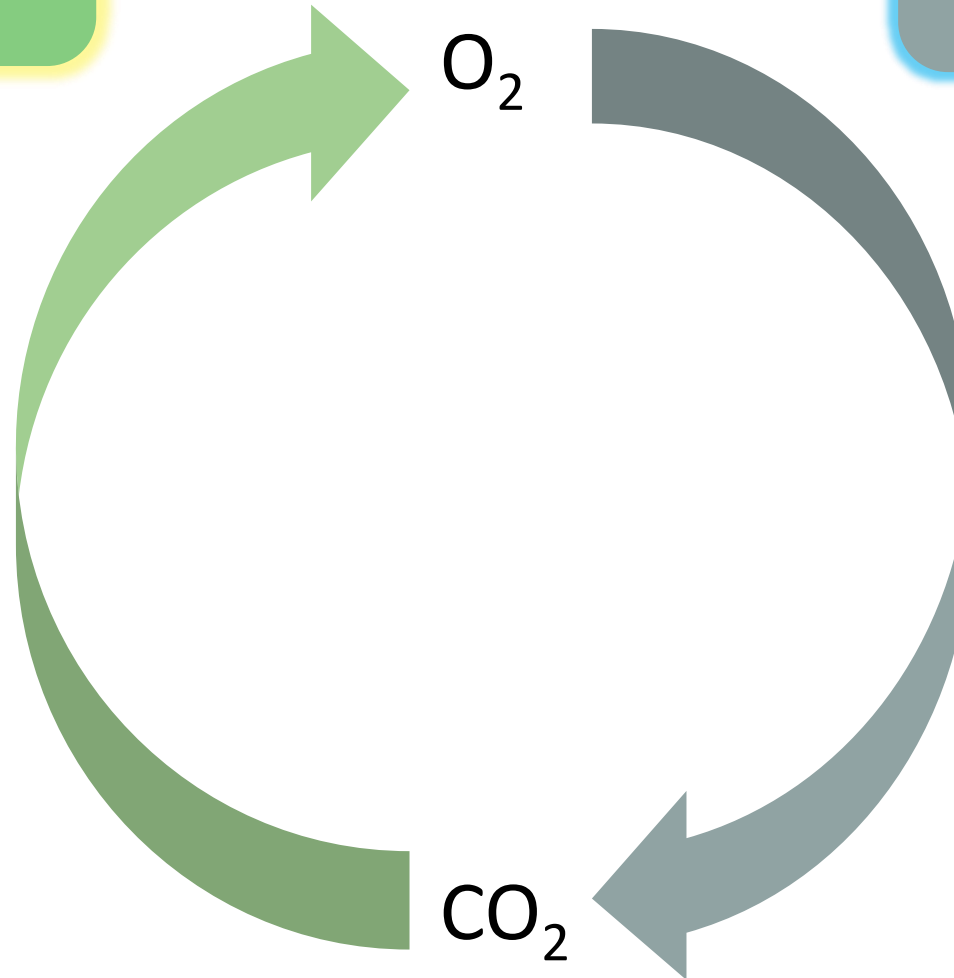
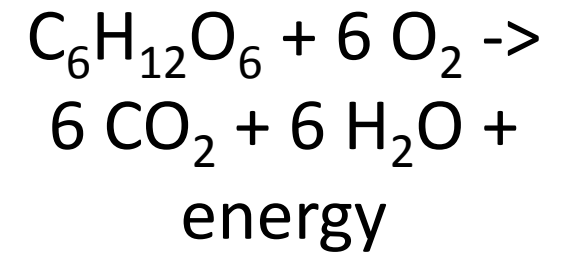
## Photosynthesis

Energy binding



## Cell respiration

Energy released





# References and further reading:

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