ASSESSMENT OF THE MANGROVE ECOSYSTEM OF TYRREL BAY, CARRIACOU (GRENADA) WEST INDIES




Prepared for:
The Nature Conservancy
Eastern Caribbean Program
3052 Estate Little Princess, Christiansted, St. Croix, USVI

Prepared by:
Gregg E. Moore, Ph.D.
Jackson Estuarine Laboratory
University of New Hampshire
85 Adams Point Road, Durham, New Hampshire, USA

USAID FROM THE AMERICAN PEOPLE

The Nature Conservancy SAVING THE LAST GREAT PLACES ON EARTH

PARKS IN PERIL

ASSESSMENT OF THE MANGROVE ECOSYSTEM OF TYRREL BAY, CARRIACOU (GRENADA) WEST INDIES

PREPARED BY:

GREGG E. MOORE, PH.D.
JACKSON ESTUARINE LABORATORY
85 ADAMS POINT ROAD
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE, USA

"This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID) and The Nature Conservancy through the Award No EDG-A-00-01-00023-00 for the Parks in Peril Program. The contents are the responsibility of YWF-Kido Foundation and do not necessarily reflect the views of The Nature Conservancy, USAID or the United States Government."

This document was produced under contract number EC-GR

ON THE COVER:– HEALTHY FRINGE MANGROVE HABITAT (UPPER LEFT), TRADITIONAL WOODEN SAIL/FISHING BOAT IN SAFE ANCHORAGE (UPPER RIGHT), CONSTRUCTION EQUIPMENT ON EDGE OF FORMER MANGROVE HABITAT (LOWER LEFT), GREEN HERON AMONG MANGROVE BRANCHES (LOWER RIGHT).

1.0 Introduction

Mangroves are the principal vegetation of low-energy intertidal zones of coastlines within tropical and subtropical regions (Lugo and Snedaker 1974, Tomlinson 1986). Within the Lesser Antilles, the few mangrove habitats that remain are comprised or red (*Rhizophora mangle*), black (*Avicennia germinans*), and occasionally white (*Laguncularia racemosa*) mangroves as well as button wood (*Conocarpus erectus*) and salt bush (*Batis maritima*). As the initial barrier between the energy of the coastal ocean and the up-gradient terrestrial ecosystem, fringe mangroves buffer the impacts of coastal flooding and storm damage by forming dense branch and root networks that trap fine sediments and suspended particles and contribute to the maintenance and stabilization of shorelines. This attenuation of tidal energy also promotes the filtering of tidal waters, thus reducing turbity and generally improving water quality. These species provide a unique and effective shelter, substrate, and breeding grounds for a host of economically important marine organisms (Turner 1977, Tomlinson 1980). The density and continuity of the mangrove forest canopy provides extensive habitat and breeding areas for a diversity of avian and reptilian species as well. Characterized by high biological productivity and acting as a source for available nutrients, this unique ecosystem is one of the most ecologically and economically important natural habitats (Costanza et al., 1997).

Figures 1 and 2: Fringing red mangroves (*Rhizophora mangle*) along the seaward edge of the Tyrrel Bay system (left), and a dense networks of roots, known as rhizopohores provide unique habitat for a host of marine organisms (right).

Increasingly, concern for the maintenance of mangrove ecosystems is being expressed in the scientific literature. This concern is being echoed by many governmental and non-governmental organizations alike, extending from their desire to protect direct, economic applications such as fisheries, conservation of wetland habitat, and sustainable ecotourism ventures (Lugo and Snedaker 1974, Ellison and Farnsworth 1996, Farnsworth and Ellison 1997, Imbert et al. 2000). While natural short-term impacts such as hurricanes may cause temporary destruction of mangroves, the forests are readily re-established by seedling recruitment and/or direct regrowth from certain local mangrove species (Baldwin *et al.* 1995). Anthropogenic wetland impacts, however, such as oil spills and eutrophication, harvest of tree and wood products, and alteration of hydrology and clear-cutting for development (Lugo 1990, Ellison and Farnsworth 1996, Farnsworth and Ellison 1997, Imbert et al. 2000) threaten the long-term integrity and functional values of these coastal wetlands. Within the Grenadine region, added threats to the remaining mangroves include land development, reclamation (i.e. filling wetlands to

create buildable upland lots), and encroachment frequently associated with tourism, hotels and marina developments (such as that presently being constructed in within a significant portion of the mangroves of Tyrrel Bay).

