Eutrophication in the 2 Seas-area

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OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

Organisation in which 15 countries and EU participate to protect the environment of the North-East Atlantic

contents

* Show you where eutrophication is a problem according to the OSPAR/MSFD system
* Is there a simple solution to eradicate eutrophication? Maybe we have to accept some problem areas?
* for good policymaking you need an integral vision using different scales (local to including the catchment area for marine areas)
* I'm afraid that apart from criteria and norms you will also need expert judgement at all levels of the ecosystem processes for an integral vision and to keep in touch with new developments.

definition

Many definitions, but the EU defines eutrophication as:

"the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, ***causing accelerated growth of algae and higher forms of plant life*** to produce an ***undesirable disturbance*** to the water balance of organisms present in the water and the quality of the water concerned"

Thus eutrophication is viewed as a ***process*** focused on ***nutrients*** and their effects on ***primary production***

Primary production is process in which plants and algae use sunlight to fix CO_2 and produce new biomass: thus forms the basis of the foodweb and the upper limit of the carrying capcity of an ecosystem.

Sources and problems eutrophication

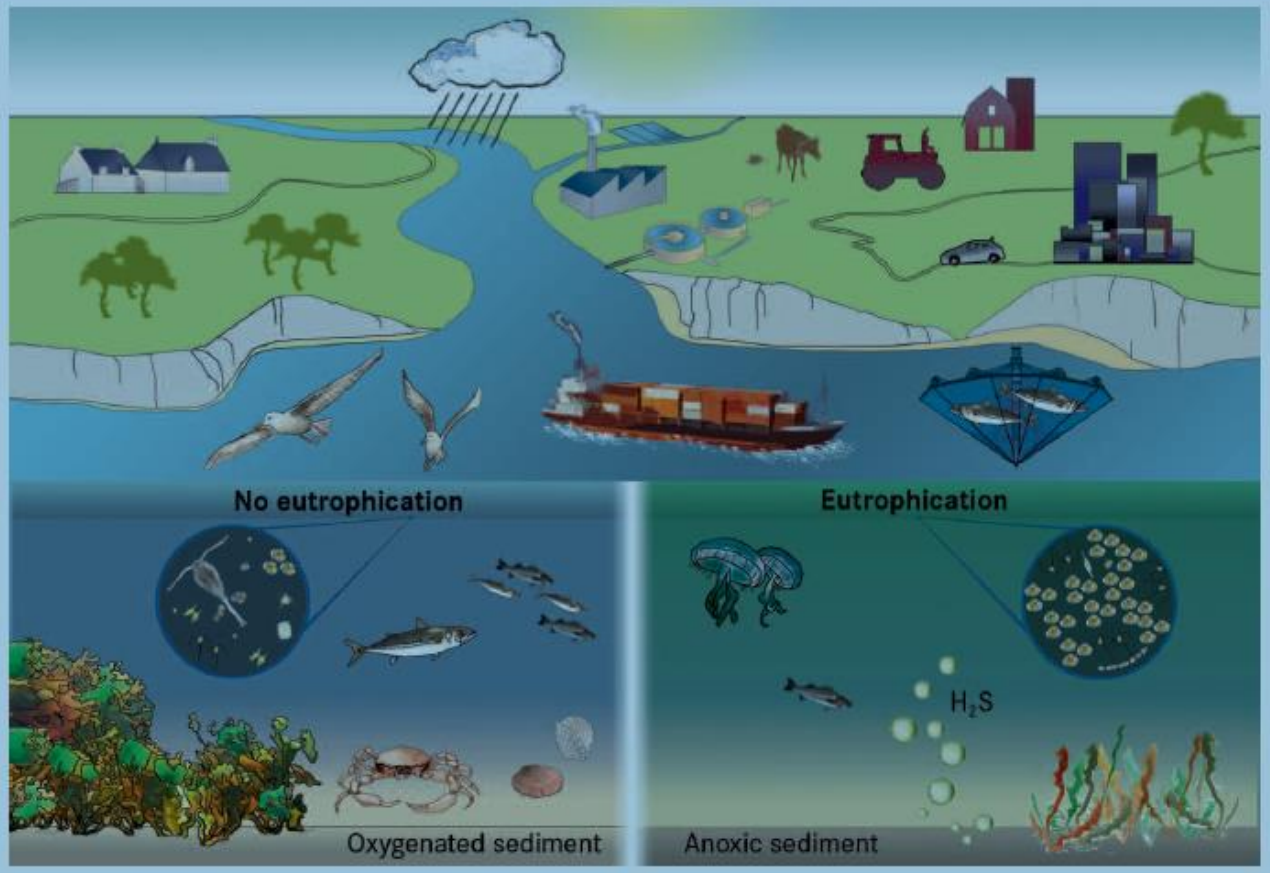


FIGURE 4.1 *Sources of nutrient input to the marine environment and simplified schemes showing eutrophication effects arising from nutrient enrichment.*

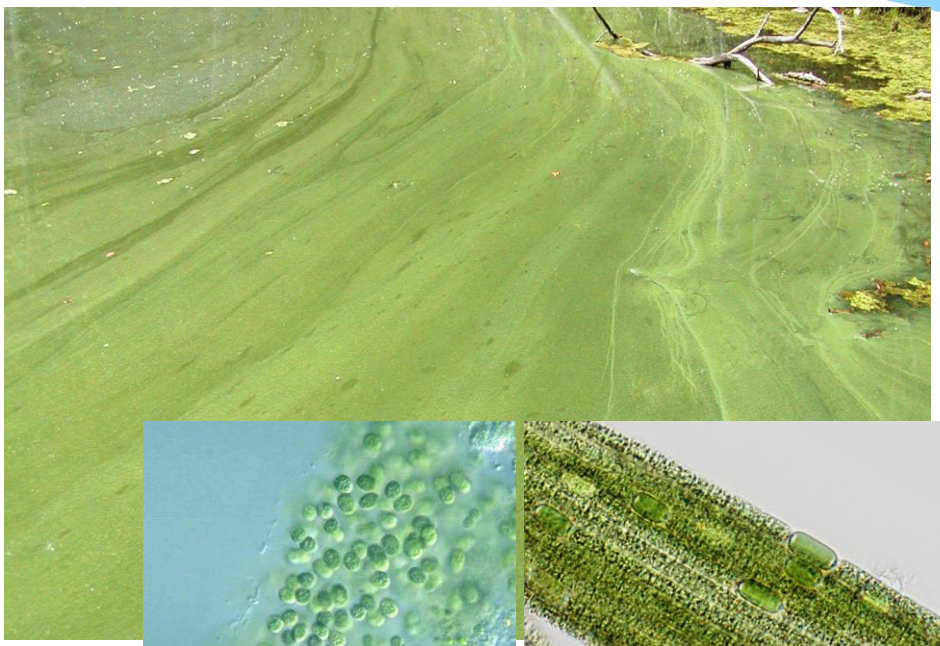
OSPAR QSR 2010

Aim of MSFD is GEnS: to obtain a sea which ecology diverse, intrinsically clean, healty and **productive,** and the **use** of marine environment is at a level that is sustainable.

