How are northeast Atlantic mackerel (*Scomber scombrus*) population dynamics impacted by food availability?

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Introduction

The ontogeny and life history of pelagic fishes are impacted by the amount of food available to them. Still, existing models are limited in their ability to account for the effects of spatial and temporal variation in food availability. Therefore, a spatially explicit, Individual-Based model is under construction, into which remotely-sensed chlorophyll-a data is inputted and updated frequently. Plankton biomass is then calculated and affords food for all life stages. Larger individuals can feed via piscivory, also, should they spatially co-occur with potential prey. Thus, an individual's success depends upon its local resources. Owing to the incorporation of migrations, population dynamics then emerge in a spatially realistic fashion.

Aim

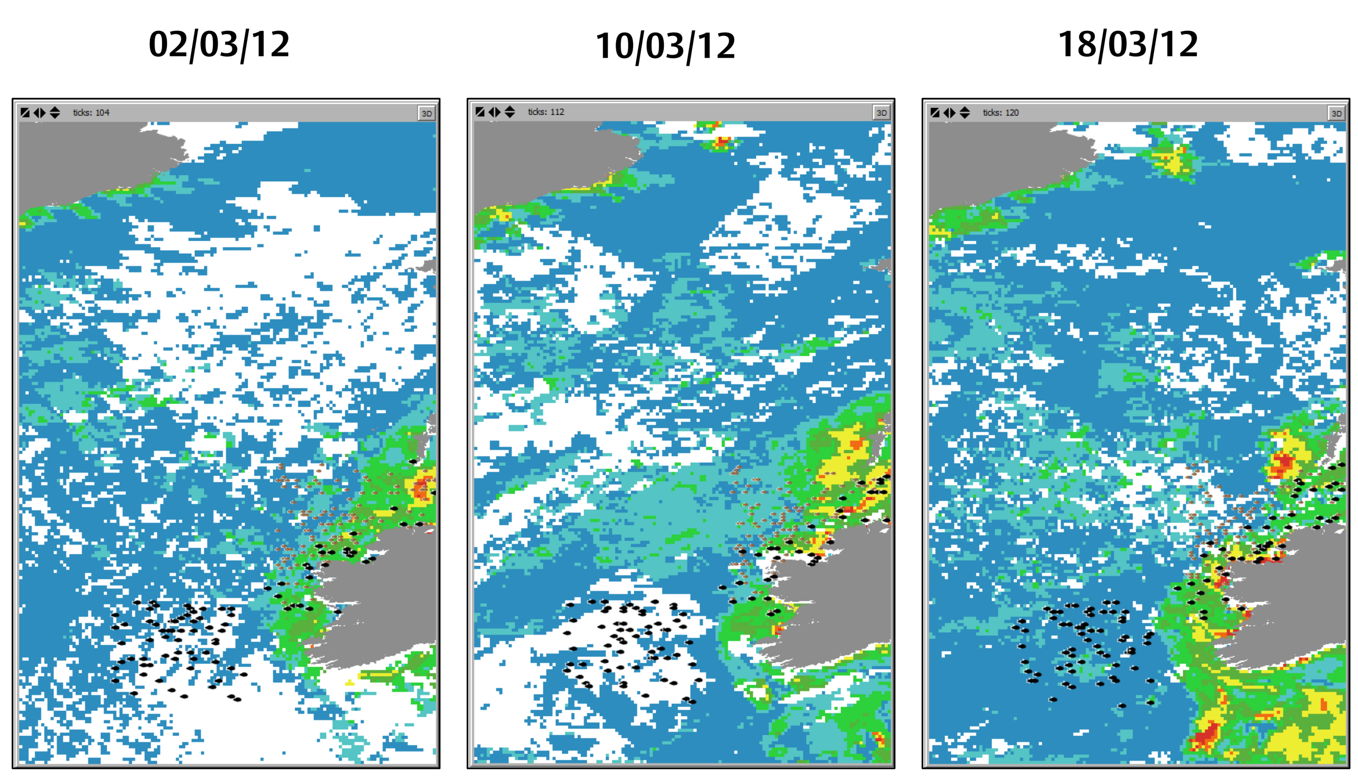
- **To explore the impact of food availability on Atlantic mackerel (*Scomber scombrus*) population dynamics in both space and time**

