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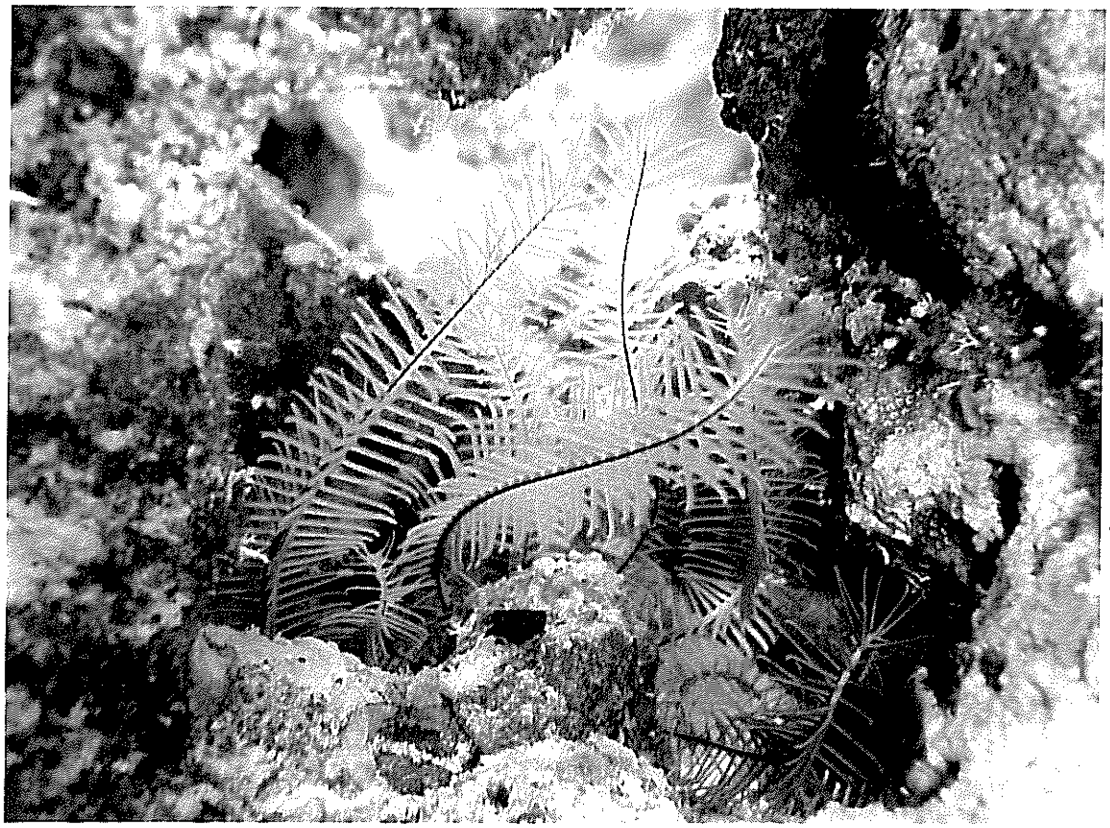

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SEASONAL SEDIMENT TRANSPORT AND UNUSUALLY LARGE SPIT DEVELOPMENT AT SANDY POINT, SAN SALVADOR, BAHAMAS

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ABSTRACT

Sandy Point forms the southwest corner of San Salvador and is the widest and most dynamic beach system on the island. Previous studies of sand transport dynamics at Sandy Point documented a seasonal pattern of sand movement by longshore currents around the point (Loizeaux et al., 1993; Beavers et al., 1995). During periods of fair weather, the prevailing easterly trade winds transport sand to the west, around the point, and north. Northwesterly storms, most common in the fall and winter months, generate sand movement to the south and east along the south-facing side of the point.