The phrase use means that sea should **produce ecosystem services and societal benefits.**

See Borja ea 2013 for more info)

Results eutrophication are most felt in freshwater



Eutrophication in fresh water (and brackish: Baltic Sea) often leads to surface scums of cyanobacteria (blue-green algae) which are often toxic.
When they die, oxygen consumption by bacteria lead to anoxic conditions and fish kills.

Measures to reduce eutrophication of the sea:

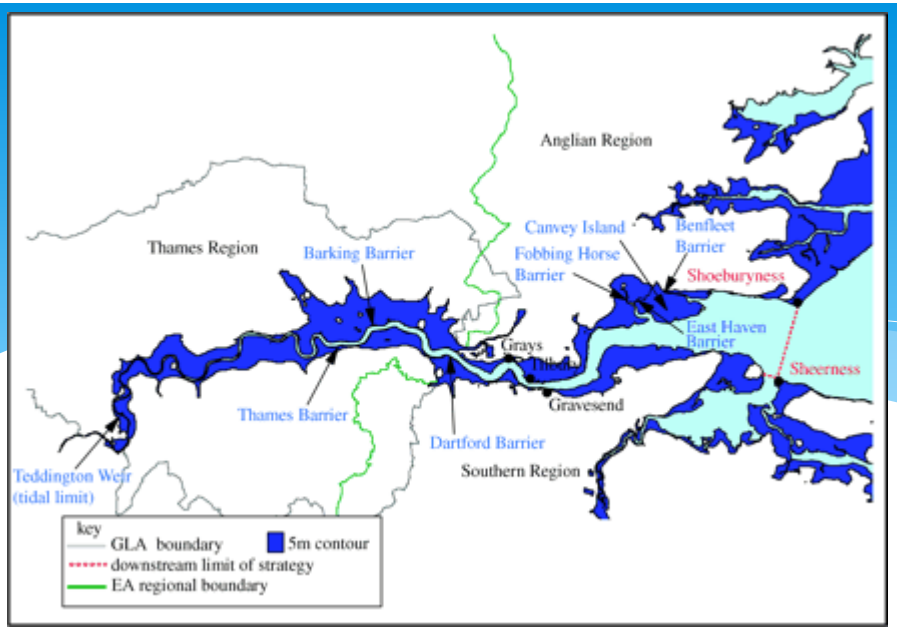
OSPAR Strategy objectives for eutrophication

→ Combat eutrophication in the OSPAR maritime area in order to achieve and maintain, by 2010, a healthy marine environment where eutrophication does not occur.

→ Reduce inputs of nitrogen and phosphorus to areas affected by or likely to be affected by eutrophication in the order of 50 % compared to 1985.

* Assessment of eutrophication and GEnS
* So OSPAR/(WFD?) focusses on pressures, not on measuring the good environmental status (GEnS ??).
* If there are no significant man induced pressures, GEnS is reached or changes are not caused by human activity (e.g. climate change), so no actions are needed.

Influence of estuaries and rivers

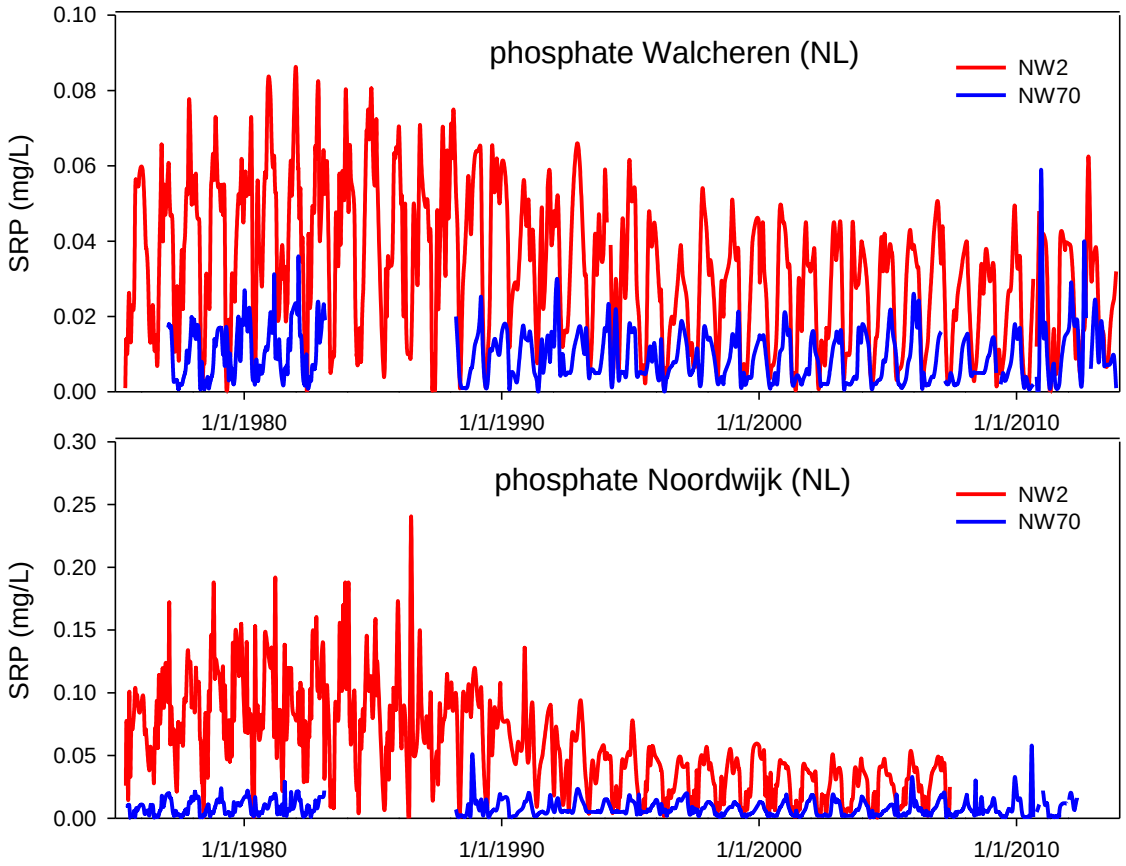


* Rivers and estuaries transport nutrient into the coastal zone
* Estuaries have filter function (biogeochemical processes removing nutrients.
  * “Filter function” can be very active (especially in estuaries with clear water and a high retention time
  * “Filter function” can also be limited, especially in turbid systems where the phytoplankton cannot utilize all the nutrients due to light limitations. These systems (e.g. like the Schelde) process less nutrients and export more to the sea

What happens at the Dutch coastal waters?

