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Arsht Ethics Initiatives

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The ethics of genetic redistribution of reef corals in an era of climate change

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Abstract

Tropical coral reefs are marine biodiversity hotspots that are critical to the livelihoods and economies of many coastal communities globally. However, coral reefs are also one of the world's most vulnerable ecosystems from a climate change perspective. Unless reef-building corals can adapt or acclimatize quickly enough to rising temperatures, there is serious scientific concern that reef ecosystems will be lost across a large proportion of their range, with negative consequences for biodiversity and human welfare, and potentially destabilizing influences on political stability in reef-dependent nations in the developing world.

One activity that might help prolong the survival of these critical ecosystems is *genetic redistribution*, defined here as the manipulation of existing patterns of genetic distribution to place genotypes (or combinations of genotypes for symbiotic organisms such as corals) in areas where they do not commonly occur. The objective is to establish non-native populations of corals on target reefs that are already pre-adapted to warmer conditions. These corals are anticipated to survive continued warming and enable coral reef ecosystems to persist. Two methods of genetic redistribution that have been proposed include: (1) relocating coral genotypes that are already pre-adapted to warmer conditions to areas that are cooler, but expected to warm; and (2) inoculating local corals with heat-tolerant algal symbionts that allow them to survive warmer temperatures.

For the first time, both of these activities are now scientifically achievable. In fact, coral relocation is already occurring in the Florida Keys over small spatial scales (10s of km), and successful symbiont inoculation methods are being pioneered by the Baker lab at

UM, with field tests and reef-based applications likely in the near future. However, the ethical implications of such activities have not been explored. The potential risks to marine systems, and the ethical issues at stake to the oceans, have not yet been widely discussed in the literature.

From an environmental ethical perspective, these activities raise critical questions of (potential) costs vs. (expected) benefits. Before undertaking these activities an assessment of the risks to native corals (and other marine wildlife on target reefs) should be undertaken. Could corals suffer outbreeding depression by crossing with native stocks and producing less fit genotypes, actually producing the opposite of the desired results (reefs that are even more sensitive to environmental impacts)? Might invasive species, or diseases, be vectored into a naïve reef system along with transplanted corals, with disastrous ecological consequences? What are the costs of doing nothing? We propose to review these issues, and compare the potential benefits of genetic redistribution with the possible risks and challenges. We will address *whether* (and if so *how*) genetic redistribution could be employed as a management action to help reef ecosystems survive climate change. Our deliverable will be a peer-reviewed scientific paper that will also be circulated to policymakers to initiate an informed discussion of the ethics, risks, and benefits of these forms of "intervention conservation" on coral reefs. These questions have immediate policy relevance to Florida (where one of the world's largest coral reef transplantation programs is already underway), and are also globally informative, because some of these interventions are already being trialed on reefs elsewhere (for example, the Great Barrier Reef, where a pilot project on the transplantation of heat tolerant corals has just begun).

This project fills a critical, and growing, gap in marine/climate change environmental ethics that UM is ideally poised to address, by virtue of its location (next to the largest contiguous reef system in the US), its long history of coral reef research, and its current expertise in coral symbiont inoculation (Baker lab). It is also particularly timely since this year NOAA is considering the listing a total of 66 new coral species under the Endangered Species Act (ESA). Such an unprecedented listing (there are currently only 2 corals listed under the ESA) emphasizes the timeliness and urgency of this work.