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# History and Ecology of Mangroves in the Dry Tortugas

## Introduction

Dry Tortugas National Park, which includes Bush, Long, Loggerhead, Garden, and Bird Keys, is a cluster of islands and coral reefs approximately 112.9 km (70 miles) west of Key West, Florida (fig. 1). These islands were explored in 1513 by Ponce de León, who named them for the abundance of sea turtles, "tortugas," and the lack of fresh water in the area. Historically, the Tortugas shoals have been valued as a military outpost, and the area is now additionally recognized as nesting grounds for diverse seabirds. The Dry Tortugas were declared a national treasure and bird sanctuary as early as 1908 and were incorporated into the National Park Service in 1935. These islands have been the setting for the U.S. Geological Survey's National Wetlands Research Center (NWRC) research into mangroves and their relationship to bird life.


Fig. 1. Dry Tortugas National Park is known for its coral reefs, colonial seabirds, and Spanish-American fort, Fort Jefferson. Mangrove forest and seabird surveys were conducted on Bush and Long Keys.

## Historical and Ecological Survey

The Carnegie Institute maintained a remote marine laboratory in the Dry Tortugas at the turn of the 20th century. Throughout historical biological investigations in the Dry Tortugas, mangrove trees, which create habitats for birds and marine life, were rarely noted. Naturalist John Henry Davis mapped the vegetation of the Dry Tortugas in 1935 and observed the conspicuous absence of mangroves that are dominant in the nearby Marquesas Atoll and Florida Keys. Consequently, in the protected shoals of Long Key in the Dry Tortugas, Davis planted thousands of red mangroves that survived several years before being washed away by hurricane strikes in the 1940's. Davis wanted to provide a chronological baseline for monitoring the growth, succession, and disturbance of mangroves in the Dry Tortugas.

A recent historical and ecological survey completed by NWRC scientists revealed that current populations of mangroves emerged on Bush and Long Keys after Davis's population was destroyed (fig. 2). The survey included a thorough review of photographs of mangrove colonization as well as anecdotal evidence consisting of historical accounts from early explorers, lighthouse keepers, and military personnel who refer to the presence of mangroves dating back to the mid-1700's. The presence of robust mangrove sites, or stands, on Bush and Long Keys in the Dry Tortugas demonstrates that propagules of all three mangrove species (*Avicennia germinans*, black mangrove; *Laguncularia racemosa*, white mangrove; and *Rhizophora mangle*, red mangrove) drift from the Florida keys and mainland and maintain their viability by recolonizing on these low relief islands.

Fig. 2. Historical photos and contemporary aerial images of the Keys helped USGS researchers reconstruct the history of mangrove colonization in the Dry Tortugas.

### *Hurricane Strikes*

Plant and animal surveys of the reefs and keys of the Dry Tortugas document the history of shoal development and colonization dating back two centuries. Historical evidence shows that the Tortugas Atoll has supported up to 11 low relief islands over this time period with only 8 in existence today. Some of the islands have disappeared and reappeared multiple times as a result of hurricane impact. Historical accounts noting the presence of mangroves coincide with decades of suspended hurricane activity, while the absence of mangroves is associated with periods of hurricane strikes. Exposure to sea conditions and hurricane impact may explain the historical evidence of recurring mangrove colonization on the Dry Tortugas prior to and since Davis's plantings. Because hurricane strikes have not affected the Dry Tortugas since the mid-1960's, 30 years of relative calm has fostered mangrove colonization.

### *Recent NWRC Field Inventory Findings*

Although mangroves are a salt-tolerant species with salt-filtering mechanisms in their roots and leaves that allow them to thrive in a saltwater environment, the flourishing, robust mangroves of the Dry Tortugas are anomalies because they grow on coral islands without organic matter. In 1995, 1997, and 2001 researchers conducted field inventories to identify the structure and composition of healthy mangrove stands and conditions that account for their current colonization and stature. Tree size and density by species were measured in fixed circular plots at Bush and Long Keys. Surface and interstitial water samples were collected to characterize the salinity, pH, and nutrient concentrations for each site.

