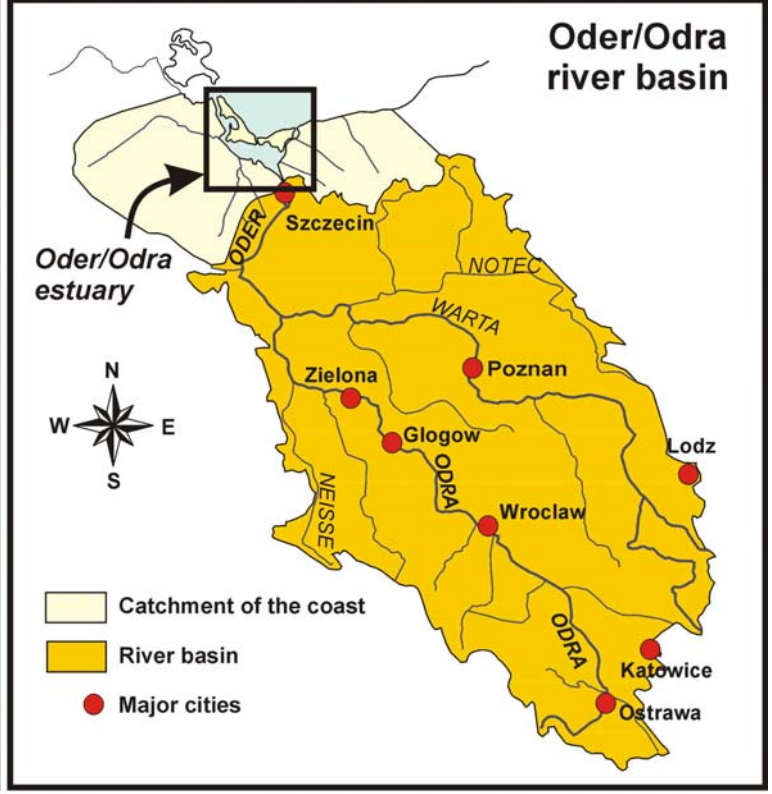
The 3rd International ASTRA Conference “Climate change and waters””
09-12 May 2007, Riga, Latvia

Climate change effects on water quality in the Oder estuary: What recent hot years tell us about the future

Gerald Schernewski & Holger Janssen

Baltic Sea Research Institute Warnemünde

The Oder estuary and the Oder river basin



Oder/Odra river basin

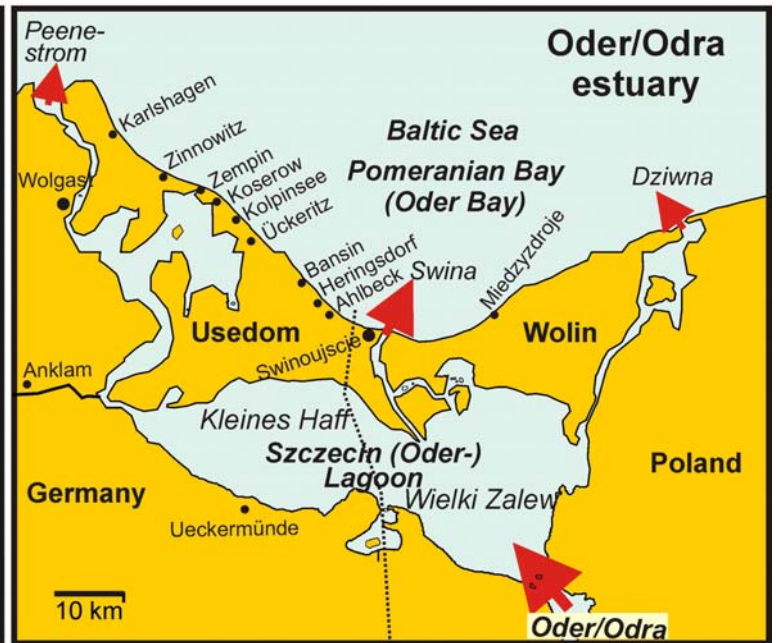
Length (km):	854
Catchment (km²):	118,000
Discharge (m³/s):	530 (average)
Population (Mio):	15.4

Oder/Odra estuary

Catchment (km²):	8000
Lagoon area (km²):	687
Lagoon depth (m):	3.7 (average)

Coastal climate:

Temperature (°C):	8.7 (average)
Precipiation (mm):	550



Climate change increases the coastal squeeze:

- **Sea level rise & river floods**
- **Direct and river induced effects on water quality**

Climate Change and water quality: Driver, pressure, state, impact

- Consumption of fossil fuels
- Inefficiency of energy use
- Slashing and burning
- Industrial agriculture

cause

Emission of green house gases

	Pre-industrial values	Values of 2005
Carbon dioxide	280 ppm	379 ppm (+35 %)
Methane	715 ppb	1774 ppb (+148 %)
Nitrous Oxide	270 ppb	319 ppb (+18 %)

Pressure on the Baltic Sea Region

- Warming of mean annual **temperature** by some 3 to 5 °C (higher than global warming)
- **Precipation** changes in southern Baltic: winter + 20 to 70 %, summer up to - 45 % (with considerable subregional and seasonal variation
- Projections about changes in **wind** speed and wind direction are not robust.

(all values SRES A2, 1961-1990/2071-2100, BACC)

Impacts on Oder/Odra river basin

Rising temperatures
- Summer: + 2,75 to 3,25 °C
- Winter: + 3,75 to 4,25 °C

Shifts in precipatation
- Summer: - 10 to 30 %
- Winter: + 15 to 30 %

- Shifts in river runnoff with impacts on nutrient loads

Direct impacts on the Oder/Odra lagoon and coastal area

- Reduced oxygen cont.
- Increased denitrification
- Anoxic conditions
- Internal eutrophication
- Algae blooms (esp. Blue-green algae)
- Frequency of floods (Coastal squeeze)

Impacts on the estuary by the Oder/Odra river

- Change in nutrient loads
- Change in N:P ratio

Impact on economy: e.g. Tourism

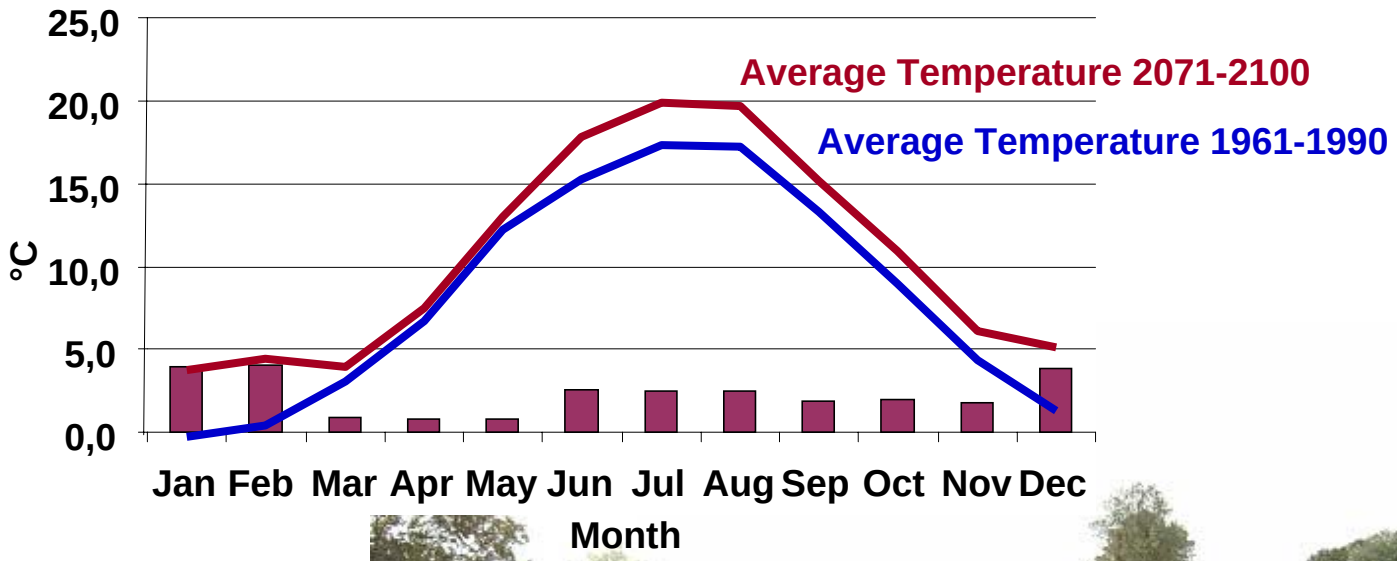
- Tourism benefits from higher (water) temperatures and longer summer seasons
- Bluegreen algae blooms (can be toxic) and jellyfish during tourism seasons

