

Technical Report Series
Number 73-2

OBSERVATIONS OF NET SHORELINE
POSITIONS AND APPROXIMATIONS OF
BARRIER ISLAND SEDIMENT BUDGETS

by
George F. Oertel

Georgia Marine Science Center
University System of Georgia
Skidaway Island, Georgia

OBSERVATIONS OF NET SHORELINE POSITIONS AND APPROXIMATIONS
OF BARRIER ISLAND SEDIMENT BUDGETS

by

George F. Oertel

Skidaway Institute of Oceanography
Skidaway Island, Georgia

February 1973

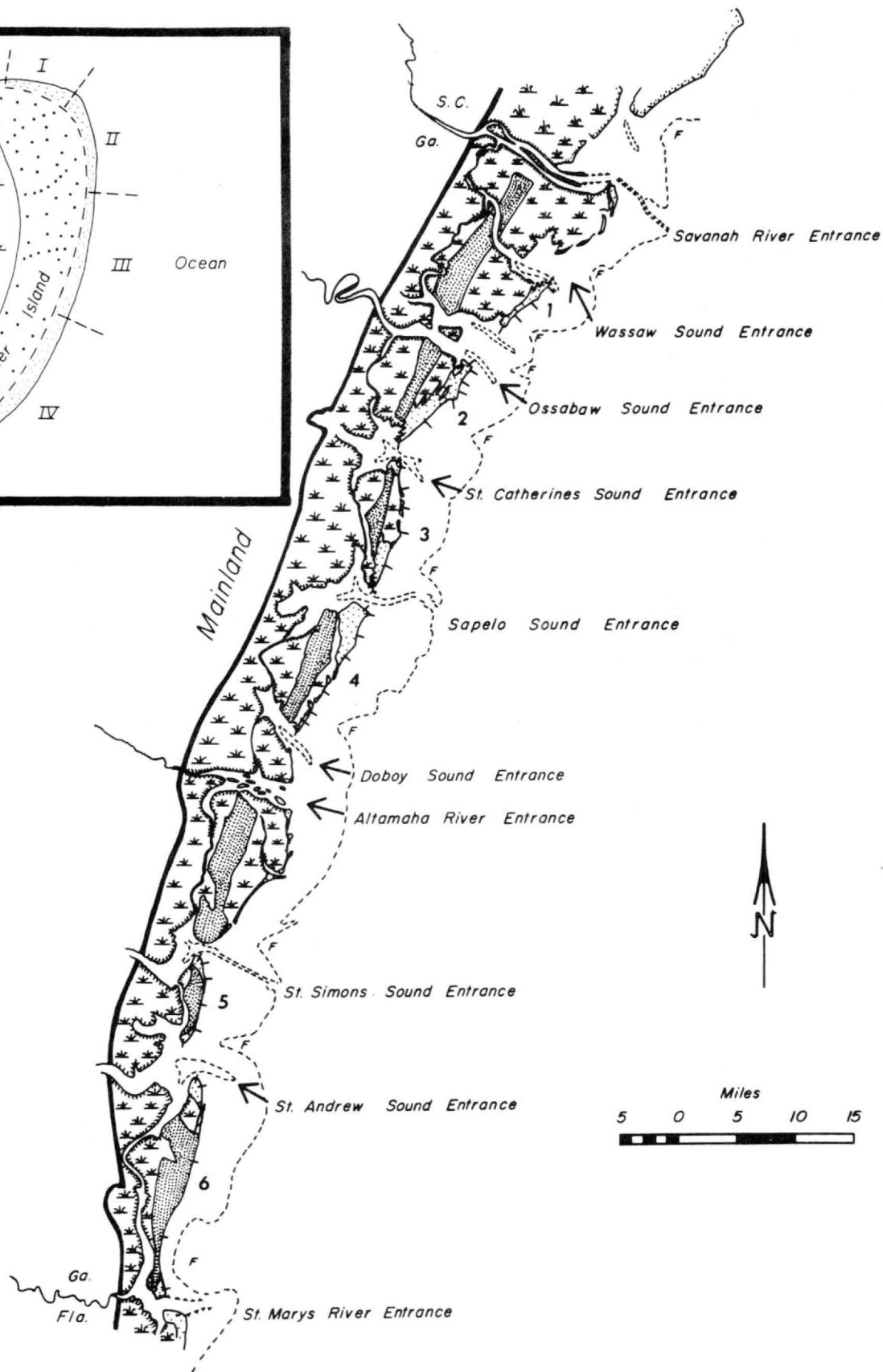
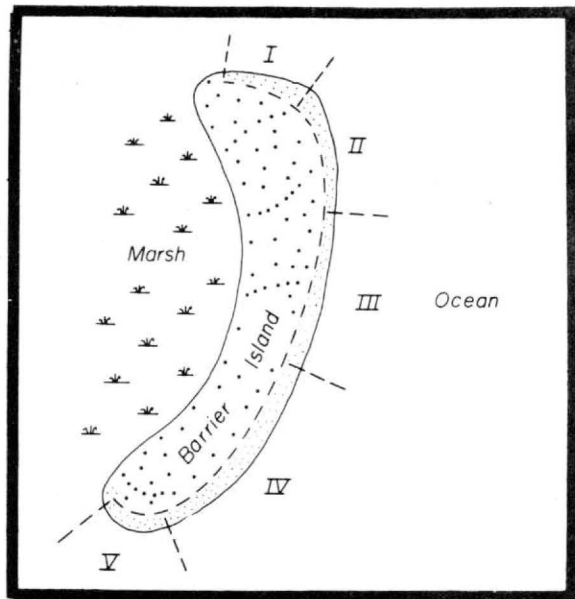
The Technical Report Series of the Georgia Marine Science Center is issued by the Georgia Sea Grant Program and the Marine Extension Service of the University of Georgia on Skidaway Island (P. O. Box 13687, Savannah, Georgia 31406). It was established to provide dissemination of technical information and progress reports resulting from marine studies and investigations mainly by staff and faculty of the University System of Georgia. In addition, it is intended for the presentation of techniques and methods, reduced data and general information of interest to industry, local, regional, and state governments and the public. Information contained in these reports is in the public domain. If this prepublication copy is cited, it should be cited as an unpublished manuscript.

