# The challenge of enhancing aquaculture in the Baltic Sea – a Finnish perspective

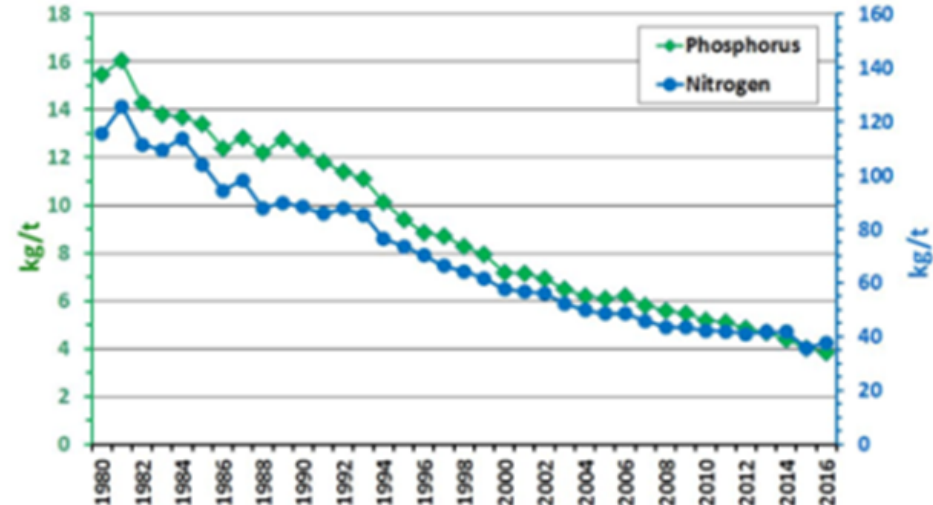(Harri Kuosa, Finnish Environment Institute)

Goal: Tripling (3x) Finnish fish farming in continental Finland (Åland Islands excluded) from 8 million kilos to 20 million kilos per year

Fish farming has progressed in its nutrient load

Feed conversion ratio at fish farms during 1980-2016 in Finland
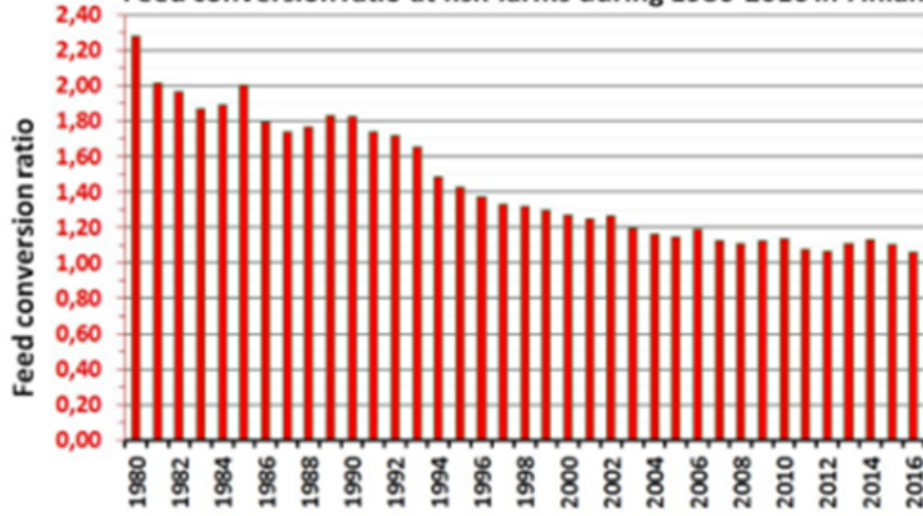
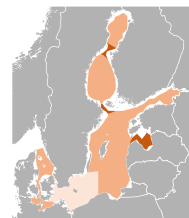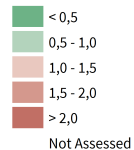Phosphorus and nitrogen (kg) per 1000 kg produced fish

But national targets have not been reached (tons per year):

Sea area	Under P target	Under N target
Gulf of Finland	170	3000
Archipelago Sea	100	1400
Bothnian Sea	60	900
Bothnian Bay	13	6

