Vandplaner på værksted
Hvordan sikrer vi sunde fjorde og landbrug i vækst?

Connections between management measures and environmental outcomes in Danish water plans

Joao G. Ferreira

NOVA - Universidade Nova de Lisboa, Portugal

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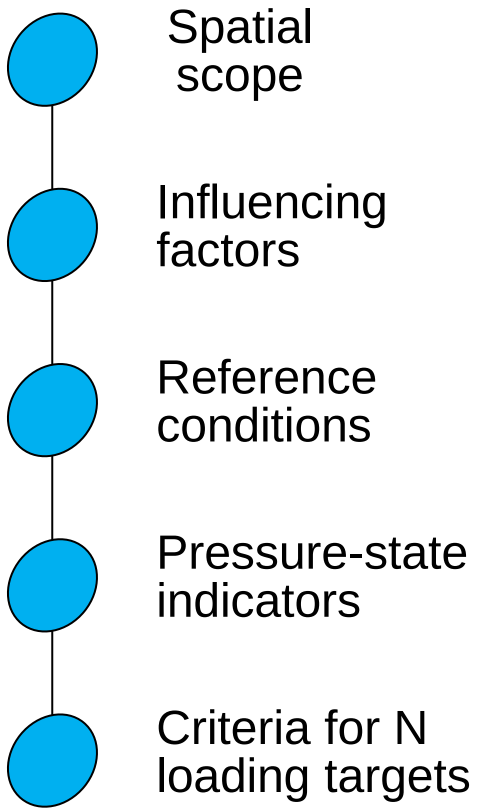
http://ecowin.org/DKWFD

Objectives of the study

- Analyse the approach proposed by Denmark in its definition of reference conditions for eelgrass
- Evaluate the relevance of the indicators chosen for assessment of the status of this BQE
- Examine the consistency and adequacy of the measures proposed to enable the coastal systems and fjords to meet the BQE reference condition for eelgrass



Consistent measures should be based on robust criteria, Adequate measures should succeed in meeting the desired objectives for WFD ecological status (good or high).

WFD Biological Quality Elements (BQE) and indicators

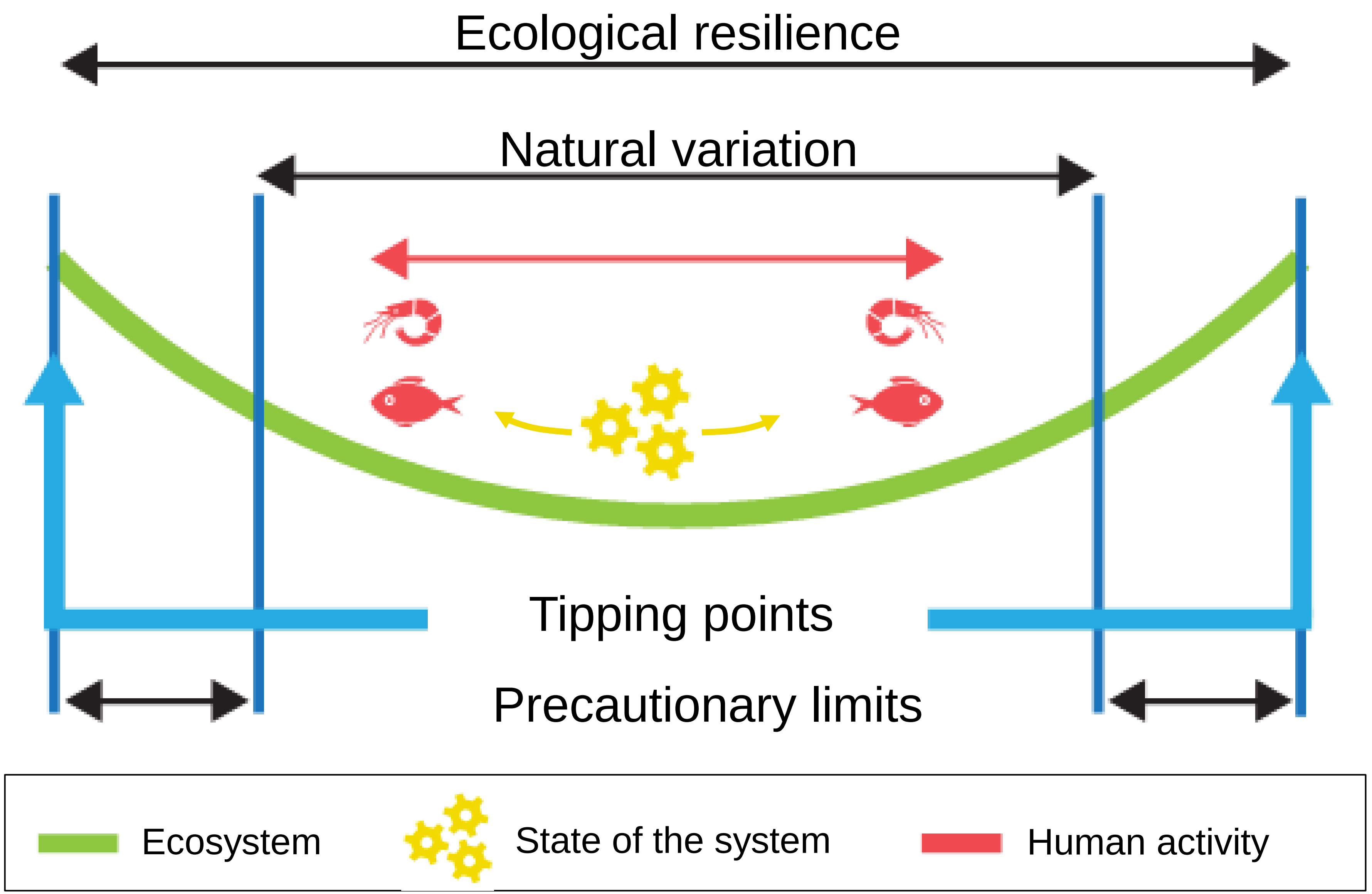
- Denmark selected eelgrass as representative of the BQE
- The reference condition is for distribution but not for abundance, which was not quantified during the early 1900's survey work
- Status assessment has been largely based on eelgrass depth, i.e. related to water transparency.