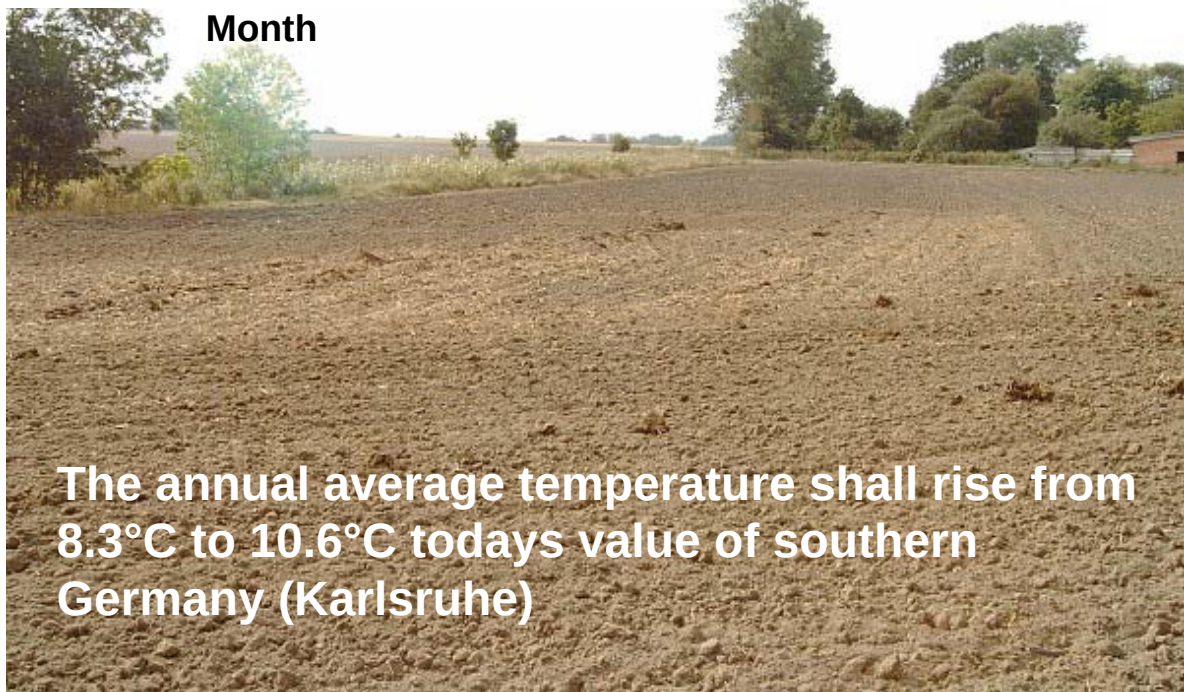
Impacts Baltic Sea

- **Sea level rise**
- **Species migration**
- **Changes in food web**
- **Less nutrient loads during summer, more during winter**
- **N gets more limiting**

Temperature scenario for the Oder Lagoon

(Ueckermünde A1B, WettReg)

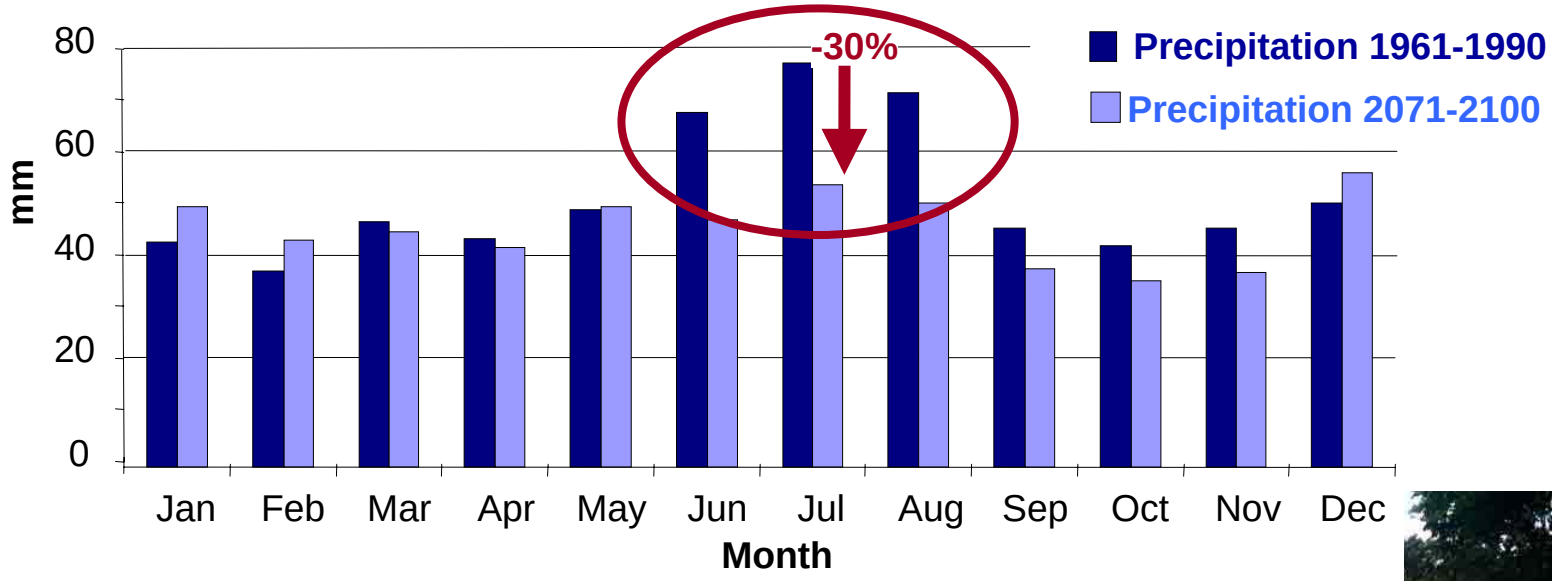




The annual average temperature shall rise from 8.3°C to 10.6°C todays value of southern Germany (Karlsruhe)

Precipitation scenario for the Oder/Odra Catchment Area

(A1B, WettReg)



