Climate change and the Baltic Sea
How will the climate change transform ecosystem services in the Baltic Sea?

Markku Viitasalo
Finnish Environment Institute - Marine Research Center
Educators for the Baltic Sea – seminar 8.9.2009
Costanza et al. 1997: The value of the world’s ecosystem services and natural capital.  

”For the entire biosphere, the value is... an average of USD $33 \times 10^{12}$ per year."

Global GNP is USD $18 \times 10^{12}$ per year.”
Costanza et al. 1997: Global map of the value of ecosystem services
Ecosystem services of the Baltic Sea (sensu Costanza et al.):

- Gas regulation
- Climate regulation
- Nutrient cycling
- Waste treatment
- Biological control
- Habitat/refugia
- Food production
- Genetic resources
- Recreation
- Cultural

Costanza et al. 1997: Global map of the value of ecosystem services

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Costanza et al. 1997: Global map of the value of ecosystem services

USD ha$^{-1}$ year$^{-1}$
Can the climate induce a change in ecosystem (services) in the sea?

Art: Juha Flinkman
A new record of seagulls in Utö (Archipelago Sea):
21,500 common gulls

- Helsingin Sanomat 8.2.2008
”The peculiarities of the Archipelago Sea perhaps induced by winds”

Margus Ellermaa, Birdlife
(Helsingin Sanomat 10.2.2008)
The North Sea in 1955-87: "Parallel long-term trends across four trophic levels and weather"

Aebischer et al. 1990
-Nature 347: 753 - 755
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The North Sea in 1955-87: "Parallel long-term trends across four trophic levels and weather"

Aebischer et al. 1990
-Nature 347: 753 - 755
Baltic Sea: Herring get smaller and salmon fewer in the Gulf of Finland

Baltic Sea: Common guillemot chicks lose weight in Stora Karlsö (Gotland)

Yes!

Climate induced ecosystem changes are taking place in the Baltic Sea!

Two basic mechanisms

1. Warming up
2. Increase of rainfall
Mechanism 1: The Baltic Sea warms up

- Air temperature increases
  - Water temperature
  - Stratification
  - Ice cover
    - Nutrient conditions
      - Warm water species increase
      - Plankton community changes
Mechanism 2: Freshwater runoff to the Baltic increases

- Runoff increases
  - Nutrient flow increases
  - Salinity decreases
  - Saline pulses decrease
  - Stratification gets stronger (?)

- Eutrophication gets worse
  - Oxygen conditions get worse

- Pelagic communities change
- Species geographic limits shift
- Benthic communities change

M. Viitasalo, SYKE
How does this affect me?

Photo: Seppo Keränen
Example 1: Geographic limits of species change

"Oceanization" of the Baltic Sea 1930s-1950s

Segerstråle 1952, 1969
Lindqvist 1959
Example 2:
Non-indigenous species increase

2000 ships on the Baltic!

Organisms from a ballast tank

Photos: Ari Laine

M. Viitasalo, SYKE
Example 3: Effects of harmful substances get worse?

- Physiological functions speed up
- Resistance to environmental stress weakens?
Example 4: Herrings get smaller

Rönkkönen et al. 2004, CJFAS 61: 219-229
Why me?

Juha Flinkman
Example 5: Benthic communities change

1928

Sven G. Segerstråle 1928
Example 5: Benthic communities change

1928

2000

Sven G. Segerstråle 1928
How do benthic animals affect the benthos?

A mysid shrimp in an aquarium
Viitasalo & Viitasalo 2004 - MEPS 281: 155-163
Example 6:
Blue-green algal blooms increase

Kaitala & Stutz, FIMR
Example 7: Eutrophication gets worse

- Blue green algal blooms
- Drifting algal mats
- Eutrophied bays
- Filamentous algae

T. Lindholm
Example 7: Eutrophication gets worse
Or does it?

Peak = high bacterial production, low primary production!

Why? Because organic carbon (in river water) is "good food" for bacteria!

Johan Wikner & Agneta Andersson, Umeå University, Sweden, unpublished results
FROM GULF OF BOTHNIA
Summary

Abiotic factors
• Temperature increases
• Salinity decreases
• Nutrient runoff increases
• Stratification…?
• Oxygen conditions…?
• Internal loading of nutrients…?

Biota
• Geographic limits shift
• Plankton community changes
• Sprat and herring stay thin
• Less valuable fish increase
• Non-indigenous species increase
• Blue green algae increase
• …
Conclusions

Climate change

1. Worsens eutrophication
   (but effects vary from basin to basin)

2. Alters diversity and ecosystem functioning

3. Influences ecosystem services:
   - Waste treatment capacity of the sea
   - Biological control by keystone species
   - Habitats/refugia
   - Food production
   - Genetic resources
   - Recreational and cultural values
Conclusions

Climate change needs to be taken into account in ecosystem-based management and spatial planning of the Baltic Sea
Remember:

- Baltic Sea is not dead, yet!
- The young of today are the decision-makers of tomorrow!

*Fejan, Stockholm archipelago*

17.06.2005