



# *WEBAP*

## *Wave Energized Baltic Aeration Pump*

**Can waves help to mitigate hypoxia in the Baltic Sea?**

*Christian Baresel*



## Baltic Sea – a unique sea for millions





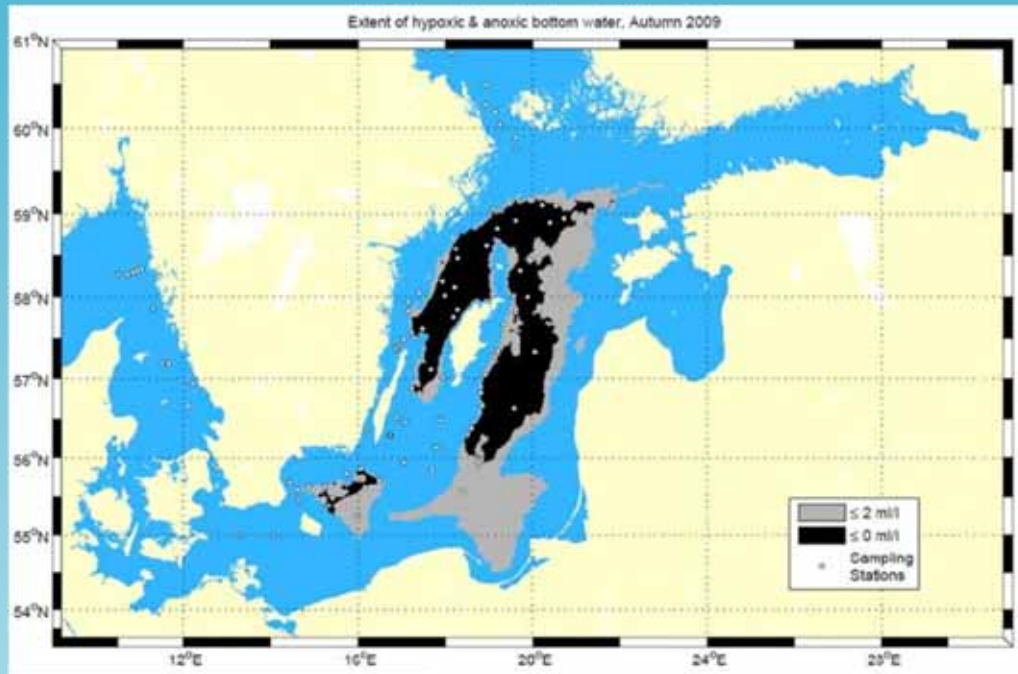
## Baltic Sea - en dumping place for millions