Recent press headlines

Drought threatens grain harvest

Drought raises food prices

Farmer claim for new water management because of drought

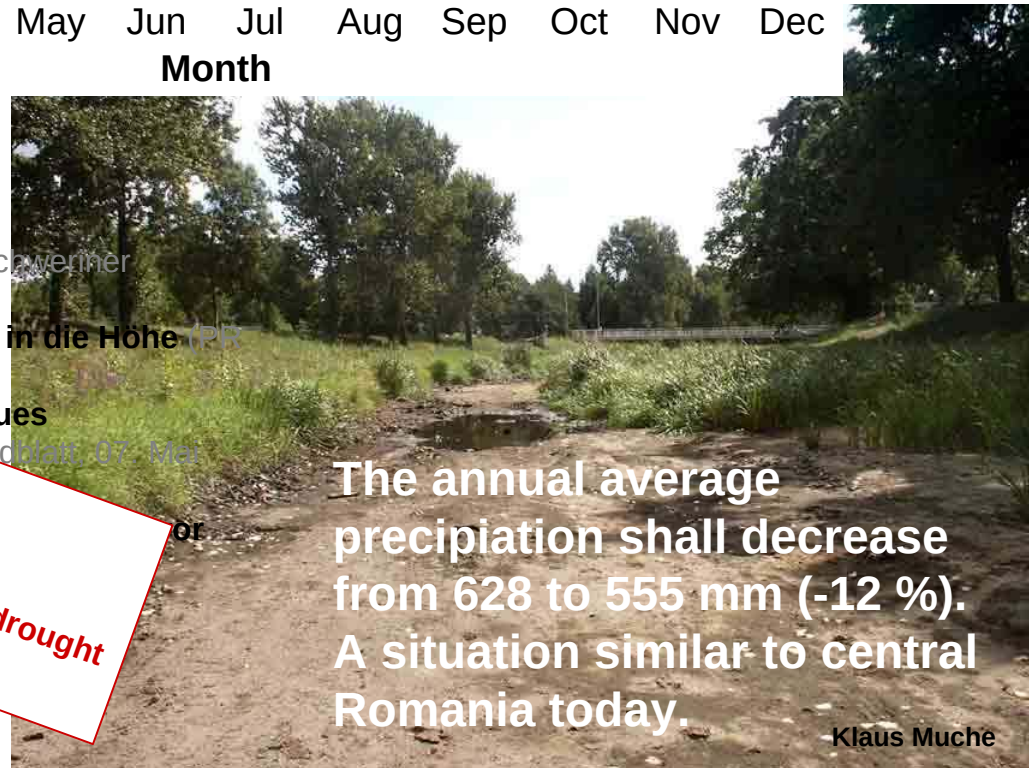
Minister of agriculture recommends harvest insurence

Trockenheit bedroht Getreideernte (Schweriner ...itung, 03. Mai 2007)

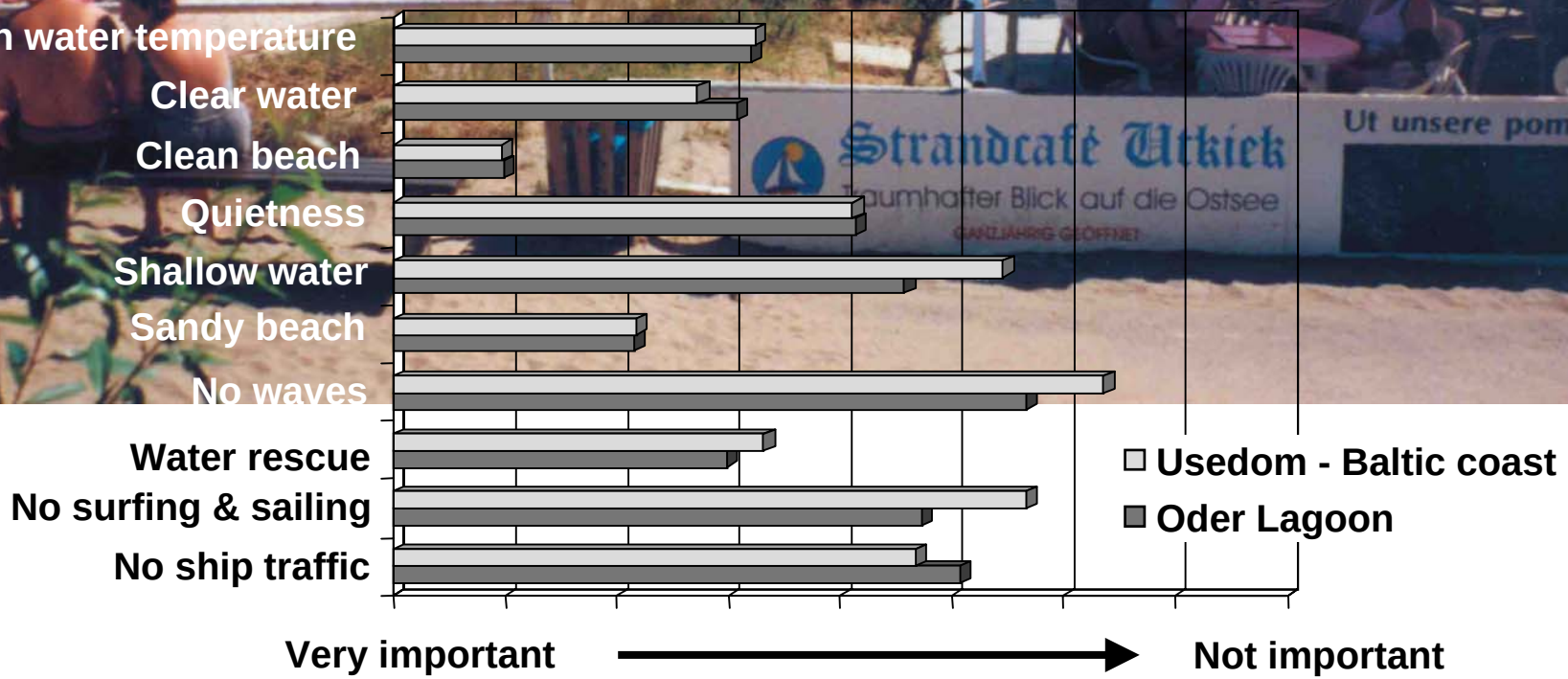
...eibt Lebensmittelpreise in die Höhe (PR ...

...nheit neues ...ndblatt, 07. Mai ...

Seene... (mdr.de, 07. ...



