Coral Reef Conservation and the Role of Blue Carbon

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As plants photosynthesise, they capture carbon dioxide and release oxygen, and this carbon sequestration is well documented in terrestrial ecosystems as a mitigation strategy for global climate change and to alleviate / reverse some of the damage caused by carbon emissions. However, the oceans are the greatest carbon sink on Earth (Sabine et al., 2004). Around half of all atmospheric CO2 emissions since the industrial revolution have been absorbed by the ocean (Nellemann et al., 2009). The term **blue carbon** refers to the carbon sequestered in coastal ecosystems and stored in their sediments over geological timescales (Howard et al., 2014). The potential to sequester carbon is an ecosystem service that has been quantified for forests and with the concept of "Blue Carbon" it has similarly been quantified for mangroves and seagrasses, but for coral reefs remains poorly understood. The ability of ecosystems to capture carbon from the environment increases their conservation value and quantifying carbon sequestration capacity can help support conservation efforts on a global scale (Howard et al., 2017). Tropical coral reef biodiversity and the unique physiology of calcifying corals makes their carbon budget more complex than other ecosystems, as tropical coral reef community metabolism includes multiple processes: photosynthesis, respiration, calcification and dissolution, which all have different roles in coastal carbon cycling.

Reefs are built by Scleractinian corals, ecosystem engineers, which secrete a calcium carbonate skeleton to form the solid foundation of the reef matrix. Coral reefs are not currently included in blue carbon budgets due to their carbon-releasing process of calcification by Scleractinian corals, however, there is debate surrounding their properties as a carbon source/sink (Suzuki & Kawahata, 2003). Reviews of previous studies into the carbon budgets and community metabolism of coral reefs have highlighted the need for further investigation, clarification and a consensus on the carbon status of coral reefs (Cyronak et al., 2018). It is likely that the carbon released by calcification is consumed in other biological processes on the reef, such as photosynthesis by associated macrophytes and kept within the system (Courtney et al., 2017; de Goeij et al., 2013). For example, high biodiversity of coral reefs means they provide habitat for many organisms which are important in the marine carbon cycle; fleshy macro-algae, coralline algae, and sponges. For example, crustose coralline algae (CCA) covers up to 60% of some reef areas and is estimated to have a significant capacity to sequester carbon (Van Der Heijden & Kamenos, 2015).

Changes in marine conditions caused by global climate change have fundamentally changed the key processes on coral reefs, the species composition, and the way that carbon interacts with this ecosystem. The increasing threat to coral reefs and predictions suggesting that corals may become extinct within this century (Carpenter et al. 2008) urges further research to understand the intricate dynamics of coral reef ecology and carbon cycling before it is too late. No-where is this more apparent than in the Caribbean, where catastrophic degradation and phase-shifts have been observed since the 1970s (Hughes, 1994). Loss of Scleractinian coral cover (Gardner, 2003), subsequent reduction in structural complexity (Alvarez-Filip et al., 2009) and macroalgal-dominated phase shifts (Hughes et al., 2007) all indicate that the Caribbean reef carbon repository is substantially altered.

Caribbean coral reefs are in decline, and reef restoration aims to return balance to the ecosystem, not only in terms of coral cover, but also within the context of carbon cycling, long-term carbon lock-down and protection of the ancient inorganic carbon stores within the very structure of the reef. Coral restoration is increasingly considered to be a viable recovery plan for declining populations of Acroporid coral - the Caribbean's fastest growing reef-building corals. This study aims to provide a modern-day coral reef budget, measured on a Caribbean reef ecosystem undergoing drastic change focussing on healthy and degraded reefs as well as reefs undergoing restoration.

Methods

In Akumal preliminary research has been conducted to trial success rates of coral nurseries where *Acropora cervicornis* is grown, propagated and then transplanted onto the reef. The methods used are minimally invasive and require cheap materials. The trials have proved to be successful, with doubling of live tissue from dying rescued fragments within one year, combined with successful fusion and growth of transplanted colonies onto the reef. Once blue carbon potential of a reef has been calculated, this can be used to measure changes in carbon processes, for example during reef restoration. Consequently, blue carbon data collection can focus on relatively health reefs with good coral coverage, degraded reefs that are algae dominated and reefs undergoing restoration of *Acropora cervicornis*.

Data will be collected via diving and snorkelling, and students will be trained to identify Scleractinian coral species, key fish species and invertebrates. At each reef site, benthic transects at two different depth profiles will be used to assess coverage of live and dead coral, macroalgae and sponges, measuring the number and size of individuals to estimate their rates of calcification, photosynthesis and respiration. Additional transects will then be conducted for key algal grazers such as urchins and herbivorous fish. The information gained from these data can then be used to calculate community metabolism and contribute to our understanding of the carbon cycle of Caribbean reefs, and to discuss their conservation implications in relation to ecosystem services and biodiversity.

Suggested Reading

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