INTRODUCTION

A short term history (30 years) of the barrier-island shoreline positions has been effected by studying aerial photographs of the Georgia barrier-islands. Distances of shoreline erosion and accretion were measured from transects established on sets of aerial photographs of barrier-island shorelines (fig. 1). Four sets of aerial photos were used in this part of the study. A 1933 set of aerial photos obtained from the Department of Commerce was used to establish transects on St. Catherines and Sapelo Island; however, the other barrier islands were not in this set. Complete sets for 1942, 1952 and 1965 were also obtained from the Corps of Engineers, the Department of Agriculture and the U. S. Coast Geodetic Survey, respectively. Although vertical photos for the 1970's were not available, oblique photos were taken from a small plane in March of 1972, and some geomorphic changes between the 1960's and 1970's were noted. The most obvious conclusion obtained after measurements and observations of changes, was that over a given interval of time there were no general trends that applied to the sediment budgets (net shoreline positions) of all barrier islands. Barriers and portions of barriers appeared to be undergoing sequential sedimentary and morphologic changes.

Transects (perpendicular to the shoreline) were established along the island beaches and their lengths were measured on the 1933, 1942, 1952 and 1965 aerial photos (fig. 1). The net progradation or retreat was determined along transects for the interval between the periods of photo coverage. The net lengths of the transects were then averaged and grouped in five different zones representing portions of the shoreline

Figure 1. Location of barrier islands under investigation; (1) Wassaw Island, (2) Ossabaw Island, (3) St. Catherines Island, (4) Sapelo Island, (5) Jekyll Island, (6) Cumberland Island. Transect positions on each of these islands are indicated by black bars oriented perpendicular to the island shorelines. The dashed lines represent the 10 meter contour line. The inlet troughs are generally much deeper than any portions of the adjacent shoreface. Funnel shaped channels on the northern sides of the inlets are designated by the capital letter (F). The insert in the upper left corner illustrates how the data from the transects were grouped for graphic presentation (Figs. 2, 4, 6).



(see insert in Figure 1). The first zone was the beach facing the inlet adjoining the north side of the island. The second, third and fourth zones included the transects along the northern 1/3 of the island shoreline, the mid-island 1/3 of the shoreline and the southern 1/3 of the island shoreline, respectively. The fifth zone was the beach facing the inlet adjoining the south side of the island.