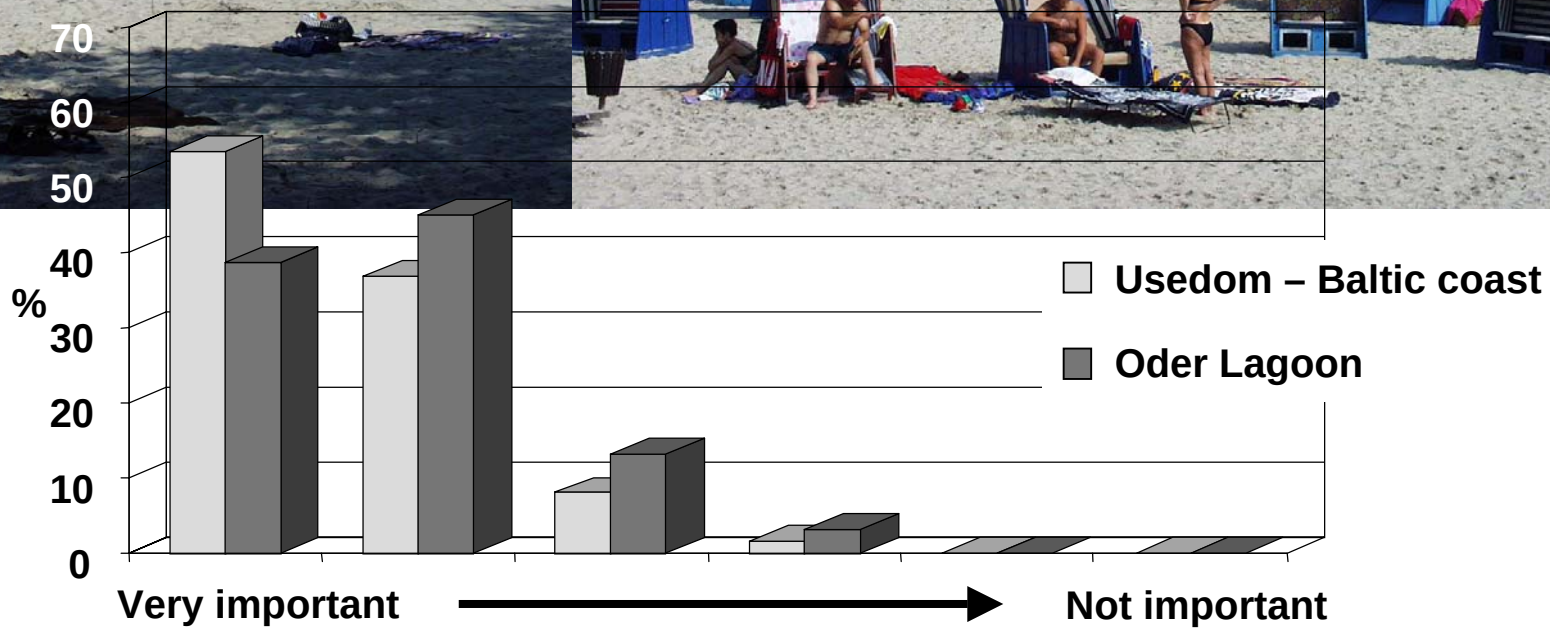
Coastal tourism: demands



Most important: warm, clear water and sandy, clean beaches !

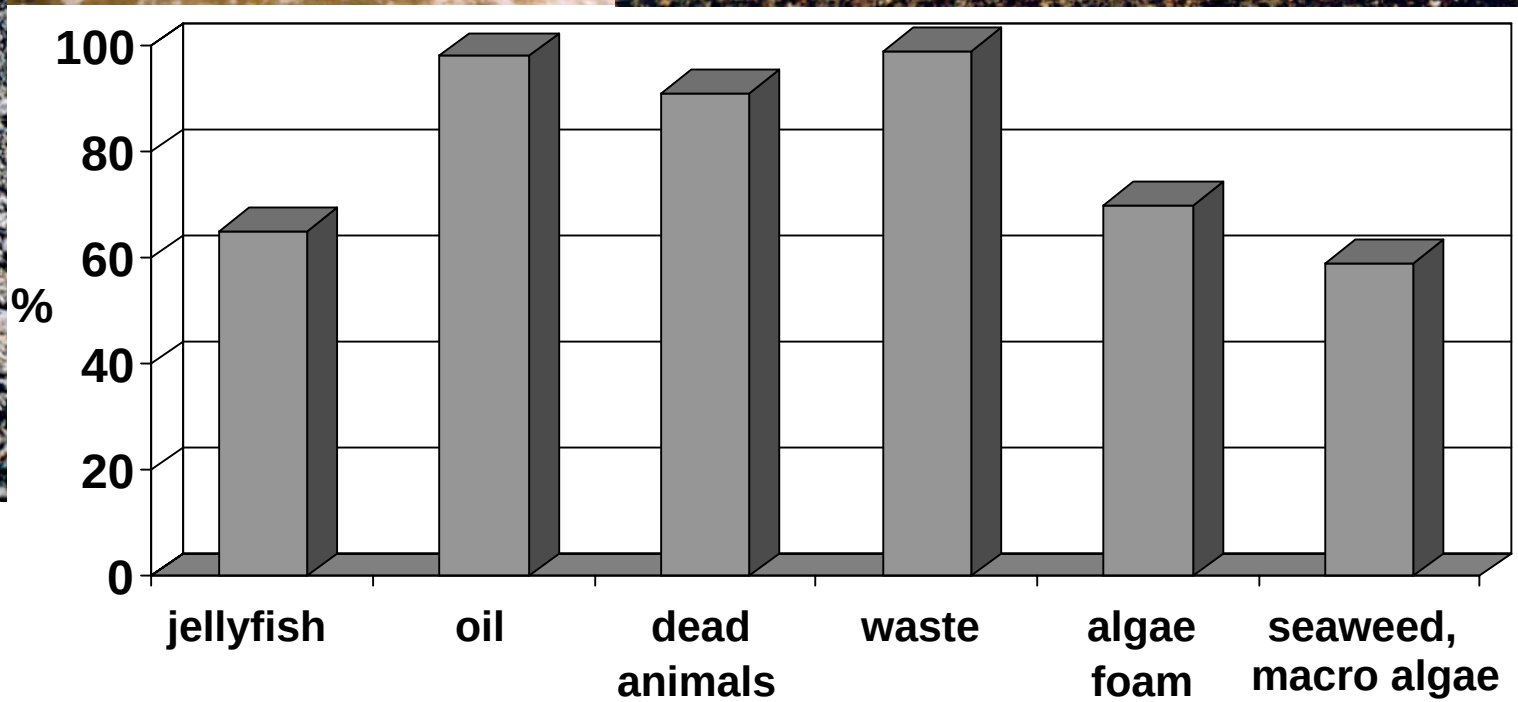
after Dolch (2002)

Coastal tourism: How important is a good water quality?



after Dolch (2002)

Coastal tourism: Major nuisences



after Dolch (2002)

Increasing water temperatures (and eutrophication) favour jellyfish

Ohrenqualle (*Aurelia*)

Warm temperatures

- favour jellyfish survival (esp. warm winters)
- favour summerly jellyfish plagues and
- are beneficial for alien species (like *Mnemiopsis*)

davidbyrne.typepad.com

- Jellyfish fish can become a problem for tourism and fisheries,
- reduce the food resources (zooplankton) for fish,
- prey on fish eggs/larvae
- alter the ecosystem

Jellyfish plague on Spanish beaches (Reuters 07/2006)

Jellyfish force bathing restrictions as thousands stung (ThinkSpain 08/2006)

