Suggested master project in biology – 2021-2023

What is the potential for larval fish to grow and survive in oligotrophic parts of the ocean around the globe?

Research question

The open ocean is often oligotrophic, with low productivity of zooplankton. The food web may be dominated by smaller zooplankton species, mainly distributed near a deep chlorophyll maximum. This means that fish larvae in such areas may struggle to find food, but on the other hand there are also few predators around, and some large highly migratory fishes like for instance tuna tend to spawn in such poor regions. What is the potential for larval fish to grow and survive in oligotrophic parts of the ocean around the globe? Can larval tuna or other fish grow through their early life stages based on the plankton concentrations found in the open ocean?

Workplan:

In the One Ocean Expedition, from August 2021-to April 2023 the SS Statsraad Lehmkuhl will sail around the globe and collect information about many potential open, oligotrophic oceans. To assess the potential for spawning in some of these areas, the students will participate in one of the surveys, and sample plankton, fish larvae and oceanographic data along the transects. The data will be used as input into simple existing simulation models of feeding, growth, and metabolism of different larval fish species (like tuna, sharks, mesopelagic fishes, and others depending on the region). This activity involves a literature review of which fishes (some of them) may spawn in the region, and what is known about their larval physiology. With the model and the field data we can assess if the area is viable for spawning at the given time of the year – and perhaps some assessment of other times of the year as well.

The projects are good opportunities to learn both practical sampling, taxonomy, physiology and some numerical simulation analysis with Phyton (or R) – the numerical code to use for this is available here https://doi.org/10.5281/zenodo.4693460. The students can participate in the surveys on Lehmkuhl, collect and analyse the data on board and do some quantitative analyses both during the cruise and after.

Supervisors: Øyvind Fiksen, Katja Enberg.. and maybe Arild Folkvord?

Some relevant references:

(Bakun 2013, Muhling et al. 2013, Fouzai et al. 2015, Reglero et al. 2018, Fouzai et al. 2019, Fiksen and Reglero subm), and A guide to the eggs and larvae of 100 common Western Mediterranean Sea bony fish species – or similar sources for taxonomic identification of plankton and ichtyoplankton.

Bakun, A. 2013. Ocean eddies, predator pits and bluefin tuna: implications of an inferred 'low risk-limited payoff' reproductive scheme of a (former) archetypical top predator. Fish and Fisheries **14**:424-438.

Fiksen, Ø., and P. Reglero. subm. Atlantic bluefin tuna spawn early to avoid metabolic meltdown in larvae.

Fouzai, N., A. F. Opdal, C. Jorgensen, and Ø. Fiksen. 2015. Effects of temperature and food availability on larval cod survival: a model for behaviour in vertical gradients. Marine ecology progress series **529**:199-212.

Fouzai, N., A. F. Opdal, C. Jørgensen, and Ø. Fiksen. 2019. Dying from the lesser of three evils: facilitation and non-consumptive effects emerge in a model with multiple predators. Oikos **128**:1307–1317.

Muhling, B. A., P. Reglero, L. Ciannelli, D. Alvarez-Berastegui, F. Alemany, J. T. Lamkin, and M. A. Roffer. 2013. Comparison between environmental characteristics of larval bluefin tuna Thunnus thynnus habitat in the Gulf of Mexico and western Mediterranean Sea. Marine ecology progress series **486**:257-276.

Reglero, P., A. Ortega, R. Balbin, F. J. Abascal, A. Medina, E. Blanco, F. de la Gandara, D. Alvarez-Berastegui, M. Hidalgo, L. Rasmuson, F. Alemany, and Ø. Fiksen. 2018. Atlantic bluefin tuna spawn at suboptimal temperatures for their offspring. Proceedings of the Royal Society B-Biological Sciences **285**:20171405.

…