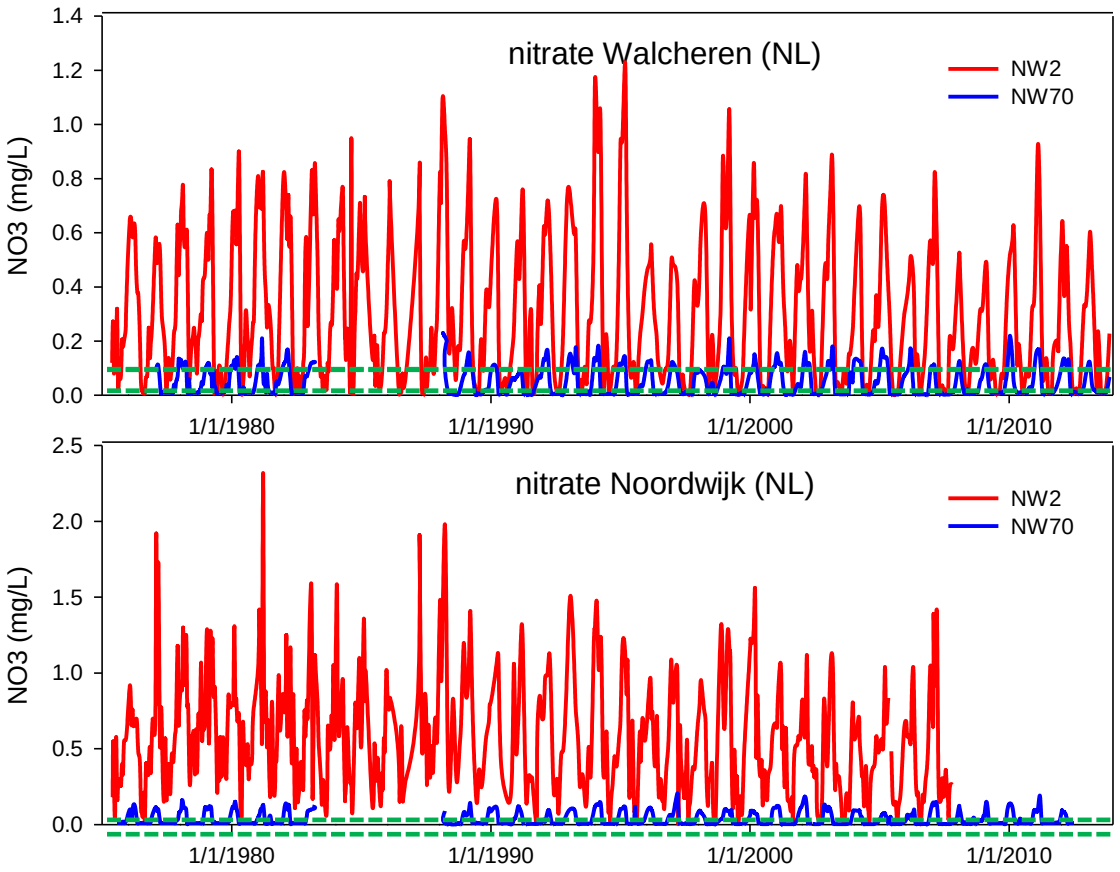
See presentation on WAS for other areas

Time series phosphate



- No norms for SRP concentrations, only for N:P-ratio's.
- Clear decrease in SRP close to the coast, but hardly offshore, and decrease in Noordwijk (Rhine) is larger.