Spanish Mediterranean coast invaded by jellyfish (Euroresidents 08/2005)

swimatyourownrisk.com

Rippenqualle Mnemiopsis, Warnemünde, Herbst 2006
Quelle: Postel/IOW

Aland Sea
http://www.ymparisto.fi/

NASA image courtesy Jeff Schmaltz

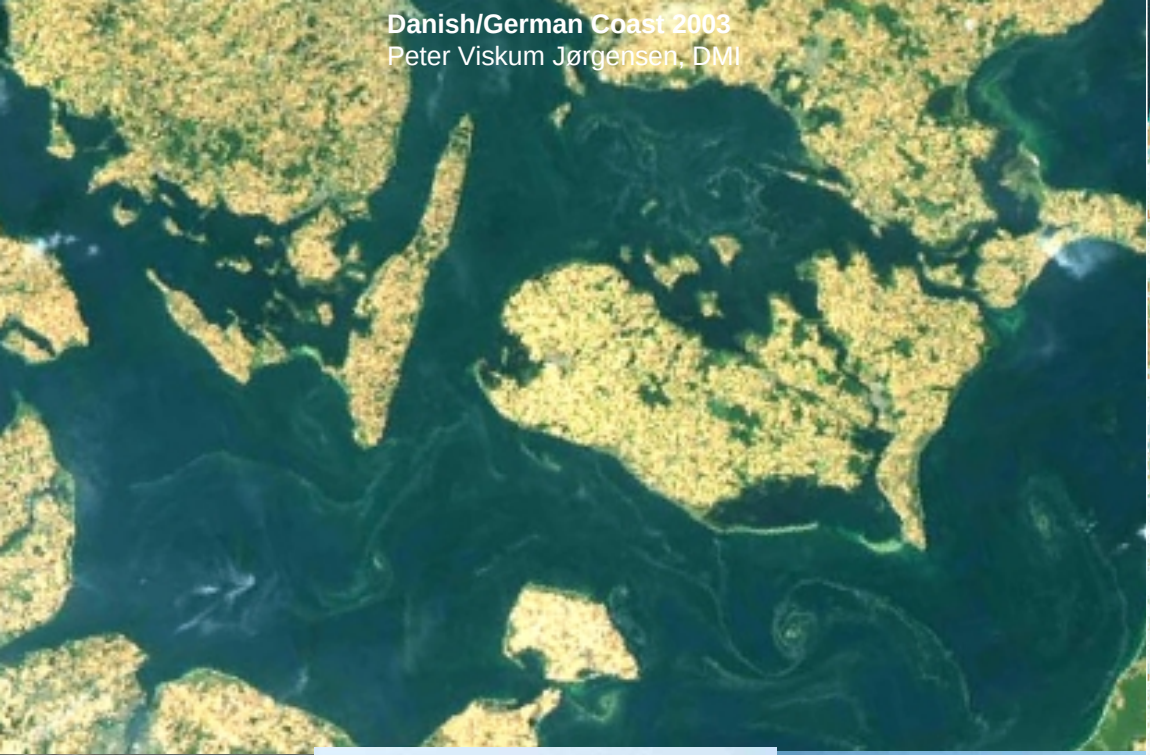
Warm weather favours blue-green algal blooms

The Baltic Sea in July 2005

„Intense blue-green algal growth is directly linked to high phosphorus concentrations in surface waters. Warm, calm and sunny weather during early July 2005, in combination with the available phosphate, resulted in a widespread and intense bloom....“(Helcom, 27.06.2006)

http://www.flickr.com/photos/jurvetson/30399340/

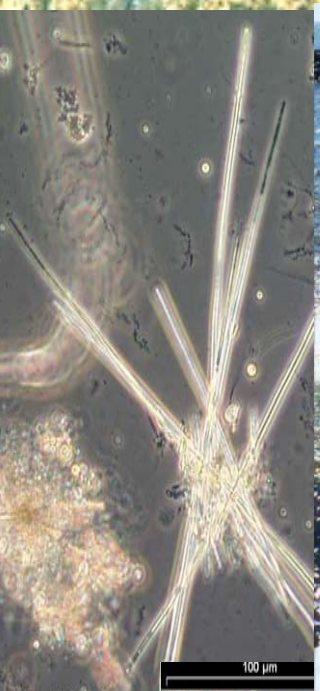
Helsinki, Taivallahti Bay
Finnish Environment Institute (SYKE)

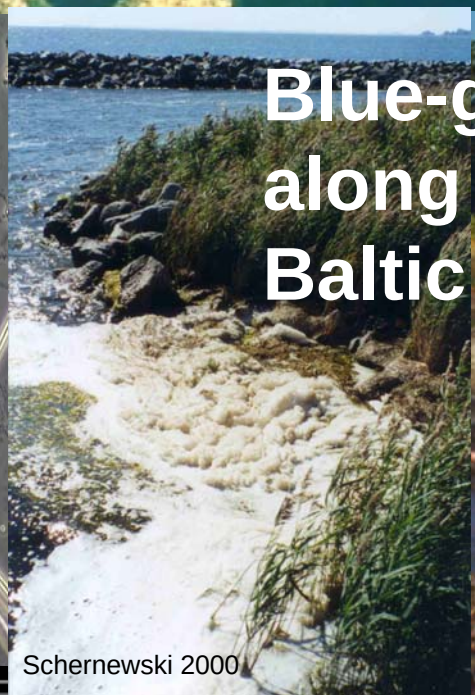


Danish/German Coast 2003
Peter Viskum Jørgensen, DMI

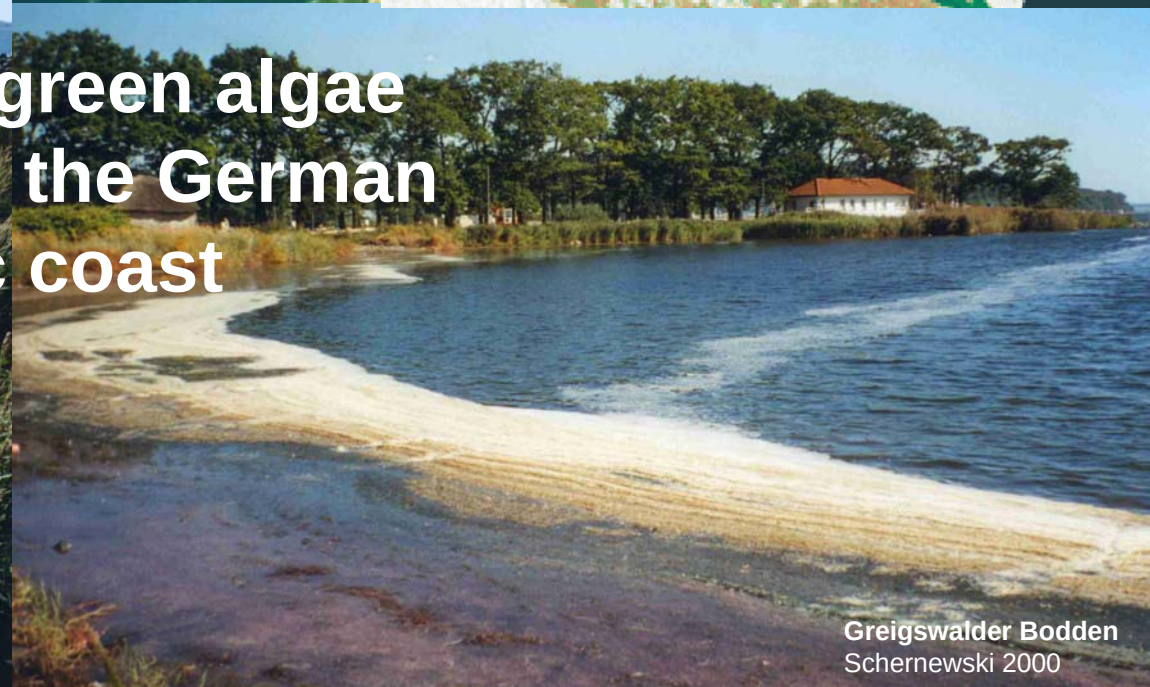
Siegel et al. 2000

Blue-green algae along the German Baltic coast





Schernewski 2000



Greigswalder Bodden
Schernewski 2000

Baltic Sea suffers from oxygen depletion

Ostseezeitung 6. Sept. 2002 title page

Ostsee leidet unter Atemnot

Umweltalarm für die Ostsee. Einleitungen und anhaltende Hitze haben den Sauerstoffgehalt absinken lassen. Kippt das Binnenmeer um?

