



 **Research in the interface between science and governance of ecological resources**


-challenges and experiences from Swedish coastal waters



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38k	59%	6k	250	8	126
Students	Female Employees	Staff	PhD:s awarded/year	Faculties	Years Old

 **Short bio**

- Professor in quantitative benthic ecology at the Department of Marine Sciences
- Master and PhD at UGOT
- Post-Doc University of Sydney, Australia
- General benthic ecology, EIA, statistical modelling, monitoring, benthic mapping, aquaculture, marine policy
- Also affiliated to *Centre for Sea and Society* and *The Swedish Institute for the Marine Environment*



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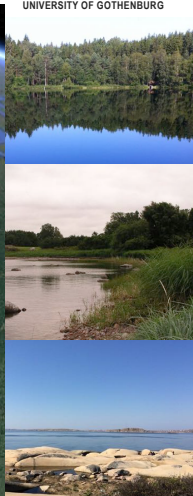
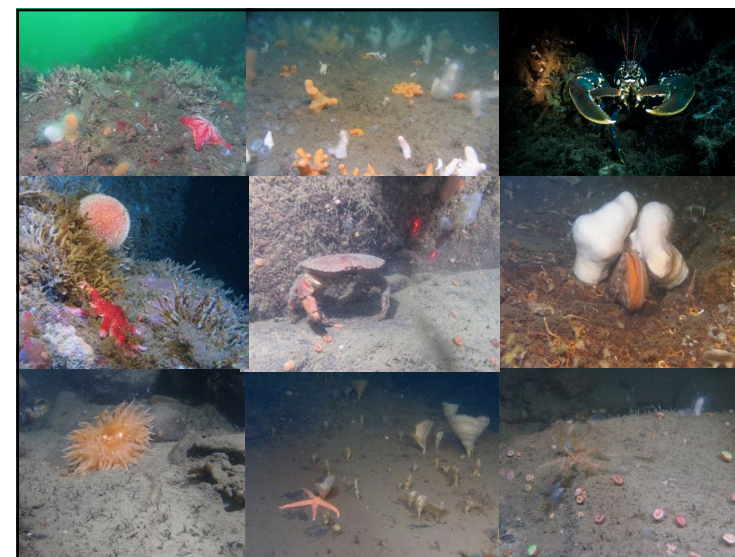
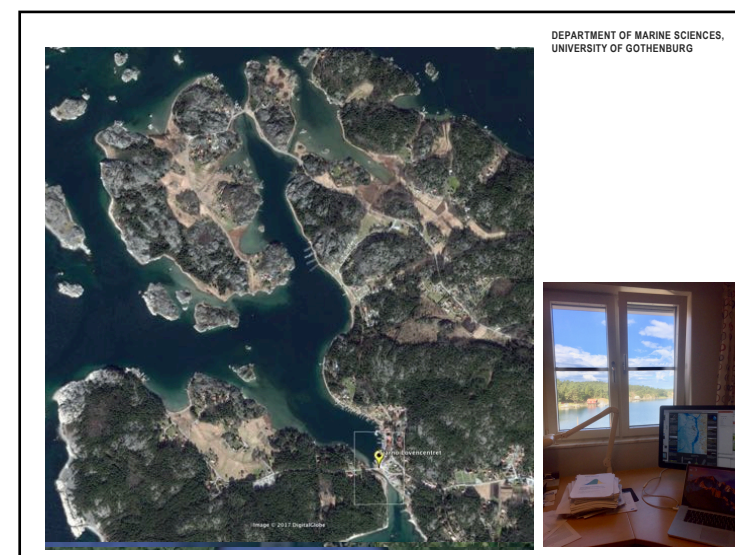
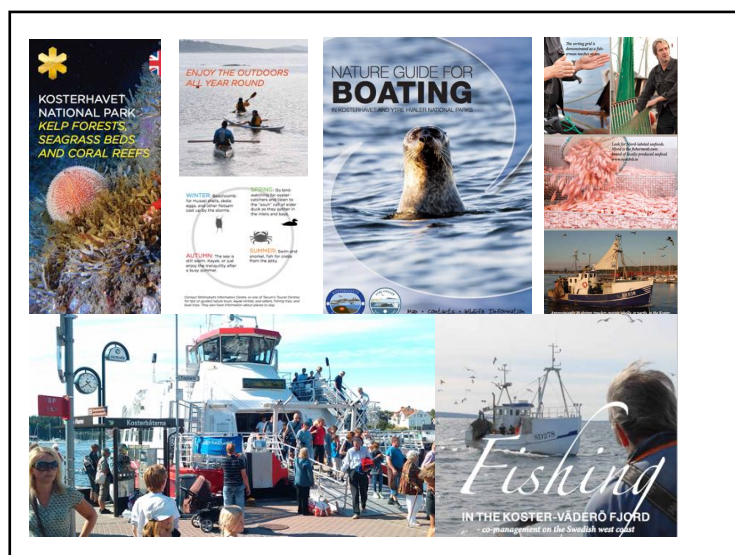



