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Baltic from Space Workshop, 29-31 March 2017, Helsinki, Finland

Monitoring of eutrophication in the sea areas around Finland

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SYKE

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SYKE's marine monitoring

- Physical and chemical water quality
- Phytoplankton
- Zooplankton
- Benthic macrofauna
- Macrophytes
- Contaminants
- River loads
- Litter
- Underwater noise
- Alien species
- Alg@line (SOOP)
- Satellite remote sensing
- Algal blooms
- State of southern coastal waters

SYKE

R/V Aranda

- Physical, chemical and biological monitoring in the open sea areas
- SYKE/MRC in co-operation with the Finnish Meteorological Institute: annually 3 extensive monitoring cruises in the Gulf of Bothnia, Gulf of Finland and the northern Baltic Proper
- SMHI performs its open sea monitoring cruises with Aranda
- SYKE and SMHI develop areal co-operation between their monitoring programs
- As a part of winter monitoring cruises also Russian waters in the eastern Gulf of Finland are sampled

Photo: Ilkka Lastumäki

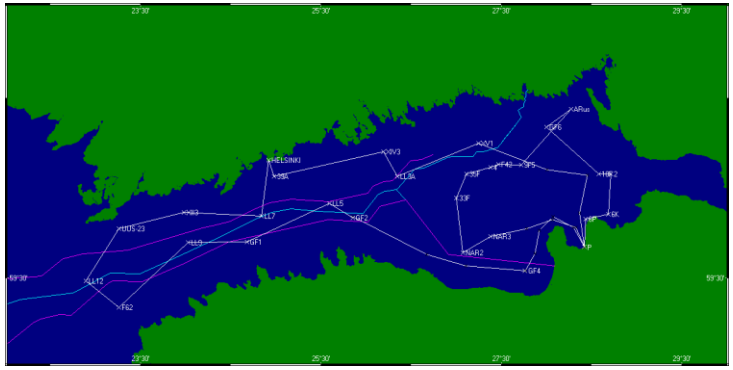


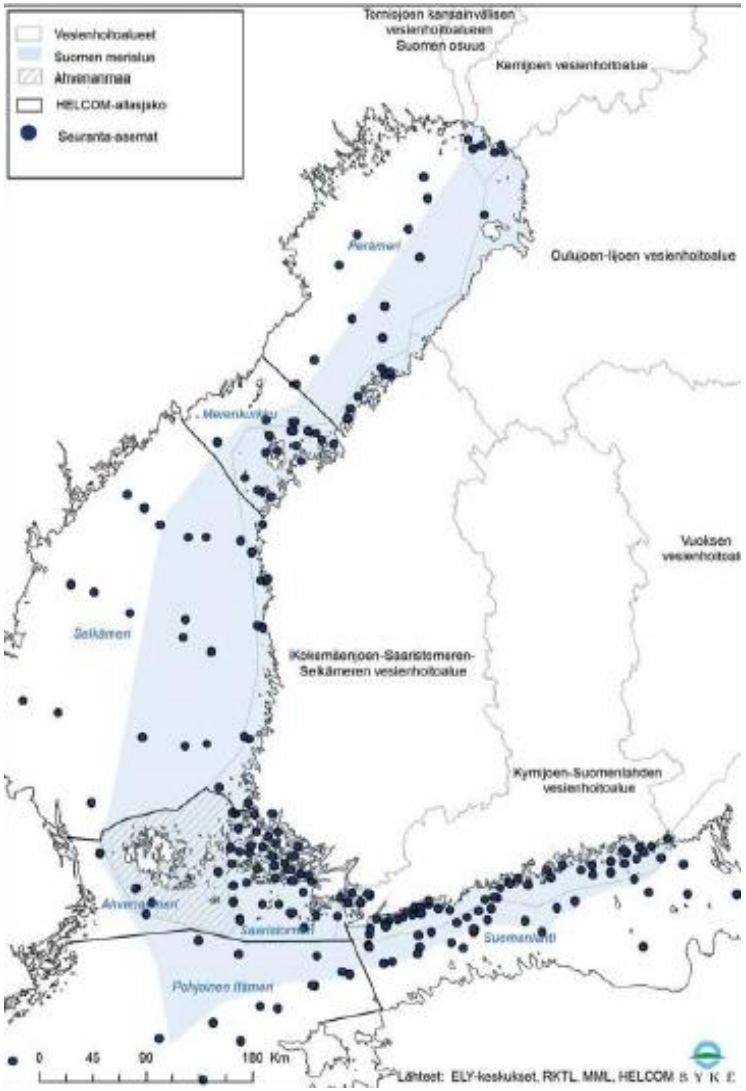
Figure: SYKE

www.syke.fi/en-US/Services/Research_vessels/Research_Vessel_Aranda/Ship

www.finmari-infrastructure.fi/research-vessels/aranda

Chemical monitoring

- Carried out by SYKE and Regional ELY -Centres (Centres for Economic Development, Transport and the Environment)
- About 200 stations
- Altogether about 1000 stations with mandatory monitoring of loaded coastal areas
- Salinity, temperature, pH, alkalinity, turbidity, color, total and inorganic N and P, silicate, iron, total organic carbon (TOC), oxygen, chlorophyll *a.*
- In addition to SYKE's data base, data is delivered e.g. ICES/ HELCOM EEA , BNI/ SU, EMODnet/ DG MARE
- Data use: Indicator development, scientific papers & reports, ecological classification, modeling, calibration and validation of satellite data, etc.

