Predicting the numbers and location of seabass for sustainable management

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The European seabass (*Dicentrarchus labrax L.*) is a large slow growing and high value fish, that is an important target for both commercial and recreational fishers. There is large interannual variation in recruitment that is largely driven by environmental factors with seabass doing well in warmer years. In the North Sea, Irish Sea and English Channel, the spawning stock biomass (SSB) of bass is declining rapidly and zero catch has been proposed for 2017 by the International Council for the Exploration of the Sea (ICES - http://www.ices.dk), a global organization that develops science and advice to support the sustainable use of the oceans. To conserve the stock, various management measures have been imposed including seasonal closures, monthly limits for commercial fishers, and bag limits for anglers. Spatial individual based models (IBMs) have been developed for seabass that include growth, mortality, spawning, migration, settlement and exploitation (recreational & commercial), and these are being used to assess the impact of different management strategies.

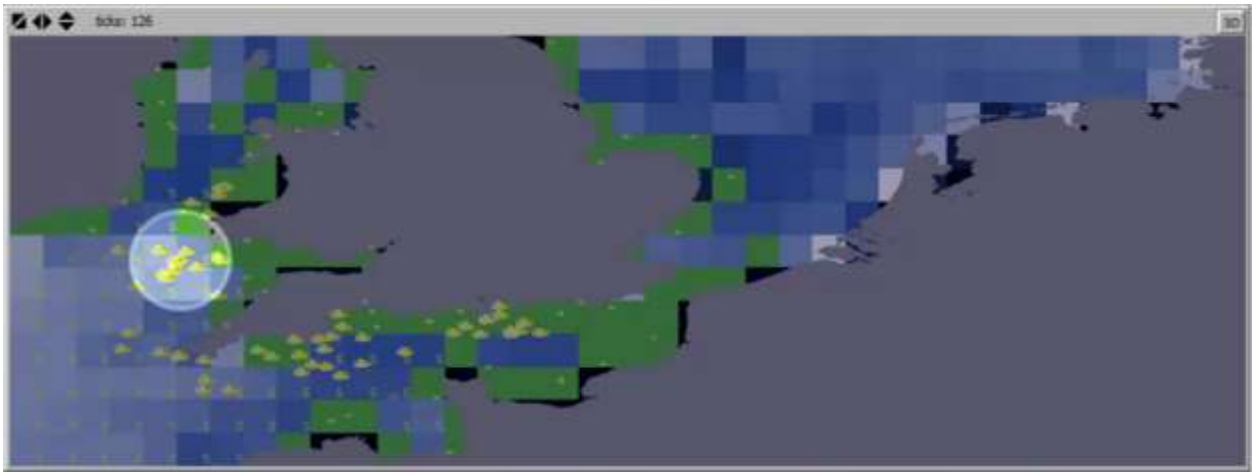

Figure 1. Output of early version of the IBM model for June 2014. Yellow symbols represent location of fish of various sizes. Sea 'blueness' represents sea temperature measured by satellite around the coast of Britain.

Further work is needed to optimise the structure and calibration of the IBMs and to add in a new submodel representing the behaviour of both recreational and commercial fishers. Both of these represent significant challenges. IBMs are quite complex computer-based models that represent the location and state of all the individuals in the population in a spatially-explicit map of their environment. They synthesise all available information and are evaluated on their ability to match population data; in our case the data are in the form of fish surveys and records of the catches of fishers

collected by ICES and Cefas (part of the UK government - https://www.cefas.co.uk/). Successful IBMs tread a delicate line between simplicity and complexity, and their calibration and evaluation are challenging. However, much progress is being made using a new technique, Approximate Bayesian Computation (ABC), which calibrates models and compares how well different possible models fit the available data. By careful use of ABC model structure can be optimised.

You will:

- Obtain relevant satellite data to construct maps of sea surface temperature in the sea areas for the years for which seabass survey and landing data are available
- Construct a new Fisher behaviour IBM for both commercial and recreational fishermen based on examples from other fisheries and link it to the biological model to investigate how the fishing decisions of fishers respond to management measures and to local availability of seabass
- Use long-term seabass survey and landings data and records of the fishing schedules of fishers to optimise the structure of the models using Approximate Bayesian Computation
- Use the models to explore the impact of different management strategies and provide outputs that can be used to support the management of seabass at a European level.

The impact of management measures on both biological sustainability and social dimension will be investigated and the potential tradeoffs assessed. Finally, results from the models will be used to inform decision-making through contributions to the relevant ICES working groups and UK advisory process. Development of these models represent significant scientific challenges, but have the potential to provide insight into the impact of management and improve the conservation of seabass.

Training opportunities: This project offers the opportunity to learn modern techniques of remote sensing and practical ecological modelling and to deploy them to help the management of fish stocks. Model development and evaluation will use Approximate Bayesian Computation (ABC), a technique partly developed at Reading http://www.sciencedirect.com/science/article/pii/S0304380015003750. You will attend in-house training courses on Python and ABC. There will be opportunities to travel and spend time at Cefas. Whilst at Cefas, you will develop a broad knowledge of marine policy and fisheries assessment, and see at first-hand how science is used to underpin decision-making. This will also include experience of the fisheries assessment process through contributions to ICES.

Student profile: We encourage applications from all relevant disciplines. We will provide training in ecology and computer programming as needed.

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http://www.reading.ac.uk/nercdtp