How could state of the art ecosystem modelling support the HELCOM eutrophication assessment

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21 Jan 2016

Kick-off workshop of the network of experts for redeveloping models of the European marine environment (Nerd-meme?)

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Contents

1. Introduction to the eutrophication assessment
2. Experience from combining ecosystem modelling and management expertise to set common goals
3. Foreseeing future possibilities for applying modelling
4. Conclusions

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HELCOM, BSAP and eutrophication

The Helsinki Convention was initiated in1974, includes all Baltic Sea coastal states

Baltic Sea Action Plan ratified in 2007, modifications in 2010

- an agreement → no legal bounds
- ecosystem-based management of human actions, adaptive management
- used also for implementation of MSFD in the Baltic Sea region

HELCOM eutrophication status assessment

- common monitoring programme (COMBINE) since 1979, first quantitative eutrophication status assessment in 2009
- Following response to nutrient load reductions
- Assessing good environmental status of MSFD D5

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Eutrophication has various expressions in the Baltic Sea

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How to assess overall eutrophication?

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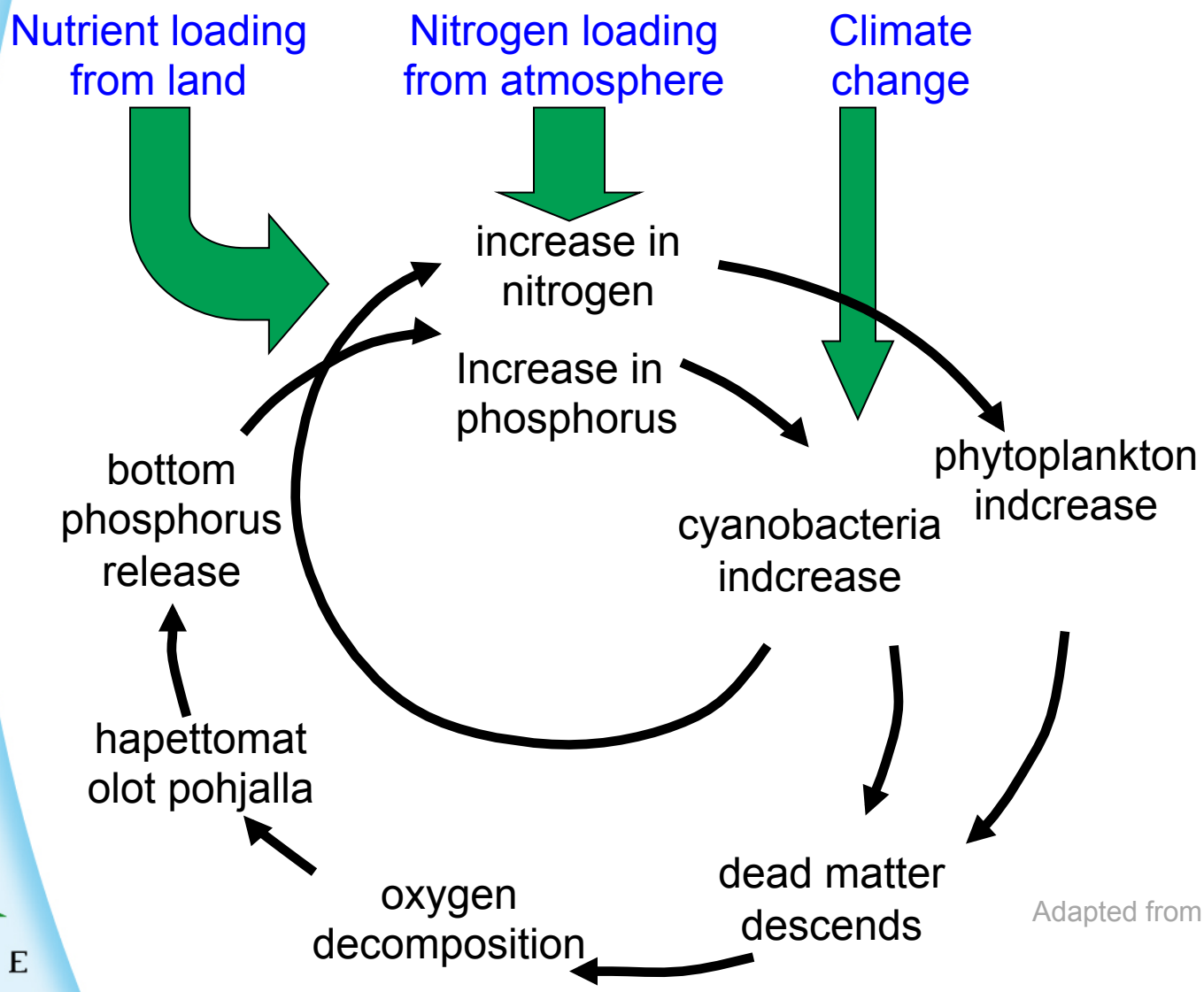
The vicious eutrophication cycle