Rostock (OZ/M.S.) Sauerstoffnot in der westlichen Ostsee: Den Fischen geht die Luft aus. Schuld sind verstärkte Gülleeinleitungen aus Dänemark. Besonders betroffen sind der Große und Kleine Belt, das Kattegat und der Öresund. Dänische Fischer schlagen bereits Alarm: Ihre Netze bleiben leer oder sind mit toten Fischen gefüllt. „Die Ostsee ist kurz vor dem Umkippen", warnen Experten.

Auch in der Mecklenburger Bucht vor Wismar sind die Aus-

Die roten und rotschraffierten Zonen der Ostsee leiden unter akutem Sauerstoffmangel. Grafik: A. Zill

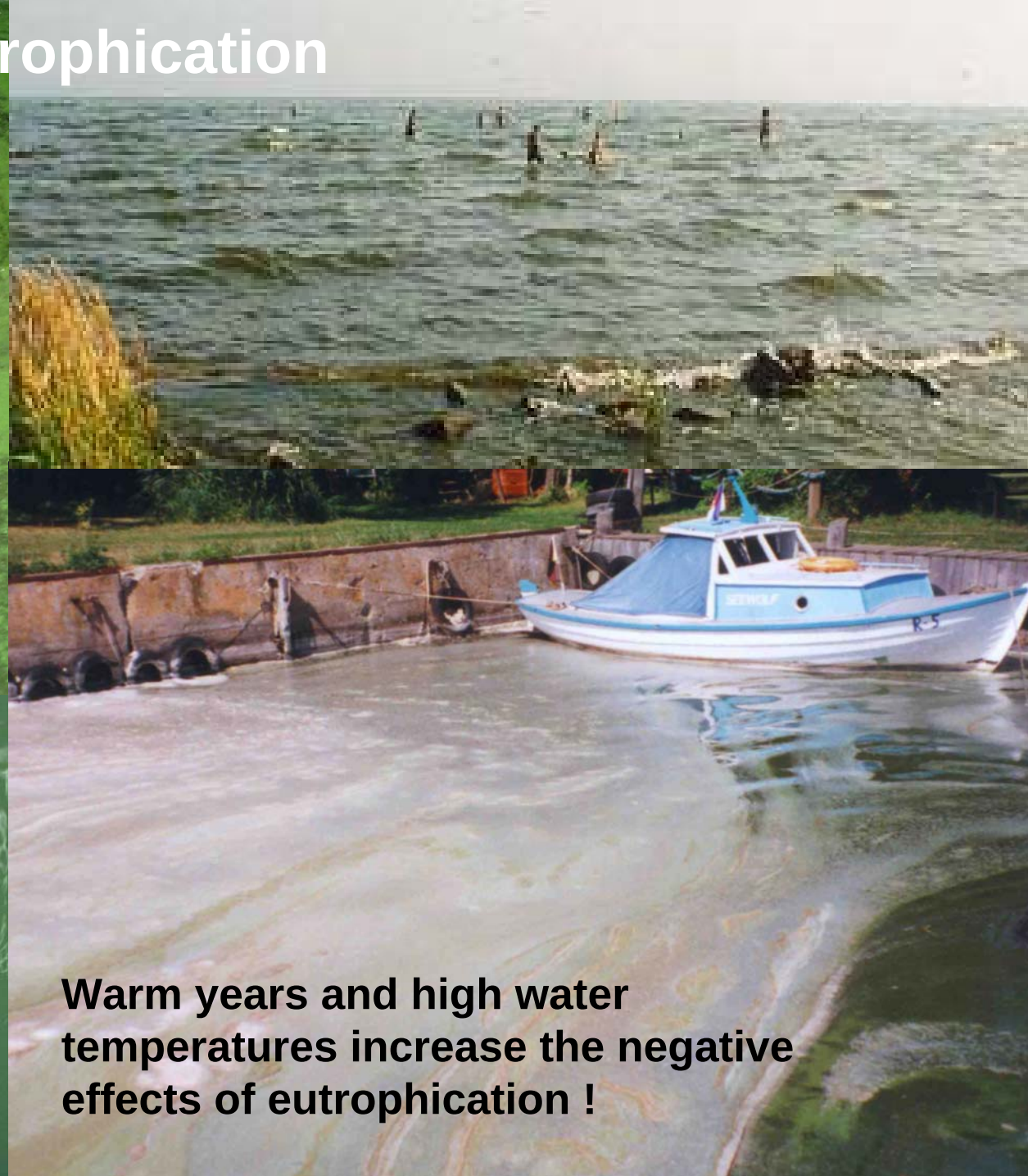
along the German Baltic Coast

„Sauerstoffmangel hat in der Lübecker Bucht zu einen großen Fischsterben geführt. Nach Mitteilung des Kieler Umweltministeriums wurden am Donnerstag mehrere tausend tote Fische an das Ufer der Ostsee gespült. Dabei handelte es sich überwiegend um Dorsch, aber auch um Aalmutter und Butt“....(3Sat, 2000)

Oder Lagoon in May 2000 (Schernewski 2000)