Wassaw Island

The northern most island studied along the sea-island section of the Georgia coast was Wassaw Island. Photo coverage of this island was not available back to 1933 and base lines were established on the 1942 aerial photo sets. The intervals between 1942 and 1952 and between 1952 and 1965 illustrated shoreline erosion on the northern portions of the island and accretion on the southern portions of the island (fig. 2a,b). The midpoint between the ends of the barrier is the inflection point where the eroding shoreline changes to an accreting shoreline. This sequence lends nicely to theories of island and inlet migration (Johnson 1919, p. 374, Hoyt and Henry 1967), and appears to be further substantiated by the relatively large areal distributions of the long, relatively straight beach-ridges. However, on the north end of the islands, a northeast offlap of some beach-ridges illustrate that Holocene island migration was to the northeast. Oblique photos of Wassaw Island and field observations in 1972 illustrate universal beach and backshore erosion along the entire shoreline. The interpretations of these observations indicate that the shoreline of Wassaw Island is generally a submerging shoreline, and the sedimentary patterns affecting the north end of the island were different during the Holocene and the present (1942-1972).

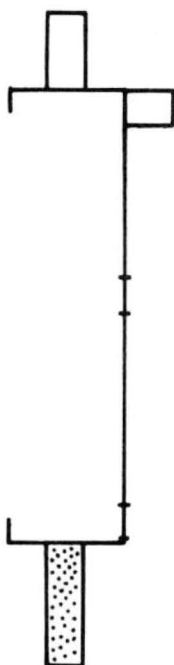
Figure 2. Graphic representations of patterns of erosion and accretion at Wassaw
a,b,c,d Island (a,b) and Ossabaw Island (c,d) for the periods from 1942-1952
 (a,c) and 1952-1965 (b,d). The island shapes and scale are schematically
 represented; however, the erosion-accretion histograms are to the scale
 indicated. Seaward is toward the right.