Decreased water transparency

Change in coastal vegetation

Change in zoobenthic communities

Change in fish populations

Adapted from *Markku Viitasalo /SYKE, Vahtera et al. 2007*

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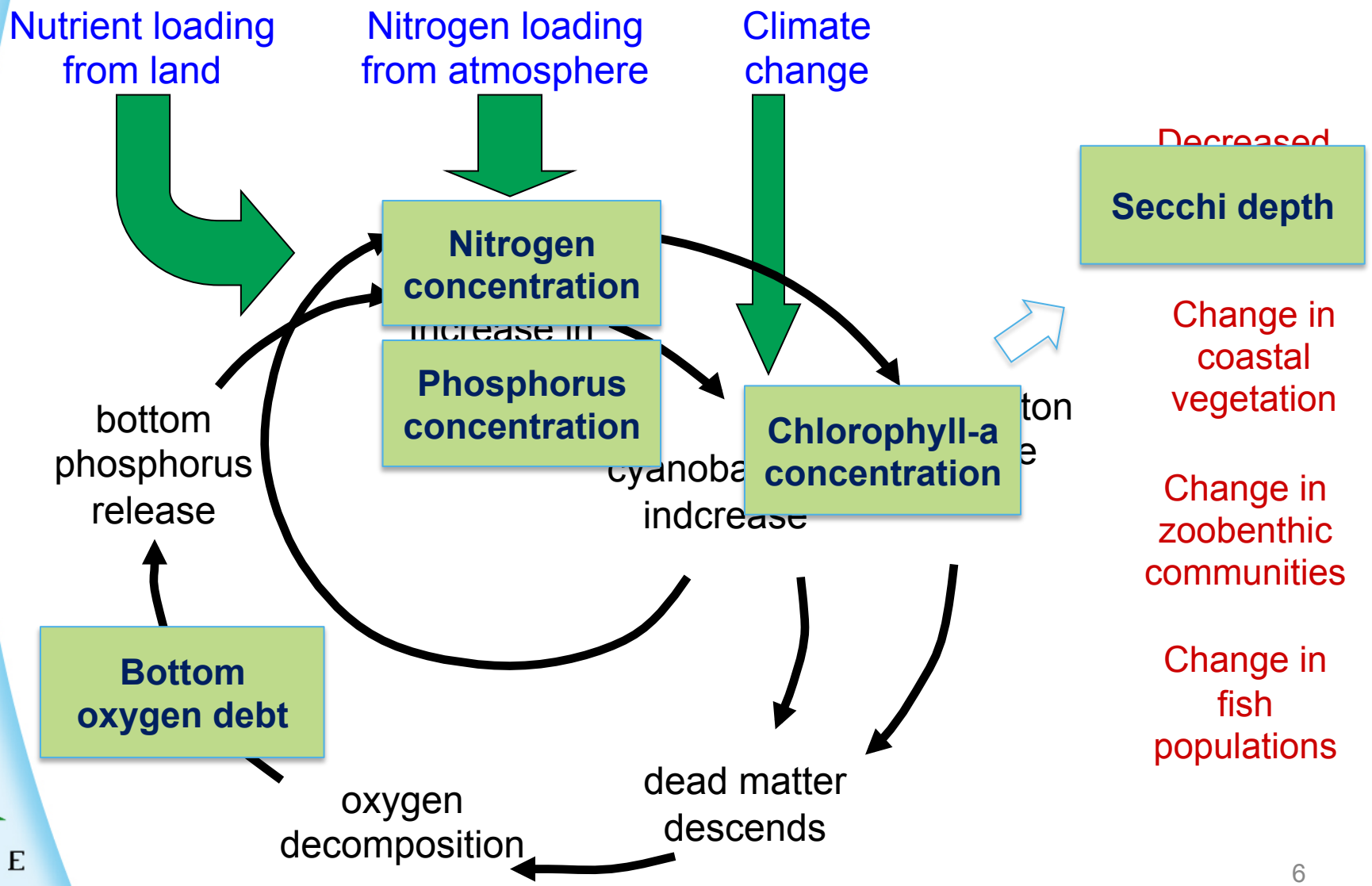
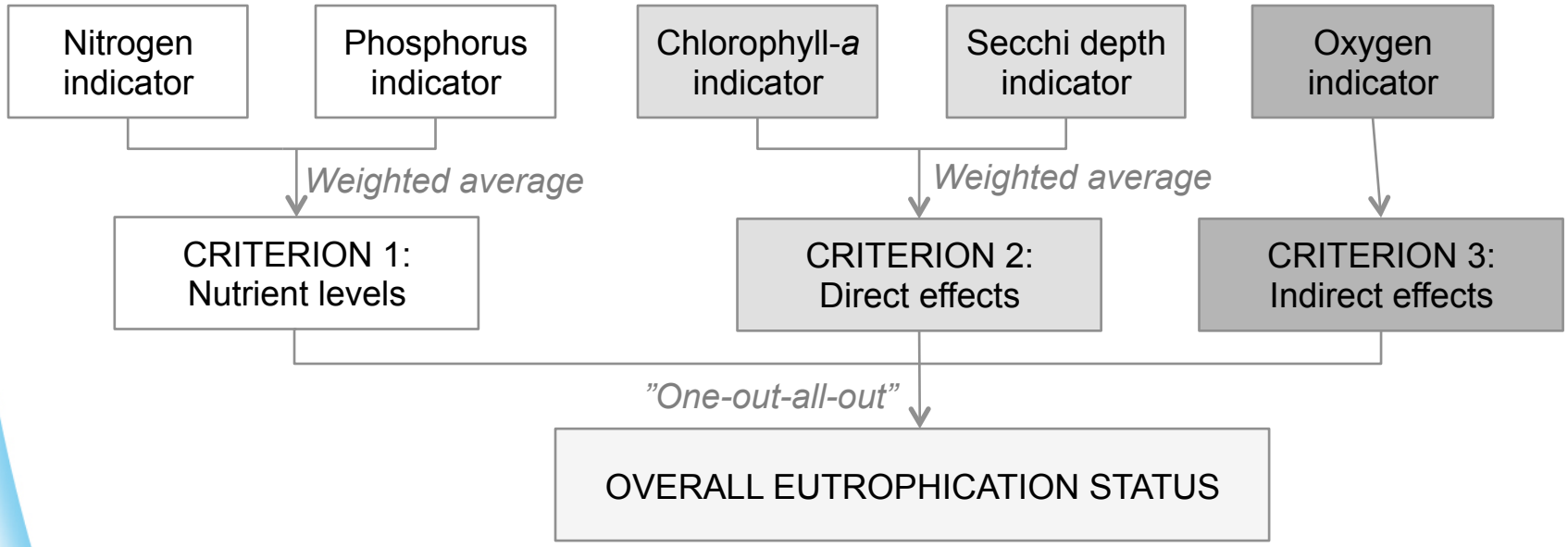
Indicators: measurable units in the cycle