A pronounced event of fair-weather sediment transport was observed and photo-documented during the summer of 2003. By mid summer, an exceptionally large sand lobe or spit was fully developed on the west side of the tip of Sandy Point. Such spits have been noted in the past, but this was the largest spit observed in recent memory. With erosion of sand from the south-facing beach by longshore currents, a prominent and virtually continuous ridge of beachrock striking east-west was exposed in the intertidal zone. To our knowledge, this extensive beachrock feature has not been reported previously. These conditions persisted until the end of the summer. By mid-September 2003 initial migration of sand from the spit back around Sandy Point and to the east had commenced, and by mid-January 2004 normal "winter beach" conditions prevailed. During late spring and summer 2004, a large spit again developed at Sandy Point. The summer-season cycle of sediment transport was abruptly terminated on September 2, 2004 by the passage of Hurricane Frances directly over San Salvador. Although vestiges of the Hurricane Frances event remain at Sandy Point, by January 2005 both the west-facing and south-facing beaches were in their normal seasonal configuration.

Future development at Sandy Point should be planned with full consideration of the pattern of seasonal sand transport that dominates this beach system. In addition, given the hazard of tropical storms and hurricanes, prudent set-back of new construction sites should be observed.

INTRODUCTION

Sandy Point on San Salvador is aptly named, as this is the widest and most dynamic beach on the island. Located at the southwest corner of San Salvador, the Sandy Point beach extends from the Holocene sea cliffs immediately south of the Grotto Bay beach around the point and eastward to headlands of late Pleistocene rock, a distance of about 2 km (Figure 1).

Previous studies of the beach dynamics at

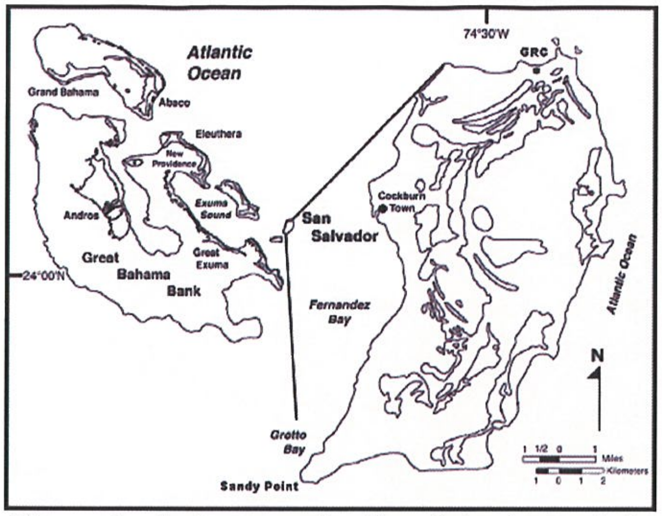


Figure 1. Index map for San Salvador and the location of Sandy Point at the southwest corner of the island.

Sandy Point by Loizeaux et al. (1993) and Beavers et al. (1995) revealed a pronounced pattern of seasonal sand transport by longshore currents around the point. The purpose of this paper is to document seasonal events of unusually large spit development at Sandy Point that were first observed in mid- to late-summer 2003 and were repeated to a somewhat lesser extent in summer 2004. In addition, the effects on Sandy Point of Hurricane Floyd in 1999 and Hurricane Frances in 2004 are briefly discussed.

GENERAL "RULES" OF SEASONAL BEACH DYNAMICS AT SANDY POINT

The seasonally changing morphology of the beach at Sandy Point, first reported by Loizeaux et al. (1993), was confirmed in the paper by Beavers et al. (1995) that summarized the work from several years of monitoring change in the beach at Sandy Point. Subsequent unpublished reports on beach morphology at Sandy Point by students in the January-term carbonates geology course at Smith College have reaffirmed these seasonal sediment transport patterns.

In simplest terms, during periods of fair weather, longshore currents generated by the prevailing easterly trade winds transport sand from east to west and around Sandy Point and then north. Long periods of fair weather, most commonly occurring from late spring or early summer to late summer or fall, result in spit development on the west side of Sandy Point. Northwesterly storms or fronts from the North American mainland provide the energy for sand transport from north to south and around the point to the east. These storms occur most commonly during the fall and winter months, and they result in the erosion of the spit, accompanied by widening of the southward-facing beach, and the formation of ridge and runnel features at Sandy Point. In some years, the runnels are spectacularly large.

