Eutrophication in the Baltic Sea: Past, present and future status

Jesper H. Andersen
Chief Scientist (PhD)
NIVA Denmark
jha@niva-danmark.dk

Co-workers: J. Carstensen, D.J. Conley, R. Elmgren, V. Fleming-Lehtinen, B.G. Gustafsson, C. Murray & B. Müller-Karulis

Outline

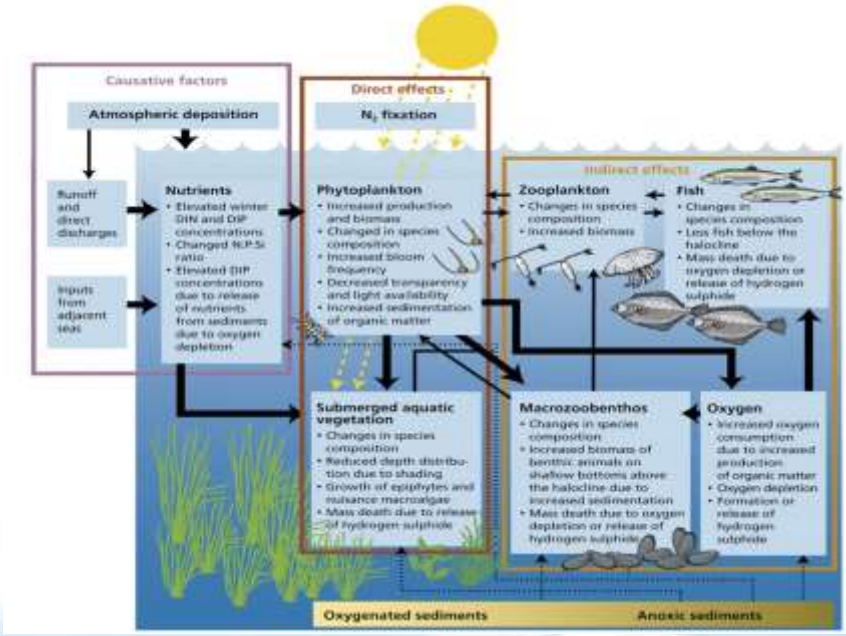
- What is eutrophication?
- HEAT and classification of past and present eutrophication status in the open parts of the Baltic Sea
- Can we trust the results?
- What are the perspectives?
- Take home messages

What is eutrophication?

- The word 'eutrophication' has its root in two Greek words: '**eu**' which means 'well' and '**trope**' which means 'nourishment'.
- The modern use of the word eutrophication is related to inputs and effects of nutrients in aquatic systems.
- Despite a common understanding of its causes and effects, there is no agreed definition of coastal eutrophication.
- **An increase in the rate of supply of organic matter to an ecosystem (Nixon, 1995)**

A modern definition sensu WFD:

- **The enrichment of water by nutrients**, especially nitrogen and/or phosphorus and organic matter, **causing an increased growth of algae and higher forms of plant life to produce an unacceptable deviation** in structure, function and stability of organisms present in the water and to the quality of water concerned, **compared to reference conditions** (Andersen et al. 2006)



Ærtebjerg et al. (2003)

