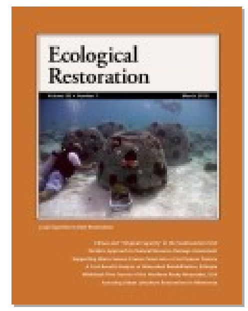
# Avoiding "Band-Aid" Solutions in Ecosystem Restorations

Jason Krumholz, Todd Barber, Catherine Jadot




Ecological Restoration, Volume 28, Number 1, March 2010, pp. 17-19
(Article)

Published by University of Wisconsin Press

**Acknowledgments**

We thank Adam Puderbaugh, Cassie Herringshaw, Dan Anderson, and Rebecca Burch for assistance with sample collection and processing, and Jimmie Thompson, Dean Biechler, Scott Brunsheen, Don Farrar, Kevin Shawgo, John Pearson, and Steve Lekwa for identification of and permission to use sample sites. Support for this project was provided by the Leopold Center for Sustainable Agriculture, the Pioneer Foundation, and McIntire-Stennis funds.

**References**

Anderson, W.B. and W.G. Eickmeier. 2000. Nutrient resorption in *Claytonia virginica* L.: Implications for deciduous forest nutrient cycling. *Canadian Journal of Botany* 78:832–839.

Blank, J.L., R.K. Olson and P.M. Vitousek. 1980. Nutrient uptake by a diverse spring ephemeral community. *Oecologia* 47:96–98.

Eickmeier, W.G. and E.E. Schussler. 1993. Responses of the spring ephemeral *Claytonia virginica* L. to light and nutrient manipulations and implications for the "vernal dam" hypothesis. *Bulletin of the Torrey Botanical Club* 120:157–165.

Lee, K.H., T.M. Isenhart and R.C. Schultz. 2003. Sediment and nutrient removal in an established multi-species riparian buffer. *Journal of Soil and Water Conservation* 58:1–8.

Mabry, C.M. 2002. Effects of cattle grazing on woodlands in central Iowa. *Journal of the Iowa Academy of Science* 109:53–60.

Mabry, C.M., M.E. Gerken and J.R. Thompson. 2008. Seasonal storage of nutrients by perennial herbaceous species in undisturbed and disturbed deciduous hardwood forests. *Applied Vegetation Science* 11:37–44.

Mitsch, W.J., J.W. Day Jr., J.W. Gilliam, P.M. Groffman, D.L. Hey et al. 2001. Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River Basin: Strategies to counter a persistent ecological problem. *Bioscience* 51:373–388.

Mottl, L.M., C.M. Mabry and D.R. Farrar. 2006. Seven-year survival of perennial herbaceous transplants in temperate woodland restoration. *Restoration Ecology* 14:330–338.

Muller, R.N. and F.H. Bormann. 1976. Role of *Erythronium americanum* Ker. in energy flow and nutrient dynamics of a northern hardwood forest ecosystem. *Science* 193:1126–1128.

Peterson, D.L. and G.L. Rolfe. 1982. Nutrient dynamics of herbaceous vegetation in upland and floodplain forest communities. *American Midland Naturalist* 107:325–339.

## Avoiding "Band-Aid" Solutions in Ecosystem Restorations

*Jason Krumholz (University of Rhode Island Graduate School of Oceanography, Narragansett RI 02882, 401/874-6011, jkrumholz@gso.uri.edu), Todd Barber (The Reef Ball Foundation, Athens GA, 30606) and Catherine Jadot (School for Field Studies, South Caicos, TCI)*

One of the more common questions in restoration science is how grassroots organizations can conduct and participate in meaningful and ecologically sound restoration projects. The Reef Ball Foundation (RBF) is a nonprofit organization dedicated to protection and restoration of reef ecosystems. Scientists and other RBF experts have been collaborating for over a decade to develop tools that can be easily implemented in the field by grassroots groups, to facilitate successful localized restoration, rehabilitation, and reintroduction projects. However, restoration efforts such as these, while often showing reasonable localized success rates, have received a fair amount of criticism about their ineffectiveness in the face of large-scale threats to coral reefs, such as climate change and ocean acidification (e.g., Pandolfi et al. 2003, De'ath et al. 2009). In light of these larger threats, small-scale coral restoration efforts have been likened to "treating cancer with a band-aid" (Stone 2007). To this end, we thought we would share a story from our personal experiences that addresses this criticism.

We are often asked whether small grassroots restorations are worth the effort in the face of many of the large-scale threats mentioned above. While it is true that grassroots groups can't reverse climate change or ocean acidification, and they won't be able to singlehandedly stop large-scale overfishing or any of the other manifold pressures facing our reef systems, they can successfully tackle localized problems and simultaneously work tirelessly to raise awareness about the bigger issues. Coral transplant, for example, is one arena in which grassroots groups have demonstrated some success while relocating or restabilizing corals damaged by storms or human activities (e.g., Bowden-Kerby 2001). One of the major services that RBF experts provide is the propagation and rescue of imperiled coral colonies. This process is sometimes quite involved, requiring heavy machinery and advanced techniques, but increasingly the use of more basic techniques for restabilization of loose, fragmented branching coral species, such as those in genus *Acropora*, has been explored (Stone 2007, Garrison and Ward 2008), as these corals have come under higher and higher levels of anthropogenic and natural stress (e.g., Williams et al. 2008). *Acropora* is globally distributed and relatively fast growing, and typically breaks branches in storms, providing many naturally occurring small fragments that can be collected and restabilized—all of these make it an excellent candidate for restoration efforts.