Indicators - assessment

- Information from indicators can be combined in several ways
- The approach used for eutrophication in the Baltic Sea: HELCOM eutrophication assessment tool (HEAT 3.0)



(modified from *Fleming-Lehtinen et al. 2015*)

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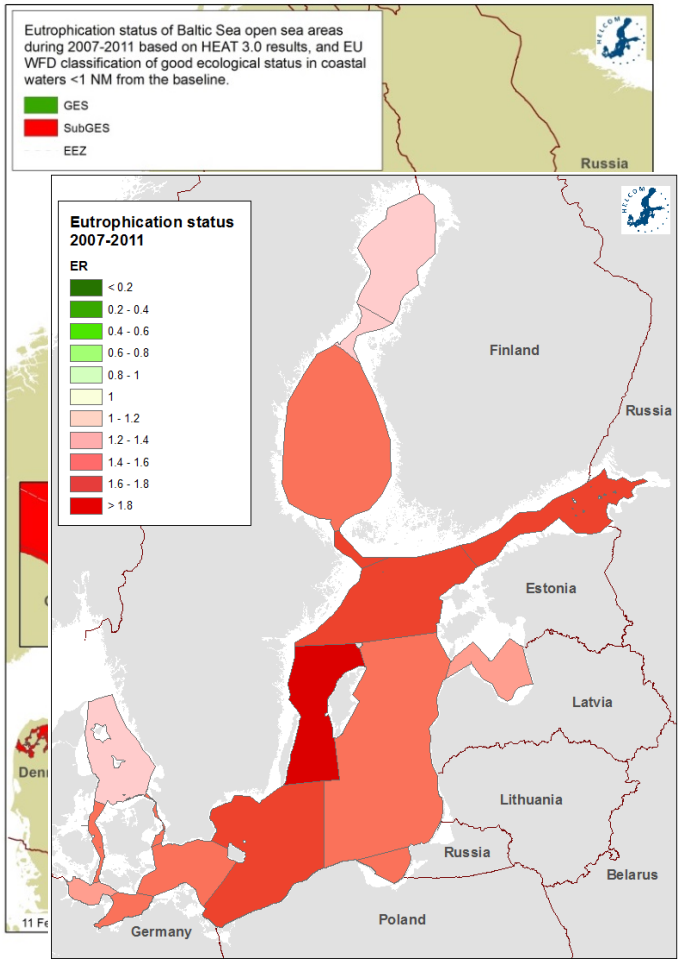
Eutrophication status for open-sea areas

- Status is assessed for 17 sub-basins, using same CORE indicators
- Classification: GES / SubGES, further levels may be used to reviel distance to GES
- Monitoring data reported by contracting parties is used to update indicator status
- Commonly agreed GES boundaries are employed

Overall eutrophication status 2007-2011



(*HELCOM 2014*)

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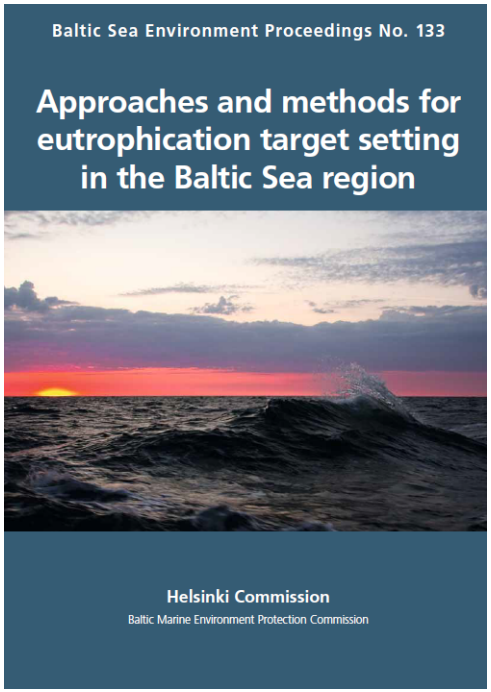
Experiences from the TARGREV project: using historical data and ecological modelling to estimate GES boundaries (HELCOM 2013)b



- All available historical monitoring data on indicator parameters was collated, resulting with time-series
  - 100 years: Secchi depth, oxygen
  - 50-60 years: nutrients
  - 40 years: chlorophyll-*a*
- Model ensemble was constructed using three models: BALTSEM (BNI), ERGOM (IOW) and MIKE-ECOLAB (DHI)
  - Simulations with different load scenarios
  - Simulating each indicator separately
  - Validation excercise showed that no single model outperformed the others

