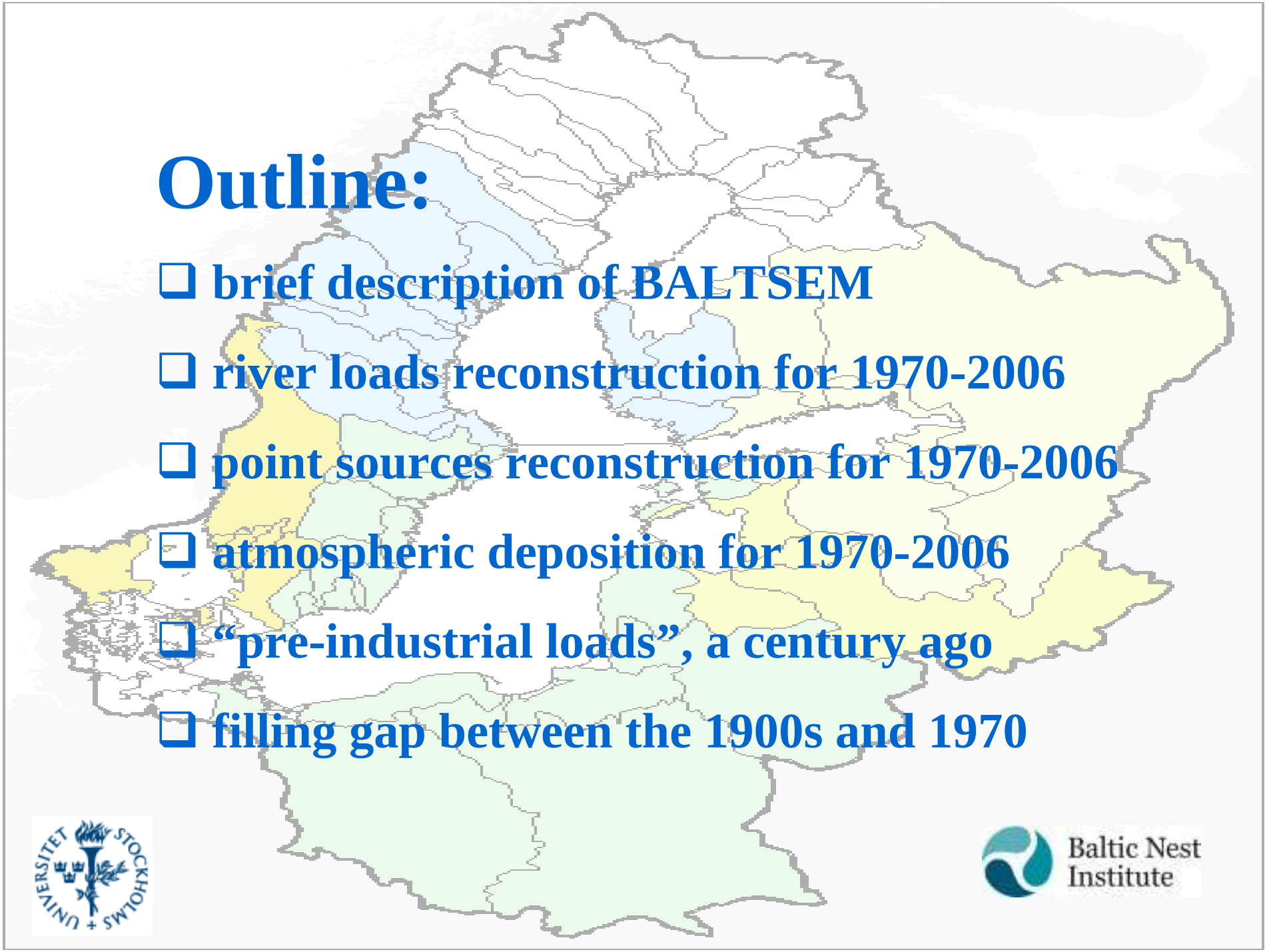
Supporting ECO SUPPORT with external nutrient loads

Oleg P. Savchuk and Bo G. Gustafsson

Baltic Nest Institute



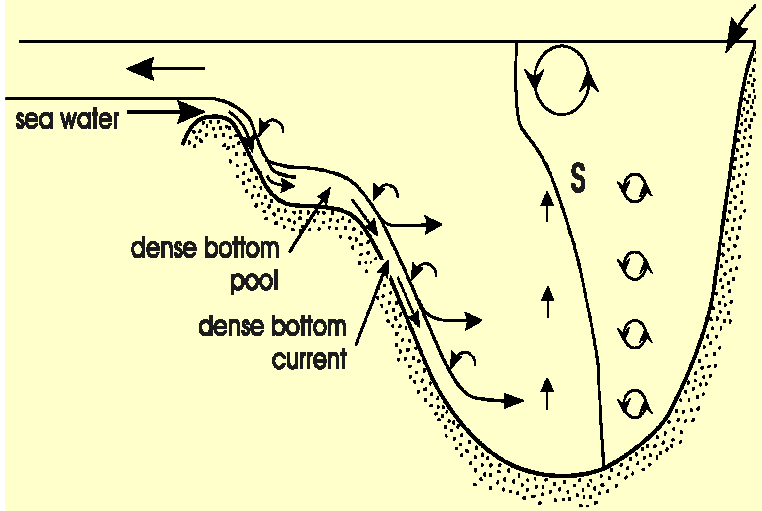
Outline:

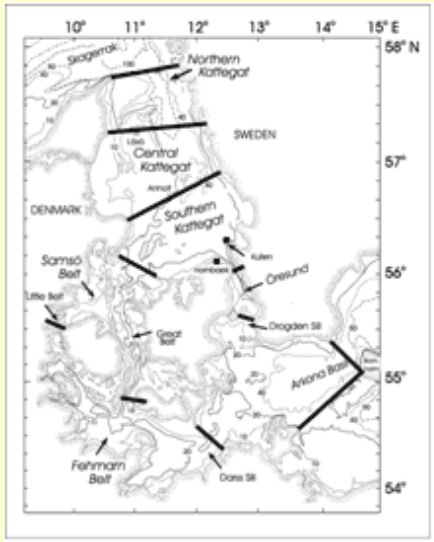
- brief description of BALTSEM
- river loads reconstruction for 1970-2006
- point sources reconstruction for 1970-2006
- atmospheric deposition for 1970-2006
- “pre-industrial loads”, a century ago
- filling gap between the 1900s and 1970

