May 31, 2021

Earth & Space

Networking between marine protected areas help sustain fisheries

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DOI 10.25250/thescbr.brk542

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This Break was edited by Dr. Akira Ohkubo, Scientific Editor - TheScienceBreaker

Marine protected areas called no-take zones – restricting human activities – are set to preserve marine ecosystems. But these same marine reserves could also help sustain fisheries. A new study reveals that a network of no-take zones provides a reliable source of offspring, which replenishes fish stocks and minimizes risk to ecosystems.

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Fisheries have an important impact on ocean health, but what if we could protect our oceans and eat it too. Setting aside ocean areas for marine conservation helps preserve marine habitats and biodiversity, but can also help sustain fisheries.

No-take zones that prohibit fishing activities are one of the strictest forms of marine protection. Carefully managing or even banning activities inside no-take zones allows previously exploited species to recover. As a consequence, it is common to find healthier populations of exploited species inside no-take zones than in areas that are regularly fished. However, the value of setting no-take zones is not in the fish that reside inside them, but in the offspring they produce to replenish neighbouring fish stocks.

Currently, only under 6% of the world's oceans are protected in marine protected areas and only a small proportion restrict fishing activities completely. But in Australia's Great Barrier Reef Marine Park, no-take zones protect a third of all coral reefs where exploited species are larger and more abundant. In principle, these protected populations will produce many more offspring than neighboring fished areas, which helps sustain fisheries through larval

subsidies: the export of larval offspring. However, knowing where larval fish go or how reliable these larval subsidies are can be a significant challenge.

Fish release their offspring into the ocean where they are entrained by currents. Within a matter of days or weeks, they may have dispersed many tens if not hundreds of kilometers. But recent advances in genetics and informatics have allowed us to 'track' where they go. For example, we can match the genetic information of the juvenile fish with their parents' to determine their home reef and how far they traveled.

From the genetic relationships between fish, we can reveal the movement of individuals between reefs and determine whether no-take zones provide reliable larval subsidies to nearby reefs. The natural patchiness of corals reefs and well-established no-take marine zones in the Great Barrier Reef Marine Park provides the ideal context to investigate how small juvenile fish move from reef-to-reef, and how fish stocks are replenished.

We investigated the movement of juvenile fish between no-take zones and fished areas in the Keppel Islands, a small group of islands in the Great Barrier Reef. For this, we focused on coral grouper, an important commercial fish throughout the Indo-Pacific region. We sampled adults inside four no-take zones and collected juveniles from all known coral reef habitats in the island group between 2007 and 2012. These juveniles arrived on the reef during six discrete periods, which gave us unprecedented insights into how movement patterns change over time.

We matched 125 juvenile fish to their parents in no-take zones based on their genetic relationship, allowing us to reveal movement patterns between reefs and measure the larval subsidies from no-take zones in each period. Collectively, the four no-take zones in the Keppel Island generate 41% of all juvenile coral grouper in the island group, confirming no-take zones contribute important larval subsidies to sustain and rebuild healthy fish stock. However, not all no-take zones contributed equally across the six discrete periods, with sometimes large fluctuations in their performance over time.

Large fluctuations in the performance of a single no-take zone suggest their contributions to the replenishment of fish populations may be unreliable. This is an important consideration when designing no-take zones, particularly when they represent a long-term investment in rebuilding fish stocks. However, we found that the larval subsidies from the network of multiple no-take zones can buffer these fluctuations to provide more reliable larval subsidies over time.

Sustainable fisheries depend on having healthy populations to support them. No-take zones provide dual benefits of preserving marine ecosystems and supporting healthy fish stocks by generating important and reliable larval subsidies. As we enter the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) to encourage the preservation of ocean ecosystems, it's essential that we recognize the value of no-take zones as not simply a tool for marine conservations, but as the basis for sustainable fisheries management and an important investment in healthy, resilient and productive ecosystems to support local communities and livelihoods into the future.