Target is good ecological status - one of the problems is eutrophication
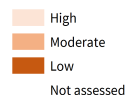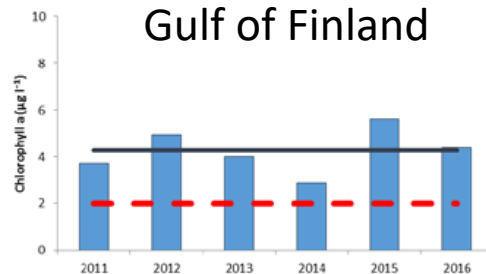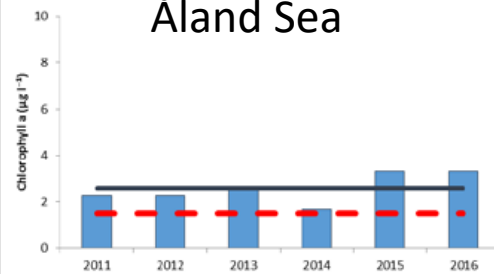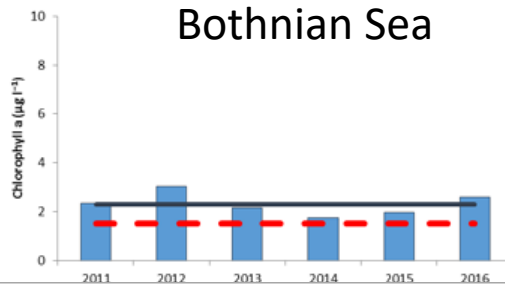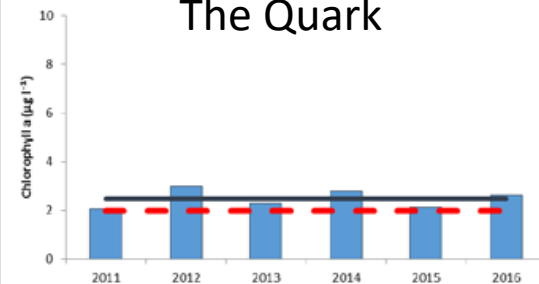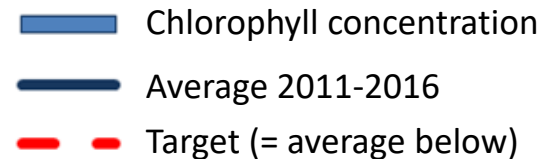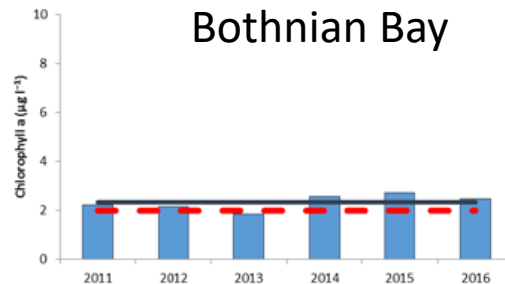
Ecological state of Finnish coastal waters in 2015 and in 2019

The effect: Carbon
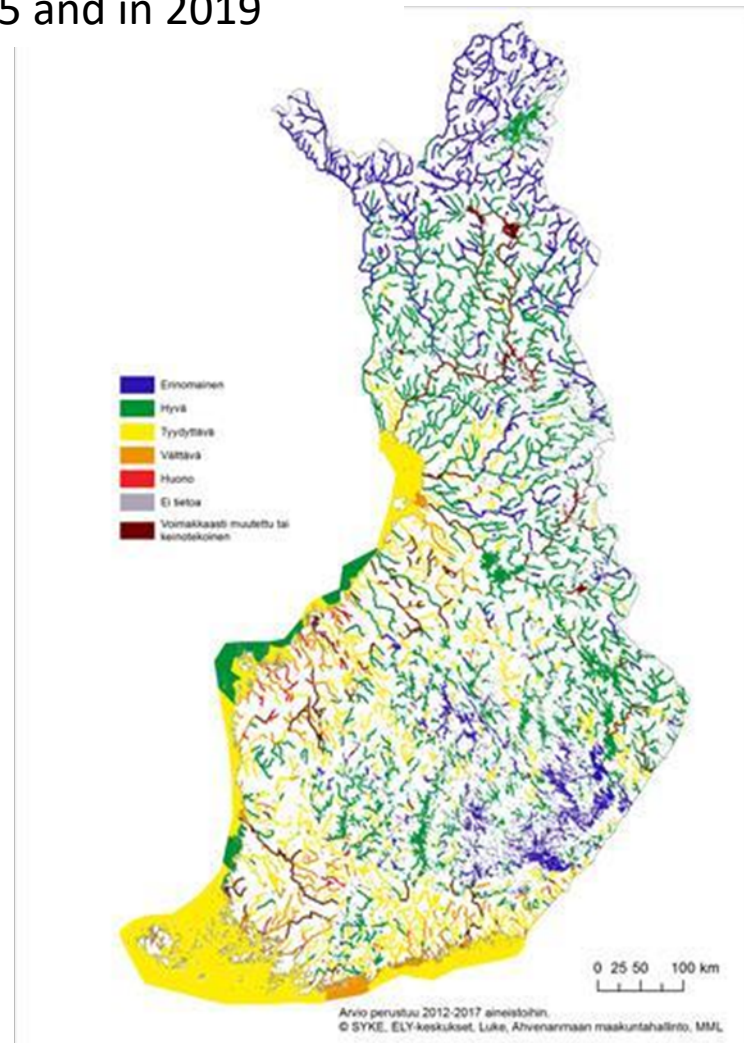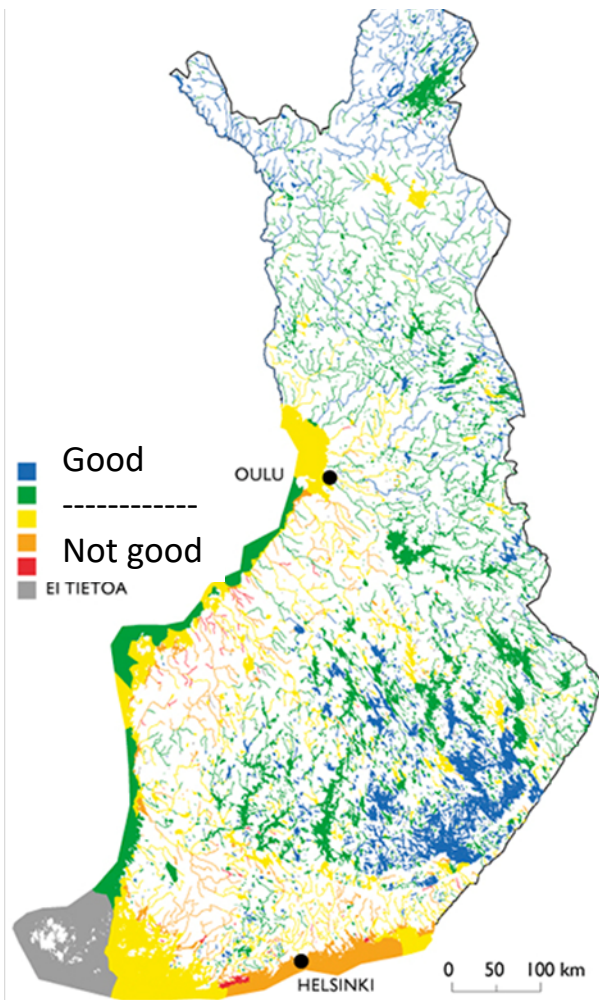