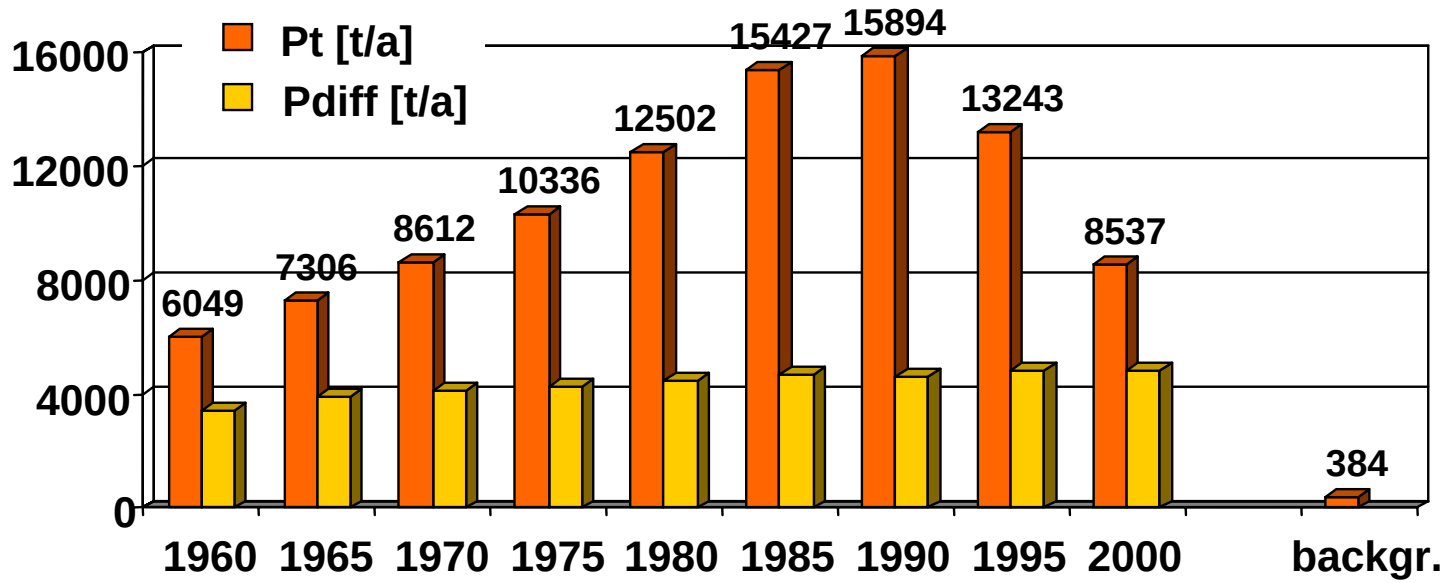
Oder Lagoon: Eutrophication

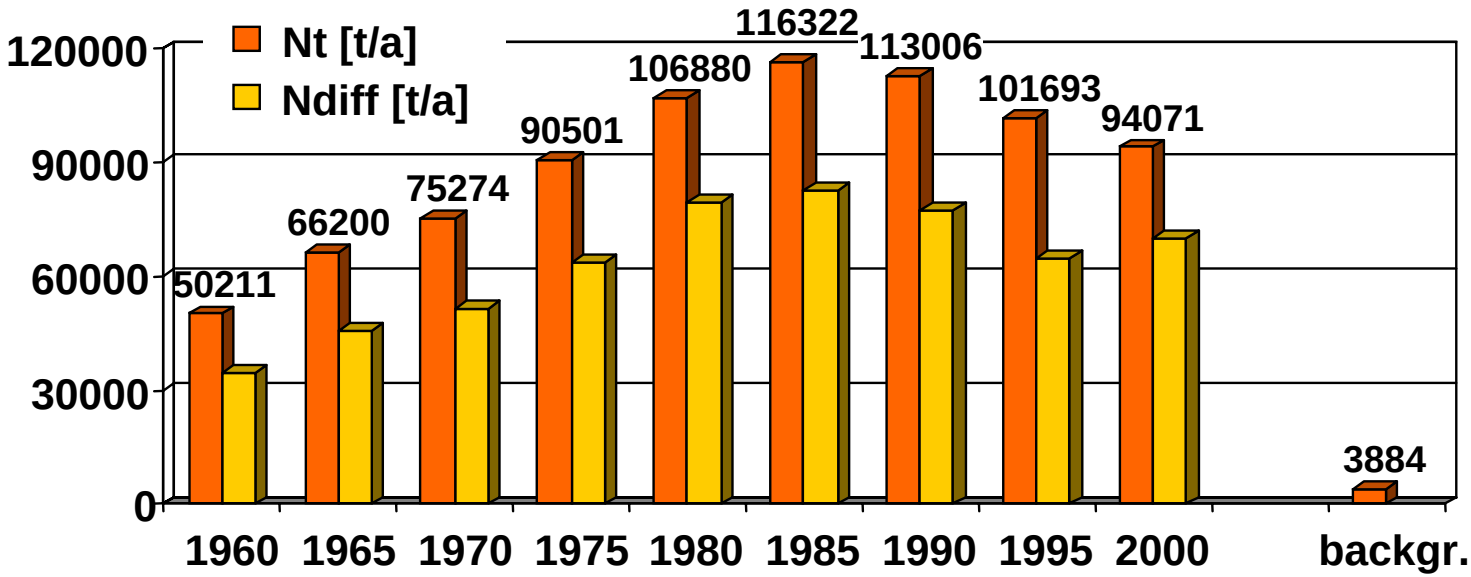
Schernewski
(2000, 2001)



Warm years and high water temperatures increase the negative effects of eutrophication !

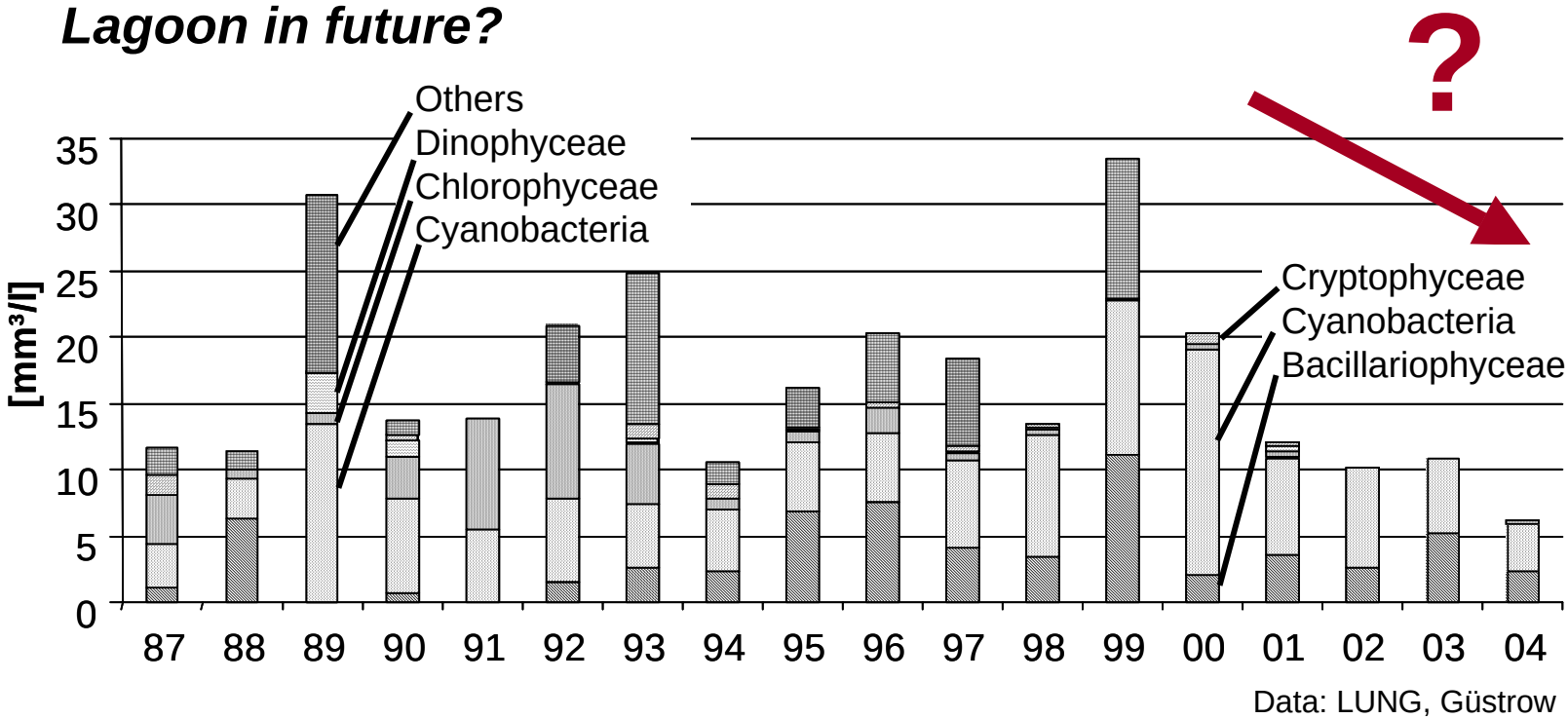
Long-term Oder/Odra river loads (5 year averages)





From: Behrendt et al. 2004 (Moneris model)

