EUTROPHICATION

- This is a problem for both ocean (the hydrosphere including lakes, rivers) and land (soil -> plants).
- Yes, in fact can occur naturally in lakes as they age (take limnology if interested); they accumulate nitrates (NO_3^-) and phosphates (PO_4^{3-}). The process is VERY slow.
- Currently, human induced eutrophication is one of the rapidly growing issues and has been recognized as pollution since mid-20th century.

Non-point source

Fertilizers:

- come from petroleum; takes petroleum to get petroleum, takes petroleum to make fertilizers from petroleum.
- agricultural practices are not ethical (considerate of the environment -> run-offs)

Point source

- waste waters
- industry
- sewage + detergents

Species lost in both water and land:

- Phytoplankton is favoured in eutrophic waters -> algae bloom -> light penetrating water in the area is lowered by much (?) -> oxygen depletion -> hypoxia -> fish and mollusk literally suffocate -> die off of phytoplankton -> methane producing bacteria in the water (and land?)
- Naturally many trees -> VOC's production -> ozone production AND ozone reduction in troposphere -> ozone (cleanser) -> destruction of CO & CH_4 (hydrocarbons) -> ozone sink = a balanced ratio of one to the other

Unintended land conversion:

- Eutrophication favors bushes, faster growing species, over trees; this, in turn, converts forests into thickets. Those do not produce as much VOC's, do not cause O_3 production to the same degree as slower growing (but bigger in the end) trees. Therefore the amount of hydrocarbons increases.
- Effects of Ammonia: stress withstanding abilities are decreased; reduced flowering -> impoverishing seed-bank, gene pool, and potentially reduces resilience to climate change
- Rain depends on rainforests. Not the other way around. Most VOC's lead to formation of particles (aerosols) – pp107 ("smoke" in the Smoky Mountains isn't the same as London smog?)
- Trees are a larger sink of CO_2 than bushes.

- Grassland soils and Vegetation responses to Nitrogen saturation in UK -> in an acidic areas increased ammonium concentration… (?)
- pH of the soil decreases with excessive N depositions (?)
- Currently in many European areas soil's fixed N concentration is double the pre-industrial
- N deposition rates increased between 3 and more than 10-fold (???) compared to preindustrial times
- Critical load for acidification are exceeded in ~7-17% of the globally – critical load for eutrophication ~7-19% (combine the numbers? Correlation=causation?)

National Institute for Public Health and Environment (RIVM, Netherlands)
Natural Environment Research Council (UK)
City of Boulder: Municipal Tree Resource Analysis
Our textbook: Holloway, Atmospheric Chemistry

pp 77: N from fertilizers -> ammonium NH_4^+ -> nitrification into NO_2^- & NO_3^- -> plant consumption
-> denitrification N_2 & N_2O

It is unclear how much is consumed and how much is denitrified, but I would assume if more fixed N available both processes must increase (?)

pp 102-103
Figure 8.3 pp108

Photolysis of NO_2 = the only known way of producing O_3 in the troposphere:

$NO_2+hv \rightarrow O+NO$
$O+O_2+M \rightarrow O_3+M$
$OH+CO \rightarrow H+CO_2$
$H+O_2+M \rightarrow HO_2+M$
$HO_2+NO \rightarrow OH+NO_2$

$CO+2O_2+hv \rightarrow CO_2+O_3$
Below a certain critical value of ratio $[NO]/[O_3]$ HO_2 reacts primarily with O_3 and not NO -> ozone loss dominate over generation
In troposphere that should be good, right?..

Nope! Tropospheric ozone determines oxidizing capacity of the troposphere (cleansing). Too much isn't good, too little either. Tropospheric ozone is a greenhouse gas and initiates the chemical removal of methane and other hydrocarbons from the atmosphere. Thus, its concentration affects how long these compounds remain in the air.

$N_2O + O^* \rightarrow NO + NO$
$NO+O_3 \rightarrow NO_2+O_2$

Non-methane hydrocarbons NMHCs, partially oxidized VOCs are very reactive and are produced and emitted by plants
Alkanes & alkenes (also from trees):
$RO_2+NO \rightarrow RO+NO_2$ -> see above
