Middle States Geographer, 1997, 30:29-34

AN EROSIONAL HISTORY OF STRAWBERRY ISLAND, NIAGARA RIVER, TONAWANDA, NEW YORK

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ABSTRACT: *A temporal study of erosional changes of Strawberry Island for the period 1934 to 1990 was conducted. Shorelines, identified from aerial photographs, were digitized using GIS software. Overlays of successive years allowed changes in area and perimeter to be calculated. Following a short period of growth between 1930 and 1942, the perimeter of the island has steadily decreased from 11,262 feet in 1951 to 5,573 feet in 1990. The acreage has steadily declined from 63.6 acres in 1934 to eight acres in 1990. Historically, the greatest cause of erosion was related to dredging and mining activities which accentuated the horseshoe shape of the island. Since the cessation of dredging activities, the primary causes of erosion are wave and storm action. Without intervention, the island may disappear in the next century. Stabilization proposals currently are being considered by several state and federal agencies.*

INTRODUCTION

Strawberry Island is located southeast of Grand Island in the Niagara River (Figure 1). The island is horseshoe-shaped with the closed end facing upstream. Strawberry Island is the first obstacle encountered by the river's currents as they flow northward from Lake Erie (Barrows et al., 1996). Over the past sixty years, the island has been subjected to extensive erosion due to wave action and ice scouring (Barrows et al., 1996) as well as dredging and mining operations (Bossert, 1973). There is local interest in the island due to its environmental and ecological significance on the Niagara River. The vegetated shallows associated with the island provide a spawning and nursery area for muskellunge and bass. The shoals provide an important waterfowl wintering area (Barrows et al., 1996).

This effort utilizes aerial photography of Strawberry Island from the 1934 to 1990. The application of GIS methodologies to study the changes in area and perimeter, and the generation of overlay maps, illustrates the benefit of such an approach to document erosional changes.

STUDY APPROACH

Historical and Erosional History of Strawberry Island

Strawberry Island has had a colorful history. Bossert (1993) presents a review of the geology of the island and several theories for its formation. Bossert (1993) also provides a summary of the ownership and jurisdiction of Strawberry Island. Much of the history of Strawberry Island is anecdotal. The summary below has been drawn from Bossert (1993), as well as through personal communications with Paul Leuchner (United States Army Corps of Engineers). Irving Tesmer, Professor Emertus at Buffalo State College, also provided his recollections about the island's history.