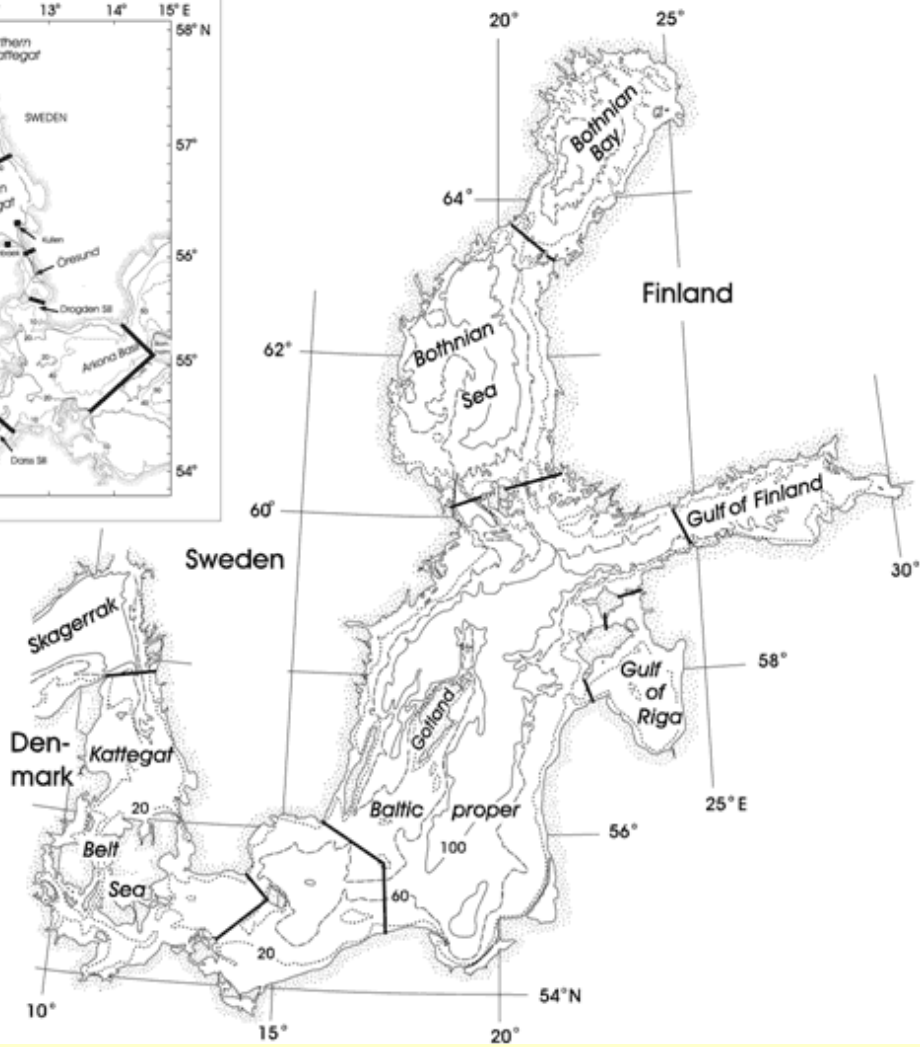
UNIVERSITET STOCKHOLMS

Baltic Nest Institute

BAltic sea **L**ong-**T**erm large-**S**cale **E**utrophication **M**odel (**BALTSEM**)



