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A system for the sustainable management of Lithuanian marine resources using novel surveillance, modeling tools and an ecosystem approach

Catching the moment: data collection, modeling and mapping of herring spawning grounds at the exposed coast

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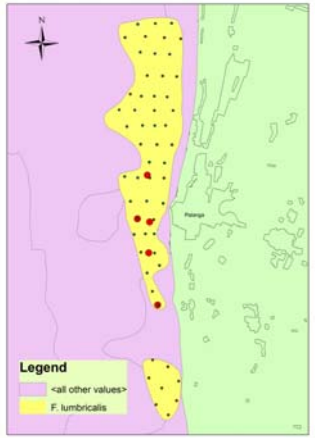
Introduction

- The Baltic herring (*Clupea harrengus membras)* spawns in a wide range of environments, and breading strategy of different populations differs a lot
- The aim of this study was to map herring spawning grounds in the Lithuanian coastal waters
- Previously no detailed herring spawning grounds mapping was performed in this area, and background information was very limited

Background information

- Herring could spawn on variety of aquatic plants. In conditions of very exposed Lithuanian coast, the spawning can not take place at too shallow areas (depth <2m), therefore it was assumed (based on literature) that the best spawning substrate is the red algae *Furcelaria lumbricalis.*
- A habitat distribution map of *F. lumbricalis* was available (but not very precise and detailed)
- In earlier SCUBA diving surveys herring eggs were found occasionally on *F. lumbricalis* at five locations
- In this study for the first field season 54 sampling points were distributed evenly along potentially suitable spawning area



The challenge

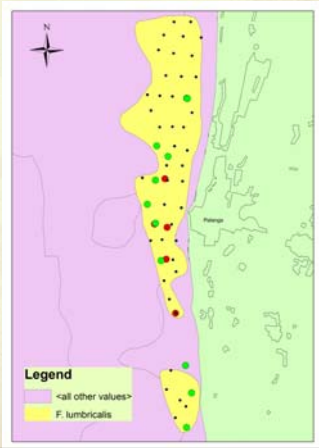
- The spawning period is relatively short: eggs remain on the benthic substrate for 3-5 weeks
- There is no clear indication that the spawning has started
- Herring eggs are hardly detectable by any remote methods: they are semi-transparent and less than 2 mm in diameter
- Only SCUBA
- During the spawning period (April-May): water T = 6-8 °C
- Low visibility, any kind of weather and sea conditions (wind, rain, waves, strong currents, etc.)
- So… catch the moment!

How we did it?

Of course we did!

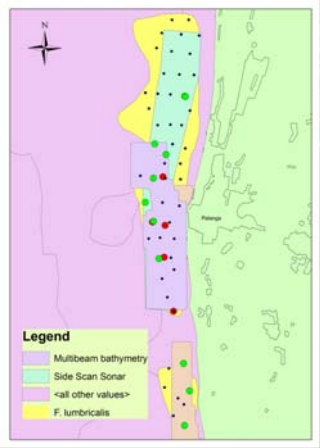
2009 field season

- 54 sampling sites, herring eggs found at 11 sites within 4 to 10 m
- Eggs found on *Furcellaria* at 9 sites, where its coverage varied from 5 to 60 %
- At two sites the eggs were found at different substrates: red filamentous algae *Polisyphonia* and bare boulders
- From 29 sites with *F. lumbricalos* cover >5%, only on 9 (31 %) herring eggs were percent



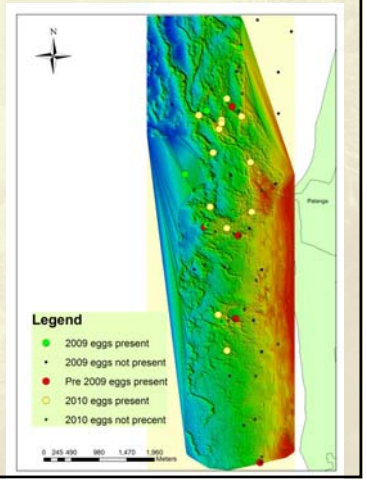
2009 season, afterwards

- So, the 2009 survey showed that distribution of the spawning grounds can not be explained only by presence of *Furcellaria*
- A detailed multibeam bathymetry and Side Scan Sonar sediment map became available for the part of the study area after the 2009 season
- Data review allowed to formulate a new hypothesis: the distribution of the spawning ground is shaped rather by geomorfological features than by the presence of *Furcellaria*



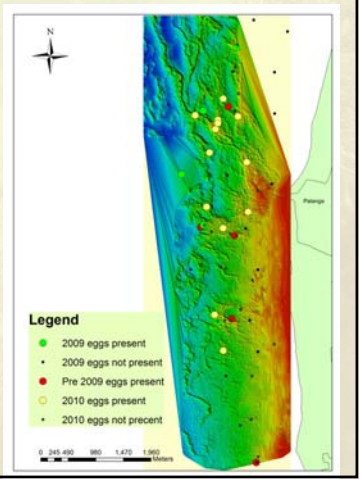
2010 field season

- 41 sites sampled, herring eggs found at 13:
  11 sites with *Furcellaria*,
  2 sites with *Polysiphonia*
  within the depth interval from 4 to 7 meters

