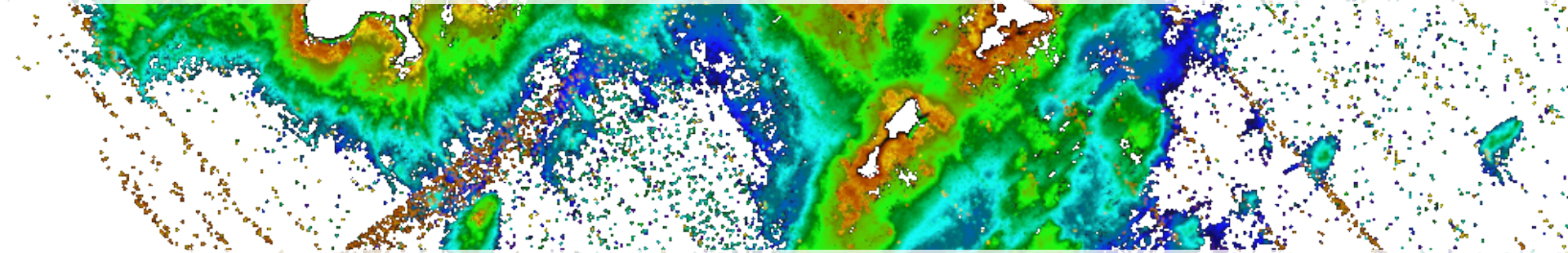
Possibilities of LIDAR in the shallow waters of the Baltic Sea and it´s application for habitat modeling



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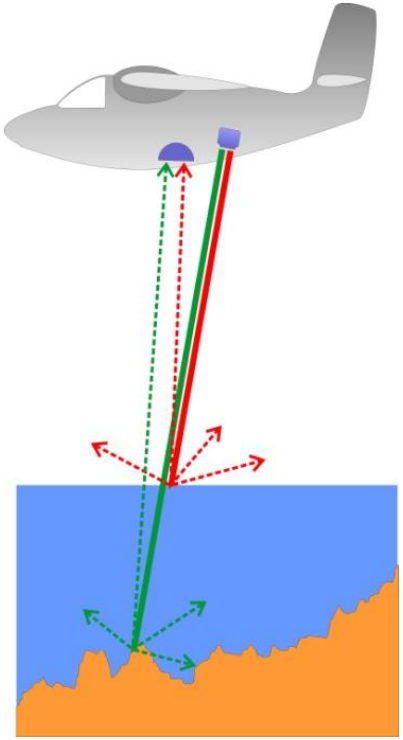
SYKE

BACKGROUND

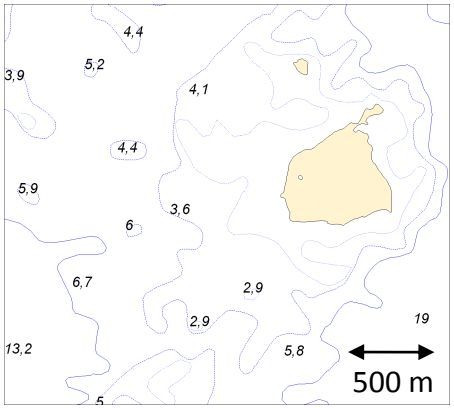
- LIDAR (Light Detection and Ranging) is an active remote sensing method, based on ”shooting” a laser pulse and measuring how long it takes for the reflection to return.

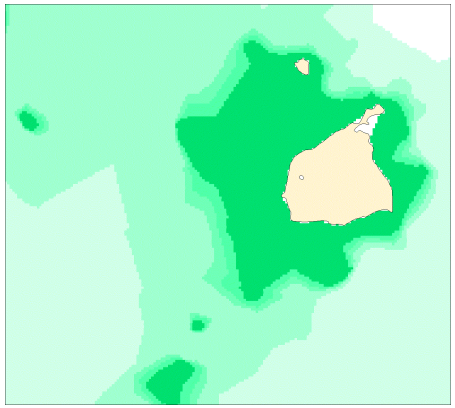


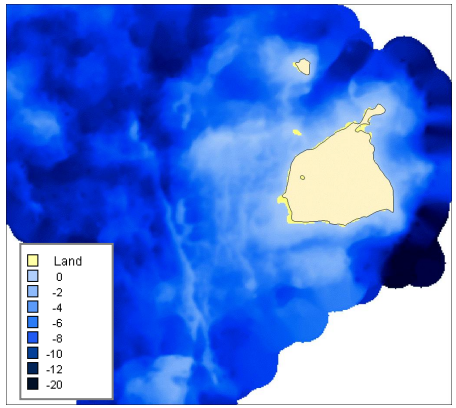
- Marine LIDAR systems use two different lasers, one red (terrestrial Lidar) and one green (cyan). The red pulse does not penetrate water but is used to calibrate a more exact depth (depth = the difference between the surface and the seafloor).
- Airborne LIDAR is a very fast data acquirement method, but has traditionally been used to generate depth information only
- We have been testing the extraction of additional seafloor information from LIDAR returns (substrate and vegetation)

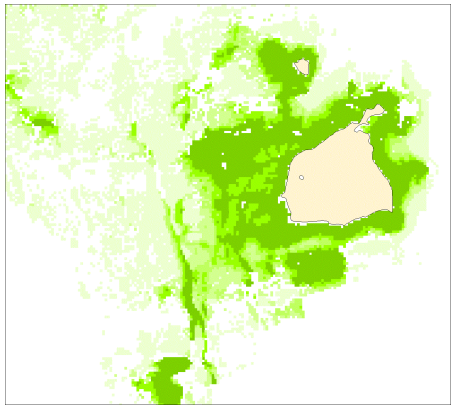
LIDAR BATHYMETRY

- Good bathymetry is, in itself, an important data set in seafloor inventories and is used for outlining seafloor structures and as a central base data set for seafloor habitat modeling.
- With a horisontal resolution of 2 x 2 meters and a depth resolution of +/- 10 cm combined with a data acquirement rate of 20 km^2 per hour airborne LIDAR makes for very efficient charting tool.
- The main drawback (in the Baltic) is that depth penetration is heavily dependent on water turbidity (2,5 – 3 x Secchi depth).