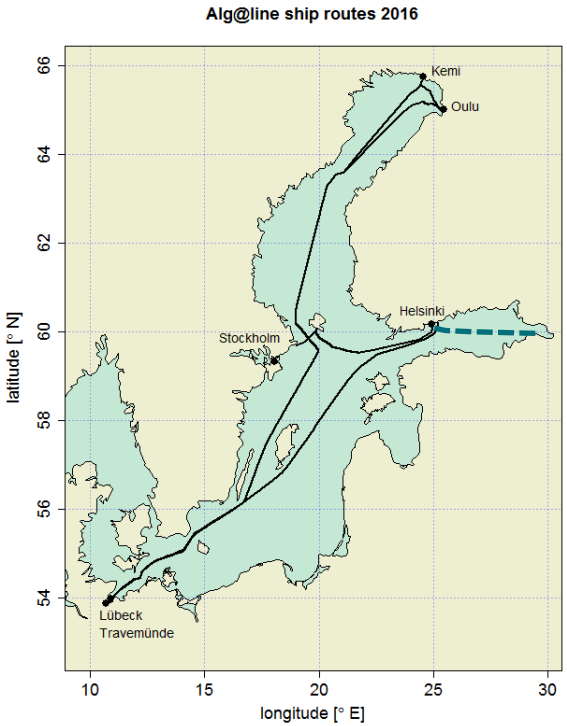


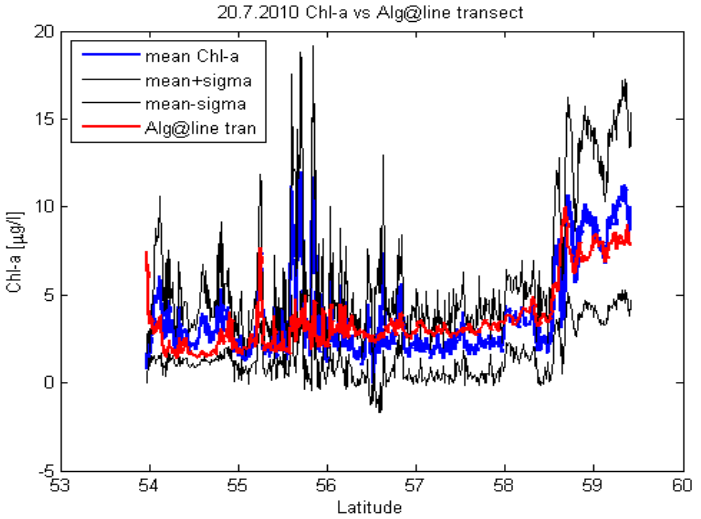
Source: Ministry of the Environment 2014. Monitoring handbook of the marine strategy in Finland (in Finnish).

Alg@line

- Nominal sampling depth 5 m
- Flow through measurements with 250 m resolution
- Thermosalinograph
- Chlorophyll, phycocyanin and CDOM fluorometers
- Turbidity meter
- Refrigerated sampling unit providing discrete water samples for laboratory analyses for phytoplankton, Chla and nutrients
- Data use: on-line monitoring of algal blooms, status reports, scientific papers, indicator development, calibration and validation of satellite data

Source: Seppo Kaitala/ SYKE
www.finmari-infrastructure.fi/ferrybox/





Comparison of different Chla-algorithms (mean and standard deviation) with Algaline results (Travemunde-Helsinki). Source: CoBiOS-project (EU/FP7, 2011-2013)/ Jenni Attila, SYKE.

