SEABASED

SEABASED MEASURES IN
BALTIC SEA NUTRIENT MANAGEMENT

SEABASED FINAL WEBINAR

26.1.2021

EUROPEAN UNION
European Regional Development Fund

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Instructions

- We recommend using the Teams app, or Google Chrome or Microsoft Edge browsers (updated versions). Note that Safari and Firefox browsers are not supported.
- Please make sure your video and microphone are turned off.
- You can leave your questions and comments in the chat box anytime during the webinar. We will answer them as best we can during the event. Unanswered questions will be compiled, answered, and published on the SEABASED website.
- In Twitter use #SEABASED
- If you have technical difficulties, try leaving and re-entering the meeting.
- Make sure that your audio settings are correct, and your computer is not muted if you have problems hearing the event.
- The event will be recorded and uploaded in the John Nurminen Foundation's YouTube-channel and on the SEABASED website. The presentations will also be uploaded on the webpage.
- Please give us feedback on the webinar! We will send you a link to a short questionnaire after the webinar.

Program

12.30–14.50 Part 1: Results from the SEABASED pilots

- Welcoming words – **Annamari Arrakoski-Engardt**, CEO, John Nurminen Foundation
- Keynote on internal nutrient load in the Baltic Sea – **Jouni Lehtoranta**, Senior Research Scientist, Finnish Environment Institute
- SEABASED pilot results presented by project partners
- Panel discussion: Experts' views on the risks, potential and future of sea-based methods
  Marjukka Porvari, Director of the Clean Baltic Sea Projects, John Nurminen Foundation (moderator)
  Mikhail Durkin, Executive Secretary, Coalition Clean Baltic
  Jacob Hagberg, Head of Delegation for Sweden in HELCOM
  Marjo Tarvainen, Senior Officer, Centre for Economic Development, Transport and the Environment for Uusimaa, Finland
  Maria Gustavsson, Water Specialist, County Administrative Board of Östergötland
  Seppo Knuuttila, Senior Research Scientist, Finnish Environment Institute
  Tony Cederberg, Station Manager, Husö Biological Station

Coffee Break

15.00–16.00 Part 2: How will the gathered knowledge be used in practice?

- Practical Guidelines: Future utilization of the piloted measures – **Miina Mäki**, Project Manager, John Nurminen Foundation
- A concept of aquatic compensations in Åland – **Annica Brink**, Coordinator, The Government of Åland
- Expert comment on aquatic compensations – **Lena Bergström**, Associate Professor, Swedish University of Agricultural Sciences
- Questions and open discussion on sea-based measures
- Next steps and closure of the event– **Marjukka Porvari**

Welcoming words

Annamari Arrakoski-Engardt, CEO, John Nurminen Foundation

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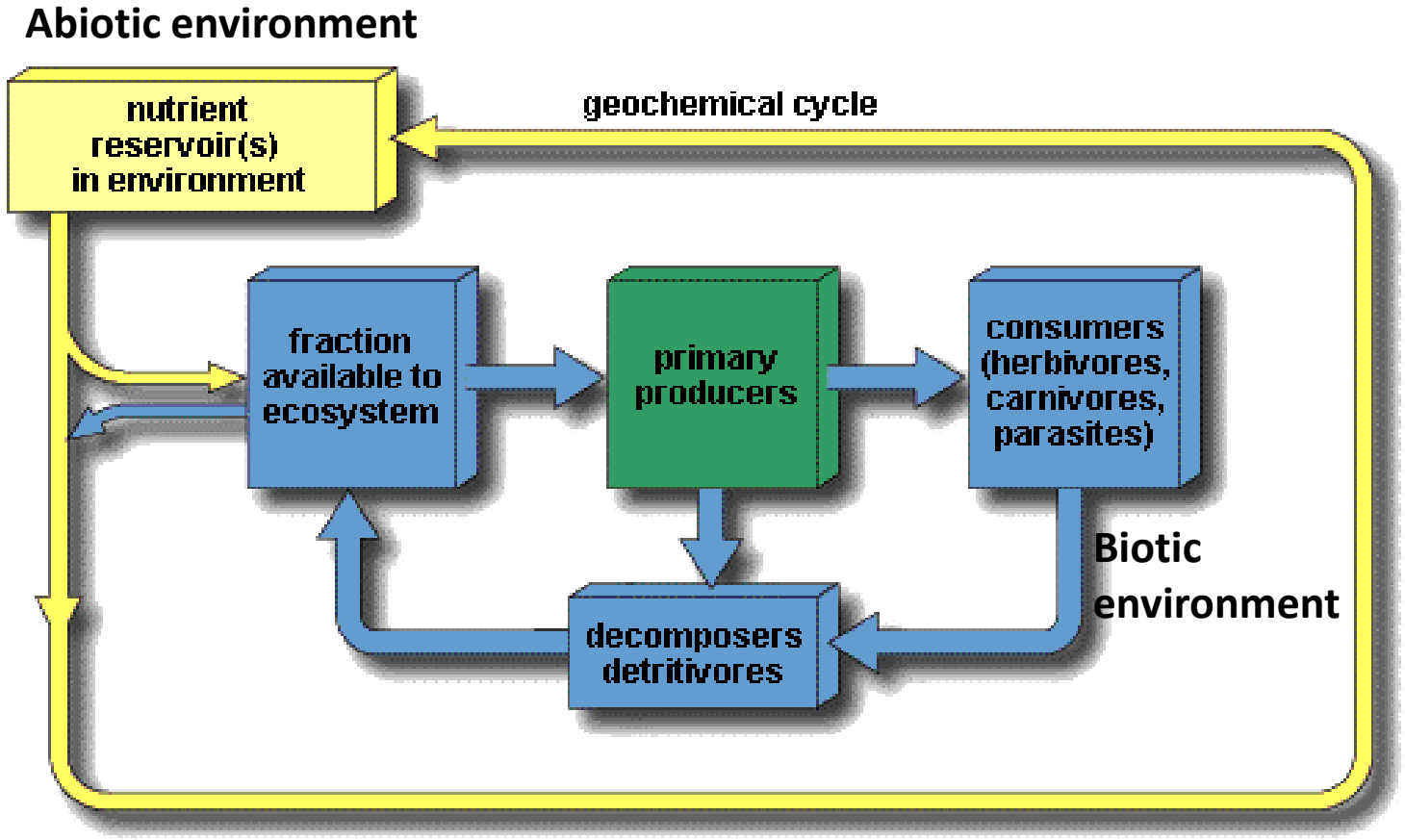
Keynote on the internal nutrient load in the Baltic Sea

Jouni Lehtoranta, Senior Research Scientist, Finnish Environment Institute, Marine Research Centre

Biogeochemical cycle

Cycle where element or molecule is transferred between biotic and abiotic systems



Reservoir

Element stays very long in same place (apatite-deposit)

Exchange pool

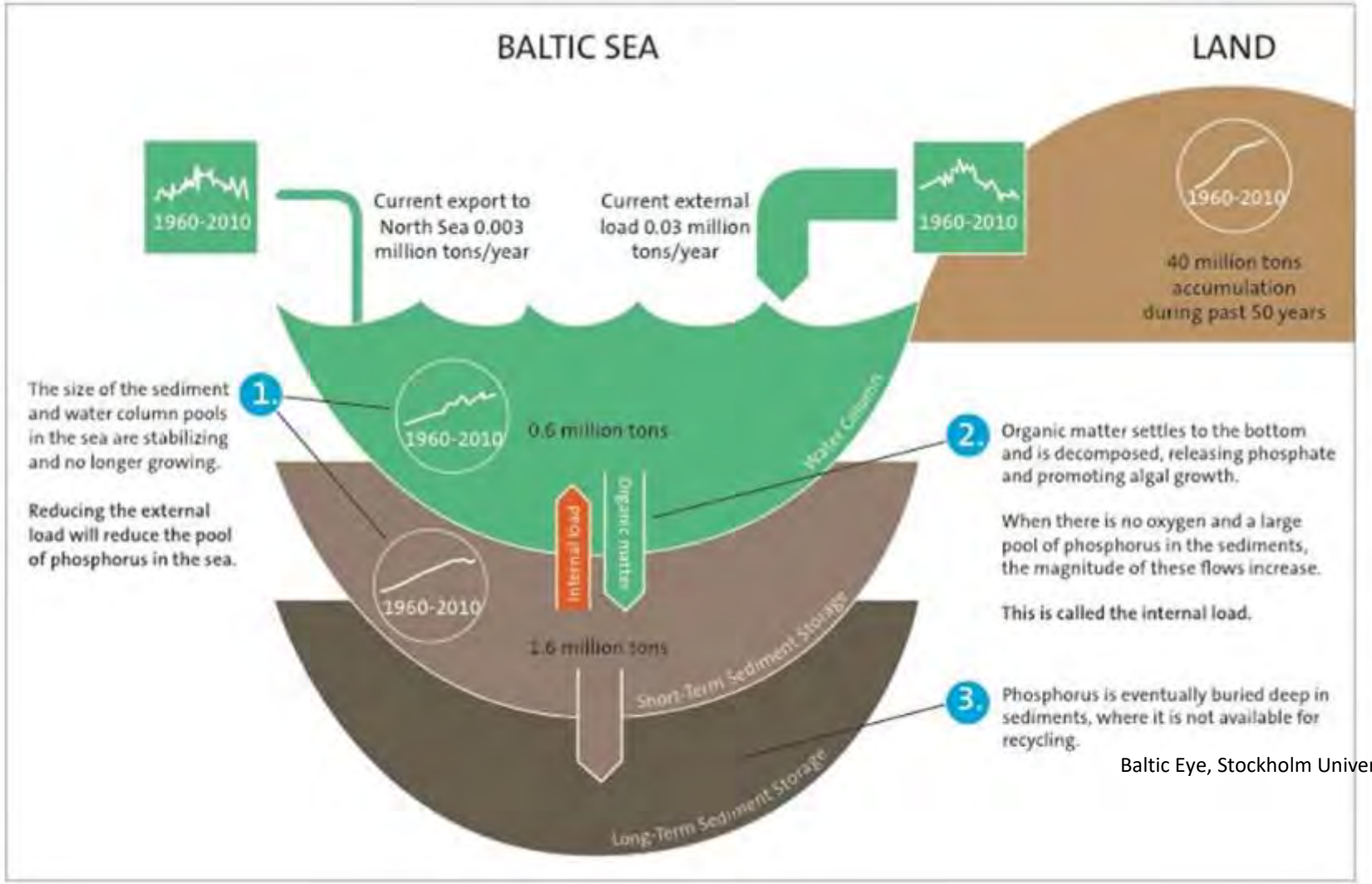
Element is stored for a ”short” period of time
Abiotic system forms commonly long term pools and exchange pools are formed by biota

Residence time

Period of time which element stays in one place

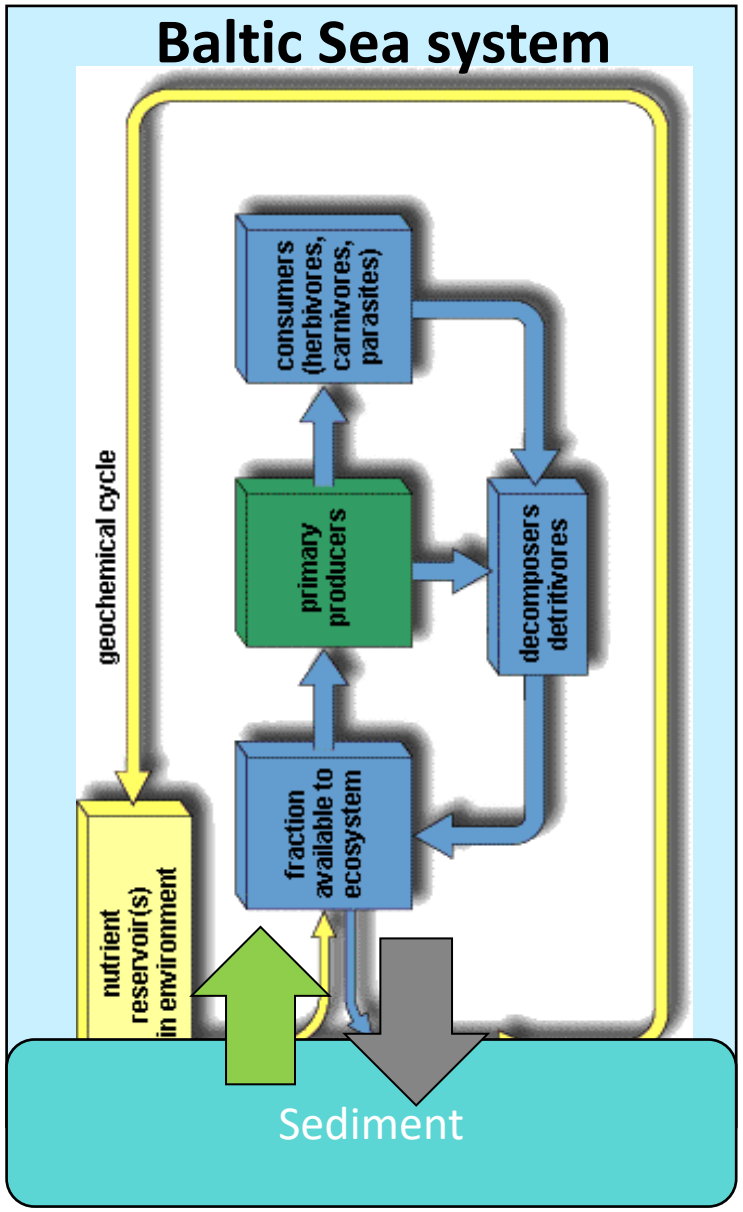
Phosphorus pools and balance in the Baltic Sea

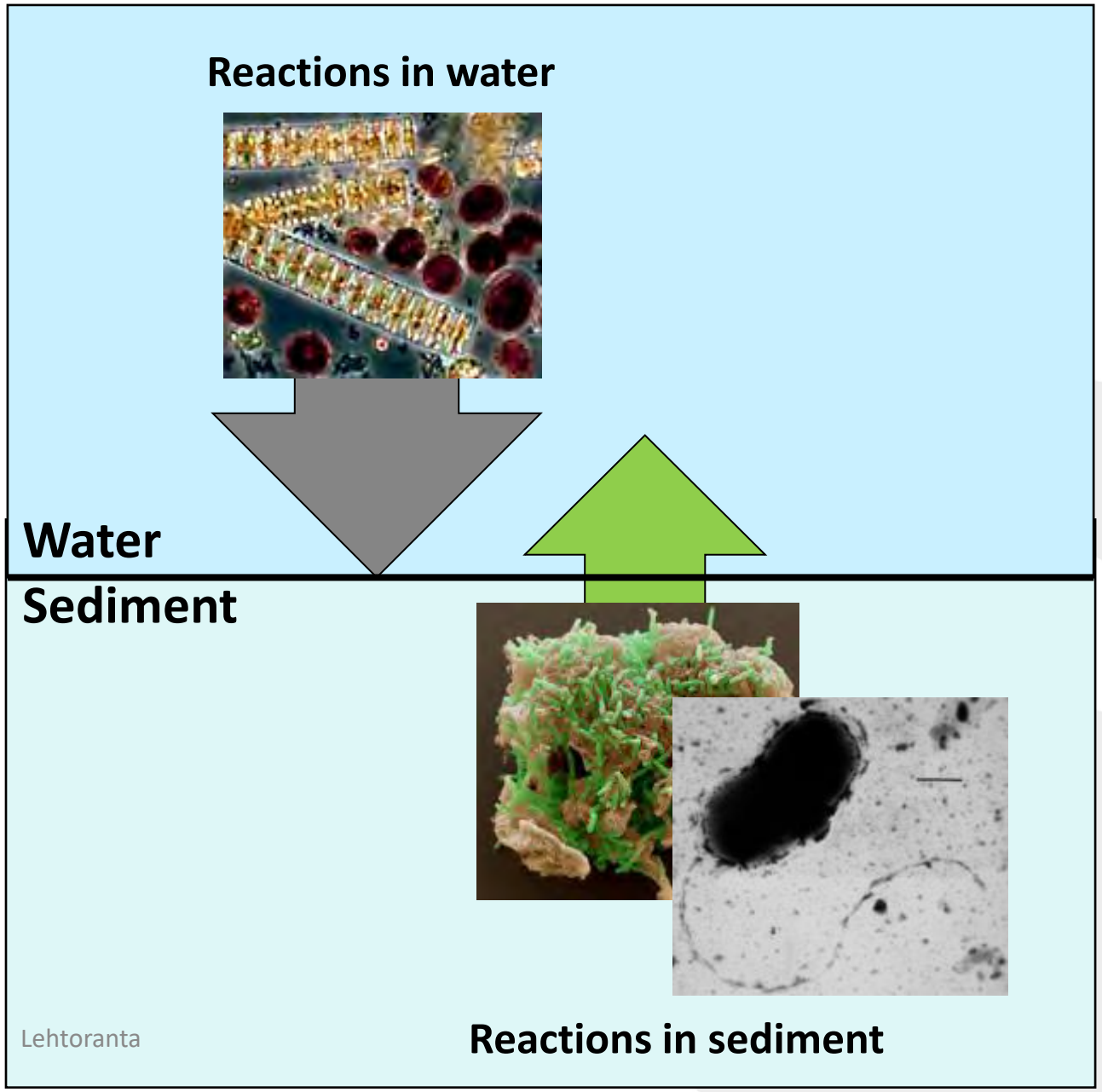
- Accumulation in field soil 40 million tons phosphorus
- Catchment loading annually 0.03 million tons
- Export through Danish straits 0.003 million tons
- In water of the Baltic Sea 0.6 million tons
- Sediment exchange pool 1.6 million tons



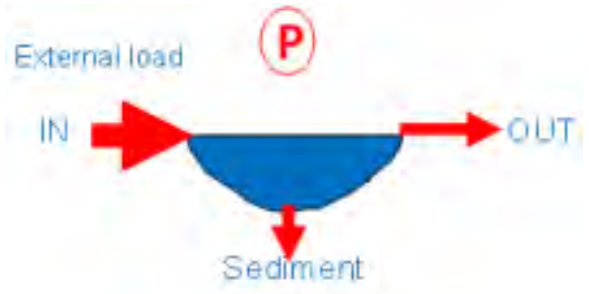
Baltic Eye, Stockholm University

Interactions between water and sediment



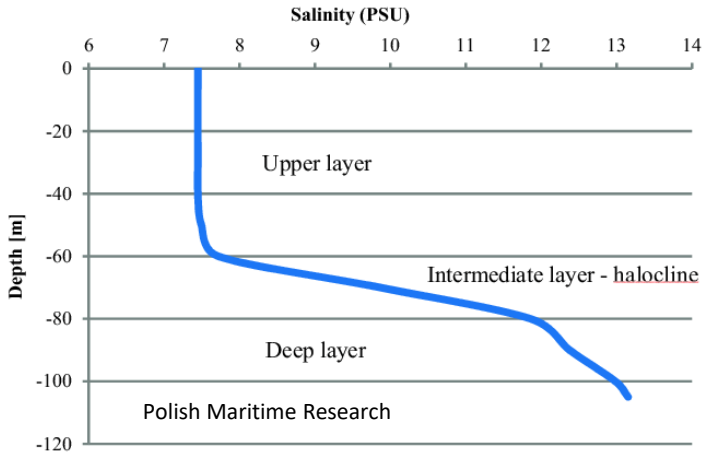


SEDIMENT LEAKS PHOSPHORUS



High loading of phosphorus
→ Legacy phosphorus in sediments

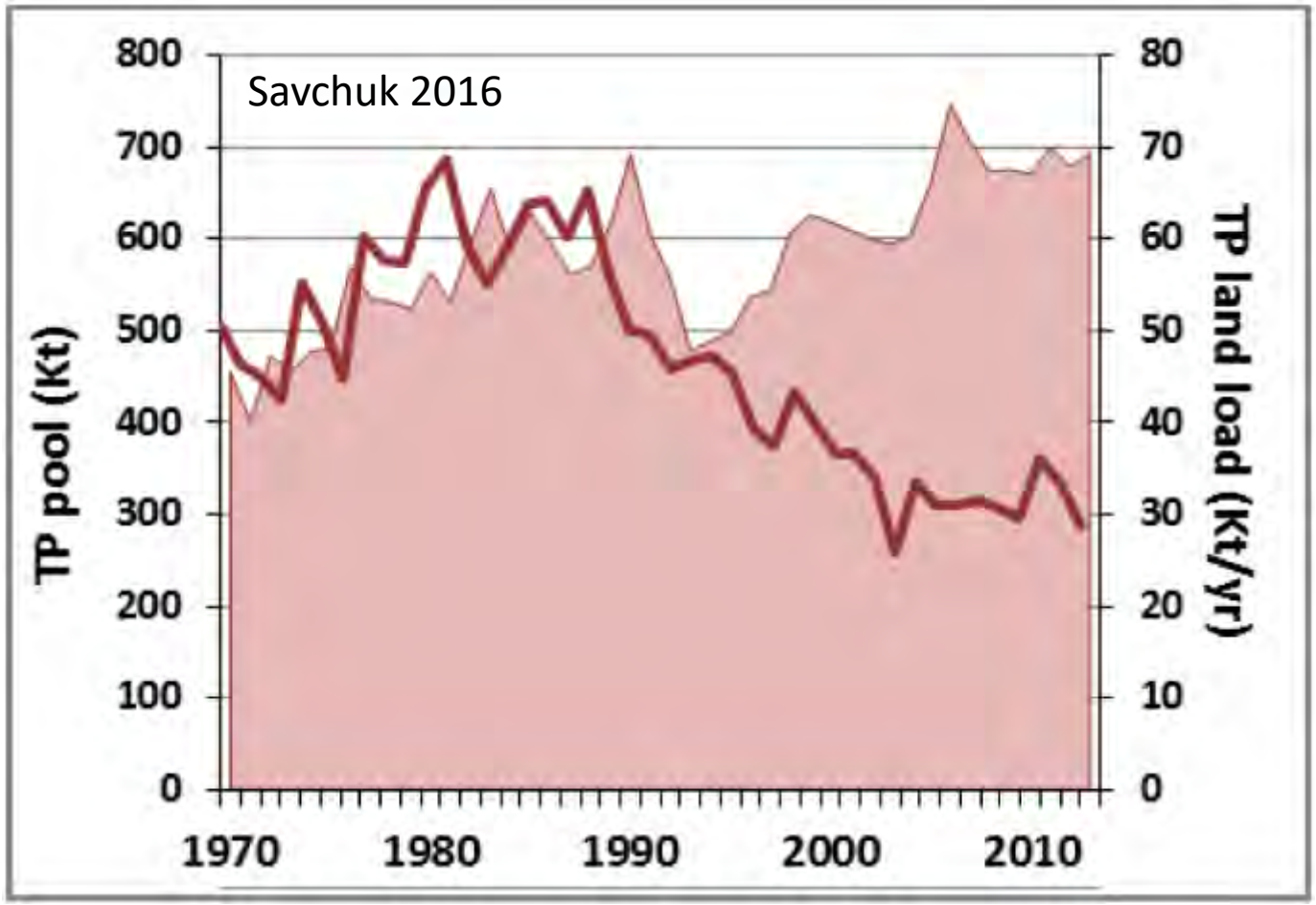
Eutrophication increases sediment organic matter
→ Poor ability of sediment to retain phosphorus



Exceptional stratification properties
→ Sensitivity towards anoxia and phosphorus release

Sediment is an exchange pool rather than a reservoir!

As a result in the Baltic Sea



We may have decreasing loading simultaneously with increasing phosphorus concentration in water!

How to improve retention of phosphorus?

Binding of phosphorus in sediments increases when

- amount of organic matter decreases and reactions improve retention of phosphorus
- weather conditions weaken stratification and improve oxygen conditions → favors retention of phosphorus
- reactions enhance phosphorus binding to calcium and aluminium compounds

Internal measures are aimed to decrease sediment phosphorus release

Are based on following mechanisms

- Measure improves geochemical conditions so that phosphorus is retained in bottom sediments
- Phosphorus binding compounds are added in sediments
- Phosphorus is removed from the system

Why use sea-based measures

- Point source nutrient loading will be largely under control
- Management of diffuse source loading still challenging
- Climate change may increase unfavorable weather conditions

- **Under present pressures it is reasonable to study and test sea-based measures and inform stakeholders of their feasibility**

Photo: Ekholm

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SEABASED pilot results presented by project partners

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Pilot:
Nutrients from Sea to Field

26.1.2021

What did we do?

