
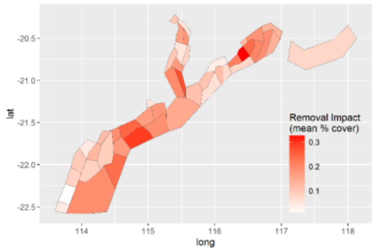


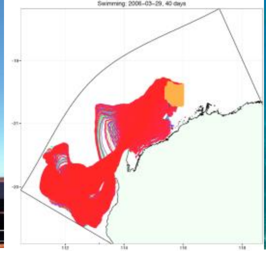


Pilbara Marine Conservation Partnership

Environmental Pressures - Connectivity

The Pilbara region in Western Australia features extensive and globally-significant fringing coral reef ecosystems with high levels of endemism given the number of species only found in this area. It is thought that some reefs may contribute disproportionally more to recruitment stock than other locations, meaning these "source" reefs are especially important to ensuring the resilience of the wider-reef ecosystem. The reverse can also be true with some reefs receiving a disproportionally high supply of larvae, meaning these "sinks" could potentially be more robust to disturbances. Having an understanding of these complex patterns and processes is important to inform management of marine resources. Using a combination of sophisticated 3D modelling of ocean currents and data on the behaviour and distribution of corals and fish, the PMCP research team has mapped out the "connectedness" of coral reef species in the Pilbara region.

Background

A huge diversity of habitats including coral reefs, seagrass meadows and sponge gardens are found in the Pilbara. Many of these habitats have patchy distributions, with organisms needing to travel long distances to reach the ones they favour.

Ordinarily, this dispersal activity occurs in the first month of life when larvae swim or float in the water column as microscopic plankton. This phase of life connects the fates of distant populations and has the potential to profoundly affect their resilience to human or natural perturbations. Yet, dispersal is extremely difficult to measure in marine environments because larvae are tiny and the ocean is vast.

Little is known about how well connected the major habitats in the Pilbara are. This region features extensive and globally-significant fringing coral reef ecosystems with over a thousand discrete reefs and islands recorded. It encompasses several Marine Protected Areas (MPAs) and supports important fisheries and major oil and gas developments.

How interdependent are individual reef communities in the Pilbara? Do the strong coastal currents mean they are well-connected by frequent dispersal, and so resilient to disturbance? Or, are some parts isolated and therefore, more vulnerable, requiring different management strategies?

The PMCP connectivity project addressed these questions and sought to understand the biophysical drivers of connectivity in the Pilbara.

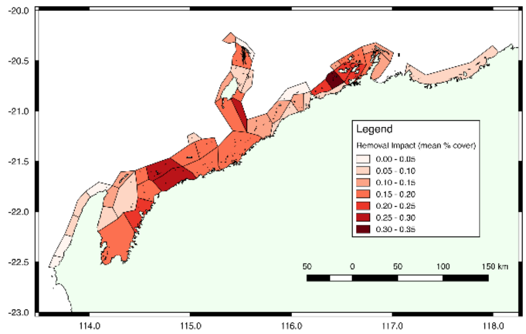

Figure 1 Impact analysis. The change in coral cover in all remaining zones, as a result of a perturbation which destroys the coral supporting habitat in a zone. Red zones have a higher regional impact.

The Approach

The PMCP researchers at CSIRO used 3D modelling of ocean currents coupled with behaviour and distribution data of representative corals and fish, to predict the connectedness of populations in the Pilbara and to evaluate how this is likely to vary across the region, through space and time. The team also used network analysis that coupled connectivity models with population dynamics, to evaluate the likely inter-dependencies in recruitment among reefs generally and between MPAs and unprotected areas, including estimating the significance of different reefs to overall system resilience (Figure 1).

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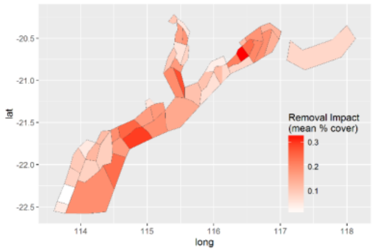


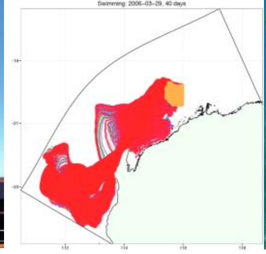


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What did we uncover?

The Coral Larvae Dispersal model predicted that some reefs are consistently important in both exporting and receiving larvae, so are key to sustaining the network of reefs in the region. For example, reefs off Onslow, south of Barrow Island (Figure 1) were predicted to be important for maintaining regional resilience. These results have important implications for marine conservation and development planning in the west Pilbara.

A run of the [Coral Larvae Dispersal Model] can be viewed at the CSIRO PMCP website. See 'Connectivity' for more details.

The models also predict year-to-year variation in how far and in which direction coral and fish larvae will be transported by currents. For example, many corals spawn during a narrow time window in autumn. In some years, such as 2008, this coincided with a dominant south-westward trend in currents, but in other years such as 2004 it coincided with a dominant north-eastward trend.

In contrast, fish like the spangled emperor *(Lethrinus nebulosus*), spawn over a long period from late spring (November) to early autumn (March), and larvae spend more than a month in the plankton before settling on or near reefs. The models predict that fish larvae spawned near the Montebello/Barrow Island marine conservation reserves in September are likely to recruit nearby, but by March most larvae are expected to be transported as far as Ningaloo Reef due to the onset of the Holloway Current (Figure 2).

Fish larvae, unlike those of corals, are strong swimmers and can swim towards favoured habitats. Can this counteract the strong currents experienced on the Pilbara? Models showed that yes, swimming does make a big difference. It means that on average fish settle on or near reefs closer to where they are spawned than would be expected purely according to currents. This matches what has been seen in field studies elsewhere.

It's important to recognise that these results are based on computer simulations that must make several simplifying assumptions because knowledge of the biology of fish and coral larvae is limited. The PMCP team have undertaken a field program measuring actual recruitment and have used those results to test model predictions.

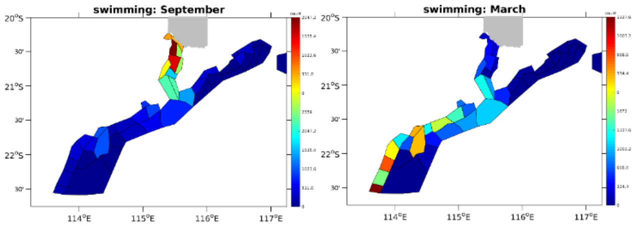

Figure 2: A comparison of the fates of spangled emperor larvae spawned near Montebello Island early and late in the season. Colours indicate the number of larvae predicted to settle after 32 days.

Who is this information useful to?

This information should assist agencies tasked with managing marine biodiversity and fisheries resources, including the planning of marine parks, and designing strategies for sustainable harvest.

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To find out more visit:

https://research.csiro.au/pmcp/

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