- Pollution causes e.g. eutrophication due to nutrients

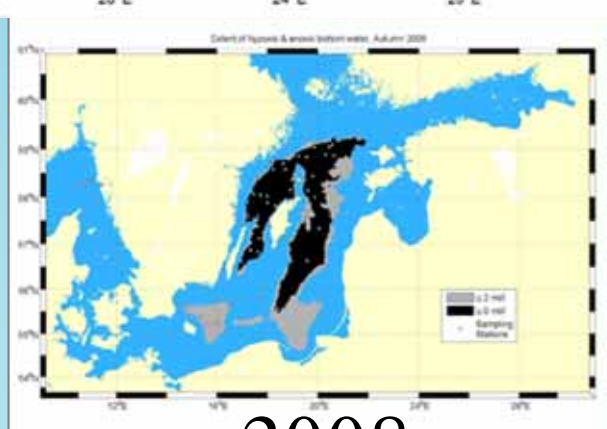




## SMHI:s Extent of oxygen-depleted bottom water in the Baltic

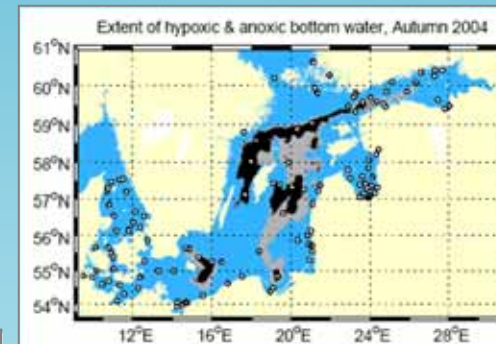


2009

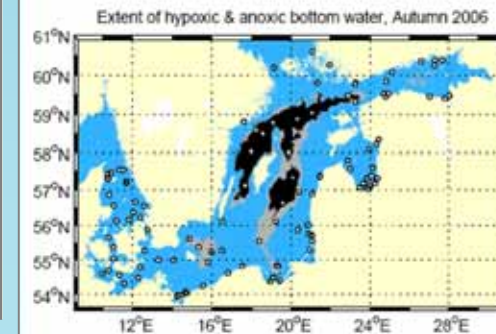


2008

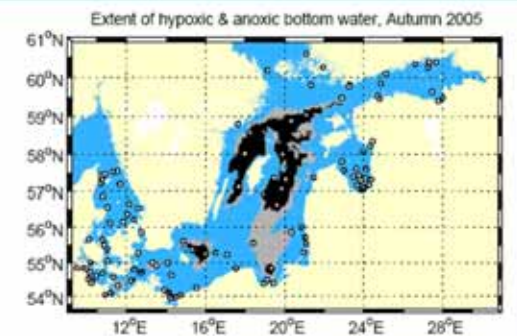
2004



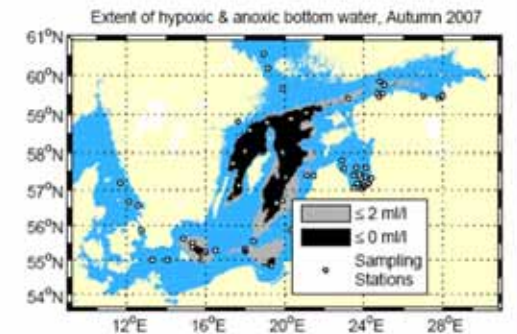
2006



2005

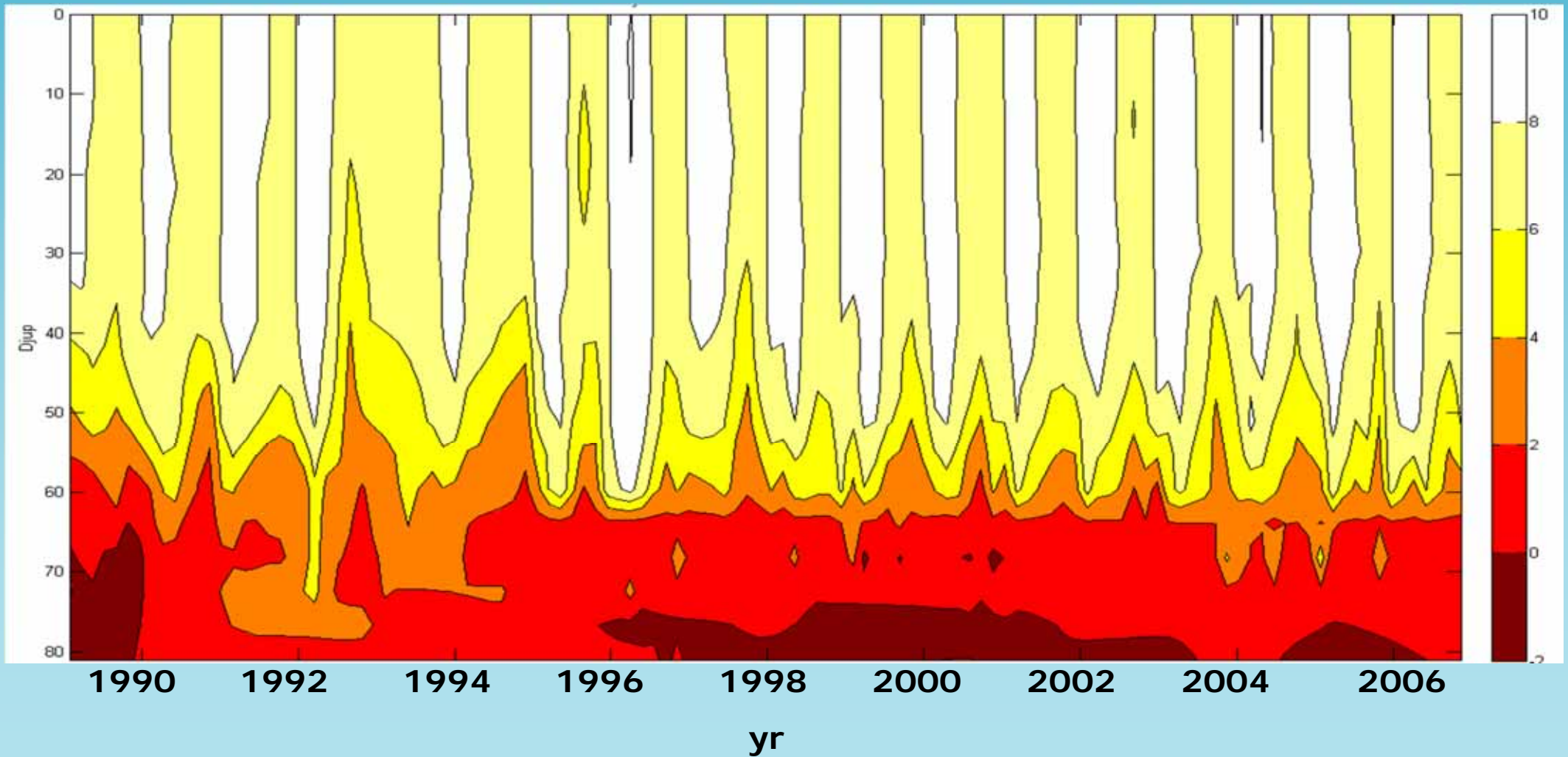