It is worth pointing out that there is some debate in the scientific literature (e.g., Edwards and Clark 1999) regarding whether transplantation efforts should be "wasted" on *Acropora* and other fast-growing branching coral species or reserved for slower growing, longer lived "reef building" corals (such as *Montastraea*, *Diploria*, or *Siderastrea*). While in theory we agree with these authors that the rescue of slower growing, longer lived species is a higher priority, we often choose to work with faster growing species for several

**Figure 1. Project members (*pictured*, Dr. Catherine Jadot) survey storm damage to shoreline mangrove communities at one of the restoration sites along the South Sound of Grand Cayman, British West Indies (BWI). Devising effective restoration techniques for high-energy environments such as this is of critical importance, not only from a conservation perspective, but also because of the ecosystem services such as erosion control provided by healthy mangroves (note major road in background, *left*).** Photo courtesy of www.reefball.com

reasons: 1) fragments are readily available and have low survival rates when not restabilized; 2) changes in growth rates can be detected in just a few years (monitoring *Montastraea* would take decades to get a detectable result); 3) they provide a rapid boost to habitat complexity and create usable void space for fish and invertebrates within a few years of transplant; and 4) *Acropora* is in serious trouble throughout its range in the Caribbean—reestablishing a source of stable recruits may increase natural recruitment rates.

In 2005, RBF transplanted 300 elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) coral fragments onto artificial reef modules in Grand Cayman, British West Indies, using well-established methods. Both species were formerly common and very important shallow-water reef-building corals in the Caribbean, providing critical habitat as well as buffering the coasts from severe storms. However, *Acropora* populations have been hit particularly hard by the combined impact of disease, storms, climate change, and increased sedimentation (e.g., Williams et al. 2008, Pandolfi et al. 2003). Abundance of these species has declined sharply throughout large portions of their range in recent decades, to the point where both are federally listed, and in many portions of the Caribbean, one or both species are considered critically endangered. Both *Acropora* species typically exhibit growth rates in the neighborhood of 5–10 cm per year, but in this particular case the individuals transplanted (as well as the parent colonies) grew at only a small fraction of this rate, even though Grand Cayman is in the center of the range for both species. Something was clearly amiss; a step back was needed to examine the larger picture.

In 2004, Grand Cayman suffered a near direct hit from Hurricane Ivan, at the time a Category 5 storm with winds in excess of 250 km per hour. Among the many casualties from this storm, the island suffered a devastating loss of its nearshore mangrove communities (Figure 1). Mangroves and coral reefs are inextricably coupled. Not only are many reef fish species dependent on the mangroves as nursery grounds, but more importantly, mangroves play a critical role in stabilizing sediment, reducing erosion, and mitigating anthropogenic nutrient fluxes onto nearshore reefs (e.g., Kathiresan and Bingham 2001, Moberg and Rönnbäck 2003). Take away the mangroves, and the corals, already stressed by diver pressure, climate change, disease, bleaching, and ocean acidification, simply don't have a chance.

In response to this, RBF has begun working on a suite of new techniques that make use of existing artificial reef technology applied to the restoration of submerged or partially submerged mangrove communities in high-energy environments (Figure 2). These areas are critical restoration targets because the mangroves buffer against storm damage and protect nearshore reefs from erosion and sedimentation; however, high-energy restoration is an area where traditional mangrove restoration techniques, for example, direct planting and PVC encasement (e.g., Riley and Selgado Kent 1999) have a low probability of success.

Our technique centers around using modified Reef Balls as "armored cultivators" to protect juvenile mangroves until they are able to develop a self-sustaining root network (Krumholz and Jadot 2009). Armored cultivators are designed to be planted in intertidal to shallow subtidal habitats and are made of a concrete mixture that is designed to break down over approximately ten years. The system can either be used with a one- or two–year-old red mangrove (*Rhizophora mangle*) seedling grown in a nursery, or with fresh propagules protected by a removable or biodegradable PVC wrack tube (similar to Riley and Selgado Kent 1999). In this way, the young trees are protected from washout and wrack, and the restoration ultimately (ten or more years down the road) shows little or no trace of human intervention. An initial pilot study of this technique was deployed in Grand Cayman in 2005, and ongoing pilot projects are underway in central Florida and the Florida Keys. Preliminary results (Krumholz and Jadot 2009) indicate that survival rates for this technique, while highly dependent on the health of the propagules used and the local conditions at the specific restoration site (sediment type, wave exposure, etc.), are much higher than those for traditional methods used at the same sites. Growth rates are comparable to those of control mangroves planted in a sheltered nursery. Mangroves planted using this technique appear to have the highest success rates in mid-intertidal to slightly subtidal conditions, where the armored cultivator is submerged at least once per day, but the plant is not completely submerged for more than a few hours at a time. While it is, of course, too early to say whether the restoration of coastal mangrove communities will lead to increased coral health in Grand Cayman, it is