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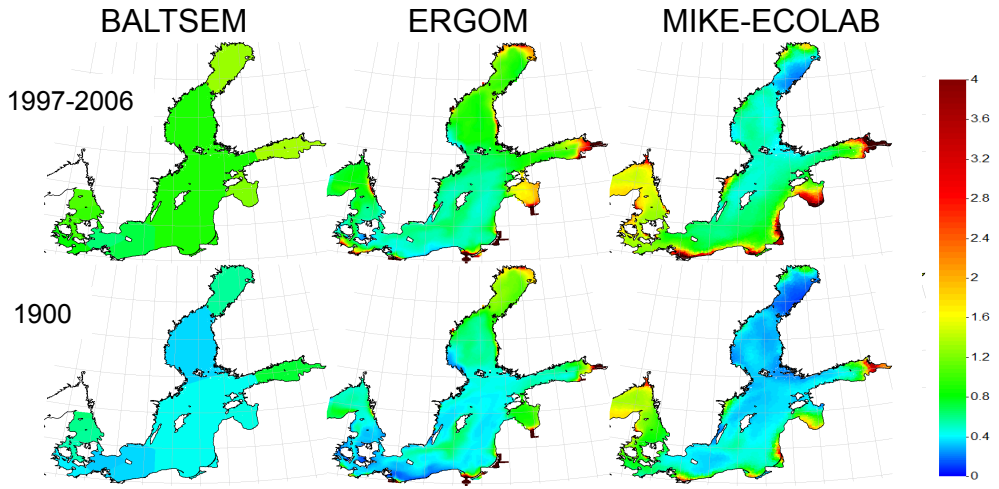
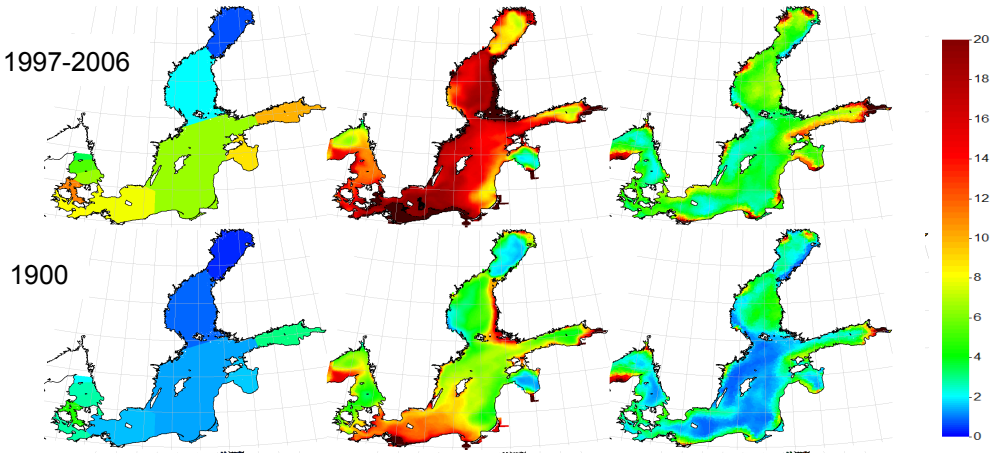
Hindcast simulation results

- All three models showed consistent responses to load changes
- All three models showed similar results for DIN, DIP and oxygen
- Differences between models in results for chlorophyll-*a* and Secchi depth

  → not applied



Dissolved inorganic nitrogen (DIN) indicator



Chlorophyll-*a* indicator

(*HELCOM 2013*)

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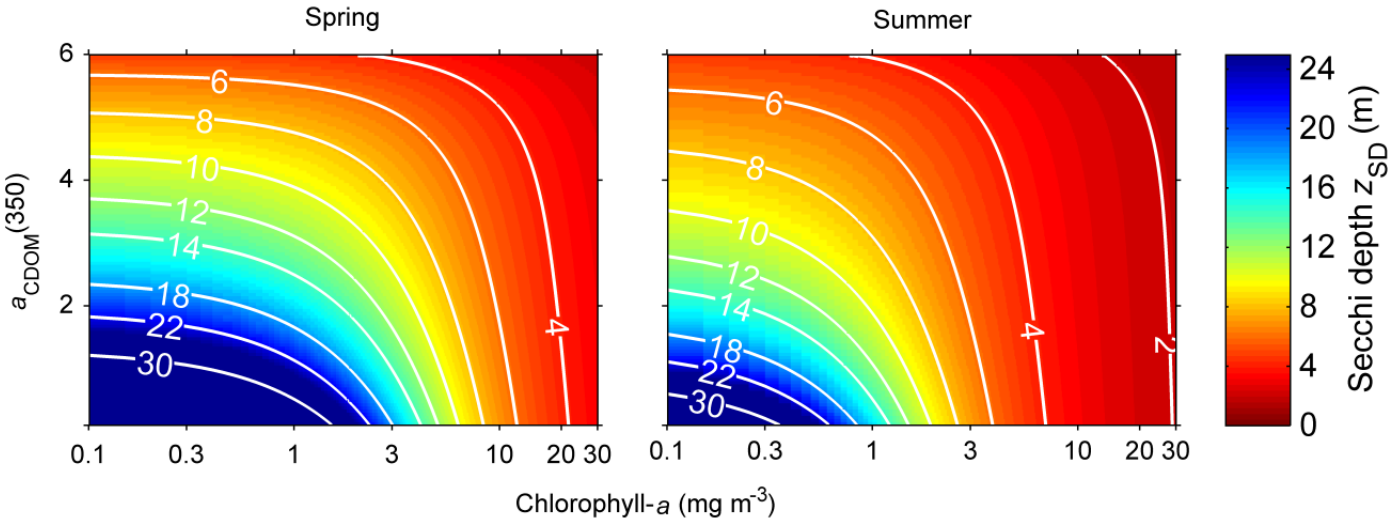
Further harmonizing chlorophyll-*a* and Secchi depth: bio-optical modelling