2007





# Oxygen-depletion in Hanöbukten





# Oxygen-depletion in Stockholms archipelago

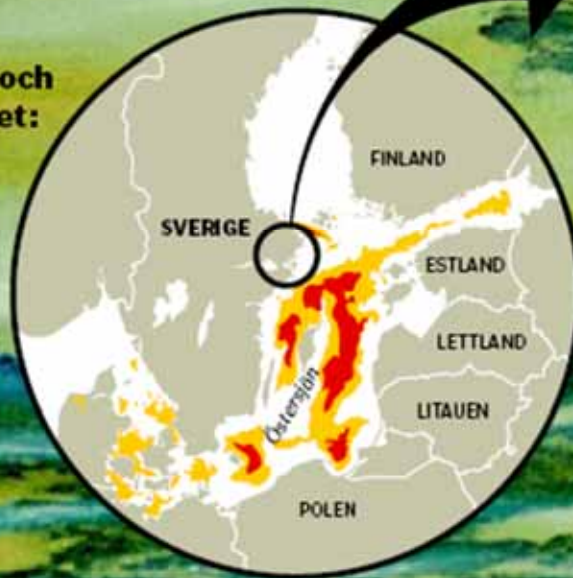
I perioder är stora områden av Östersjöns botten syrefria, framför allt de djupare delarna och Finska viken. Även i Stockholms skärgård finns drabbade områden. I spåren följer massiva algblomningar, oftast under de vackraste sommarveckorna.

