Sensitivity analysis of a local-scale coral larval connectivity model to biological parameters

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Abstract: Coral reef systems are in decline due to pressures from climate change and other human activities. Understanding how coral reef ecosystems will respond to future environmental changes is important to develop ways to help corals adapt and restore damaged coral reefs. Connectivity between coral reefs enables the exchange of marine organisms between populations and can promote population recovery from disturbance such as coral bleaching and tropical cyclones. Connectivity models are used to infer coral larval connectivity patterns, but the estimates they produce carry uncertainty, stemming from limitations in the hydrodynamic models that simulate ocean currents as well as from uncertainties in the representations of larval biology and behaviour during dispersal and settlement. Simulated connectivity is not only sensitive to ocean currents (Ani et al., 2024), but also sensitive to assumptions about the biological behaviours of larvae during dispersal and settlement. This has implications for coral reef intervention modelling. Assessing the sensitivity of biophysical models to biological parameters can help characterise the uncertainty in coral connectivity estimates and identify which biological traits of coral larvae require further study to inform intervention modelling.

In this study, we assessed the impacts of the following biological parameters on connectivity estimates: timing and duration of spawning, larval competency acquisition and loss, mortality, settlement and number of released larvae. Additionally, we assessed the impacts of the temporal resolution of velocities on connectivity predictions. The coral larval connectivity model used in this study comprises 3D velocities from the high-resolution (200–250 m) hydrodynamic model, RECOM (Relocatable Coastal Model–`https://research.csiro.au/ereefs/models/models-about/recom/`), nested within a 1 km grid resolution hydrodynamic model of the Great Barrier Reef Marine Park, as input to OceanParcels (Delandmeter and Van Sebille, 2019), a particle tracking model. The connectivity model was used to simulate larval dispersal and settlement of broadcast-spawning *Acropora* corals within the Moore Reef cluster of reefs, located in northern Great Barrier Reef (GBR), following annual mass spawning events in 2015, 2016 and 2017. The connectivity metrics used to assess the connectivity model's sensitivity to biological parameters are the percentage of sources, sinks and settled larvae.

Our model results show that the model is highly sensitive to the temporal resolution of velocities, timing of spawning, number of released larvae and larval competency acquisition and loss. Our findings on the sensitivity of coral larval connectivity model results to varying estimates of biological parameters can help identify the most influential biological parameters and how connectivity model predictions vary with different estimates of parameter values, while also highlighting future research priorities. Finally, our findings can help promote studies aimed at improving the reliability of model predictions of coral connectivity, which are critical for improved GBR resilience to climate change stressors.

References

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