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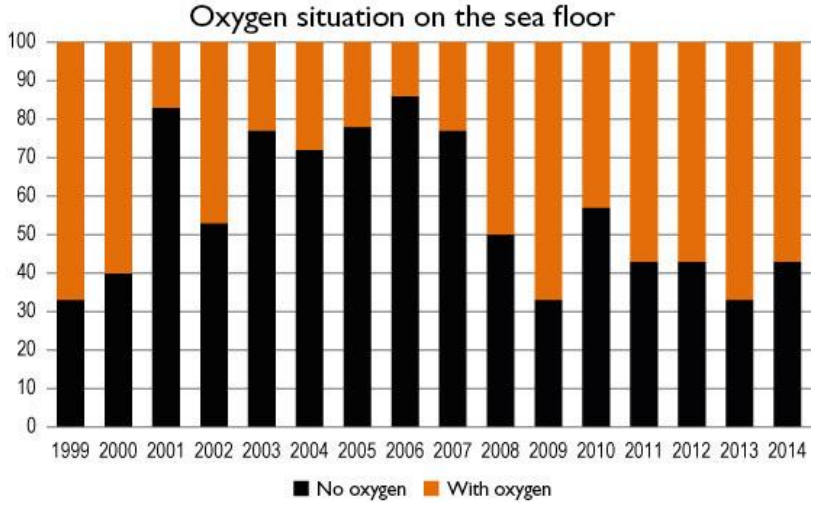
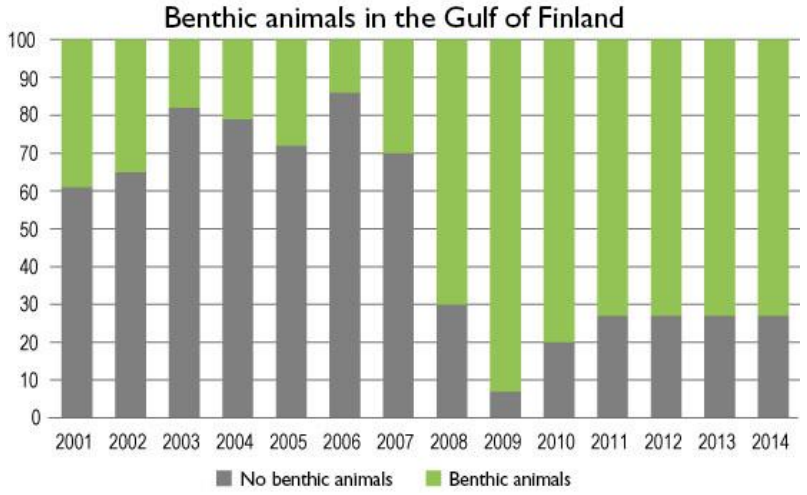
Status of sediment surface in coastal deeps by the southern Finnish coast



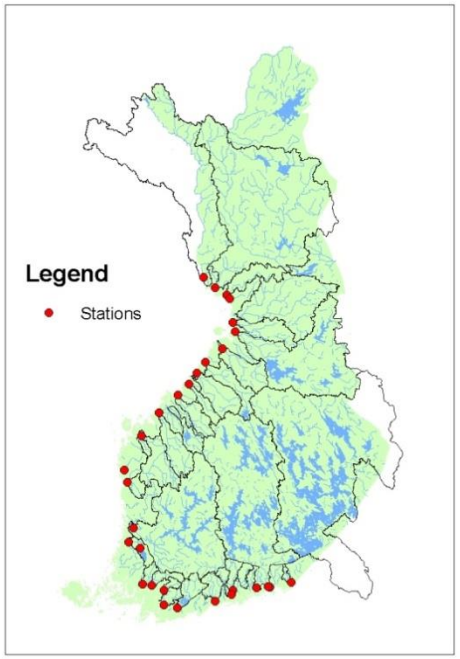


Source: Seppo Knuuttila/ SYKE
http://www.ymparisto.fi/en-US/Sea/What_is_the_state_of_the_Baltic_Sea/State_of_the_sea_floor_and_benthic_anima%2831551%29

SYKE

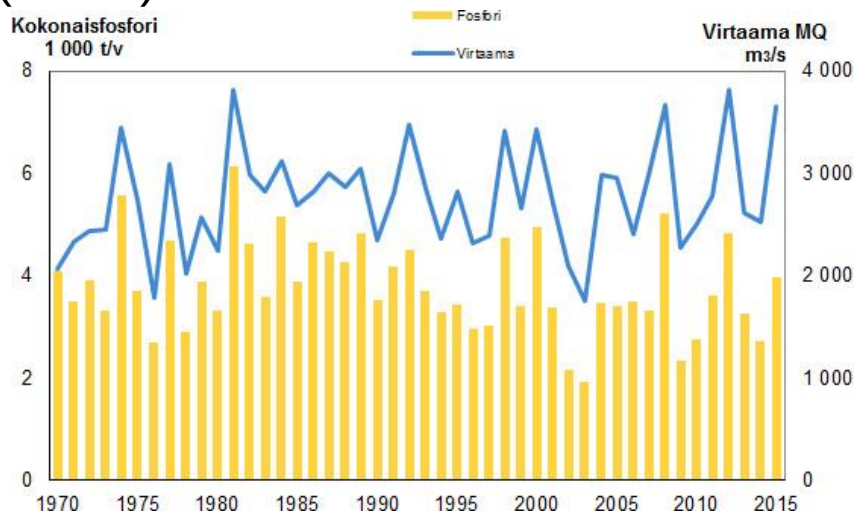
Riverine material inputs

- Started in 1970
- Implementation by regional ELY-Centres, national coordination by SYKE
- Includes 31 rivers
- Covers over 90 % of the Finnish Baltic Sea catchment area
- 12 to 22 annual samples
- Monitoring reports, programs of measures, modeling, scientific papers, data delivered also to HELCOM for PLC-work (BSAP)