Of course, there are many variables in even this simple model for sand transport at Sandy Point. For instance, northwesterly "winter" storms can occur out of season or periods of fair weather trade winds dominance can have longer than normal duration. The greatest "wild card" is the occurrence of tropical storms and hurricanes. Such storms have affected Sandy Point in the past and will continue to do so in the future, but each storm is different in terms of direction of approach, strength, and duration. At this time, we do not have sufficient observations on the effects of tropical storms and hurricanes on Sandy Point to make even a general statement regarding their effects. We do know that in September 1999 Hurricane Floyd caused significant erosion of the beach and dunes on the west-facing side of Sandy Point (Curran et al., 2001, Figure 6), whereas Hurricane Frances in September 2004 had minimal long-term effect at Sandy Point but generated much damage to infrastructure and caused major beach erosion on the east and northeast coasts of the island (Parnell et al., 2004).

SPIT DEVELOPMENT – SUMMER 2003

The initial observations of unusually large spit development at Sandy Point were made by Vince and Sandy Voegeli in July 2003. Oblique aerial photos taken on July 23, 2003 (Figure 2A, B) show the spit in full development, extended well to the west and with a slight curvature to the north. Unfortunately, no ground measurements of the total length of the spit were taken, but with careful examination of the aerial photos and knowledge of distances from previously surveyed beach profile points on Sandy Point, we estimate that, by July 23rd, the spit reached a length of at least 200 m from the normal winter position of the foreshore beach on the west side of Sandy Point. In all likelihood, the spit grew even more before the end of the summer.

By September 10, 2003, the beach on the south-facing side of Sandy Point was quite narrow, with its sand having been transported westward to feed the growth of the spit. With the removal of sand, a nearly continuous ridge of beachrock, running from the eastern rocky headland west and parallel with the south-facing beach was exposed in the intertidal zone (Figure 2C-E). This is the first report of the existence of this beachrock ridge, which we believe is normally completely buried by foreshore beach sand. The Voegelis found a large engine block firmly cemented into the beachrock, attesting to the very recent time of origin of this beachrock ridge.

The Voegelis also made a scuba dive from the west end of the spit into an area of small coral patch reefs and out to the edge of the steep "wall" at the shelf-slope break. They reported very turbid conditions in the water column with partial burial of some of the smaller patch reefs. Streams of sand were moving downslope in channels through and around the reefs. This sand is forever lost to the deep.

By September 14, 2003, sand was beginning to move from west to east along the south-facing beach at Sandy Point, filling in the areas of exposed beachrock (Figure 2F; compare with Figure 2D of September 10th). Presumably this process continued intermittently throughout the fall. During the fall season, the frequency of north-westerly storms undoubtedly increased, resulting in erosion of the spit and transport of its sand back to the east, to be welded to the south-facing beach.