SvD måndag 28 april 2008

## Botten med syrebrist

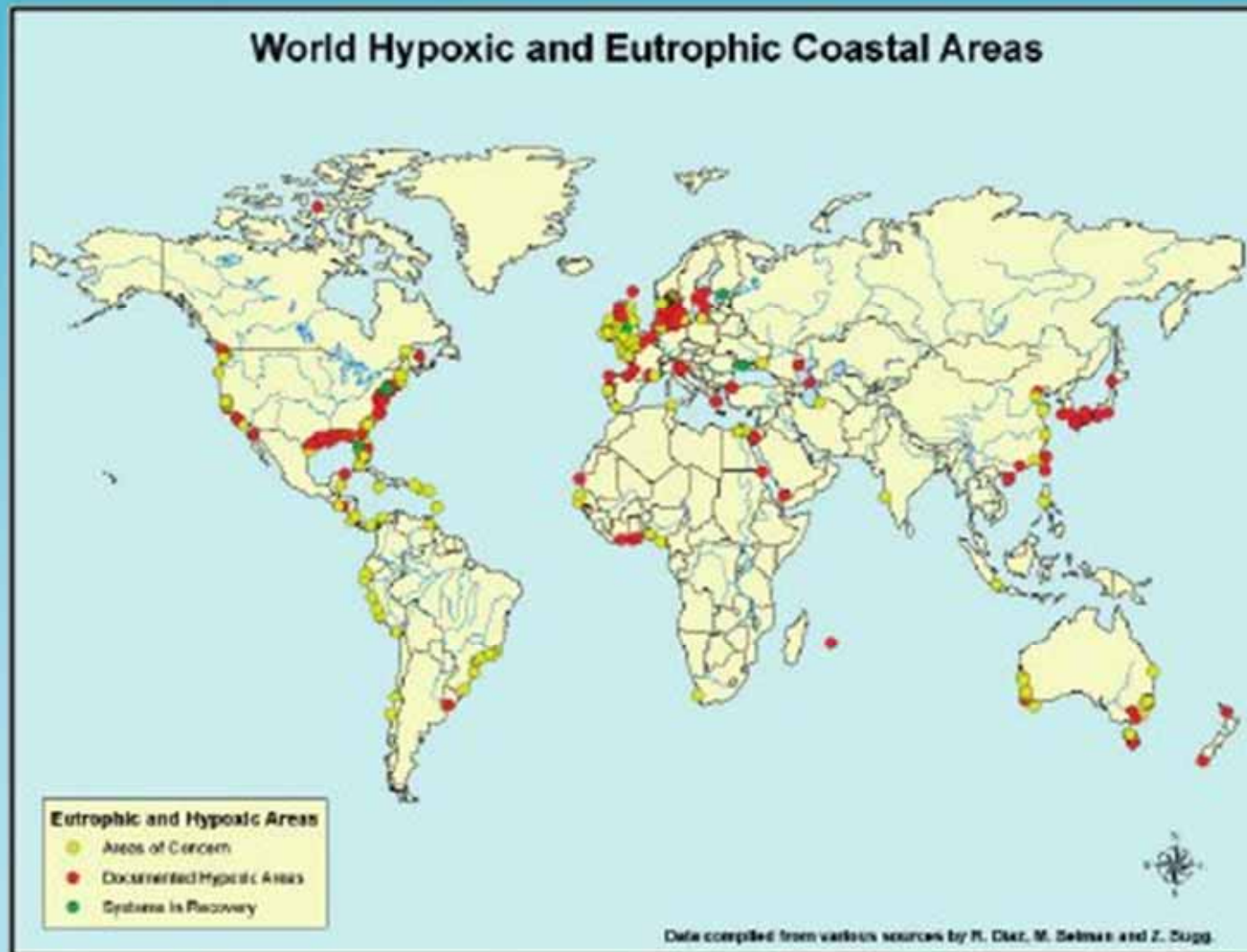
-  Tidvis syrefria botten
-  Permanent syrefria botten

## Östersjön och Västerhavet:





# Dead bottoms around the world





## Need for action?

- Doesn't the Baltic take care of itself?
- How affects and is the Baltic affected by climate change?
- Can technical solutions help in a long term?



Why do we think we need actions also in the Baltic and not only at sources?

- There sure is a good monitoring of sources and these sources can be abated?
- The Baltic in imbalance? Weakening of natural processes? Restore the Baltic Sea self-cleaning biogeochemical processes?





## Possible mitigation measures

- **Reduce nutrient loads from anthropogenic sources**  
Highest priority, applied for many years, includes demands for lower nutrient loads from WWTP and agriculture, etc.



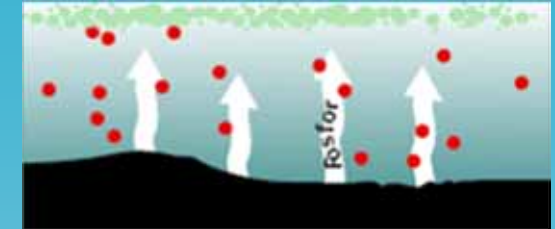
### Our contribution?

- Development and export of Swedish know-how and technology for municipal and industrial water treatment.
  - e.g. Test- and demonstration facility Hammarby Sjöstadsverk
- Development of technology to reduce phosphor leakage from agriculture.
  - e.g. Ditch dams and ditch filters
- Observation of ecosystems
  - e.g. Changes in Swedish coastal sediments
- **Oxygenation of hypoxic areas**





## WEBAP: Aim



Improved oxygen situation in deep water layers

- Species that are dependent on conditions in deep water, would get a better environment and opportunities for reproduction.
- Solved inorganic phosphorus released due to the reducing conditions in the bottom sediments will be bound in complexes and thus reduce the inorganic nutrient concentrations in the water.

Yet:

- 2-6 million tons of oxygen needed each year!
- Enormous amounts of energy to pump oxygen down to 80-120m depth!