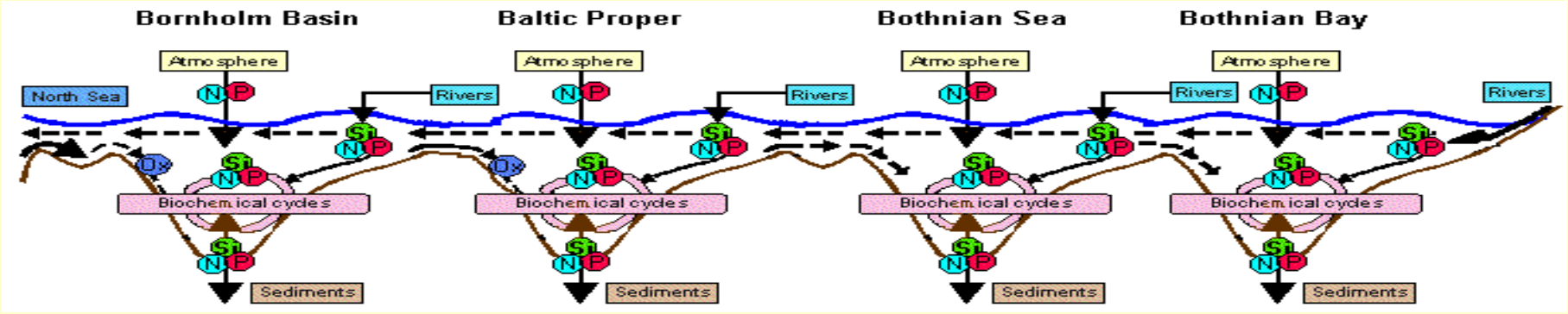


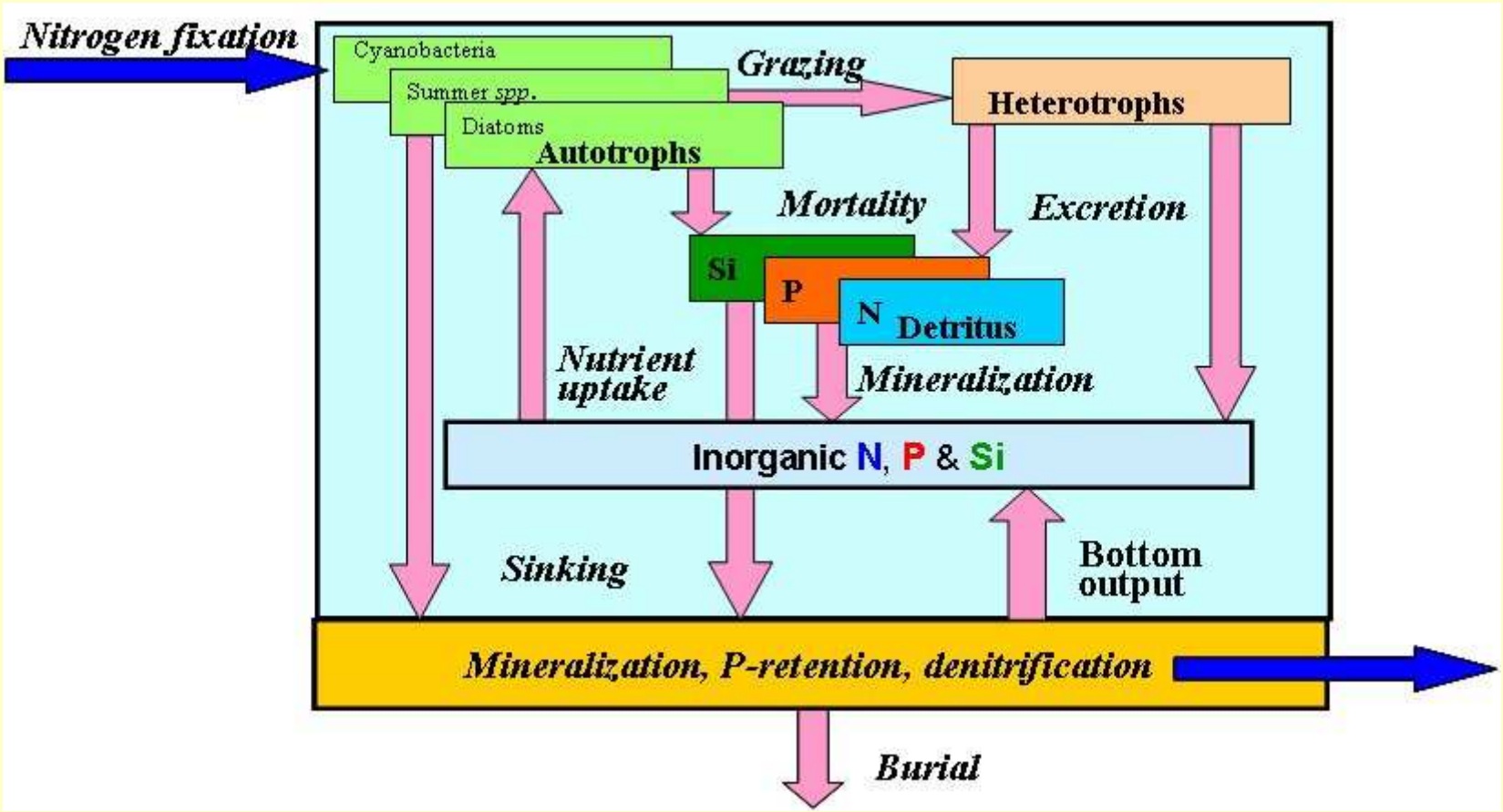


Main characteristics:

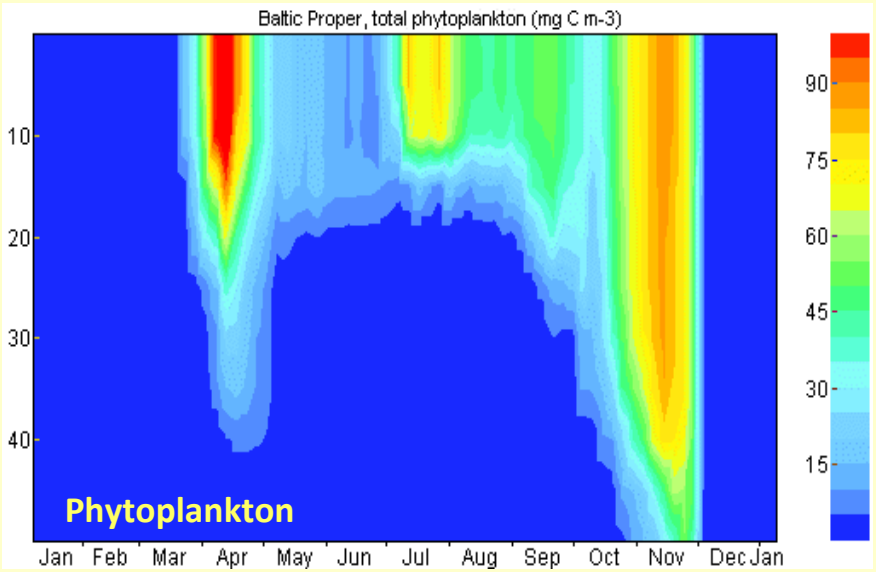
- 13 sub-basins
- High vertical resolution
- Full air-sea exchange including sea ice
- Water exchange from well-founded stea dynamics
- Wind and buoyancy forced mixed-layer c and wind-forced deep-water mixing
- Dense gravity current mixing sub-models
- Typical simulation times on 8 core MacPr
  - with only physics 1.6 sec/year
  - with BGC ~14 sec/year

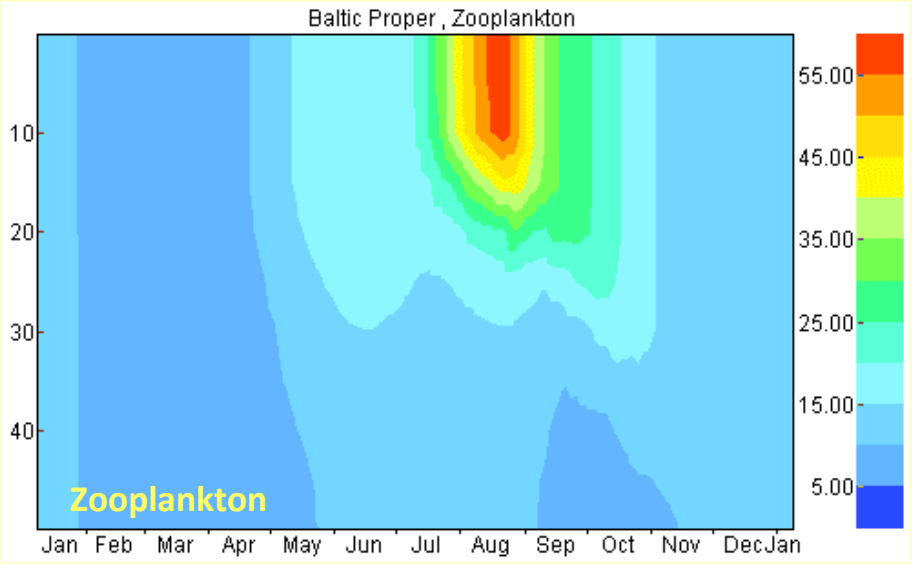
Coupled N, P, and Si biogeochemical cycles in BALTSEM

