

BUILD FOR NATURE, NOT ONLY WITH NATURE, TO ENGINEER RECOVERY OF COASTAL ECOSYSTEMS

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BUILD FOR NATURE INSTEAD OF WITH NATURE

In contrast to most engineering with nature or what are commonly called 'build with nature' projects, we term the engineered recovery of degraded coastal ecosystems 'build *for* nature' projects. The ambition is to promote natural recovery through active restoration measures that first and foremost use ecological and engineering science to understand the pressures that have led to the degradation, and then tailor engineering solutions to mitigate the pressures and kickstart natural recovery. 'Build for nature' requires initial capital investment, but if done properly will lead to the enhanced delivery of ecosystem services emanating from recovered ecosystems, at no further cost to landowners or developers or public agencies.

Baird has been involved with innovative 'build for nature' projects in different coastal environments throughout the world, however we here focus on coral reef, seagrass, and marshland recovery projects in the Caribbean. We distinguish these coastal engineering projects from those that build 'nature-based solutions' such as artificial wetlands, as well as hybrid projects such as the U.S. Defense Advanced Research Projects Agency (DARPA)-funded hybrid coral reef being planned in Biscayne Bay. In contrast to these engineering with nature projects, we showcase 'build for nature' projects for which investment of effort was made to understand the problem and tailor an ecosystem-wide solution. In addition, Baird has made significant investment in long-term monitoring of coastal engineering-mediated restoration, to ascertain if ecosystem resilience in these project sites has been restored.

FIRST, UNDERSTAND THE STATE OF THE ECOSYSTEM

To effectively build for nature, it is necessary to undertake problem scoping at any project site. This entails understanding what ecosystems are present, assessing their condition, and determining the pressures leading to degradation. This is especially true when the demand for coastal engineering is in response to an environmental problem or set of problems, such as shoreline erosion, beach loss, coastal flooding, water quality deterioration, or reduction of aesthetic values.

Mustique (a small island in the Grenadines) provides an example of how ecological assessment and understanding the nature of degradation can influence the engineering solution. Baird was hired to address beach erosion in L'Ansecoy Bay, and when it first began working to stabilize the shoreline in 2010, it quickly became apparent that the desalination outflow was causing seagrass die-off in the shallow waters of the bay. Baird

recommended the outfall be moved offshore. However, in during later work to expand the reach of the beach stabilization using flow-through groynes, it was determined that significantly more seagrass mortality had taken place (Figure 1). Baird therefore recommended that the outfall be moved even farther offshore. Improving seagrass health was important to the goal of beach stabilization over the long term, since the shallow water ecosystems are habitat for the growth of calcareous algae that provide much of the beach sand material.

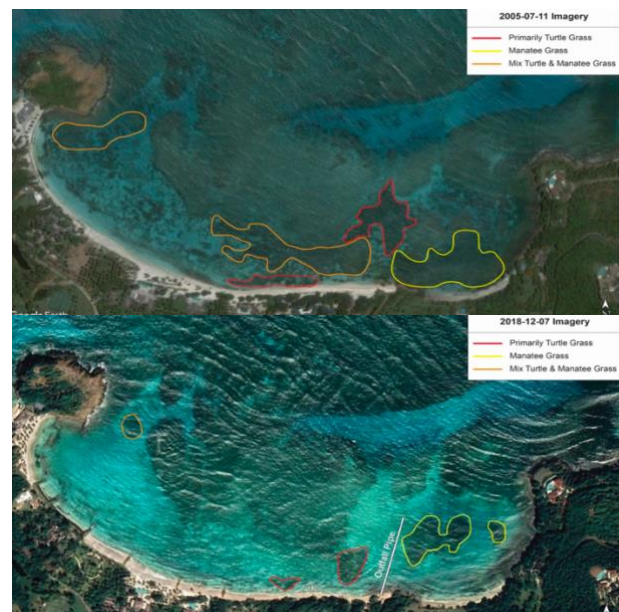


Figure 1. Changes in distribution of seagrasses in L'Ansecoy Bay from 2005 (top) to 2018 (bottom), partly in response to desalination brine discharge, first in the nearshore and later in the mid-bay outfall location.

Coastal planners often reach for solutions without fully understanding the problem they are trying to solve. When Baird takes on a coastal engineering project, it sets out to understand what the client desires, and determine whether that objective is feasible. Without an understanding of ecosystem functioning and the factors that impede it, engineering solutions may not provide the desired or expected outcome. Investing in solid ecological assessment is therefore good business practice.