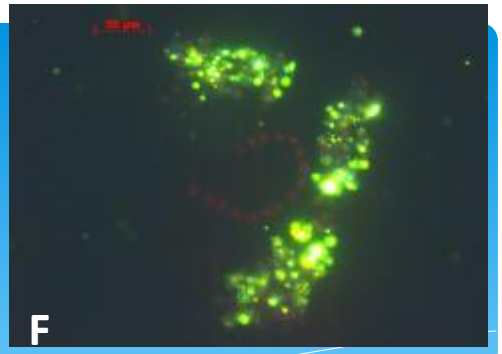
Time series nitrate

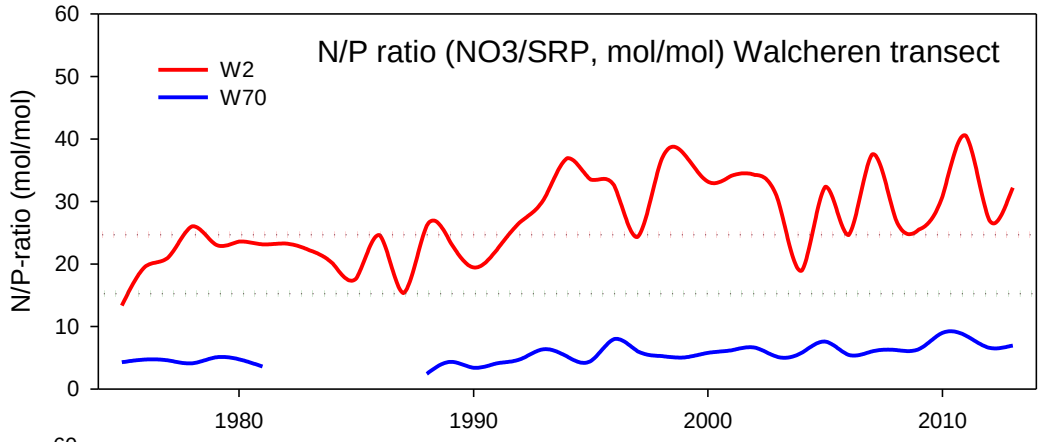


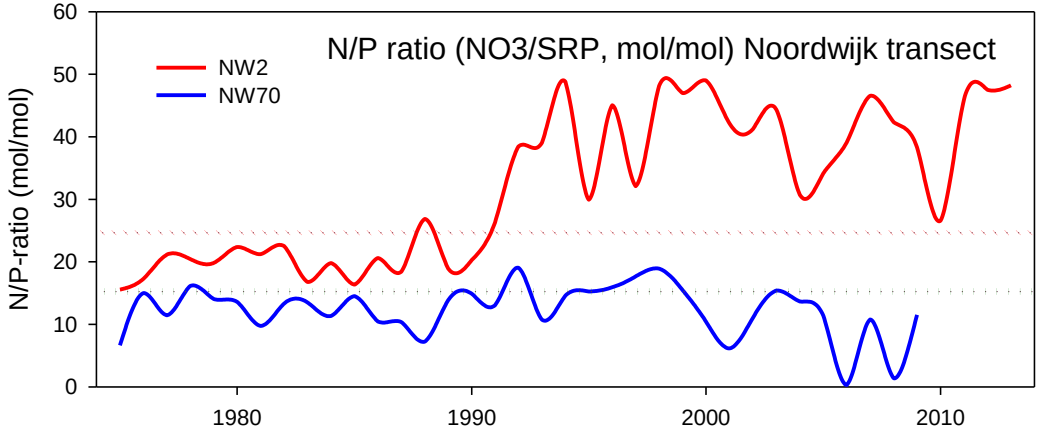
winter
0.28 coastal
0,21 offshore

Conclusion nutrients: offshore OK, coastal waters still a problem
Decrease in NO_3 is not as fast as for SRP

N:P-ratio







N:P-ratio:
N:P=16 (“Redfield-ratio)

N:P> 16: N-surplus or P-shortage

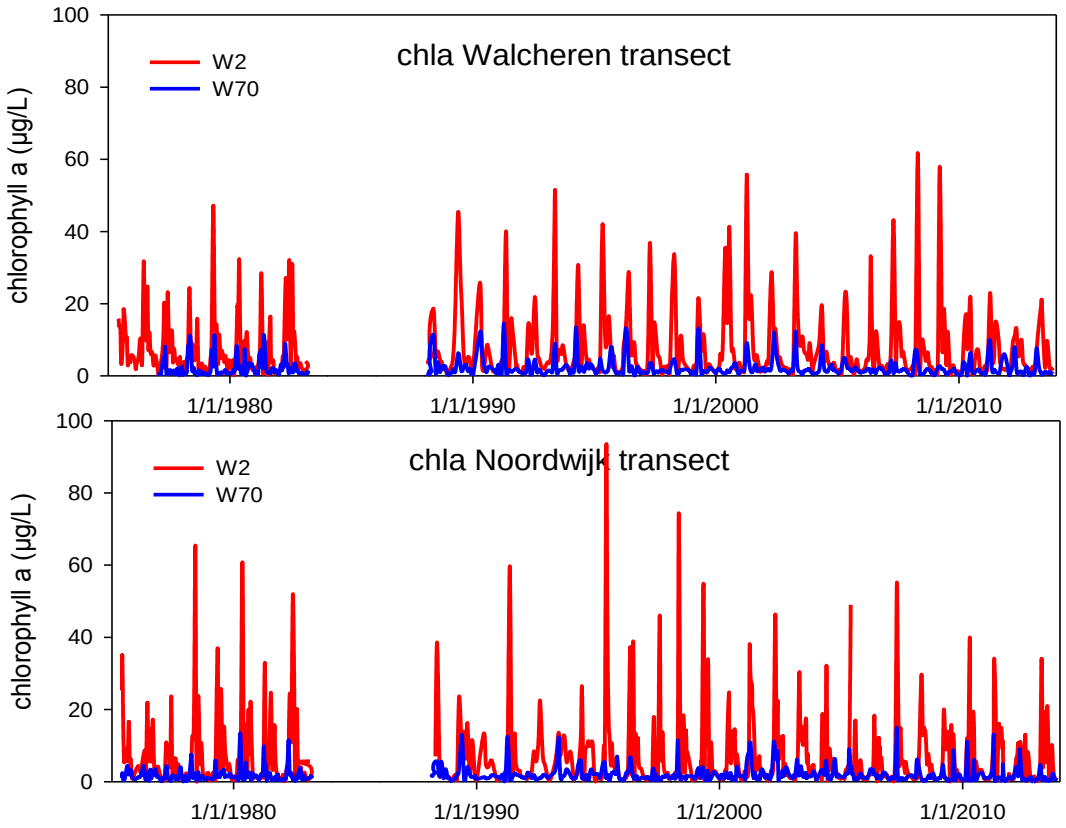
N:P< 16: P-shortage or P-surplus

N:P+50% > 24 treated as indicator of poor water quality

Dutch coastal waters have unbalanced nutrient supply ratio (which can select for harmful algal species)

P-limitation of coastal phytoplankton likely!

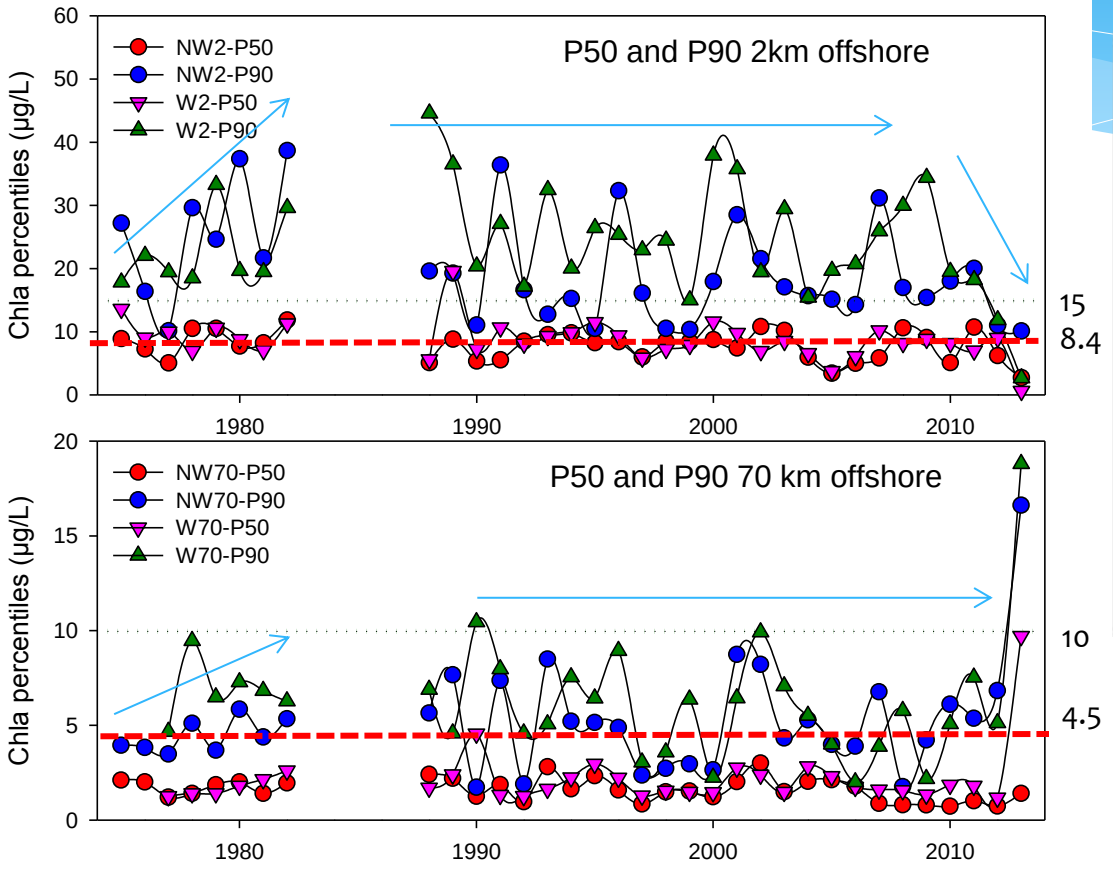
Phytoplankton biomass (chl*a*)