Image Landsat © Copernicus
Image Mapbox
Image US Government Service
Data: NOAA, US Navy, NGA, GEBCO






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Outline

- Global challenges for sustainability
- Policy responses in a European context
- Swedish perspectives
- Personal experience
 - Ecological status assessment & water quality
 - Ecological mapping & MSP
 - Aquaculture
- Some lessons from a UGOT-perspective



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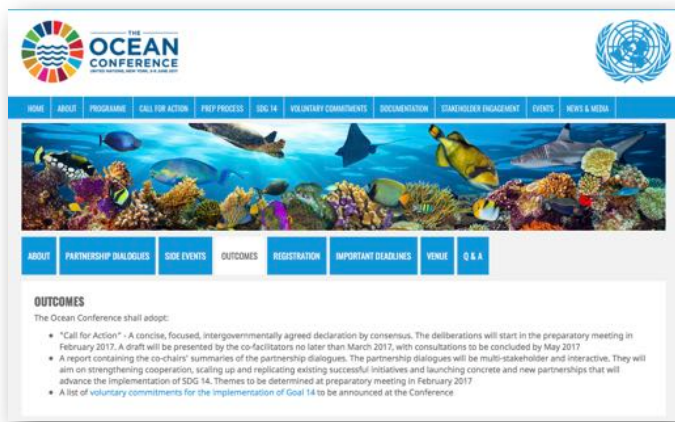
UN sustainable development goals



GOAL 14: CONSERVE AND SUSTAINABLY USE THE OCEANS, SEAS AND MARINE RESOURCES

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THE OCEAN CONFERENCE
OUR OCEANS, OUR FUTURE: PARTNERING FOR THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOAL 14
5 - 9 JUNE 2017, NEW YORK



OUTCOMES

The Ocean Conference shall adopt:

- "Call for Action": A concise, focused, intergovernmentally agreed declaration by consensus. The deliberations will start in the preparatory meeting in February 2017. A draft will be presented by the co-facilitators no later than March 2017, with consultations to be concluded by May 2017
- A report containing the co-chairs' summaries of the partnership dialogues. The partnership dialogues will be multi-stakeholder and interactive. They will aim on strengthening cooperation, scaling up and replicating existing successful initiatives and launching concrete and new partnerships that will advance the implementation of SDG 14. Themes to be determined at preparatory meeting in February 2017
- A list of voluntary commitments for the implementation of Goal 14 to be announced at the Conference



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According to SDG14 we should...

- ...prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
- ...sustainably manage and protect marine and coastal ecosystems
- ...minimize and address the impacts of ocean acidification
- ...effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans
- ...conserve at least 10 per cent of coastal and marine areas
- ...prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing
- ...increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources
- ...increase scientific knowledge, develop research capacity and transfer marine technology,... in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries
- ...provide access for small-scale artisanal fishers to marine resources and markets
- ...enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea



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The SDG14 means...

