ECOLOGICAL CONSEQUENCES OF COASTAL AND OFFSHORE MARINE URBAN DEVELOPMENTS: THE JELLYFISH ASPECT

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INTRODUCTION

Marine urbanization is increasingly altering the global seascape. Worldwide demand for energy and for renewable energy in particular, has resulted in a growing number of offshore installations expanding previously local ecological consequences to larger scale effects. Even though the concrete and steel structures have proved to offer considerable amounts of substrate suitable for attachment of Scyphozoan polyps, the influence of ocean sprawl on jellyfish populations is often overlooked. In the Adriatic Sea, moon jellyfish polyps have only been found in ports, on a shipwreck and on a gas drilling platform. Oddly enough none have been found in natural environment.

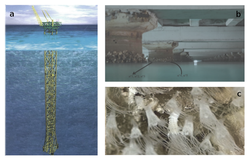

Fig. 1: Underwater substrate in ocean sprawl - offshore platforms (a), piers (b). Image c shows strobilating polyps.

We have set up a high resolution circulation model and coupled it with an individual based model to form a biophysical computer model of moon jellyfish (*Aurelia aurita* s.l.). We ran a 5-year long realistic simulation and used the results to analyze the impact of moon jellyfish polyp populations that have established themselves in some ports and offshore gas-drilling platforms in the Adriatic sea.

Fig. 2: Modelling area - Adriatic sea (Europe).

JELLYFISH DISTRIBUTION

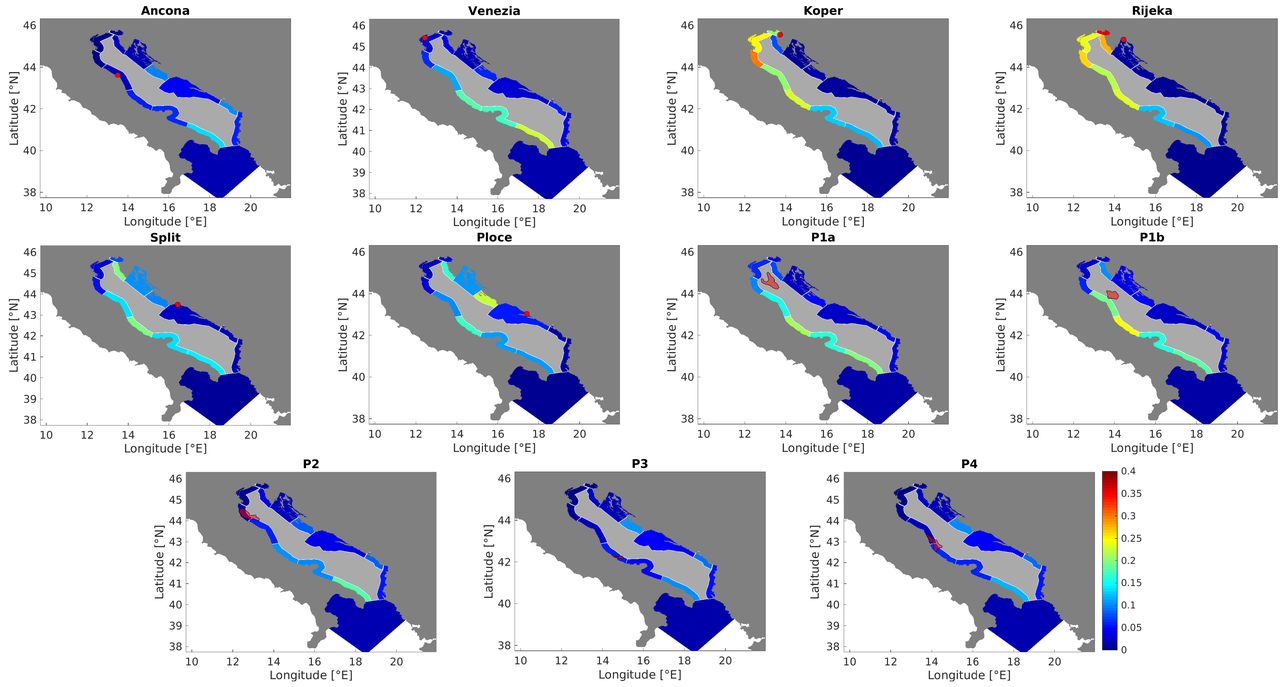

Fig. 3: Number of particles per km^2 that cross each region. We plot a five-year average and for each source separately. The source location is marked with a red dot for ports (Ancona, Venezia, Koper, Rijeka, Split, Ploče) and with a red polygon for gas-drilling platform areas (marked with P1a - P4). Each particle represents a large group of jellyfish (in the case of Koper each particle represents approx. 250000 jellyfish), nevertheless it is also important to note that the number of polyps at each location is not known and plots can't be compared quantitatively.

CONCLUSIONS

- Man made constructions have significant influence on jellyfish presence and that should be considered in future governance plans.
- Jellyfish can cover long distances during their lifetime and it is hard to predict which areas will be affected by new substrates.
- Bio-physical models are a useful tool that could be used when evaluating the temporal and spatial impact of new man-made constructions on jellyfish presence and blooms.
- Interannual variations in current patterns cause high variability in jellyfish presence and should be accounted for.

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INTERANNUAL VARIATIONS

Interannual variations in jellyfish density are surprisingly high, considering that the strobilation pattern and intensity are the same for all years of the simulation. The currents are the only source of interannual variance. This shows that, additionally to other environmental and biological factors, interannual current variability strongly influences jellyfish presence. Our model results qualitatively roughly match the observations from Italian citizen science campaign.

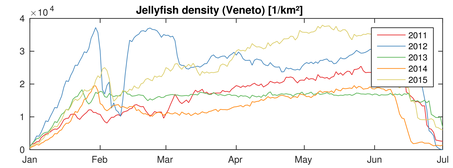

Fig. 4: Interannual variations in jellyfish density (in number of jellyfish per km^2 - for moon jellyfish originating from Koper) for one of the most affected coastal regions (Veneto - Venice).

MODEL SETUP

- Ocean model: ROMS_AGRIF with 1.9 km horizontal resolution and 31 sigma levels.
- Atmospheric forcing: ECMWF historic forecasts .
- Open boundary conditions: Mediterranean Forecast System.
- Individual based model *ichthyop* was modified to allow for 4 predefined depths daily - as observed moon jellyfish diel vertical migrations in Mljet lake and Elefsis bay.
- Strobilation (particle release) timing and intensity was modeled according to 3-year long observations in the Port of Koper.
- 120000 particles were used in the simulation - 2000 from each source every year.

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