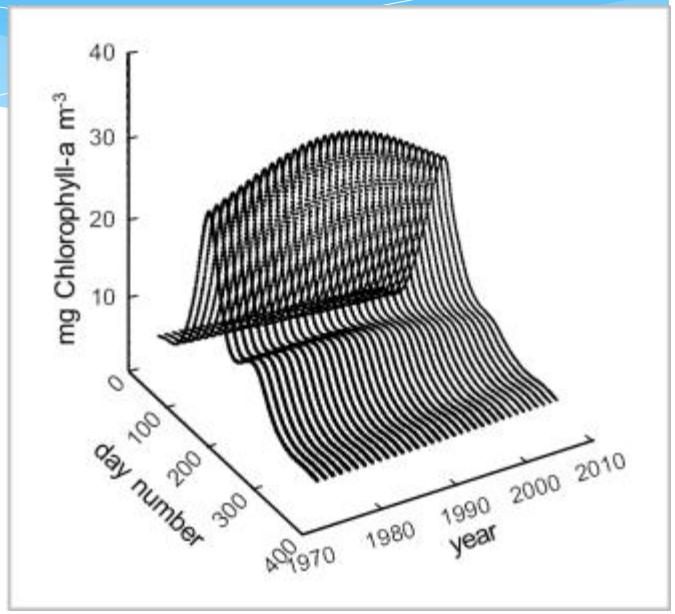


[Chl*a*] higher near shore than offshore, and nearshore higher spring bloom maxima in Noordwijk than in Walcheren?

Criteria: 90% percentile (P90) in growth season (March-September, 15 and 10 µg/L for coastal and offshore)

Chl*a* median (P50) and P90 values



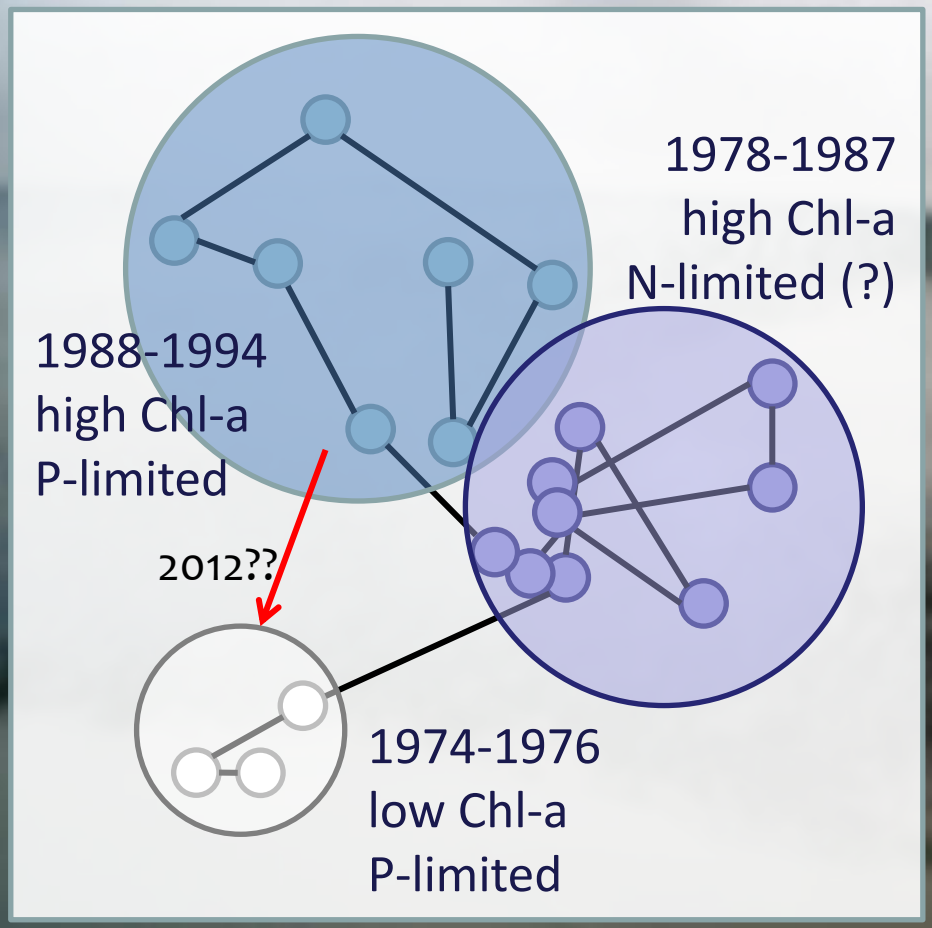


Marsdiep

Philippart et al. (2010)

- Decrease in SPR load did not lead to a decrease in Chla: different stable states?
- near shore, old & norm: concentrations too high (up to 2012?). Offshore: old norm: P90 70km ~OK, but according to the new norm, too much Chla.
- But how much of a problem is this?

Succession in phytoplankton structure?