Common eelgrass (the wildlife trust)

- Water transparency was chosen as the primary indicator, but light penetration is not the only factor limiting eelgrass recovery—eelgrass is subject to multiple stressors

There is a consensus in the Herman et al (2017) report and in my own review that the indicators should be eelgrass abundance and composition. This is in the spirit of the WFD legislation.

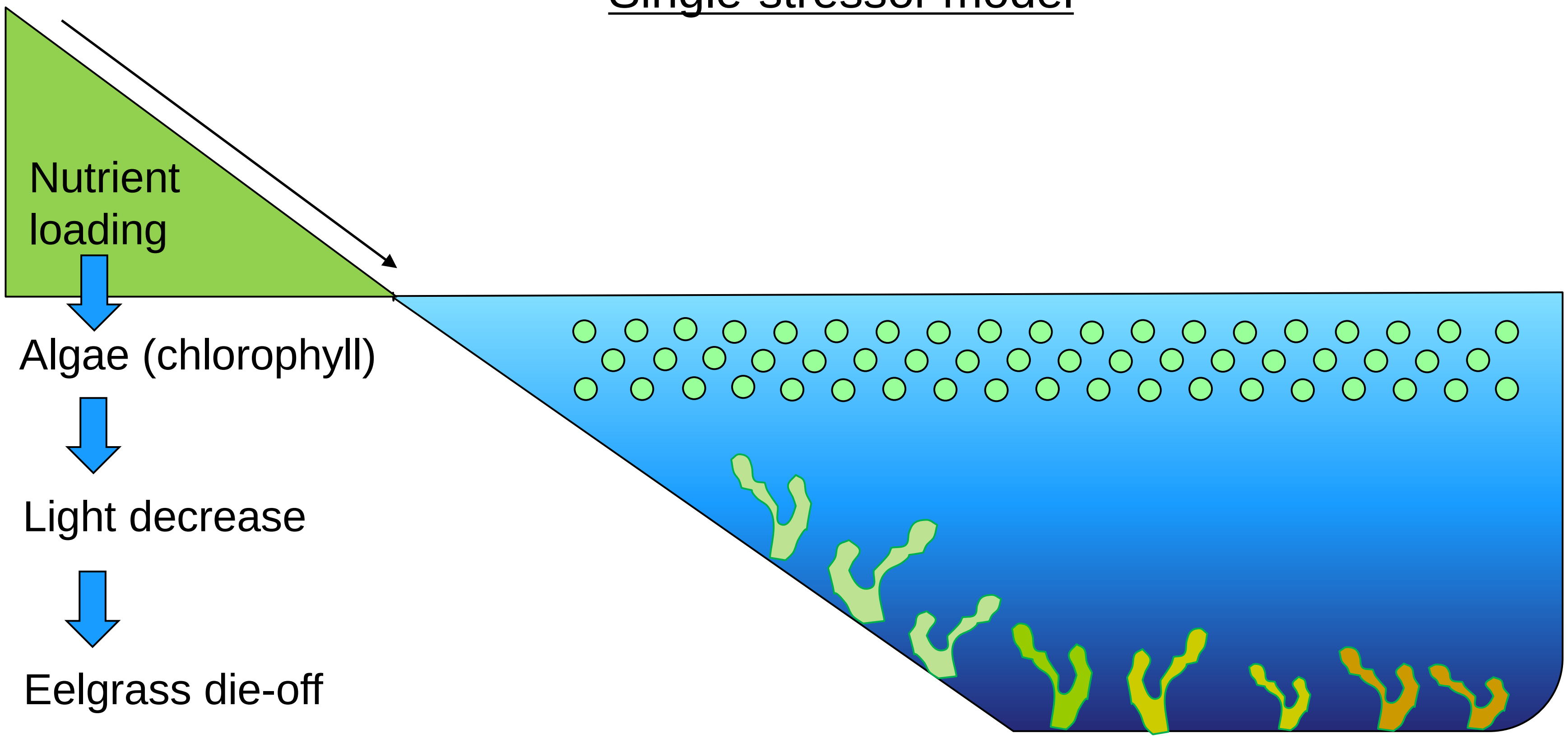
Change in aquatic systems



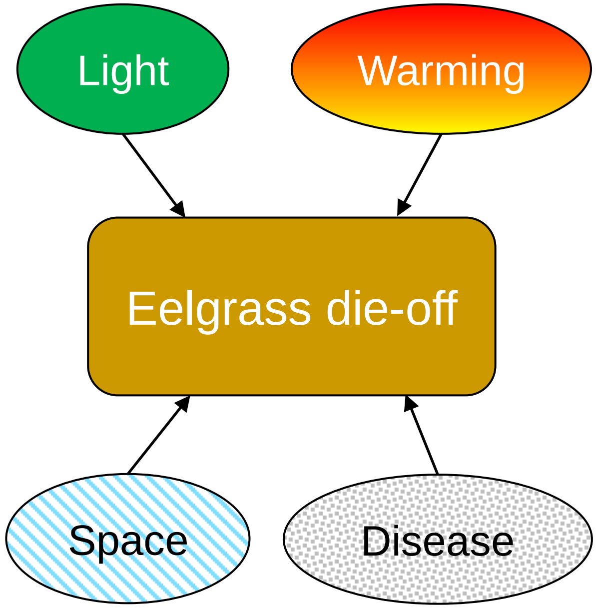
Water managers must deal with systems that are constantly changing.