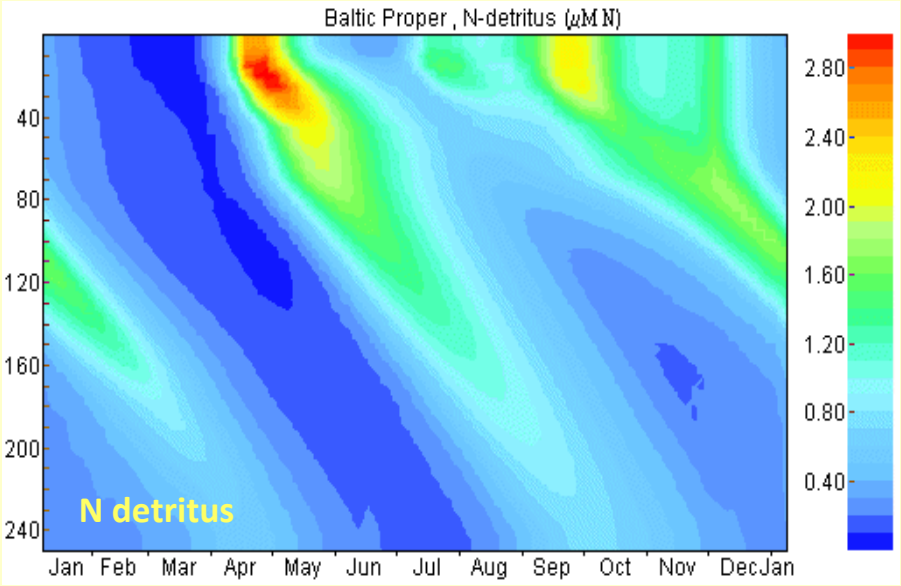


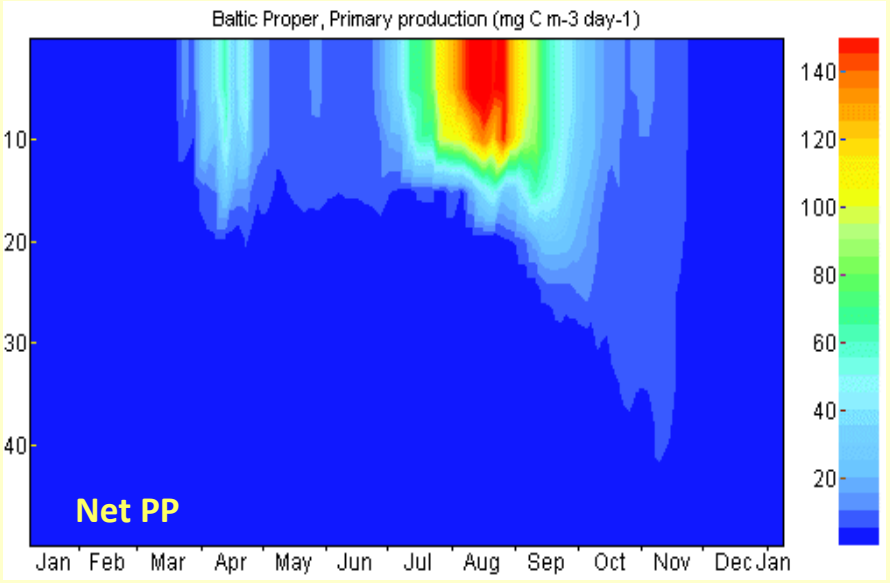


Average seasonal dynamics of plankton, DN, and PP in the Baltic Proper









Reconstruction of river nutrient loads for 1970-2006

Sources:

- BED (Baltic Environment Database, http://nest.su.se/bed)
  accessible through DSS Nest http://nest.su.se/nest
  contains river water runoff and nutrient inputs from 85 rivers and 95 non-monitored areas with monthly resolution for 1970-2000

Reconstruction of river nutrient loads for 1970-2006

Sources:

- BED (Baltic Environment Database, http://nest.su.se/bed) accessible through DSS Nest http://nest.su.se/nest contains river water runoff and nutrient inputs from 85 rivers and 95 non-monitored areas with monthly resolution for 1970-2000
- HELCOM PLC-5 compilation processed at BNI within BSAP revision, covers very many coastal areas, monitored and unmonitored rivers for 1994-2006 with annual resolution

Reconstruction of river nutrient loads for 1970-2006

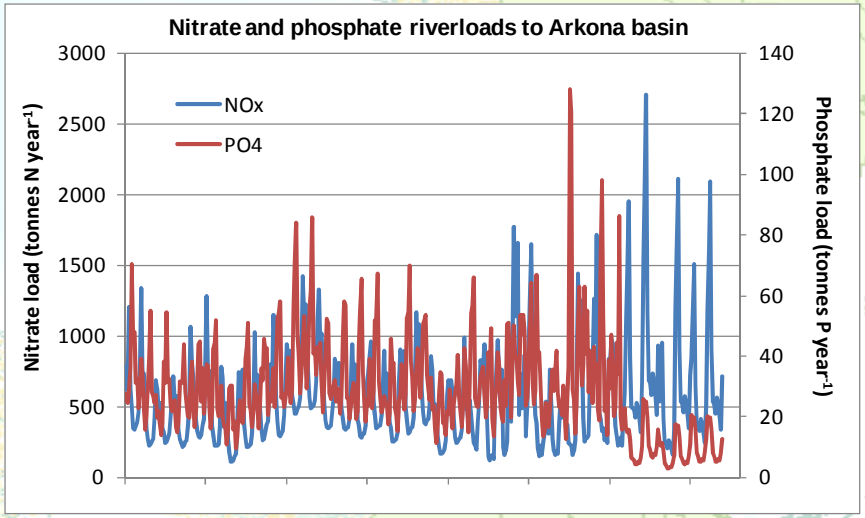
Sources:

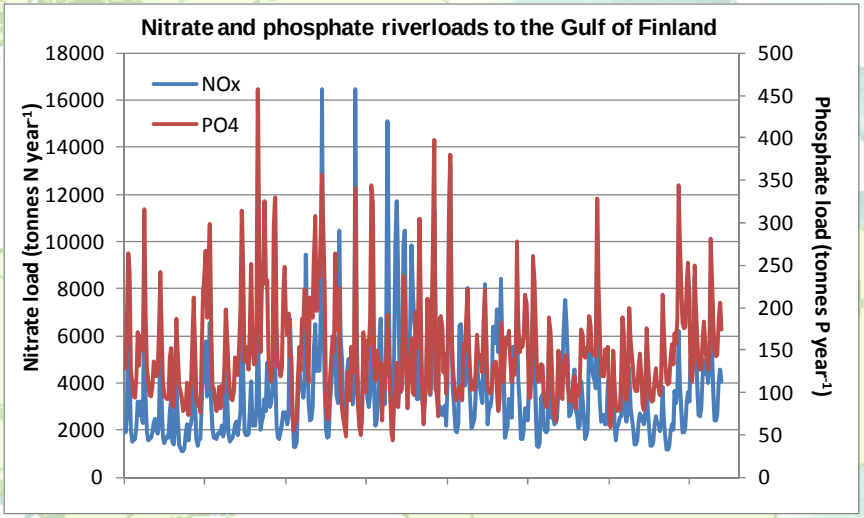
- BED (Baltic Environment Database, http://nest.su.se/bed) accessible through DSS Nest http://nest.su.se/nest contains river water runoff and nutrient inputs from 85 rivers and 95 non-monitored areas with monthly resolution for 1970-2000
- HELCOM PLC-5 compilation processed at BNI within BSAP revision, covers very many coastal areas, monitored and unmonitored rivers for 1994-2006 with annual resolution

Procedures:

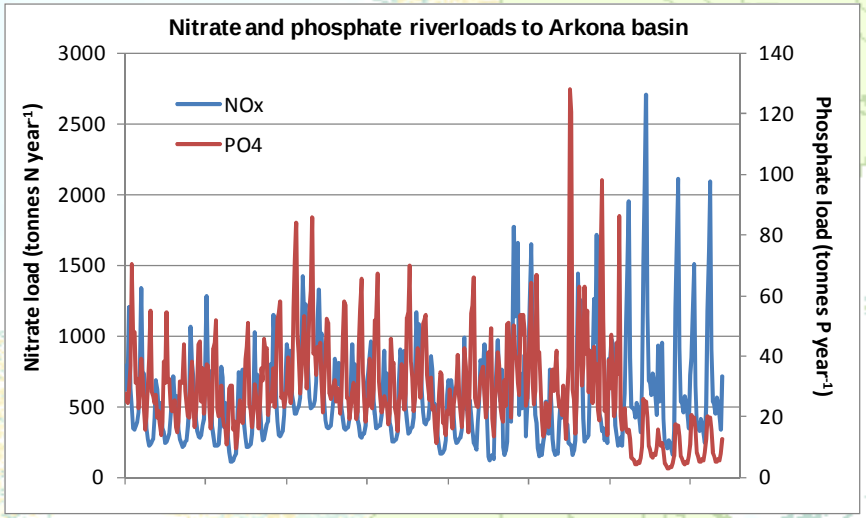
- Monthly time series from BED were aggregated over 13 marine BALTSEM sub-basins
- Aggregated time-series for 1994-2000 were used to reconstruct basin-wise seasonal patterns
- These patterns were used to decompose annual integrals from PLC-5 over 2001-2006 into monthly time-series.

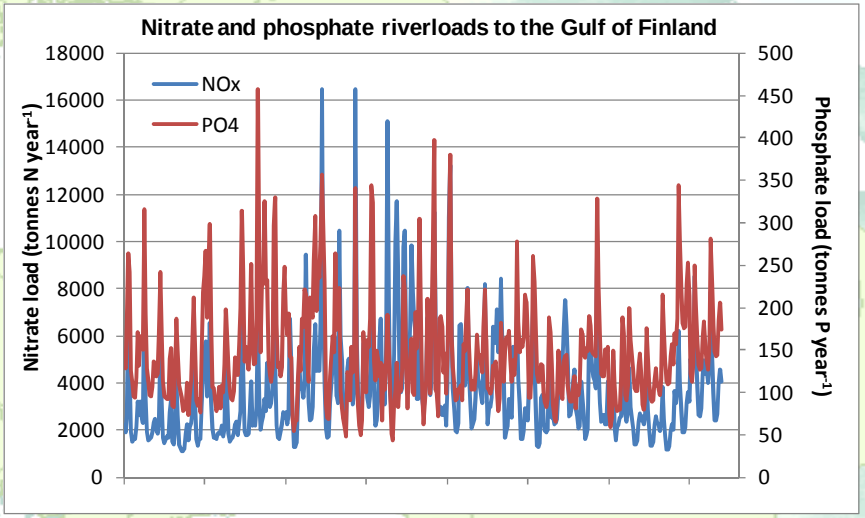
Reconstruction of river nutrient loads for 1970-2006