The effects of adding N

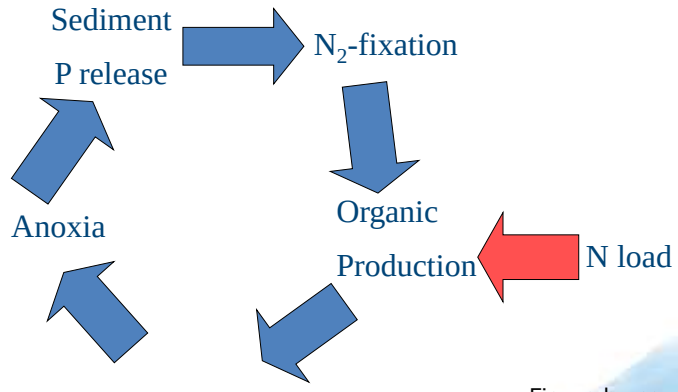


Figure by courtesy of Prof. Ragnar Elmgren, Stockholm University

The effects of adding P

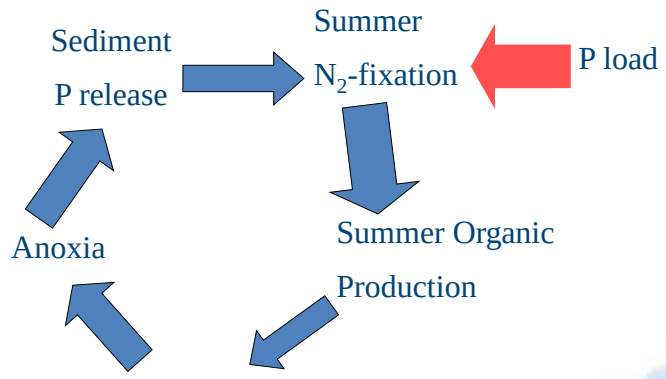


Figure by courtesy of Prof. Ragnar Elmgren, Stockholm University

The positive feedbacks between N and P

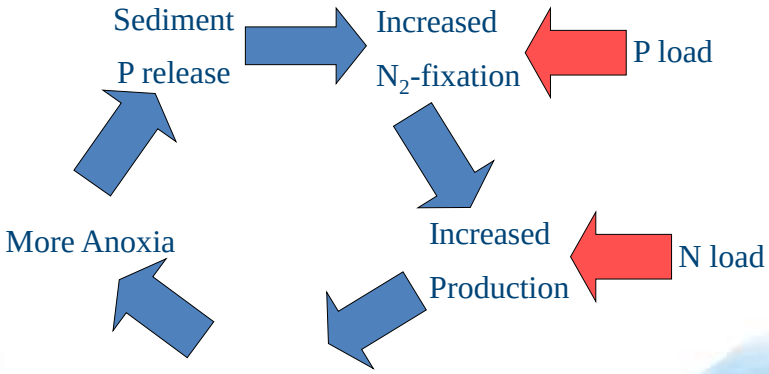
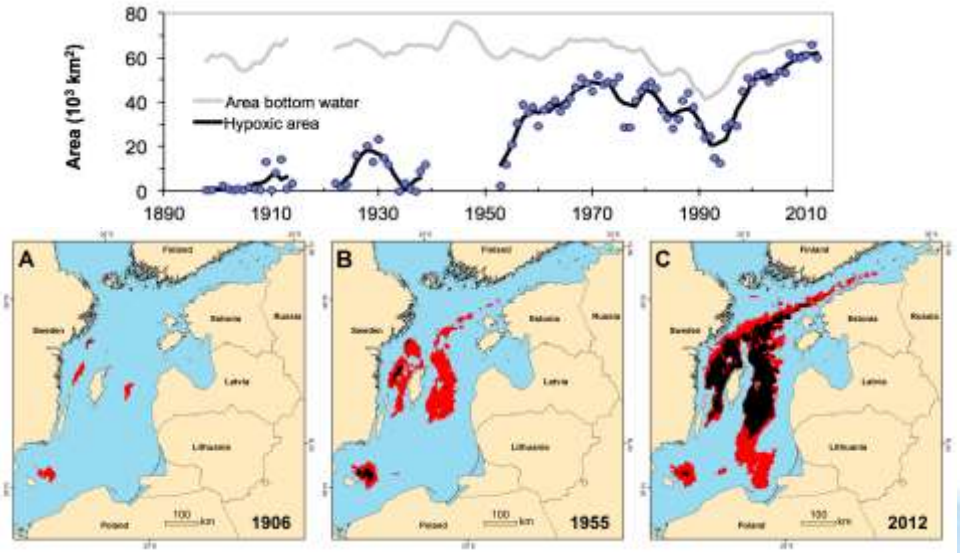


