Effects of global change to Finnish coastal ecosystems

Topic description

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General problem area

Climate change and global warming considerably affect also the Baltic Sea and Finnish coastal areas. We already observe some of the predicted effects: decreased snow cover, loss of sea ice, increased sea level, increased eutrophication, longer heat waves, increased level of greenhouse gases. The reasons and past changes of these phenomena are quite well understood. Based on this knowledge and measured data powerful models for climate predictions are built in the Finnish Meteorological Institute. Although this is an active area of research [1,2], there is still a lack of understanding the future changes in species dynamics in these areas. This work is focused on modeling the dynamics of some biological (***fish***?) species on Finnish coastal region. We apply state-of-art spatial statistical models for prediction the effects of climate change on biota (***larvae?***) distribution.
The results from this work (predicted larvae density in measured coastal points) could be useful for example in fishing industry.

Research questions

1. Which are the most important factors affecting the biological dynamics of investigates species?
2. Which one of the investigated models shows the best tradeoff between complexity, uncertainty and prediction power?
3. Pros and cones of the examined models
4. New insights after analyzing the visualizations from different models.
5. Discussion and comparison of different scenario predictions.

Methodologies

This work is provided in close collaboration with Natural Resources Institute (LUKE) and Finnish Meteorological Institute (FMI).

The past data and model predictions for future distribution of environmental covariates are provided from Finnish Meteorological Institute. The provided raster data are for the period 1975 – 2060. The data are in common NetCDF format. We use R script to open and work with them.

The data about biological species will be provided from LUKE.

All statistical models will be simulated and analyzed in STAN and R. We mostly apply hierarchical Bayesian statistical models.
If needed, python language could also be used.

Since the real data are quite massive, we plan to use the computational resources, offered from Helsinki University and CSC (ukko2 or Puhti servers, or visual desctop).

Preliminary plan of the work

1. We start with the simplest model of logistic regression and examine its predictive power first using the small part of the environmental data in table format.
2. Repeat the same analyses using Poisson model.
3. Include the spatial effect into both models.
4. Use real raster netCDF data for environmental covariates.Some of the difficulties in this step are because the spatial resolutions of both kind of data are different or because the covariates are not exactly comparable.
5. In case there is time we can try to increase the complexity of the models involving spatial random effects or more covariates.

Key References

1. Meri Kallasvuo, Jarno Vanhatalo and Lari Veneranta (2017). Modeling the spatial distribution of larval fish abundance provides essential information for management. Canadian Journal of Fisheries and Aquatic Sciences, 74:636-649

2. Lari Veneranta, Richard Hudd and Jarno Vanhatalo (2013). Reproduction areas of sea-spawning Coregonids reflect the environment in shallow coastal waters. Marine Ecology Progress Series, 477:231-250.