Wassaw Island

Ossabaw Island

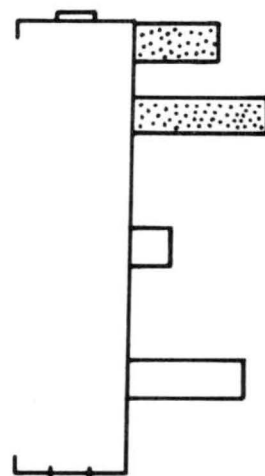
a

1942 - 1952



c

1942 - 1952

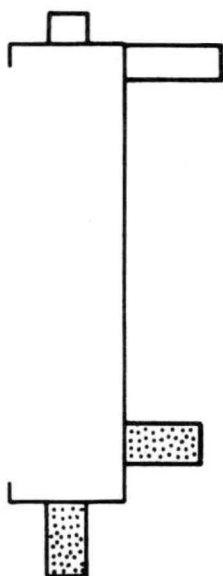


Yards

100 0 200

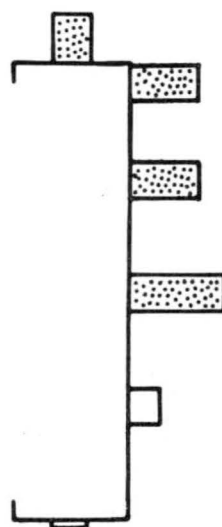
b

1952 - 1965



d

1952 - 1965



Erosion

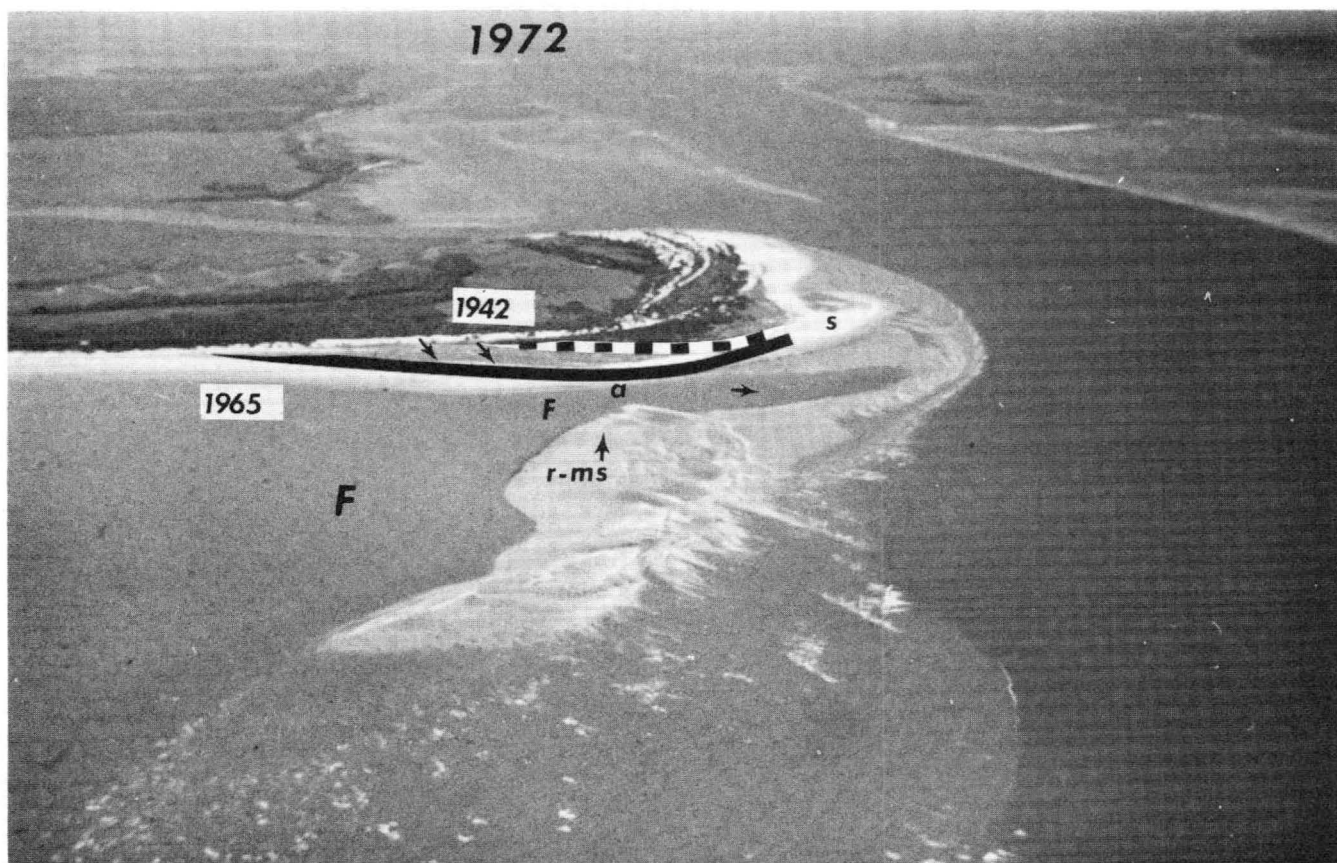


Accretion

Ossabaw Island

Ossabaw Island is the next barrier island south of Wassaw Island. Photo coverage of Ossabaw Island also was not available back to 1933 and base line transects were established on the 1942 aerial photographs. The net shoreline positions established for the 10 year intervals between photo sets illustrate a trend that was essentially the reverse of the trend found on Wassaw Island. The island was found to be accreting along the northern shorelines and eroding along the southern shorelines (fig. 2c, d). Observations of net shoreline positions between 1942 and 1952 illustrated that inlet beaches were holding their positions while the shoreline along the northern 1/3 of the island was rapidly accreting and the shoreline along the southern 1/3 of the island was rapidly eroding (fig. 2c). During the period between 1952 and 1965, (fig. 2d) it was also obvious that the north end of the island was building while the south end was eroding. The development of a small cape along the shoreline of the northern 1/3 zone (the 2nd zone) accounts for much of the accelerated accretion along that area of the shoreline. On the north end of the island, shoreline accretion was accentuated by the appearance of a 200 yard-wide set of beach ridges which developed between 1942 and 1965. Oblique photos taken in March of 1972 indicated that the seaward portion of this beach-ridge set was being truncated by a flood tidal channel which was temporarily restricting the supply of sand from this portion of the beach (fig. 3). Between 1942 and 1965 the ramp-margin shoal was attached to the beach, and the onshore transfer of sand from the shoal to the beach produced accretion (fig. 3a). Between 1965 and 1972 a funnel-shaped tidal channel (fig. 3f) extended northward and cut off the sand supply to the shoreline (at point a). In 1972 the northern portion of the ramp-margin shoal was still attached to the shoreline and spits adjacent to the point of attachment