Food Carbon

100 %

Fish
48.7 % respired

29.7 %

Fish biomass

29.7 %

21.6 %

Dissolved waste

3.2 % DOC

Particulate waste POC

18.4 %

(15 % of POC produced)
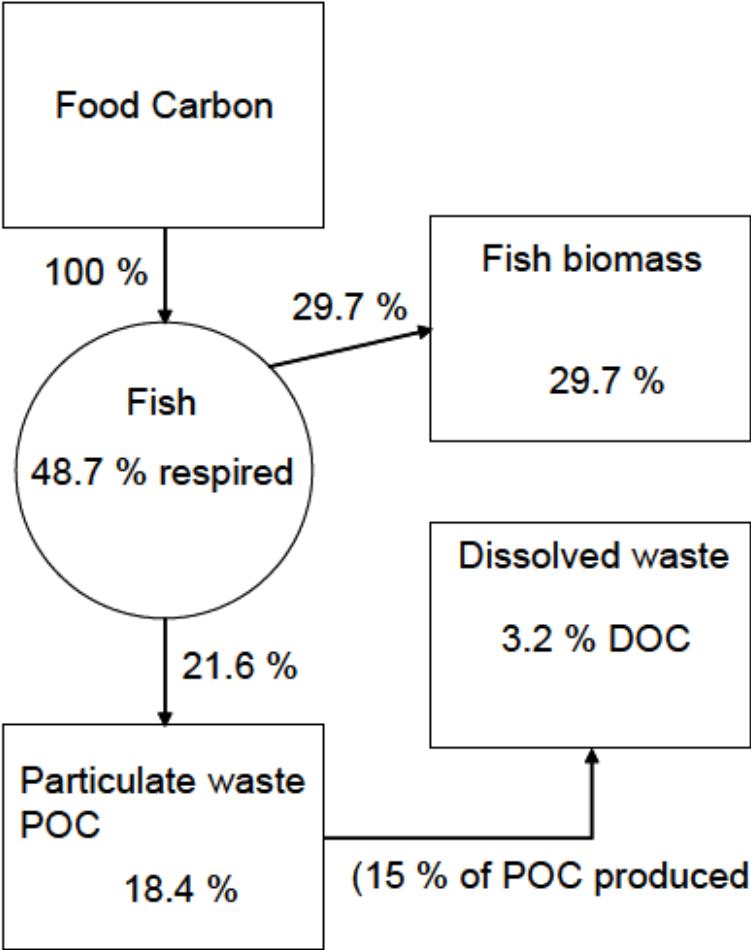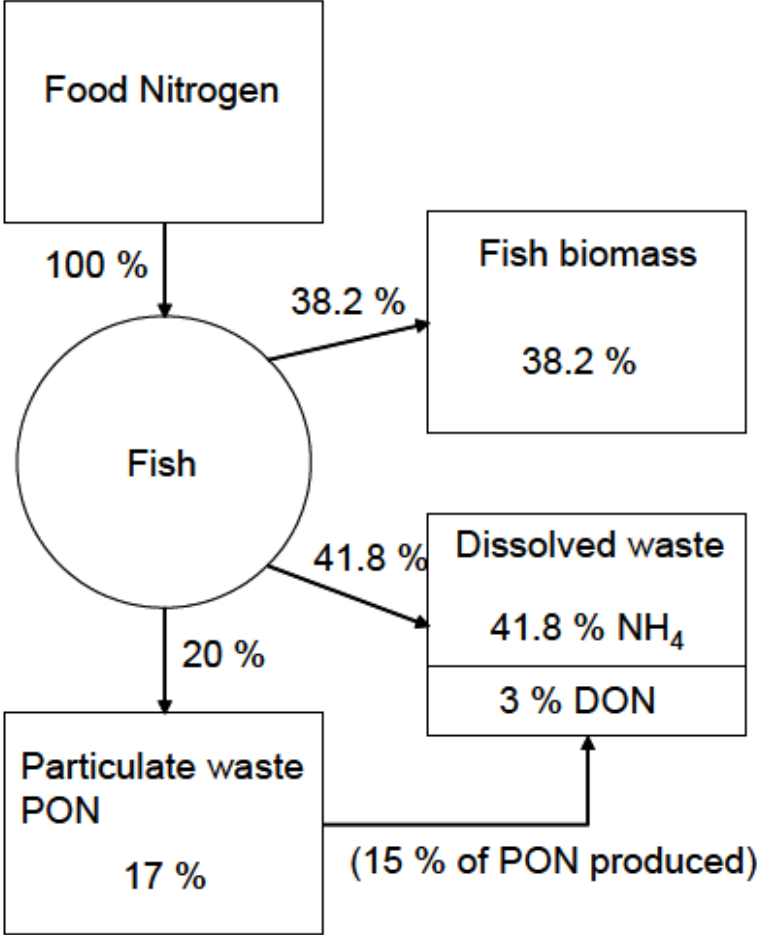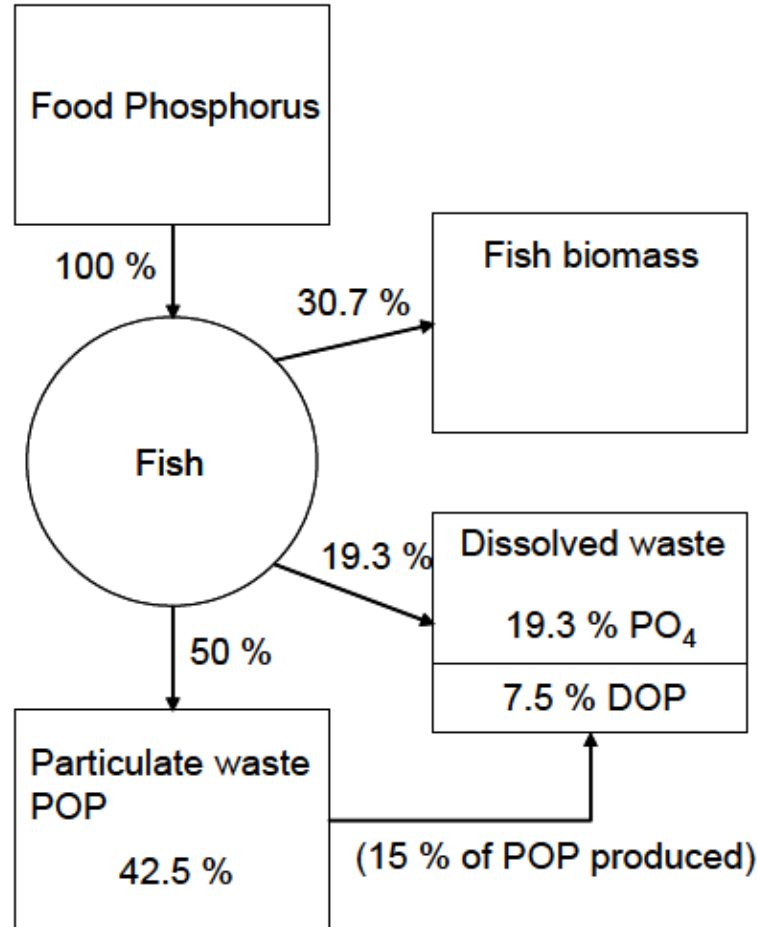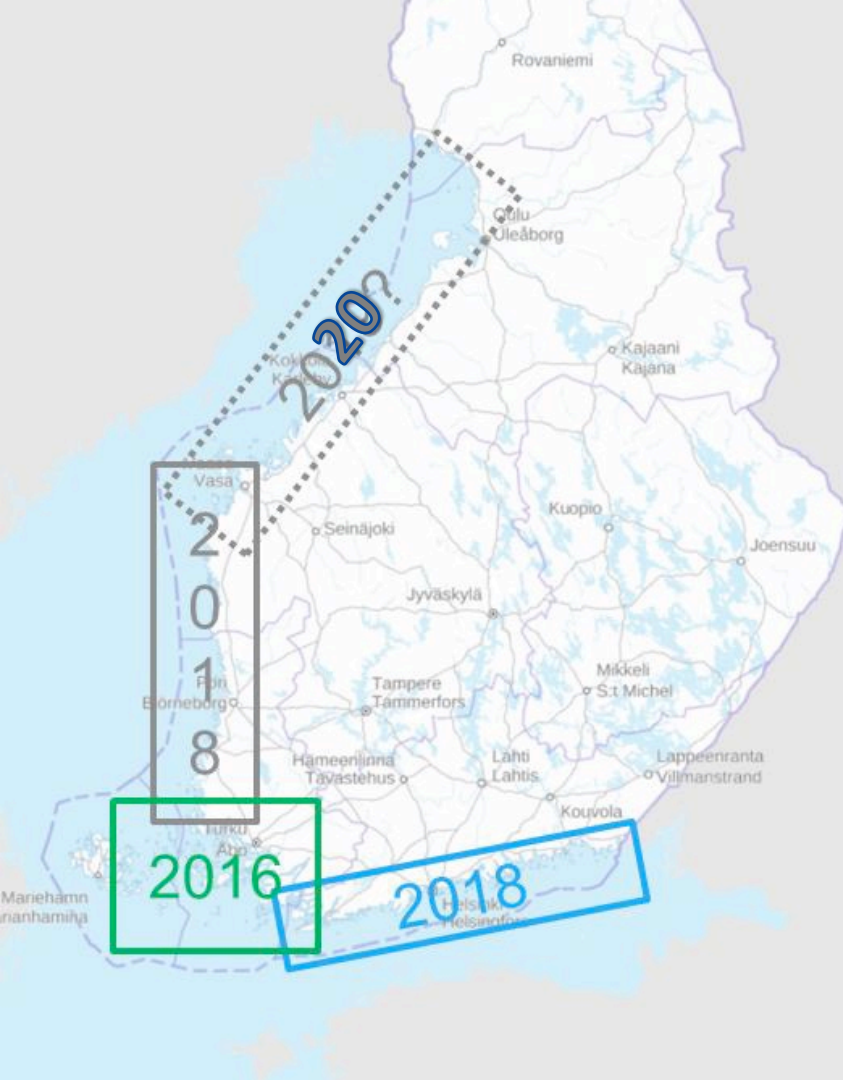
Oxygen comsumption