Cause and Effect

Single-stressor model

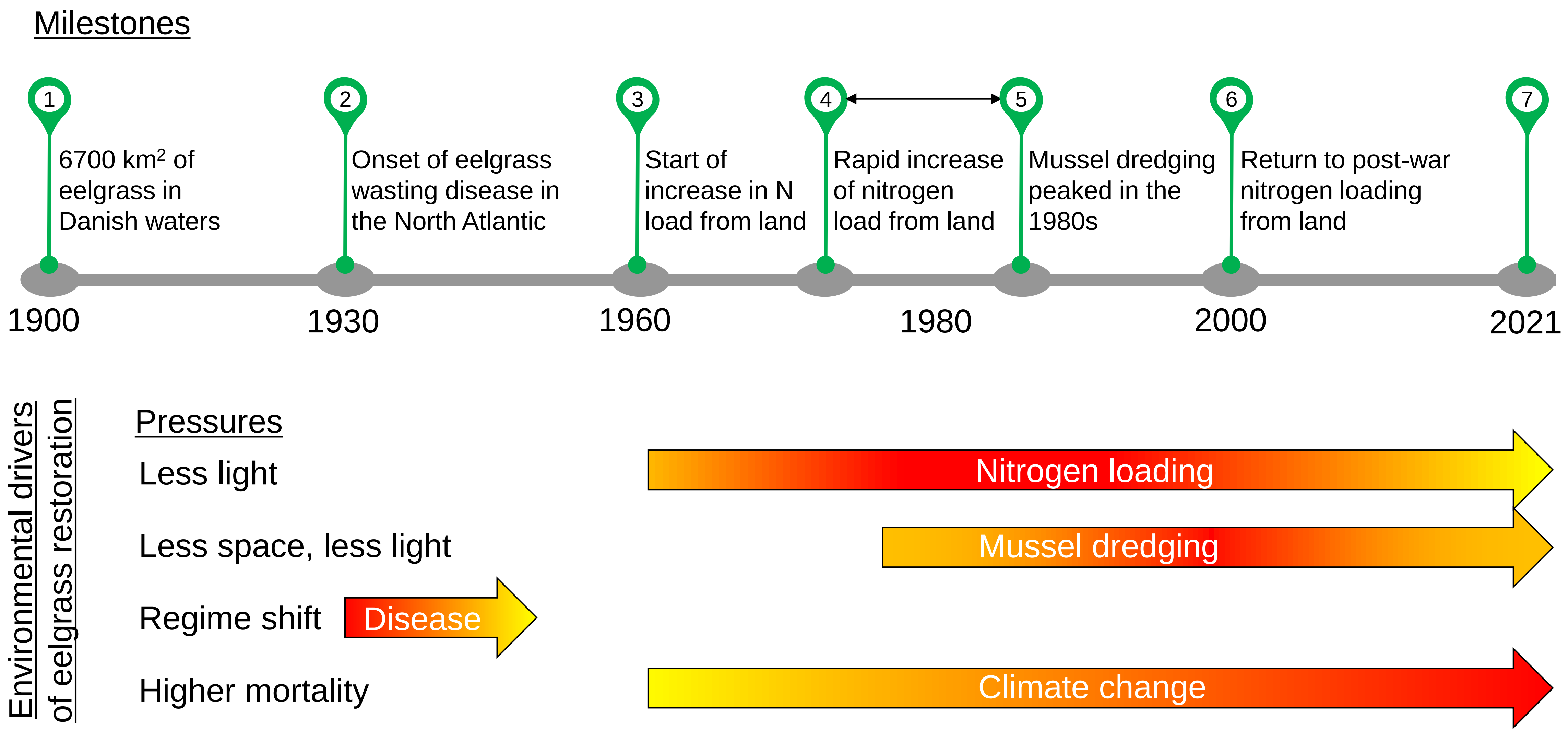


Multi-stressor model



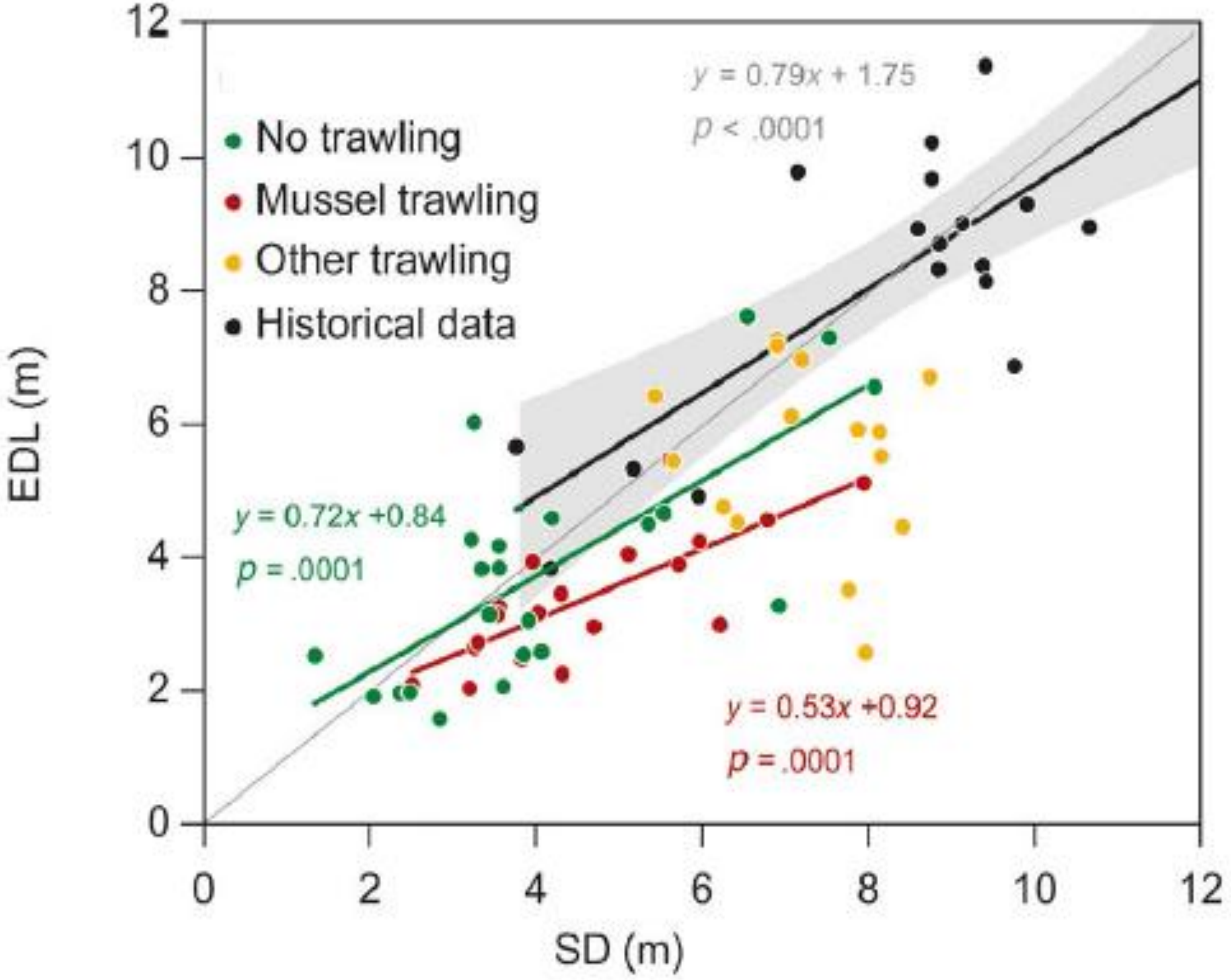
Management measures focused on nitrogen load reduction from Denmark appear to deal only with a single-stressor model for eelgrass restoration.

Timeline



Several Danish authors and international colleagues identify eelgrass loss as a complex multi-stressor issue. Water clarity is very important, but it only establishes the potential for recovery.