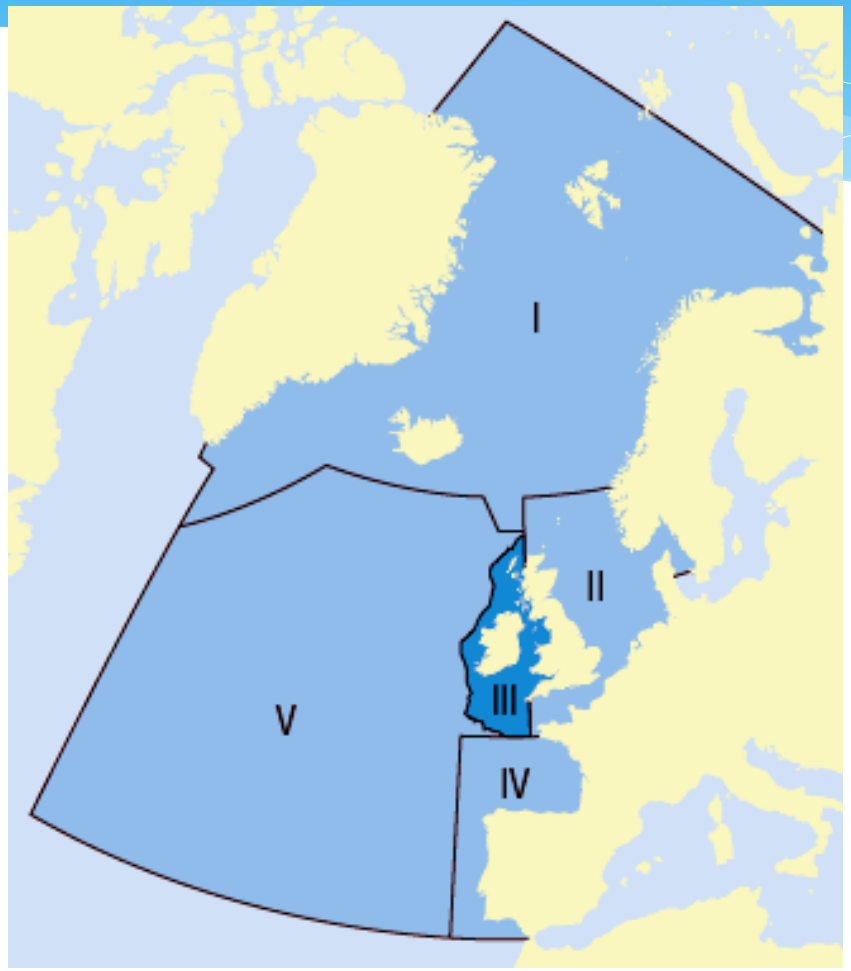
Philippart et al. (2000)

Phytoplankton community Marsdiep tidal inlet station (1974-1994)

- Shifts in dominant species between 1977 and 1978
- Shift in dominant species between 1987 and 1988
- Relatively stable during the three periods
- Change back to pre-eutrophication level recently? **Need more/continuation in monitoring!**

Note: consequences for food quality?

What about other areas?



Did contries make 50% reduction regions II & III

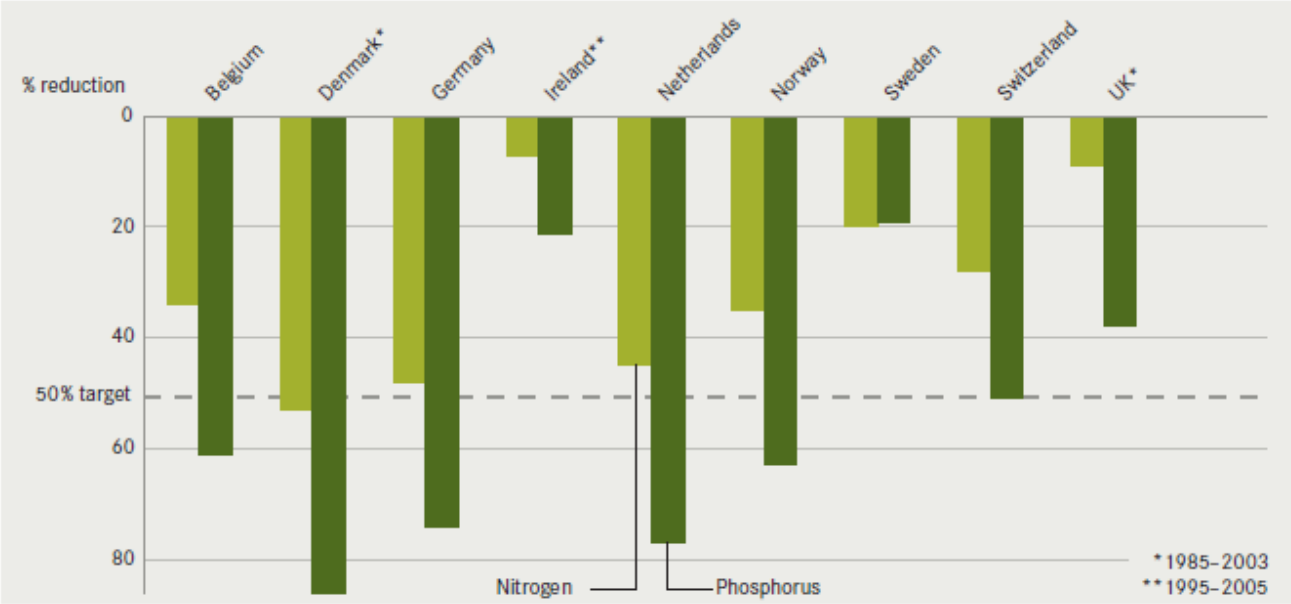


FIGURE 4.2 *Reduction of discharges and losses of nitrogen and phosphorus to problem areas reported for 2005 relative to 1985. Most countries in Regions II and III have met the target reduction of 50% for phosphorus, but not for nitrogen. For France data on source-related discharges and losses to problem areas are not available. France reported, however, a 50% reduction in riverine inputs of phosphorus to its coastal waters in the period 1990–2007, but no significant trend in nitrogen inputs. It is not possible to compare directly the reductions achieved by OSPAR countries owing to differences in the periods over which the reduction measures were applied and the different methods used to calculate reductions.*

