

Impacts of Natural and Human Disturbance On Forests of St. John, U.S. Virgin Islands

By Anne E. Reilly

For years, researchers have been exploring changes in successional patterns and processes in plant community development following disturbance events (Pickett and White 1985). Understanding the disturbance effects on vegetation is important for land managers involved with protection and acquisition of parks and reserves. Effects of both human and natural influences often promote different responses in vegetation.

Human Disturbance

The history of the island of St. John, U.S.V.I., is similar to that of many other islands in the Caribbean. Originally the island was completely forested, but as numerous groups of Ameri-Indians and Europeans settled here, the island landscape began to change. Initially, the impact probably was minor, since many of the early arrivals existed by hunting and gathering. As other groups arrived, some land was developed for subsistence agriculture. Eventually, with the arrival of Europeans, a large scale plantation economy emerged. It is during this period that the greatest changes in the island's forests most likely took place.

Approximately 90 percent of the forests were removed during the 1700s and 1800s, when the sugar-cane industry was at its peak (Tyson 1987). A combination of factors eventually led to the demise of this exploitive economy: emancipation of the slaves, declining soil fertility, increasing erosion, and the low price of sugar. Following this period of intense environmental destruction, the land was abandoned. The few individuals who remained practiced subsistence agriculture; thus, the forests began to recover.

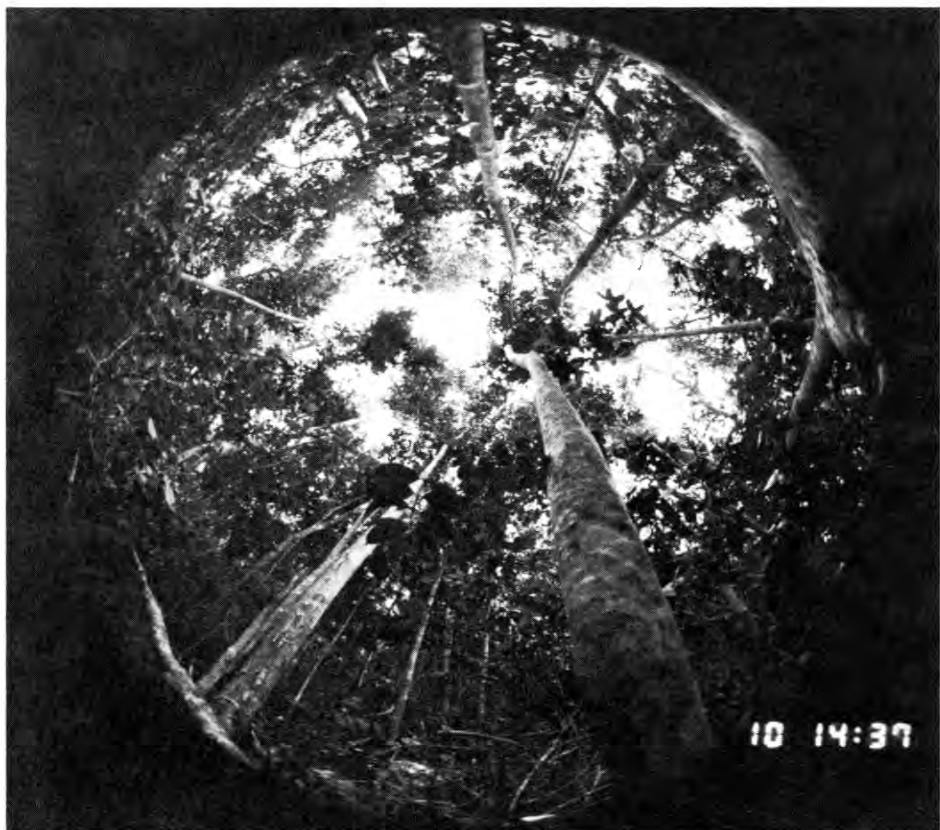
The Virgin Islands were purchased by the United States from Denmark in 1917, and in 1956 approximately 50 percent of the land was designated as a national park. Protection of more than half the island provided a unique research opportunity (Reilly et al 1990).

In 1985-86, the St. John Forest Dynamics Project was initiated with NPS support. Over the years other institutions also have been involved – the Yale School of Forestry, the New York Botanical Garden, The University of the Virgin Islands, and U/GA's Institute of Ecology. The intent of the research program was to monitor forest regeneration in relation to past land use history as part of the Virgin Island Resource Management Cooperative's (VIRMC) islandwide study of three critical watershed systems. This is the sixth year of the long-term monitoring program.

Natural Disturbance

Humans have significantly modified this landscape. Some researchers believe the current vegetation is much drier than what originally was present, due to the long lasting effects of the plantation economy (Woodbury and Weaver 1987). However, natural forces also have played a role in the disturbance regime, hurricanes being the most severe form. It is estimated that once every 70 years a severe hurricane will pass over an island (Neumann et al 1978). The most recent such, affecting St. John, was Hugo in the fall of 1989 (Reilly 1991).

Despite the damage they pack, hurricanes appear to increase species diversity (Weaver 1989). They provide a myriad of habitats, which can support many different species due to variety of light and moisture environments. Empirical evidence from long-term



Looking at the forest canopy through the eye of a hemispherical lens. Image analysis software used in conjunction with the photograph will enable quantification of incoming light.

studies of hurricane influenced forests (Crow 1980, Weaver 1986) indicates specific patterns of forest recovery following hurricanes in terms of species richness, tree density, and basal area.