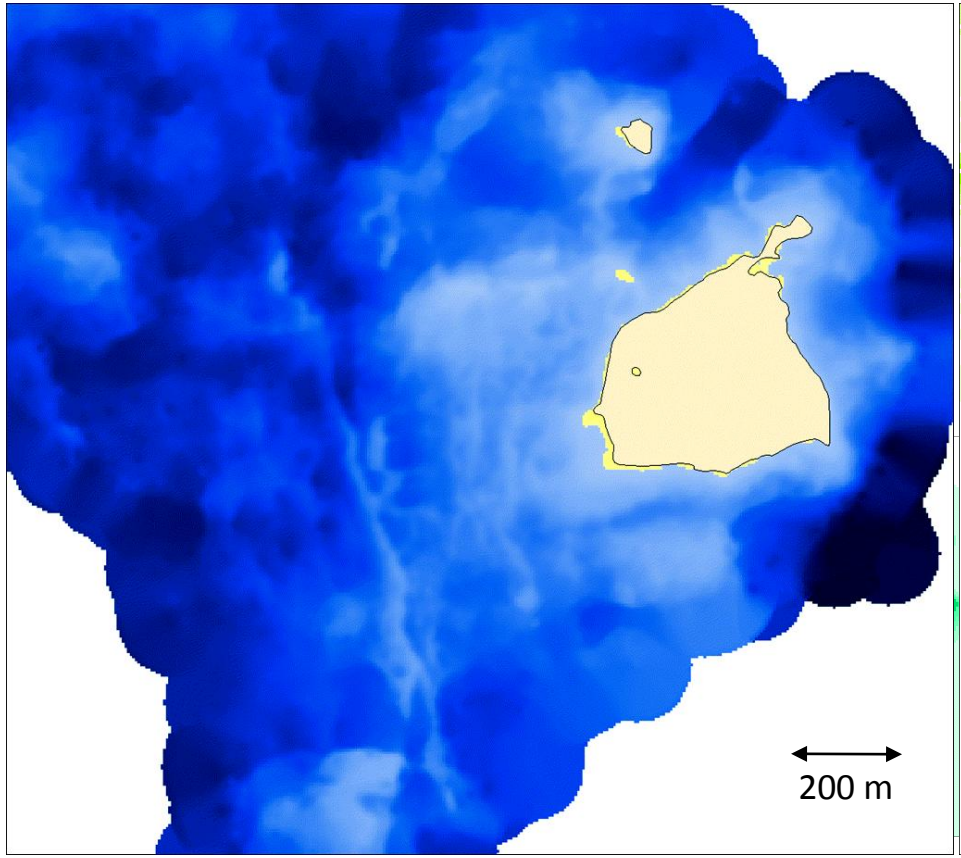


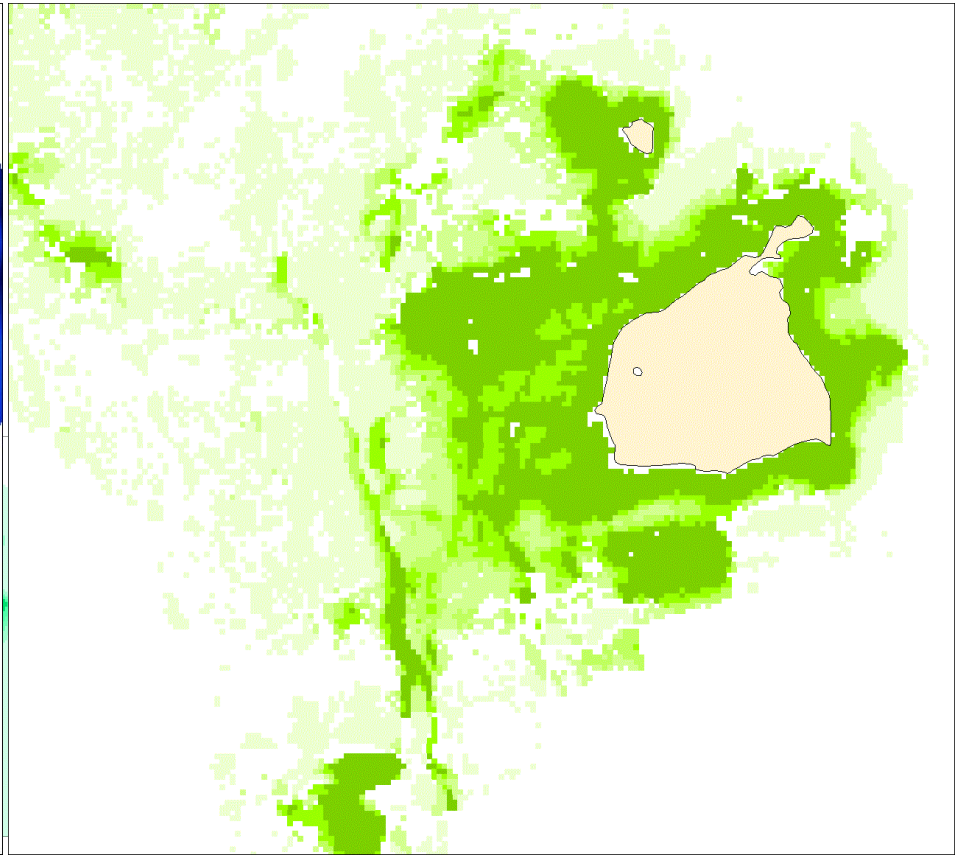




EFFECTS ON MODELING

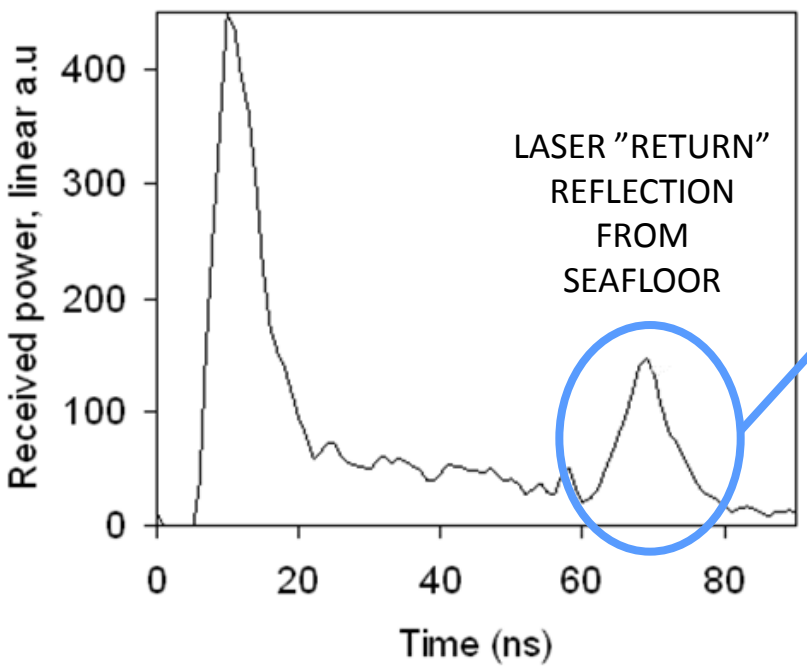
- When modeling underwater habitats in the Baltic good bathymetric data is essential, since the effect of light attenuation is quite large due to water turbidity (vegetation occasionally goes down to 20 meters, but usually peters out at around 10 meters).

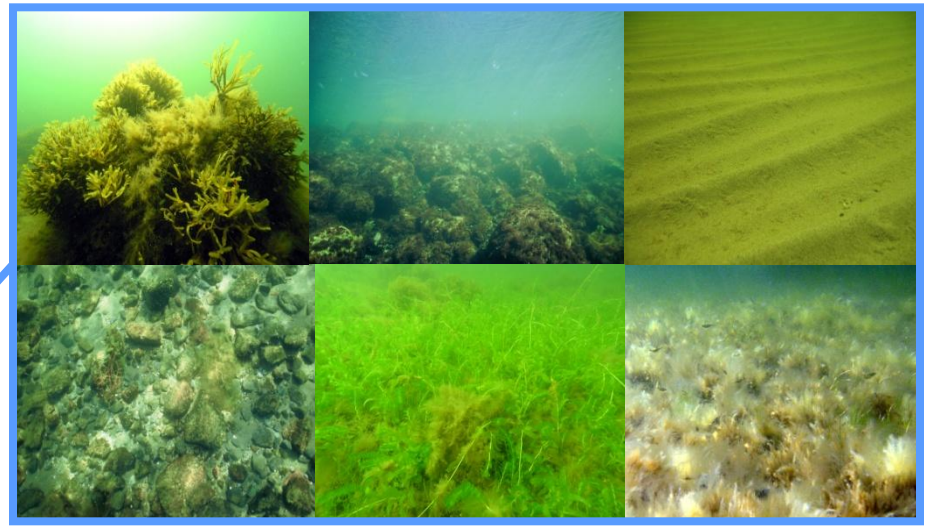




MINING ECOLOGICAL DATA

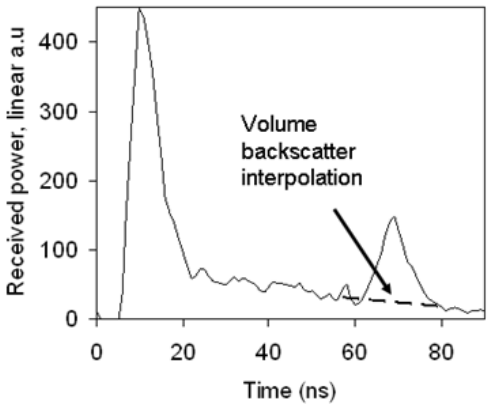
- The seafloor substrate and vegetation generates interference in the reflection of the laser pulse, which traditionally has been seen as a problem (when trying to measure only depth).
- We have ”simply” used the geological and biological information contained in this ”disturbance” (the effects on the shape of the LIDAR return curve) to classify habitat groups on the seafloor.