- Irrigation of fields with nutrient-rich brackish water from bays with bad ecological status
- Win-win solution
- Summer 2019 and 2020
- Monitoring: bay water, irrigation water, ley (grass), soil, and groundwater

Pilot sites

Kaldersfjärden

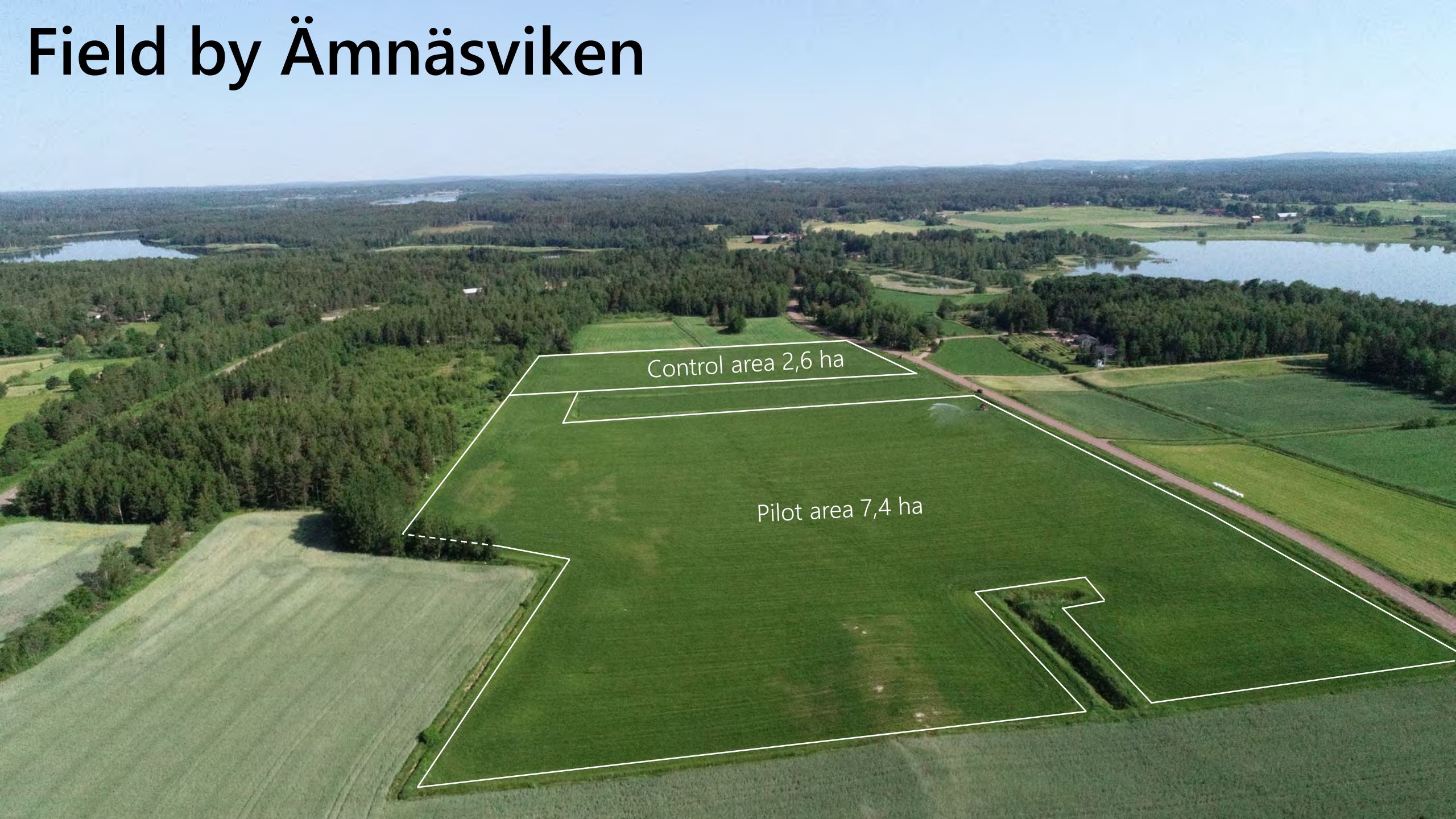
- Max depth 6.3 m
- Stratified
- Organic ley
- No fertilization
- Water inlet at 3,5 m
- Irrigation:
  2019, 4 x 40 mm
  2020, 4 x 40 mm

Ämnäsviken

- Max depth 2.9 m
- Wind-mixed
- Ley
- Artificial fertilizer
- Water inlet at 0,5 m
- Irrigation:
  2019, 2 x 40 mm
  2020, 1 x 35 mm and
  1 x 30 mm

Field by Kaldersfjärden

Field by Ämnäsviken



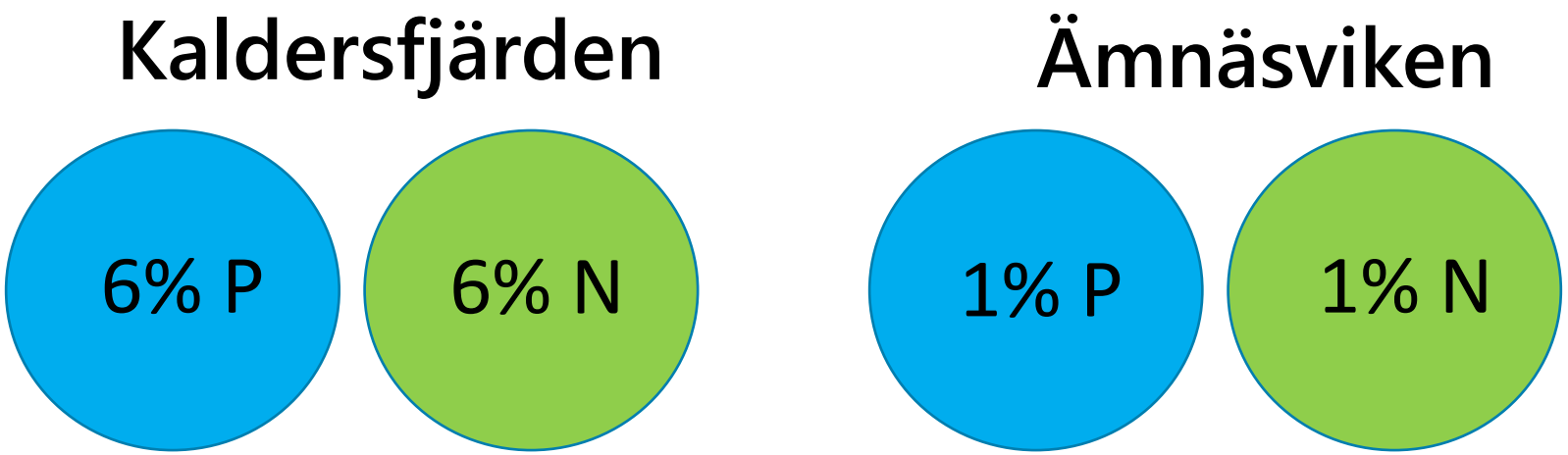
Nutrients from the sea…

3 kg P

31 kg N

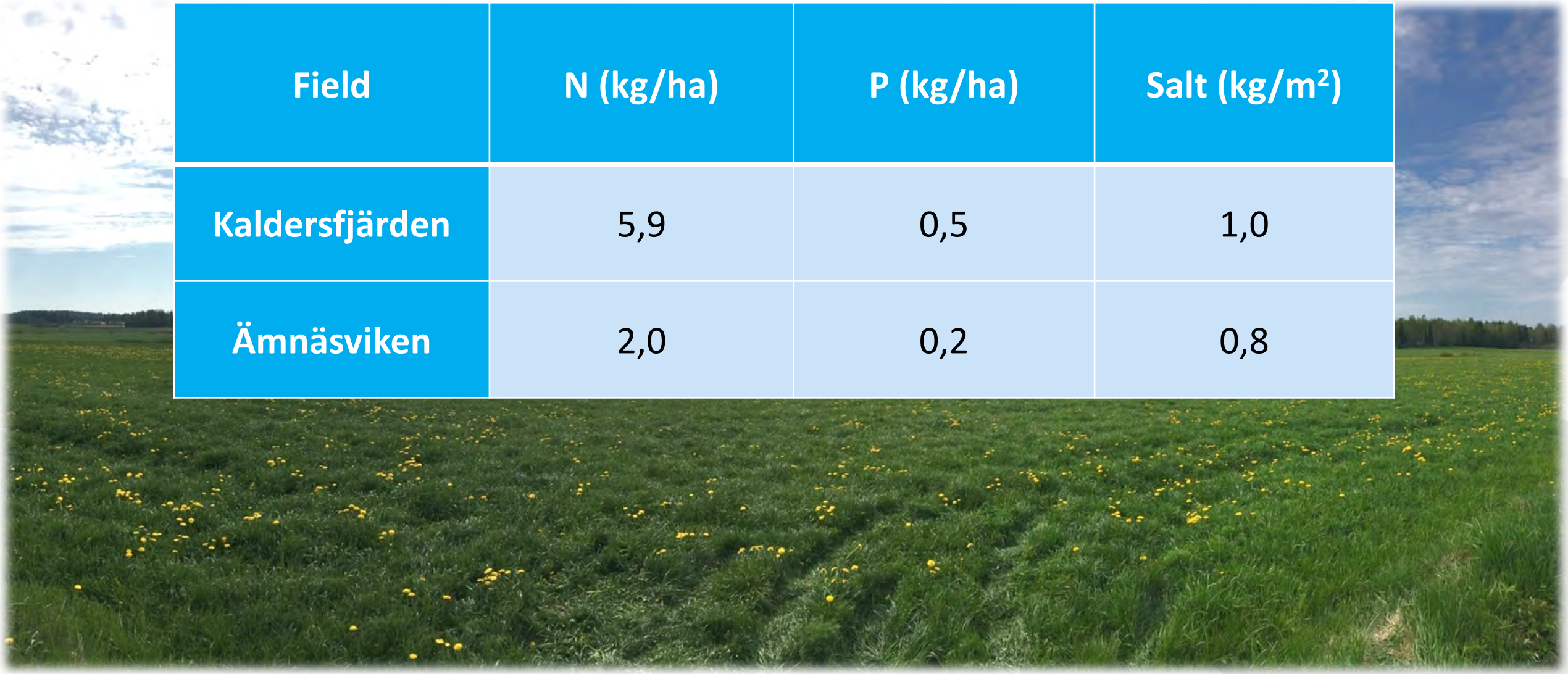
Removal vs. needed removal

- Simplified calculations made with SMHI ”Coastal Zone Model”
- Indication on N and P removal need to achieve ”good ecological status” (WFD goal)

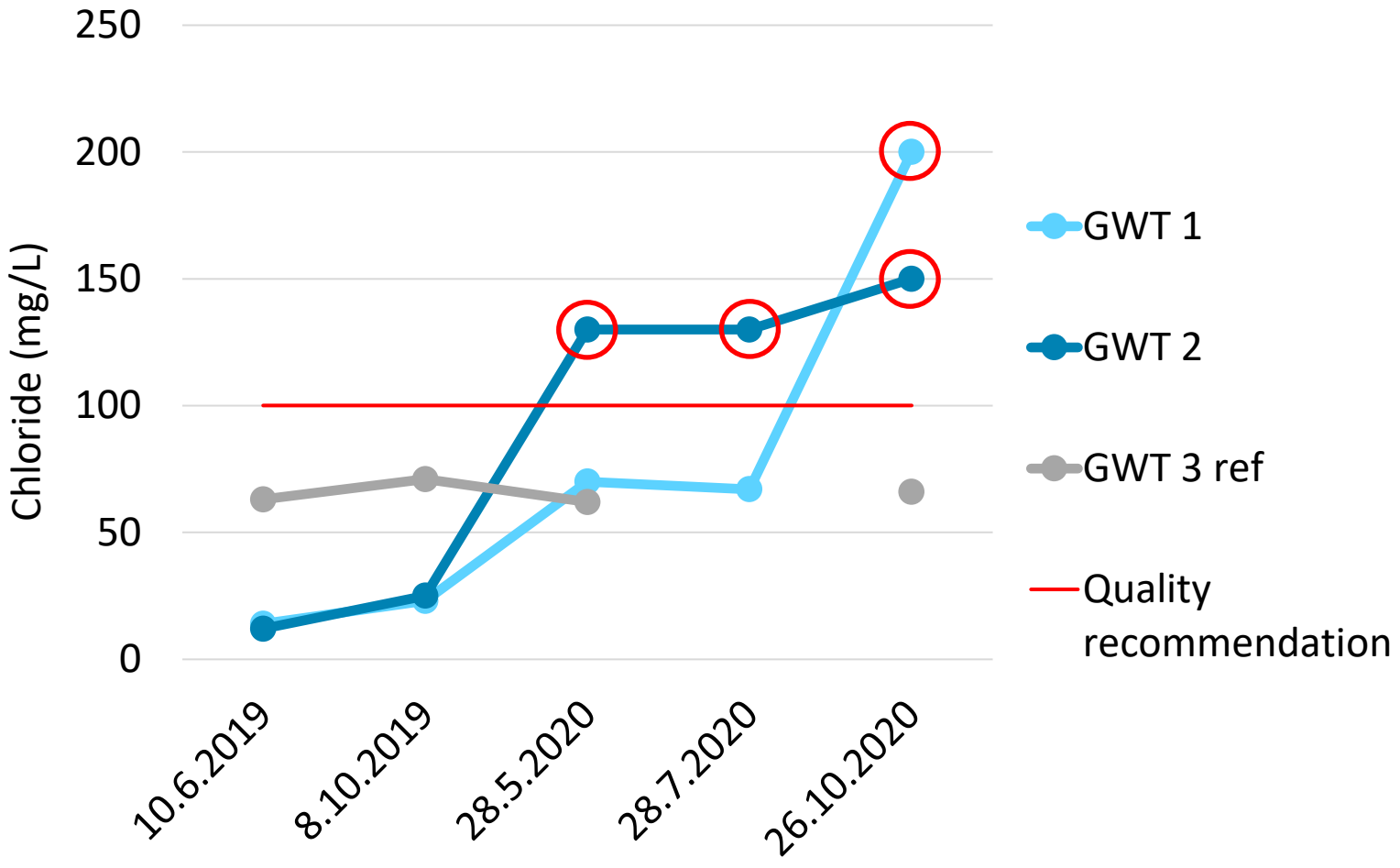


...to the fields

Field	N (kg/ha)	P (kg/ha)	Salt (kg/m^2)
Kaldersfjärden	5,9	0,5	1,0
Ämnäsviken	2,0	0,2	0,8



Groundwater analyses



Quality recommendation:
< 100 mg/L for private wells

→ Increase in chloride concentration in the groundwater at the pilot area by Ämnäsviken

Soil analyses

Soil fertility classes? → No apparent distinction between pilot and control sites

Reduction in cations? → No apparent distinction between pilot and control sites (Slight increase in Na at pilot site)

Reduction in PO_4^{3-}? → No apparent distinction between pilot and control sites (slight increase in Fe at pilot site)

Chloride accumulation? → Higher chloride content at pilot site (washes out of soil with precipitation)

Crops analyses (silage)

- Similar characteristics between pilot and control site
- Lower amount of dry matter from pilot site
- Lower content of sugar from pilot site
- Higher content of Na in silage from pilot site

SEABASED team, visit to pilot site

Increase in crop production

Bay	Production increase
Kaldersfjärden	40–170%
Ämnäsviken	60–70%

Visual results, Kaldersfjärden 2019

No irrigation

Irrigation 4 x 40 mm

Happy project coordinator and farmer

Recommendations

- Brackish water can be used for irrigation of ley, but with caution for salinization of soil and groundwater
- Investigate the run-off pattern
- Do not irrigate continuously year after year, let the soil and groundwater restore itself
- Preferably during dry summers, as a life support for crops
- If possible, collect samples for chloride analyses; soil, groundwater (wells)
- Collect soil samples more often than the regular 5-year interval

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Ålands
landskapsregering

Contact:

Annica Brink, Project Coordinator
Government of Åland
annica.brink@regeringen.ax

www.seabasedmeasures.eu

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CAB Östergötland- Project results

Maria Gustavsson & Kenneth Winroth

26.1.2021

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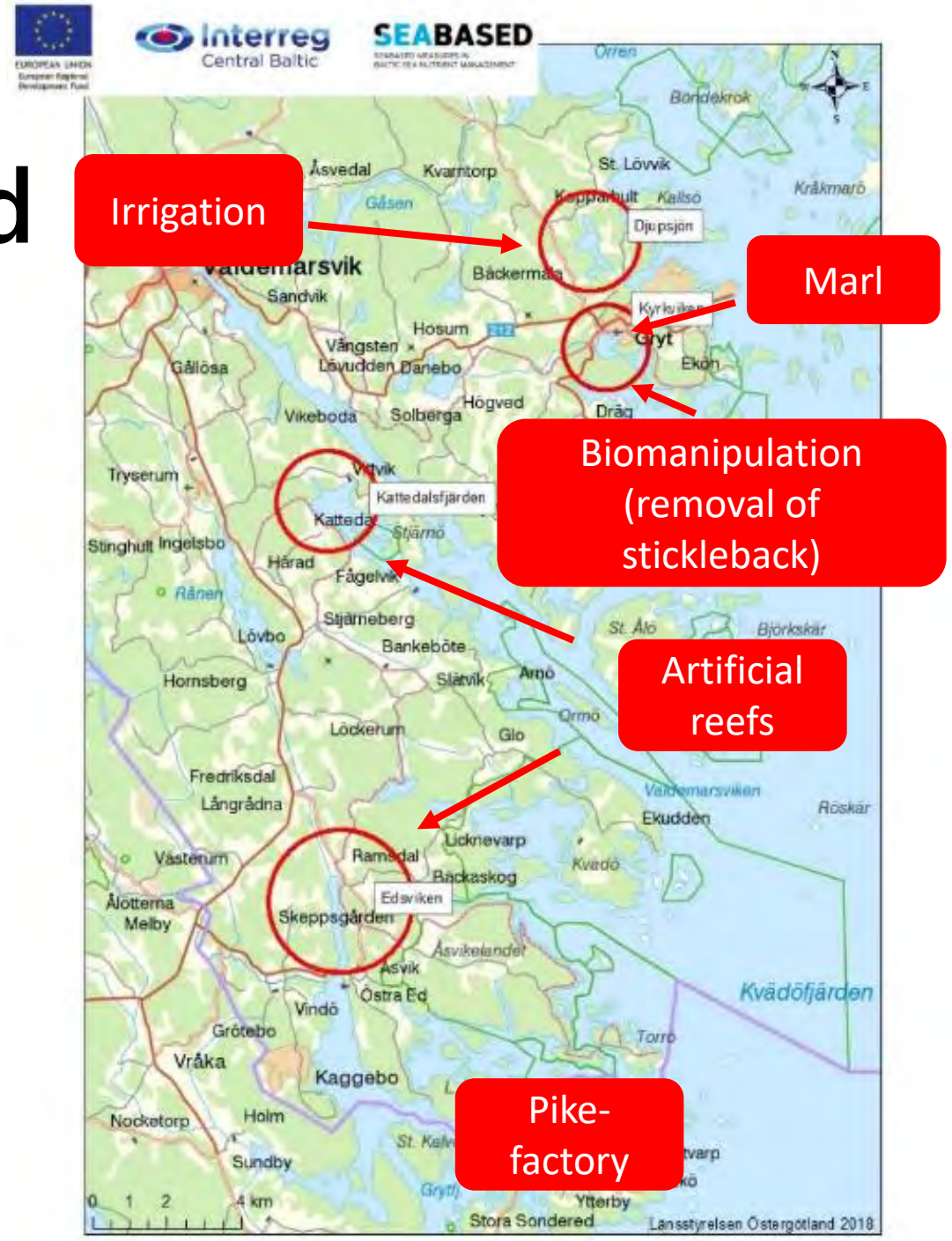
LÄNSSTYRELSEN
ÖSTERGÖTLAND

Pilot areas in Östergötland

- Kyrkviken *(SE580890-165500)*
- Djupsjön *(SE645330-155839)*
- Edsviken *(SE580250-164000)*
- Kattedalsfjärden *(SE580585-164720)*



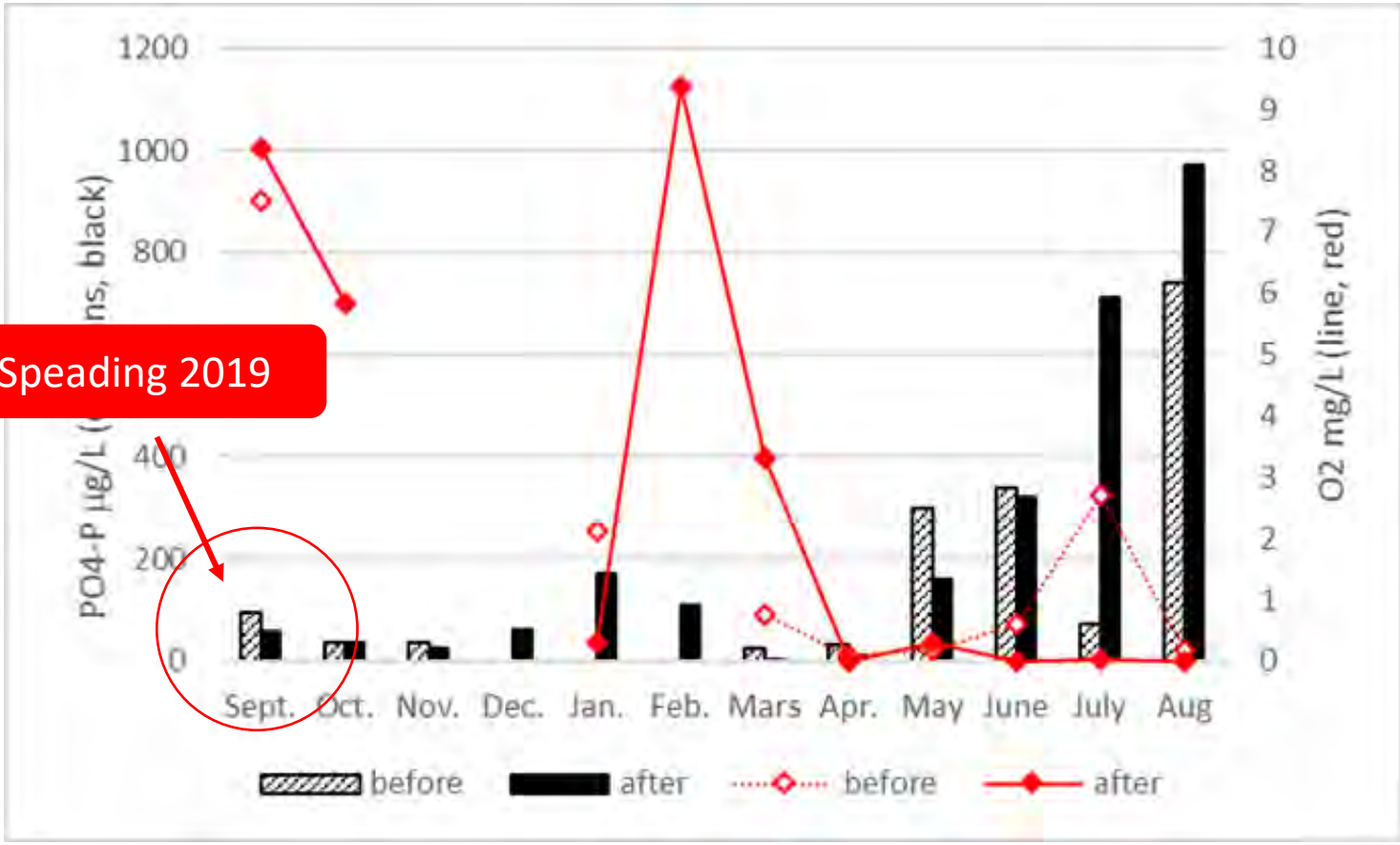
WPT4

Results in Kyrkviken: Marl

13 ton/9 ha->
a little more than 100 g/m^2
Spread in the deepest area of the bay (6-8 m)

Results in Kyrkviken: Marl

PO4-P (µg/L) at 8–10 m depth before and after spreading of the sorbent (100 g/m²)



Speading 2019

Conclusion:
Effect directly after spreading (2019), but no lasting effect after 1 year

Results in Kyrkviken: Biomanipulation (Stickleback)

- Biomanipulation (removal of sticklebacks) was done in November 2019.
- Only a few sticklebacks caught, probably due to the season
- Side results: 8 tons of cyprinid fish was caught, mainly roach, bream and ide.
- Resulting in the removal of 60 kg of phosphorus and 200 kg of nitrogen.