 **Mission impossible?!**



## WEBAP: How?

### The use of natural resources:

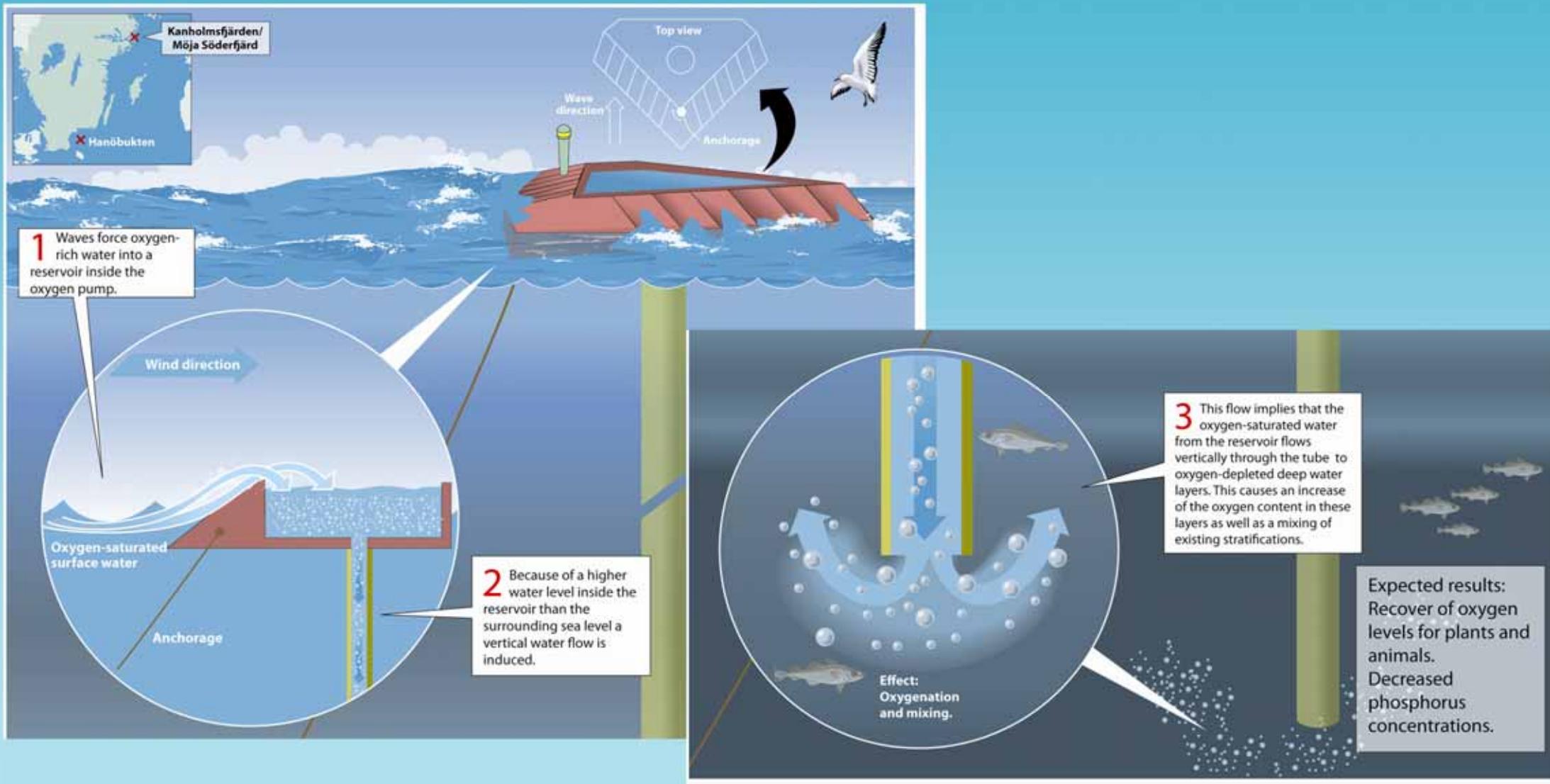
- Source of energy: waves
- Source of oxygen: oxygen-rich surface water

### Advantages:

- Oxygenation & mixing
- Simple and robust design with no moving parts
- No need for electricity



## WEBAP: Principle



## WEBAP: Testing sites?

- 2 pilot units

Mainly two purposes and differences

- Pilot I: Pumping effect of waves and behavior in open sea
- Pilot II: Effect of oxygenation