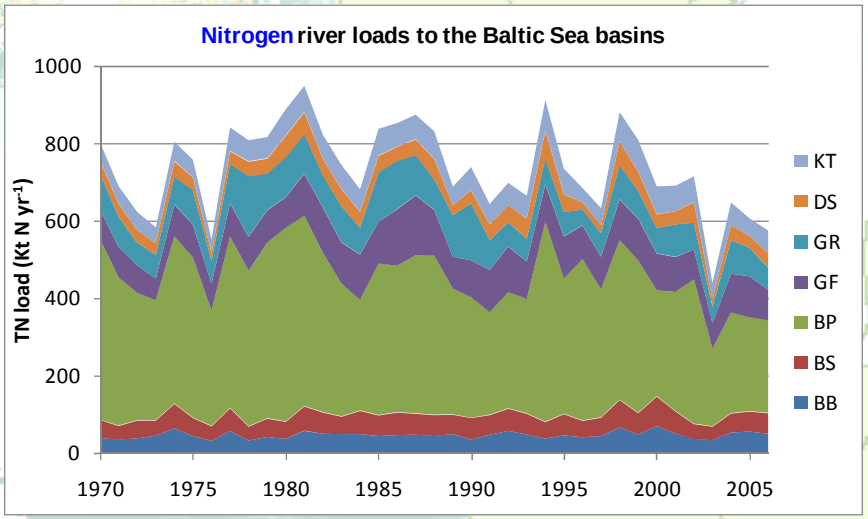


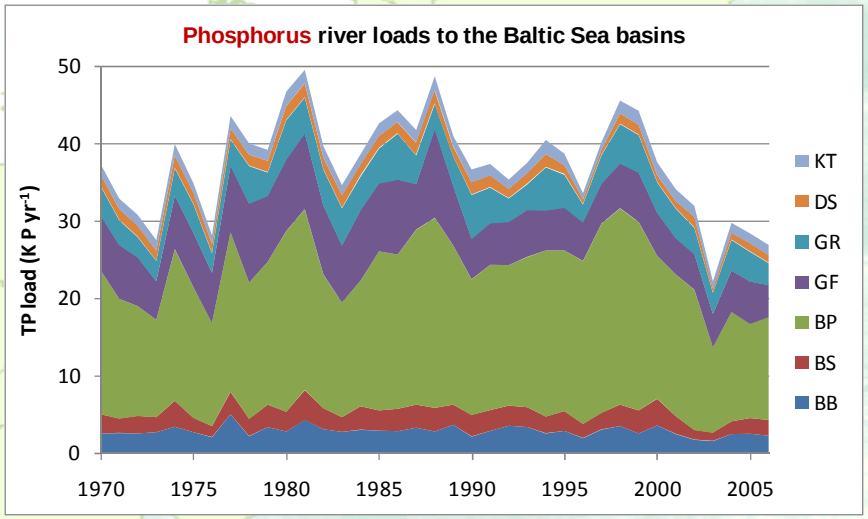


Reconstruction of river nutrient loads for 1970-2006







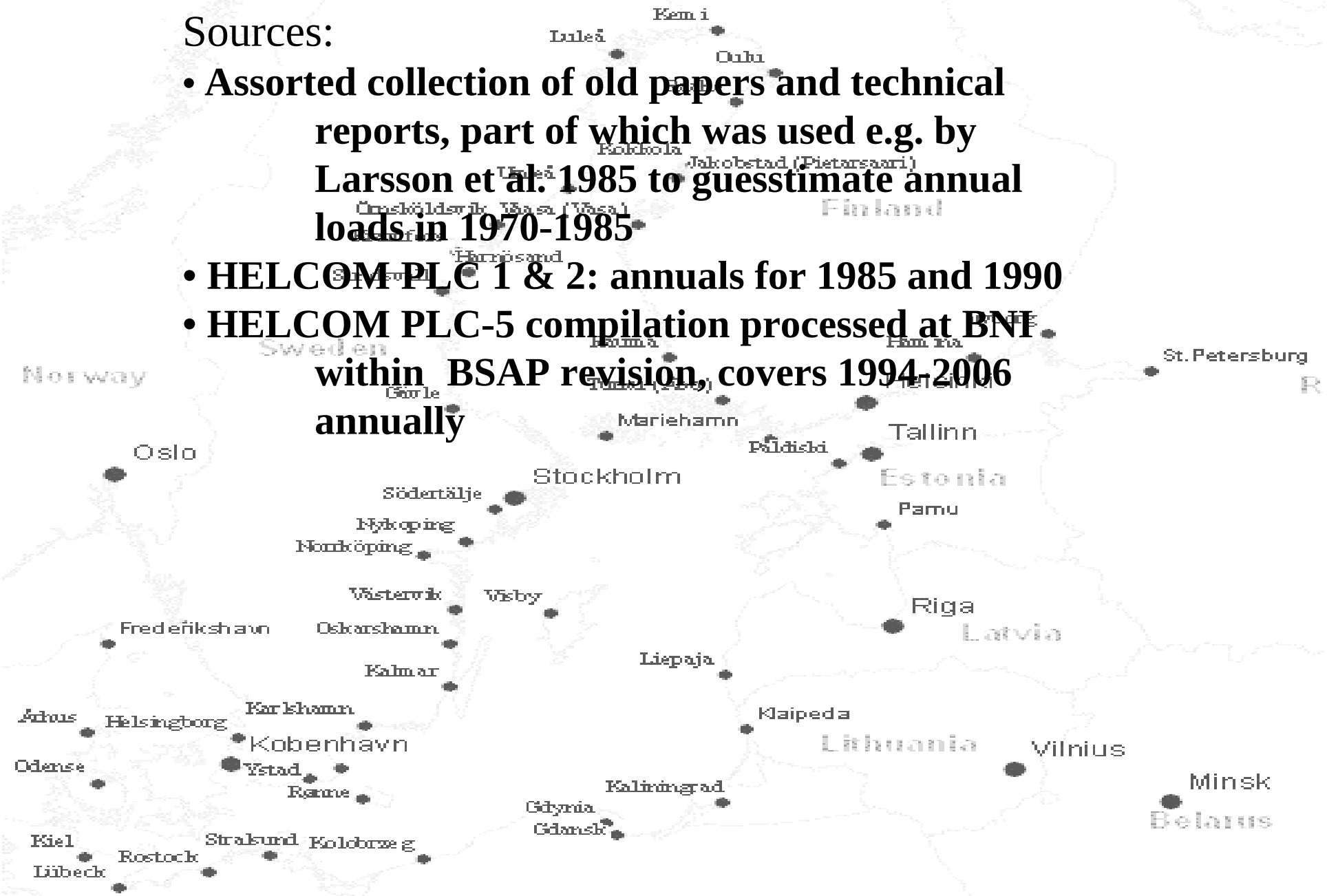


Reconstruction of direct point nutrient sources for 1970-2006

Reconstruction of direct point nutrient sources for 1970-2006

Sources:

- **Assorted collection of old papers and technical reports, part of which was used e.g. by Larsson et al. 1985 to guesstimate annual loads in 1970-1985**
- **HELCOM PLC 1 & 2: annuals for 1985 and 1990**
- **HELCOM PLC-5 compilation processed at BNI within BSAP revision, covers 1994-2006 annually**