Conclusion:
To catch stickleback in sheltered bays, it is important to do it during the right season and when they are closer to the shore.

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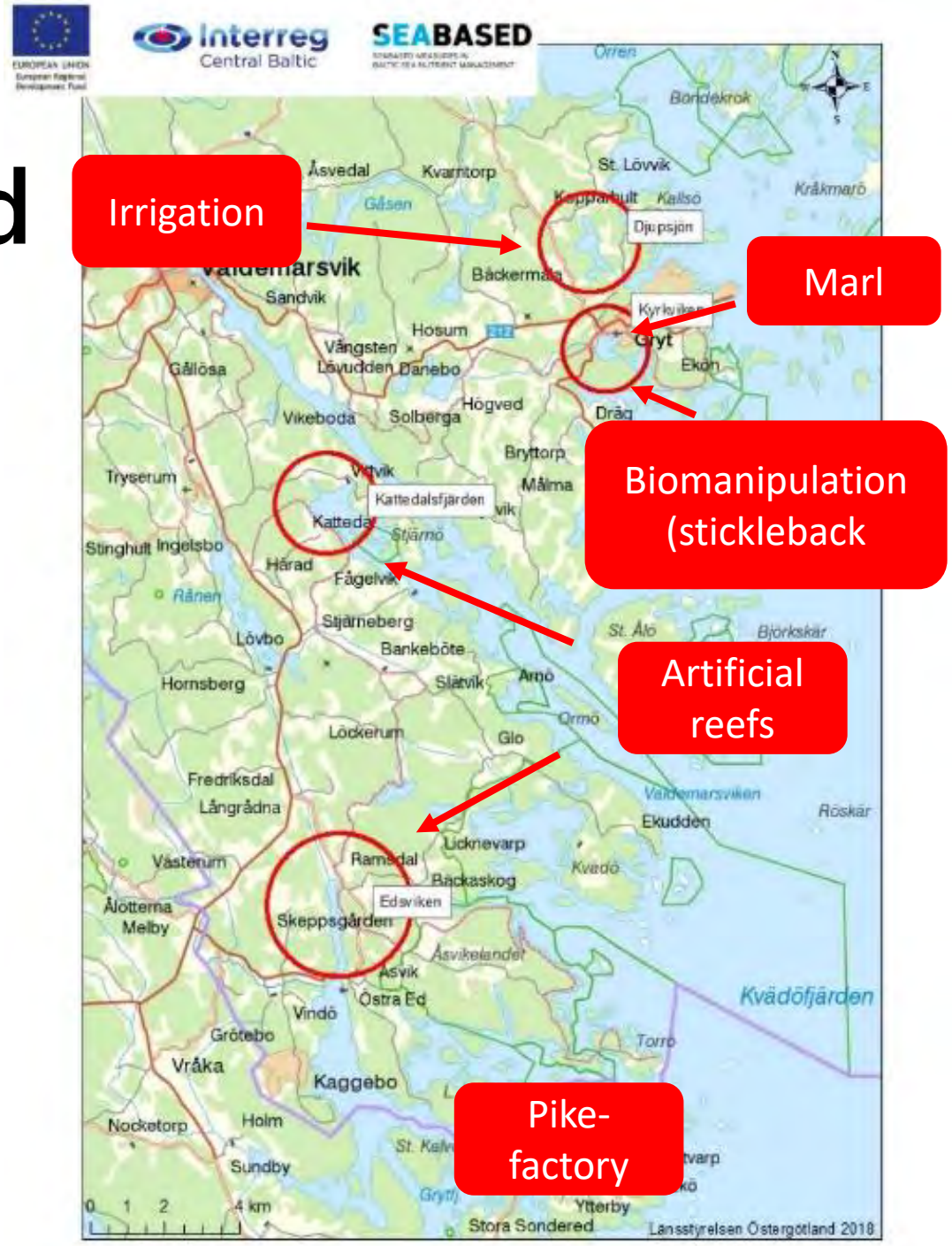


Results in Djupsjön: Irrigation

- 2 test sites, surface & bottom water
- 4 irrigations, 2 harvests

Results in Djupsjön: Irrigation

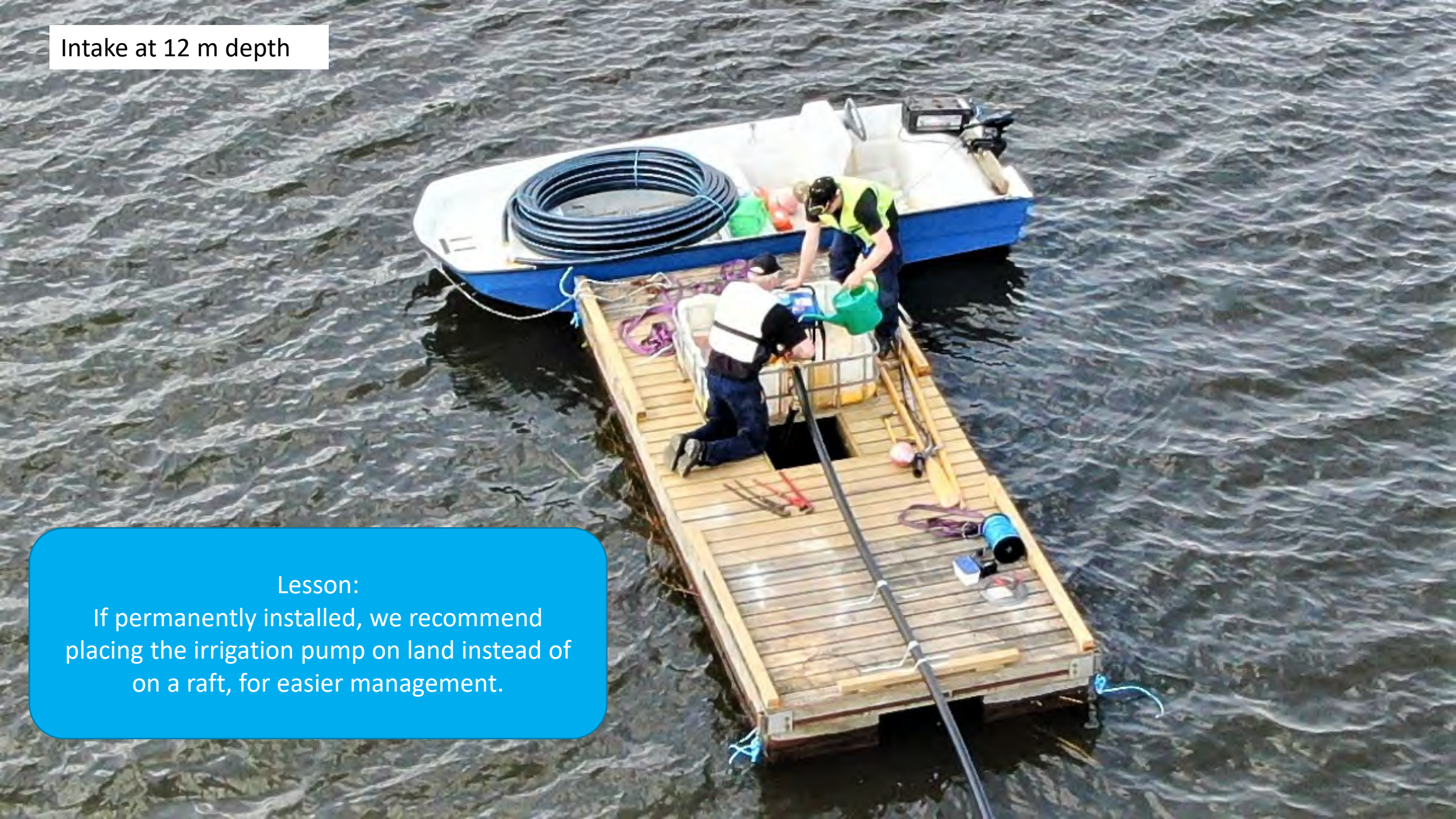
40 mm á 4 times
-> 160 liters/m^2

Phosphorous content in water	
Bottom	*Surface*
200-340 µg/l	Ca 30 µg/l
Gives	Gives
32-58 mg P/m^2	Ca 4,8 mg P/m^2
Removed from the Lake 2020	Removed from the Lake 2020
48-64 g phosphorous	Ca 7 g phosphorous

Implications	
Bottom	Surface
200-340 µg/l	Ca 30 µg/l
Per ha	Per ha
0,38-0,58 kg P/year	0,048 kg P/year
Per field (á 10 ha)	Per field (á 10 ha)
3,8-5,8 kg P/year	0,48 kg P/year

Conclusion:
Quite effective to use bottom water instead of surface water.

Intake at 12 m depth



Lesson:
If permanently installed, we recommend placing the irrigation pump on land instead of on a raft, for easier management.

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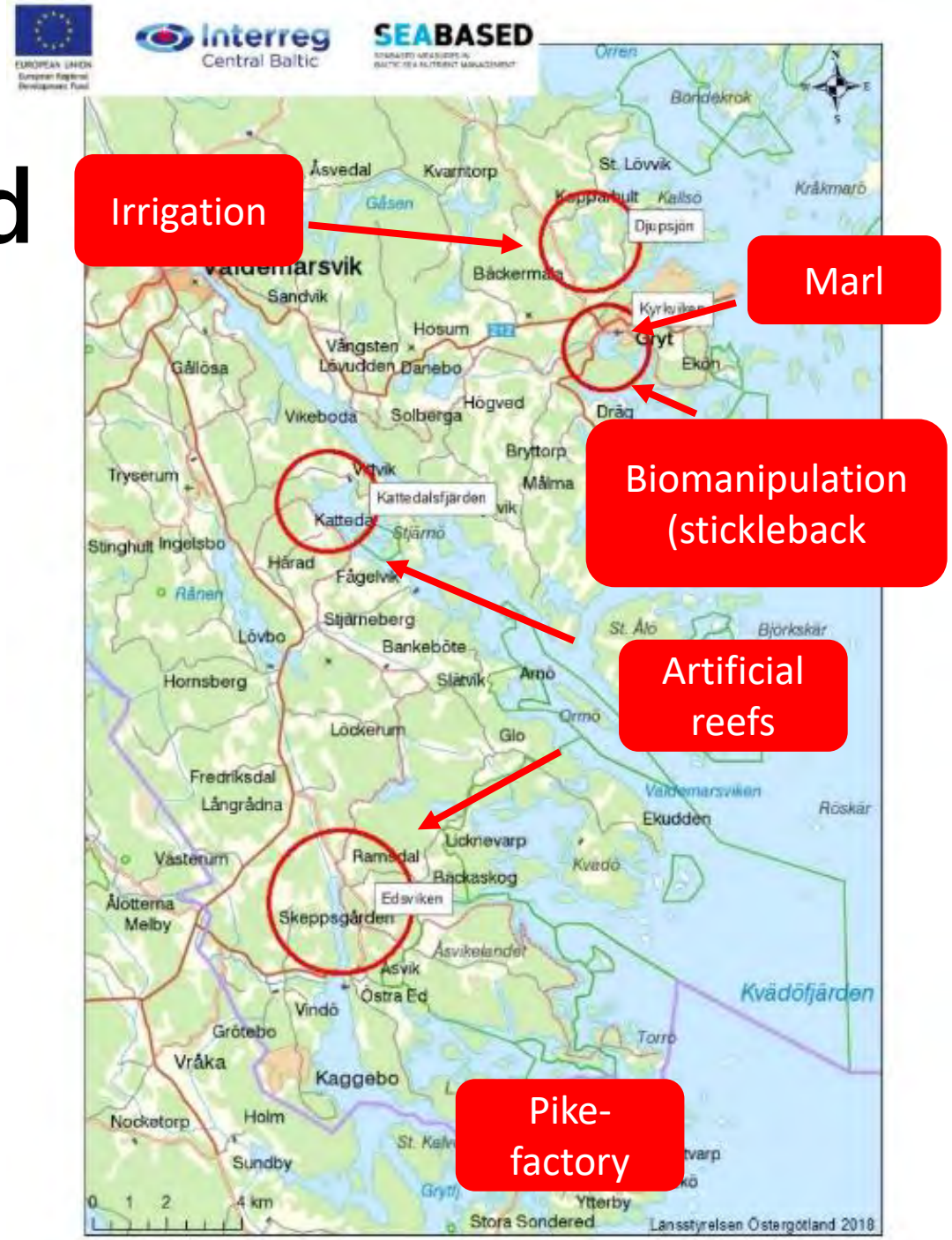
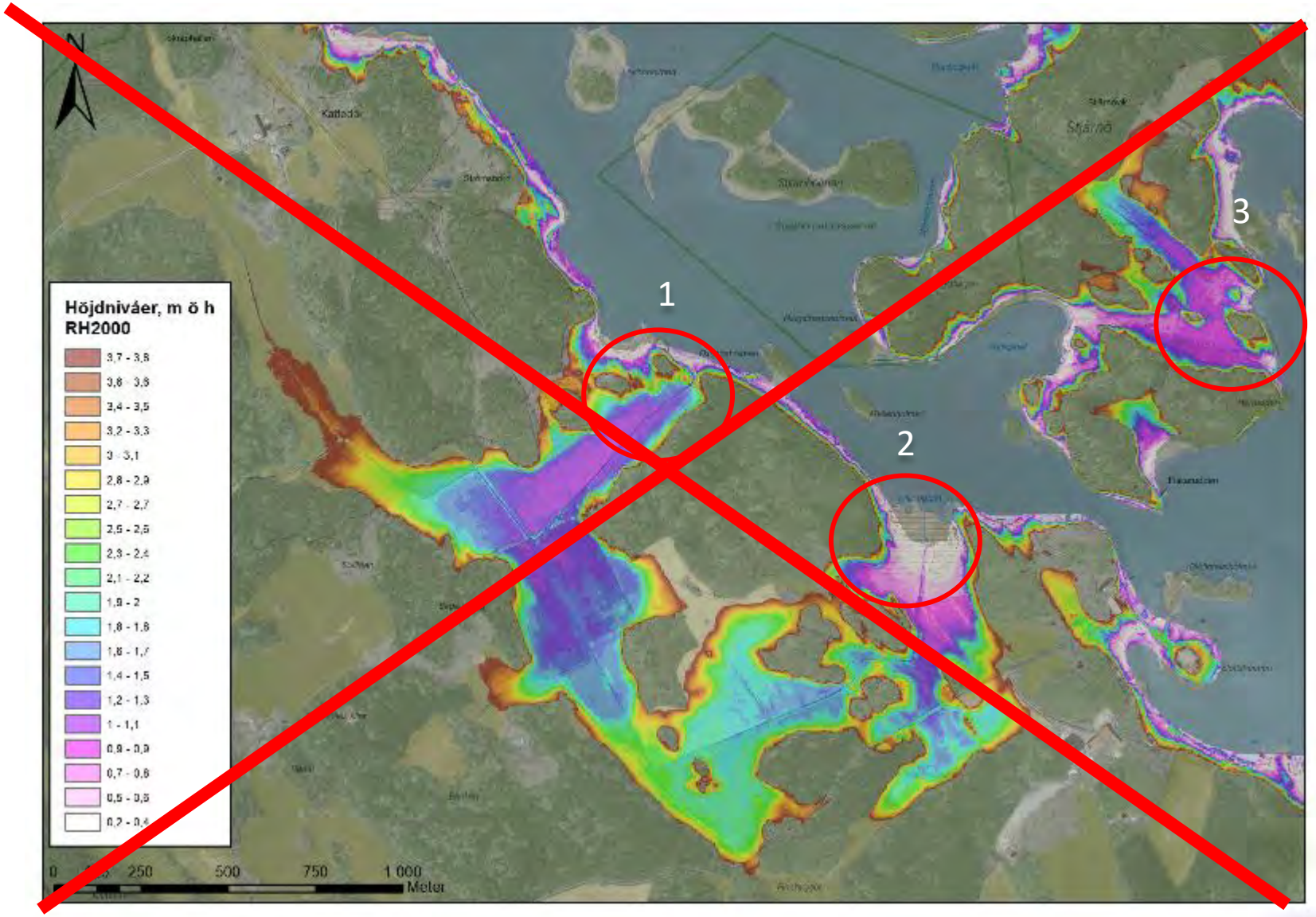
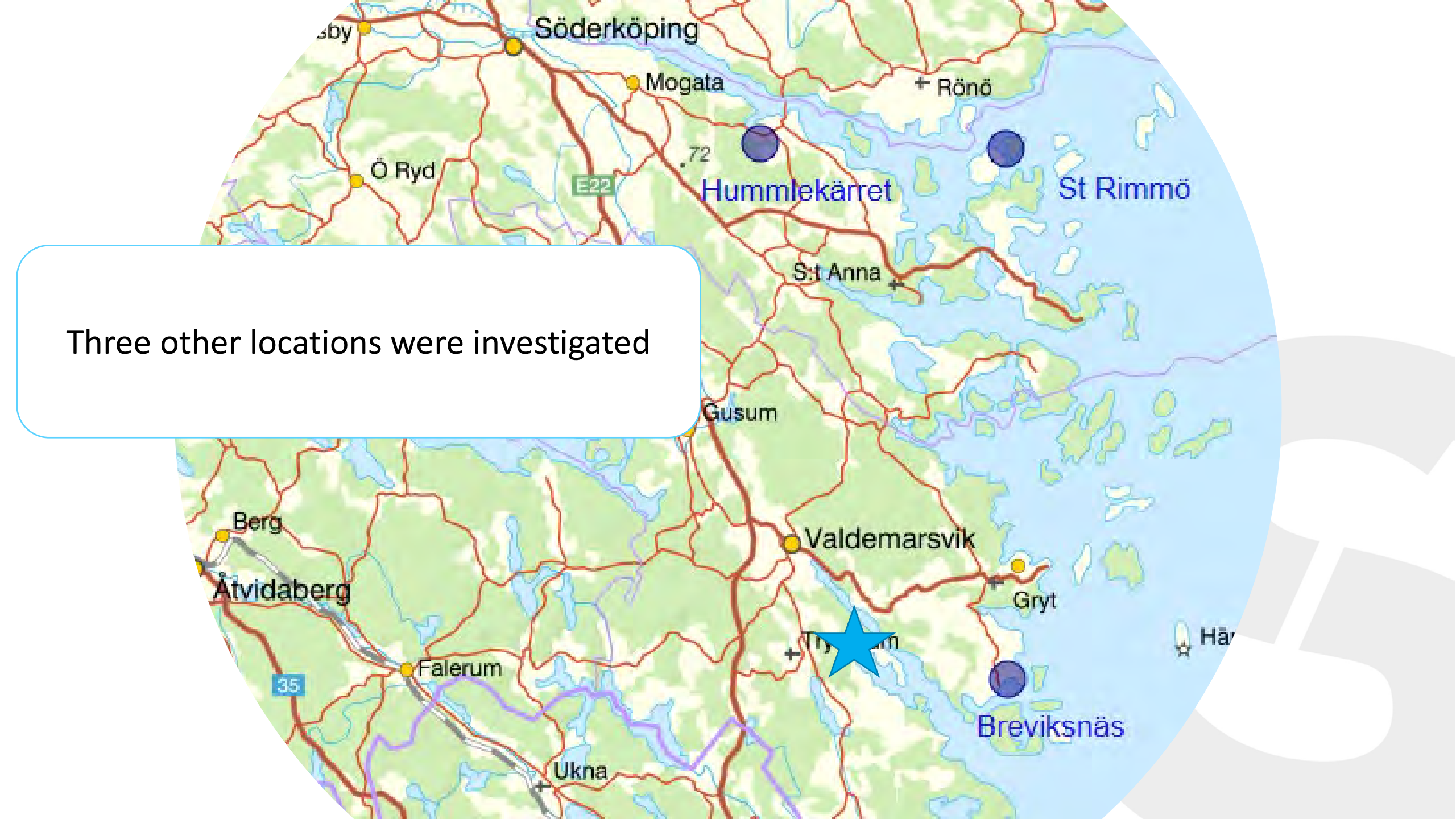


Results in Kattedalsfjärden: Pike-factories

- None of the first three intended objects would hold water properly
- None of the other three projects could be done in time due to autumn weather.





Three other locations were investigated

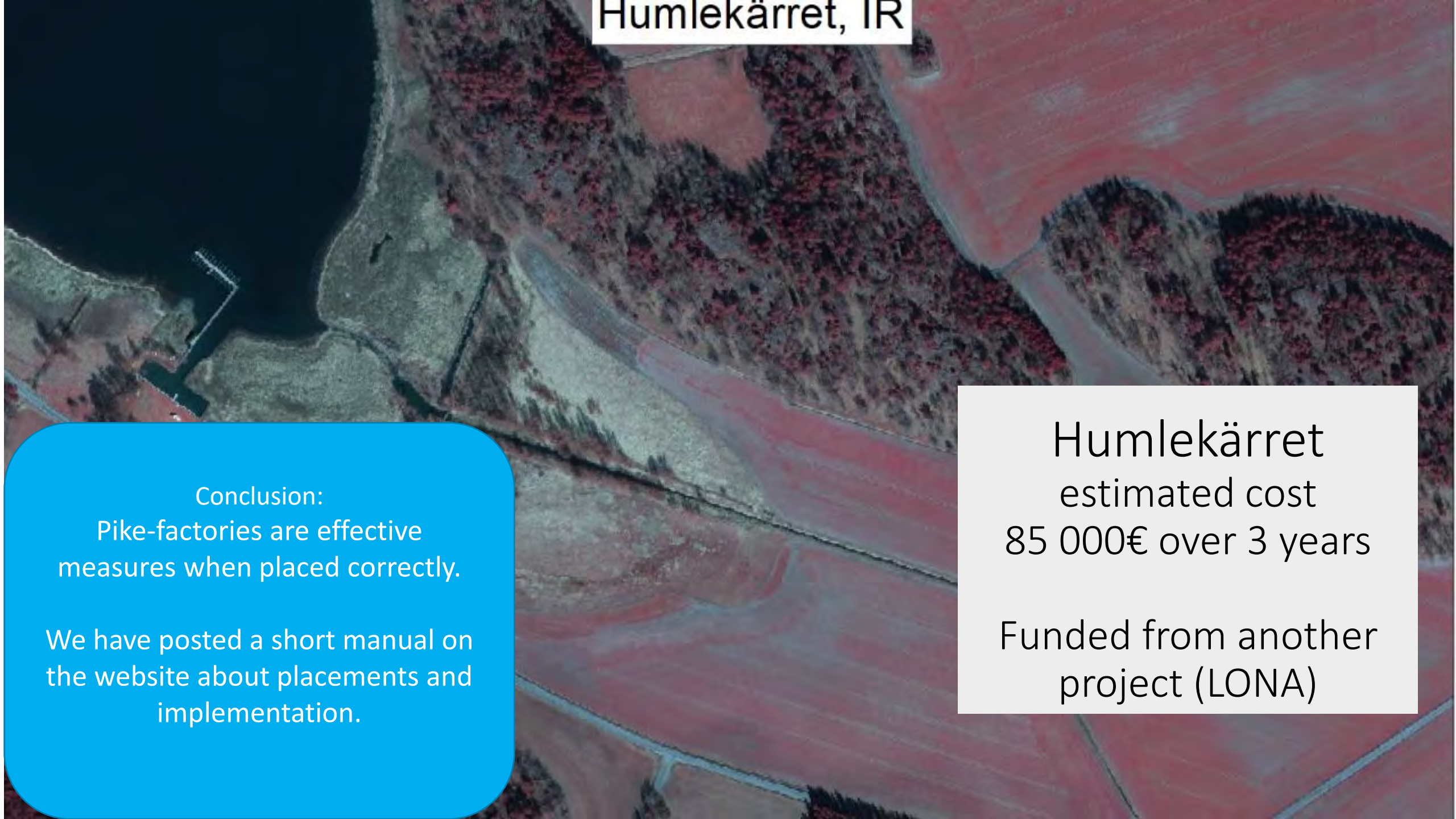
Possible pike-factory: Stora Rimmö

Location at an island in the archipelago found, positive landowner!