- Great challenges for the managers, policy makers and business
- Important roles for science and academics
 - Develop new scientific knowledge and understanding
 - Education and capacity building
 - Engage in the society at different levels
- Transdisciplinarity is needed to cope with ecological, economic and social dimensions
- The SDG's are global but we need to develop and implement policies, regulations, actions, research etc. at regional, national and local levels



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The European context

- Development of common policies regarding environment, fisheries, maritime affairs etc...
 - CFP (Common fisheries policy)
 - IMP (Integrated maritime policy)
 - WFD, MSFD (Water Framework Directive and Marine Strategy Framework Directive)
 - REACH (Registration, Evaluation, Authorisation and restriction of Chemicals)
 - ...and many more
- Implementation into national laws and regulations
 - National targets
 - National indicators and routines
- Great influence on governance practices since Sweden joined the EU in 1995.



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The Water Framework Directive

- Introduced in 2000 in order to...
 - Meet the increasing pressures on fresh- and marine water resources
 - Create an integrated water policy based on catchment areas
 - Develop common practices for management and status assessment
 - Achieve good ecological status in 2027.
- Involves ground- and surface-water (lakes, streams and coastal waters)
- The WFD defines general principles but need to be adapted to regional and local conditions



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The Water Framework Directive

- Cyclic, adaptive management process
- Assessment of ecological status in lakes, stream or coastal areas ("water bodies")
- Biological, chemical and physical "quality elements"
 - Fish
 - Benthic fauna
 - Benthic vegetation
 - Phytoplankton
- "One-out-all-out principle" for biological quality elements (precautionary principle)
- Common assessment scale, EQR (0-1)



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Large number of water bodies

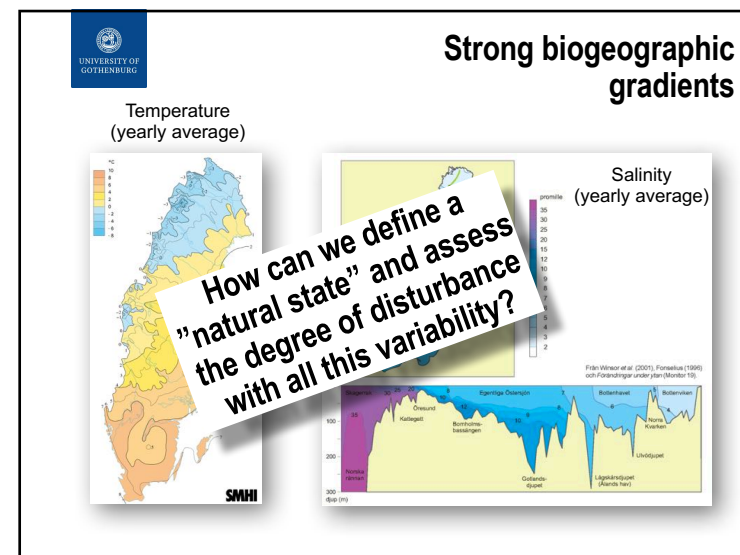
Habitat	BQE	No. assessed using complete data	No. assessed using expert methods	No. not assessed
Coastal	Benthic fauna	103	248	
	Macrophytes	61		
	Phytoplankton			
Lakes	Benthic fauna			6498
	Macrophytes		53	6586
	Phytoplankton			
Stream	Benthic fauna	656	307	12969
	Macrophytes		222	12969
	Phytoplankton	761	0	1386*

How can we monitor and assess status in all of those?