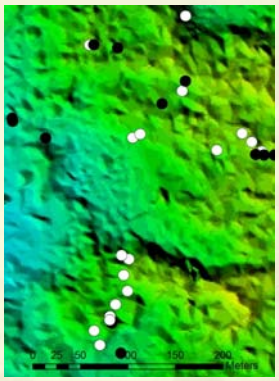


SCUBA diving data used for modeling

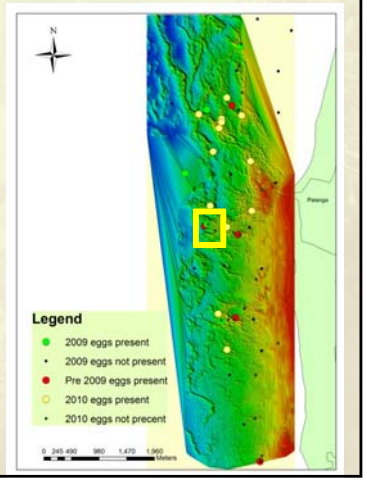
- In total 100 points: 95 sampling sites (2009-2010 field seasons) + info from 5 earlier occasional findings of herrings eggs
- The herring eggs were found in 29 locations, but…



…did we find them all?



White dots: eggs present
Black dots: eggs not present



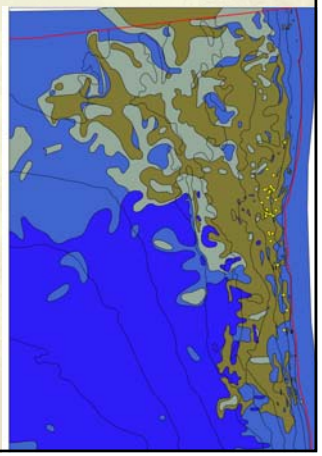
Model of choice – Bayesian Probability Maximum Entropy

- Because detected "absences" may be false, presence/absence based models could gave biased results
- The MAXENT software, based on Bayesian Probability Maximum Entropy was used for modeling
- In Bayesian probability, the principle of maximum entropy is a postulate which states that the probability distribution which best represents the current state of knowledge is the one with largest entropy

Predictor layers at the scale of the entire coast

- Bathymetry (from isobaths)
- Substrate (rough map)
- East&Northness (from aspect)
- Curvature
- Terrain roughness index 150x150 m (<->rugosity)
- SWM (Isaeus, 2004)
- SWM bathymetry corrected

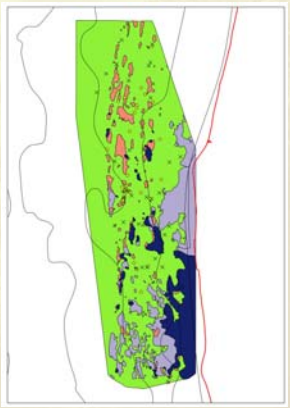
All in 50 x 50 m grid

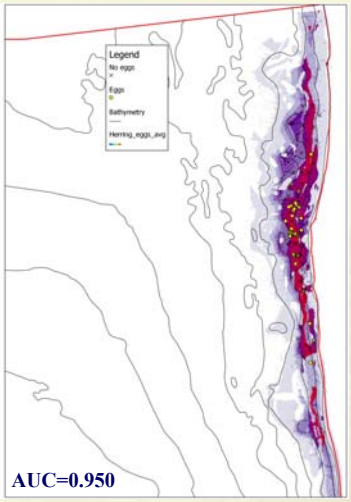


Predictor layers at the finer scale (”multibeam area”)

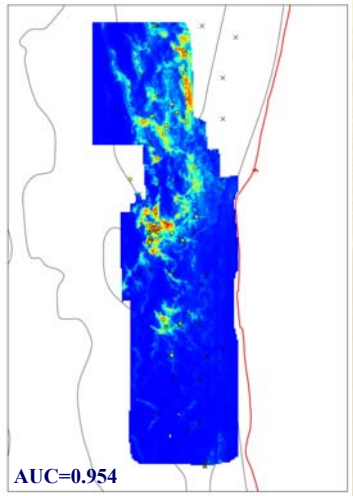
- Bathymetry (from multibeam)
- Substrate (classified from Side Scan & the rough map)
- Eastness, Northness (aspect)
- Compass direction (N/E/S/W from aspect)
- Slope
- Curvature
- Terrain roughness index (3 scales)
- Rugosity
- Protection index (2 scales)
- SWM, bathymetry corrected

25 x 25 m grid





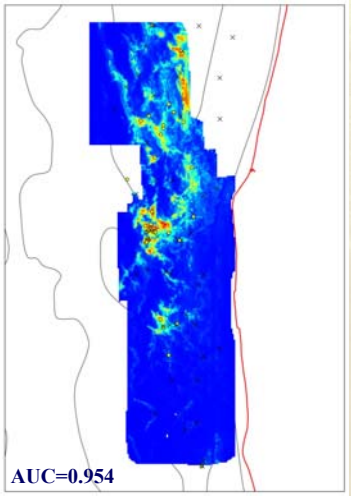
AUC=0.950



AUC=0.954

Summary

- Except sediments, predictive layers used for modeling, were generated from bathymetry
- Generated predictive maps are in good agreement with field data, models were stable, with high training AUC
- Herring spawning grounds distribution in Lithuanian coastal waters is shaped rather by physical factors (such as local geomorphological features) than by biological



AUC=0.954

AKNOWLEDGEMENT

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