Figure by courtesy of Prof. Ragnar Elmgren, Stockholm University



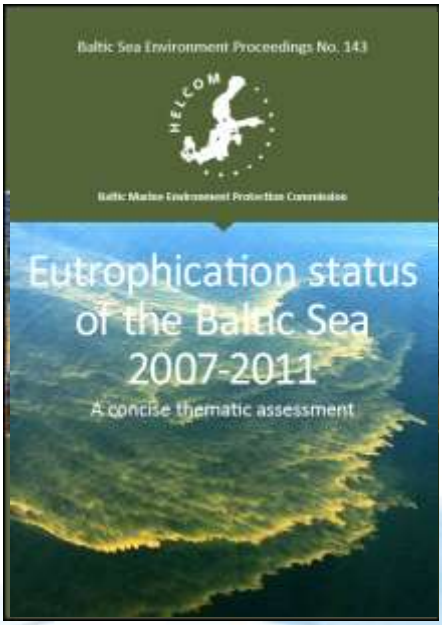
1,500 km^2 25,000 km^2 65,000 km^2

Carstensen et al. (2014)

HEAT 3.0

- HEAT = HELCOM Eutrophication Assessment Tool

- HEAT 1.0 cf. WFD
- HEAT 2.0 cf. MSFD/North Sea
- HEAT 3.0 cf. MSFD/Baltic Sea



HEAT 3.0 assessment process

- Step 1: Calculation of a Eutrophication Quality Ratio (ER) per indicator (G/M boundary = 1.00)
- Step 2a: Grouping of indicators (Nutrient levels, direct effects and indirect effects)
- Step 2b: Classification of status per group of indicators
- Step 3: Integration of groups ('one out-all out' principle)

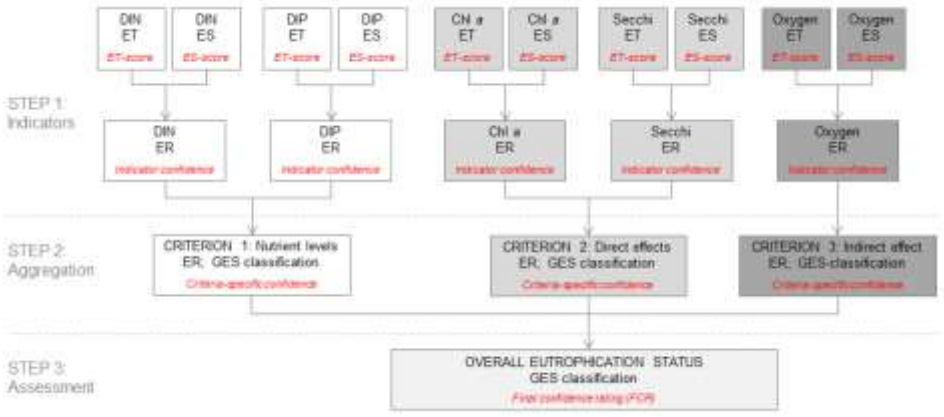
ER	Status	Class	Deviation range
0.0 = ER = 0.5	Unaffected by eutrophication	High	No or insignificant deviation from background values
0.5 < ER < 1.0		Good	Slight deviation below target value
1.0 = ER < 1.5	Affected by eutrophication	Moderate	Slight deviation above target value
1.5 = ER < 2.0		Poor	Major deviation above target value
ER = 2.0		Bad	Significant deviation above target value

Andersen et al. (submitted)

Data sources

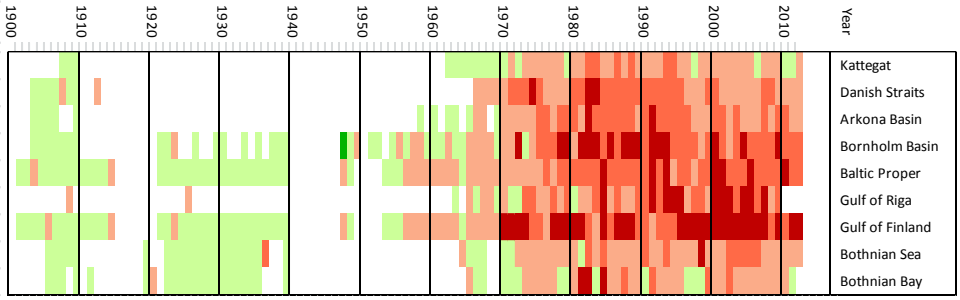
- HELCOM's revised numerical eutro-phication targets for:
  - DIN + DIP
  - Chl-a + Secchi depth
  - Oxygen (+ BQI's)
- An unique dataset covering 111 years (1901-2012)