≈ 654 coastal

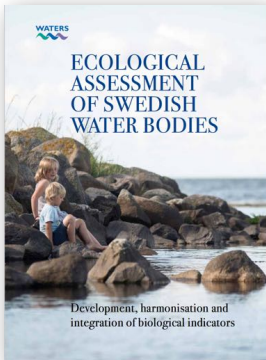
≈ 7 000 lakes

≈ 14 000 streams



WATERS –
Waterbody Assessment Tools for Ecological
Reference conditions and status in Sweden

- Reliable and sensitive indicators for biological quality elements.
- Consistent methodology for defining references, class boundaries and uncertainty in estimation and classification.
- Develop a common framework for integrated assessment.
- Close interaction with national and regional authorities and users!

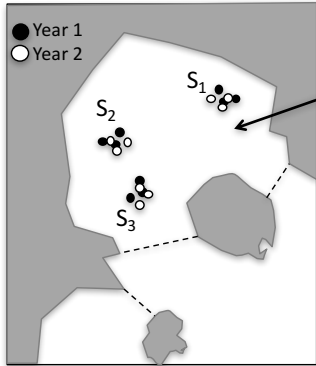


ECOLOGICAL ASSESSMENT OF SWEDISH WATER BODIES
 Development, harmonisation and integration of biological indicators

Harmonisation of methods



Status assessments are based on monitoring data



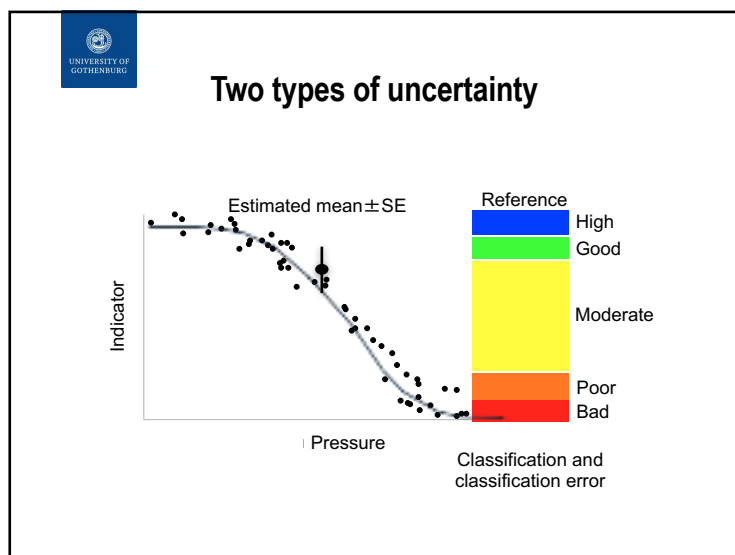
● Year 1
 ○ Year 2

Water body with **3 stations**, each monitored with **3 samples** at each of **2 years**

Assessment of a 6-yr period involves variability due to years, sites, samples, etc.

“Uncertainty is an uncomfortable position. But certainty is an absurd one.”

— VOLTAIRE



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- A general method developed in a series of technical reports (www.waters.gu.se)
- Carstensen, Lindegarth, Johnson

WATERS

UNCERTAINTY OF BIOLOGICAL INDICATORS FOR THE WFD IN SWEDISH WATER BODIES

MONITORING BIOLOGICAL INDICATORS FOR THE WFD IN SWEDISH WATER BODIES

MONITORING OF BENTHIC FAUNA FOR THE MSFD ON THE SWEDISH WEST-COAST

DEVELOPING PRACTICAL TOOLS FOR ASSESSING UNCERTAINTY OF SWEDISH WFD INDICATORS

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General methodology based on:

- Partitioning of sources of variability

$$y = \mu + \text{year} + \text{YEAR} + \text{season} + \text{SEASON} \times \text{YEAR} + \text{DIURNAL} + \text{IRREGULAR}$$