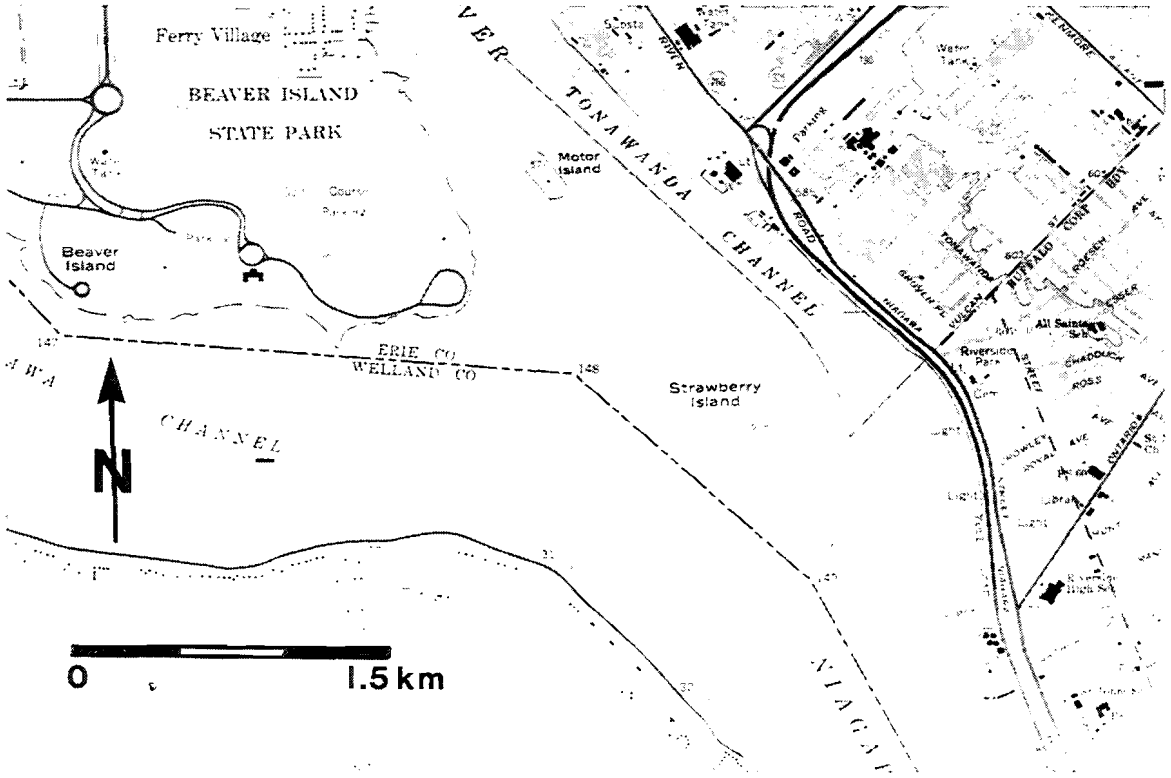

Figure 1. Location map of Strawberry Island.

Strawberry Island initially may have formed during the Pleistocene when glacial sediments carried by the Niagara River were deposited around a small outcrop of Camillus shale. The earliest records of settlers and explorers to this region indicate that the island has been called "Strawberry" since 1750. The origin of its name is unclear; at one point in its history, it was shaped more like a cucumber than a strawberry. Perhaps the name related to the presence of wild strawberries that may have grown on the island.

The island played a small, but significant, role in the history of the Niagara Region. In 1814, Colonel Wilkinson of the British Army used the island as a staging area for the 1814 siege of Buffalo. One year later Strawberry Island, along with two other islands in the Niagara River (Motor Island and Grand Island), were purchased for $11,000 from the Seneca Indians. During that same year, Dewitt, the first Surveyor General for New York State, listed Strawberry Island as a 100 acre parcel with a value of $100. In 1819 Strawberry Island grew to 138 acres due to the deposition of sand, gravel, and rock excavated during the construction of the Erie and Barge Canal. A two-story hotel was erected on the island in 1882; the hotel property included an eleven acre grove of trees. A canal was dug into the island so that ladies could enjoy the Niagara River without having to experience swift currents. Approximately ten years later, in 1892, the hotel fell into disrepair due to the popularity of new and larger resorts on Grand Island. According to Tesmer (personal communication), the hotel was dismantled by locals and carried off piece by piece. In 1896, the majority of the island was privately owned by the Hamilton Cherry Estate. The southwestern tip of the island was excluded from the estate and was owned by Mary E. Moore (Bossert, 1973). During the early 1890's Teddy Roosevelt could occasionally be seen fishing off of the island. Japanese lanterns were placed around the perimeter of the island so locals could row their boats to the island at night to view the Pan-American Exposition. A Boys Club, known as the Sunny Side Gang, was formed in 1911 and the island was used for camping (Tesmer, personal

communication). The island increased in size yet again in 1908 as the excavated material from the construction of the Black Rock Lock was placed around its periphery. In 1912, the island was sold to the Border Island Gravel Company. The United States Army Corps of Engineers (USACE) canceled the mining permits shortly after. From 1938 to 1941 dredging resumed at the northwest side of the island. By 1948, the island was reduced to just 36 acres. The USACE, concerned about changes in flow and water quality, halted island dredging in 1949. Dredging eventually resumed, but was restricted to the center of the island. By 1950 a large lagoon occupied the center of the island, reducing the surface area to about 25 acres. The dredging effort accentuated the horseshoe shape (Bossert, 1973). In 1953, the Buffalo Gravel Company sold the island to the Town of Tonawanda. The Town wanted to use the island as a staging area for construction and maintenance of a new water intake that was located off the shore of the island.