- Radiative transfer software Ecolight 5
- In water optical measurements from the Baltic Sea → generalization of optical properties
- Adjusting model output with historical monitoring data
- Resolving the share of natural variation in CDOM concentration in determining Secchi depth



Fleming-Lehtinen and Simis, subm.

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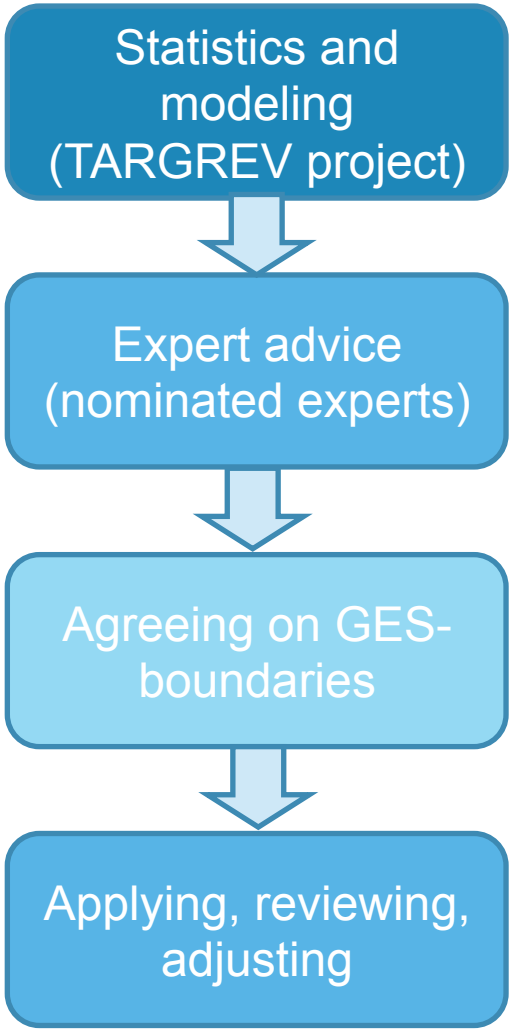
Setting the GES boundaries: combining science and management expertise to support policy



- Change point detection to time-series
- Historical monitoring data, ecosystem modelling

- Comparison with other results
- Attempt to harmonize between sub-basins and indicators

- Consensus at Baltic Sea level

- Applied in eutrophication status assessment 2007-2011
- To be reviewed at regular intervals

