NSW AMSA General Postgraduate Student Award Application

2017

Steven Hawes,

PhD Candidate,

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Supervisor: A/Prof. Will Figueira

The University of Sydney

Accepted abstract

Title

An analysis of current trends in connectivity modelling and where to next

Authors

Steven Hawes and Will Figueira

Abstract

Biophysical connectivity modelling has consistently used by marine researchers over the past twenty years for estimating connectivity patterns. The outputs of these models have been used for everything from assessing population dynamics to aiding the design and testing the effectiveness of marine protected areas. However, the evolution of biological models have not kept pace with the physical models. Physical models have been progressively improving through utilising higher resolution satellite data and enhanced algorithms. The advancement of the biological models has been slower, with many studies that investigate the connectivity of pelagic marine larvae still implementing the larvae without behavioural traits. We reviewed the current literature (2010-2016) on connectivity driven biophysical models to compare how the implemented biology affects the output. In addition, we discuss how modelling different movement behaviours of pelagic ichthyoplankton influences connectivity patterns based on the results of a recent theoretical study we undertook. These outcomes allow us to understand both the behaviours to prioritise in the implementation of biophysical models for future connectivity modelling studies, and where to focus our efforts in finding unknown information about biological traits of the modelled marine larva.

Outcomes and significance of project

The general aim of my project is to investigate connectivity patterns of icthyoplankton, using a coupled biological-physical modelling. The primary focus of the modelling is to investigate the biological parameters of pelagic reef fish larvae that influence connectivity, with both theoretical and practical applications.

Metapopulations are defined as a series of connected, but spatially discrete local populations. In marine systems, long distance larval dispersal allows organisms to transfer between seemingly unconnected populations. This exchange of individuals between populations is defined as connectivity (Cowen and Sponaugle 2009). Connectivity within metapopulations can be volatile, leading to extinction events. Shifting connectivity is caused by either intrinsic (i.e. too few larvae exchanged) or extrinsic (i.e. ocean current variation) phenomena (Hanski 1998).

In order to conserve and manage metapopulations, first we need to identify them and then understand their population dynamics. Connectivity has often been overlooked when designing marine protected areas (Crowder and Figueira 2006), instead notions of habitat quality or habitat preservation have been prioritised. It is not disputed that both notions are important factors, however, they do not utilize the concepts of population biology or ensure preservation of metapopulations (Almany et al. 2009). Therefore understanding and measuring connectivity within a metapopulation is essential and as such connectivity should be a key consideration in the design of marine protected areas (Botsford et al. 2009; Christie et al. 2010).

Connectivity is one of the more challenging problems to study empirically in marine ecology. Fish larvae are minuscule (1–8 mm); they can disperse over long distances and they suffer from high mortality. It is not practical (or possible) for a scientist to follow larvae from spawning to settlement. There are several current empirical techniques for measuring connectivity (e.g. physical marking, genetics), which all suffer from labour-intensive methodologies and become less scalable as the dispersal distance increases.

Computer modelling allows us to predict connectivity at finer temporal and spatial resolutions than is possible with the current empirical methods. Biophysical models use physical and biological models to simulate movement of individuals in a system. The physical model is a hydrodynamic model, based on raw oceanographic measurements or a refined analysis of the oceanographic measurements. The biological model uses the larval characteristics predicted to influence the dispersal during the pelagic larval stage. Biophysical models predict the realised connectivity, the physical model acted upon by the biological model, which provides a more realistic framework.

My Phd has focused on investigating how the biology of fish larva, especially as they undergo ontogenetic changes, have the ability to influence patterns of dispersal. Most current studies treat larva as zooplankton, whereas the more we understand about early life history of ichthyoplankton, suggests they become necktonic during this pelagic larval stage. The results of my thesis will lend greater strength to the argument to include biological parameters in connectivity modelling studies, which has flow on effects when for example using connectivity to design a marine protected area.

Short curriculum vitae

Education

2013 - Present: Enrolled in a PhD at the University of Sydney 2012: Bachelor of Science (Hons) at the University of Sydney 2009-2011: Bachelor of Science at the University of Sydney

Conference presentations

- 2016 Poster: Connectivity of temperate reef fish along the eastern Australian coast and the effects of ontogenetic vertical migration. Ocean Sciences Meeting 2016, New Orleans, 21–26 February.
- 2015 Talk: Vertical distribution of temperate fish larvae off NSW. Australian Society of Fish Biology, Sydney, 11–14 October.
- 2015 Talk: Making sense of connectivity studies using a biophysical modelling approach. Australian Marine Sciences Association conference (AMSA), Geelong, 5–9 July.
- 2014 Talk: Modelling connectivity of reef fish: evaluating larval sources and the importance of biophysical transport process. Australian Marine Sciences Association conference (AMSA), Canberra, 6–10 July.

Seminar

- 2015 Seminar: Connectivity of temperate reef fish in NSW, Tropical Marine Science Institute, National University of Singapore, 12 November.

Awards

- 2014: Peter Holloway award for best student talk in oceanography at AMSA conference in Canberra

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RE: Steven Hawes

Dear Selection Committee

I am writing to verify that Steven Hawes is a PhD student at the University of Sydney under my supervision and that I strongly support is application for this award. Steve has conducted innovative work evaluating the importance of various larval processes to the outcomes of biophysical connectivity modelling. His work sits nicely within the themes of the upcoming national meeting ("Connections through shallow seas") and it would be great for AMSA to support him in presenting his work. I hope that you will look favourably upon his application.

Regards,

Will Figueira

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