EVENTS OF 2004 - EARLY 2005

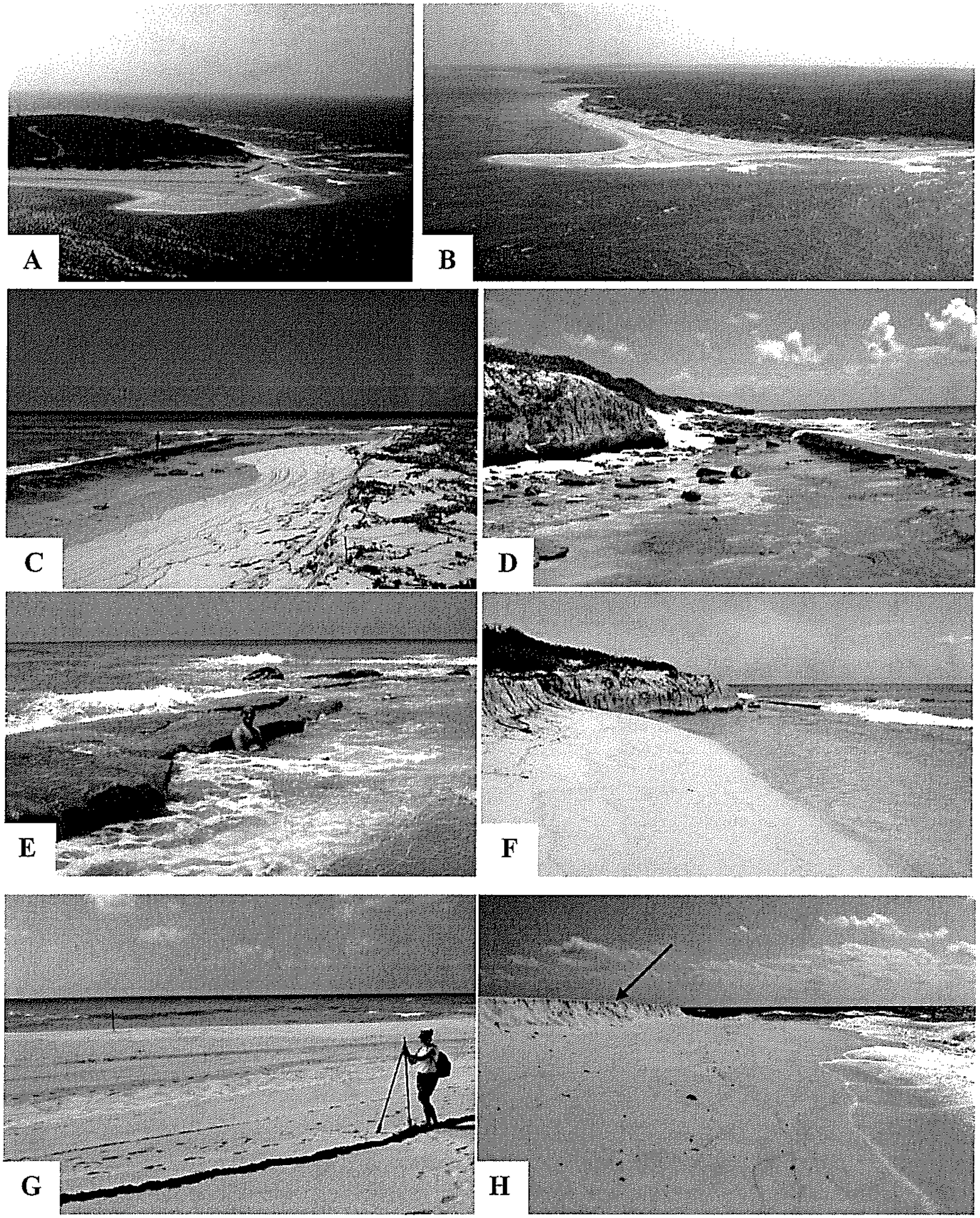
January 2004

By mid-January 2004, the south-facing beach at Sandy Point was wide (Figure 2G) and exhibited its usual seasonal ridge and runnel morphology. The spit, so prominent during summer 2003, was gone, and an erosion scarp was present on the westward-facing beach at Sandy Point. This scarp (Figure 2H) was particularly prominent south of the Savio House, the southern-most beach house on the west side of Sandy Point. A beach profile taken in January 2004 a short distance south of the Savio House (Station 3 of Loizeaux et al., 1993, and Beavers et al., 1995) was about 15 m wider than a profile made at the same station in 2002 (Figure 3), but the general shape of both profiles was similar, reflecting the overall seasonal erosional conditions on this west-facing side of Sandy Point.

Summer and Early Fall 2004

An aerial photo taken over Sandy Point on June 3, 2004 (Figure 4A) showed that Sandy Point spit development was right on schedule, larger than expected, and comparable in size to that of 2003. A ground-based photo taken on July 12th, showed the presence of a wide west-facing beach just south of the Savio House (Figure 4B). Interestingly, the beachrock ridge on the south-facing beach was again emergent (Figure 4C), although not to the extent observed in summer 2003. A photograph taken on August 29th (Figure 4D) suggests that sand was beginning to fill in over the beachrock by this date.

Four days later, on September 2, 2004, Hurricane Frances passed directly over San Salvador. The hurricane track map of Parnell et al. (2004, their Figure 4) indicates that Sandy Point received strong wind and wave energy from the northwest. Parnell et al. (2004, p. 4) reported evidence of a large storm surge and erosion at Sandy Point. Although the Parnell et al. (2004) report gave few specifics, Hurricane Frances undoubtedly provided much of the energy needed to erode away the large summer spit. Our model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←Figure 2. A) July 23, 2003 – aerial view of Sandy Point from the west showing development of the large spit. B) Same date – view of the spit from the south. C) September 10, 2003 – view looking west showing the emergent ridge of beachrock in the intertidal zone and paralleling the south-facing beach at Sandy Point. D) Same date – view of the beachrock ridge looking east toward the Pleistocene rock headland. Note that most beach sand has been transported away. E) Same date – close-up of the beachrock ridge, Vince Voegeli for scale. F) September 14, 2003 – view looking east showing filling of sand by longshore transport from the west; compare with photo D above. G) Mid-January 2004 – view at Sandy Point looking south; note the wide beach. H) Same date – view from the west-facing beach looking south from the Savio House; note the erosion scarp on the beach (arrow).