## Mangrove Populations on the Keys

When researchers compared historical maps and photos taken by Davis in 1942 to recent aerial photography, they found that the north end of Bush Key has undergone much shoreline erosion since the 1940's. Beach erosion may be hastening the death of the red and white mangroves that have grown to 20-25 cm (8-10 inches) diameter at breast height (dbh) over the last 50 years. While emergent red mangrove saplings were found inside the beach dune, many were dying from an excess input of nutrients from pelican guano, and others were extremely chlorotic, or experiencing a loss of chlorophyll (fig. 3).

Researchers found a mixed mangrove stand containing all three species, black, white, and red, on the east end of Bush Key. The largest canopy trees approached 14 cm dbh and 7.5 m high (6 inches dbh and 25 ft high) and are estimated to be 25 years old. Researchers also established plots on the north and south ends of Long Key in a fairly large stand consisting of mature mangroves of all species, the largest and tallest of which were 25 cm dbh and 15 m high (10 inches dbh and 49 ft high). Personal accounts and dated aerial photography confirm a stand age of 50 years or younger.

Fig. 3. Large mangroves on the north end of Bush Key are succumbing to a combination of beach erosion and increased concentrations of phosphate and nitrate from the accumulated droppings of roosting pelicans.

## Frigatebird Association

The period between major hurricane events in the Dry Tortugas may have provided the opportunity for mangroves to develop sufficient size and density to attract nesting seabirds. A colony of magnificent frigatebirds (*Fregata magnificens*) that is thought to have migrated westerly from previous nesting grounds in the Marquesas Atoll circa 1989 occupies the most developed mangrove stands, those approaching 15 m (49 ft) in height along the extended shoal of Long Key (fig. 4). Frigates have been observed in the Dry Tortugas area for most of the last century either roosting or feeding, and recently, researchers confirmed that they have nested in the area as well. The current population number of frigates is estimated at 100-150 breeding pairs. The nutrient input of nearby colonies of frigatebirds provides fertile growing conditions for the mangroves.

Scientists determined age estimates and growth rates of young red mangrove saplings from Bush Key by measuring internodes, or stem lengths between leaf scars. They based mangrove growth potential and seasonal elongation patterns on growth rates from 1995 to 1997 to calculate tree age and yearly productivity. Age estimates based on seasonal growth cycles indicated that the red mangrove saplings were 10-12 years old by 1997. Increased internode elongation patterns coincided with the nesting history and relocation of a frigatebird colony to the island.

Laboratory results demonstrated orders of magnitude differences in nitrate and phosphate concentrations in the vicinity of frigate roosts. These findings indicate that seabirds dependent on mangroves for nesting and roosting increase nutrient loads in surrounding soils and waters. The added nutrients improve mangrove photosynthesis and water-use efficiency, resulting in enhanced growth. While mangrove-dependent seabirds elevate nutrient levels of surrounding seawater and sustain largely favorable growth conditions for mangroves, excessive nutrient loading can cause overgrowth stress and kill them. The relationship between breeding bird populations and mangrove community development and decline poses an important research and management question for the Dry Tortugas National Park.

Fig. 4. Frigatebirds have claimed the flourishing mangroves on Long Key as their current nesting site.

## Risk of Destruction

If mangroves on the Dry Tortugas withstand hurricanes and the influence of humans, they can achieve stand stature and density comparable to mainland populations, despite less than favorable conditions. The current risk of destruction to mangrove habitat and nesting sites remains high, however, depending on the recurrence and intensity of future hurricanes. NWRC researchers hope to monitor the health and resilience of mangroves of known stand age in order to develop and validate simulation models of mangrove growth and colonization in the Dry Tortugas.

**For more information, contact**

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