The purpose of this report is to qualitatively document the existing mangrove habitat of Tyrrel Bay as well as to highlight current and projected impacts of the marina construction on this threatened ecosystem and its ecological functions and values. Herein, I make reference to other mangrove habitats in Carriaciou and the smaller Grenadine islands to the south, as they are equally threatened by present and future impacts of poor land management and pending development. I am hopeful that this documentation will serve to underscore the importance of these systems, and the critical level of protection and research needed to insure their continued growth and sustainability.

2.0 Site Description

Located in the southwestern portion of Carriacou, Tyrrel Bay (historically referred to as Retreat Bay) contains one of only three mangrove assemblages on the island and is arguably the most ecologically significant due to its relative size (approximately 185-acres), configuration, and potential for wildlife habitat. The mangroves of Tyrrel Bay are cited as one of several ecologically significant areas in Carriacou nominated as a Marine Protected Area and Seascape (Huber et al. 1988). Like the fringe mangroves of Petit Carenage to the north and the basin system at Lauristan, the Tyrrel Bay mangrove includes a dominant stand of red mangrove, interspersed with black mangrove, buttonwood and scattered salt bush. White mangrove was not observed within this system, but has been observed in Petit Carenage and nearby small islands within the southern Grenadines. These observations are consistent with Howard (1952) who reports that red and black mangroves, buttonwood and salt bush occur within Tyrrel Bay, but notes that white mangrove was present only in the Laureston mangrove system.

The Tyrrel Bay system contains mangrove types classified as fringe and basin habitats. Fringe mangroves are characterized by the preponderance of red mangroves along the exposed coastal edge. Fringe systems commonly have relatively low organic accumulation due to regular tidal flushing and increased decomposition rates. As a result, these systems typically have the highest biomass productivity of the mangrove forest types. A marginal basin type community occurs within the interior of the mangrove forest, between the fringe community and the adjacent upland habitat of Harvey Vale. Black mangroves dominate this system with relatively short stature compared to the fringe system. Located further from the direct effects of tidal exchange, these areas may experience prolonged shallow flooding, high salinity, and deep organic accumulation in highly reduced sediments.

Within the fringe habitat, however, the system also has characteristics of a lower-energy lagoon system due to the presence of a protected coastal backwater that winds into the mangrove interior. It is this protected interior that has for many years provided locals a ‘hurricane hole’ or safe haven for fishing and recreational boats during coastal storms and

hurricanes. It is expected that Tyrrel Bay's former name of Retreat Bay is a reference to its virtue in this capacity, as shelter or *retreat* from dangerous storms.

In the lagoon area particularly, and directly adjacent areas outside of the footprint of the developed coastline, are extensive sea grass beds containing species such as turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium* sp.). These plants provide cover during the day for a host of marine species, and constitute the vast majority of grazing habitat for the green turtle (*Chelonidae mydas*).

3.0 Wildlife Habitat Potential

In addition to the occasional use of Tyrrel Bay as a protected shelter, this mangrove maintained a long-standing reputation throughout the Lesser Antilles for its oyster beds growing upon the rhizophores (aerial roots) of the red mangroves fringing the backwater interior. Observed species include the mangrove oyster (*Crassostrea rhizophorae*) and flat tree oyster (*Isognomon alatas*). Like most sessile organisms, oysters are highly dependent on water quality for their success. While particularly tolerant of changes in salinity, temperature and pH (Posa and Rodriguez 1984), increases in nutrients, sedimentation and turbidity can have detrimental effects on their health and survival. During my observations over a six-year period I have noted a decrease in the percentage of live, mature oysters growing along the rhizophores, although no quantitative measurements were performed. Howard (1952) refers to a long history of oyster productivity in these mangroves citing references from travel books published in 1850. He suggests that populations were on the decline in 1950, but again makes no estimate of population density or percentage of population lost over time. Despite declines, the two species of oysters remain along the mangrove fringe, which provides unique habitat not reported elsewhere in Carriacou or the region overall.

Figures 3 and 4: Oysters and tunicates growing on *R. mangle* in Tyrrel Bay (left), and a green heron (*Butorides virescens maculata*) fishing the shallows of a basin mangrove system (right).

Mangroves provide important habitat for a number of bird species that are dependent upon these coastal wetland forests for roosting, nesting and foraging. Without mangrove habitat, it is unlikely that many of these wetland-dependent species would utilize the remaining habitats in Carriacou. Species such as yellow crowned night herons (*Nyctanassa violacea bancrofti*), green herons (*Butorides virescens maculatus*), little blue herons (*Florida caerulea*), great egrets (*Egretta t. thula*), spotted sandpipers (*Tringa*

actitis macularia), ruddy turnstones (*Arenaria interpres morinella*), and greater and lesser yellow legs (*Tringa melanoleuca* and *T. flavipes*) have been observed in the mangroves of Tyrrel Bay, while numerous other species fish frequent the near coastal waters bordering this habitat (including terns, osprey, pelicans and boobies).