Eelgrass depth and mussel dredging

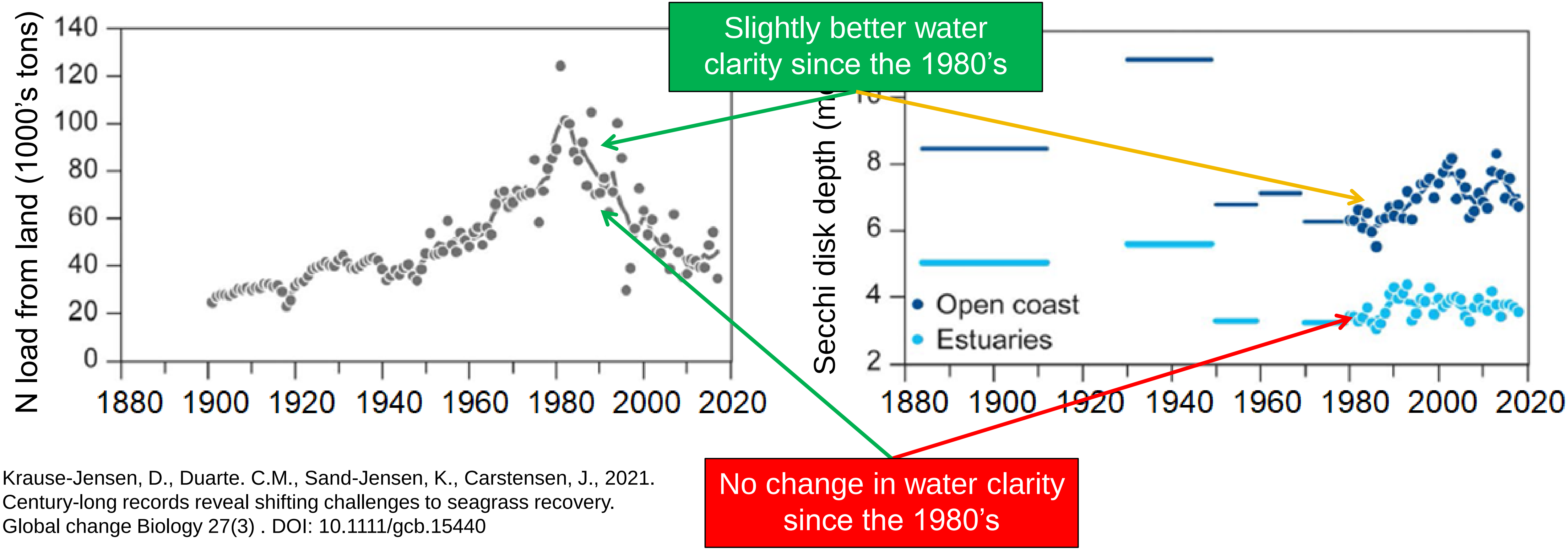


Krause-Jensen, D., Duarte. C.M., Sand-Jensen, K., Carstensen, J., 2021. Century-long records reveal shifting challenges to seagrass recovery. Global change Biology 27(3) . DOI: 10.1111/gcb.15440

Mussel dredging appears to play a part in reduction of water clarity, or eelgrass depth.

Effectiveness of measures – three questions

Question 1: Is the reduction in nitrogen loading effectively increasing water clarity?