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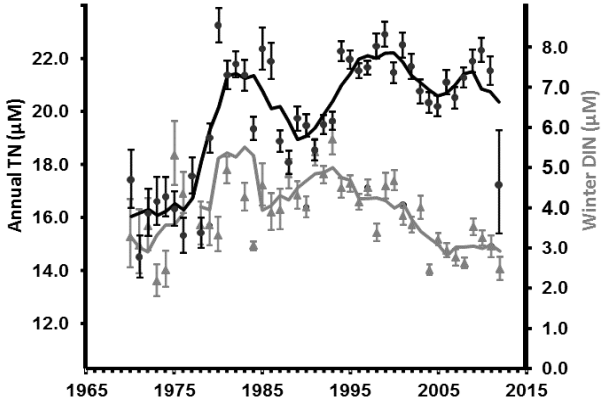
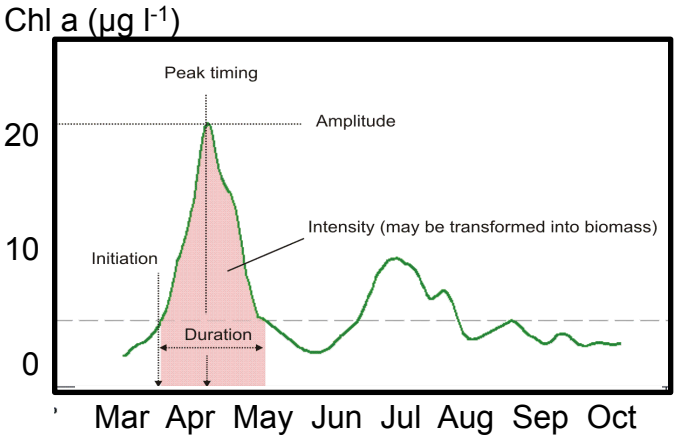
Future needs: GES boundaries for indicators under development

- Total nutrient indicators
  - hindcasting: monitoring does not provide information from pre-eutrophied period
  - difficult to model?



(modified from *HELCOM 2013*)

- Spring bloom chlorophyll-a indicator
  - process-based approach: how does descending biomass affect oxygen consumption and overall eutrophication?
  - historical approach: hindcasting spring bloom biomass



(*HELCOM 2016*)

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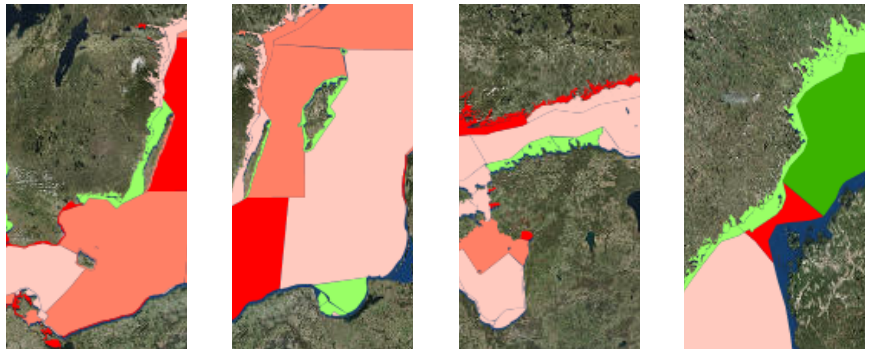
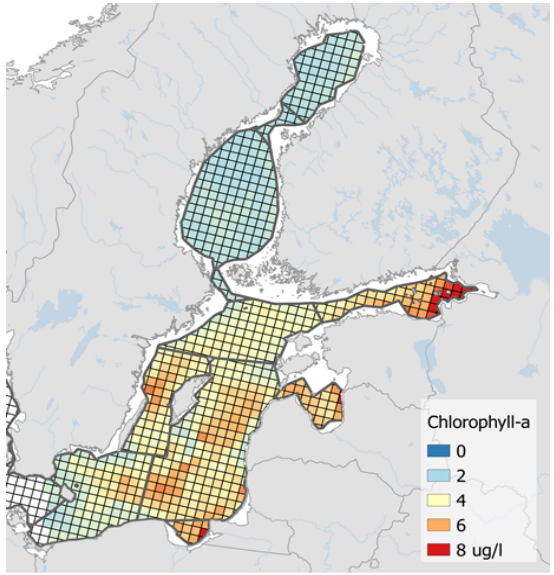
Other anticipated modelling possibilities

- Further harmonization of GES-boundaries accross assessment unit boundaries and between indicators



Examples of preliminary indicator results showing potential boundary discrepencies. *HELCOM 2016*.

- Including model-derived data into the update of core indicators (eg. nutrients?)



The SYKE EO-data product is included to update of chlorophyll-*a* indicator as 20K grid daily geometrical means. *HELCOM 2016*.

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Conclusions

- Most important: Setting the key parameters to assess the phenomenon as a whole – a political decision relying ecological expertise
- All assessment information is a compromise between availability, confidence and usability
- The assessment methodology is under constant improvement, adapting to increased scientific knowledge
- Applying new techniques to regional sea convention assessments is essential – but the process from scientific results to implementation is slow

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