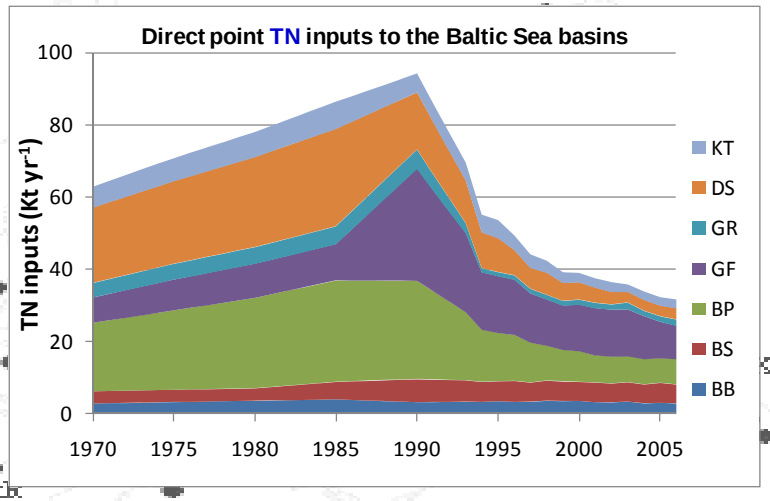


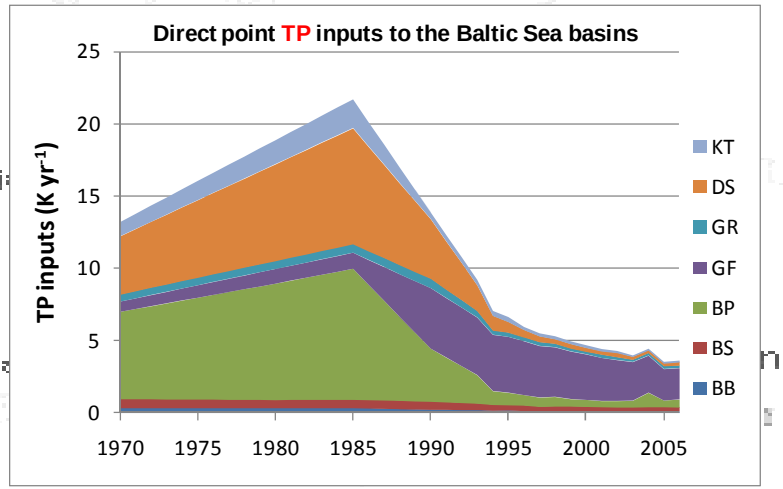
Reconstruction of direct point nutrient sources for 1970-2006

Sources:

- **Assorted collection of old papers and technical reports, part of which was used e.g. by Larsson et al. 1985 to guesstimate annual loads in 1970-1985**
- **HELCOM PLC 1 & 2: annuals for 1985 and 1990**
- **HELCOM PLC-5 compilation processed at BNI within BSAP revision, covers 1994-2006 annually**

Procedure: **Simple interpolations**





Reconstruction of atmospheric nitrogen inputs for 1970-2006

Reconstruction of atmospheric nitrogen inputs for 1970-2006

Sources:

- Monthly estimates of wet and dry, reduced and oxidized fractions by Granat (2001) for 1970-1991
- HELCOM publications in 1988, 1991, 1997
- EMEP simulations, annual depositions for 1980, 1985, 1990, 1995-2006, since 1997 accessible through DSS Nest http://nest.su.se/nest

Reconstruction of atmospheric nitrogen inputs for 1970-2006

Sources:

- Monthly estimates of wet and dry, reduced and oxidized fractions by Granat (2001) for 1970-1991
- HELCOM publications in 1988, 1991, 1997
- EMEP simulations, annual depositions for 1980, 1985, 1990, 1995-2006, since 1997 accessible through DSS Nest http://nest.su.se/nest

Procedures:

- Monthly time series from Granat for 1986-1990 were used to reconstruct basin-wise seasonal patterns
- These patterns were used to decompose annual integrals from EMEP annual integrals

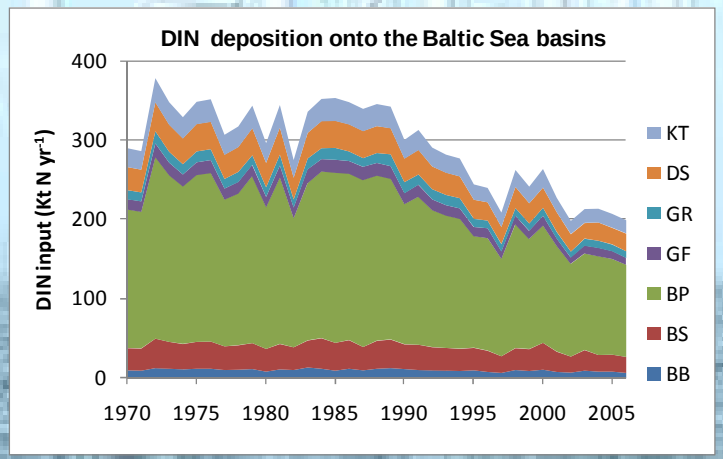
Reconstruction of atmospheric nitrogen inputs for 1970-2006

Sources:

- Monthly estimates of wet and dry, reduced and oxidized fractions by Granat (2001) for 1970-1991
- HELCOM publications in 1988, 1991, 1997
- EMEP simulations, annual depositions for 1980, 1985, 1990, 1995-2006, since 1997 accessible through DSS Nest http://nest.su.se/nest

Procedures:

- Monthly time series from Granat for 1986-1990 were used to reconstruct basin-wise seasonal patterns
- These patterns were used to decompose annual integrals from EMEP annual integrals