In 1989 the island was transferred to the New York State Office of Parks, Recreation and Historic Preservation. Severe storms during the fall of 1992 resulted in accelerated erosion along the southwest shoreline and in December, river currents broke through the narrow spit entering the lagoon. By the following spring the breach was more than 50 feet wide and several feet deep and split the island into two distinct parts (Barrows et al., 1996). In 1993 an alliance of businessmen and government agencies repaired the breach of the island by adding rock and gravel and by planting shrub willows and other vegetation. The New York State Office of Parks, Recreation and Historic Preservation and the United States Fish and Wildlife Service (USF&WS) continue to evaluate and develop preservation and management plans for the island.

Methodology for the Determination of Shoreline Erosion

Aerial photographs of Strawberry Island were obtained from the United States Department of Agriculture Natural Resource Conservation Service and through the United States Fish & Wildlife Service from Canadian sources. No systematic evaluation of aerial photography quality was completed. Photographs were generally taken in late spring, "leaf off" images. Image quality was fair to good for most images (typical of USDA and National Aerial Photography Program photography). Scales ranged from 1:7,920 to 1:20,000. Most images were from photographs printed at an approximate scale of 1:15,840 (1" = 1320'). No digital aerial photography was available. Methodology followed registering and digitizing procedures described in the SCS-GRASS and ERSI Arc/Info and ArcView user manuals and "standard operating procedure" guidance documents prepared by the East Aurora Field Office's USDA/AmeriCorps GIS and Conservation Technology Team.

Using geographical information software, shorelines on the photographs were digitized following the procedure outlined below. The first step in digitizing each photograph involved locating identical points on a photograph and topographic map. These points, registration points or tic marks, are the coordinates of the points determined from the topographic map. In order to account for any radial distortion of the photograph, the tic marks on the topographic map were used to determine the distance between points on the photograph. In this way, a scale was created for each aerial photograph. The next step involved tracing the outlines of the island onto mylar to facilitate defining the shoreline. As indicated above, tree coverage and variations in river level caused some uncertainty in mapping the shoreline. A registration file was created using Geographic Resources Analysis Support System (GRASS) version 4.1 and tic marks were digitized from the topographic map. These values were then compared to the tic marks in the registration file. A real mean square error of less than 3% was considered acceptable. Next, the shoreline tracing was digitized. This allowed the area and perimeter of the island to be calculated and created a vector polygon file showing the outline of the island.

Once all shorelines were digitized, they were edited and exported from GRASS files to digital line graph files (DLG). The DLG files were imported into PC ArcEdit. At this point, the files could be transported into PC ArcView. Using PC ArcView, the shorelines were overlaid on each other to visually represent the erosional differences between selected years.

As shorelines were compared, it became apparent that some of the shorelines had shifted position due to transferring the files from GRASS files to DLG files. To resolve this problem, these shorelines were transferred into PC ArcView and

were shifted to account for the distortion. The files were saved and transferred into PC Arc/Info.

RESULTS AND DISCUSSION

The digitized shorelines were compared for discrete time periods to account for erosion from 1934 to 1990 (Figure 2). Composite summary maps for the years 1934, 1951, and 1990 are provided in Figure 3. Figure 4 a and b represent the perimeter and acreage changes between 1934 and 1990.

The documented temporal changes in the size and shape of Strawberry Island are consistent with the historical record for the island. Due to the interior dredging of the island from 1930 to 1942, a lagoon was formed resulting in the perimeter of the island increasing. Thereafter, the perimeter steadily decreased, with 1951 being an exception. This increase was due to the presence of a lagoon in the interior of the island which increased the perimeter. The perimeter of the island in 1951 was 11,262 feet decreasing to 5,573 feet in 1990.