Forest Dynamics Project

The goal of current research is to investigate the role of disturbance, both natural and human induced (i.e. past land use history) in three forest plots on the island. Disturbance plays a key role in determining the species composition and physiognomy at each site. The degree of disturbance in a particular forest area may promote different responses in the vegetation.

Three permanent forest plots have been established within the boundaries of Virgin Islands NP to investigate the impact of these disturbances. The plots are representative of the surrounding forests, can be separated along a moisture gradient, and are in three different watersheds. Using the local names and the vegetation classifications of Woodbury and Weaver (1987) the areas can be described as: Bordeaux, upland moist forest, 1.0 ha in size, located on the Reef Bay watershed; L'Esperance, gallery moist forest, 1.0 ha, located in Fish Bay watershed; and Hawksnest, dry evergreen woodland, 0.5 ha, in the Hawksnest Bay watershed. Within these plots, all stems 5 cm or greater have been identified to the species level, measured to the nearest mm, and mapped to the nearest 0.5 meter. In addition, 250, 1x1 sub-plots have been established to examine seedling regeneration in the forest plots.

To date, well over 6,000 stems have been examined

for rates of growth and mortality, levels of recruitment, hurricane damage assessment, and other factors. In addition, several hundred seedling plots have been studied to assess changes in species composition and percent cover over time, and – fortuitously for this study – changes due to hurricane damage.

The forest at Bordeaux is approximately 100 years old, based on the plantation's time of abandonment shown in tax records (G.Tyson and S.Edwards, pers. com.). This 1-ha site contains 63 species, represented in 34 families (Table 1). This plot is dominated by native species, of which some of the most common are *Guapira fragrans* (black mampoo), *Pimenta racemosa* (bay rum tree), *Inga fagifolia* (amarat), *Ardisia obovata* (breakbill), and *Byrsonima coriacea* (hogberry).

The L'Esperance plot supports trees that are approximately 80 years old (G.Tyson and S.Edwards, pers. com.) and is home to 56 species in 29 families (Table 1). This 1-ha site also is dominated by native species. Most commonly encountered are *Ardisia obovata*, *Guapira fragrans*, *Andira inermis* (pig turd), *Ocotea coriacea* (pepper cillament), and *Chrysophyllum pauciflorum* (palmat).

Hurricane Impacts

The diameter and height of the stems in the forest, the species composition, and the topography of the landscape as well as the direction of the winds, all affect the response of the forest to a hurricane. Each stem was ranked into a damage class category that

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Table 1. Summary of forest characteristics at three permanent sites.

Study Site	Bordeaux	L'Esperance	Hawksnest
Area	1 hectare	1 hectare	0.5 hectare
Watershed	Reef Bay	Fish Bay	Hawksnest Bay
Approximate Age	100 years	80 years	45 years
Life Zone	Upland Moist Forest	Gallery Moist Forest	Dry Evergreen Woodland
Species and Family Richness	63 species 34 families	56 species 29 families	51 species 27 families
Dominant Species	<i>Guapira fragrans</i> <i>Pimenta racemosa</i> <i>Inga fagifolia</i> <i>Ardisia obovata</i> <i>Byrsonima coriacea</i>	<i>Ardisia obovata</i> <i>Guapira fragrans</i> <i>Andira inermis</i> <i>Ocotea coriacea</i> <i>Chrysophyllum pauciflorum</i>	<i>Melicoccus bijugatus</i> <i>Guapira fragrans</i> <i>Bursera simaruba</i> <i>Ocotea coriacea</i> <i>Eugenia monticola</i>

indicated whether there was loss of a primary or secondary branch or whether the stem was snapped off or tipped over. Results from Hugo suggest that taller and larger diameter trees usually were more severely damaged than shorter, smaller diameter trees; that forests on slopes facing the winds were more damaged than leeward forests, and that low elevations received more damage than higher elevations within each site (Reilly 1991).

Current work is focusing on the recovery of forests to hurricane damage. One method being employed to document these changes is the use of hemispherical photography. A fish-eye lens is used to photograph an upward looking image (i.e. the forest canopy) in a 180-degree field of view. This image is processed with an image analysis software package, to estimate light that is reaching the forest floor and thereby facilitating growth. Six weeks following Hurricane Hugo the canopy above all seedling plots was photographed. In fall 1991, another set was taken in the same locations. Results of this work should indicate the resilience of these systems to natural disturbance.

Changes in percent cover and species composition triggered by the recent hurricane also are being investigated. Data were collected in the spring before Hugo, and then again in the spring of 1991. Preliminary analysis indicates changes in both species composition and percent cover (Reilly unpub. data).

Future work will provide further insight into the patterns and processes of these tropical forest ecosystems. Of specific interest are canopy-seedling interactions, species distributions as influenced by

topographic position, mortality and recruitment rates of native and exotic tree species, and changes in forest composition through time. Understanding the responses of vegetation to the impacts of natural and human disturbance – the sensitivity or the resistance of these systems – should greatly aid management of these limited natural resources.

Reilly is a doctoral student at U/GA's Institute of Ecology. She has been investigating tropical plant community ecology on St. John for the last 6 years.

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