temporal sources of uncertainty

$$+ \text{gradient} + \text{GRADIENT} + \text{PATCHINESS}$$

spatial sources of uncertainty

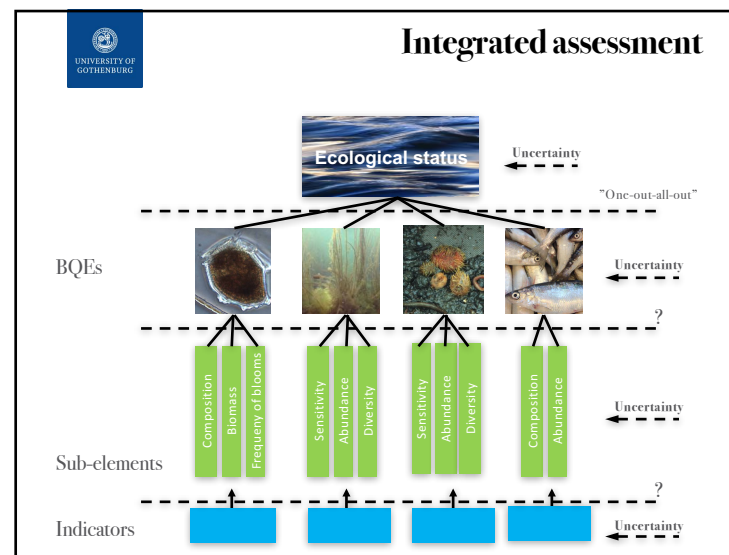
$$+ \text{YEAR} \times \text{GRADIENT} + \text{SEASON} \times \text{GRADIENT}$$

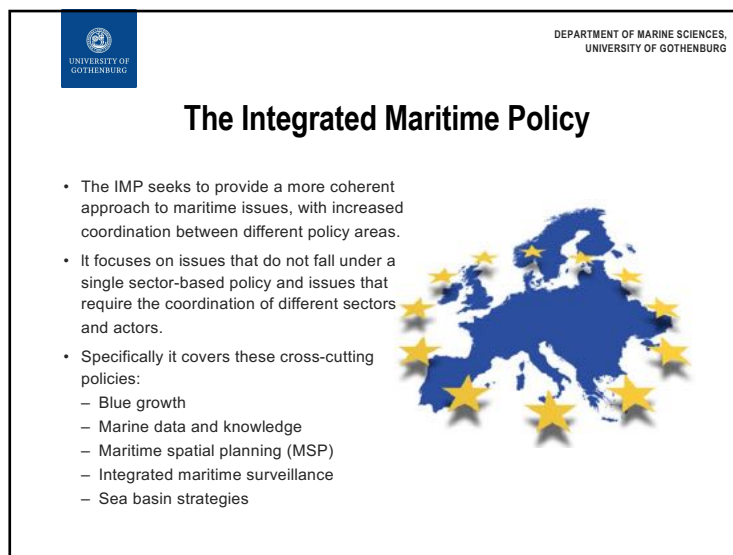
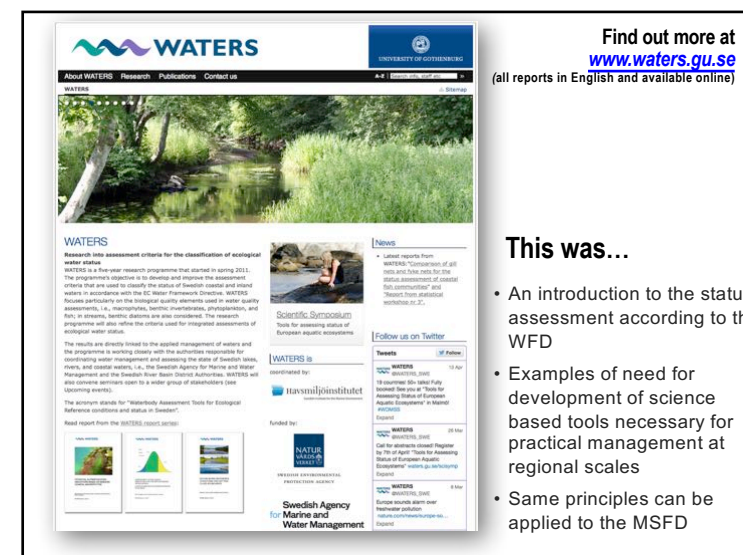
spatio-temporal interactions

$$+ \text{sampling devices} + \text{PERSON} + \text{instrument} + \text{REPLICATE}$$

sampling and measurement uncertainties
- Assessment of overall uncertainty at relevant spatial and temporal scales through error propagation.