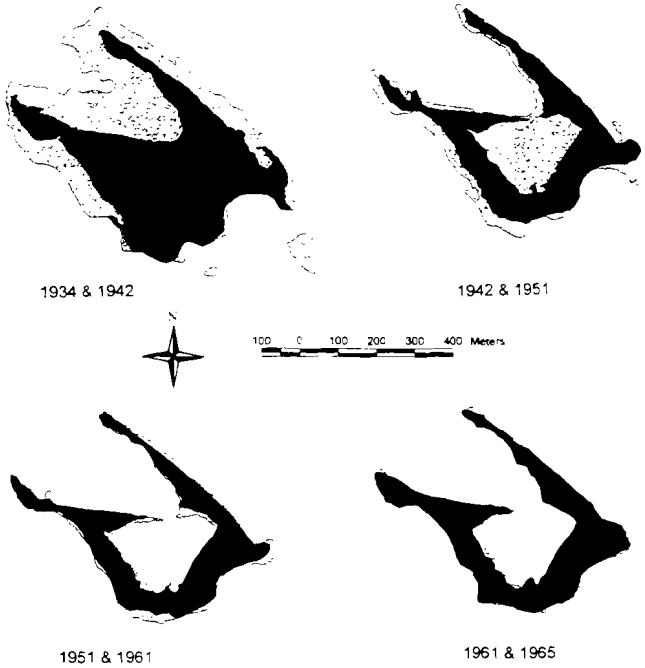

Figure 2. Erosional changes of Strawberry Island for the period 1934 to 1965.

From 1934 to 1990 the area of the island has steadily decreased. The island was largest in 1934 at 63.6 acres and smallest in 1990 at 8 acres. Between 1934 and 1942, the island decreased by 27.5 acres, a change largely due to higher water levels submerging the peripheral wetlands observed, and digitized in the 1939 aerial photograph but not present in the 1990 aerial photograph. The other major acreage loss was during the period 1942 to 1951. The decrease in acreage from 36 to 21 coincides with extensive dredging activities in the interior of the island. While traditional aerial photography analysis and interpretation, including necessary scale adjustments and overlay techniques, could have provided useful comparisons and measurements of changes, using GIS methodologies to digitize the shorelines from aerial photography provided an efficient and effective means of calculating area and perimeter changes over time. Additionally, GIS techniques facilitate visual comparisons of temporal changes along with the ability to prepare and print maps at any scale. Another advantage is the ease of sharing and managing electronic (digital) data compared with analog data.

In 1950 the island was surveyed and its size was calculated at approximately 25 acres (Leuchner, personal

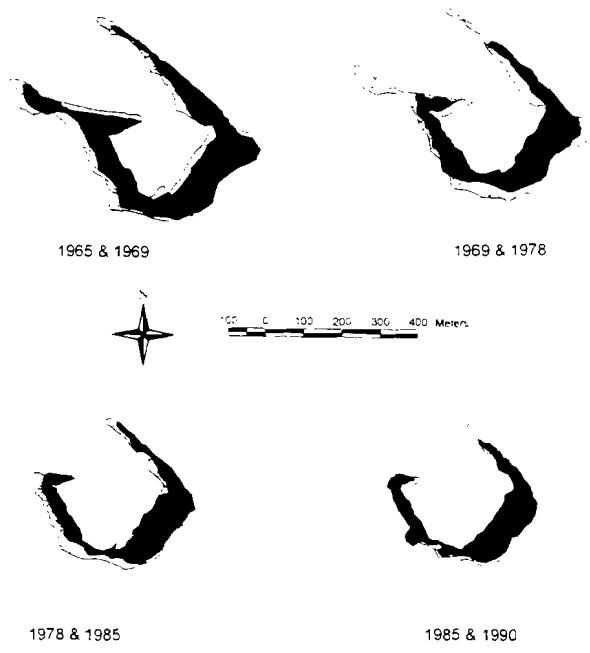

Figure 2 (cont.). Erosional changes of Strawberry Island for the period 1965 to 1990