Conceptual model with indicators, criteria and integrated assessment



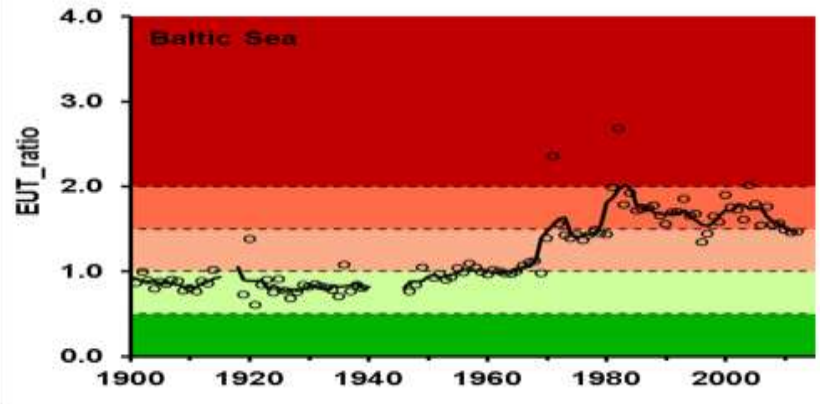
Fleming-Lehtinen et al. (2015)

671 individual HEAT classifications



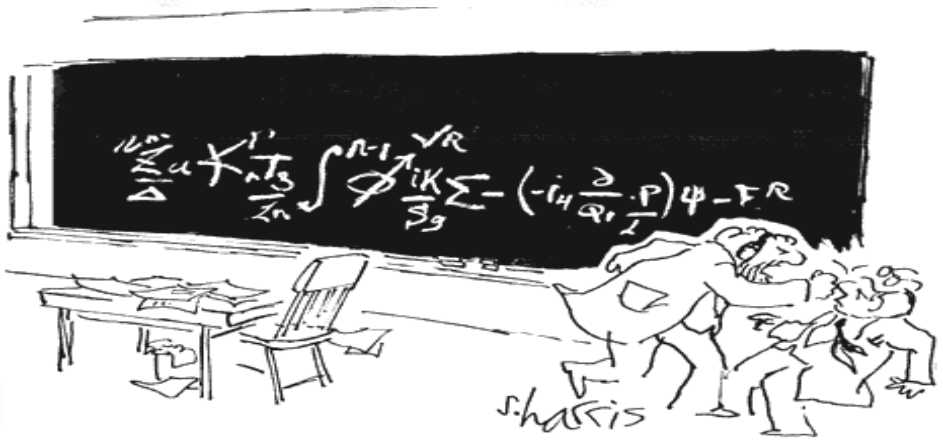
Anderssen et al. (submitted)

Past and present in a single slide (1901-2012)



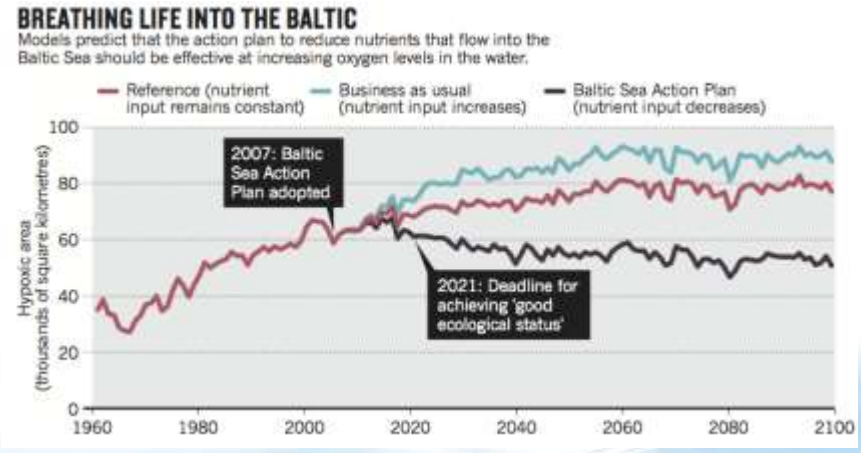
Andersen et al. (submitted)

Can we trust the results?