Sources of N and P

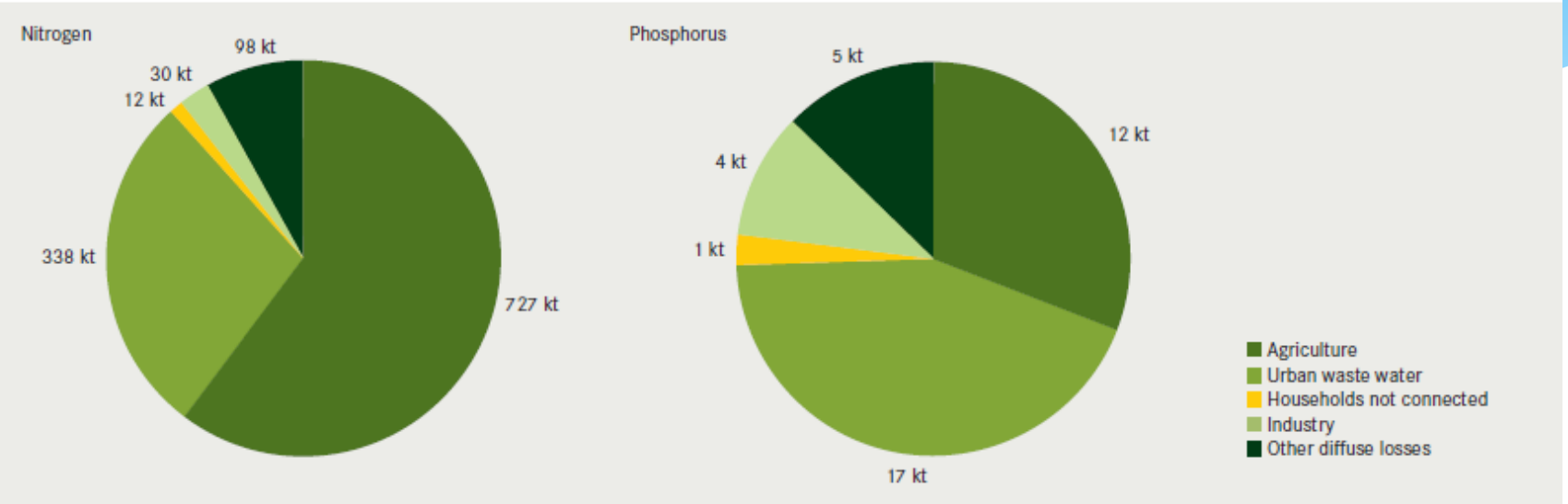


FIGURE 4.3 *Relative contribution of sources of discharges and losses of nitrogen and phosphorus to eutrophication problem areas in Regions II and III in 2005. Eight OSPAR countries reported combined totals of around 1200 kt nitrogen and 40 kt phosphorus for discharges and losses. Data on discharges to problem areas in Region IV are not available. The category 'other diffuse losses' includes background losses, atmospheric deposition on freshwater and some losses from agriculture. Releases from coastal and freshwater aquaculture are not shown in the chart as they are substantially smaller than those from other sources, amounting to around 260 t of nitrogen and 45 t of phosphorus.*

Most of N from agriculture: rather diffuse source difficult to handle (unless farmers use less fertilizer)

Non-problem, potential and problem areas

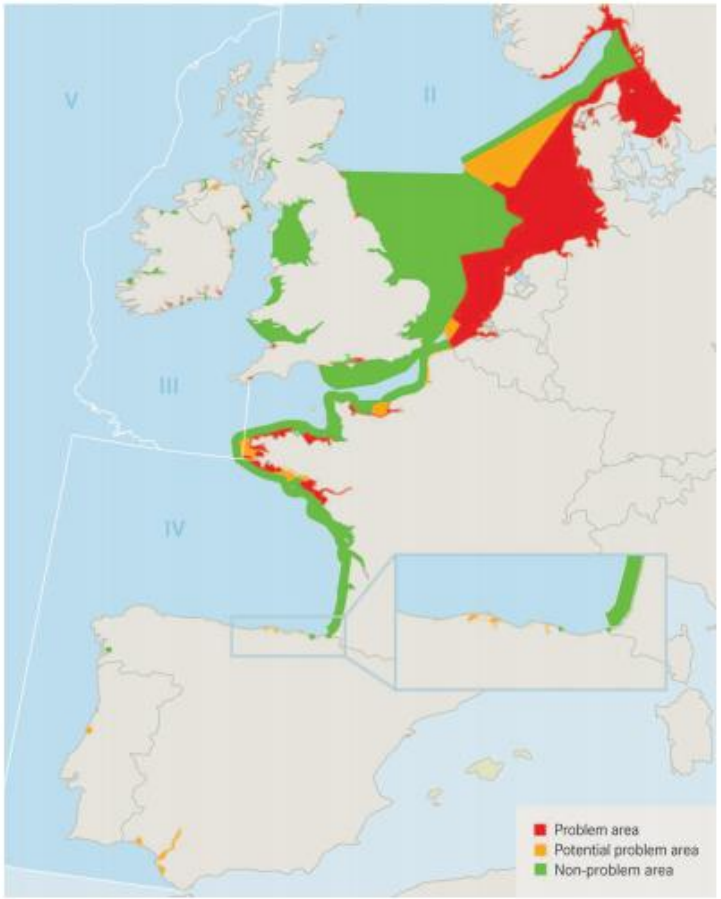
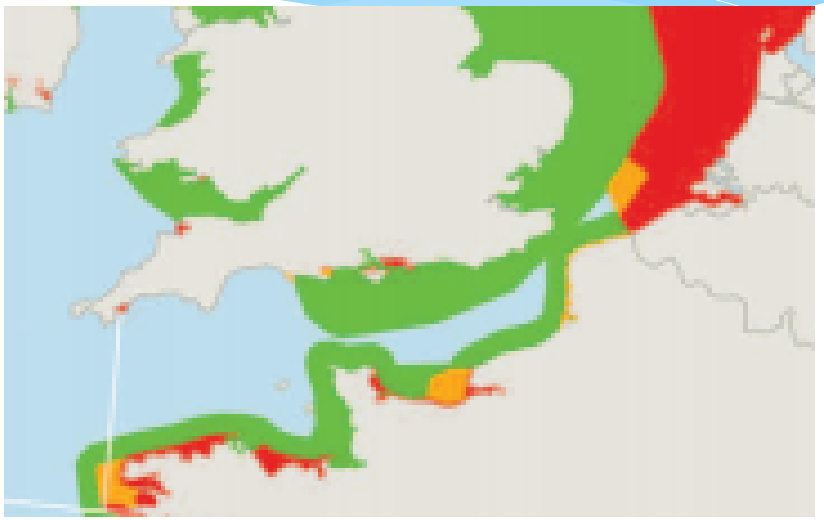


FIGURE 4.7 *Eutrophication status in the period 2001–2005. Large areas of the North-East Atlantic were screened in 2001 for obvious non-problem areas. The latest application of the Common Procedure relating to the period 2001–2005 assessed those areas of the North-East Atlantic which have shown eutrophication problems or which gave rise to concerns that their non-problem status might have changed.*