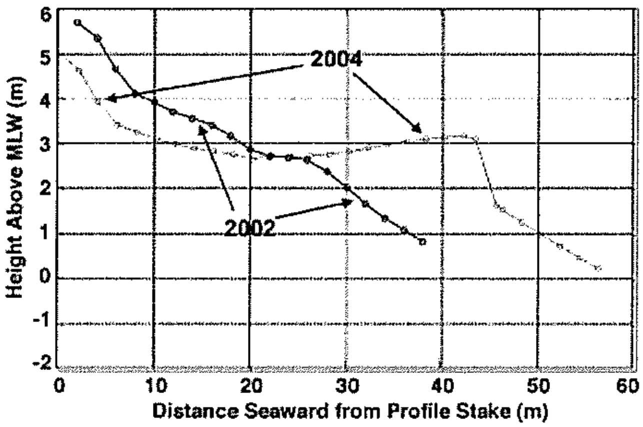

Figure 3. Comparison of January beach profiles made on the west-facing beach at Sandy Point at a profiling station a short distance south of the Savio House (Station 3 of Loizeaux et al., 1993 and Beavers et al., 1995). Although the 2004 profile recorded a wider beach that in 2002, both profiles revealed the narrow beach with steep foreshore that is typical of January beach morphology for this reach of Sandy Point.

