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CASUARINA-INDUCED BEACH EROSION REVISITED

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ABSTRACT

In 2003 the concept of beach erosion as a consequence of *Casuarina* invasion was presented to the Symposium. Since that time it has been possible to visit further areas suffering from *Casuarina* invasion and examine the effect on beach erosion. In addition the original site of Small Hope Bay has been revisited following the progressive removal of *Casuarinas* by the owner. In other areas, including Abaco and Eleuthera, *Casuarina* removal has been instigated as a direct result of the original article, and it has been possible to study the impact of the removal and the planting

of native species in a variety of different settings. In all cases the original assertion of related beach erosion has been confirmed. Where removal has been conducted there has been a rapid establishment of native species and the restoration of beach and dune.

INTRODUCTION

The paper presented in 2003 was titled *Small Hope Bay, a Case Study in Casuarina-Induced Beach Erosion* (Sealey 2005, also see Sealey 2006). Based on existing chronic beach erosion threatening the Small Hope Bay resort in

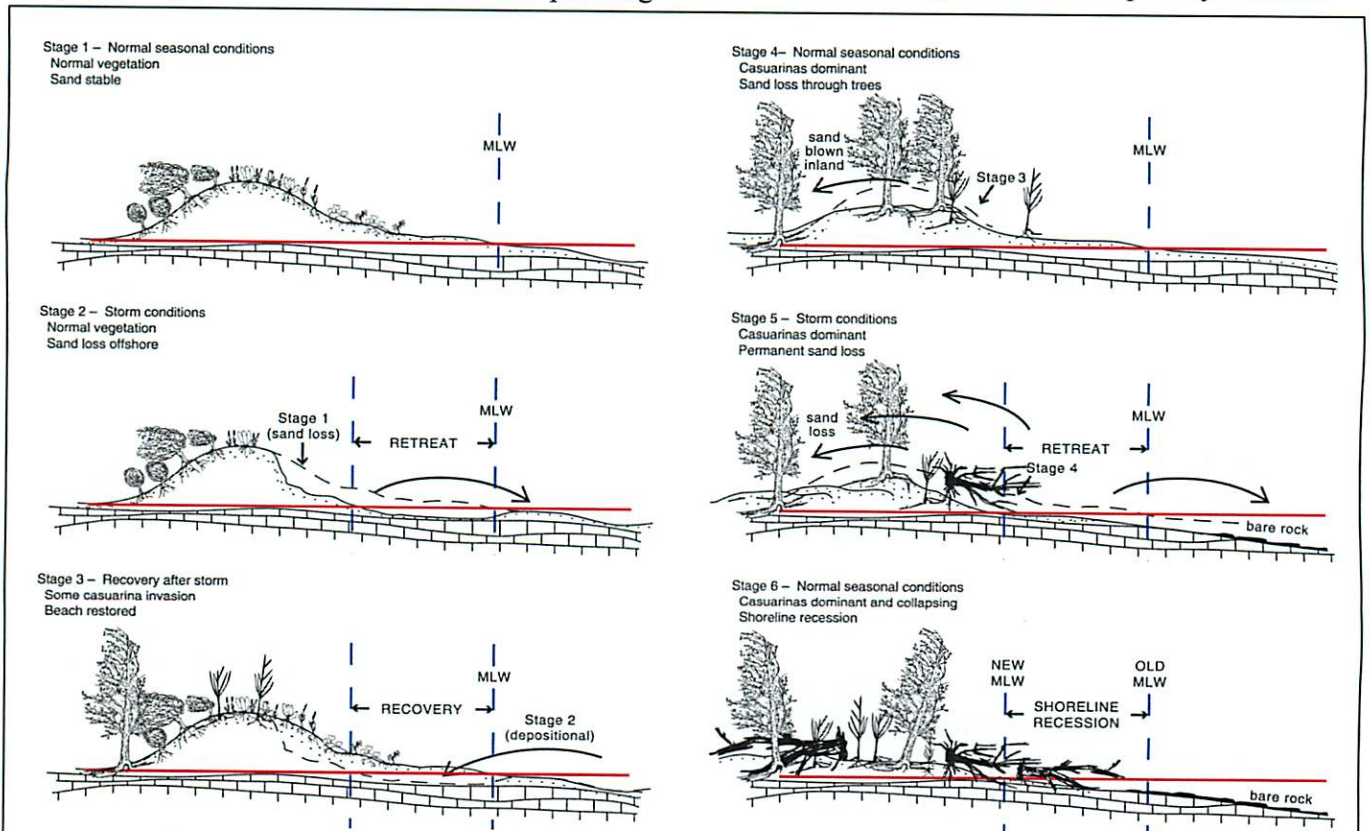


Figure 1. The stages of the cycle showing the transition from stable beach and dune to eroded and retreating beach. (MLW = mean low water mark).