Problem:

- Needed an exemption from the shore protection legislation
- Large- over budget
- Large- big project to manage in time
- <u>Low land- becomes wet early in the autumn- no time to dig</u>

Object Breviksnäs:
Probably functional pike factory today



Conclusion:
Pike-factories are effective measures when placed correctly.

We have posted a short manual on the website about placements and implementation.

Humlekärret
estimated cost
85 000€ over 3 years

Funded from another project (LONA)

Pilot areas in Östergötland

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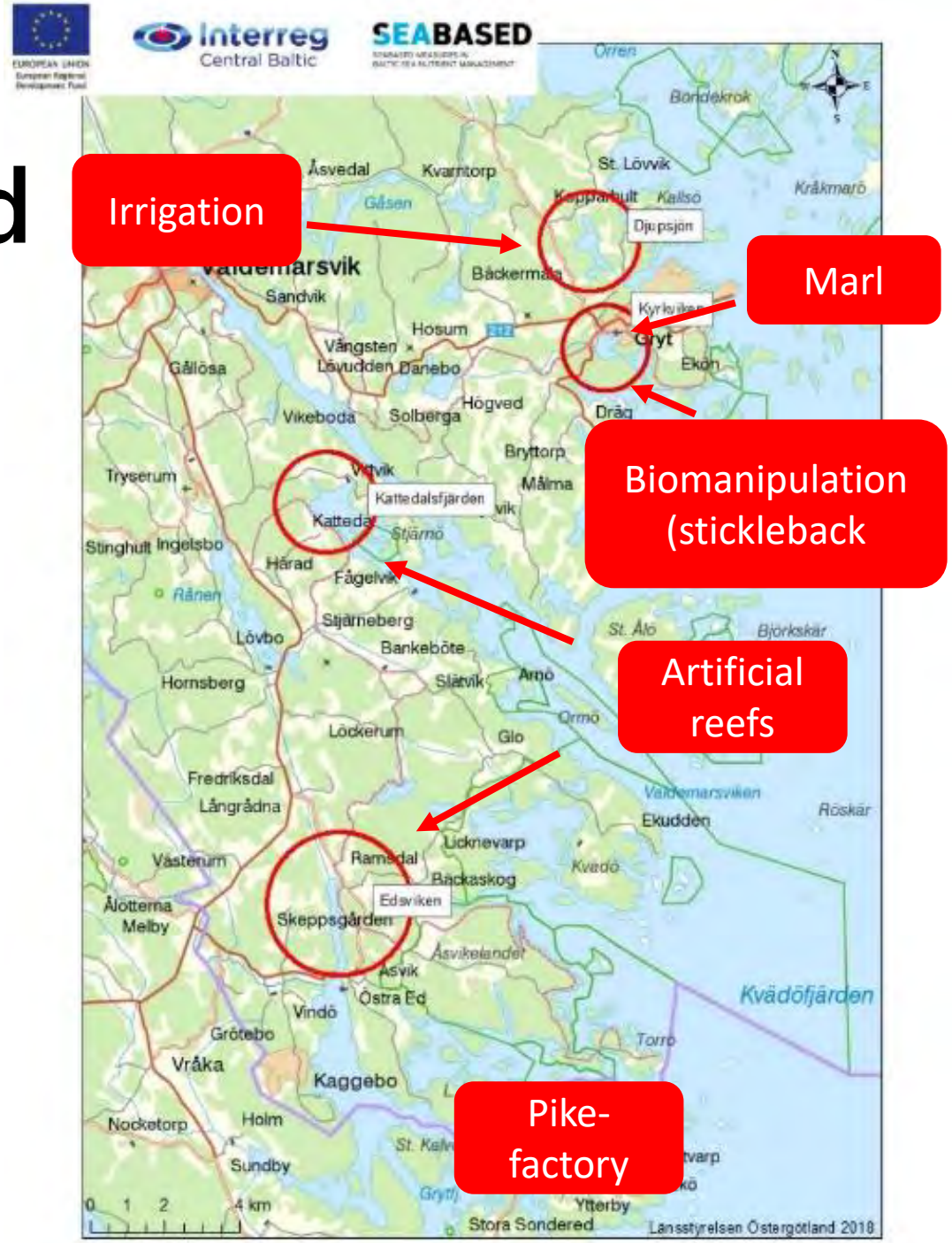

Results in Kattedalsfjärden & Edsviken: Artificial reefs

Artificiall reefs in Edsviken
SEABASED spring 2019

Artificiall reefs in Kattedalsfjärden
SEABASED spring 2019

Results in Kattedalsfjärden & Edsviken: Artifial reefs

Conclusion:
Effective measure when placed correctly in areas where the reproduction and spawning have decreased due to environmental factors

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Contact:

Maria Gustavsson: maria.b.gustavsson@lansstyrelsen.se
Kenneth Winroth: kenneth.Winroth@lansstyrelsen.se

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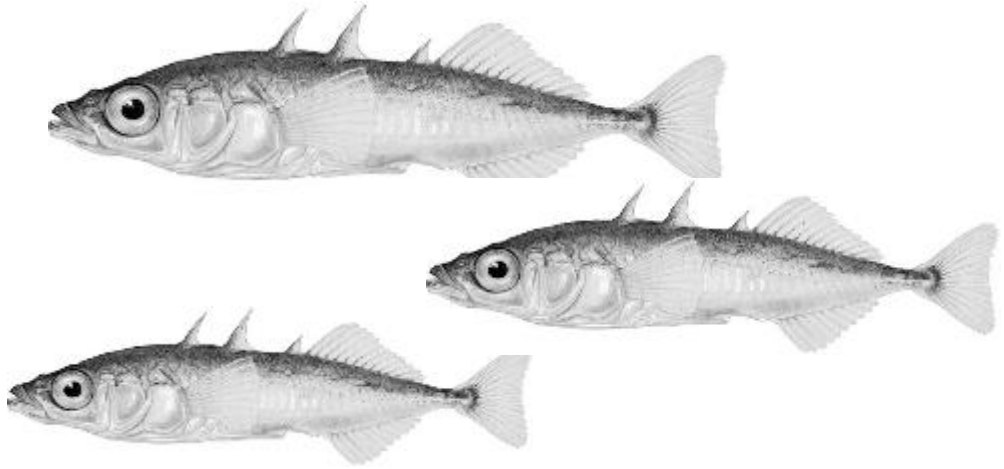


Pilot: Stickleback harvesting on Åland

Rosita Broström

Åland Fish Farmers' Association

26.01.2021

Why stickleback?

CHALLENGES

- Very small fish

⇒ hard to catch

- Thorny fish

⇒ lumps together and gets stuck in the net

Photo: Ulf Bergström

Why stickleback?

ECOLOGY

Stickleback populations in the Baltic Sea is estimated to have increased fifty-fold in the last 30 years (SLU)

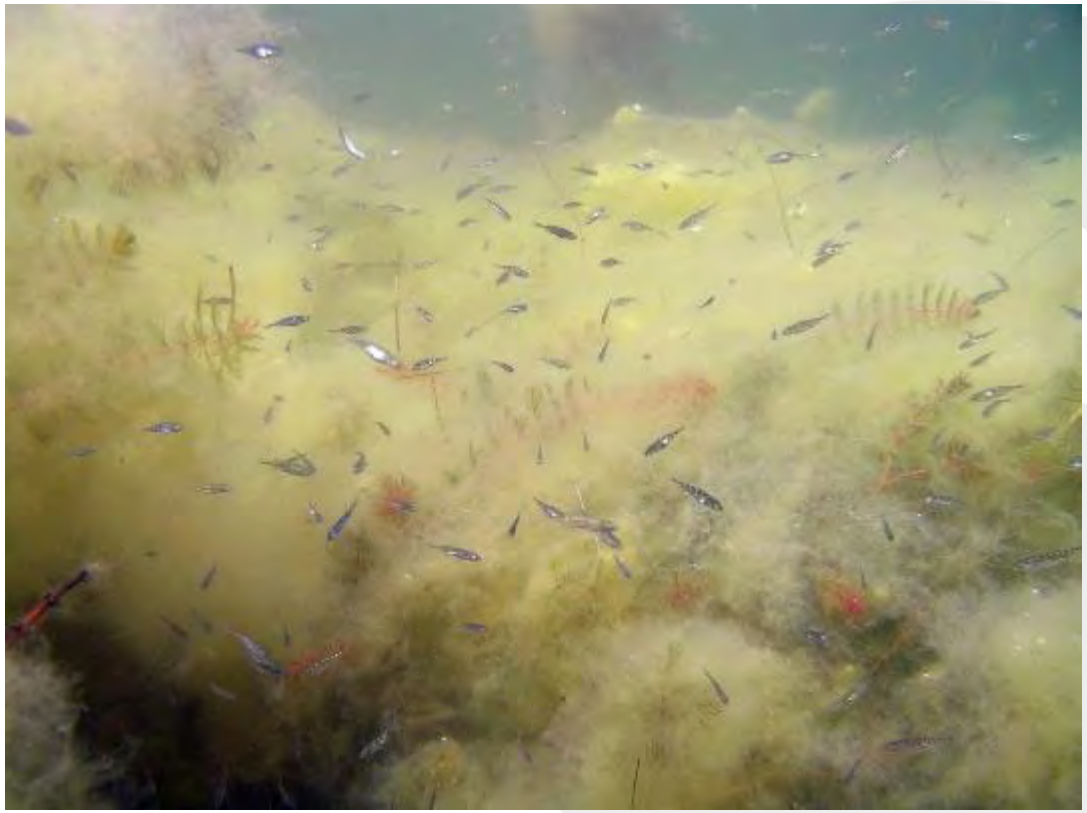
- Adult sticklebacks predate on the juveniles of perch and pike

Many stickleback = fewer perch and pike

- Sticklebacks predate on benthic fauna and zooplankton, thereby decreasing the predation pressure on phytoplankton

More stickleback = more algae blooms

Photo: Ulf Bergström



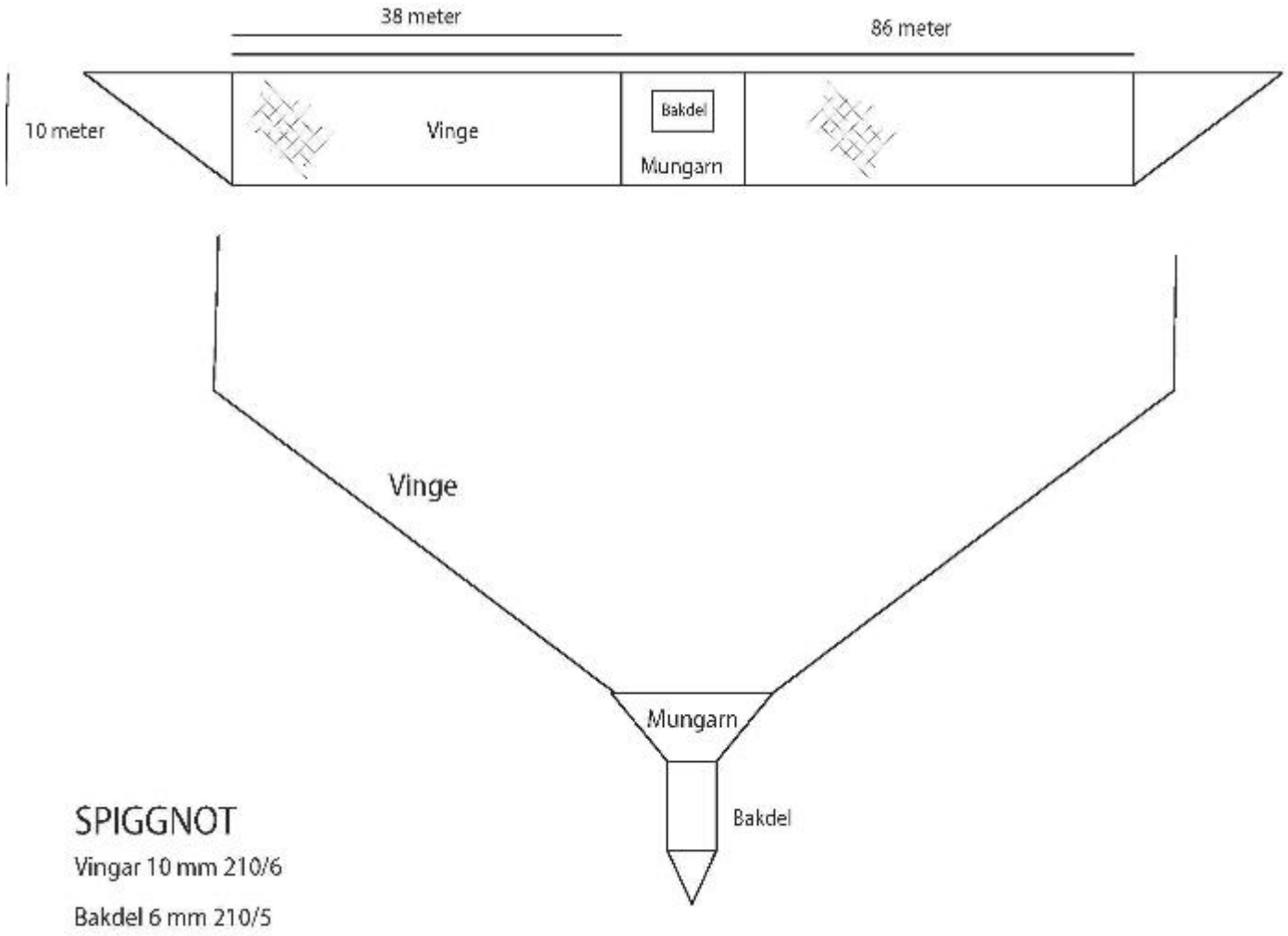
Why stickleback?

SOCIOECONOMICS

- A new potential niche for small scale coastal fishermen, that offers job opportunities and income without increasing pressure on the commercial fish populations
  - Sustainable yield: At least 25 500 tonnes/yr (SLU)
- A new, high quality ingredient for fish feed
  - marine raw materials are a limited resource
  - recycling of nutrients within the Baltic Sea

Equipment: Custom made stickleback seine

- Size of seine is customized to match size of fishing boats on Åland
- Smaller mesh size to catch sticklebacks
- Less tangling and clumping together compared to trawling



Modifications of fishing equipment

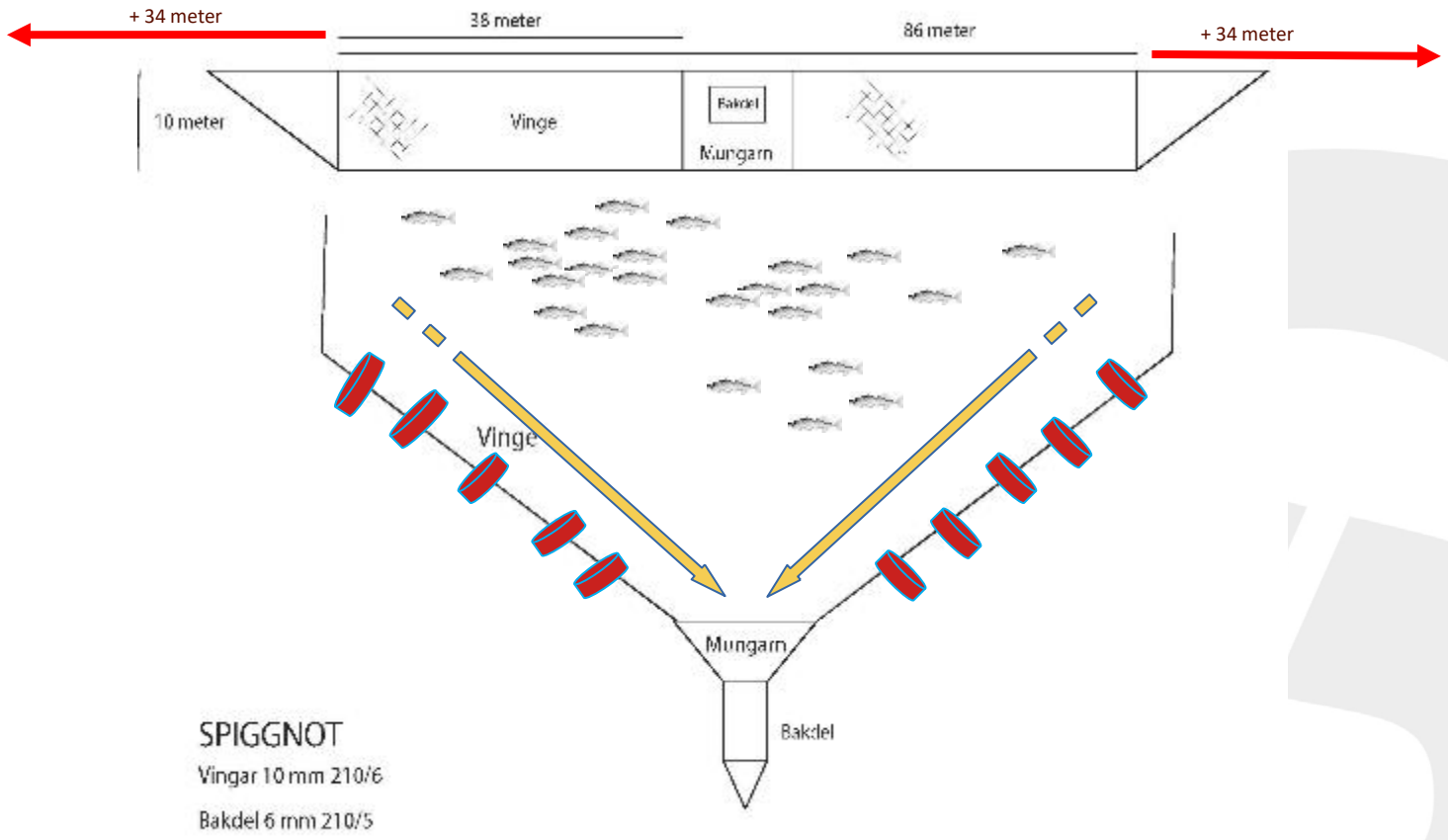
By recommendation from the fishermen that have participated in the trials:

1) The arms have been extended with 34 m on each side

- Circumference: 86 m → 154 m

2) Rings and a purse line were added to the bottom

- Less fish can escape through the bottom of the net



Testing of equipment in the field

Results

- During the project, we had to tweak our fishing methods and make several modifications of the equipment before we got the equipment functional. Our main challenges were:

    1) hauling technique
    2) preventing fish from escaping
    3) finding the right time and place for fishing

Results (cont.)

1) Hauling technique

The small mesh size (10 mm) of the net creates a lot of friction, putting strain on the hauling machines, so it has to be assisted manually without causing entanglement.

2) Preventing fish from escaping

We caught many large schools of stickleback in the seine, but most of them escaped downwards, until we added rings and a purse line.

3) Finding the right time and place for fishing

Stickleback seems to be abundant from spring to autumn, but even with 10mm mesh, juvenile fish are too small to catch, hence April-June is the best period. Fishing close to shore prevented escapes but resulted in bycatches of perch which should be avoided.

What's next?

- A few more fishing trials will be done in winter/spring 2021.
- The method and fishing techniques developed in the project will be compiled in a manual, for future trials or projects.
- The stickleback population on Åland will hopefully be surveyed, to find out more about it's ecological impacts and also where, when and in what amounts it can be found. This would be valuable information for future projects.

The future of stickleback fishing

- Commercial fishing of stickleback within the next 10 years?

- In the Baltic Sea: Trawling of stickleback, as a complementary to the declining fishing quotas of Baltic herring and sprat

  → compensation measure, fish feed ingredient

- On Åland: Small scale fishing of stickleback in the archipelago

  → fish habitat restoration, compensation measure, fish feed ingredient

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Contact:

Rosita Broström: rosita.brostrom@fiskodlarna.ax

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WP T4: Binding phosphorous into sediment

Nils Ekeroth, NIRAS
26.01.2021

Laboratory tests

- The sorbent is made by treating of marl/limestone residue with heat
- Laboratory results show that heat treatment greatly improves phosphorus (P) sorption capacity
- The laboratory work was mainly carried out at the cement manufacturer Cementa's plant in Slite on the island of Gotland, Sweden
- The raw material originates from Gotland and was provided by the limestone producer Nordkalk AB

Small scale experiments:

- Controlled experiments with focus on certain details such as P-sorption efficiency and stability of the sorbent and its effects on sediment biogeochemical variables.

Stockholm University

ELY Centre

CAB Östergötland

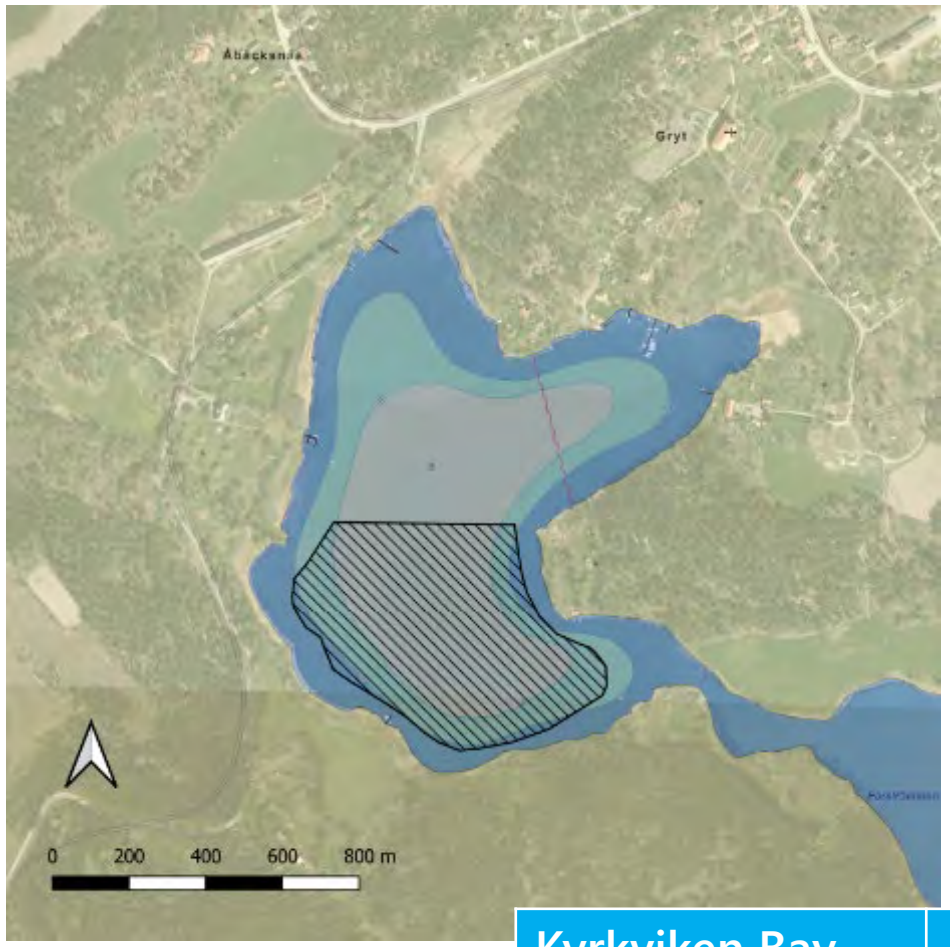
Whole-bay field trials:

- Spreading of the sorbent over the entire sediment area impacted by oxygen depletion with the aim of lowering P-bioavailability in the bays.