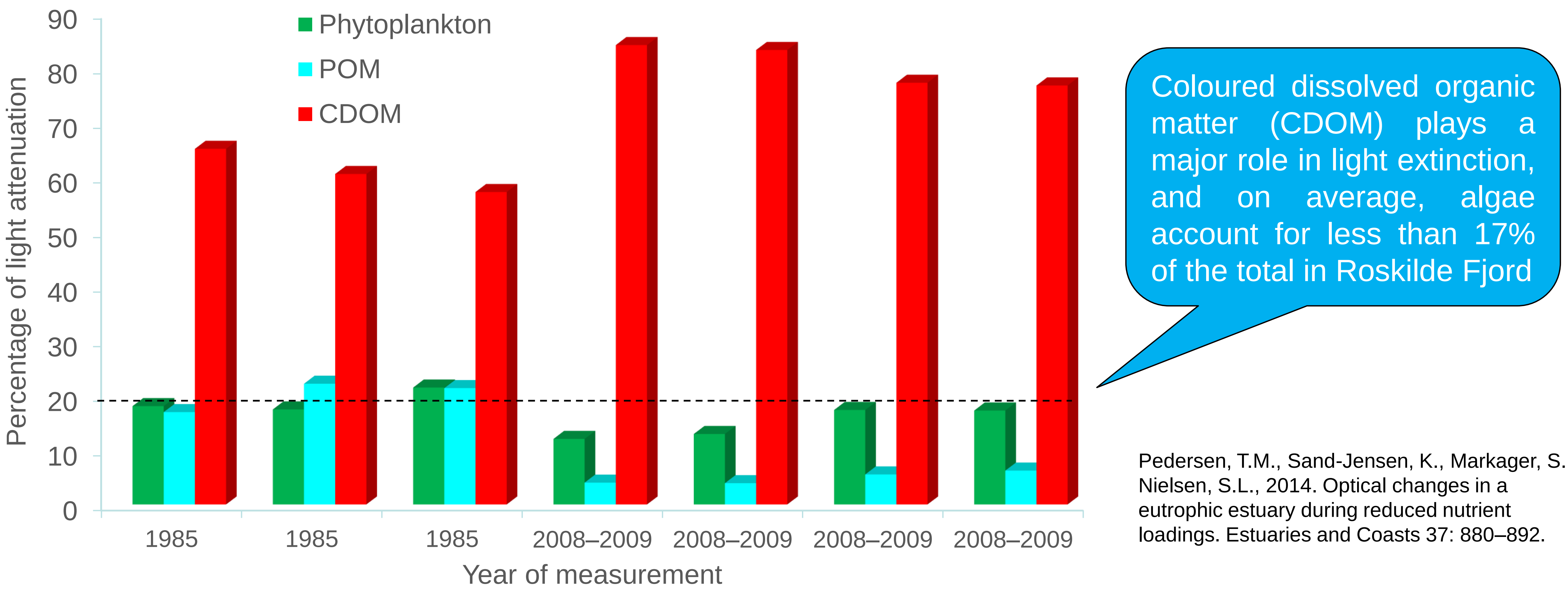


Krause-Jensen, D., Duarte. C.M., Sand-Jensen, K., Carstensen, J., 2021. Century-long records reveal shifting challenges to seagrass recovery. Global change Biology 27(3) . DOI: 10.1111/gcb.15440

Water clarity shows a slight improvement (but erratic) in open waters and no significant improvement in fjords, despite (i) a 60% reduction in N load; and (ii) a forty-year period.

Effectiveness of measures – three questions

Question 2: Are phytoplankton algae (chlorophyll) the key drivers of water clarity?