$$V[y] = \frac{s_y^2 * (1 - \frac{a}{\gamma})}{a} + \frac{s_b^2}{b} + \frac{s_{\gamma}^2}{ab} + \frac{s_{ab}^2}{abn}$$
- Confidence in classification of BQEs and overall uncertainty





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MSP - "the universal cure to all problems"

National MSP Regional plan for "blue growth"

Havs- och vattenmyndighetens samrådshandling

STRÖMSTAD KOMMUN

ÖSTERÖ LÄN

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Reconciling aims for conservation AND economic growth

- Focus on "ecosystem services"
- Reveals and illustrate the great diversity and magnitude in which the marine environment provides benefits to individuals and societies
 - Supporting
 - Regulating
 - Provisional
 - Cultural
- Report on assessment of services from Swedish seas

Havs- och vattenmyndigheten

Ekosystemtjänster från svenska hav

Status och påverkanfaktorer

Havs- och vattenmyndighetens rapport 2015:12

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The MSP - process

UNESCO's Step-by-step Approach for Marine Spatial Planning toward Ecosystem-based Management offers a 10-step guide on how to get a marine spatial plan started in your region. Explore the guide by choosing steps here.

Download Guide PDF 1.30 MB

MARINE SPATIAL PLANNING
A Step-by-Step Approach
toward Ecosystem-based Management

- STEP 1 Establishing Authority
- STEP 2 Obtaining Financial Support
- STEP 3 Organizing the MSP Process
- STEP 4 Engaging Stakeholders
- STEP 5 Analyzing Existing Conditions
- STEP 6 Analyzing Future Conditions
- STEP 7 Developing the Plan
- STEP 8 Implementing the Plan
- STEP 9 Evaluating Performance
- STEP 10 Adapting the Process

- MSP is a participatory process involving many steps and stakeholders!
- Performance depends on the quality of information / data on existing conditions
- What about spatial information on biodiversity and ecological processes?

Methods for habitat mapping

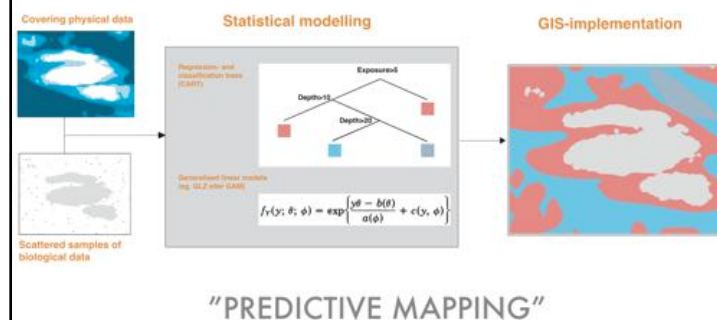
"DIRECT MAPPING"

- Bathymetry
- Bottom hardness
- Biodiversity?
- Ecological functions?

Sampling of benthic biota



Methods for habitat mapping



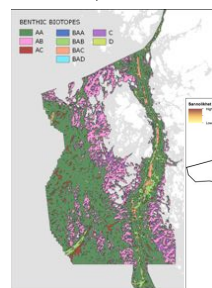
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Applied to a range of areas (examples from Koster)