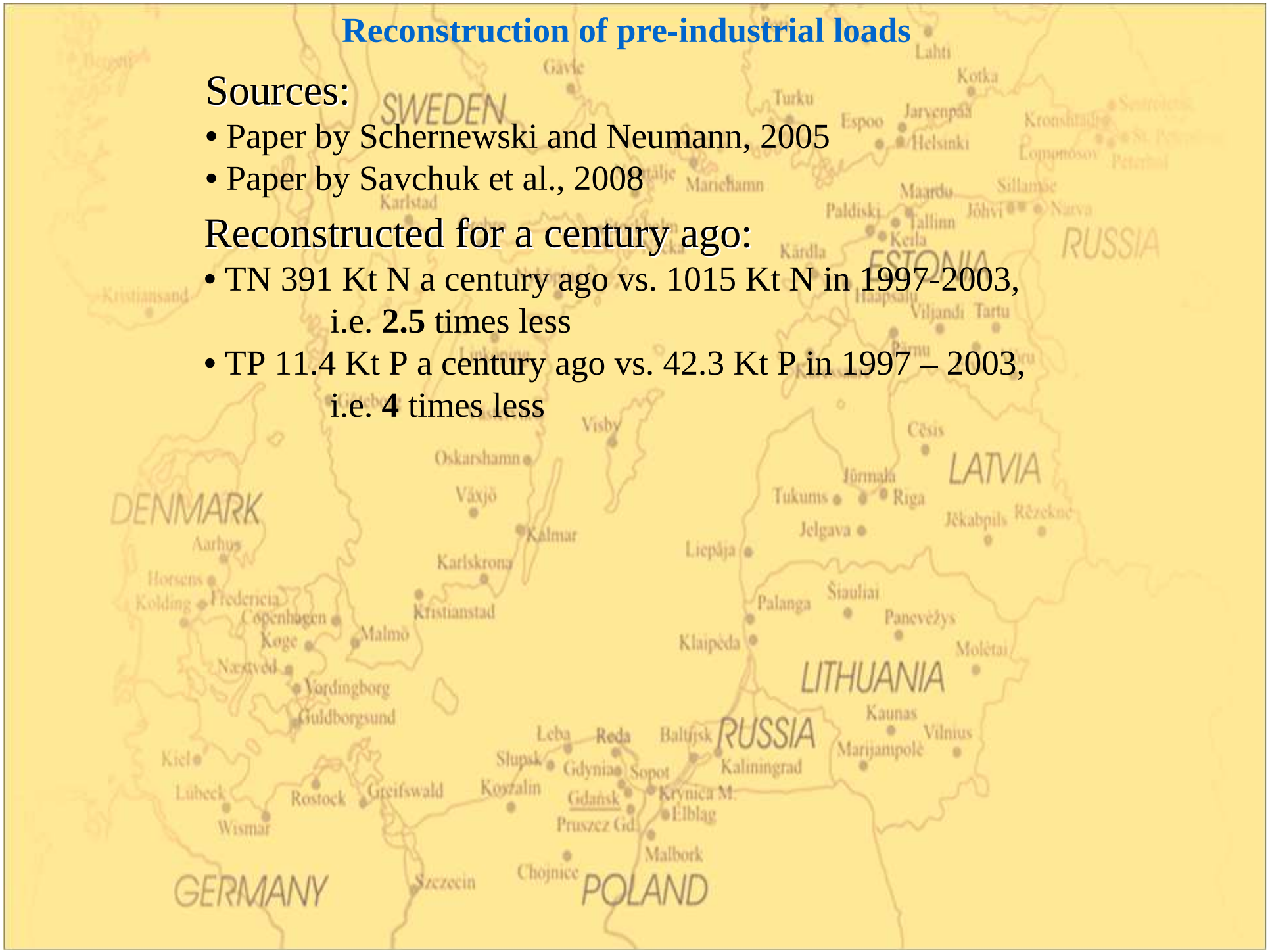
Reconstruction of pre-industrial loads

Sources:

- Paper by Schernewski and Neumann, 2005
- Paper by Savchuk et al., 2008

Reconstructed for a century ago:

- TN 391 Kt N a century ago vs. 1015 Kt N in 1997-2003, i.e. **2.5** times less
- TP 11.4 Kt P a century ago vs. 42.3 Kt P in 1997 – 2003, i.e. **4** times less



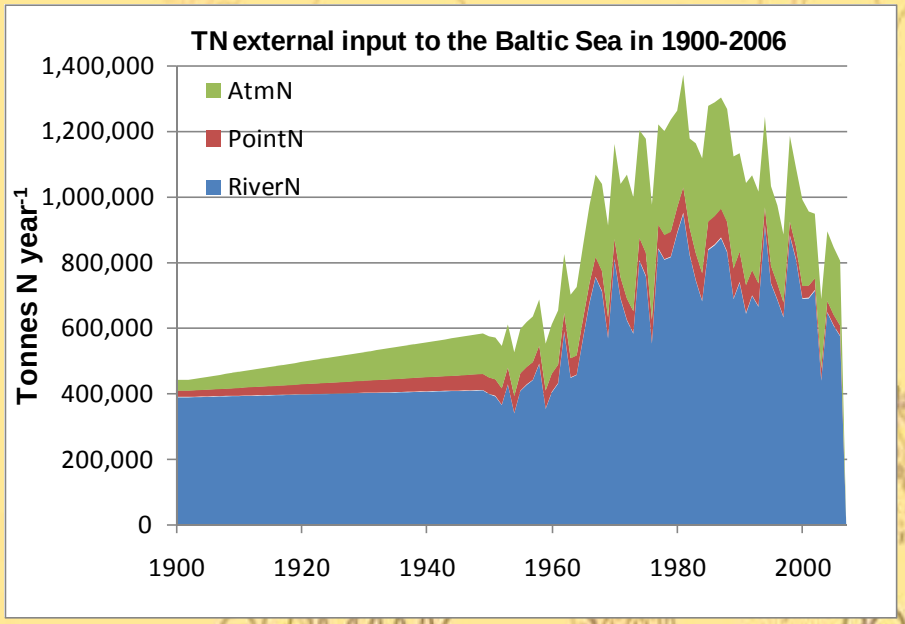
Reconstruction of loads for 1900-2006

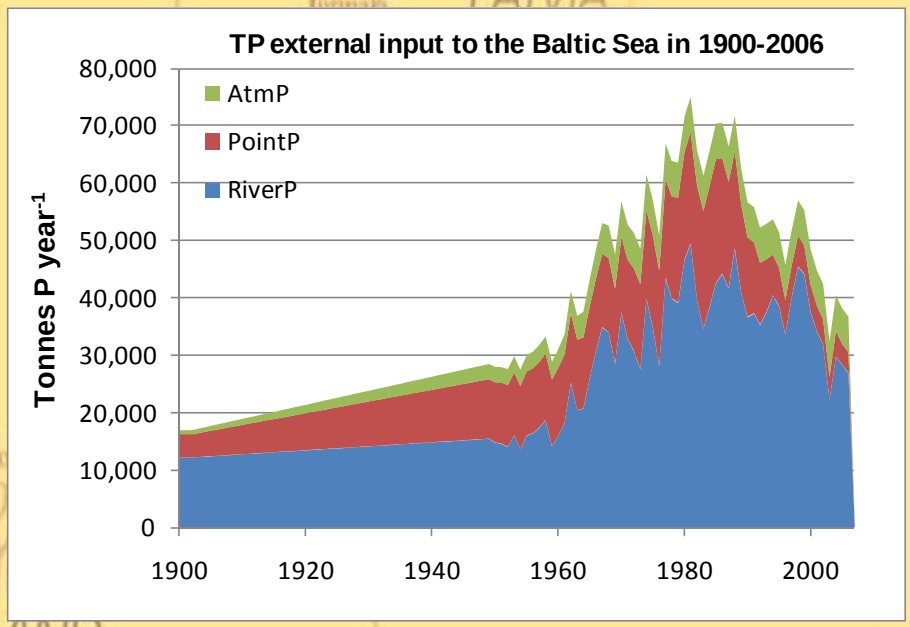
Sources:

- Paper by Schernewski and Neumann, 2005
- Paper by Savchuk et al., 2008

Reconstructed for a century ago:

- TN 391 Kt N a century ago vs. 1015 Kt N in 1997-2003,
  i.e. **2.5** times less
- TP 11.4 Kt P a century ago vs. 42.3 Kt P in 1997 – 2003,
  i.e. **4** times less





Pristine to present day simulation, Baltic proper