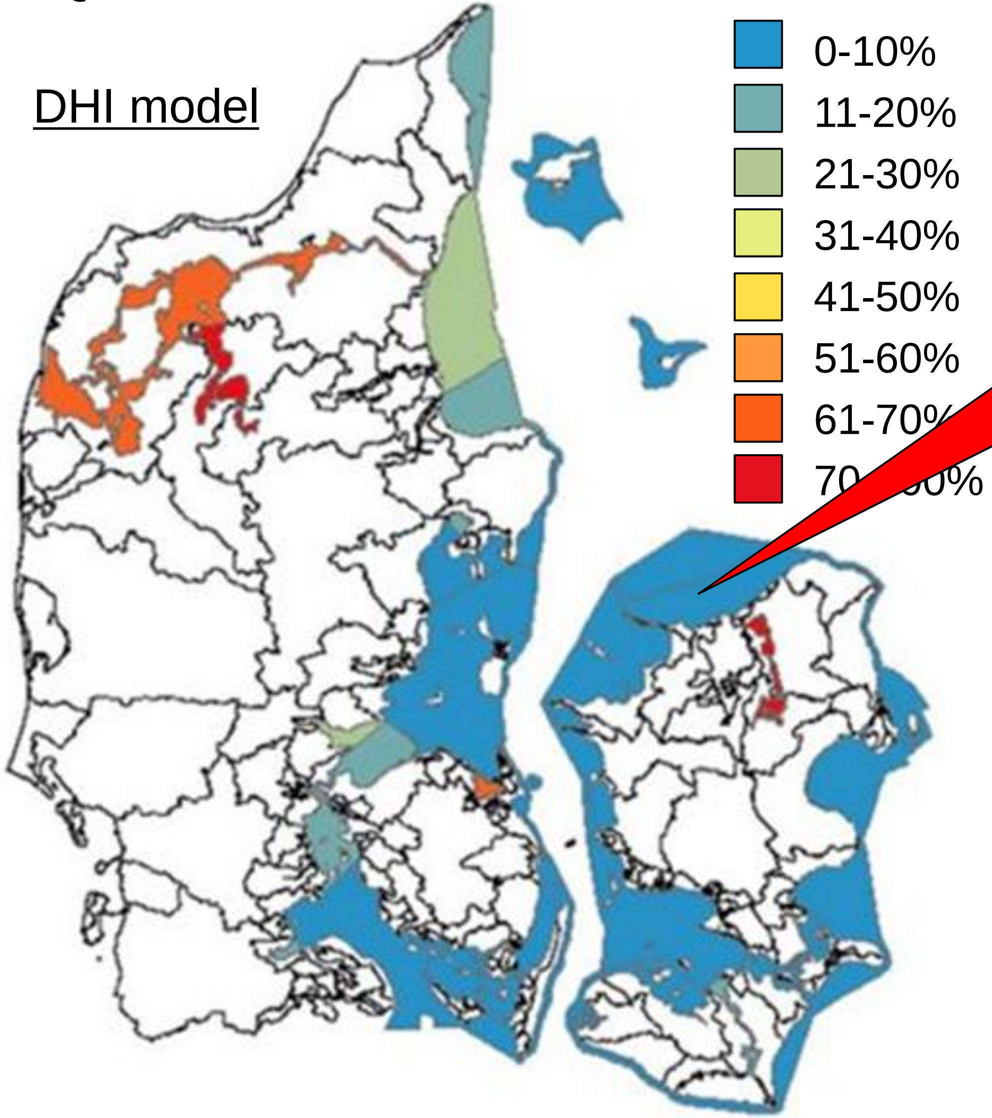


Pedersen, T.M., Sand-Jensen, K., Markager, S., Nielsen, S.L., 2014. Optical changes in a eutrophic estuary during reduced nutrient loadings. Estuaries and Coasts 37: 880–892.

The evidence suggests the relationship between chlorophyll and Danish nutrient loading is not that strong, and that chlorophyll plays only a part in reduction of water clarity.

Effectiveness of measures – three questions

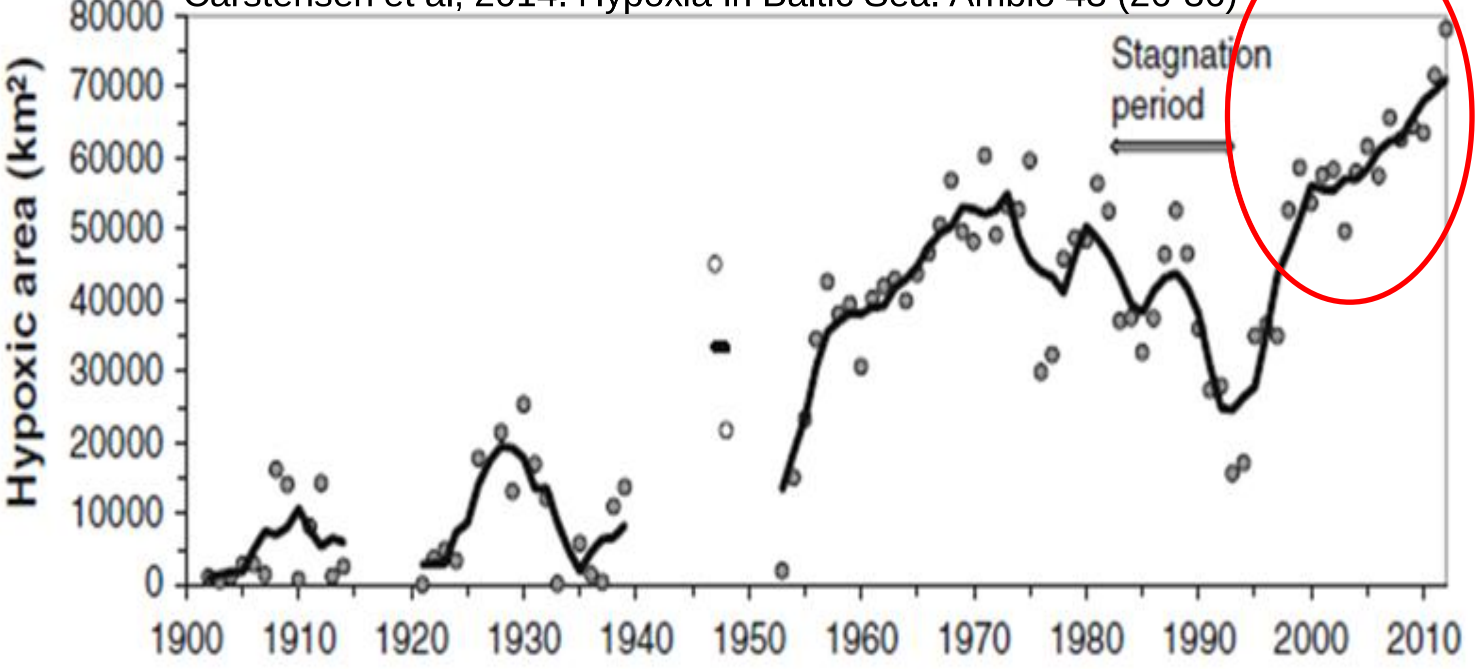
Question 3: How much of the chlorophyll production is driven by Danish emissions?



Most Danish load reductions on the eastern seaboard would affect at best 30% of production

Baltic Sea low oxygen area has doubled in the last twenty years

Carstensen et al, 2014. Hypoxia in Baltic Sea. Ambio 43 (26-36)



Apart from inland areas such as the Limfjord and Roskilde Fjord, most of the chlorophyll in the water is not driven by Danish N loading. Neither is the increase in low oxygen area in the Baltic.

If there is a nutrient problem—how can we fix it?