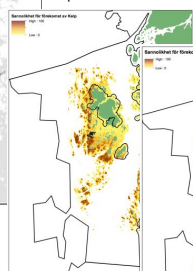
Available data in
Kosterhavet



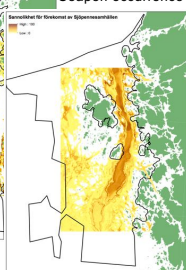
Benthic biotopes



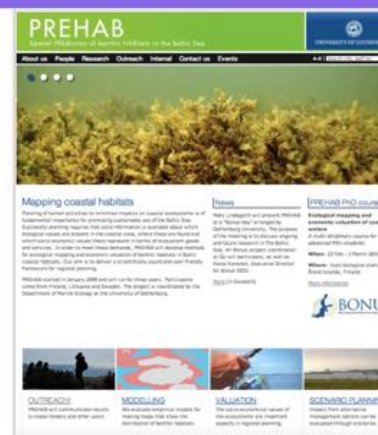
Kelp occurrence



Seapen occurrence



www.prehab.gu.se



Modelling and mapping growth of blue mussels

- Project on testing the potential use of mussel farming to mitigate eutrophication by local reduction of phytoplankton biomass
- Model, predict and map the geographic patterns of growth in Bohuslän
- High growth rates = increasing potential for eutrophication mitigation = increasing economic output from mussel-farming
- Result useful in MSP!

Blue Oceans with Blue Mussels
Management and planning of mussel farming in coastal ecosystems
Per Bergström
Department of Biological and Environmental Sciences
University of Gothenburg

Bergström, Lindegarth and Lindegarth (accepted).
Modelling and predicting the growth of the mussel, *Mytilus edulis*: implications for planning of aquaculture and eutrophication mitigation. Ecology and Evolution

Modelling and mapping growth of blue mussels

Empirical measurements of growth of transplanted mussels

Measurements at ≈120 sites at four times during a two-year period

Modelling and mapping growth of blue mussels

Empirical measurements of growth of transplanted mussels


Period 1 (Sept-Nov 2010)
Period 2 (May-July 2011)
Period 3 (Aug-Oct 2011)
Period 4 (June-Aug 2012)

Resulting layer of spatial predictions for mussel growth

- Off-shore areas generally have lower growth rates
- Inner fjord areas, which have the most severe eutrophication problems have higher growth rates.
- 15% of the area is characterised as high growth areas.
- Largely coincides with farming permits.
- Useful in MSP and regional planning

Modelling and MSP

- High growth areas suitable for mussel-farming identified and used in local planning



Lessons

- The pressures on marine resources will increase and so will the needs for sustainable solutions.
- The SDG's set the agenda for future research on sustainable development
- There are plenty of opportunities for the scientific community and academic institutions to contribute.
- Transdisciplinarity work and interactions with society are necessary.



Transdisciplinary research platforms at UGOT

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University of Gothenburg / Research / Research Organisation / UGOT Challenges - Global Societal Challenges

UGOT Challenges - Global Societal Challenges

UGOT Challenges is a unique research initiative where the University of Gothenburg invests 300 million SEK in six multidisciplinary research centres.

The premise is that a strong multidisciplinary research effort is needed to meet today's global societal challenges.

The six research centres cover many research disciplines together. All of them have significant multidisciplinary elements. Some initiatives are new; others start from earlier research structures that have extended as a result of the perspective.

FRAM - Centre for Future Chemical Risk Assessment and Management Strategies

FRAM is a multi-disciplinary research centre focusing on chemical exposure and chemical pollution on ecosystem services that are provided for people, nature and coastal areas.

CeCAR - Centre for Large-scale Collective Action Research

CeCAR is a research centre established to seek the answers about the driving forces behind collective action. During which circumstances can large-scale collective actions occur?

CARE - Antibiotic Resistance Research

Care is an interdisciplinary effort to meet the development of antibiotic resistance. The research centre will primarily focus on a critical threat: multi-resistant coliforms producing enterotoxins (ECs).

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SWEMARC

Aquaculture Centre West became SWEMARC during 2016.

SWEMARC is one of six University of Gothenburg's new strong research based on important and current social issues. SWEMARC is built on the strong interdisciplinary research needed to solve contemporary global societal challenges.

About the website

This website is only available in Swedish.

Please visit the Swedish version for more information

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