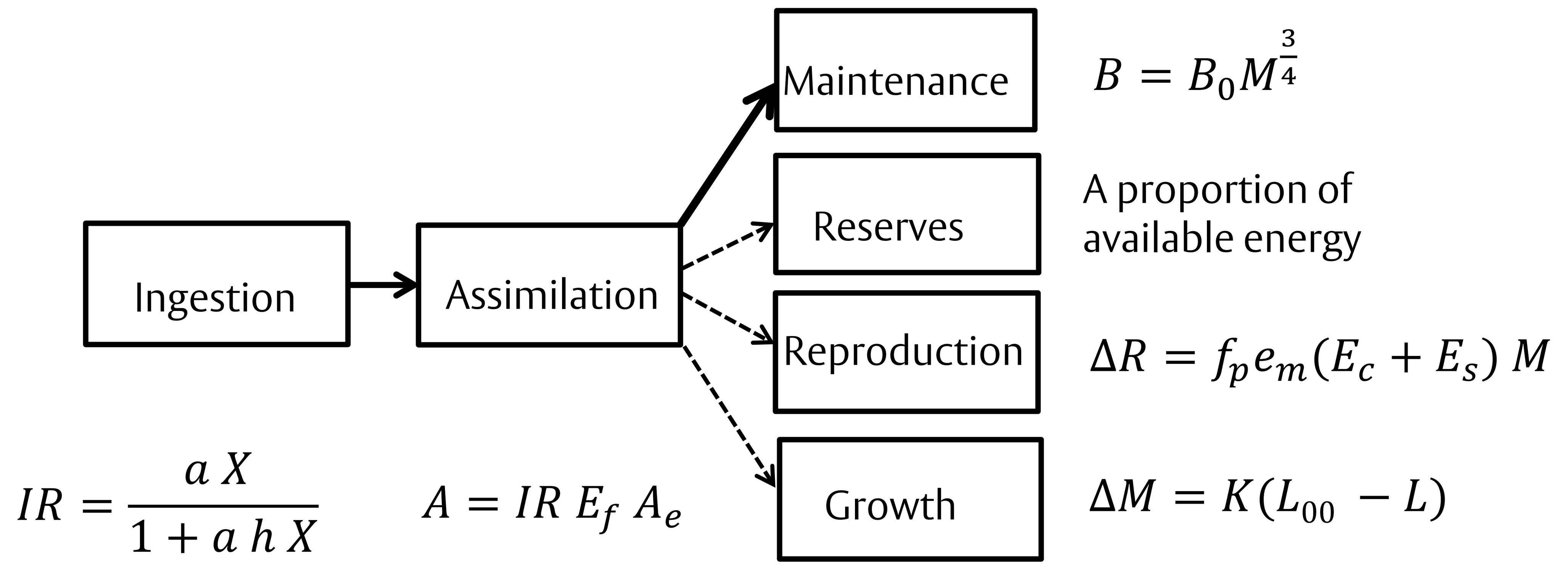
Methodology

- An "individual" represents an aggregation of individuals with identical variables, a super-individual, for computational reasons
- Each 9 km^2 grid cell has attributed to it variables for 8-day average SST and chl-a
- All individuals can eat plankton, and larger individuals can eat other, explicitly modelled, individuals according to size rules
- Each individual possesses its own energy budget, which allows variation in food availability and SST to manifest as differential physiological rates (eg growth or reproduction) at different times of year
- Individuals move locally at stop-off points (eg spawning or feeding grounds) until departing on migrations on set dates

Translating food availability to life history

a)





Spatial and temporal variation in food availability

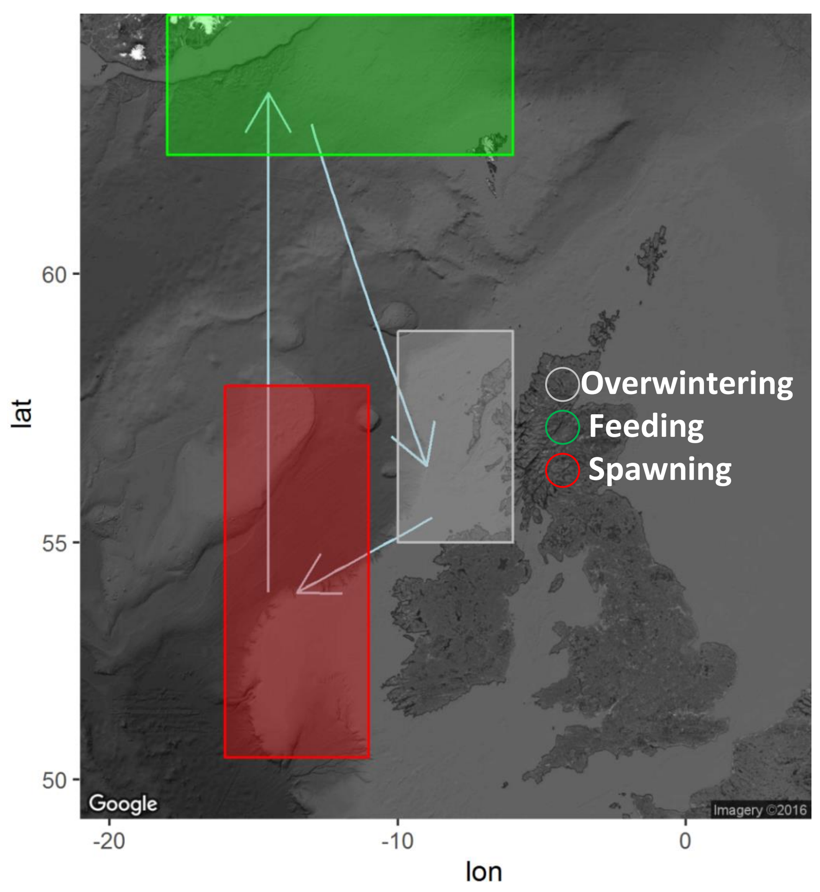
The model domain covers the majority of the geographical range of northeast Atlantic mackerel. New satellite-derived chl-a maps are inputted every 8 days, allowing the explicit representation of spatial and temporal variability in plankton availability. Plankton availability impacts larval success, which in turn provide food for larger, piscivorous, individuals.