communication). From the digitized aerial photograph shoreline for 1951 the acreage was estimated to be 21 acres. This four acre difference could be due to the

distortion in the photograph or error in interpretation of the actual shoreline. Another close acreage comparison occurs between the 1990 photograph and estimated acreage of 1996. At the present time, Strawberry Island is estimated to be 5 acres. From the 1990 photograph, the island was a mere eight acres. Any changes in river level or frequency and intensity of storms will affect the future of the island. Without intervention, it is likely that Strawberry Island may disappear in the next century. One example of such an intervention occurred after a 20' wide breach developed between December 1992 and April 1993 on the southwestern corner of the island (Leuchner, personal communication). Before irreversibledamage could occur, the breach was repaired. Figure 5 is an aerial photograph taken shortly after the breach repair work.

A long-term stabilization plan is being formulated to save Strawberry Island. In the interim, the United States Department of Transportation and the United States Army Corps of Engineers have developed a temporary stabilization plan for the island. This plan consists of securing the northwest and northeast corners of the island with rock armoring. Further plans for the island include efforts to learn more about subsurface geology using coring. The submerged pilings left by the dredging operation in the late 1940's also will be removed. Once these operations have been completed, the island may be included in an underwater natural resource management area that would provide effective protection of valuable fish and wildlife habitat (Leuchner, personal communication).

CONCLUSIONS

Since 1934, Strawberry Island has been steadily eroding. Although the currents and waves of the Niagara River contribute to the erosion of the island, as evidenced by the breaching of the island in 1992/93, the main historical cause of erosion was dredging operations conducted in the late 1940's. If a stabilization plan is not formulated, the island faces possible extinction. The loss of Strawberry Island would symbolize the end of an era. Boaters no longer will be able to land on the island and picnic, and more importantly, critical riparian habitats will be permanently lost.

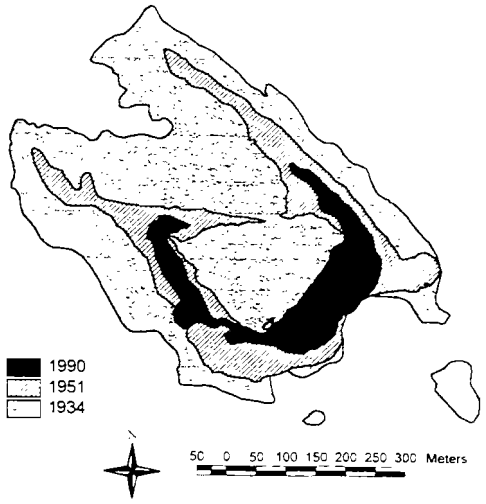

Figure 3. 1934, 1951 and 1990 composite of Strawberry Island shoreline.

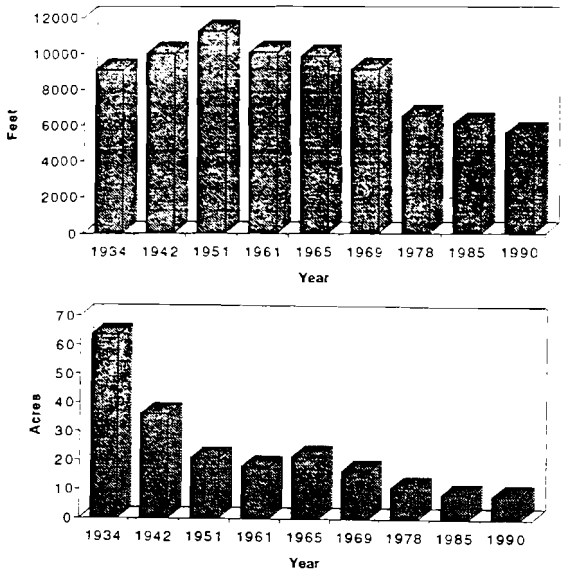

Figure 4a and b. Perimeter (a) and acreage (b) changes between 1934 and 1990.