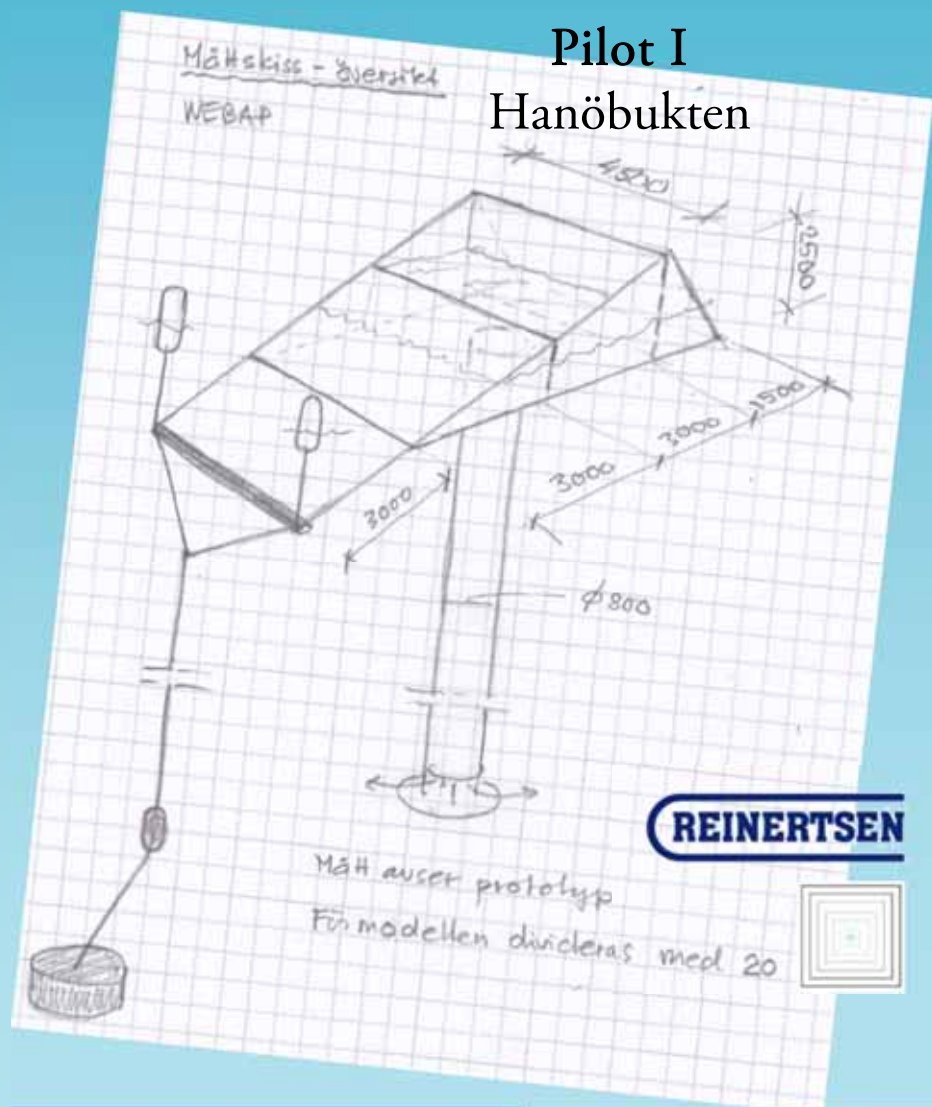
## WEBAP: Planned activities

- Installation of WEBAP prototypes in September/October with test runs and fine tuning of the system.
- Continuous sampling and measuring at sites
- Complementary effect studies at the sites and the lab
- Continuous measuring and monitoring of the prototypes
- Evaluation and modeling of effects
- Evaluation of WEBAP prototypes