The effect: Nitrogen

Algal growth

The effect: Phosphorus

Food Phosphorus

100 %

Fish

30.7 % → Fish biomass

19.3 % → Dissolved waste
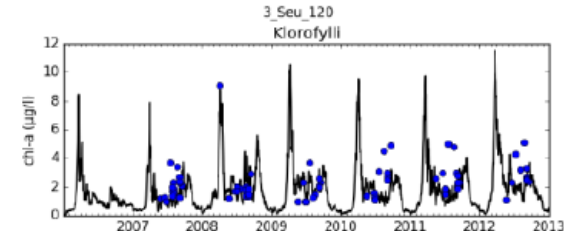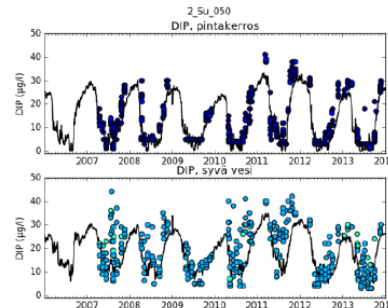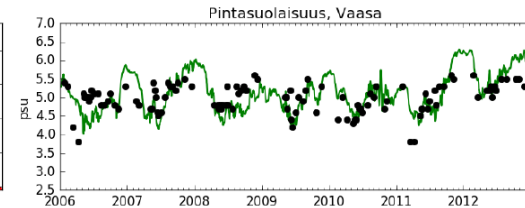19.3 % PO$_4$
7.5 % DOP