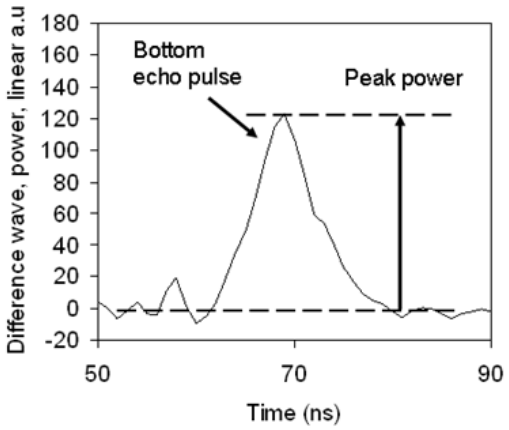


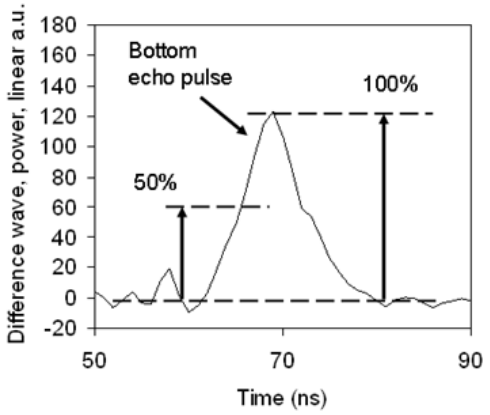


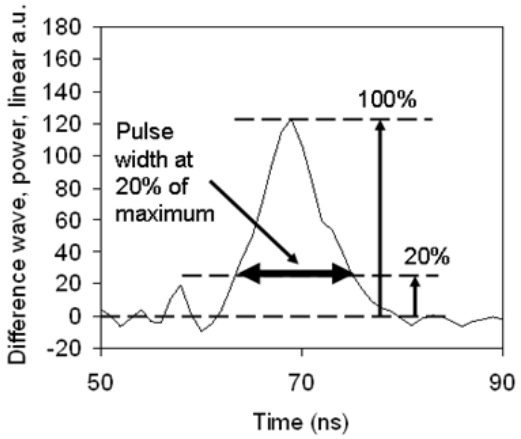
ANALYSIS OF LIDAR RETURNS

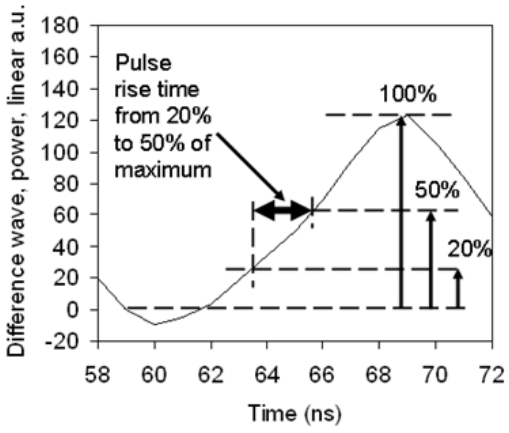
- The LIDAR ”bottom return”, the amount of light reflected from the seafloor over time, holds more information than is apparent at first glance. More than 30 different variables were tested, incl. corrections by residuals, normalization and ratio corrections.

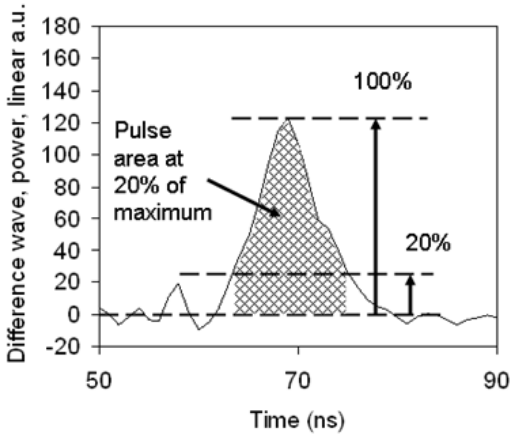








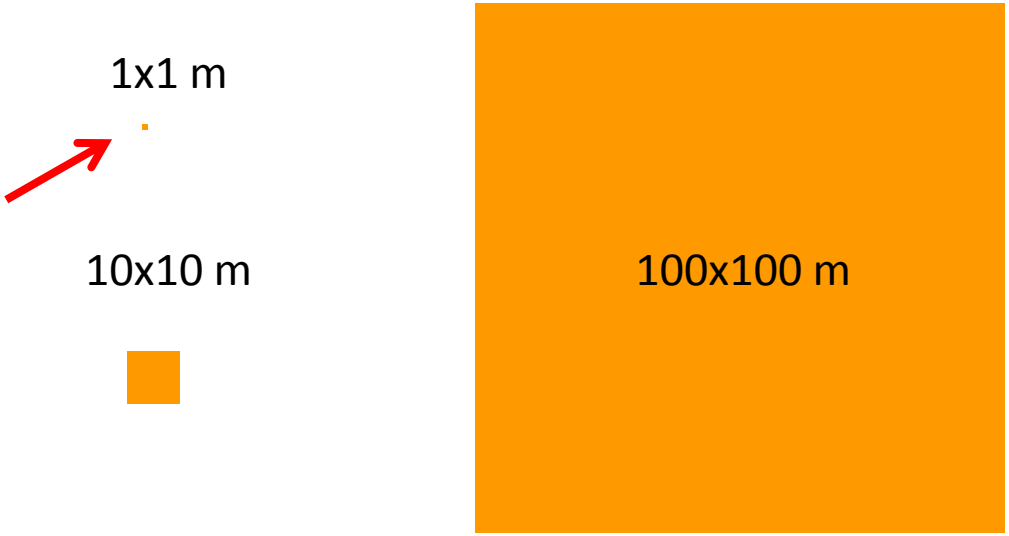


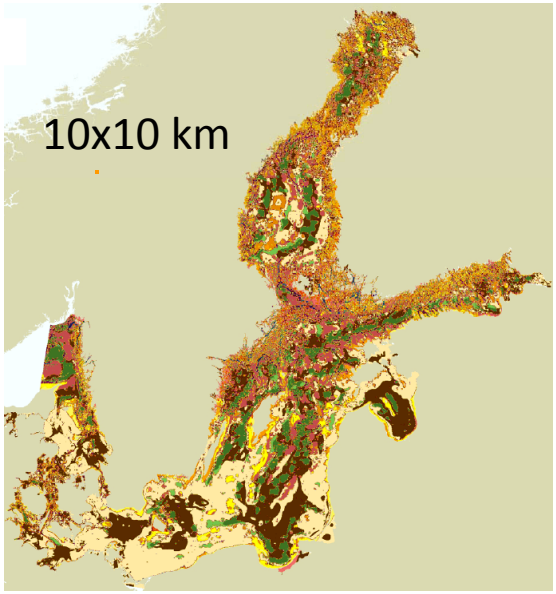


SPATIAL SCALES AND MSP

- One of the VELMU Program's main goals is to develop and standardize a set of practical, science-based and economically effective MSP tools for three different spatial scales: national, regional and local land use planning.