4.0 Historical Perspectives

Considered undesirable for agricultural activities and land development until only recently, historical accounts of the mangrove formations within Carriacou are limited or non-existent. Despite this, Howard (1952) briefly describes the mangroves of Tyrrel Bay and Laureston. It is interesting to note, however, that of the competent botanical surveys conducted by Nichols (1891), Beard (1949), and Howard (1952), the significant mangrove of Petit Carenage are not referenced by any of these investigators. In his 1950 survey of Carriacou, Howard notes that the mangrove formation at Tyrrel Bay is marginal, estimated to be approximately 100 yards wide. In contrast, the mangrove at Laureston was referred to as "an extensive swamp" that had in 1861 measured "one mile in length and a half mile wide and [was] open to the sea at its southern end." Howard adds that in 1950, Laureston had been reduced to one quarter its original size due to its entrance being blocked from the sea, subsequent drying out, as well as the unrestricted cutting of mangrove trees.

More recently, Laureston has been reduced to a fraction of its historically documented size, while Tyrrel Bay seems to have been maintained, if not expanded in size. My observations of Tyrrel Bay in 1997, 1999 and 2003 demonstrate that the fringe and basin habitats extend at least twice the area cited by Howard, while Laureston has been all but completely eliminated. While the reduction of Laureston can be clearly attributed to direct resource extraction coupled with a dramatic restriction of tidal exchange (mean porewater salinity < 8ppt), the perceived expansion of Tyrrel bay is not so readily explained. Unfortunately, the case for Tyrrel Bay has dramatically changed over the last two to three years in the wake of an ambitious marina development.

The ecological significance of each of the mangrove areas in Carriacou has been extensively documented and nominated as Protected Areas and Seascapes by the OAS (Huber et al. 1988). This important nomination is supported by the local government, board of tourism, environmental groups and non-governmental organizations – yet this support appears to have not prevented the mangrove of Tyrrel Bay from significant alteration, as outlined below.

5.0 Construction Activities and Development Objective

Based upon documentation posted at the site, the objective of this development project is to construct a multiple slip marina complex with associated appurtenances. This ambitious initiative is being developed by a locally owned group, the Carriacou Development Corporation, Ltd. While construction plans are not presently available for review, a schematic of the development posted at the site suggests accommodations for 80-100 yachts, ample boat hauling and dry storage facilities, and associated marine

services. To my knowledge, no environmental impact report has been prepared, or is available for review. Therefore, it is not clear if the obvious direct impacts of the development will be mitigated on-site or elsewhere, or at what ratio. At present, I will review only the observed and perceived impacts based on the existing conditions. Further assessment should be conducted upon receipt of formal site development plans, draft/final environmental assessment report(s) and the like.

6.0 Observed and Perceived Construction Impacts

Conducted completely within the confines of an ecologically significant area slated as one of several Protected Seascapes (Huber et al. 1988), impacts resulting from the present and continuing construction and development activities may be classified into two main categories, temporary and permanent. Removal of vegetation and soils, placement of fill material, and subsequent destruction of sessile organisms are characterized as permanent impacts, while erosion, increased turbidity and altered water quality, displacement of species, and partial vegetation clearing and vista pruning are characterized as temporary disturbances. Each bear their own consequences on these increasingly threatened habitats, and in this sense are equally significant to the ecosystem services mangrove systems provide.

Figures 5 and 6: Dramatic clear-cut of fringe and basin mangroves of Tyrrel Bay, December 2003.

I estimate that approximately 10-15 acres of fringe and basin mangrove have been directly destroyed and thus permanently altered in this wetland reclamation project thus far. As shown clearly in photos (Figures 5 and 6), the heart of the southernmost fringing red mangroves have been clear-cut. The impacts to the basin portion of this system are less obvious as tree density was lower than in the fringe area, however significant portions have been cut and extensive fill added. These activities have caused both direct and indirect impacts to the plant community and its ability to provide wildlife value respectively. Bird and invertebrate species are expected to be the most significantly impacted, as removal of vegetation would have displaced resident species from this altered habitat. While disruptive, non-sessile organisms should be able to relocate to adjacent unaltered areas, provided that disturbance to the surrounding mangrove does not occur. Sessile organisms, like oysters, anemones, and tunicates colonizing the fringing red mangrove prop roots however, were permanently damaged.