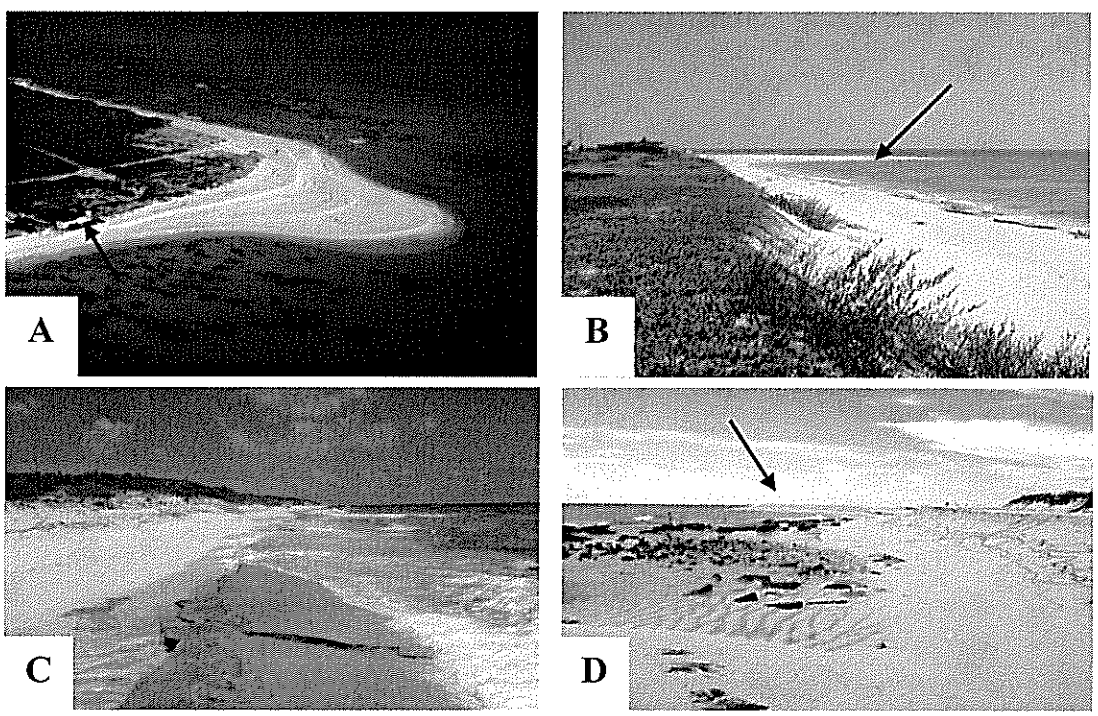

Figure 4. A) June 3, 2004 – aerial view of Sandy Point showing development of another large spit. Arrow indicates location of the Savio House. B) July 12, 2004 – view of the west-facing beach at Sandy Point looking south from the Savio House; note the wide beach and compare with Figure 2H. Arrow marks position of the spit. C) Same date – view from the south-facing beach looking east; note the emerged beachrock ridge and compare with Figure 2D. D) August 29, 2004 – view from the south-facing beach looking west; note that newly transported sand is beginning to fill in and cover the beachrock. Arrow marks position of the spit.

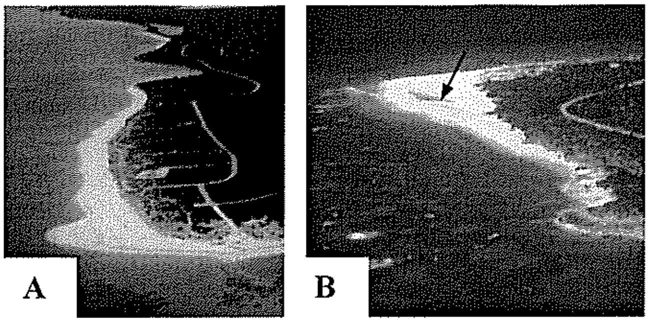

Figure 5. Some older aerial photos of Sandy Point. A) July 1990 – stage of normal spit development, not to the degree observed in 2003 and 2004. Estimated length of this spit is 100 m. B) January 1996 – the spit is gone and the south-facing beach is wide and dominated by ridge and runnel topography. Arrow points to a large runnel.

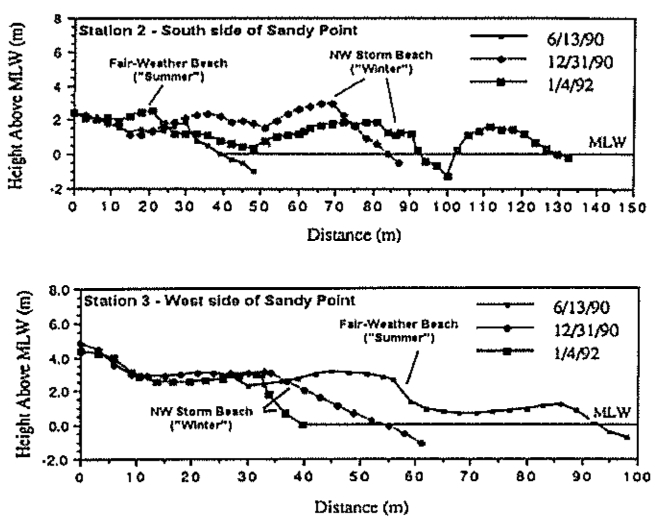

Figure 6. Composites of beach profiles comparing the seasonal sand transport effects on the south-facing beach versus the west-facing beach at Sandy Point. Note that the south-facing beach (top profiles) is narrow in summer and wide in winter whereas the west-facing beach (bottom profiles) is wide in summer and narrow in winter. Modified from Loizeaux et al., 1993.

holds that the eroded sand of the spit moved via longshore currents around to the offshore area on the south side of Sandy Point. In a real sense, Sandy Point was buffered from the effects of Hurricane Frances by the presence of its seasonal spit and wide beach on the west-facing side of the point.

Winter 2005

Al Curran made a brief reconnaissance visit to Sandy Point on January 19, 2005. Although the storm surge line of Hurricane Frances was evident, the beaches on both the west and south sides of Sandy Point were within their normal seasonal range of appearance (i.e. width and morphology) for mid-January. There was no large erosion scarp on the west-facing beach, as was the case after Hurricane Floyd (Curran et al., 2001). In fact, sand was in good supply in front of the Savio House, and Mrs. Savio reported that their house suffered little structural damage from Hurricane Frances, although there had been considerable sand washover on the property from the hurricane storm surge.