- We must fix the problem together as a society, we cannot fix it by moving agriculture to Asia or Africa

- We must choose the correct approach: if it's a hard question, let us look at less simple answers

- Wastewater treatment plants have solved the urban part of nutrient loading: in 1900, the total DK load was 25-30 thousand tonnes, but 60-70% of that was urban, the situation at present is quite different

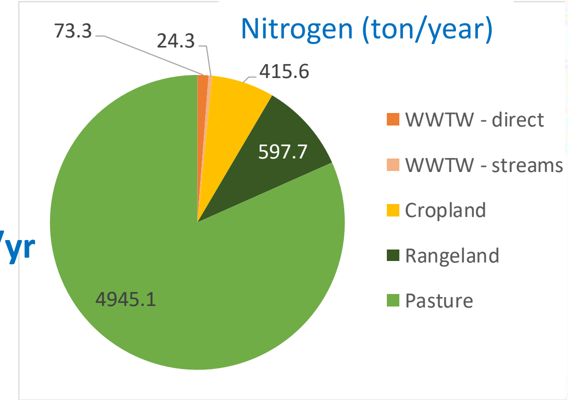
- A bulk reduction of nitrogen is unlikely to succeed, a regional approach for a range of catchments would help to understand what works where

What are other countries in Europe doing about nutrients and agriculture, in terms of integrated watershed management?

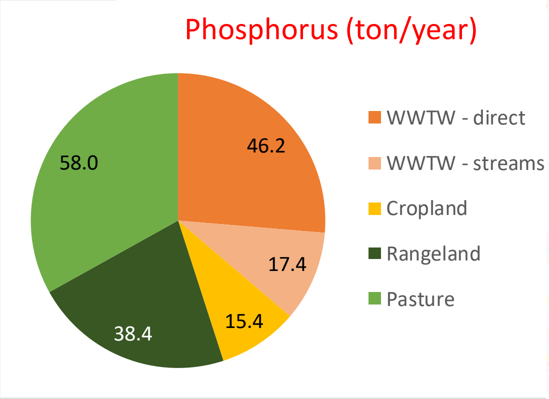
SWAT – Source apportionment of loading to Lough Foyle, a transboundary system (UK/Ireland)

Nutrient loads to Lough Foyle
(inorganic, 2014)