The Kyrkviken Bay and Kolkka Bay

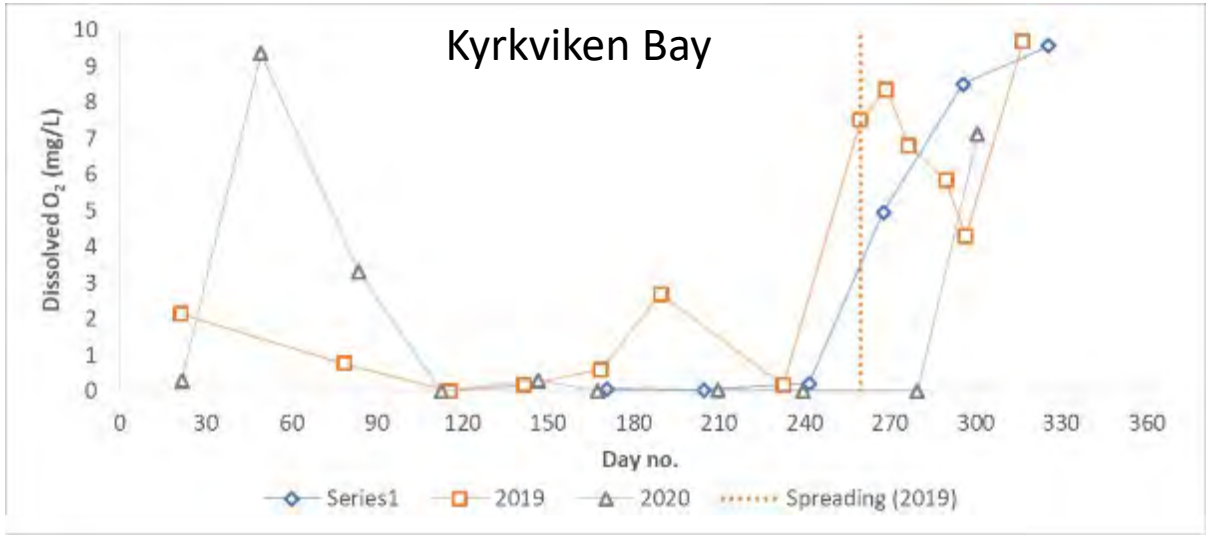
Whole-bay field trials:

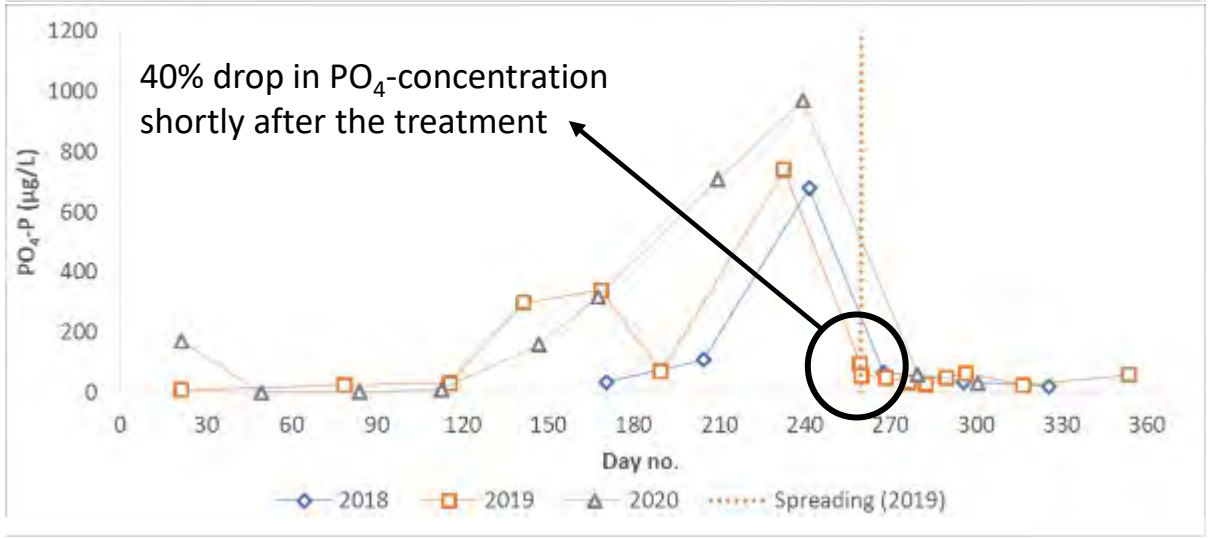
- Spreading of the sorbent over the entire sediment area impacted by oxygen depletion with the aim of lowering P-bioavailability in the bays.

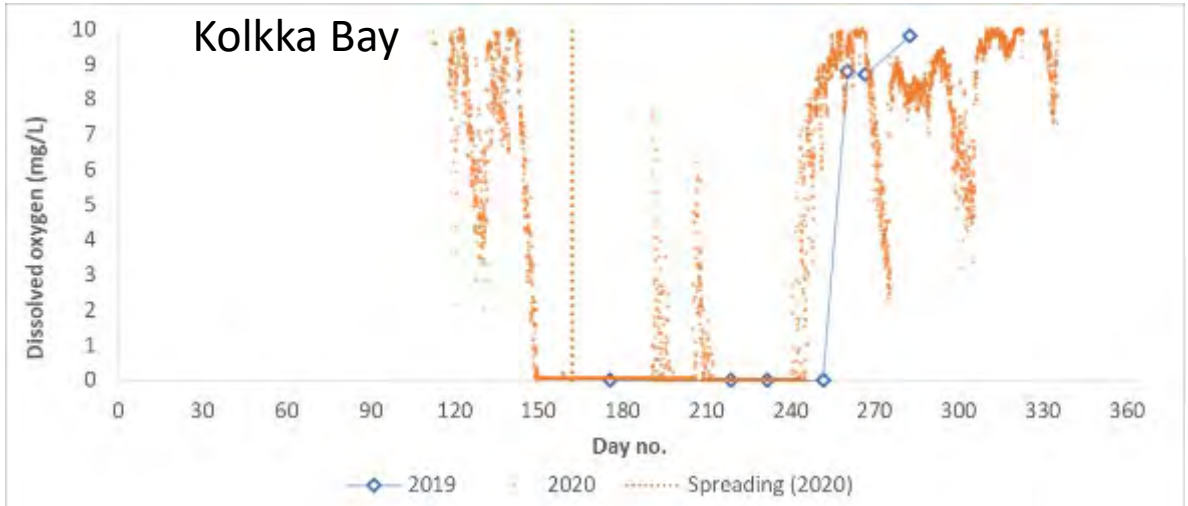


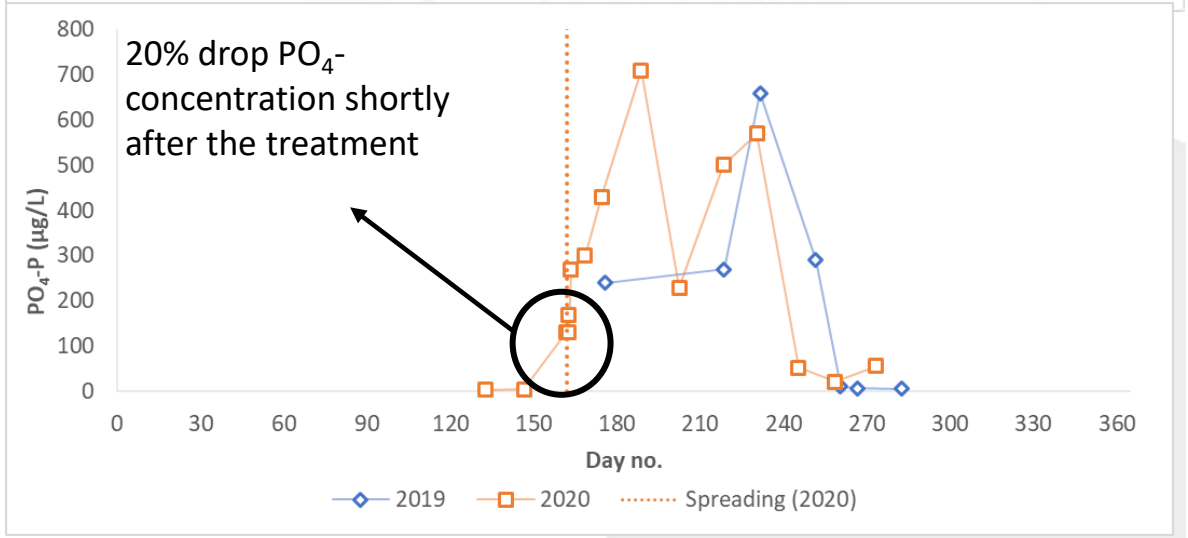
Kyrkviken Bay		Kolkka Bay
90000	Treatment area (m^2)	80000
12000 (139 g/m^2)	Amount of sorbent (kg)	8000 (100 g/m^2)
June 2018	Start monitoring program	June 2019
Sept. 2019	Spreading of the sorbent	June 2020

Bottom water – short term changes but no signs of lowered P-concentrations on longer term









The Djuröfladen Bay

Aim:

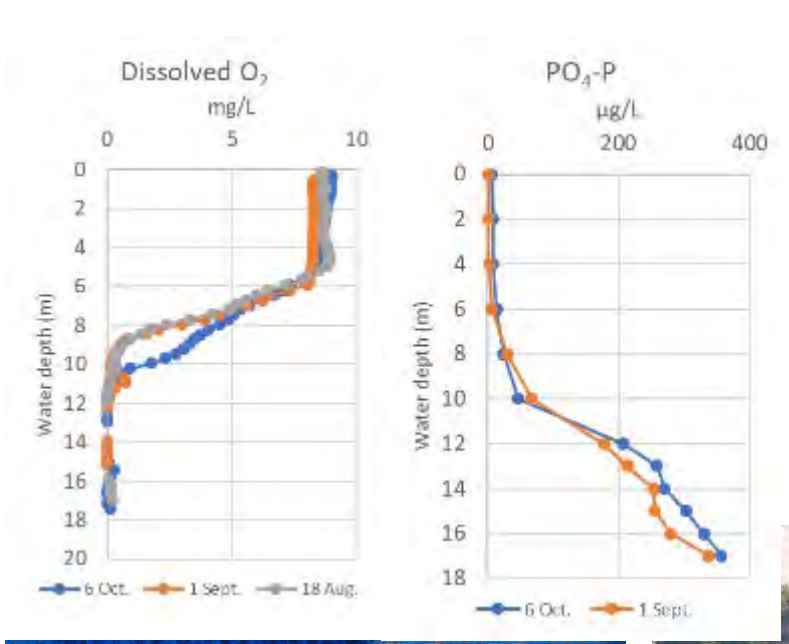
- Measure changes in physicochemical variables in the sediment by marl sorbent addition

Hypothesis:

- Addition of marl sorbent will increase the P-content in the solid phase of the sediment lower pore water PO_4-concentrations
- Addition of marl sorbent will increase the Ca-content in the sediment and increase pH

Results:

- The marl sorbent increased pH and Ca but no effect on P



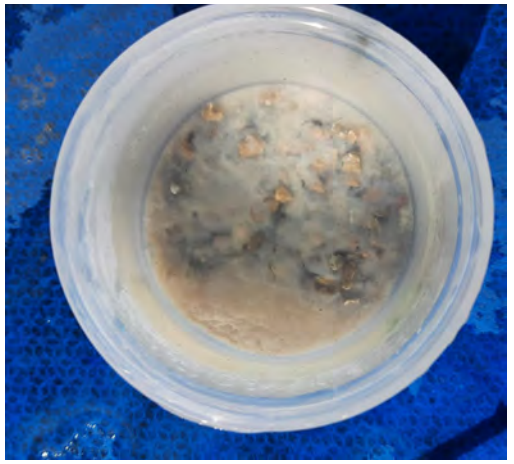
The Farstaviken Bay

Overall aim:

- Determine why the sorbent appears to have lower efficiency in field conditions than in laboratory studies

The Farstaviken Bay - Results

- One tenth of the sorbent was pulverised
- The fine grain material was clearly enriched in P (2-8 times higher P content than background level in sorbent)
- Still, lower P content than anticipated from lab studies



P binding efficiency (lab experiments)	P-concentration in fine grain sorbent from the field trial in the Farstaviken Bay
mg P/kg sorbent	mg P/kg dwt
10000-16800	186-350

Conclusions

- The sorbent has capacity to bind phosphorus, but the capacity is lower than anticipated
- The sorbent's relatively low capacity to sequester P likely explains the lack of long-term changes in P-availability in the Kyrkviken Bay and Kolkka Bay and why the sediment P-content the Djuröfladen Bay did not increase by treatment with the marl sorbent

Conclusions

- The sorbent's relatively low capacity to sequester P is likely related to the heat treatment

Production for lab-experiments

Large-scale production (30 000 kg) for field trials

Conclusions

- No harmful effects were observed due to spreading of marl (pH-effects, clouding, dusting)

Outlook

- Results show promising signs but more development work is needed
- In particular, the large scale production method needs to be optimised (planned for 2021)
- Controlled experiments on mesocosm-scale is recommended before additional full-scale field trials are carried out

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Thank you!

Contact: nils.ekeroth@niras.se

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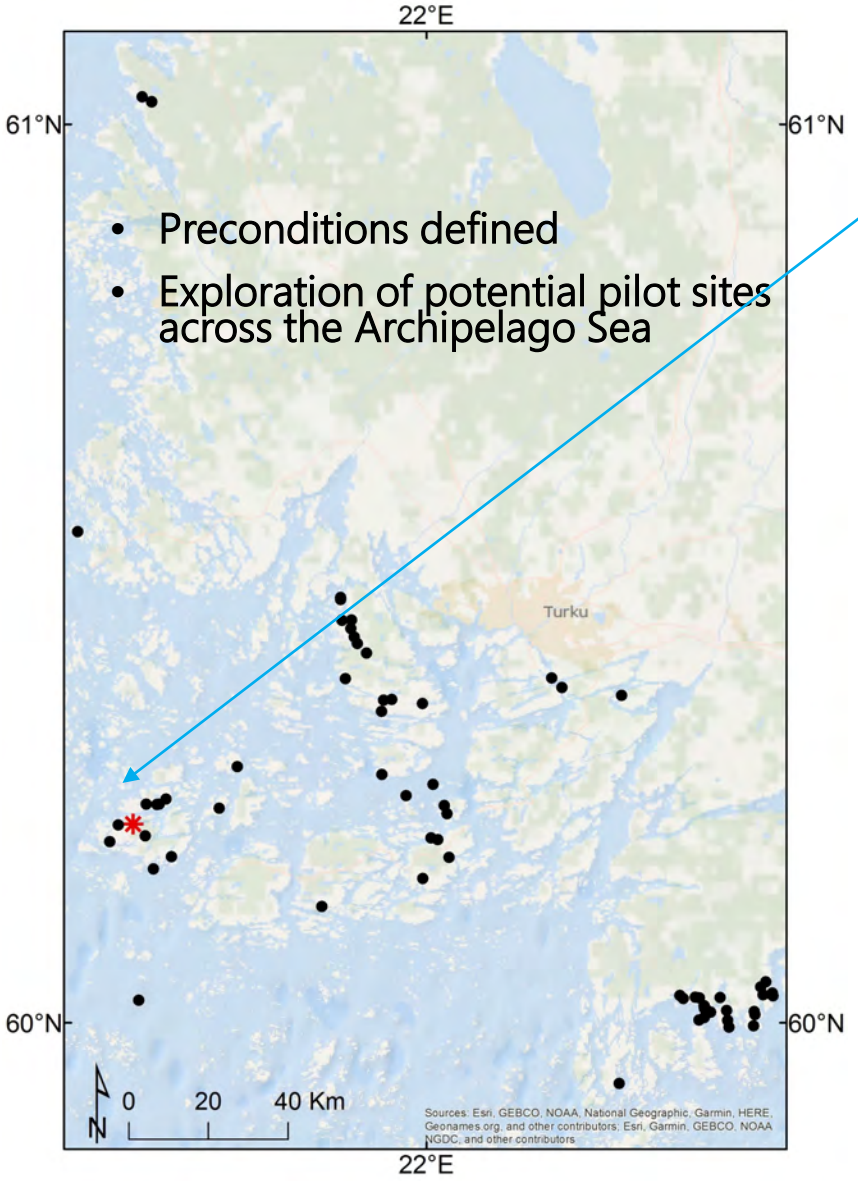
Sediment removal

26.1.2021

Irma Puttonen, Pekka Paavilainen & Janne Suomela

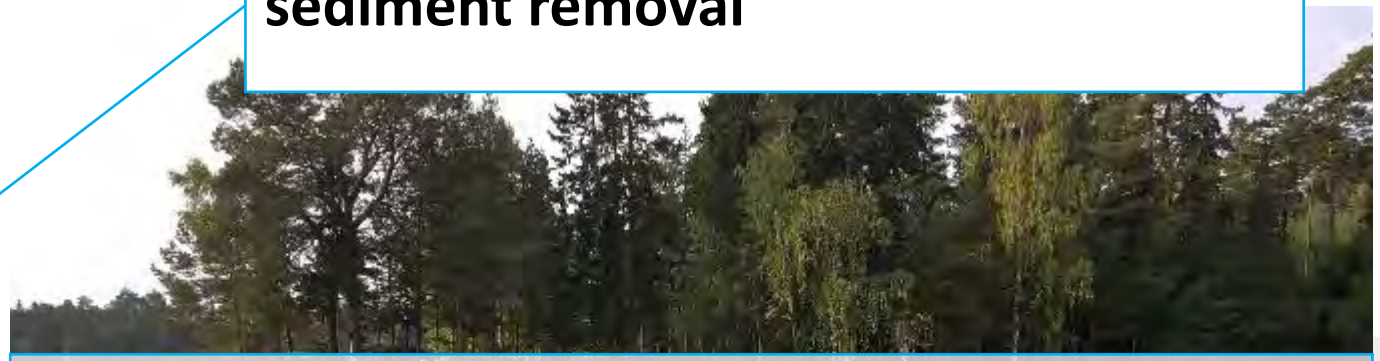
Centre for Economic Development,
Transport and the Environment

Pilot site selection



- Preconditions defined
- Exploration of potential pilot sites across the Archipelago Sea

Hålax vik selected as a pilot site for sediment removal



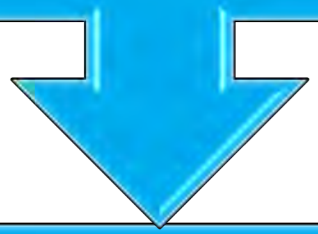
- Restricted water exchange due to a threshold in the mouth of the bay
- Sediment accumulation and oxygen depletion in the bottom
- Phosphorus release from the sediment
- High phosphorus concentration in the water
- High primary production
- No zoobenthos in the deepest parts
- Previous water quality data available
- Excellent co-operation with the local inhabitants

Planning of sediment removal

- Exploration and finding solutions for
  - removal
  - deposition
  - recycling of the sediment
- Challenges:
  - Marine scale
  - High water content of sediment
  - Logistical issues
  - Infrastructure construction
  - Lack of competition, new technical solutions needed

Pilot implementation

Cost of sediment removal too high



Replaced by a sediment incubation test in a laboratory

Will sediment removal change

- Biological oxygen demand in the sediment?
- Nutrient fluxes (particularly phosphorus) to and from the sediment?

Results of the sediment incubation test

Sediment *BOD_7 declined with sediment depth

* indicates how much oxygen micro-organisms need for breakdown of organic matter in seven days

Sediment removal moderated oxygen demand

25 cm sediment removal lowered phosphate concentrations in the water

Change in supernatant P concentration depended on initial concentration in the test

Nitrogen concentrations in the water did not show detectable trend

Theoretical removal of nutrients

- Removing 10 cm thick sediment layer per hectare in Hålax vik:

150kg Phosphorus
1150 kg Nitrogen
7900 Carbon/7700 kg OC

- Based on average data on sediment and water chemistry in Hålax vik
- Amount of nutrient removal is site-specific

Sustainability

✓Careful planning

- Risk assessment
- Environmental monitoring
- Permit procedure
- Transparent public procurement (in our case)
- Communication and informing
  - Local people, authorities, entrepreneurs

Summary

Expensive, many challenges

Marine scale

- Depth and extent of bays
- Logistics
- Constructing infrastructure

Sediment removal

- 10 cm insufficient
- Costly with available solutions, lack of competition
- New, affordable technical solutions needed for the whole process

Sediment deposition

- Steep, rocky coast
- Recycling
- Geotube applications
- Possible sediment pollution

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Centre for Economic Development, Transport and the Environment

Contact:

Janne Suomela
Senior Specialist
janne.suomela@ely-keskus.fi
+358 295 022 947

Irma Puttonen
Project Coordinator
irma.puttonen@ely-keskus.fi
+358 295 022 801

Pekka Paavilainen
Senior Officer
pekka.paavilainen@ely-keskus.fi
+358 295 022 921

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Experts' views on the risks, potential and future of sea-based methods

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Experts' views on the risks, potential and future of sea-based methods

Marjukka Porvari, Director of the Clean Baltic Sea Projects, John Nurminen Foundation (moderator)

Mikhail Durkin, Executive Secretary, Coalition Clean Baltic

Jacob Hagberg, Head of Delegation for Sweden in HELCOM

Marjo Tarvainen, Senior Officer, Centre for Economic Development, Transport and the Environment for Uusimaa, Finland

Maria Gustavsson, Water Specialist, County Administrative Board of Östergötland

Seppo Knuuttila, Senior Research Scientist, Finnish Environment Institute

Tony Cederberg, Station Manager, Husö Biological Station

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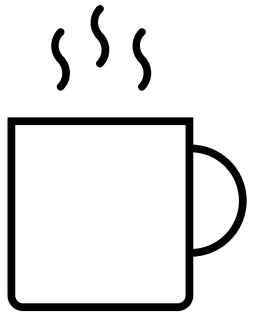
Coffee break



Program continues at 15.00

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Welcome back!

14.45–16.00 Part 2: How will the gathered knowledge be used in practice?