- But scaling is tricky business, and developing and using different methods for usa at all needed scales is very expensive.





IMPLEMENTING THE MSFD

- VELMU also has a central role in the national implementation of the Marine Strategy Framework Directive (MSFD):

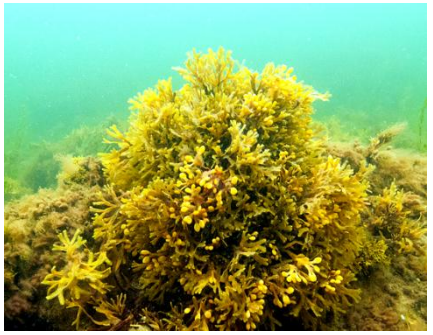
Biological diversity is maintained. **The quality and occurrence of habitats and the distribution and abundance of species** are in line with prevailing physiographic, geographic and climatic conditions.

All elements of the marine **food webs**, to the extent that they are known, **occur at normal abundance and diversity**...

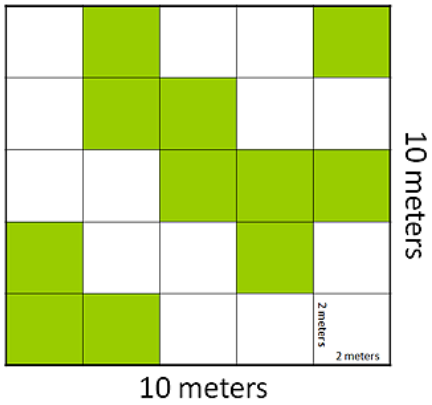
Human-induced eutrophication is minimised, especially adverse effects thereof, such as **losses in biodiversity, ecosystem degradation**, harmful algae blooms and oxygen deficiency in bottom waters.

MAPPING BLADDERWRACK

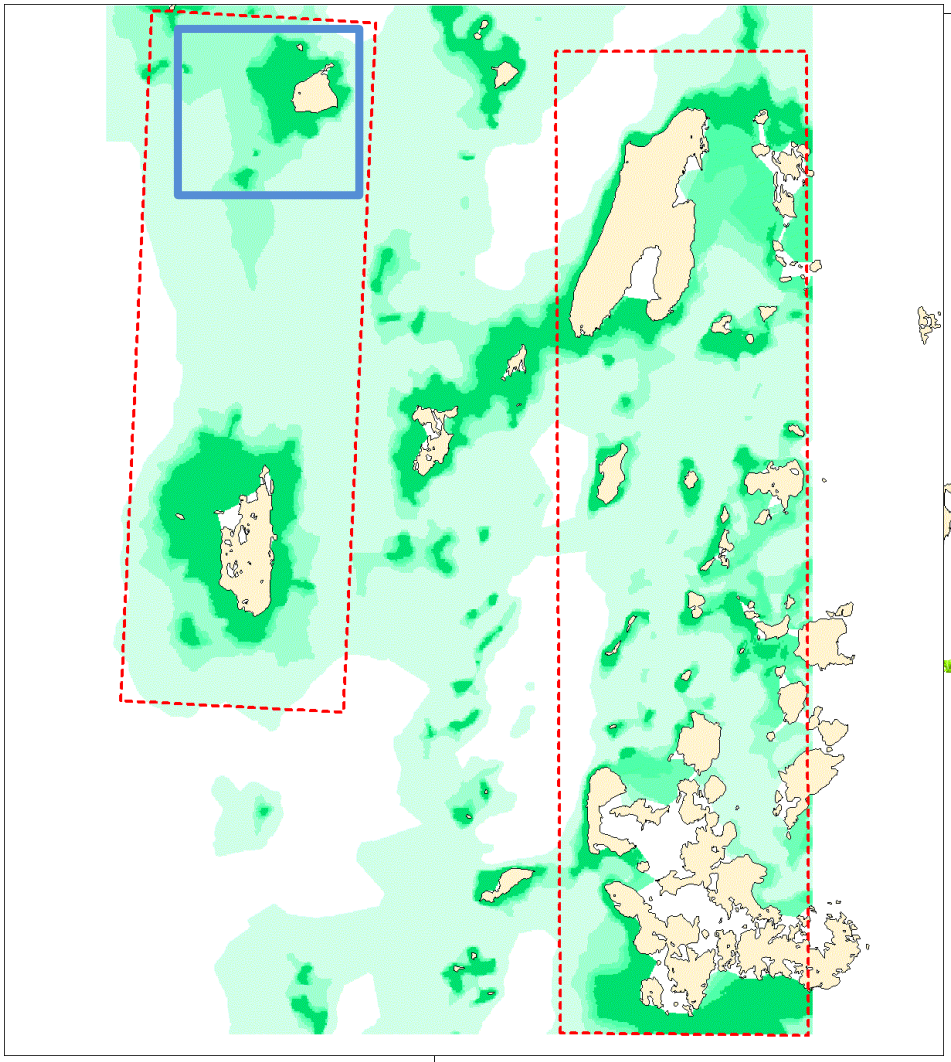
- Bladderwrack (*Fucus vesiculosus, F. radicans*) is a key habitat-forming species in the Baltic. It is both directly and indirectly affected by water quality and is widely used as an ecological indicator.