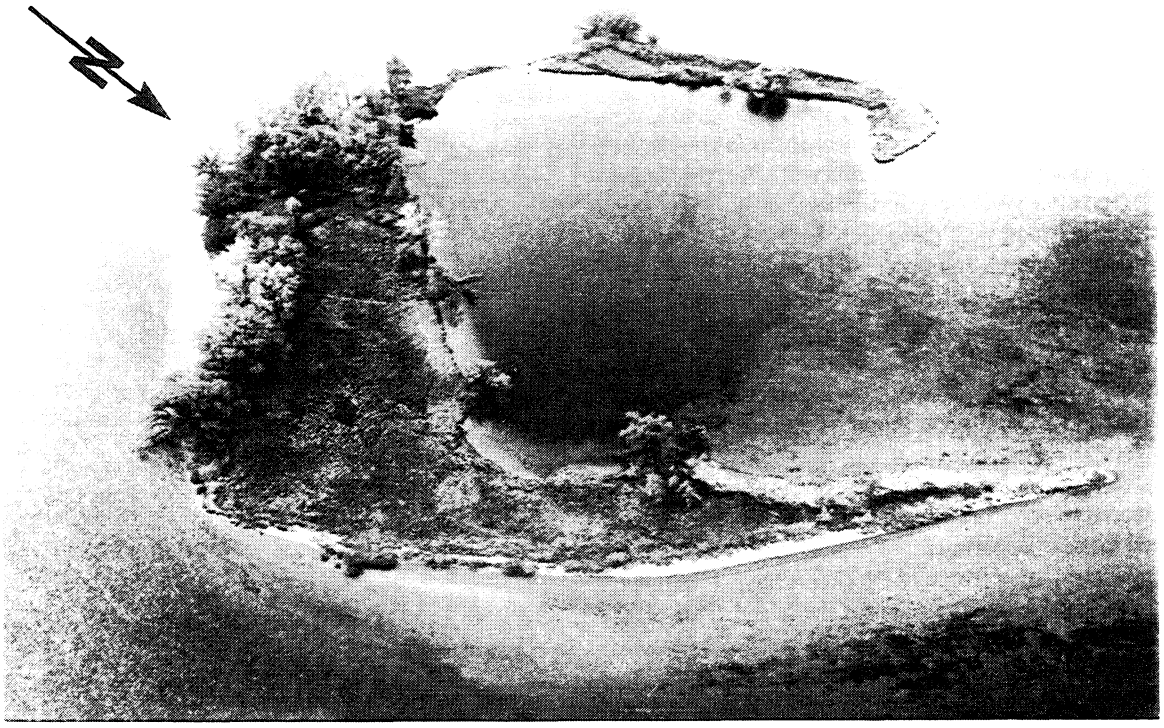

Figure 5. Aerial photographs taken shortly after the completion of the breach repair work.

ACKNOWLEDGMENTS

The authors wish to thank Anne Poole, formerly with the US Fish and Wildlife Service, for helping us to locate several of the aerial photographs. Paul Leuchner and Irving Tesmer provided valuable background information, and Paul Leuchner reviewed an earlier version of this manuscript. The authors acknowledge the constructive comments provided by the anonymous reviewers and the technical assistance provided by John Grant. We also are indebted to the AmeriCorps Program which permitted Lisa Matthies to work on this project. The work was completed at USDA Natural Resources Conservation Service, East Aurora Field Office, 50Commerce Way, East Aurora, NY, 14052.

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