- Practical Guidelines: Future utilization of the piloted measures – **Miina Mäki**, Project Manager, John Nurminen Foundation
- A concept of aquatic compensations in Åland – **Annica Brink**, Coordinator, The Government of Åland
- Expert comment on aquatic compensations – **Lena Bergström**, Associate Professor, Swedish University of Agricultural Sciences
- Questions and open discussion on sea-based measures
- Financier's views on environmental projects – **Samu Numminen**, Project Manager, Central Baltic Programme
- Next steps and closure of the event– **Marjukka Porvari**

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Practical Guidelines: Future utilization of the piloted measures

Miina Mäki, Project Manager, John Nurminen Foundation

WP 1: Practical Guidelines for sea-based measures

A compilation of neutral and verified information on

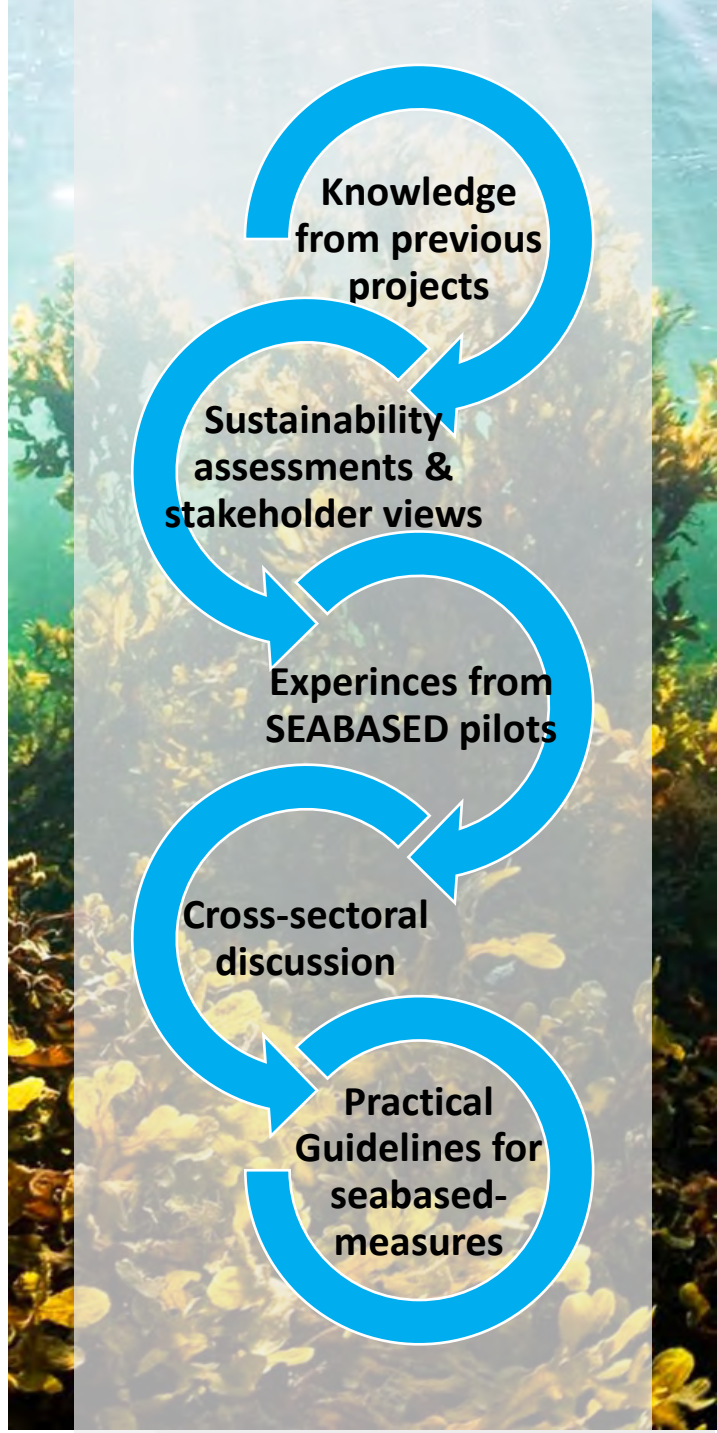
- Practical and scientific knowledge on different measures
- Sustainability assessments of piloted measures
- Potential effects and risks
- Costs and technical feasibility of measures

Participatory approach in Guideline development

- Comments and experiences of SEABASED partnership
- Stakeholders' views (interviews, surveys, national forums)
- Scientific knowledge (scientific forums)
- Cross-sectoral discussion (interviews, events, international forums)

Aim of the Guidelines is to provide

1) Guidance for organizations planning to carry out sea-based activities
2) Decision support for relevant authorities (e.g. permitting)
3) Practical information to national and international decision making



The Practical Guidelines - contents

1) Summary
2) Background
3) Aim of the Guidelines
4) Introduction to sea-based measures
5) Environmental aspects
6) Cost-efficiency of measures → **Comparison based on pilot examples**
7) International legislative framework → **Literature review & permitting**
8) Social aspects
9) Guidance for project planning
10) Attachments, e.g.
    - Reports from SEABASED Pilots

Background, SEABASED Project

- State of the play: current knowledge on sea-based measures
- Aims of the SEABASED Project

Sea-based measures in Baltic Sea Protection

- Examples of different measures – experiences from SEABASED pilots & from some previous projects
- Technical feasibility of measures – examples from pilot projects (SEABASED & some previous projects)
- Potential effects of measures – results from pilots

Ecological risk assesment framework

1) Site selection
2) Choosing of measures
3) Ecological impact assessment
    - General indicators
    - Measure specific indicators
4) Potential risks related to sea-based measures
5) Monitoring and risk management

General acceptability and views

- Stakeholder workshops
- Views among environmental authorities, other stakeholders and local communities
- Helcom

Ecological impact assessment

Ecological impact assessment for the planned measure should aim at:

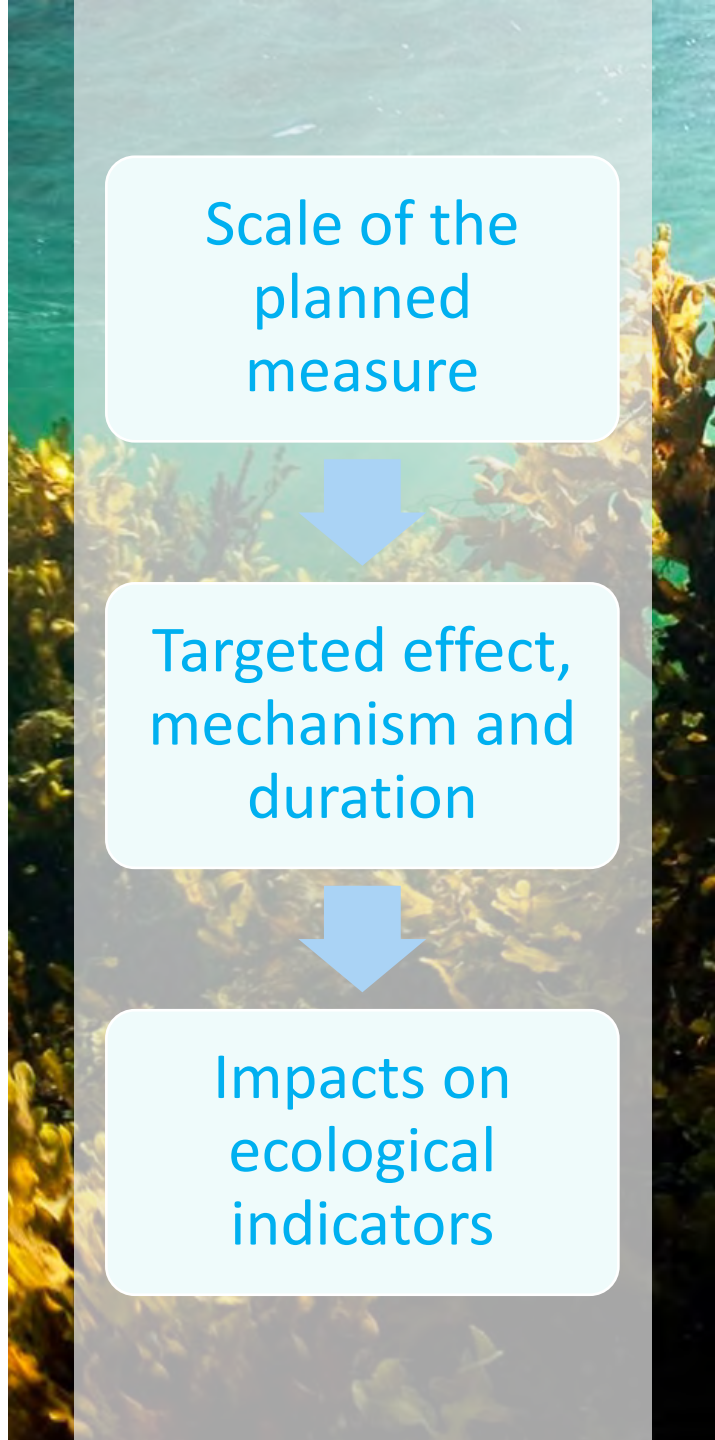
a. Identifying potential ecological effects, benefits and risks and

b. Understanding e.g.
   - direction (positive/negative, indicators)
   - magnitude
   - extent
   - duration (in time)

   of the identified effects.

- By evaluating the effects on different ecological indicators, biggest risks and risk thresholds, "no-go's", can be identified.
- These are also the key issues to consider when evaluating the applicability of possible future pilots of sea-based measures.

Different ecological indicators can be used for evaluating the effects of sea-based measures. Part of the indicators are measure-specific, and, thus, might not be relevant in case of all measures. Therefore, the impact assessment should be planned thoroughly to ensure the selection of the suitable indicators for different measures.

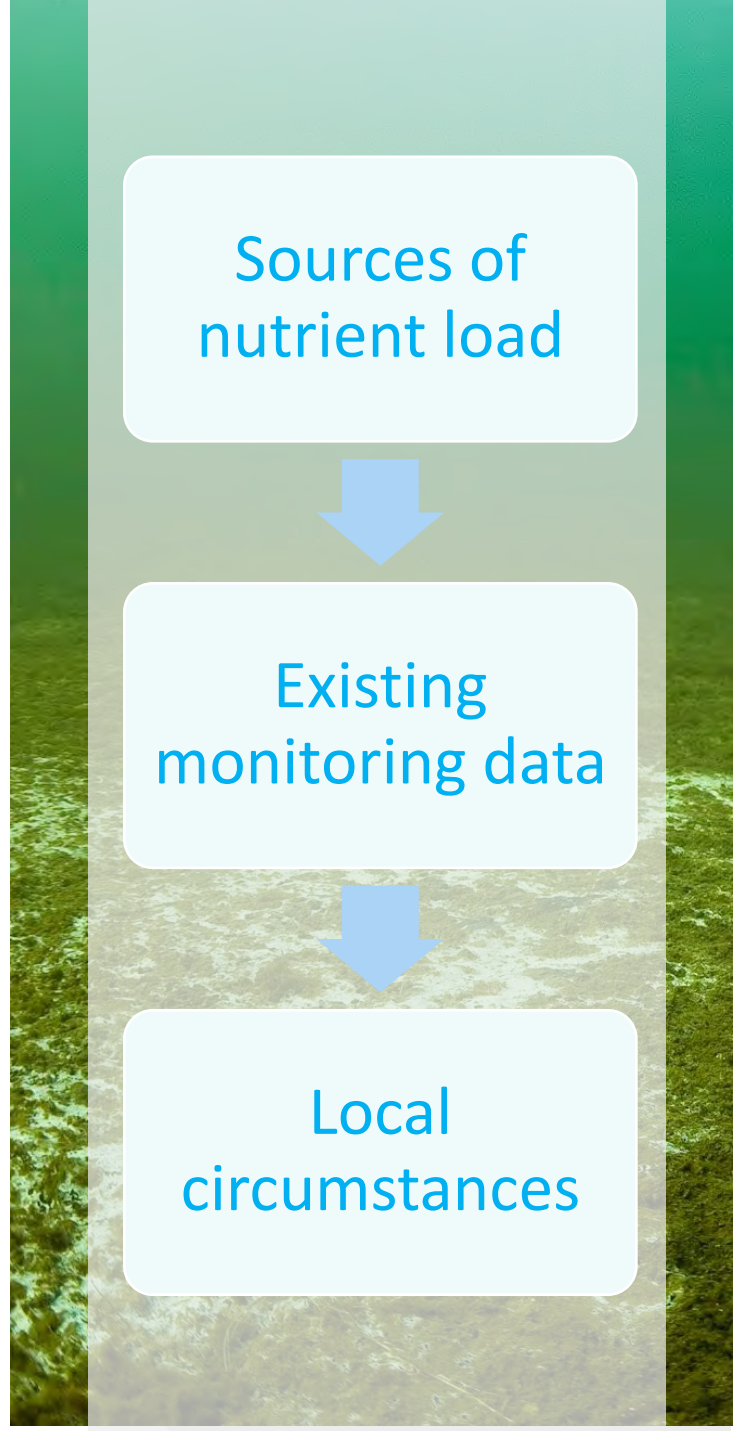


Site selection

In general, sea-based measures should be targeted only at areas identified as potential/significant sources of internal nutrient loading.

<u>The following preconditions should be considered:</u>

- Reduced external loading from land-based sources
- Enclosed/ semi-enclosed conditions to control and limit the effects
- Existing monitoring data before implementation
- Specific attention should be paid to hazardous substances (avoiding of contaminated areas)
- Selection of measures should be based on site-specific conditions
- At oxic, shallow areas with high pools of mobile nutrients, thorough evaluation of negative and positive impacts on local ecosystem is needed before the implementation of sea-based measures.



Risks management

- Spatio-temporal coverage of the monitoring plan: possible long-term effects or effects on neighboring water areas
- Impacts on Natura 2000 and other marine protected areas
- Plan for minimizing the potential identified risks or negative effects
- Risks with severe consequences, depending on the measure, e.g.
    - Disturbing of the ecosystem functioning as a whole
    - Risk of biodiversity loss
    - Risk of releasing of nutrients/ hazardous substances
    - Impacts on nutrient concentrations in productive water layer
    - Effects of changes in the environment over longer period of time
    - The measure-specific aspects

In addition to the ecological risks, an assessment and management plan for other identified risks should be included in project planning, e.g. for technical, juridical, social or economic risks in project implementation.

How to proceed when planning a project?

<u>Preconditions for suitable site:</u>

- Efficiently reduced external load
- High nutrient load from internal sources
- Closed/semi-enclosed area

Environmental Risk Assessment

- Local water protection targets
- Status of ecological indicators
- Choosing of measure(s)
- Implementation plan
- Monitoring plan
- Financing plan

Permitting

- Consulting of relevant authorities
- Economic and social impact & risks assessment
- Views of local stakeholders
- Project plan and budget

Implementation

- Financial resources for implementation
- Resources for monitoring
- Documentation of all steps
- Monitoring, before and after (long enough, even years)

Adequate documentation of all steps of the implementation, results and monitoring data!

Social sustainability survey – mapping views of environmental authorities

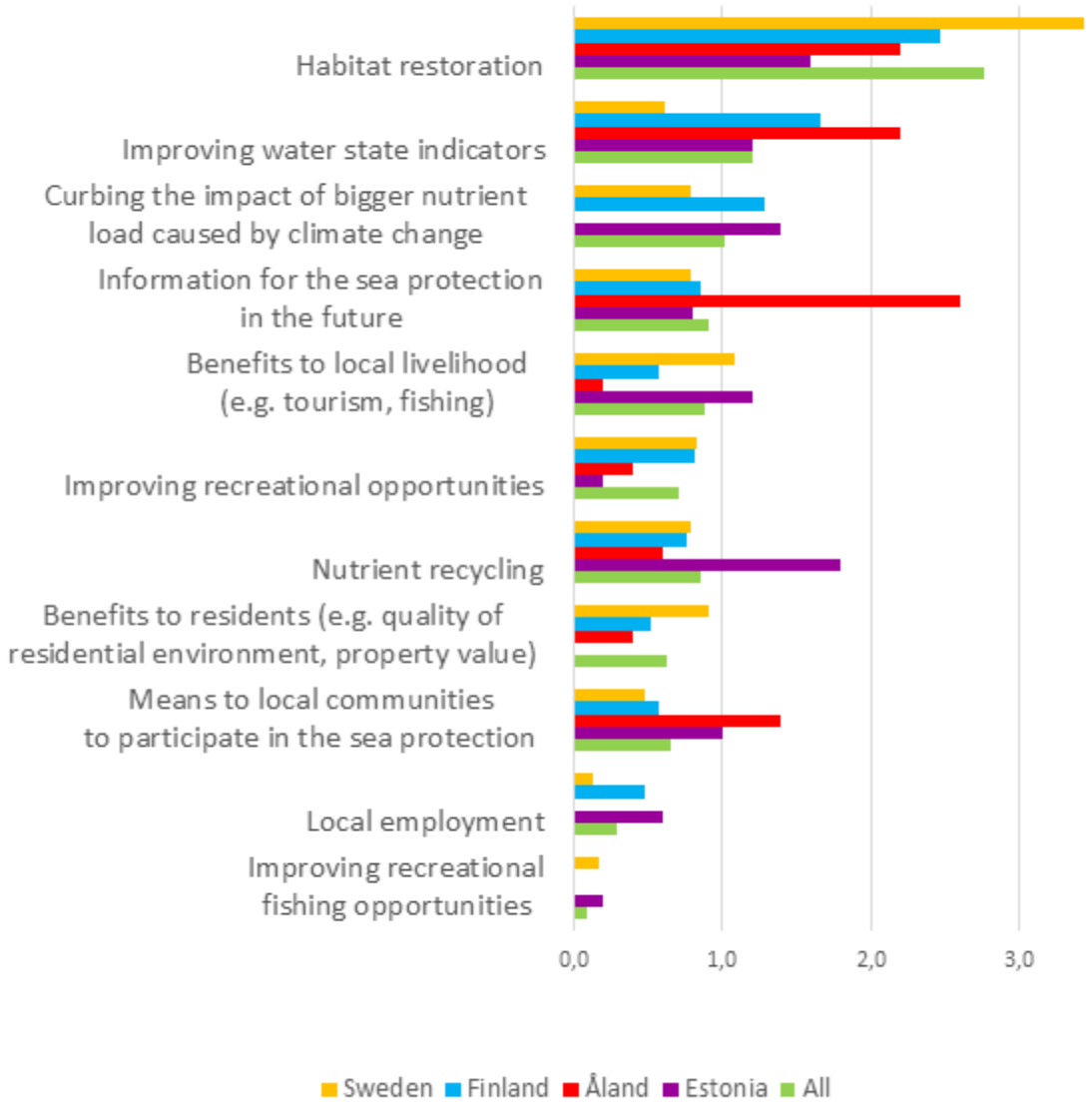
- Questionnaire was sent to approx. 240 contacts in Finland, Sweden and Estonia.
- Altogether 54 answers (22,5%)
  - 23 from Sweden
  - 21 from Finland
  - 5 from Åland
  - 5 from Estonia
- Division of answers:
  - Majority of answers (approx. 50%) from regional authorities (e.g. County administrations, ELY-centers)
  - 25% from local level authorities (e.g. municipalities)
  - 25% from national authorities (e.g. environmental and other relevant ministries)

What we asked (examples):

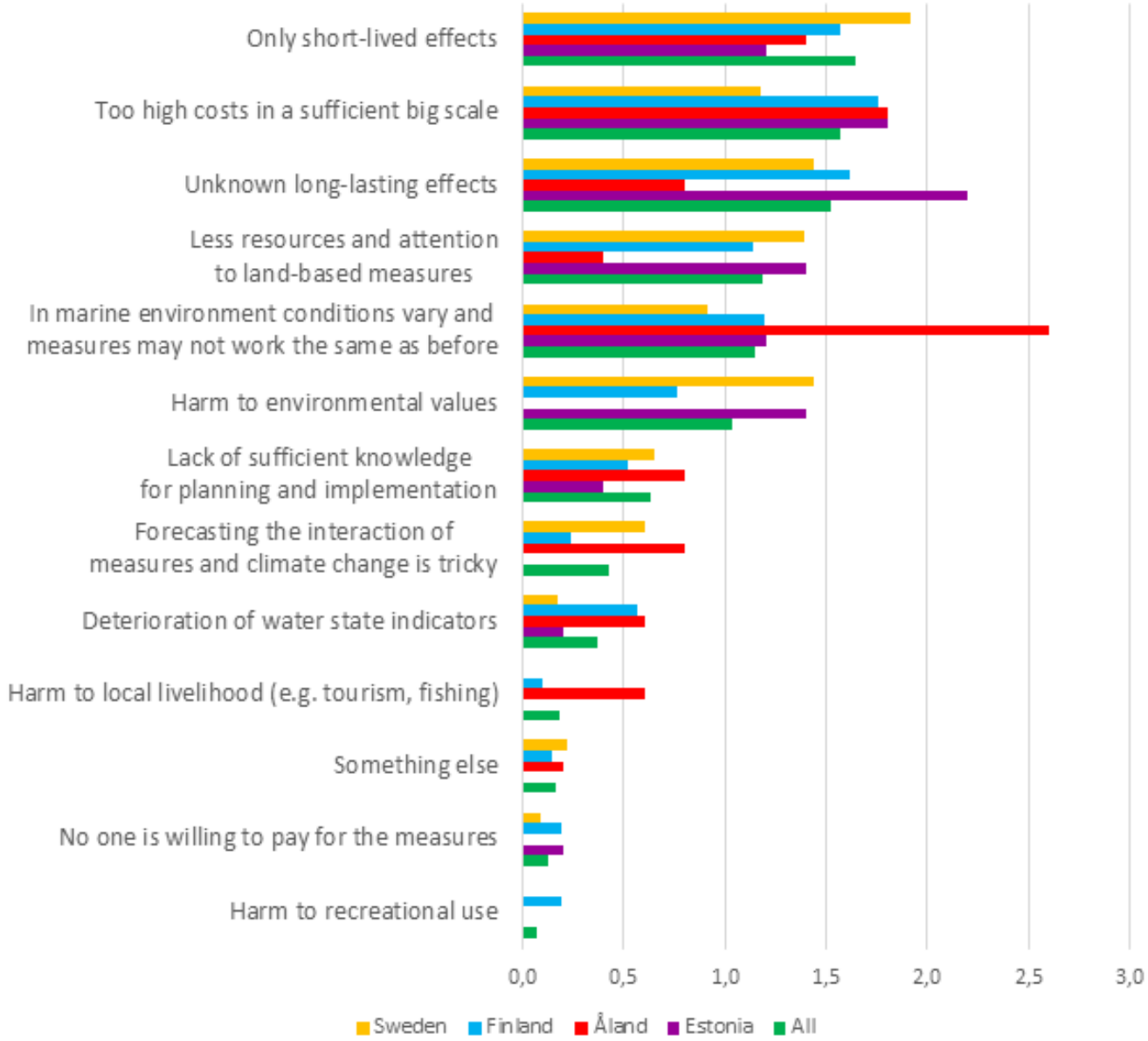
- **What would you see as biggest benefits of utilizing small-scale sea-based measures?**
- **What, in your opinion, are the biggest risks related to the small-scale sea-based measures?**
- **When there is enough information on the effects, risks and feasibility of sea-based measures, should these measures be extended to larger scale?**
- **Which are the main reasons that hinder the use of sea-based measures?**
- **Should the internal load and sea-based measures be included in water management plans?**

In addition, questions e.g. on level of knowledge, existing information, financing and organizations responsible for implementation were included, with the possibility to comment also in open answering fields.