"You want proof? I'll give you proof!"

The response of the Baltic Sea to nutrient reductions will take time

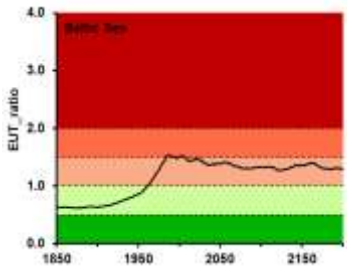


Conley(2012); based on Meier et al. 2010)

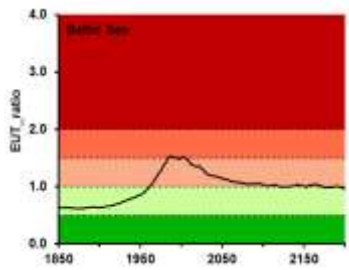
Past, present and future eutrophciation status - modelled

NB: Preliminary results!

Pre-BSAP
(2007 loads)



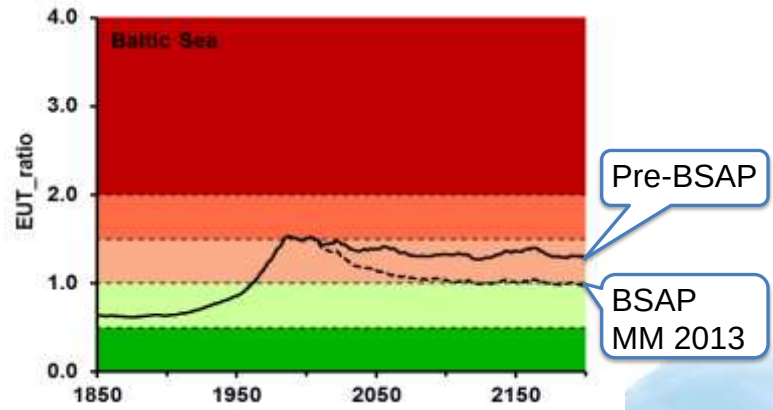
BSAP
(HELCOM MM 2013)



Andersen et al. (in prep.)

Past, present and future status - the BSAP is going to work …

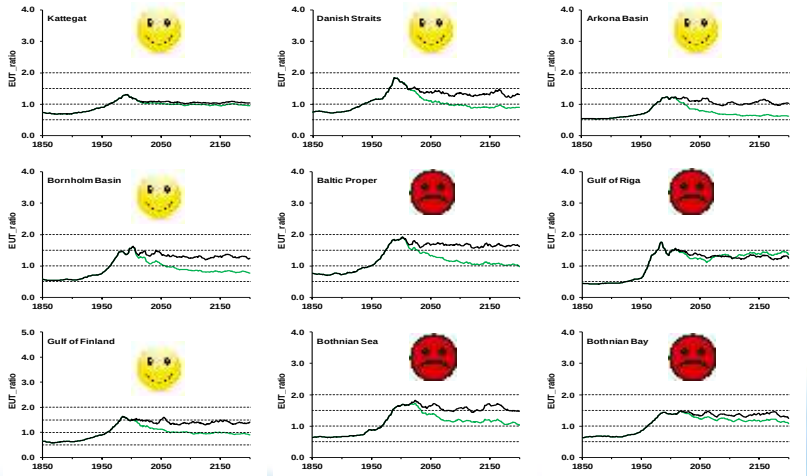
NB: Preliminary results!



Andersen et al. (in prep.)

Past, present and future status - not all basins will make it …

NB: Preliminary results!



Andersen et al. (in prep.)

Take home messages

The Baltic Sea has changed from having a good eutrophication status to being a large-scale eutrophication problem area

AND

Eutrophication trends have been reversed through regional cooperation and adaptive management, e.g. HELCOM

BUT

The HELCOM Baltic Sea Action Plan will probably not lead to a healthy Baltic Sea without any eutrophication problem areas

THEREFORE

Farmers should improve N efficiency and UWWTPs should retain and recycle P (as discharges, losses and emissions of N and P represent a waste of valuable resources)

Thank you for your attention

- Also many thanks to my colleagues:
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