Variables:

Al , Alkalinity, As, Ca, Cd, Cl, COD, Conductivity, Cr, Cu, Fe, Hg, K, K, Mg, Mn, Na, NH4-N, Ni, NO2+ NO3-N, NTOT, O2, Pb, pH, PO4-P, PTOT, Se, SiO2, SO4, SS, Temperature, TIC, TOC, Turbidity , Zn

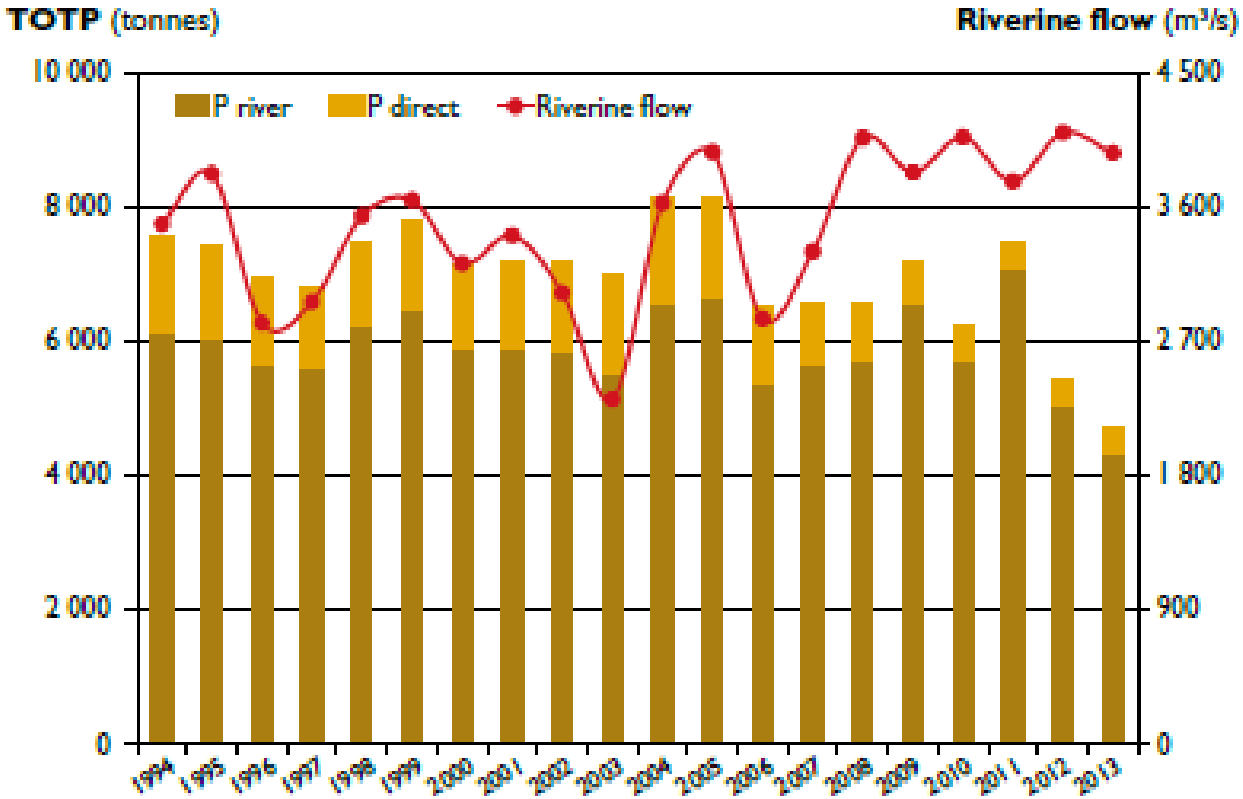


Flow (m^3/s, blue line) and input of total phosphorus (1000 t/a, yellow bars) from Finnish rivers into the Baltic Sea in 1970-2015.