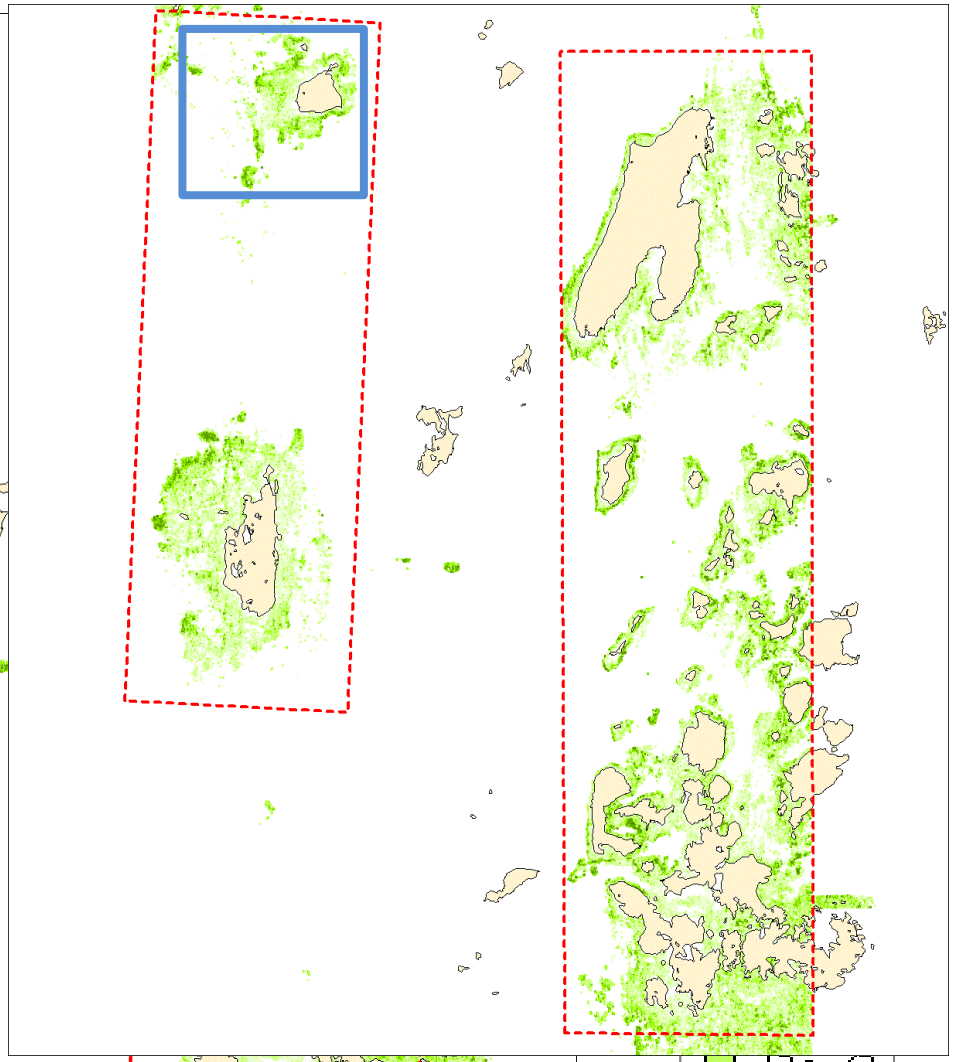


- Multivariate analysis aggregated several ecological variables (mainly vegetation and bottom substrate composition) into a ”superclass” that could be described as ”dense bladderwrack on hard bottom”.
- Extensive field testing of this class showed a correlation between the LIDAR results and and ground-truthing data in excess of 80% (which is considered quite good).
- For mapping purposes the 2x2 meter LIDAR patches were aggregated into 10x10 meter grid cells, and the amount of bladderwrack patches present as the ”measurement”.