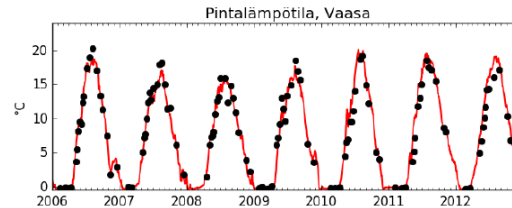50 % → Particulate waste POP
42.5 %

(15 % of POP produced)
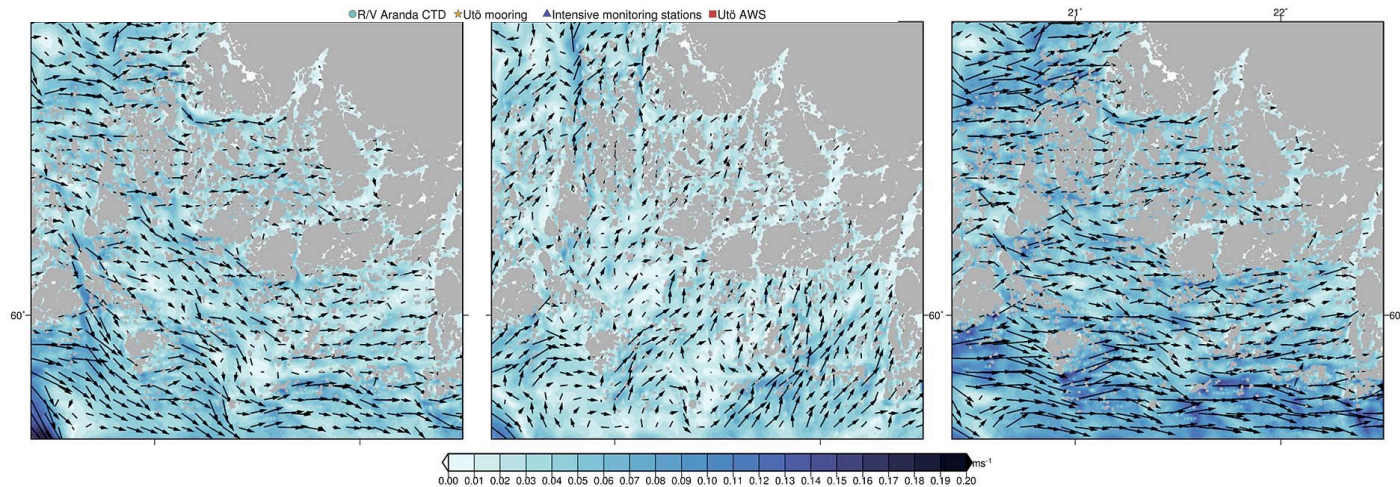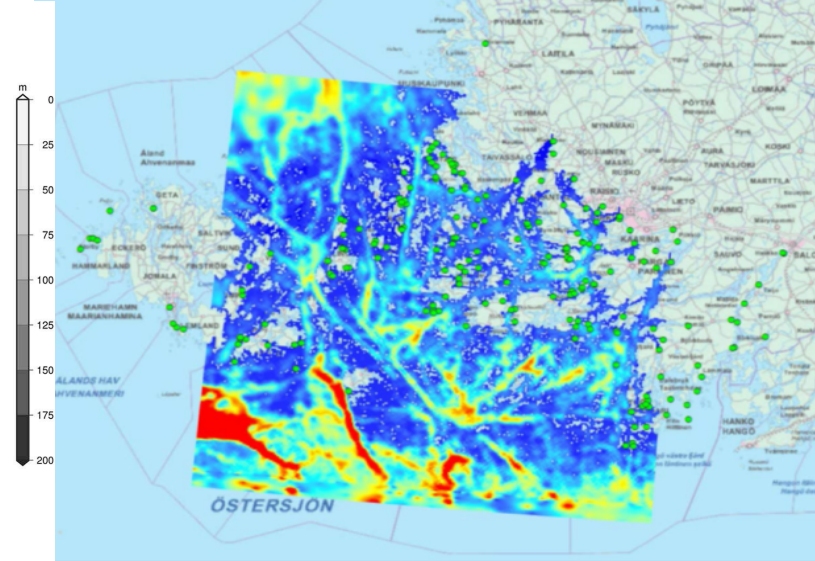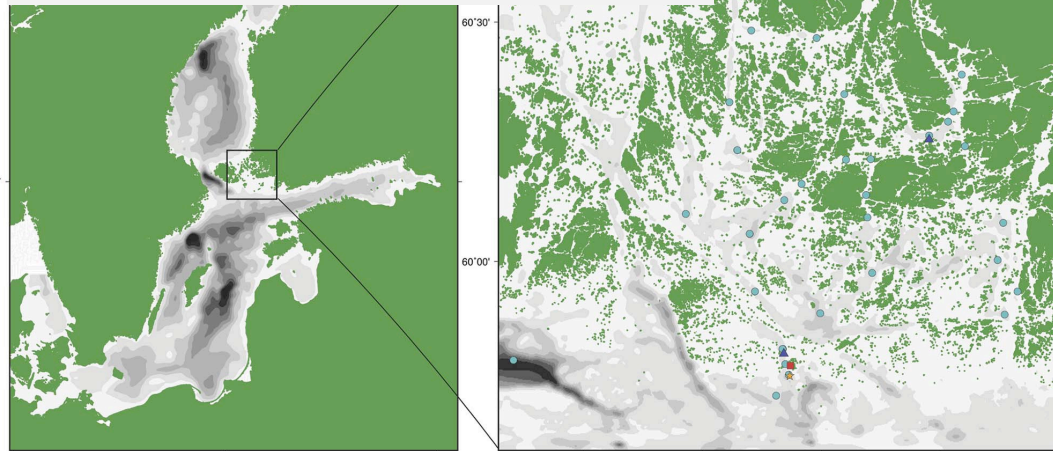
Algal growth (cyanobacteria in certain areas)