North Andros, but using observations and other studies from around The Bahamas, the hypothesis was made that the Casuarinas invaded cleared or damaged land. Once established, which doesn't take long, the Casuarinas suppressed the local vegetation due to their poisonous impact on the ground around them. This resulted in bare sand under the trees which under storm conditions was washed inland, and lost from the beach and dune forming processes. This caused beach recession,

and the sacrificial presence of the Casuarinas ensured that this became a permanent state as long as the Casuarinas reseeded themselves and occupied the foreshore (Figure 1).

- The Small Hope Bay investigation suggested that this was due to the suppression of other vegetation beneath the trees.
- This led to sand blown onshore not being trapped to form dunes.
- The ideal situation under storm conditions is for sand from the face of a dune to be transported offshore. It is then available to rebuild the beach when normal conditions return (Figure 2).



Subsequent studies and observations have established the following additional support for the

Figure 2. Normal reconstruction of eroded dune without casuarinas on Windermere Island.

proposition, namely:

1. Areas with extensive Casuarina invasion show chronic erosion.

2. Beaches without Casuarinas show rapid recovery after storm damage.
3. Stretches of beach with Casuarinas alternating with natural vegetation show differential erosion.
4. Areas cleared of Casuarinas show rapid sand accumulation with or without replanting.

AREAS WITH EXTENSIVE CASUARINA INVASION SHOW CHRONIC EROSION

Casual observation of a number of shorelines show extensive Casuarina presence, and in most cases these shorelines are eroding. The Small Hope Bay investigation suggested that this was due to the suppression of other vegetation beneath the trees, although this may not be total. This led to sand blown onshore not being trapped to form dunes, so that during storm episodes there was nothing to stop massive beach erosion and sand loss onshore, where it stayed. These sites show Casuarina presence and erosion. The ideal situation is sand from the face of a dune being transported offshore where it is available for return to the beach when normal conditions return (Figures 3 and 4). A report from a developer in the Turks and Caicos, who had read the Small



Figure 3. Chronic erosion and shoreline retreat after loss of dune at Small Hope Bay, North Andros.

Hope paper, called to say the situation on West Caicos was identical to what was described, and he planned to remove the Casuarinas.



Figure 4. Total loss of beach and dune at Blanket Sound, North Andros



Figure 6. Well-developed beach/dune system on Long Island. Sand removal in left foreground may cause future problems.

The invasion of Casuarinas is illustrated by the total occupancy of the spoil island created by Disney at Guana Cay. It is comparable with the colonization of the virgin slopes of the new Krakatoa in the eighteenth century.

It is also worth noting that no vegetated shorelines have been found with chronic erosion except those with Casuarinas.

BEACHES WITHOUT CASUARINAS SHOW RAPID RECOVERY AFTER STORM DAMAGE.



Figure 5. Stable dune and beach without Casuarinas on Rum Cay

Fortunately there are still a number of these in The Bahamas, not least on San Salvador. The details of East Beach and its recovery after storms have been studied and detailed elsewhere (Beavers et al, 1995), but similar beaches exist along many shores, including Cat Island and Long Island (Figures 5 and 6). Under normal conditions a sequence of vegetation establishes itself, leading to the formation of a sand dune. Dunes will form on any shore, but the highest are those facing the Atlantic. Rebuilding after damage is rapid and continuous.

- Under normal conditions a sequence of vegetation establishes itself
- Dunes will form on any shore, but the highest are those facing the Atlantic
- Rebuilding after damage is rapid and continuous.

STRETCHES OF BEACH WITH CASUARINAS ALTERNATING WITH NATURAL VEGETATION SHOW DIFFERENTIAL EROSION.



Figure 7. *Casuarina* invasion causing erosion in healthy beach at Staniel Cay, North Andros.

While the mere presence of *Casuarinas* dominating a beach and associated with erosion does not necessarily prove that *Casuarinas* were responsible, the presence of erosion associated with *Casuarinas* on a beach that also has a natural dune with native vegetation is instructive. In these cases we can see that the *Casuarina* areas are hollowed out and contain little native vegetation. In most cases these areas have not accumulated sand and would be easily breached under storm conditions. Andros as usual provides good examples,



Figure 8. *Casuarina* intrusion and dune retreat within stable dune on Paradise Island.



Figure 9. Chronic erosion of dune beneath *Casuarinas* shown in figure 8.

(Figure 7) but even in New Providence there is a surprising example on Paradise Island.