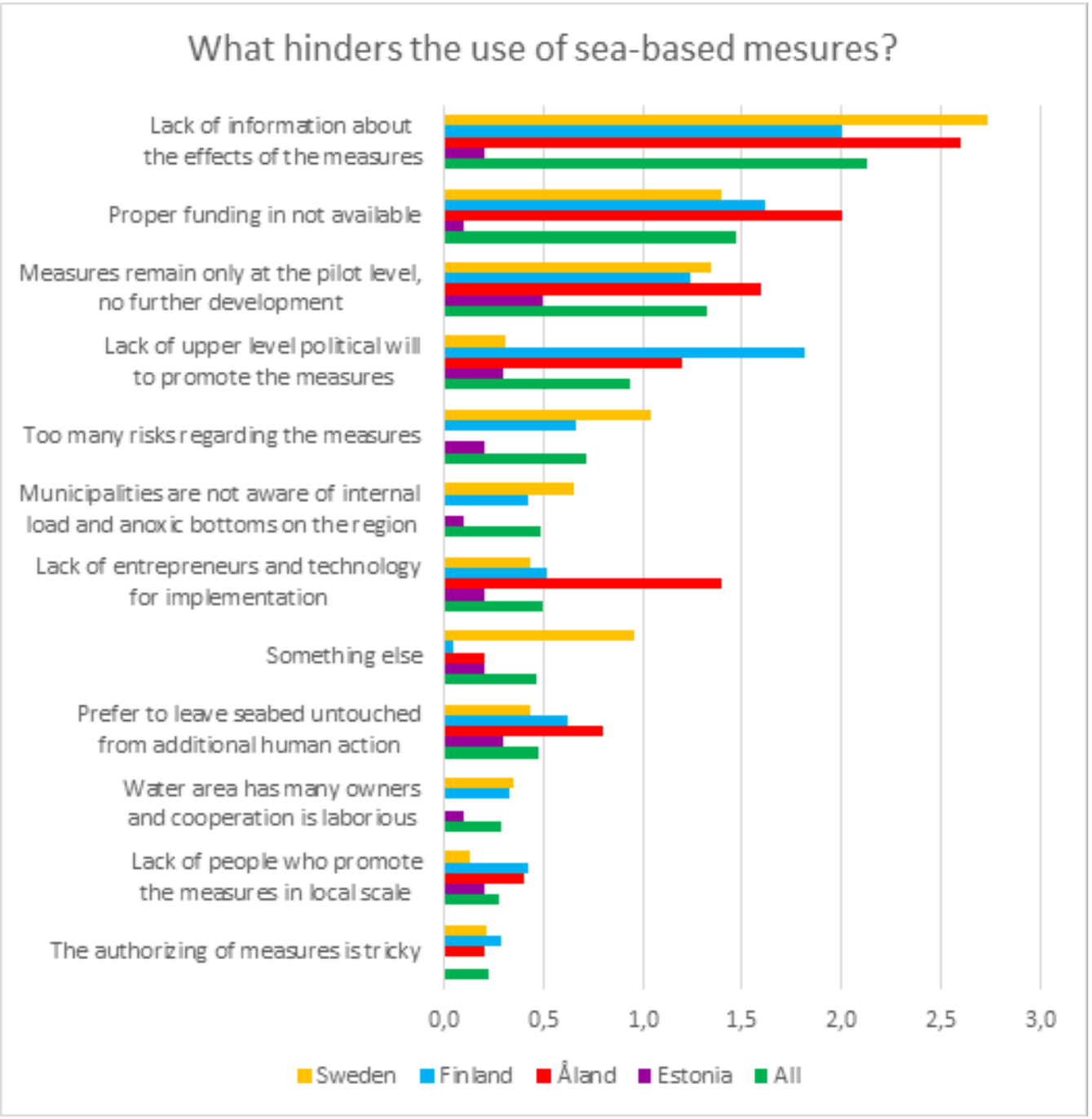
The most relevant benefits

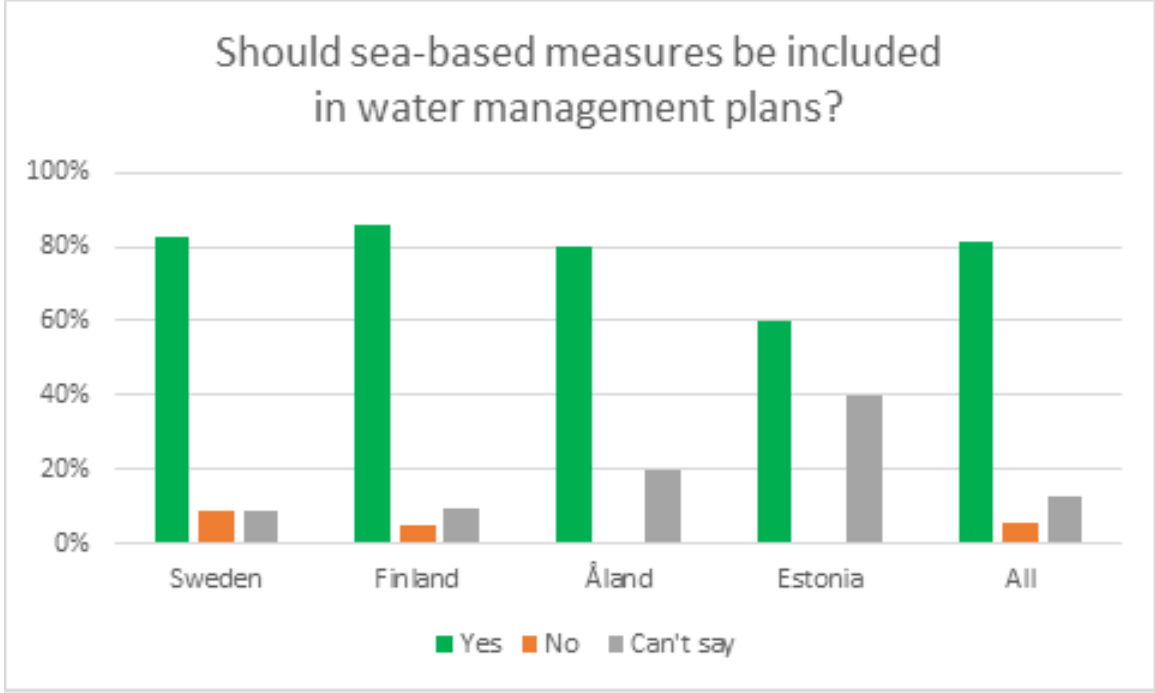


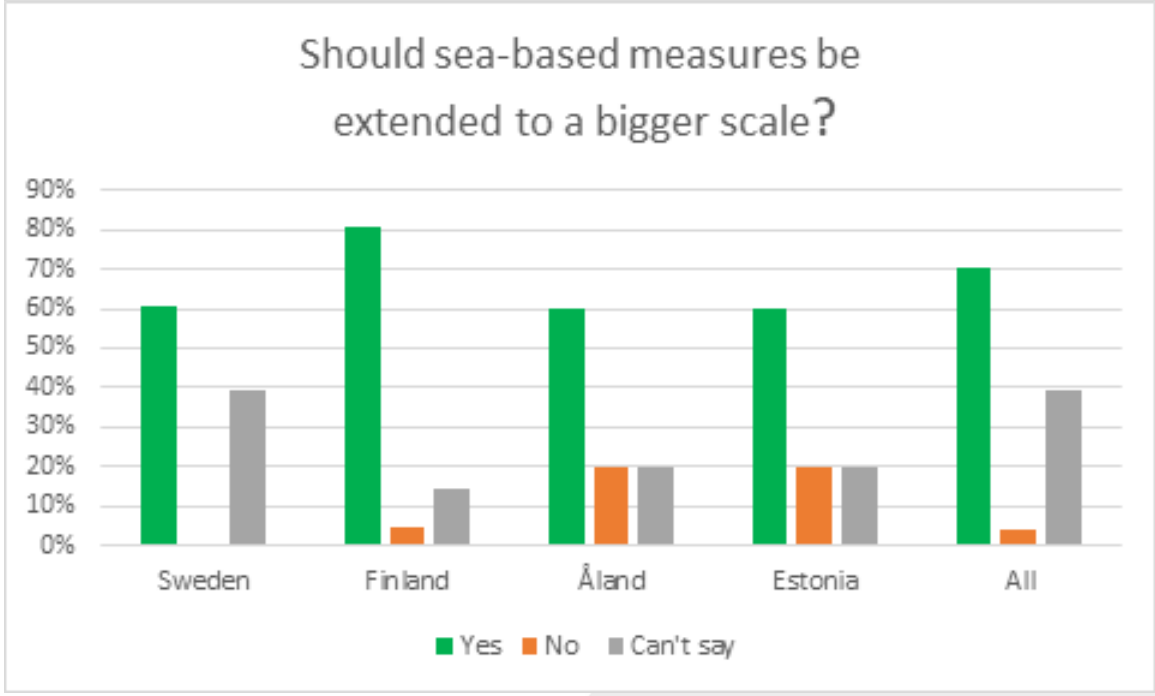
The most relevant risks regarding sea-based measures



Results from SEABASED Social Sustainability Survey for environmental authorities in 2020 (n=54)







Results from SEABASED Social Sustainability Survey for environmental authorities in 2020 (n=54)

Cost-efficiency of sea-based measures?

- Only verified costs taken into account in the estimations in SEABASED Guidelines.
- Some preliminary estimates can be provided for
  - Al treatment
  - mussel farming
  - management fishing
  - Reed harvesting
  - irrigation with nutrient rich water from coastal bays
- For the other measures, missing information on costs or impacts prevent reliable calculations.
- For some measures cost-effectiveness calculations have been distorted by using unrealistic assumptions for the market value of e.g. the removed biomasses or marine sediment.

“Geo-engineering” measures

(e.g. sediment removal, P binding, oxygenation)

- Calculating cost-effectiveness is impossible for measures that
  - lack information on P removal/binding efficiency
  - Lack information on implementation costs

  → **The steps to gather this information need to be taken first**
- For some measures, piloting even in coastal scale has turned out to be challenging due to high implementation costs.

  → **Poor cost-effectiveness or major technical development needs?**
- Based on the project pilots and earlier projects, the most of “geo-engineering” measures still seem to be clearly less cost-effective than land-based measures.
- However, some of these measures could be used locally for small coastal areas, where the role of internal load on eutrophication is proven and water quality cannot be improved with other means.

Measures based on biomass removal

(e.g. management fishing, reed harvesting, mussel farming)

- Market value of the biomass is decisive for cost-efficiency and economic sustainability of the activity.
- The amount of nutrient reduction can be reliably verified
- Often difficult or impossible to prove any direct improvements on local water quality.
- Some measures based on biomass removal seem to be cost-effective
  - with estimated costs of less than 200€ / kg P removed
  - when compared to the measures in reducing land-based load from diffuse sources (e.g. agriculture)
  - even when no assumption on market value for the biomass has been included in the calculation

Conclusions, part 1

- The suitability of the sea-based measures is always site-specific.
- Results from one site can’t be directly applied to other locations.
- Concerning large-scale (open sea) applications, no techniques are mature enough yet. Results from local pilots can’t be generalized to open sea as such.
- Impacts to be considered might not be restricted to the marine environment (e.g. utilization of biomass, biodiversity)
- Cost estimates should be based on realistic information on both, costs and nutrient reduction efficiency of the measure.
- Some of the sea-based measures could be cost-efficient in local scale water protection, for supporting nutrient load reductions from land.

Conclusions, part 2

- More research and techical development is needed for future applications of the geo-engineering measures.
- Identified knowledge gaps exist e.g. in understanding of sediment processes, nutrient cycles and impacts of the climate change in the Baltic Sea marine environment.
- Monitoring and documentation of all pilots is crucial!

→ Focus should be kept in reducing land-based nutrient load.

→ Some of the sea-based measures can be cost-efficient for utilization in small-scale local marine protection.

→ Also, some of the novel measures are potential but need further research and technical development.

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www.seabasedmeasures.eu

www.johnnurmisensaatio.fi

Miina Mäki
miina.maki@jnfoundation.fi

Pictures: Jukka Nurminen

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Nutrient compensation in the aquatic coastal environment

Annica Brink, Coordinator, The Government of Åland

What is compensation?

Dictionary:

“Something given or received as an equivalent for damage, loss or injury”

Compensation measures = Indemnification of negative impact on our environment caused by human activity

Why should we compensate?

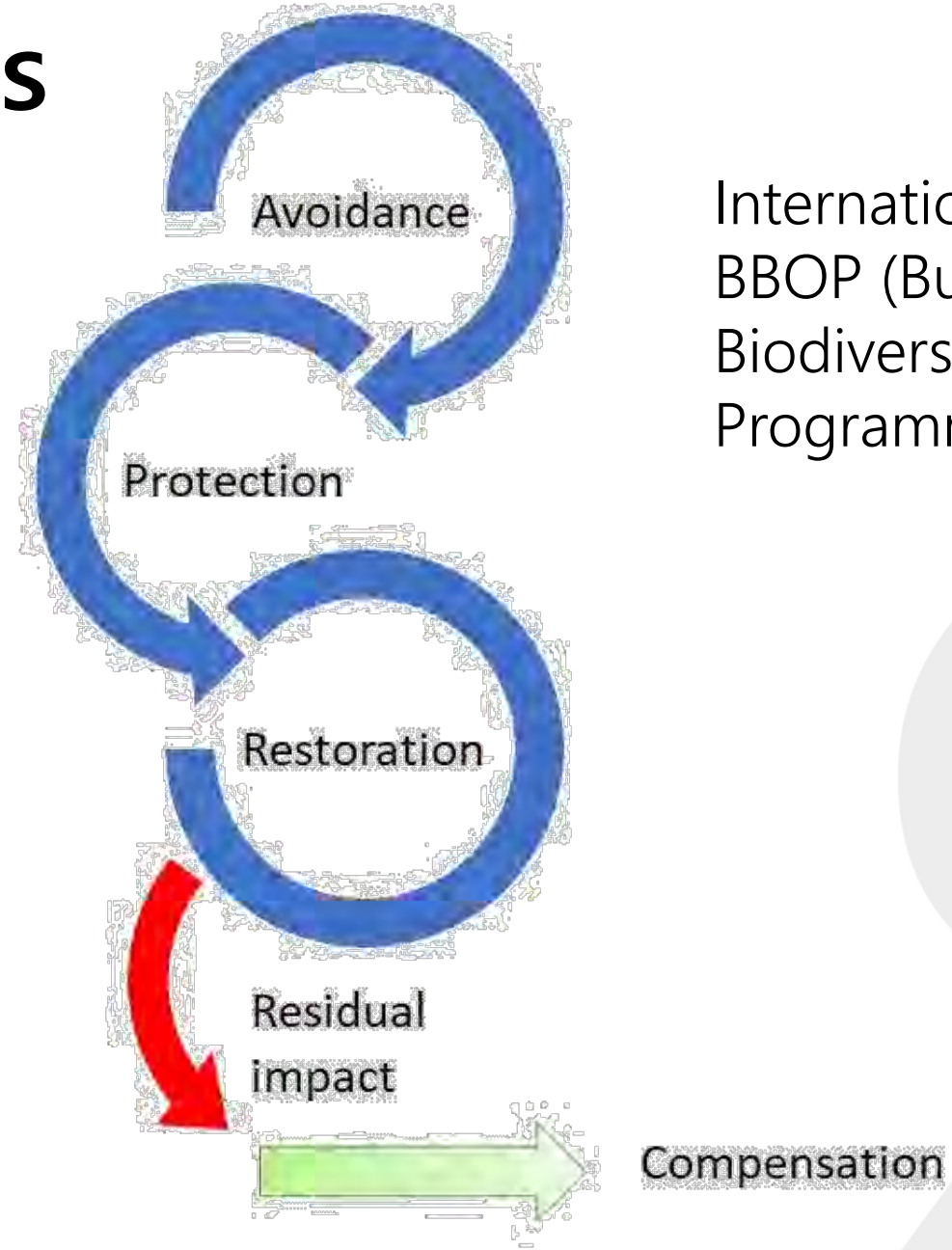
- Weser ruling, European Court of Justice, 2015: ”Member States may not authorize projects which may cause a deterioration of the status of a surface water body unless derogation is granted.
- Renewal/approval of permits?
- Compensation ⟶ win-win for entrepreneurs AND the environment!

Central concepts

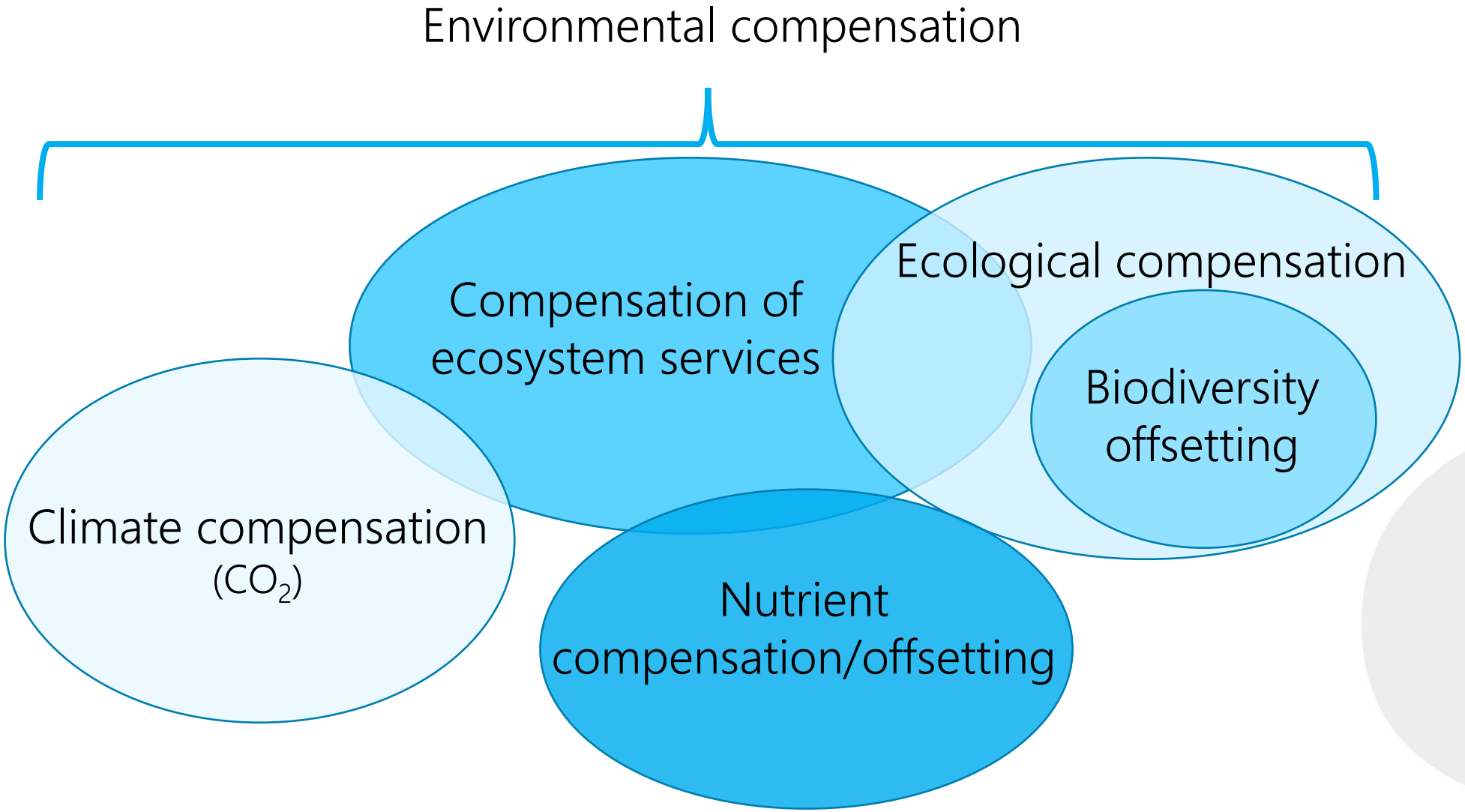
Mitigation hierarchy

Additionality

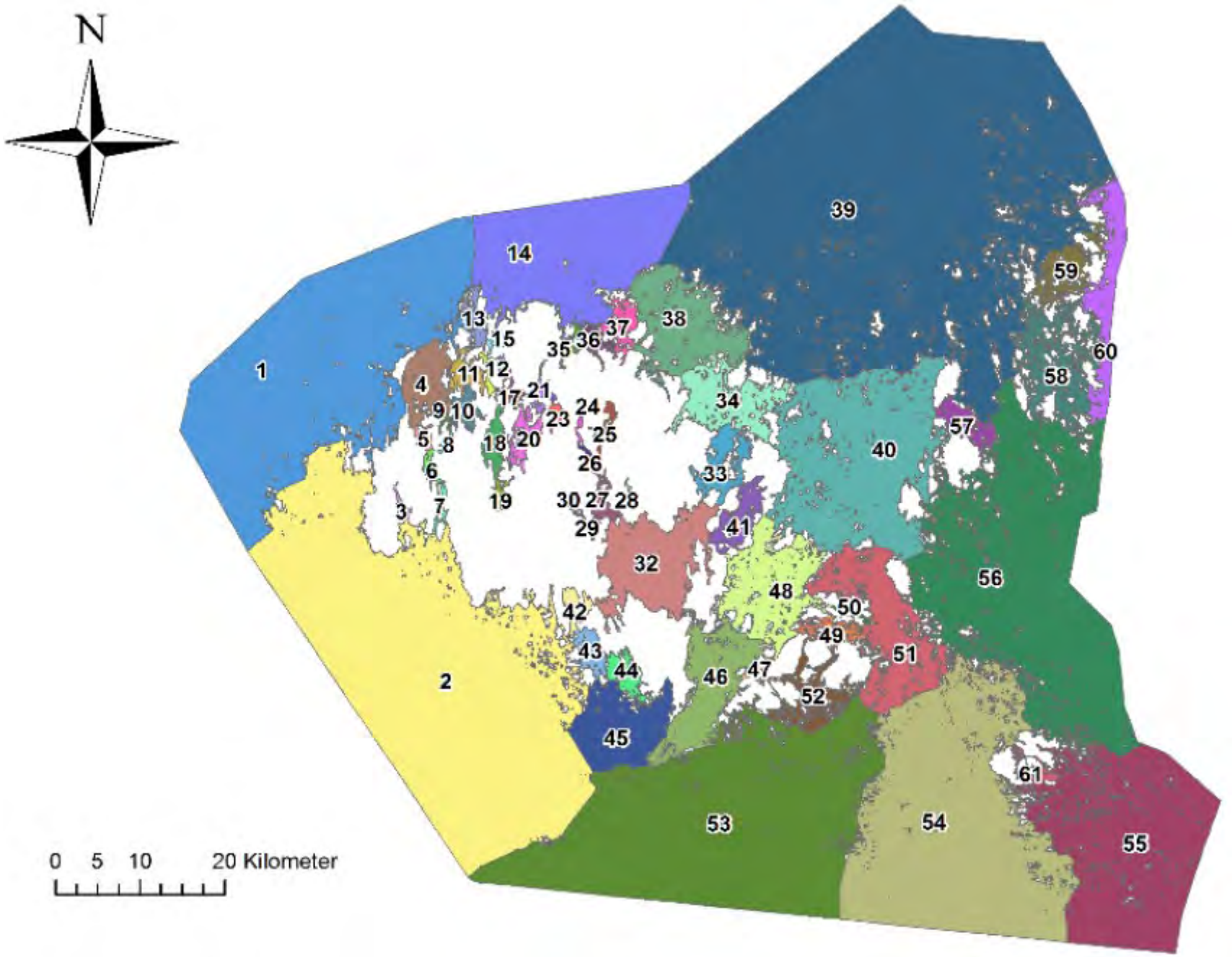
No net loss



International cooperation
BBOP (Business and Biodiversity Offsets Programme)

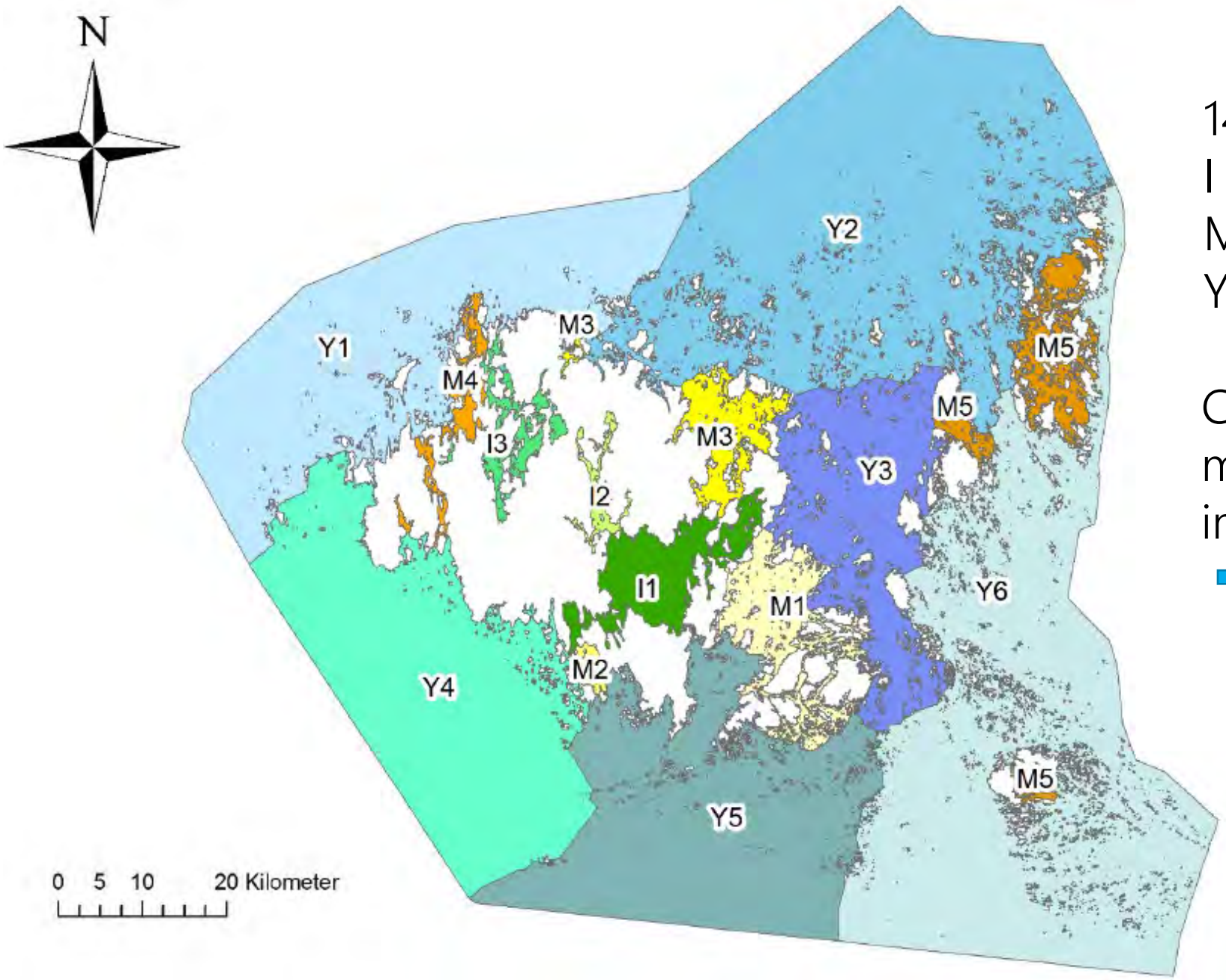


- Ecological compensation is possible, but how can it be incorporated into legislation?
- Need for supervision and demonstration of effects
- Nutrient compensation; models for nutrient reduction



Compensation should be done where the negative impact has occurred.

