Coral reefs make up less than one percent of the ocean environment, but they are home to 32 or 34 animal phyla living there (rainforests, by contrast, contain 9 animal phyla). Valued at $29 billion/year in fishing and tourism, coral reefs also provide critical protein for 100s of millions of people.

Coral cover has declined by 80 percent in the Caribbean and 50 percent throughout the tropical Pacific since the 1980s. Reef decline is caused by many factors, including overfishing, climate change, disease, pollution, invasive species and predation. Adequate coral cover is essential to support reef organisms. Loss of corals leads to loss of reef fish, which in turn, precipitates additional coral decline because intact fish communities aid in coral recovery. Loss of both fishes and corals is catastrophic.

Recruitment process
Most coral reef organisms have a two-part life cycle, a relatively sedentary adult produces a dispersive larval stage. Larvae leave the reef environment to escape predation and mature in the open ocean. Once developed, larvae must locate a suitable adult habitat. The open ocean is featureless and therefore larvae rely on olfactory and auditory cues to find a reef. Adult coral reef fish rarely move more than a few meters from their initial habitat selection and corals are fixed to the ocean floor, so movement after settlement is impossible. Therefore, locating a quality habitat is extremely important during the larval stage. We now know that even though larvae are small, they are able to choose their final habitat.

Fish life cycle
- Egg
- Larvae
- Juvenile
- Adult

(Figure modified from Fautin and Allen 1997)
How do Marine Protected Areas work?

Current reef management has focused on establishment of Marine Protected Areas (MPAs). Typically, these are small areas of reef that are closed to human activities such as boating, fishing, etc. MPAs work in two ways: they protect the organisms within the MPA and consequently, the protected individuals produce more offspring (larvae), which can seed or recruit to the non-protected sites. Enforced MPAs are effective at protecting organisms within their boundaries, but it is unclear whether MPAs are seeding the neighboring non-protected locations. To understand reef ecology and wisely manage threatened locations, we need to understand the behavioral components of habitat selection, including why larvae choose to settle on one reef over another.

Conclusions

In areas where coral reefs differ in habitat quality, MPAs may effectively protect the organisms inside the boundary, but this does not guarantee that the organisms will seed neighboring degraded locations. When designing MPAs, it is vital to consider a marine organism’s behavioral preferences since larvae control their final settlement habitat. While MPAs remain an important coral reef management tool, additional research is needed to prevent further coral reef decline. In particular, reef organism behavior can no longer be ignored and must be considered when evaluating ways to improve and preserve coral reef ecosystems.

Are MPAs enough for coral reef management?

When selecting a home, coral and fish larvae use chemical cues to distinguish between healthy and non-healthy habitats. In areas where an MPA is healthier than a neighboring non-MPA location, larvae will select the healthy MPA over the non-MPA through smell alone. The smell of corals, for example, is an attractive cue for fish and coral larvae, whereas the smell of seaweeds is a repulsive cue. Laboratory data showing olfactory preferences is supported by field data that show a 6-9x greater recruitment into the MPA over the non-MPA sites, despite having 3x more predators.

Legend: MPA | Non-MPA * Units (#/60 m²)

Study sites: (A) Votua (B) Namada (C) Vatu-o-lailai
Along the coral reef coast of Viti Levu, Fiji.

<table>
<thead>
<tr>
<th>Site</th>
<th>Recruits*</th>
<th>Species Richness*</th>
<th>Predators*</th>
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