How the effects have been tried to predict:
- A group of models, which are tailored for our coastal areas.
- The models are tested by using existing monitoring data (solid line = model, dots = data).
- Red = temperature
- Green = salinity
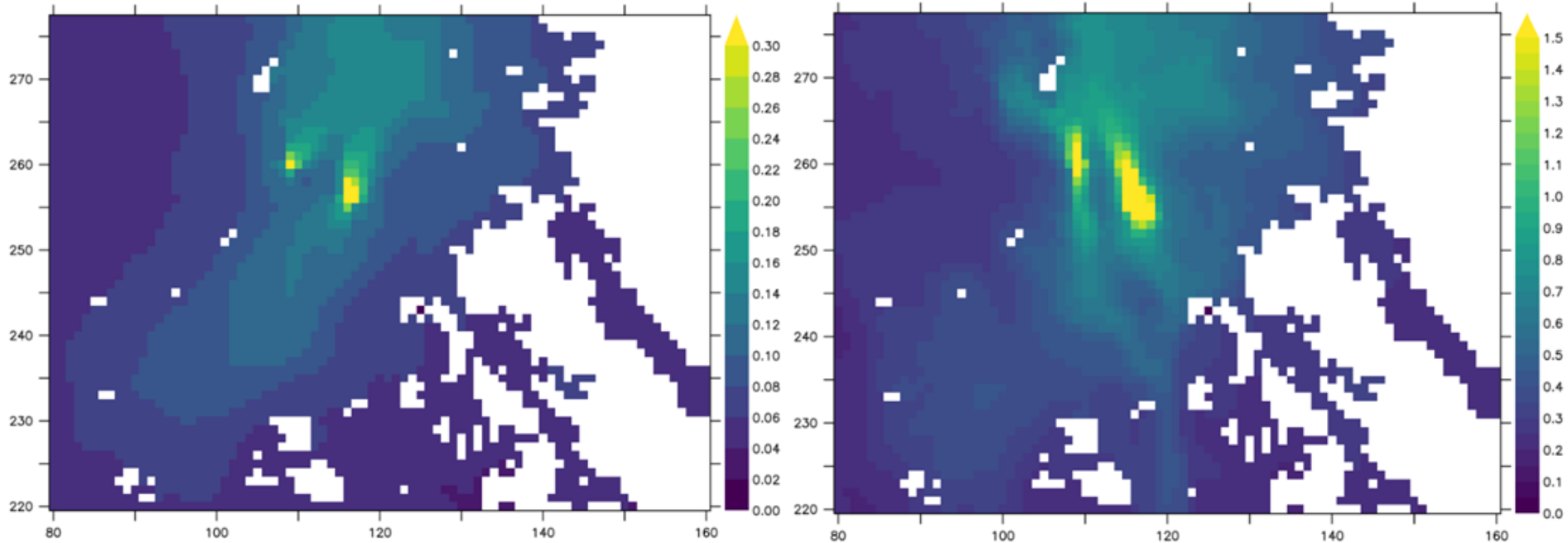- Lower panels phosphorus and chlorophyll

Physical modelling:

R/V Aranda CTD ★ Utö mooring ▲ Intensive monitoring stations ■ Utö AWS

0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.19 0.20 ms⁻¹

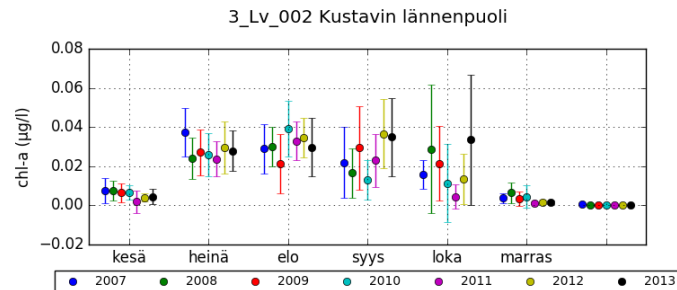# An example on distribution of a point source loading
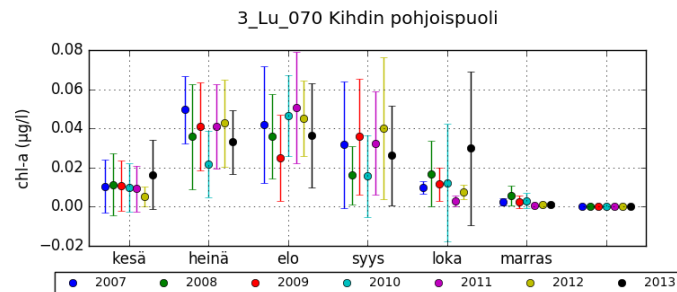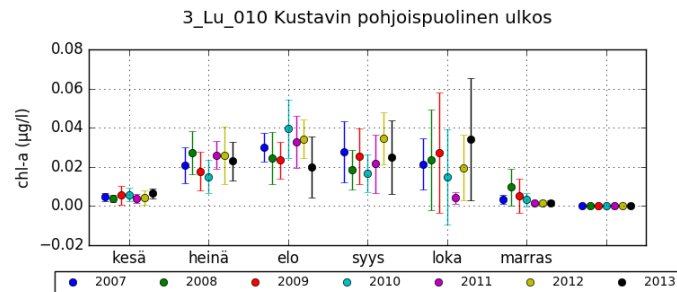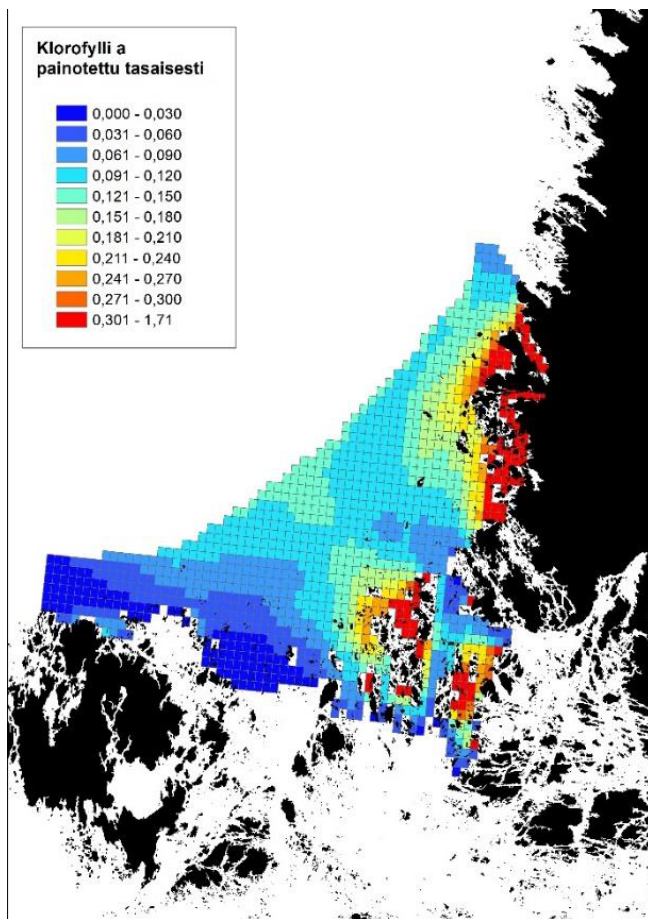
Surface (0 – 10 m)   Deep water
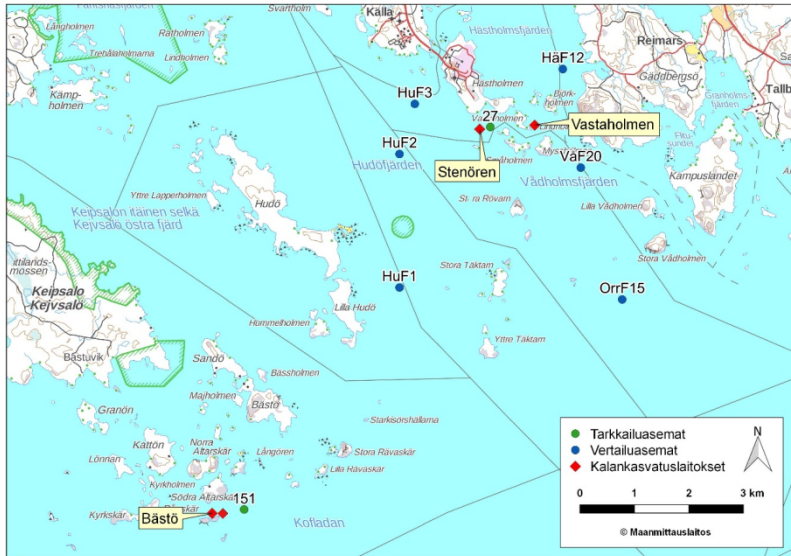

Average for a month

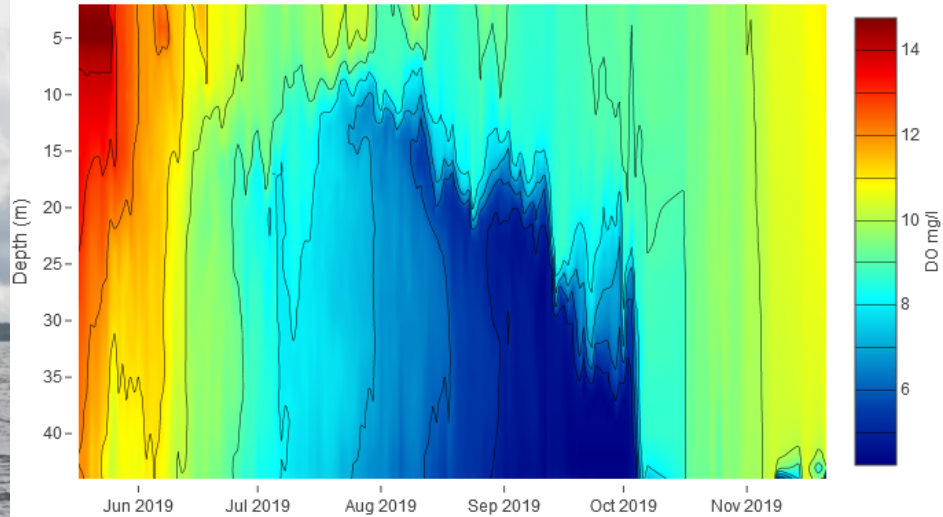# Algal response from distribution and loading data

The real effects are followed by monitoring:

o nutrients

o chlorophyll

o oxygen

o benthos

Effective monitoring will benefit from new instruments

Automatic oxygen measurements

So what are the main problems:
- Limits - is 1% deterioration acceptable?
- Local effects are stronger than water body effects
- Cumulative effects are difficult to predict – specifically in benthic habitats
- Annual variability is wide – risk level?
- Compensation mechanisms have multiple ecological effects in addition to nutrients
- Loading without an obvious effect (= strong mixing areas) are difficult to handle