Sources: Antti Räike/ SYKE

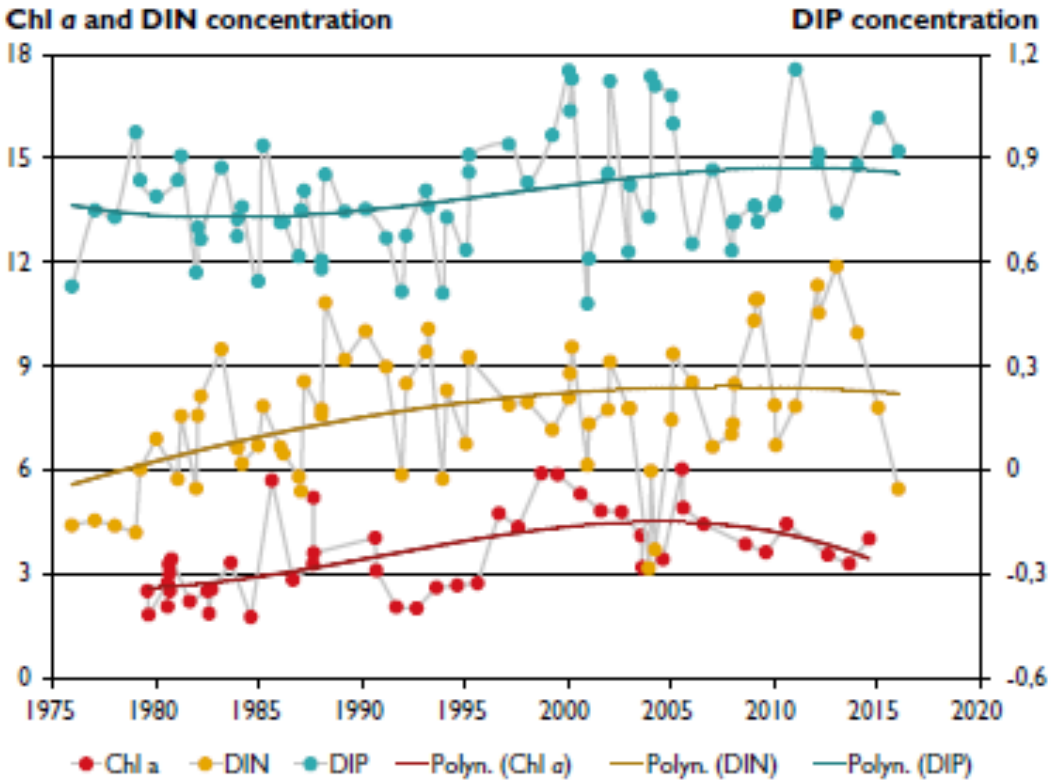
http://www.ymparisto.fi/fi-FI/Meri/Mika_on_Itameren_tila/Itameren_fosforikuorma_Suomesta%2831444%29

Total phosphorus loading from Russia, Finland and Estonia into the Gulf of Finland



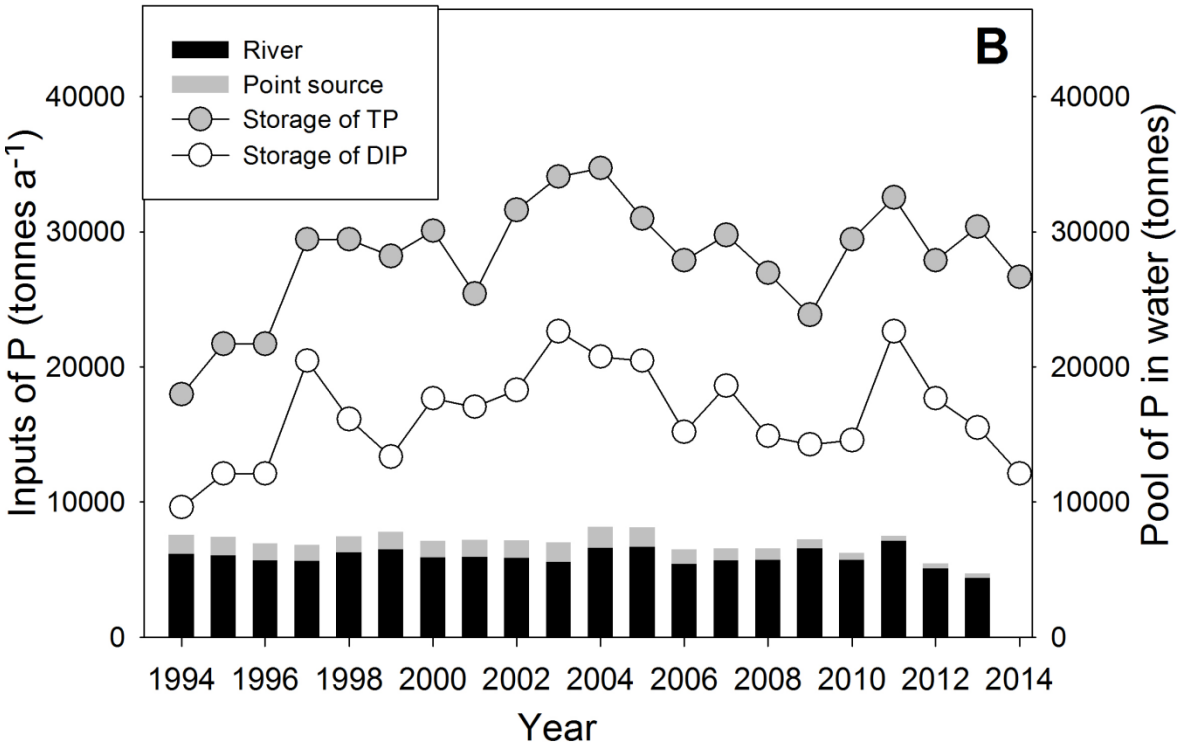
Sources: Räike, A. et al. (2016). Nutrient inputs. In: Raateoja, M. & Setälä, O. The Gulf of Finland assessment. Rep. of the Finnish Environment Inst. 27: 89-93. HELCOM (2015) Updated fifth Baltic Sea pollution load compilation (PLC 5.5). Baltic Sea Env. Proc. 145.

