Mapping of fish production habitats in the Baltic Sea to support management

Management strategies to conserve marine resources
Seminar

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Background

• Productive fisheries strongly linked to ecological state of essential habitats
• Essential fish habitats = usually fish reproduction areas
• Most Baltic species reproduce in shallow coastal habitats
• Coastal habitats under severe pressure from shoreline construction, eutrophication etc.
• Coastal habitats in high need of protection

• Fish habitat maps needed for efficient protection and spatial planning → Finnish national **VELMU programme 2004-2015**
Study area: Finnish coast

• 46 000 km of shoreline, area 30 100 km²
• Both marine and freshwater species, low species richness
• Coastal areas: extensive archipelago
• Large spatial & temporal environmental gradients
What we have achieved in VELMU?

1. Developed and tested new survey and mapping methods
   - Field sampling (almost 10,000 sampling sites, several methods, >20 species)
   - Use of GIS and remote sensing
   - Species distribution modeling

2. Produced distribution maps of key reproduction habitats of coastal fish
   - Modelled reproduction habitat maps of 9 species
   - Allows visual and numerical comparison of coastal areas
Habitat mapping process

Field surveys (fish + background environmental data)

Predictor variables in GIS form

Occurrence/abundance of larvae linked to environmental predictors by modelling

Probability/intensity map in GIS

Validation of model and map

Final reproduction habitat map
Probability maps

- Method: Logistic regression
- Binary (pres/abs) response variable
- Allows area-based comparison

Veneranta et al. 2011: Turbidity characterizes the reproduction areas of pikeperch (Sander lucioperca (L.)) in the northern Baltic Sea. Estuarine, Coastal and Shelf Science 95: 199-206
Density maps

- Method: Gaussian process (GP)
- Model combines a non-linear predictor with a spatio-temporal random effect
- Continuous (abundance) response variable
- Outcome: Predicted average density of larvae in 50x50 m grid cells in the study area
- Allows numerical comparisons: predicted amount of larvae per area

Kallasvuo, Veneranta, Vanhatalo 2016: Modeling the spatial distribution of larval fish abundance provides essential information for management. Submitted to CJFAS
Interpretation of maps

Cut-off values needed to classify the maps for end-users:

1. *Where larvae exist*
   Predicted area where larvae present within one 50x50 m cell, calculated with >50% confidence

2. *The most productive areas*
   Areas which produced in total 80% of larval production, calculated from the cumulative predicted number of larvae
Easy-to-interpret information in map-form

Allows prioritization of areas with high production potential (abundance) over areas that are suitable for reproduction but do not significantly contribute to the larval production.

Kallasvu, Veneranta, Vanhatalo 2016: Modeling the spatial distribution of larval fish abundance provides essential information for management. Submitted to CJFAS
Typical reproduction areas for coastal fish species

Vegetated shores

Flad bays

River mouths

Coastal bays

Coastal bays
Conclusions

• We mapped most important coastal fish reproduction habitats in the northern Baltic Sea
• Set cut-off values that aid in quantified interpretation and comparison of larval production
• Very limited areas can be crucial for fish production
  – Total area suitable for larval production varied
  – Total area producing 80% of larval production was two to five times more limited than total area
• Variation between species and sea area was large
• Maps available: http://paikkatieto.ymparisto.fi/velmu/
How to use the results?

• Concrete support to spatial planning
  – EU Marine Spatial Planning directive → Important fish habitats noted in MSP
  – Planning of coastal areas → “Kymenlaakso regional plan”
• Concrete support to fisheries and environmental management
  – Planning of local fishing restrictions (no-take areas?) and marine protected areas (MPA)
  – New Finnish Fishing Act (enacted on January 1st 2016) → Management plans for local fisheries units
  – Local dredging permission procedure
• New cost-effective field methods
Whitefish larvae at the Bothnian Bay
Perch larvae at flad bay in Quarken area

© Luke/ Lari Veneranta
Fucus and sticklebacks at Archipelago Sea
Underwater meadow at Western Gulf of Finland
Newly-hatched pikeperch larvae at Archipelago Sea
Pike larvae catching a roach larvae at Western Gulf of Finland
Thank you!