**Figure 2. Project volunteers (*left to right*: Hannah Williams, Dr. Catherine Jadot, David Hudson, and Jason Krumholz) assist in deploying and collecting initial monitoring data for a pilot test of the "armored cultivator" high-energy mangrove restoration technique at the Cayman Islands Sailing Club in Grand Cayman, BWI. Cultivator units (foreground) are filled with local sediment, sealed with a slow-release fertilizer disc (shown on top of cultivators), and anchored in place so the top of the wrack tube is a few inches above the spring high-water level.**
Photo courtesy of www.reefball.com

certainly a step in the right direction, and there are lessons to be learned from the above story.

The major point is that grassroots groups have made and will continue to make a difference. Without help from many local grassroots groups, projects like this can almost never happen. Local expertise, manpower, and willpower are at the center of almost every successful restoration. Furthermore, the Internet has provided a vast and powerful resource through which grassroots groups can communicate to share experiences from their various successes and failures. To this end, we encourage all grassroots groups to carefully monitor and document restoration projects, so we can avoid repeating the same mistakes, and also invite any interested grassroots groups to contact us (reefball@reefball.com) to receive a copy of our *Grassroots Guide to Reef Rehabilitation*, a continually evolving publication which shares our 15-plus years of experience (both good and bad) in planning and executing reef restorations around the world.

There is, however, a caveat to this optimistic message, and it is a constant concern for those who work on coral restoration, often in heavily human-impacted environments (let's face it, there's not much restoration work to be done on pristine reefs). If we are not careful, and we fail to see the big picture, in many cases, we are treating cancer with a band-aid. Too many restoration projects have failed because they attempt to reintroduce a species (whether coral, seagrass, mangrove, or any other species of interest) into a portion of its former range without first addressing the problems that led to its extirpation in the first place. Efforts such as these serve only to needlessly expend limited resources that could be better directed elsewhere and provide ammunition for those who argue that restoration and mitigation are a waste of time and money. In many cases, such as a ship grounding or a storm, reintroduction is a reasonable course of action to give mother nature a "leg up" in getting things back on track. In other cases, a species may be dwindling or failing because local environmental conditions are no longer conducive to its survival and growth. Until we step back and address these problems at their source, restoration is simply not a feasible option.

## Acknowledgments

We would like to thank all of the RBF personnel and volunteers who have taken part in our coral and mangrove efforts in Grand Cayman and Florida. In particular, we owe thanks to B. Chisholm, L. Beggs, and H. Williams for their help in the design and implementation of the armored cultivator technology. We would also like to thank our project sponsors, partners, and beta-test sites for their continued efforts to test and refine this system. This project was made possible by logistical and financial support from the Cayman Islands Department of Environment, and the URI Coastal Institute IGERT Project (NSF grant #0504103).

## References

Bowden-Kerby, A. 2001. Low-tech coral reef restoration methods modeled after natural fragmentation processes. *Bulletin of Marine Science* 69:915–931.

De'ath, G., J.M. Lough and K.E. Fabricius. 2009. Declining coral calcification on the Great Barrier Reef. *Science* 323:116–119.

Edwards, A. J. and S. Clark 1999. Coral transplantation: A useful management tool or misguided meddling? *Marine Pollution Bulletin* 37:474–487.

Garrison, V. and G. Ward. 2008. Storm-generated coral fragments - A viable source of transplants for reef rehabilitation. *Biological Conservation* 141:3089–3100.

Kathiresan, K. and B.L. Bingham. 2001. Biology of mangroves and mangrove ecosystems. *Advances in Marine Biology* 40:81–251.

Krumholz, J. and C. Jadot. 2009. Demonstration of a new technology for restoration of red mangrove (*Rhizophora mangle*) in high-energy environments. *Marine Technology Society Journal* 43:64–72.

Moberg, F. and P. Rönnbäck. 2003. Ecosystem services of the tropical seascape: interactions, substitutions and restoration. *Ocean & Coastal Management* 46:27–46.

Pandolfi, J.M., R.H. Bradbury, E. Sala, T.P. Hughes, K.A. Bjorndahl et al. 2003. Global trajectories of the long-term decline of coral reef ecosystems. *Science* 301:955–958.

Riley, R.W. and C.P. Salgado Kent. 1999. Riley encased methodology: Principles and processes of mangrove habitat creation and restoration. *Mangroves and Salt Marshes* 3:207–213.

Stone, R. 2007. A world without corals? *Science* 316:678–681.

Williams, D.E., M.W. Miller and K.L. Kramer. 2008. Recruitment failure in Florida Keys *Acropora palmata*, a threatened Caribbean coral. *Coral Reefs* 27:697–705.