Long-term trends of winter inorganic N and P, and summer Chla in the middle Gulf of Finland from the late 1970s to 2016



Source: Raateoja, M. et al. (2016). Nutrients in the water. In: Raateoja, M. & Setälä, O. The Gulf of Finland assessment. Rep. of the Finnish Environment Inst. 27: 94-113.

Annual mean content of total and inorganic phosphorus vs. external phosphorus loading into the Gulf of Finland 1994-2014



Source: Lehtoranta et al. (2017). Atmospheric forcing controlling inter-annual nutrient dynamics in the open Gulf of Finland. Journal of Marine Systems (accepted).

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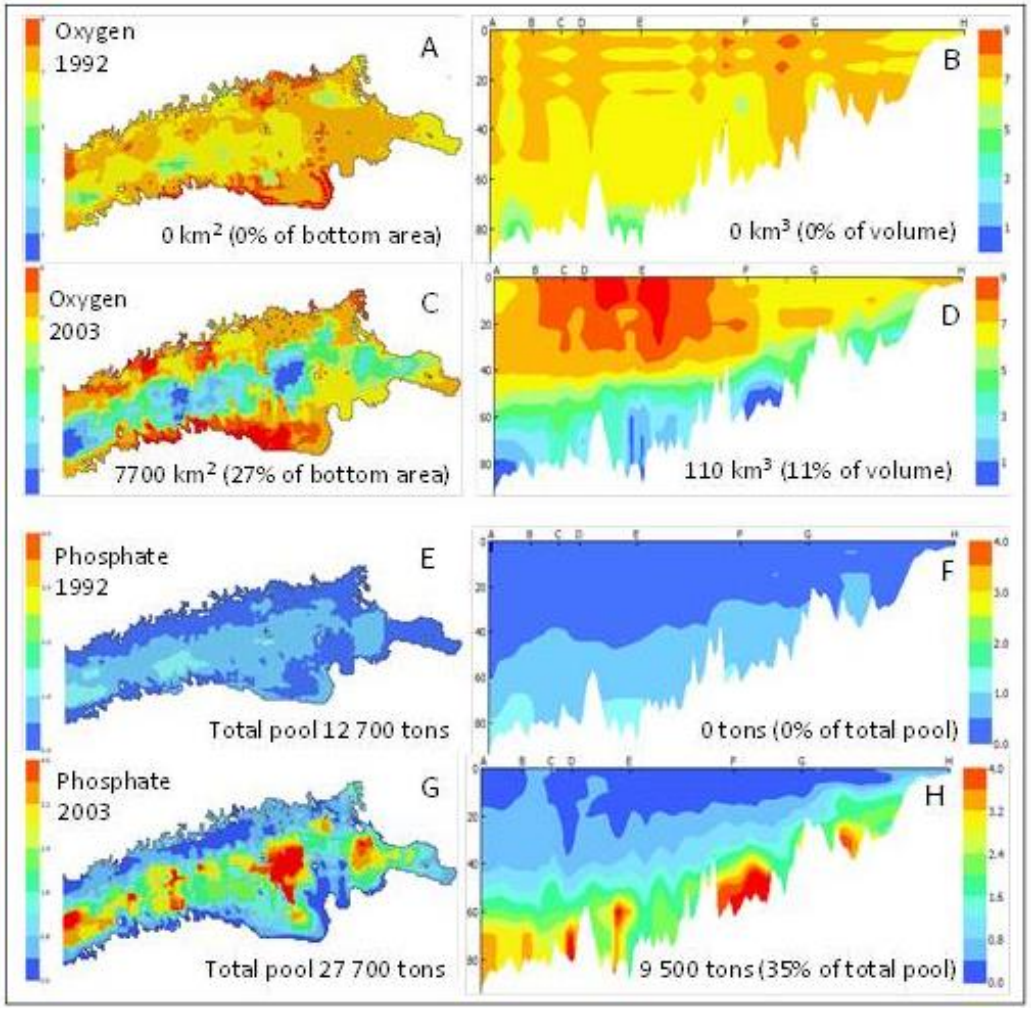
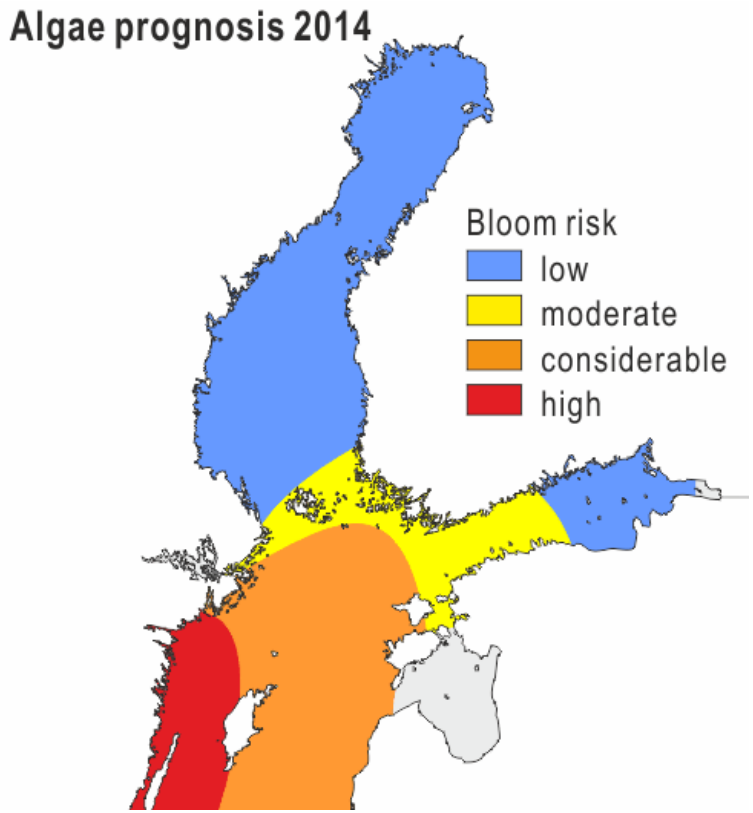
Horizontal bottom and vertical distributions in oxygen (mL/L) and phosphate (µM/L P) for 1992 (strong WSW winds, weak stratification) and 2003 (weak WSW winds, strong stratification)

