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Efficacy of Alternative Low-cost Approaches to Mangrove Restoration, American Samoa

ERIC GILMAN^{1,*} and JOANNA ELLISON²

¹ IUCN (The World Conservation Union) Global Marine Programme and University of Tasmania School of Geography and Environmental Studies, 2718 Napuaa Place, Honolulu, Hawaii 96822

² University of Tasmania School of Geography and Environmental Studies, Locked Bag 1-376, Launceston, Tasmania 7250, Australia

ABSTRACT: Three mangrove restoration methods were tested at Nu'uuli, Tutuila Island, American Samoa. Since clearing 27 years ago converted the mangrove into a mudflat, the ecosystem was sufficiently altered that it could not self-correct; the ecosystem showed no natural regrowth despite an ample supply of propagules. While several years of monitoring may ultimately be required to determine the project's success, and several decades could be required to fully return the full suite of functions, the project's low-cost, nontechnical restoration techniques, using readily available materials, have proven to be modestly successful, with 38% sapling survival after six months. Several years of monitoring will be necessary to determine if the restoration site's small elevation deficit relative to a reference site ultimately requires modifying the site's physical structure to correct the hydrology. Direct community participation in the project was critical to reduce the risk of human disturbance of the restoration site. One year project costs were about USD \$2,150 or USD \$13,030 ha⁻¹. Labor comprised 84% of expenses; replicating the restoration project in developing countries would cost less due to lower wage levels. Six months after initial restoration activities, there was a highly significant difference between *Bruguiera gymnorrhiza* and *Rhizophora mangle* sapling survival, with 21% and 45% of the original 42 *R. mangle* and 95 *B. gymnorrhiza* saplings remaining, respectively. The lower *R. mangle* survival may have resulted from an unavoidable need to source saplings from an area with different environmental conditions than the restoration site. Saplings were transplanted into tires filled with sediment as a simple, low-cost method to raise the elevation of the sediment surface. Saplings were also transplanted adjacent to rebar and without any support mechanism. There was no significant difference in sapling survival by treatment for individual or combined species. The restoration project is a model for the community-based, simple, low-cost approaches to ecological restoration needed in the region. Pilot projects using similar techniques may be worth pursuing at the other 15 Pacific Island countries and territories where mangroves are indigenous.

Introduction

Mangrove rehabilitation includes enhancing degraded mangroves by removing stresses that caused their decline, restoring areas where mangrove habitat previously existed, and creating new mangrove habitat where it did not previously exist (habitat conversion). (Mangrove is used here to refer to the mangrove habitat type, community, or mangal, as coined by MacNae [1968] and further defined by Tomlinson [1986], and not the constituent plant species.) These practices contribute to reversing trends in mangrove losses in the Pacific Islands region and globally (Ramsar Secretariat 1999; Valiela et al. 2001). Mangrove rehabilitation also increases resistance and resilience to the myriad of stresses faced by this sensitive coastal ecosystem, including outcomes of climate change such as relative sea-level rise, clearing for development, conversion to aquaculture, and logging

(Hansen and Biringer 2003; Ellison 2004; Gilman et al. 2006, 2007).

The cumulative effects of natural and anthropogenic pressures make mangroves one of the most threatened ecosystems. Roughly 50% of the global area has been lost since 1900 (Ramsar Secretariat 1999; Valiela et al. 2001). Between 56% and 75% of the Asian mangrove area was lost during the 20th century (Primavera 1997; Smith et al. 2001). The remaining 17 million hectares of mangroves continue to decline at a global average annual rate of about 2.1%, exceeding the rate of loss of tropical rainforests (0.8%; Valiela et al. 2001; FAO 2003; Wells et al. 2006).

Pacific Island governments have recognized the value of mangroves and the need to augment conservation efforts (South Pacific Regional Environment Programme 1999). The Pacific Islands contain roughly 3% of the world's mangrove area, a small area in global terms, but each island group has a unique mangrove community structure (Ellison 2000) and mangroves provide site-specific functions and values (e.g., Lewis 1992; Gilman 1998). While a mangrove species may have a wide

* Corresponding author; tele: 808/722-5424; fax: 808/988-1440; e-mail: egilman@blueocean.org