Figure 3. Oblique air photo (1972) of the north end of Ossabaw Island, illustrating the positions of the shorelines in 1942, 1965 and 1972. The funnel-shaped channel (F) has temporarily separated a portion of the ramp-margin shoal from the beach between 1965 and 1972. During this time, spit (s) accreted on the north end of the island. However, the "re-attachment" of the ramp-margin shoal is anticipated as the shoal expands landward (RMS↑).



were accreting into the inlet in a northeast direction. As the ramp-margin shoal expands by entrapping sediment (Oertel, 1971) it moves in an onshore direction and, upon attachment, it is expected that accretion will again be initiated adjacent to point (a).

The sediment budget (based on net shoreline positions) for the entire shoreline of Ossabaw Island also lends to theories of island and inlet migration (Johnson, 1919, p. 374, Hoyt and Henry, 1967); however, the direction of migration would again be opposite to that suggested by the Wassaw Island sediment-budgets (net shoreline positions).

The sequential development of Holocene beach ridges on the northern portion of Ossabaw Island indicated a northeast offlap direction while sequential beach-ridge development on the southern portion of the island illustrates a southward island development. It appears that this barrier was accreting in two almost opposite directions throughout the Holocene.

St. Catherines Island

Transects along the St. Catherines Island shoreline were established on a 1933 set of aerial photos. The sediment budget estimated by the net shoreline positions of the St. Catherines Island shoreline was very similar to the sediment budget estimated for the Ossabaw Island shoreline (fig. 4). The north end of the island was accreting, while the beach that faces the inlet was eroding at a moderate rate (fig. 4a). The mid-island and southern shorelines also were generally retreating with the former apparently retreating at a more rapid rate. The graphic representation for the 1933-1942 interval (fig. 4a) and the 1952-1965 interval (fig. 4c) illustrates that rates of erosion appear to increase toward the mid-island areas. Erosional retreat in the mid-island

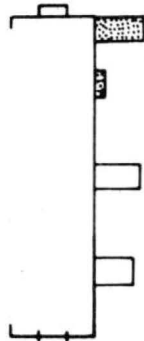
Figure 4. Graphic representation of patterns of erosion and accretion at St. Catherines Island (a,b,c) and Sapelo Island (d,e,f) for the periods from 1933-1942 (a,d), 1942-1952 (b,e), 1952-1965 (c,f). The island scale and shapes are schematically represented; however, the erosion-accretion histograms are to the scale indicated. Seaward is toward the right.