## WEBAP: Status

Pilot I  
Hanöbukten



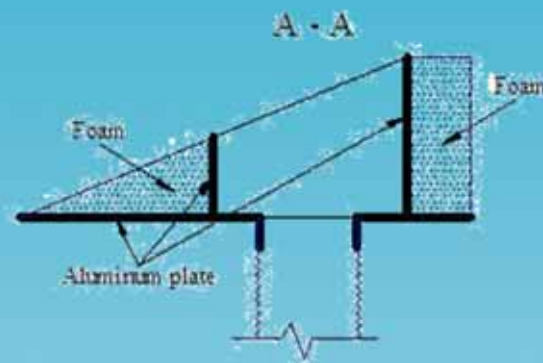
Pilot II  
Kanholmsfjärden



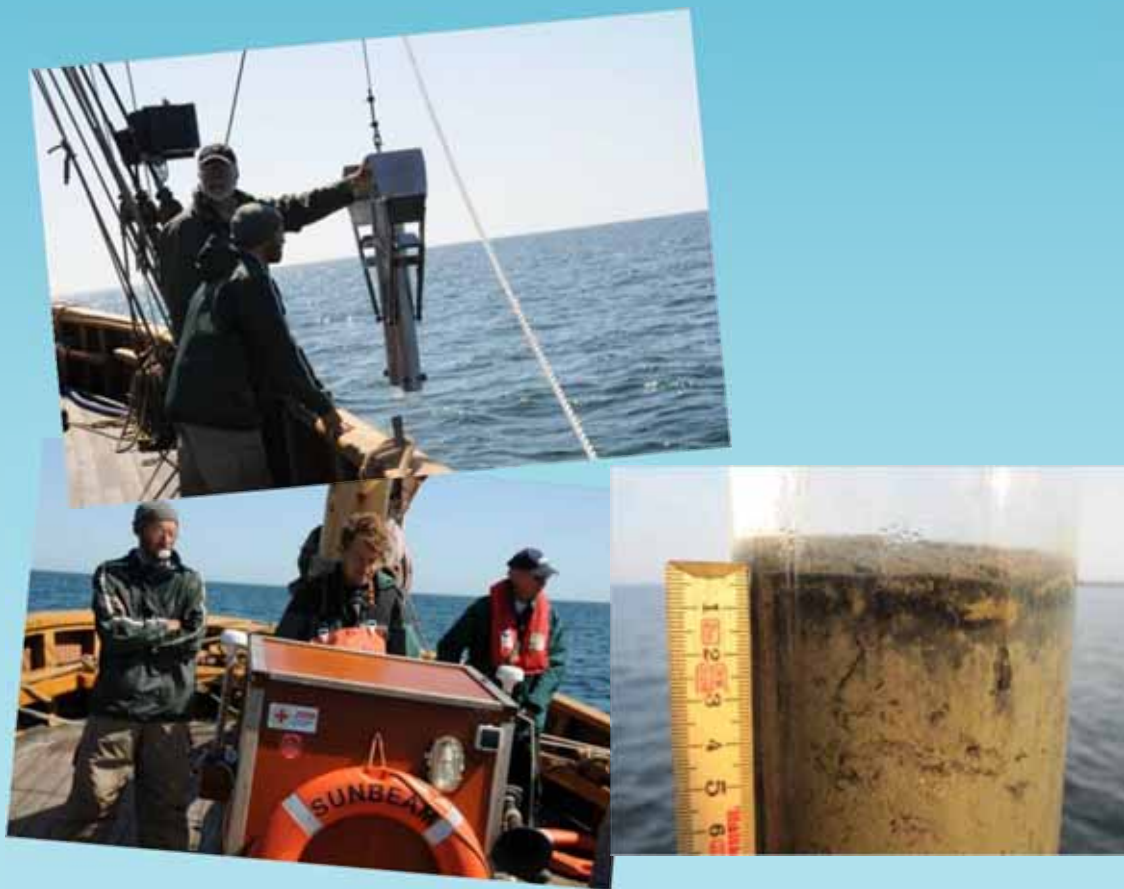


## WEBAP: Status

### Basin tests



### Field campaigns



### Construction







## Project partner & collaboration partner

### Project group

- IVL Swedish Environmental Research Institute
- KTH – Royal Institute of Technology
- Municipality of Simrishamn



### Collaboration partner (selection)

Åbo Akademi University, KIMO - Local Authorities International Environmental Organization, Institute of Oceanology of the Polish Academy of Sciences, Erken Laboratory, Österlen Trade Society, Marint centrum, Österlens Fishing Association, ITT Water and Wastewater, Reinertsen, BWN consulting, Marincenter Syd, Konceptfabriken, MJK etc

### Planned collaboration with other ongoing projects

BOX, PROPPEN, SEABED, Innovative Aquaculture Åland Islands



## Future: solution combination?

- Aquaculture?
- Research station?
- Tourism/Recreation
- Energy platform?
- Entrée to the Baltic?





[www.webap.ivl.se](http://www.webap.ivl.se)

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