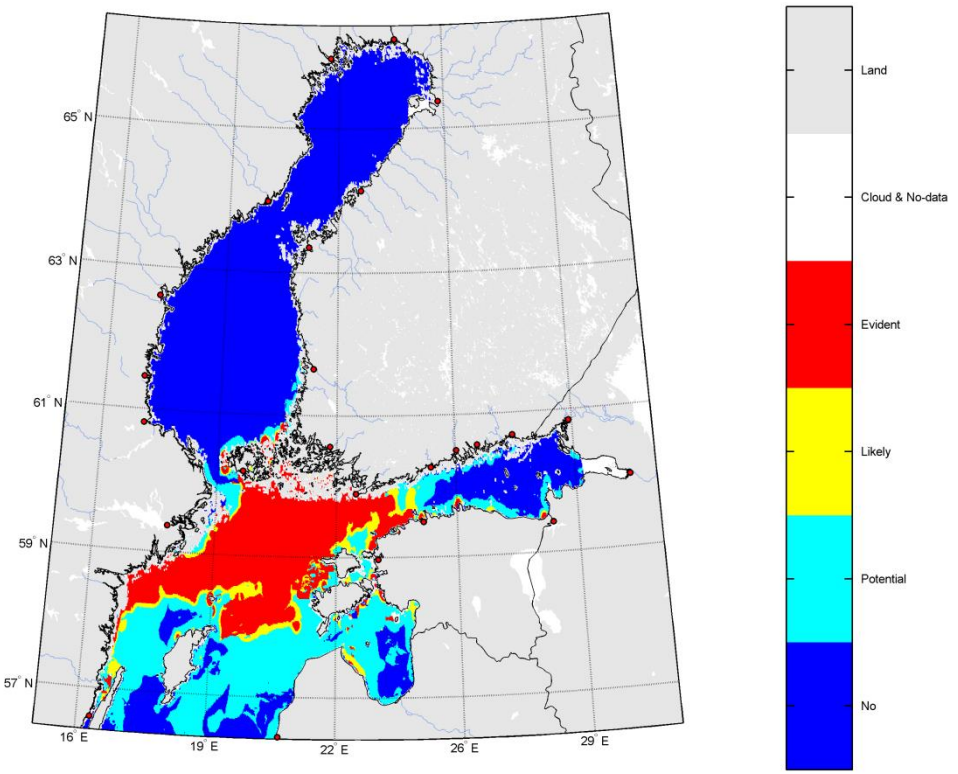


Source: Lehtoranta et al. (2017). Atmospheric forcing controlling inter-annual nutrient dynamics in the open Gulf of Finland. Journal of Marine Systems (accepted).

