PAME II-2019: Agenda 4.2
Modelling Arctic oceanographic connectivity to further develop PAME's MPA toolbox

Lead country: Sweden (SwAM)
Göran Broström and Per Jonsson
Department of Marine Sciences, University of Gothenburg, Sweden

Background

The project "Modelling Arctic oceanographic connectivity to further develop PAME's MPA toolbox" is a two-year project (2019-2020) commissioned by Sweden (Swedish Agency for Marine and Water management) to support the work of developing a representative and coherent Pan-Arctic MPA network. Connectivity, which involves spreading and migration of species, is an important component when developing a well-functioning network of Marine Protected Areas (MPAs). Oceanographic connectivity will be used to describe how free-drifting larvae is transported, and if the larvae will find a suitable location for settlement and continued growth.

Overall aim

The overall aim of the project is to develop an Arctic oceanographic connectivity model to:

- Model **connectivity** among populations of key marine species with free-drifting larvae
- Identify **minimum size** of MPAs for sufficient self-recruitment
- Identify optimal **MPA networks** based on modelled connectivity
- Identify major **barriers** to gene flow based on modelled connectivity

Methods and Underlying models

The biophysical model of connectivity in the Arctic Ocean will combine ocean circulation models with individual-based particle tracking simulations. Particles released from a particular area, e.g. an MPA, are moved with the modelled ocean currents and the connectivity with other areas can be estimated. The released particles will be given biologically relevant characteristics representing free-drifting larvae of major groups of marine invertebrates and fish.

The underlying ocean model for the present analysis is the TOPAZ model system (http://marine.copernicus.eu/), and Arctic20/Arctic4 from Norwegian Meteorological Institute. TOPAZ has about 10 km resolution with data from 1991-2016 available for every 3 hours.

The particle tracking model where particles are moved according to the local ocean currents uses a custom-built code based on an Lagrangian advection scheme with linear spatial interpolation.

Meta-analysis of larval dispersal traits

The biophysical model should represent key species in the Arctic Ocean and the project includes an analysis of published information about dispersal traits, mainly spawning season, time drifting as larvae, and larval drift depth in the water column. In this work the project communicates with CAFF and WWF (PamPan).

Preliminary results

An example from the model are displayed in Figure 1. From these data connectivity can be calculated as the probability to move from the red area to any other area. This is then repeated across the whole Arctic Ocean. The project has also finished a summary of dispersal traits that will be used as input in the particle tracking model.

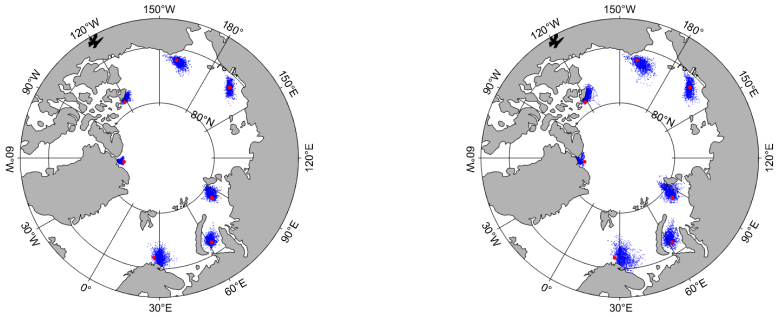

Figure 1: Some results from the particle tracking model used in this study. Particles are seeded at red dots and blue dots show positions after 30 (left) and 50 days (right).

Time plan

- The project started in November 2018, and will finish in June 2020.
- Preliminary test for particle tracking model (July 2019).
- Literature study on key species, their distribution, spawning season, and larvae behavior (September 2019).
- Main particle simulation result (Jan 2020).
- MPA analysis (April 2020)
- Delivery of report (June 2020)