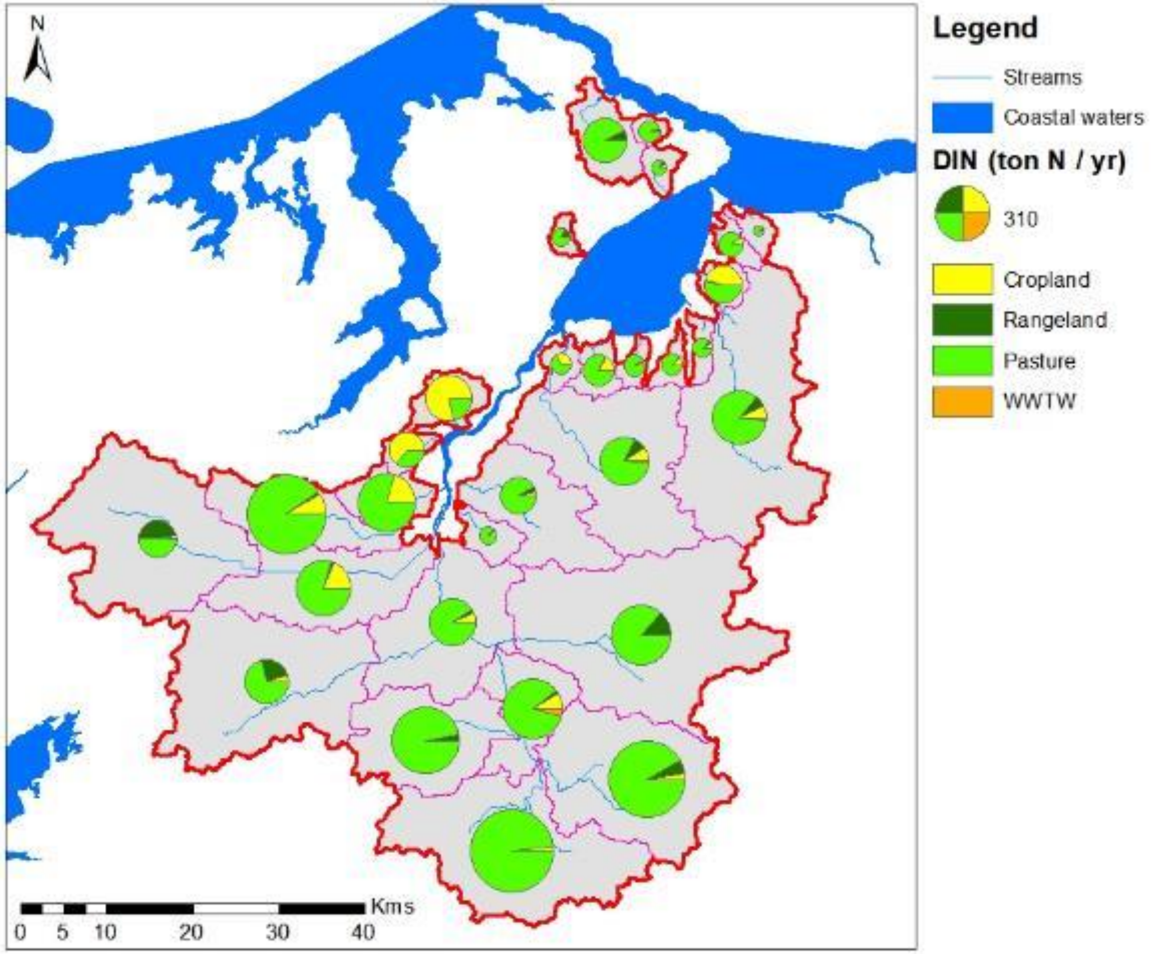
Total N:
6 056 ton/yr



Total P:
175 ton/yr

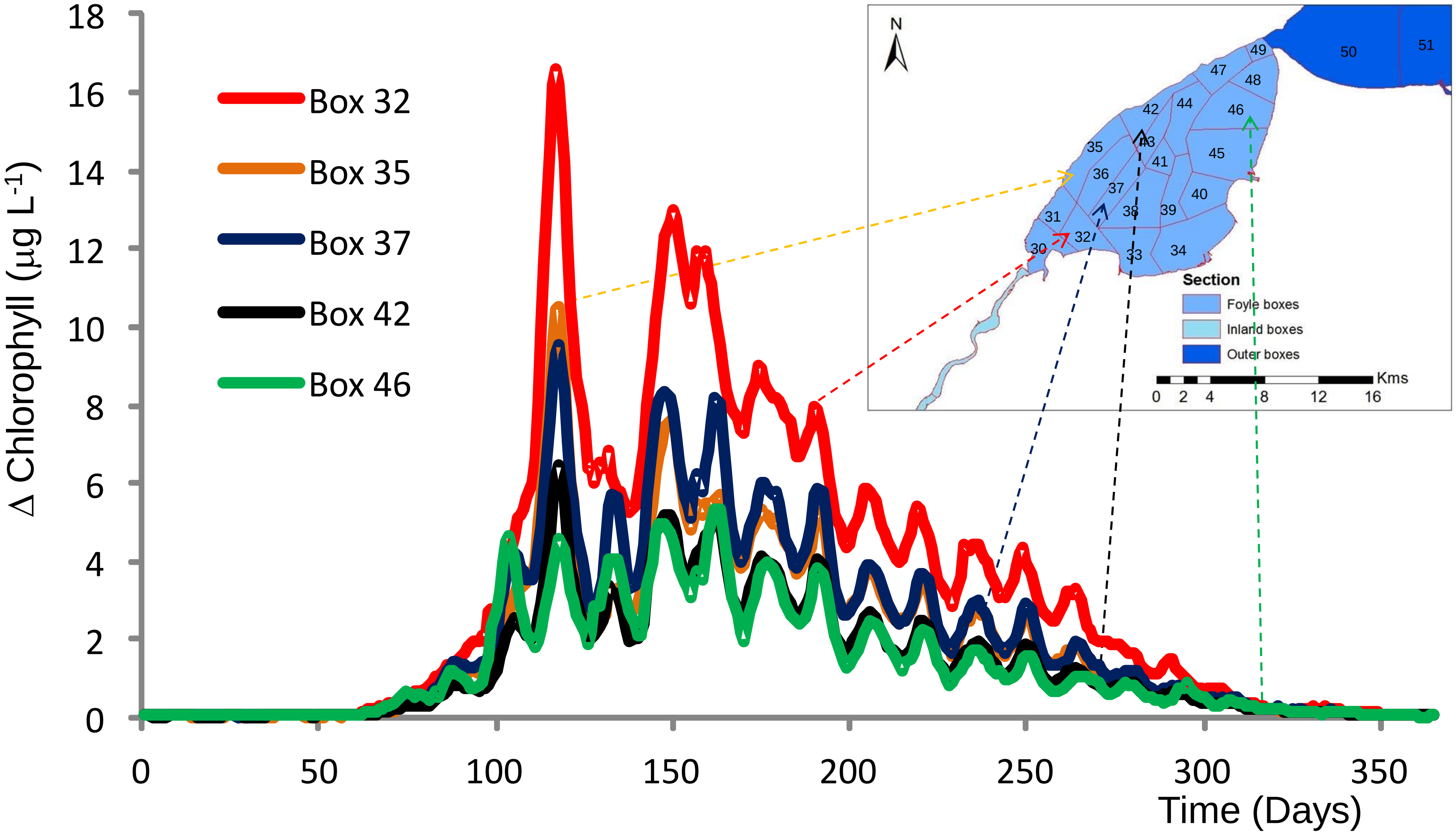


Terrestrial sources of nitrogen
(inorganic, 2014)



The drivers of nitrogen input to Lough Foyle are mainly pastures, rangeland,and crops.

EcoWin.NET Lough Foyle Standard Model
Phytoplankton drawdown by shellfish, Year 9



Ferreira, J.G., Bricker, S.B., 2019. Assessment of nutrient trading services from bivalve farming. In A.C. Smaal, J.G. Ferreira, J.G. Grant, J.K. Petersen, Ø Strand (Eds) 2019. Goods and Services of Marine Bivalves. 616 pp. Springer.

The strongest drawdown is in the central and upper parts of the lough, where both native oyster (*O. edulis*) and blue mussel (*M. edulis*) are grown.

Findings

- The use of historical data for eelgrass distribution as a reference condition is appropriate, although nothing can be stated concerning abundance;
- The only indicator chosen is the SQE ‘Transparency’, rather than the eelgrass BQE itself. The emphasis must be on the biological indicator;
- There is little consistency between N loading determined for small catchments at present, and the restoration of eelgrass to conditions observed in 1900;
- The adequacy of the proposed measures (reduction in nitrogen loading from land) is not clear, because these fail to address restoration as a multi-stressor question;
- This complex multi-stressor problem has been reduced to setting a target for nutrient emissions, which is unlikely to lead to good ecological status.

Recommendations

- The eelgrass distribution and abundance should be the primary chosen indicators since they represent the overall outcome of management measures;
- Water transparency is indispensable for eelgrass growth, but other SQE such as '*Structure and substrate of the coastal bed*' should also be included, to deal with other stressors such as mussel dredging;
- Make full use of mathematical modelling, taking advantage of DHI competence. Only a model can address source apportionment and transboundary issues, but ultimately management decisions belong to policy makers;
- Management measures must connect drivers, pressure, and state in order to be effective. For water clarity, investigate the relationship between land-based N loading and the components of light attenuation;
- If reductions in nutrient emissions do not result in eelgrass restoration, the trade-off in social costs to farming communities and acceptance of management measures by Danish society will become divisive issues.

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