INTERPRETATION AND DISCUSSION

In its simplest form, the model for beach dynamics at Sandy Point, based on beach profiles and visual observations initiated in summer 1990 (Loizeaux, 1993), holds that longshore currents generated by the easterly trade winds transport sand from east to west along the south-facing beach of Sandy Point and around the point to the north. Long periods of fair weather, as during the late spring and summer permit the build-up of sand in the form of a spit that grows westward from the point (Figure 5A). The pattern is reversed by northwesterly storms that erode sand from the west-facing beach of the point and move it back around the point to build a south-facing beach with ridge and runnel morphology (Figure 5B). This normally takes place during the late fall and winter months (Loizeaux et al., 1993;

Beavers et al., 1995). The patterns of the Sandy Point model are shown in the aerial photographs of Figure 5 and the comparative beach profiles of Figure 6.

The reality of the sediment dynamics at Sandy Point is obviously much more complex than this basic model suggests. The timing and intensities of northwesterly storms are a big variable, as is the duration of periods of fair weather with easterly trade winds dominanting. Further complicating the story is the unpredictable nature of the form and effects of tropical storms and hurricanes that are so much a part of the natural system of the tropics and San Salvador Island.

In both summer 2003 and 2004, it appears that extended periods of fair weather conditions led to the development of unusually large spits at Sandy Point, with the previously unreported exposure of the extensive beachrock ridge along the south-facing beach of the point, as documented in this report. However, the fact remains that there are large observational gaps in our knowledge of the Sandy Point sand transport system, particularly for the late summer and fall months. Closer monitoring of the Sandy Point beaches likely would improve the model and expand our understanding of this dynamic system of carbonate island sand transport.

CONCLUSIONS

Spit development at Sandy Point during the summer months of 2003 and 2004 was much more pronounced than that observed in previous years. The high-volume movement of sand from east to west along the south-facing beach of the point to feed the westward growth of the spit exposed a large and near-continuous beachrock ridge in the intertidal zone that runs parallel to the beach. Nonetheless, the seasonal pattern of sand transport at Sandy Point, as reported by Loizeaux et al. (1993) and Beavers et al. (1995), remained in effect, with the beaches at Sandy Point having a "normal" configuration in both January 2004 and January 2005.

Northwesterly wave energy from Hurricane Frances generated a large storm surge at Sandy Point (Parnell et al., 2004), but erosion effects on the west-facing beach likely were buffered by the presence of the unusually large spit and wide beach of summer 2004. The west side of the point did not suffer the extensive dune scarping that resulted from Hurricane Floyd in 1999 (Curran et al., 2001).

The west side of Sandy Point already is moderately developed with private beach houses, some of which are closer to the sea than is optimum. In addition to the hazard of hurricanes, any future development along the Sandy Point coast should be planned with an understanding and full consideration of the pattern of high-volume seasonal sand transport that dominates this reach of San Salvador's coast.

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REFERENCES

Beavers, R.L., Curran, H.A., and Fox, W.T., 1995, Long-term, storm dominated sediment dynamics on East Beach and Sandy Point, San Salvador Island, Bahamas, *in* Boardman, M.R., ed., Proceedings of the 7th Symposium on the Geology of the Bahamas: San Salvador, Bahamian Field Station, p. 1-15.

Curran, H.A., Delano, P., White, B., and Barrett, M., 2001, Coastal effects of Hurricane Floyd on San Salvador Island, Bahamas, *in* Greenstein, B.J. and Carney, C.K., eds., Proceedings of the 10th Symposium on the Geology of the Bahamas and Other Carbonate Regions: San Salvador, Gerace Research Center, p. 1-12.

Loizeaux, N.T., Curran, H.A., and Fox, W.T., 1993, Seasonal sediment migration and sediment dynamics on Sandy Point Beach, San Salvador Island, Bahamas, *in* White, B., ed., Proceedings of the 6th Symposium on the Geology of the Bahamas: San Salvador, Bahamian Field Station, p. 83-93.

Parnell, D.B., Brommer, D., Dixon, P.G., Brown, M.E., and Gamble, D.W., 2004, A survey of Hurricane Frances damage on San Salvador: Bahamas Journal of Science, v. 12, no. 1, p. 2-6.