Sands and sediments from the near-coastal areas have been mined and deposited upon the clear cut areas in an attempt to compact the soft, organic sediments underlying the mangrove system. The extent of disturbance associated with sand mining could not be estimated visually, but it is expected that an area at least equal to the footprint of fill within the mangrove had been mined. The removal of sand has created a permanent disturbance to sea grass beds and innumerable benthic organisms caught in the path of the extraction. These activities temporary displace the many species that depend upon this habitat for food and breeding areas. Other clearly observed and documented impacts include erosion and siltation from careless deposition of unconsolidated fill resulting in dramatic increases in water turbidity, particularly adjacent to the construction and reclamation activities, which impact sessile organisms in nearby unaltered areas (Figures 7 and 8).

Figures 7 and 8: Placement of fill without appropriate mitigation to prevent runoff (left), soil slumping and siltation has resulted in severe increases in turbidity to the near coastal waters (right).

7.0 Management Implications

Development is an essential component of maintaining a sustainable and healthy local economy in any area. Development of a marina in Carriacou would seem to be a logical and lucrative business venture that could be a positive catalyst for economic growth on the island. However, when development of such a project is designed within the well-documented boundaries of a proposed Marine Protected Area, promotion of this work seems a miscarriage of environmental justice if not simply detrimental to the overall principle of promoting a green, ecotourism-based land management plan.

Given that the project is under way, a suggestion to land managers would be to consider how the impacts associated with this development might be minimized and mitigated. I would further urge local review of the project to consider how the essential habitat lost may be replaced or restored, or wildlife encouraged to return. Whether restoration is possible or not, education and stewardship campaigns promoting awareness and conservation of the remaining mangroves can be an effective management tool (Shunula 2002). The intent of this report is *not* to stop a development that is inevitable, but merely to document that which has been lost as a result and to protect what remains. Future protection or replacement of ecosystem functions and values begins with a clear understanding of the ecosystem services they once provided.

8.0 Literature Cited

Baldwin, A. H., W. J. Platt, K. L. Gathen, J. M. Lessman and T. J. Rauch. 1995. Hurricane damage and regeneration in fringe mangrove forests of Southeast Florida, U.S.A. Journal of Coastal Research 21: 61-69.

Beard, J. 1949. The natural vegetation of the Windward and Leeward islands. Ox. For. Man. 21: 1-192.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neil, R., Paruelo, J., Raskin, R., Sutton, P., and van den Belt, M. (1997). "The value of the world's ecosystem service and natural capital." Nature, 387, 253-260.

Ellison, A. M. and E. J. Farnsworth. 1996. Anthropogenic disturbance of Caribbean mangrove ecosystems: Past impacts, present trends, and future prediction. Biotropica 28(4a): 549-565.

Farnsworth, E. and A. Ellison. 1997. The global conservation status of mangroves. Ambio 26(6): 328-334.

Howard, R. A. 1952. The vegetation of the Grenadines, Windward Islands, British West Indies. The Gray Herbarium of Harvard University, Cambridge.

Huber, R., Vincent, G., MacFarland, C., and R. Meganck. 1988. Plan and Policy for a system of national parks and protected areas in Grenada and Carriacou. Technical Report to the Government of Grenada, prepared by the Grenada Forestry Department/Organization of American States. 130 pp.

Imbert, D., A. Rousteau and P. Scherrer. 2000. Ecology of mangrove growth and recovery in the Lesser Antilles: State of knowledge and basis for restoration. Restoration Ecology 8(3): 230-236.

Lugo, A. E., S. Brown and M. M. Brinson. 1990. Concepts in wetland ecology. Ecosystems of the World (15): Forest Wetlands. A. E. Lugo, M. M. Brinson and S. Brown, Elsevier. 15.

Lugo, A. E. and S. C. Snedaker. 1974. The ecology of mangroves. Annual Review of Ecology and Systematics 5: 39-64.

Poza, J and R.J. Rodriguez. 1984. Tolerance of the mangrove oyster to variations in temperature, salinity and pH. Venezuelan Acta Scientifica 35(1):

Shunula, J.P. 2002. Public awareness, key to mangrove management and conservation: the case of Zanzibar. Trees 16:209-212.

Tomlinson, P. B. 1980. The Biology of Trees Native to Tropical Florida Published privately, Pertersham, MA.

Tomlinson, P. B. 1986. The Botany of Mangroves Cambridge University Press.

Turner, R. E. 1977. Intertidal vegetation and commercial yield of penaeid shrimp. Trans. American Fish. Society 106: 411-416.