Despite Atlantis's understanding of the nature of *Casuarinas*, which they removed en masse from all parts of their property in the 1990s, adjacent properties haven't learned the importance of natural vegetation, and between two Atlantis properties is an island of *Casuarinas* with accompanying erosion (Figures 8 and 9). Atlantis responds quickly to limited damage with beach scraping.



Figure 10. Loss of beach at South Ocean, New Providence. Adjacent area without *Casuarinas* is stable (Figure 11).



Figure 11. Healthy accreting beach immediately east of site in Figure 10 – Casuarinas visible in background.

In the south of New Providence a popular public access point has classic Casuarina-induced beach erosion, but as soon as the adjacent Albany house is reached erosion has been stopped and there is clear evidence of accretion (Figures 10 and 11).

- The presence of erosion associated with Casuarinas on a beach that also has a natural dune with native vegetation is instructive.
- The Casuarina areas are hollowed out and contain little native vegetation.
- These areas have not accumulated sand and would be easily breached under storm conditions.

AREAS CLEARED OF CASUARINAS SHOW RAPID SAND ACCUMULATION WITH OR WITHOUT REPLANTING

(Robin Lewis reported that after clearance of Casuarina-infested wetland at West Lake along the Intra Coastal Waterway near Hollywood, Florida, mangroves established themselves without seeding once the original hydrology was restored. Details are at <http://www.lewisenv.com>).

John Rodgers and Doug Gamble have recently published a study (Rodgers and Gamble 2008) indicating that hurricane Frances in 2004 had a minimal effect on Casuarinas, which survived mostly intact in coastal and inland areas. Rodgers is further studying the spread of Casuari-

nas along San Salvador shorelines. He reports that 'At East Beach, there are a lot more new Casuarinas in 2008 and the coordinates show that it has greatly expanded its range along the beach.' (Personal comm. 2009). Other sites showed no increase but this might be because of existing saturation at one site, and all terrain vehicles killing seedlings at another.

The northern end of Windermere Island is an interesting case. The proprietor came across a copy of the Small Hope paper and, recognizing an almost identical situation on Windermere Island, had all the trees on his property removed. Subsequent surveys show a stable or accreting beach (Figures 12 and 13).

An adjoining section of shoreline with Casuarinas still in place has continued erosion and the owners have resorted to geotextile beach tube protection. Study of these tubes has suggested



Figure 12. Windermere Island with dominant Casuarinas prior to 2004. (Photo: Carry Rich)



Figure 13. Windermere Island beach after Casuarinas removal. Note that beach now extends under and behind Casuarinas remains.

they are only a short-term solution at best and likely to fail when exposed to direct wave attack (<http://chl.erdc.usace.army.mil/library/publications/chetn/pdf/chetn-ii-51.pdf>). They need to be kept covered with sand, and a 50 feet wide beach should be maintained in front of them for this purpose.

On Guana Cay on a south-facing shore, replanting after massive *Casuarina* removal with plugs of sea oats led to a steady regrowth and moderate sand accumulation. (Figures 14-16) The dune also aligned itself after planting where the plant line was not synchronized with tidal movement (Figure 17).



Figure 16. Replanting the beach with sea oats after *Casuarina* removal, Guana Cay, Abaco, 2005.



Figure 14. Massive *Casuarina* infestation of Disney site on Guana Cay, Abaco



Figure 17. Reconstructed beach after removal of *Casuarinas*, Guana Cay, Abaco.



Figure 15. Aggressive removal of *Casuarinas* by developers of Guana Cay, Abaco, 2005.

At Small Hope bulldozing and some dune reconstruction using gabions and plants has led to some sand retention. This can be compared with uncleared areas that still show erosion and retreat.

To sum up:

- Re-establishment of native species occurs without replanting.
- Sand accretion is matched by vegetation growth.
- Replanting speeds up the process on sheltered shores.
- Vigilance is needed to suppress *Casuarina* regrowth.

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Mr. Jeff Birch of Small Hope Bay Lodge initiated this study by drawing attention to erosion at Small Hope Bay, and subsequently conducted corrective measures. He has been a faithful advocate of Casuarina removal and provided access to his property again in 2008. My wife Kathleen provided information and assistance in the study of the Casuarinas on Guana Cay, and I am indebted to Dr. Livingston Marshall and the Discovery Land Company for their support and access to their property on many occasions. Mr. Carry Rich of Windermere Island provided access to his property and encouraged the study of Casuarinas and their removal on his property, and was invaluable in providing further insights into beach erosion after Hurricane Floyd. John Rodgers graciously provided advance details of his studies on Casuarinas. John Mylroie, Doug Gamble, Al Curran, Vince Voegeli and Tom Rothfus, and many others, assisted on a number of field trips, and my thanks go to all these co-workers.

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