BLADDERWRACK RESULTS 1

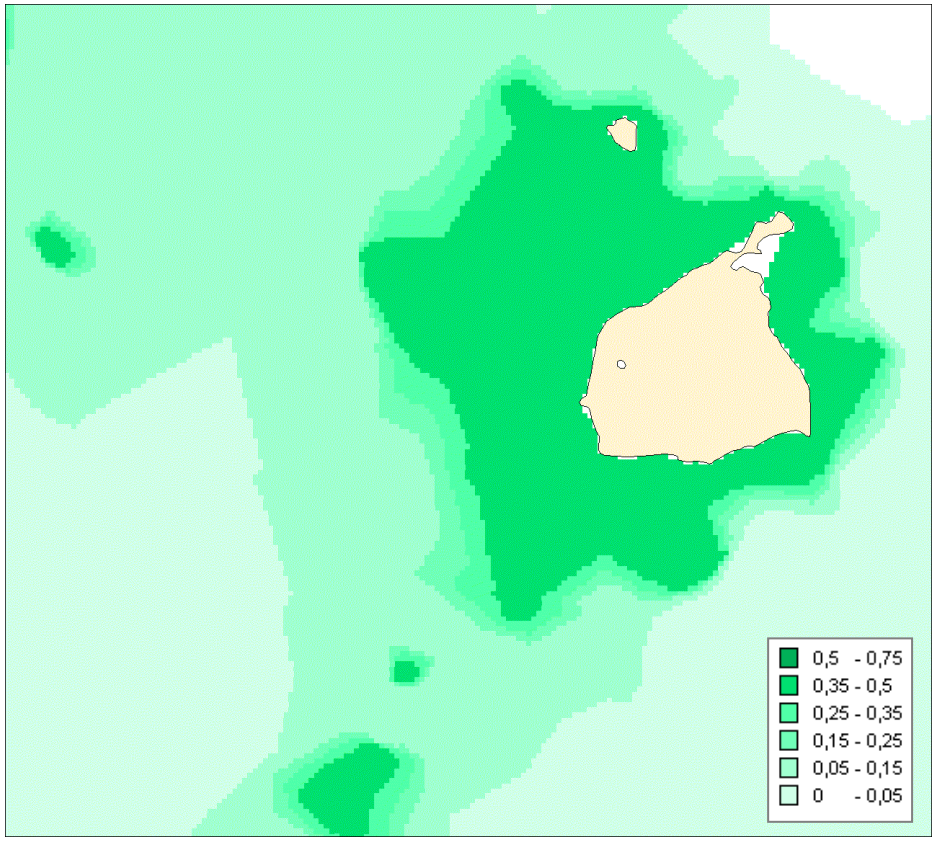


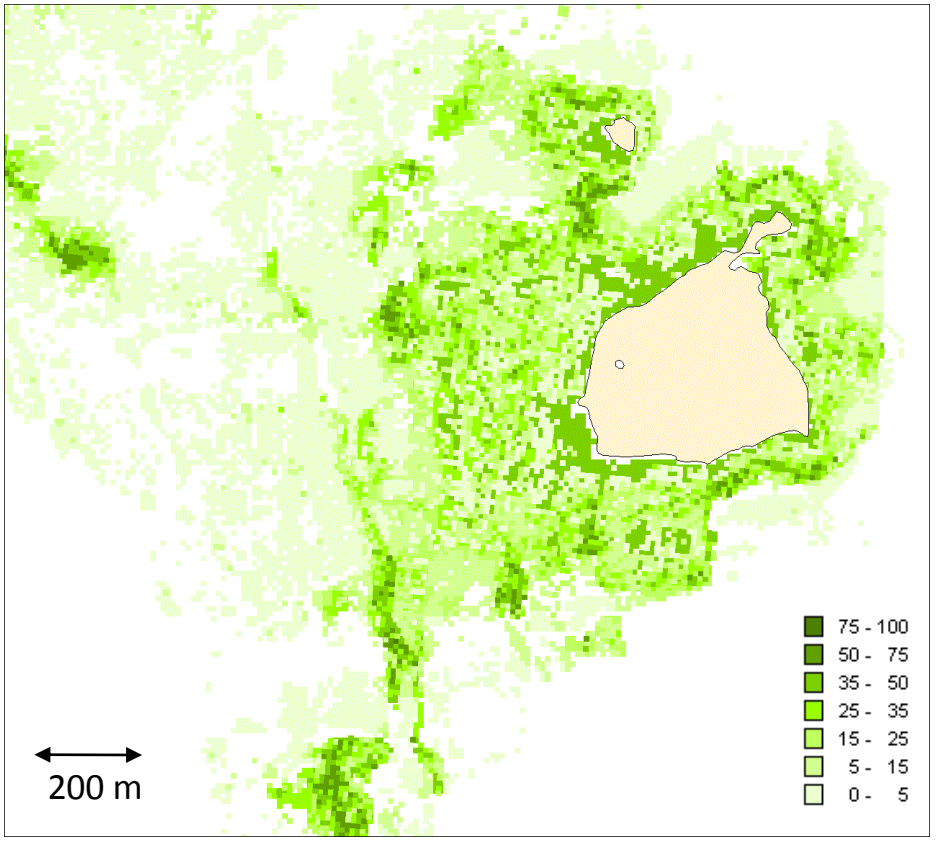


Modeled using best available methods and standard bathymetry.

Measured from LIDAR returns with a reliability of around 80%.

BLADDERWRACK RESULTS 2



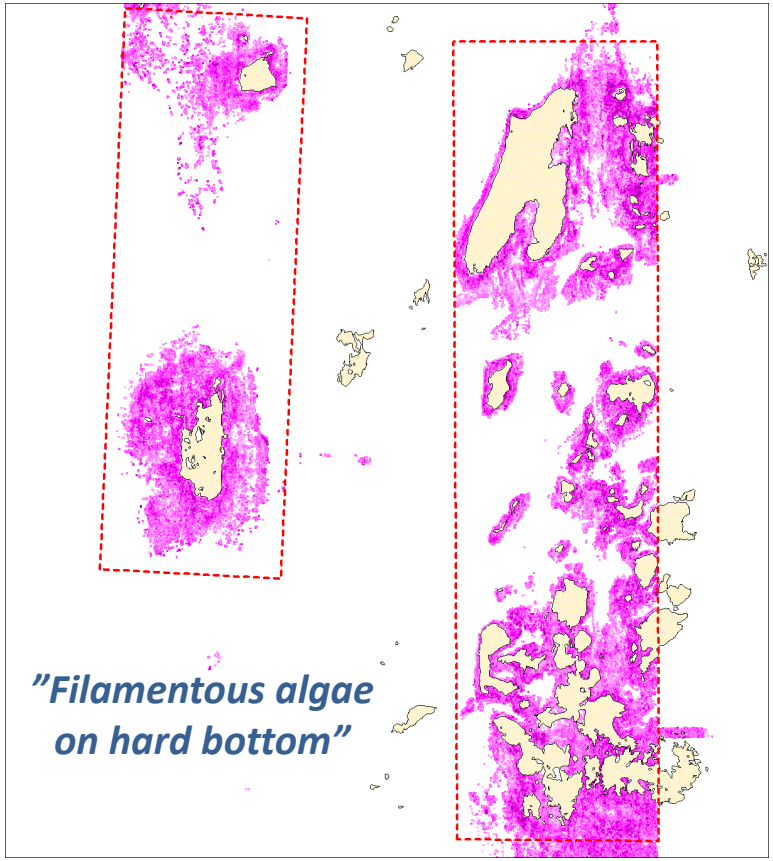


Modeled using best available methods and standard bathymetry. Good for initial prediction of occurrence, moderately reliable for estimating population (a good model combined with enough real data), unusable for monitoring. Very cost-effective.