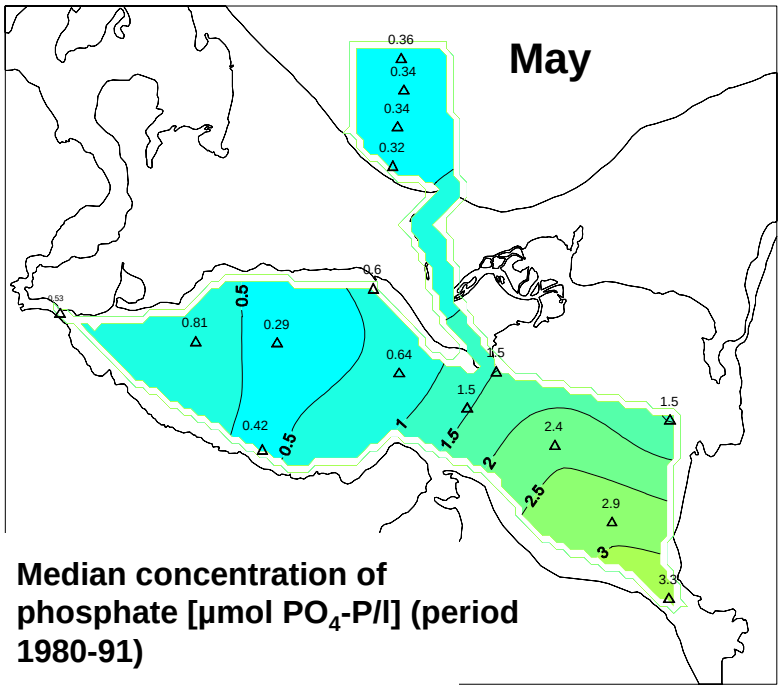
Decreasing summer-phytoplankton biomass in the Oder Lagoon in future?



Data: LUNG, Güstrow

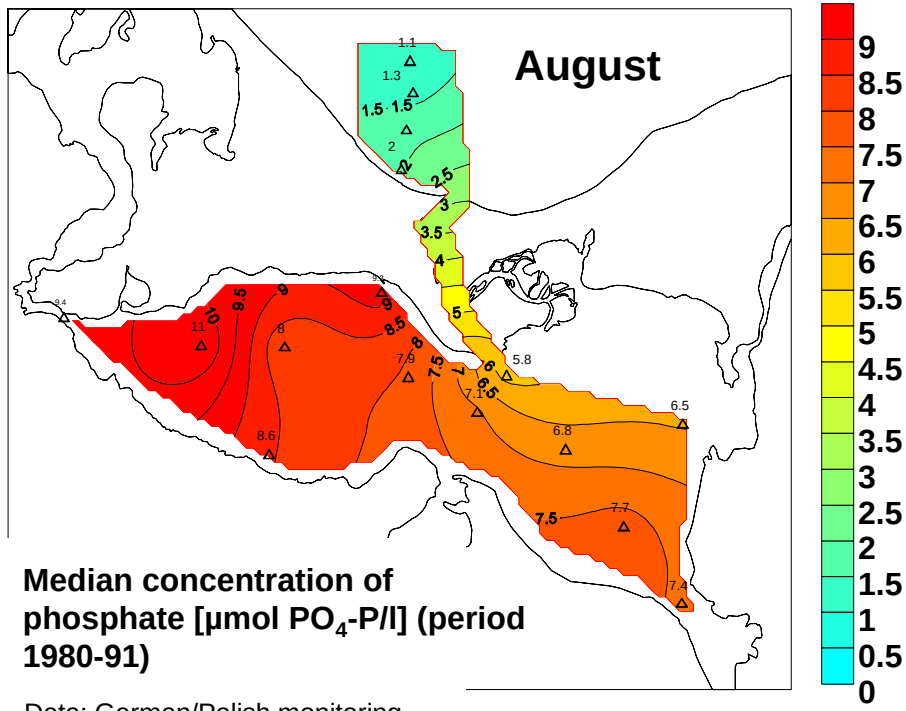
- The summer phytoplankton concentration (volume) of is decreasing during the last six years.
- The summer phytoplankton diversity seems to become lower and diatoms and blue-green algae are now dominating.
- Reduced river water discharge and nutrient loads (due to drier summers) seem to cause a regular nitrogen limitation in the lagoon during summer.
- This river discharge situation is already close to what Climate Change scenarios predict.
- Do we have to expect blue-green algae blooms in the lagoon in future?

Oder Lagoon: Increasing internal eutrophication?



Median concentration of phosphate [µmol PO_4-P/l] (period 1980-91)

Data: German/Polish monitoring programme by LUNG and WIOSZ



Median concentration of phosphate [µmol PO_4-P/l] (period 1980-91)

Data: German/Polish monitoring programme by LUNG and WIOSZ

- High water temperatures and calm weather condition favour a thermal stratification
- P release from the sediment under anoxic conditions can contribute up to 400 t P (the Oder load of 3 month) during short periods in summer.
- It has no effect on phytoplankton in the lagoon but is threat for the (nutrient limited) coastal Baltic Sea.
- Internal eutrophication counteracts remediation measures and has an increasing likely-hood in future.

Summary

- **Climate Change will alter our aquatic ecosystems and coastal zones in many and unexpected ways!**
- **Climate Change will increase many effects of eutrophication. Therefore, nutrient load reductions remain a major task for the future!**
- **The temporal and spatial resolution of our recent research on Climate Change consequences is still not sufficient. Surprising results can be expected!**
- **Climate Change consequences on water quality are still an underestimated topic!**

Recent research is carried out within the projects:

ICZM-Oder *(Research for an Integrated Coastal Zone Management in the Oder/Odra estuary region)*

&

ASTRA *(Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region)*

Results and further informations are available under: ***www.ikzm-oder.de***

Funding:

Bundesministerium für Bildung und Forschung

Baltic Sea Region INTERREG III B

Danish/German Coast 2003
Peter Viskum Jørgensen, DMI

Blaualgenblüten an der deutschen Ostseeküste

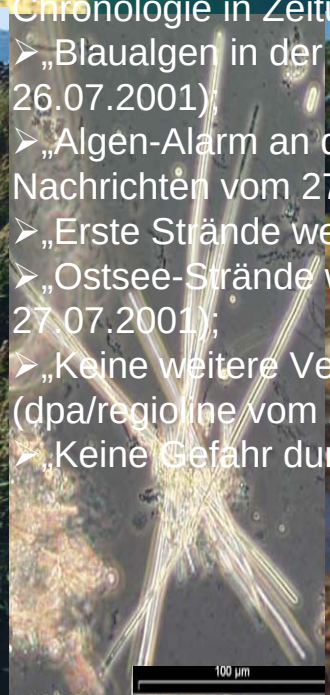
Siegel et al. 2000

Blaualgenblüte vor der dänischen Küste im Juli 2001. Die Algen-Schlieren und aufgetriebener Schaum betrafen die Lübecker Bucht und bedrohten einige Tage auch die Region Warnemünde-Kühlungsborn, bevor die Algen durch Winddrehung wieder auf die Ostsee hinausgetrieben wurden.

Chronologie in Zeitungsüberschriften:

- „Blaualgen in der Ostsee - Zum Teil giftige Arten“ (dpa/regioline vom 26.07.2001);
- „Algen-Alarm an der Ostsee - Warnung an Urlauber“ (Lübecker Nachrichten vom 27.07.2001);
- „Erste Strände wegen Algenpest gesperrt“ (dpa/online vom 27.07.2001);
- „Ostsee-Strände wegen Blaualgen gesperrt“ (dpa/serviceline vom 27.07.2001);
- „Keine weitere Vermehrung der Algen in Ostsee - Lage entspannt“ (dpa/regioline vom 28.07.2001);
- „Keine Gefahr durch Algen“ (Ostsee Zeitung vom 30.07.2001).

Schernewski 2000



Greigswalder Bodden
Schernewski 2000