61 water bodies



14 monitoring areas
I = inner archipelago
M = middle archipelago
Y = outer archipelago

Compensation outside the monitoring area where the impact has occurred.

→ heavier burden of proof

Compensation concept

- Consultant team: SYKE and Swedish Ministry of the Environment
- Goal: Concept of aquatic compensation with focus on nutrients within an ecological context
- Legal, ecological and financial/administrative aspects
- Compensation measures

Compensation report

Legal aspects:

- What does EU law say about compensation?
  - Water Framework Directive (WFD)
  - Marine Strategy Framework Directive(MSFD)
  - Implement necessary measures to reach environmental objectives

- Comparison between countries. Several possibilities for compensation, no one has implemented a complete system.

- Few examples from aquatic systems

Ecological aspects:

- Adequate measures on temporal and spatial scale
- Effect of different measures on the ecosystem
- Capacity for nutrient removal
- Potential risks

Financial/administrative aspects:

- Voluntary/mandatory compensation
- Public or private sector, or a combination
- For a market-based system (seller-buyer of compensation); need for demand. Increased demand if compensation is mandatory
- Public sector crucial to define laws, rules and frameworks

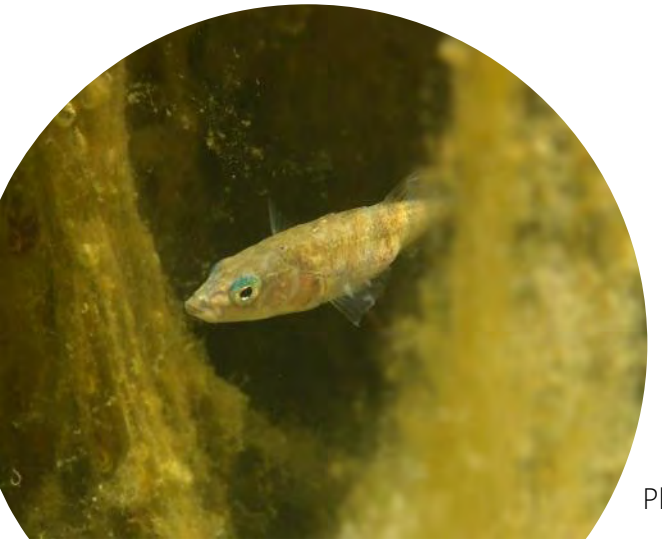


Photo: Ulf Bergström

Compensation measures

- Removal of biomass:
  - Macroalgae
  - Mussels
  - Harvest of common reed
  - Fish
- Irrigation with nutrient-rich brackish water
- Removal of nutrient-rich sediments
- Permanent bindning of P i sediments
- Land-based measures within catchment area

Next steps…

1. Start with EU law
2. Keep legislation simple
3. Clear definitions
4. Step-by-step approach
5. Tools for permit processes (price for nutrient emissions, verified methods, legal decrees)
6. Experiences from other countries
7. Social acceptance (public/private sector, stakeholders, general public)
8. Models for nutrient loading
9. Combination of land- and sea-based measures
10. New projects – bridge between theory and practice.

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Nutrient compensation for aquatic coastal environment

— legal, ecological and economic aspects in developing an offsetting concept

Kirsi Kostamo, Sara Kymenvaara, Minna Pekkonen, Antti Belinskij

Photo: Mats Westerbom, Metsähallitus

SYKE

Ålands landskapsregering

Compensation report

- https://www.regeringen.ax/miljo-natur/vatten-skargard/pagaende-projekt
- https://seabasedmeasures.eu/aquatic-compensation/

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landskapsregering

Contact:

Annica Brink, Project Coordinator
Government of Åland
annica.brink@regeringen.ax

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Expert comment on aquatic compensations

Lena Bergström, Associate Professor, Swedish University of Agricultural Sciences

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Aquatic compensations

- some comments on concepts and complications

Lena Bergström
Swedish University of Agricultural Sciences

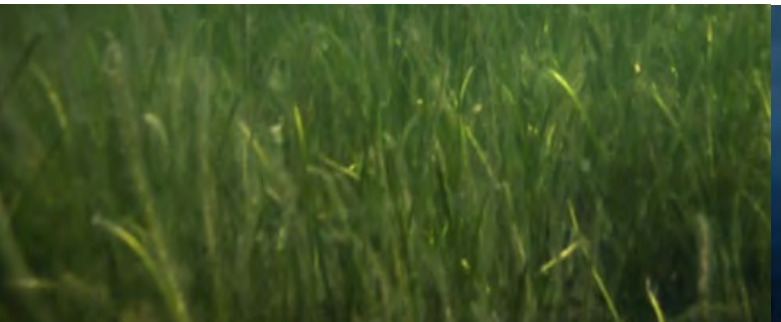
International SEABASED webinar 26.1.2021

MILJÖ | NATURVÅRDSVERKET FORSKNING

The ECOCOA project (2018-2021) aims to explore **environmental compensation** as a management tool to halt losses to biodiversity and ecosystem services in coastal areas.

Lead by SLU Aqua, together with researchers from Anthesis Enveco, KTH, EnviroEconomics Sweden,

University of Gothenburg, Stockholm University



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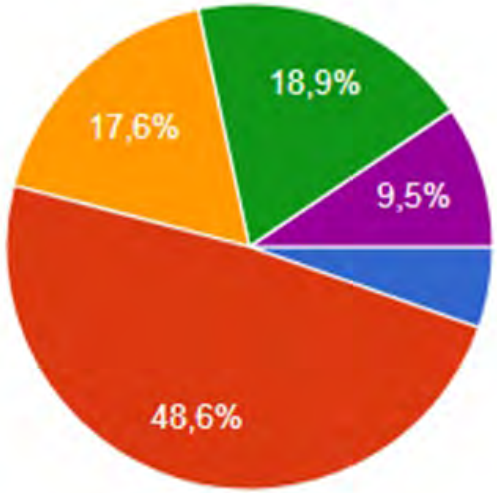
Environmental compensation is the focus a of a Swedish national research investment during 2018-2021

Seven projects

- MuniComp - on municipality perspectives. Ingemar Jönsson, Kristianstad University
- Effects on the environment and economy. Jonas Nordström, Lund University
- Systematizing ecological knowledge to optimize ecological compensation. Lina Widenfalk, SLU
- When can ecological compensation preserve biodiversity and ecosystem services? Erik Öckinger, SLU
- ECOCOA – on coastal areas. Lena Bergström, SLU
- ECOPAL- on compensation pools in the agricultural landscape. Katarina Elofsson, SLU
- Ethical aspects to compensation. Karin Edvardsson Björnberg, KTH Royal Insitute of Technology

Co-funded by the Swedish Environmental Protection Agency and the Swedish Agency for Water and Marine Management

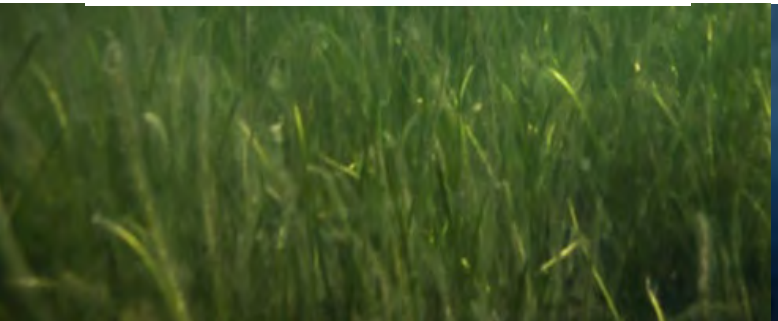
A growing interest in compensation as a management tool - but many questions to address

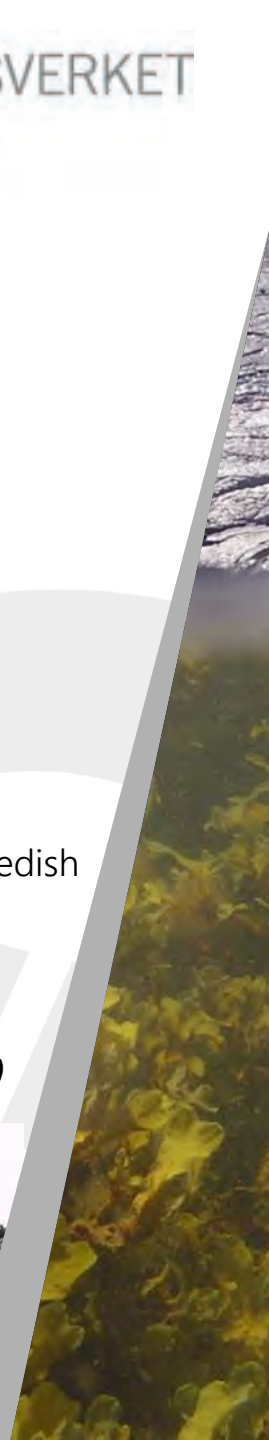


- I have only a vague understanding what it is
- I know what it is but have not worked with it
- Have attempted/ planning to use
- This is part of my regular work
- Not applicable to my situation

Based on 75 respondents representing experts on coastal management at Swedish regional and national agencies (76 %), universities (9 %), NGOs (8 %) and consultancies (7 %) in 2018

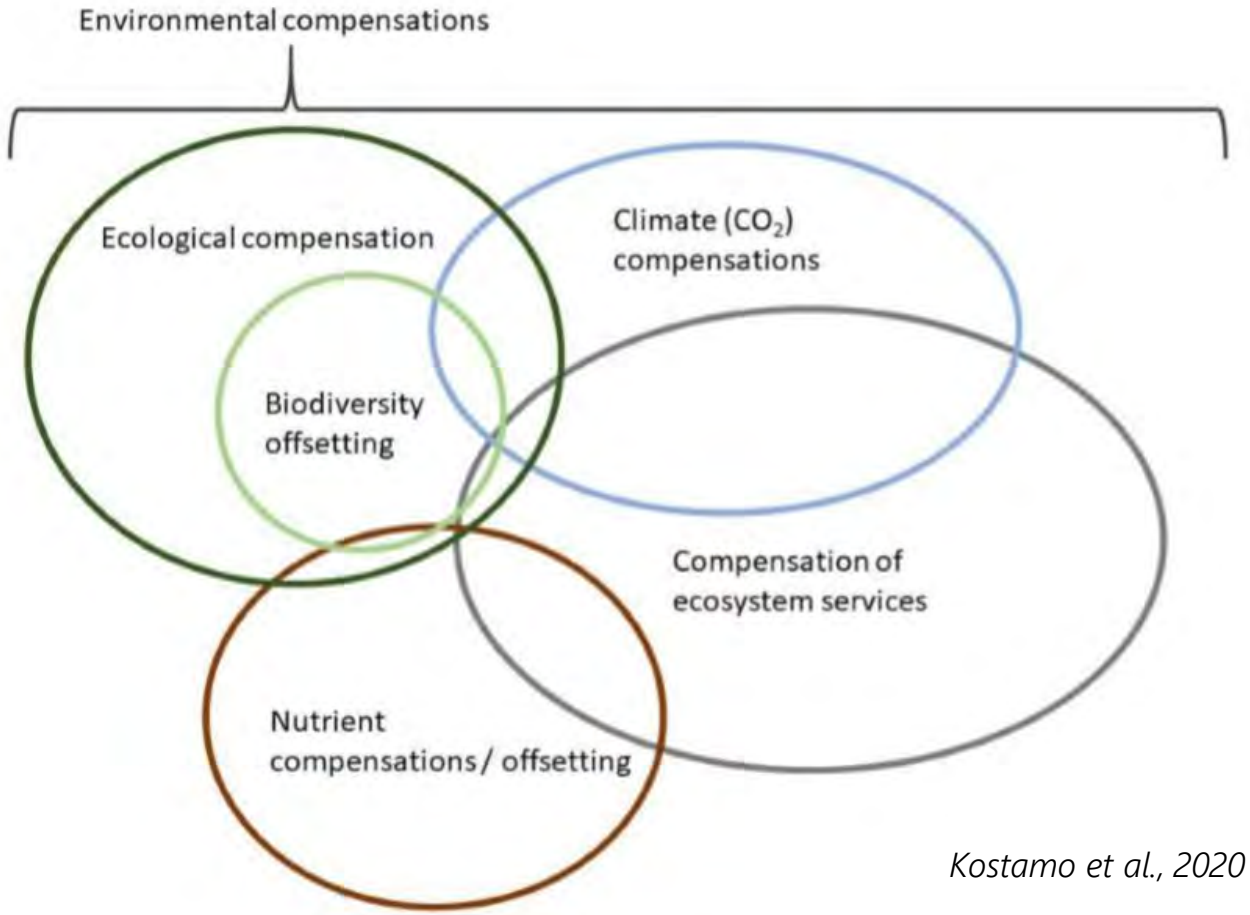
Bergström et al. 2021 (in manus)





Many types of compensation concepts exist

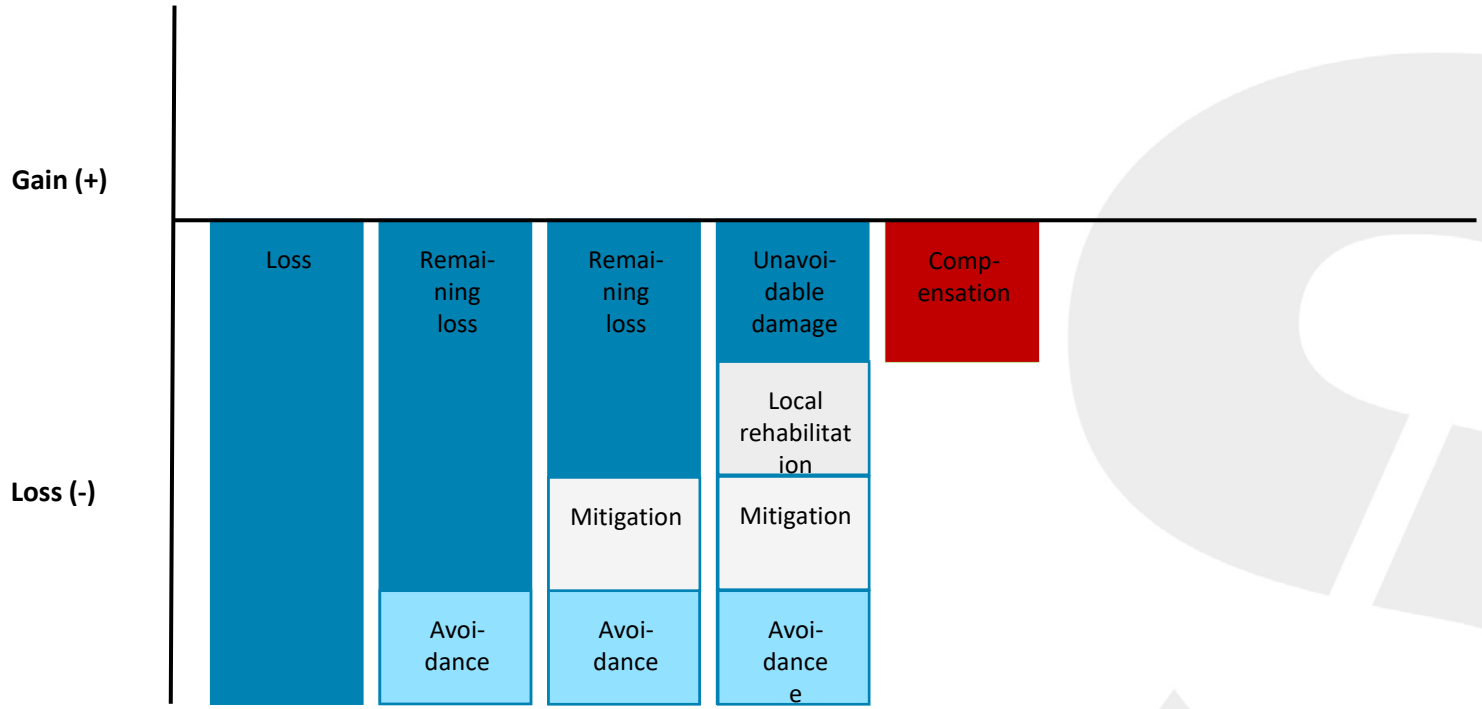
- Do we need different tools in all these cases
- Do the different types of compensation complement each other - or just add complexity?



Kostamo et al., 2020

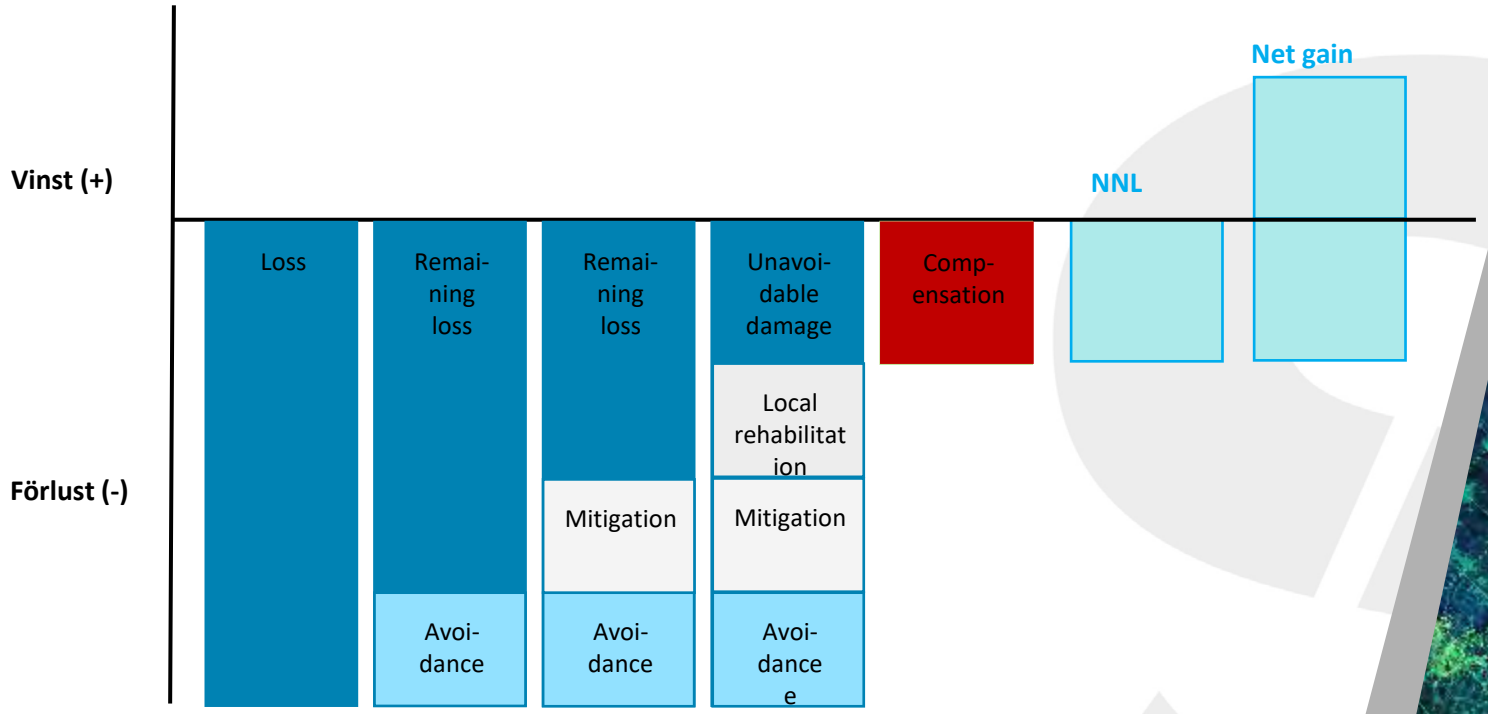
The importance of the mitigation hierachy

- How to ensure that the mitigation hierarchy is followed?
- Application of the mitigation hierarchy varies between different situtations
- How to define ”unavoidable damage”



Ensuring Not Net Loss, or (preferably) net gain

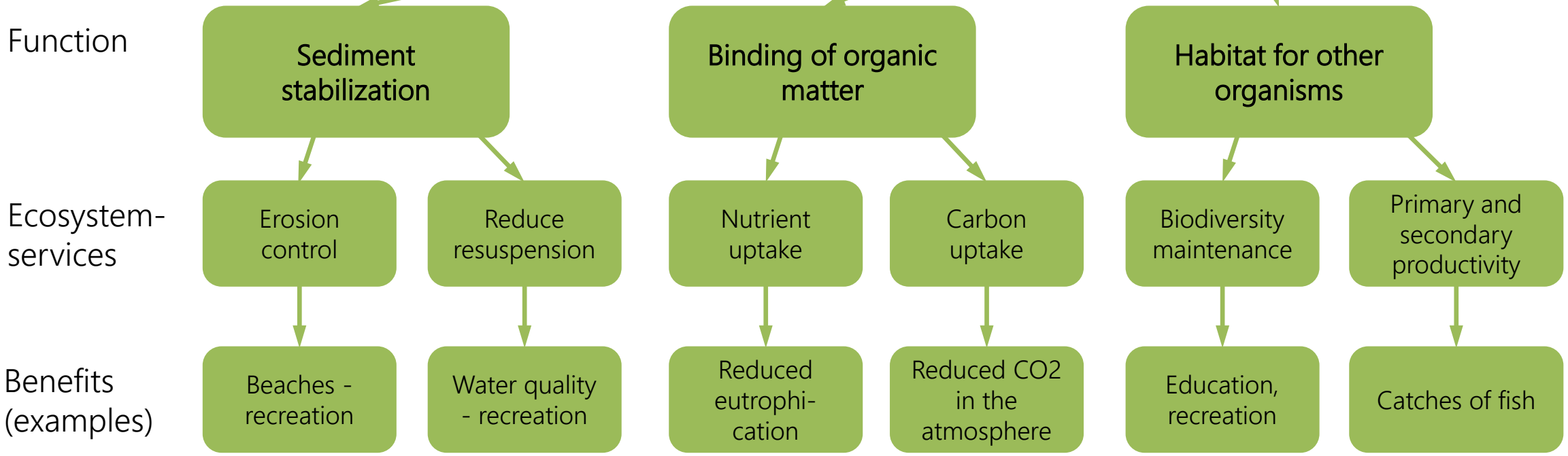
- What aspects are damaged, over what scale and what time perspective?
- What measures are available to apply?
- Follow-up is important



Polluter pays principle

How to distinguish between compensation on the one side, and restoration measures which would have been needed anyway on the other side?

It is particularly interesting to identify measures that could meet multple objectives



Bergström et al. 2021

Thank you

Lena Bergström
SLU, Department of Aquatic Reosources
lena.bergstrom@slu.se

CREDITS: Scott Cole, Linus Hasselström, Tore Söderqvist, Patrik Kraufvelin, Ulf Bergström, Per-Olav Moksnes, Göran Sundblad, Sofia Wikström

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Questions and open discussion on sea-based measures

Please write your question in the chat

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Financier's views on environmental projects

Samu Numminen, Project Manager, Central Baltic Programme 2014-2020

Next steps and closure of the event

Marjukka Porvari, Director of the Clean Baltic Sea Projects, John Nurminen Foundation

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Thank you for attending the webinar!

Find contact details and more information on the project:

www.seabasedmeasures.eu