Measured directly from LIDAR returns. Produces real occurences (25 measurements in every 10x10 meter grid cell, with an 4/5 reliability. Excellent for estimating population size, usable for monitoring. Expensive, needs initial “local” ground-truthing.

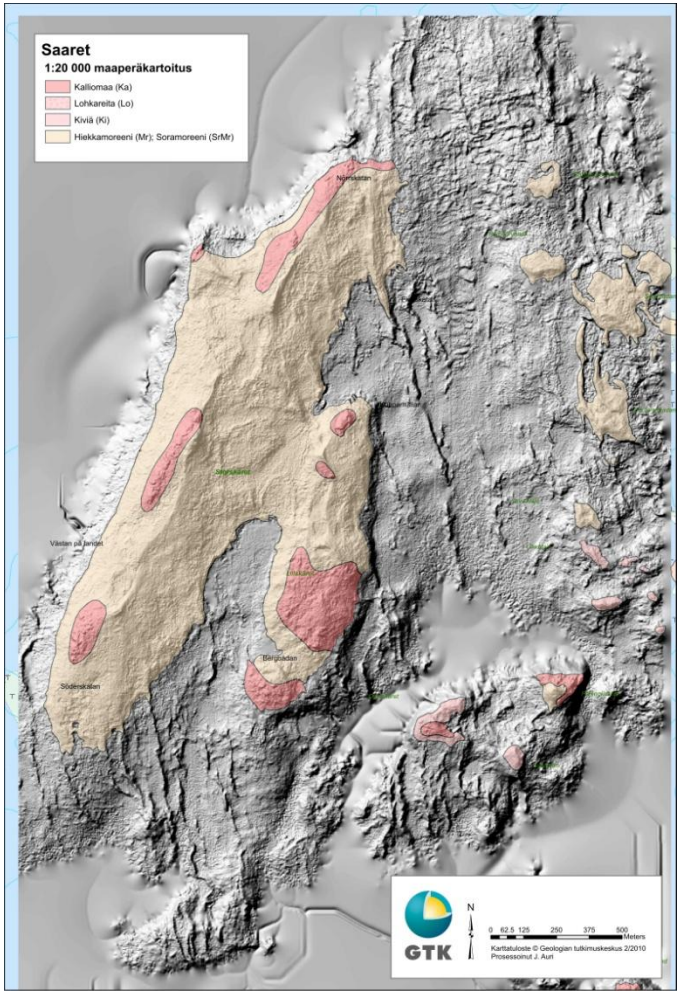
OTHER ”SUPERCLASSES”

- The results indicate that if enough good quality ground-truthing data is available current marine LIDAR data can be used to reliably ”split” LIDAR seafloor returns into 3-5 classes (with a correlation reliability between 80-95%).



THE SUPERB PROJECT

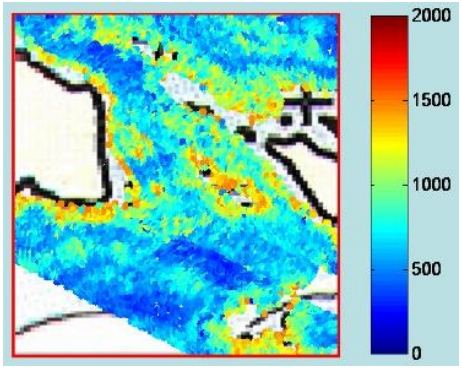
- The evaluation of marine LIDAR as a MSP toolis a joint Finnish-Swedish project, financed by the EU (Interreg IVA) and the Ministry of the Environment. The project will finish in late 2013.
- There are several actors involved, either testing the use of either LIDAR bathymetry as such or evaluating the habitat data. New technical tools are also being developed to improve effectiveness of ground-truthing data collection.
- The method is currently being tested in two additional areas, and the work on a feasibility study has just started.



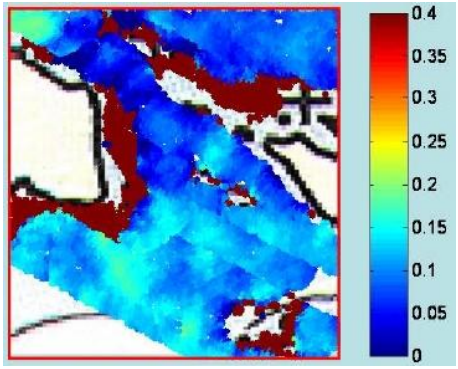
Bottom structure map (De Geer moraine ridges) produced by GTK from the Rönnskären archipelago.

REALLY NEW STUFF…

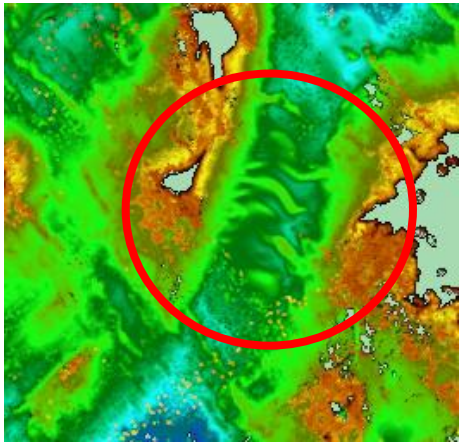
- Using LIDAR reflectance variables as a grouping level = delineate ”habitats” by clumping vegetation patches and other areas with congruent reflectance together.



- Improving the classification of habitats by determining water turbidity straight from the LIDAR data. The turbidity values can the be used as correction variables.



- Automatically delineating and estimating the size of the two ”main” marine N2000 habitats in Finnish and Swedish waters (”Reefs” and ”Sandbanks”). Even if only partly successful the impact would be huge…



ECOLOGICAL INVENTORIES IN SHALLOW WATERS CAN BE CHALLENGING …

THANKS!