SYKE

Risk forecast for cyanobacterial blooms in summer 2014 and actualized blooms based on satellite data

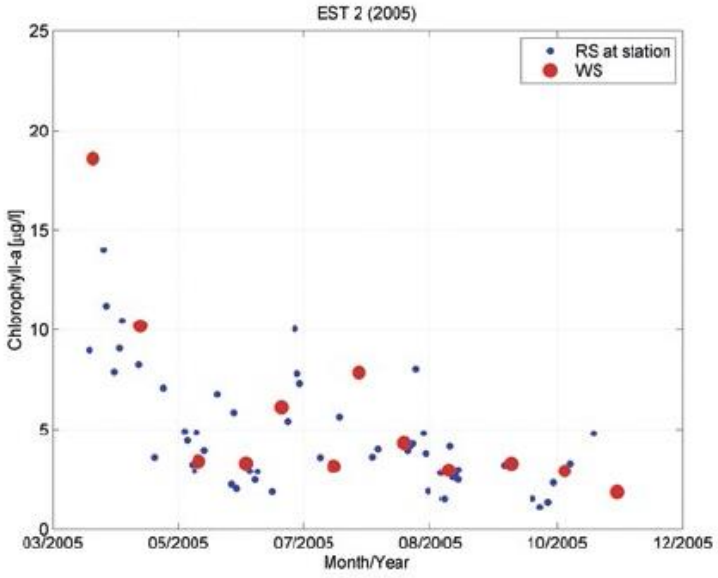




http://www.syke.fi/en-US/Research__Development/Sustainable_management_of_the_Baltic_Sea_and_freshwater_resources/Algae_prognosis_considerable_risk_of_blu%2829780%29

Algae bloom product by SYKE, source image: MODIS

Comparison of remote sensing (RS) and water sample (WS) based chlorophyll-a



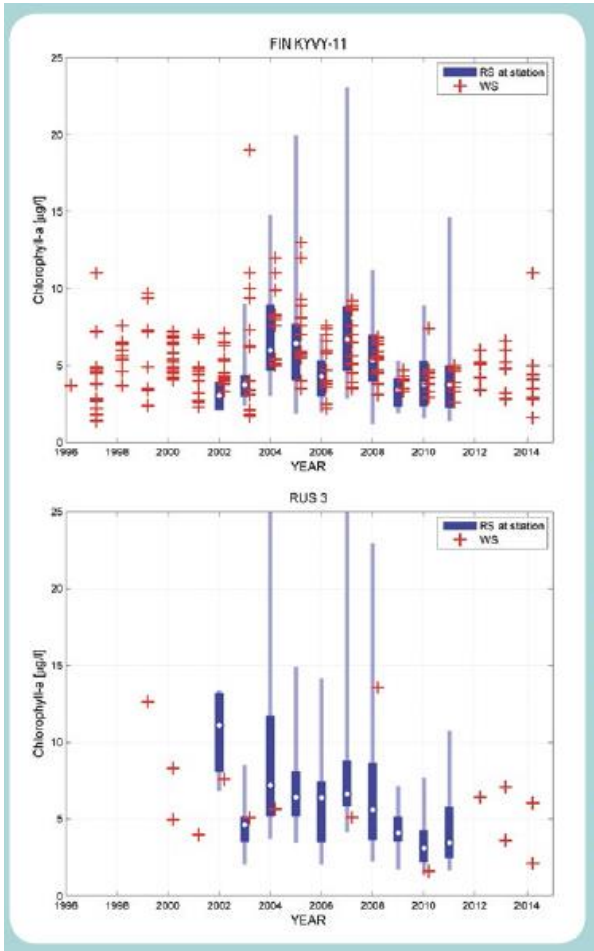


Figure 13.
The RS-based and WS-based Chl *a* (µg/l) at KYVY-11 (above) and at 3 (below) as a function of time in June–September in 1996/1998–2014. As for the RS data, the variation of Chl *a* was presented using boxplots, where the extremes of the thinner parts of the pillar describe the 5th and 95th percentiles and the box marks the of 25th and 75th percentiles. The white dots represent the geometric mean value (ChlGM) during the assessment period. As for the WS data, the results of Chl *a* are indicated by red crosses. Source: GOF2014 dataset (WS) and SYKE (RS).

Source: Kauppila, P. et al. (2016). Chlorophyll *a* and phytoplankton blooms. In: Raateoja, M. & Setälä, O. The Gulf of Finland assessment. Rep. of the Finnish Environment Inst. 27: 114-123.

Summary

- New and conventional monitoring approaches together (+ modelling) will supplement each other and give us the best spatio-temporal understanding on the status and its changes in the marine environment (data fusion)
- The role of automatic *in situ* -monitoring and remote sensing has increased and will further increase in the future. Only these methodologies can produce spatio-temporally high-frequency measurement data
- Conventional (ship based) sampling is still the way to operatively monitor most of the variables required e.g. by MSFD
- Ship-based data are needed as calibration and validation data for automatic and remote sensing methodologies, and are essential in explaining physical and biogeochemical dynamics behind the status changes of marine systems


Thank you!