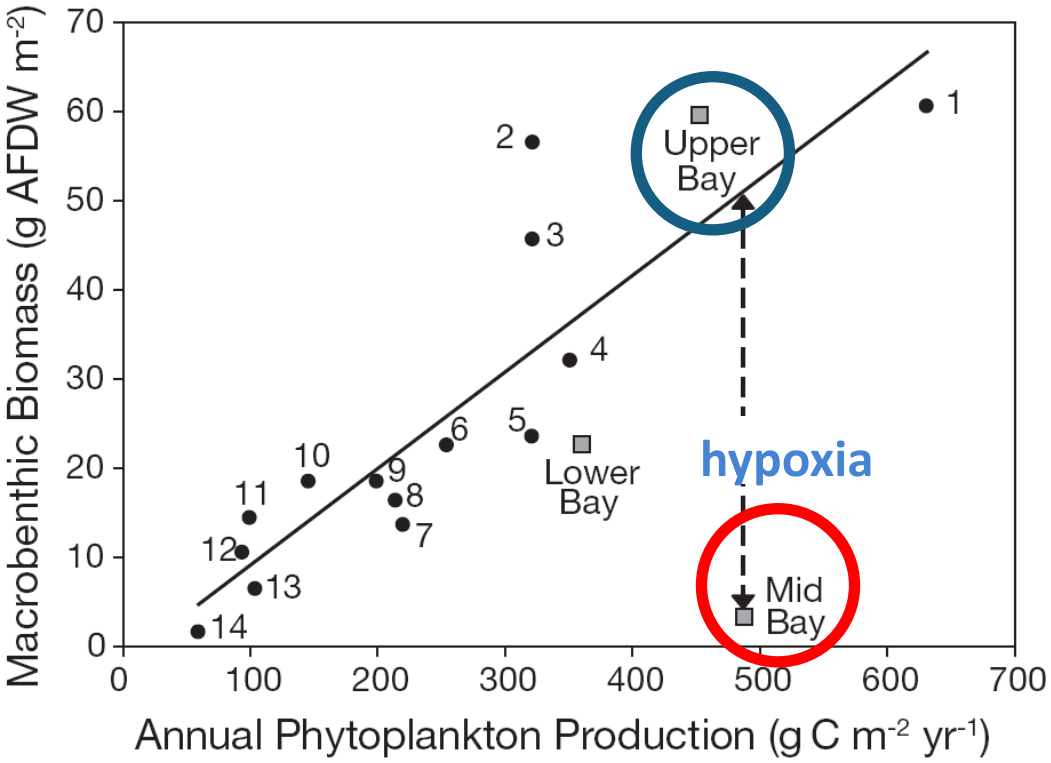
Most eutrophication occurs close to the coast in bays and estuaries.

What is the problem? Same cause but different results

* E.g: sometimes massive growth of *Ulva*
* *Phaeocystis* ("foam algae"): takes over from diatoms when they are Si depleted (very efficient use of SRP)
* HAB:-occurrence of some toxic species result of increased N:P-ratio (?)
* Some diatom species too big to be grazed (recently a new species *Mediopyxis*)?
* Is further reduction in nutrient load the solution? Or should we reduce the nutrients so that they are close to the Redfield ratio (N:P:Si=16:1:16)?
* *Phaeocystis* has always been there, so it is a natural phenomenon (Si input varies with river discharge, so Redfield ratio not possible every year.

Phaeocystis foam in Aberdeen, Sept 2012

Phytoplankton production (not Chla!) is linearly related to biomass higher trophic levels



Herman et al. 1999; Kemp et al. 2005

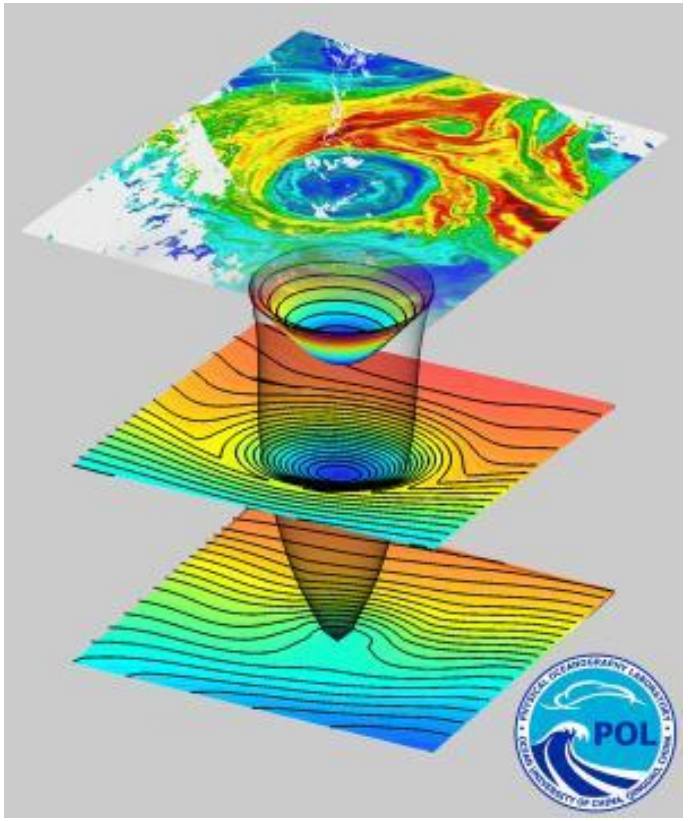
- **Estuaries worldwide**
- Linear relationship between PP and biomass MZB
- Outlier is result of extreme (lethal) environmental conditions for MZB
- So a **further general reduction in nutrients might lead to a reduction in primary production** (as is happening in the Wadden Sea and likely in parts of the coastal North Sea): good for problems in the freshwater but fisheries industry might object! (and vice versa).

To fight eutrophication we need to look at different scales

Large regional problems need global solution, areas II & III (IV?) in NW Europe only N-reduction is necessary? (for coastal zone problem).

Caused by fertilizers local farmers and the St Andrew golf courses: needs local solution .

You need experts as well



New Scientist June 2014:
"Giant whirlpoolsin the ocean, up to 500 kilometres across, are driving the world's climate on a scale previously unimagined. We just don't know exactly how yet". They move as much water as the biggest ocean currents!

Nature will always plays tricks on you: you need experts to keep in touch with new developments and with help of interpretation of all the monitoring results (expert judgement).

Marine systems are too complex to only use fixed criteria which do not take local conditions into account.

Thank you for listening!