SECOND, IDENTIFY MEASURES THAT WILL ADDRESS ECOSYSTEM DEGRADATION

To the extent practicable, determining ways to address threats to ecosystem health will ensure that coastal engineering solutions have durable, biodiversity-positive outcomes and that nature continues to deliver valuable ecosystem services. Coastal engineers will likely not be able to implement measures that mitigate all pressures, but

by investing in comprehensive assessment and by flagging priority pressures, they can spur effective management by government and community partners. And there will be some steps to mitigate pressures that can be built into the engineering solution, such as improving drainage and thereby enhance water quality, or reducing erosion that causes siltation on coral reefs. At the same time, adopting conventional 'build with nature' elements, such as planting coastal wetlands or improving the hydrology in mangrove forests, can also enhance ecosystem health, and be part and parcel of 'build for nature' (Manea et al. 2023).

THIRD, TAKE STEPS TO BUILD RESILIENCE IN THE FACE OF PRESSURES THAT CANNOT BE ABATED

There will be many pressures on coastal ecosystems that localized management and engineering cannot address, most notably climate change and related effects such as sea level rise, seawater warming, ocean acidification, and increased intensity of storm events. Acknowledging these factors is necessary to crafting effective engineering solutions to coastal problems, however little can be done to lessen the stressors. It is therefore even more important to lessen the pressures that can be locally addressed, in order to increase the resilience of systems like coral reefs, seagrasses, wetlands, and mangroves, and contribute to maintaining ecosystem health to the maximum degree possible. The increase in ecosystem services that result will have ecological value, as well as social value (Balmford et al 2023).

In Barbados, Baird has partnered with the Coastal Zone Management Unit of the government, which has played a leadership role in coastal management and has set an example for all Caribbean small island states. Baird projects aimed at stabilizing shorelines, enhancing beaches, and providing greater access to coastal lands for both landowners and the public are often coupled to environmental enhancement. Such enhancement can be improving drainage to improve water quality, build submerged breakwaters in such a way as to create nursery habitat for fishes and induce colonization by corals, or prevent flooding and inundation to lessen the amount of nutrients and other pollutants reaching coastal waters. The engineering solution to a coastal problem, coupled to environmental improvements, can kickstart recovery of coastal ecosystems and improve the flow of valuable ecosystem services.

FOURTH, MANAGE EXPECTATIONS

We have mentioned the importance of understanding both the state of the ecosystem and what is possible in terms of crafting a coastal engineering solution. Communicating that throughout the life of the project is crucial, and it is imperative that coastal engineers do not oversell nature-based solutions. Living systems are highly dynamic and because marine ecosystems are open systems with a multitude of pressures affecting them at a variety of scales, there will always be some degree of uncertainty in how well an engineered solution will achieve the desired outcome. It is important to be honest about uncertainties, and help clients understand

the probable (but not precisely predicted) outcomes. Visualizations can help clients imagine the outcome of 'build for nature', but these must be realistic (Pennsylvania State University 2023). And expectations will need to be managed across the life of project.

FIFTH AND FINALLY, PAY ATTENTION TO THE FUTURE

As mentioned, coastal systems are highly dynamic and under a lot of pressure from a diversity of human activities in the area and beyond, as well as climate change. We acknowledge uncertainties, especially as innovative new techniques, tools, and models are harnessed in engineering. Knowing what works and what doesn't, well into the future, improves our collective ability to build for nature. For this reason, Baird feels it is mission critical to monitor projects post implementation, effectively carrying out the sort of ecological assessment that is done at the start of a project and carrying that forward for a number of years. These data serve to improve Baird's efficiency in designing and carrying out projects, for we can learn from both successes and missteps. We also believe in openly sharing that information, to enhance government capacity to manage their coastal systems, and to build the overall body of knowledge about marine ecology and human impact on it.

REFERENCES

Balmford, Keshav, Venmans, Coombs, Groom, Madhavapeddy, Swinfield (2023) Realizing the social value of permanent carbon credits. Nature Climate Change October 30, 2023

Manea, Agardy, Bongiorni (2023). Link restoration to marine spatial planning through ecosystem management to maximize ocean regeneration. Aquatic Conservation: Marine and Freshwater Ecosystems. <https://doi.org/10.1002/aqc.3999>

Pennsylvania State University (2023) Q&A: Seeing coastal storm impacts in advance can help communities prepare. Phys Org Sept 30 2023