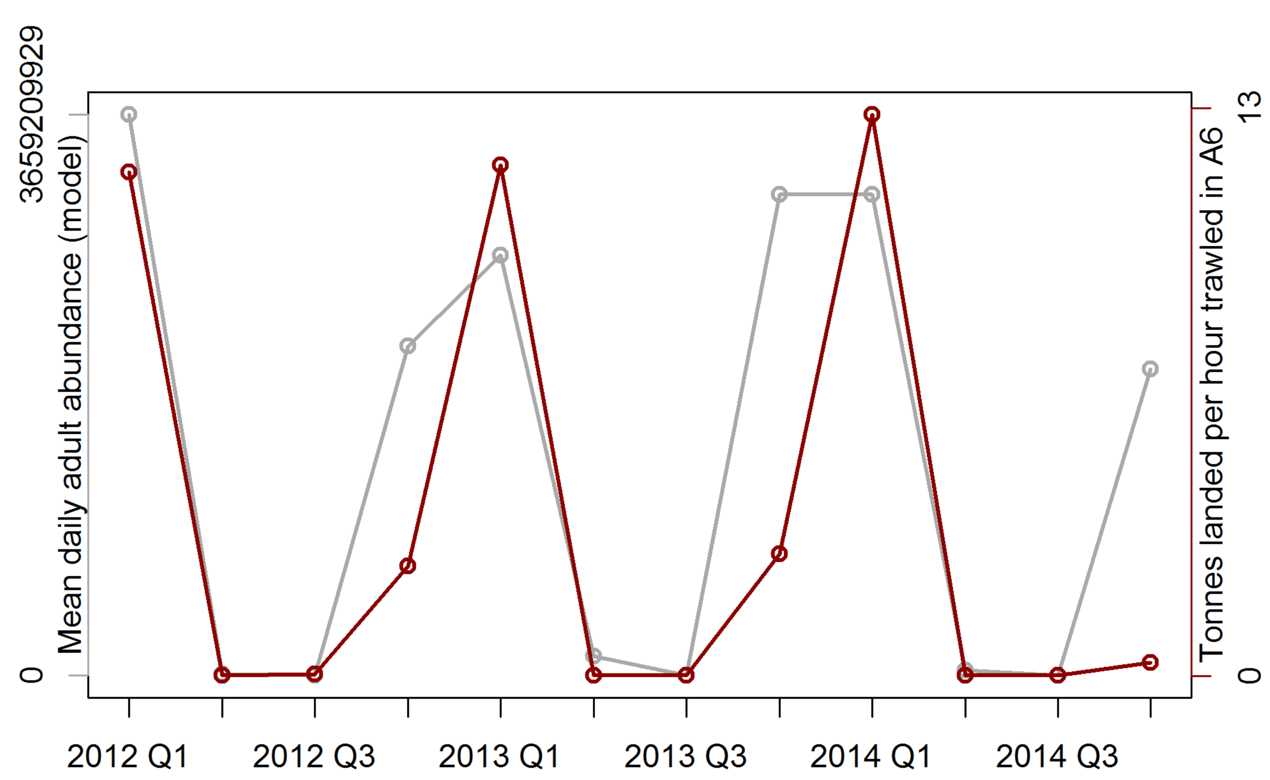
Acquisition and distribution of energy

A proportion of ingested food, an assimilation efficiency, is converted to units of energy (kJ) and allocated to vital processes. The order of priority depends upon life stage and time of year. The energy required to meet the maximum rate of somatic or reproductive tissue synthesis can be adjusted if insufficient energy is available.

Figure 1a) the model mid-run highlighting the spatio-temporal variation in chl. Black fish represent adults, and the smaller, orange individuals are juveniles **b)** a partial energy flow diagram outlining the way in which energy is acquired and allocated to various processes

Movement





Migrations

Individuals move locally when in "stop offs" (eg nursery, spawning, feeding and overwintering grounds) until departure for migration. Departures dates are derived from the literature and imposed. The timing of arrival in post-migration areas depends upon an individual's swimming speed, which is a function of body length.

Figure 2a) Adult mackerel migration routes and **b)** the (model) abundance of adults in division 6 (grey) and LPUE data (red) against time. In this way the model's ability to describe the spatial distribution of mackerel can be qualitatively evaluated

Next Steps

- The incorporation of temperature dependence with respect to the energy budget
- Expansion of the model domain to include all feeding areas for the stock
- Calibration of the parameter set using Rejection Approximate Bayesian Computation (ABC)

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