St. Catherines Island

Sapelo Island

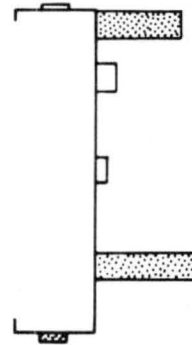
a

1933 - 1942



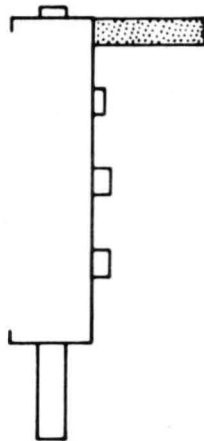
d

1933 - 1942



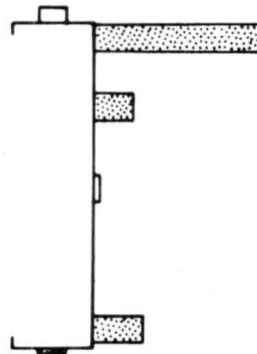
b

1942 - 1952



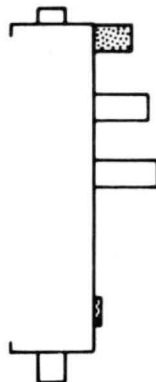
e

1942 - 1952



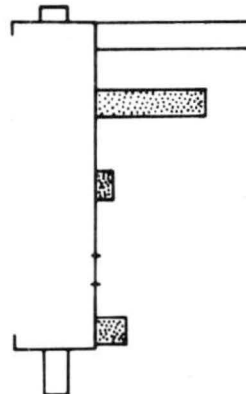
c

1952 - 1965



f

1952 - 1965



Yards
100 0 200

□ Erosion
▨ Accretion

areas was characterized by well-developed washover fans. Washover fans on the younger aerial photo (1965) cover a larger area than the fans on the older aerial photo (fig. 5). It may also be noted from these photos that the small inlet has migrated northward as the shoreline retreated.

During the intervals between 1942 and 1952 (fig. 4b) and between 1952 and 1965 (fig. 4c), the beaches facing the inlets were retreating at faster rates than during the 1933 to 1942 interval (fig. 4a). During these periods, the beach facing the inlet adjoining the south end of the island was eroding at a greater rate than the beach facing the inlet north of the island.

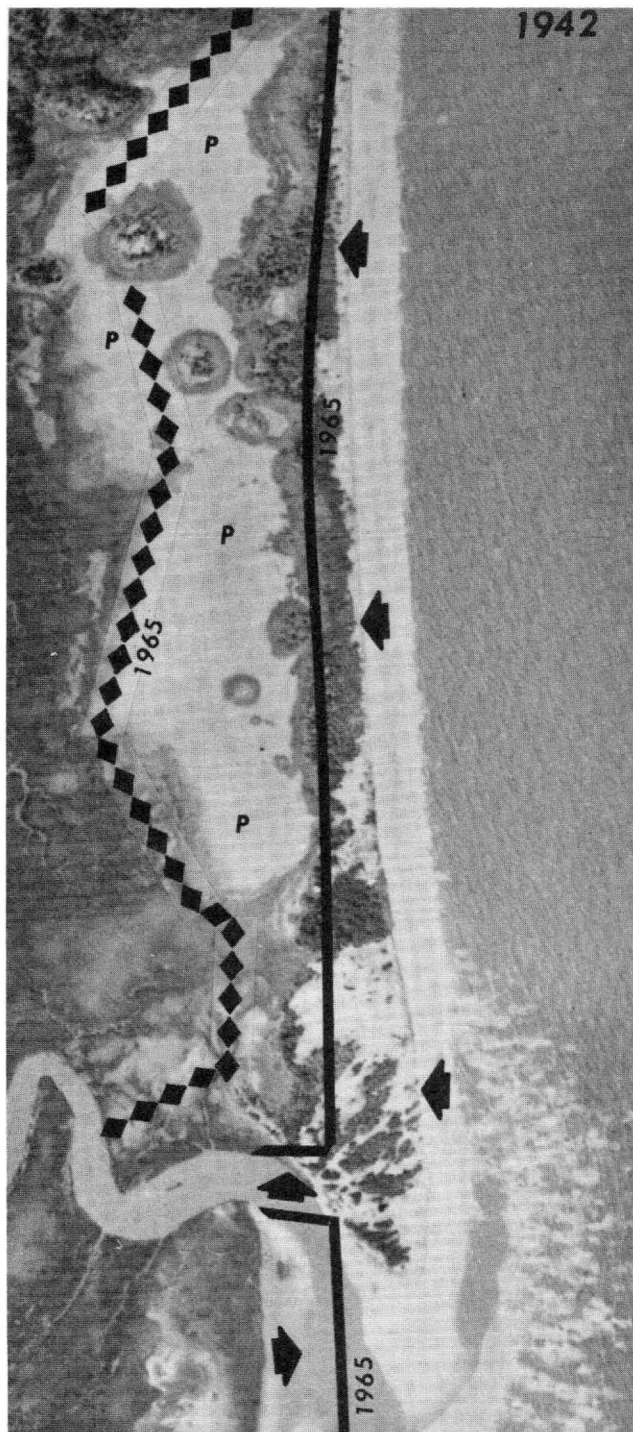
Sapelo Island

Aerial photo coverage of Sapelo Island was available for 1933, 1942, 1952, 1965 and oblique photos were taken from a small plane in 1972. Eight transects (perpendicular to the shoreline) were established along the beach.

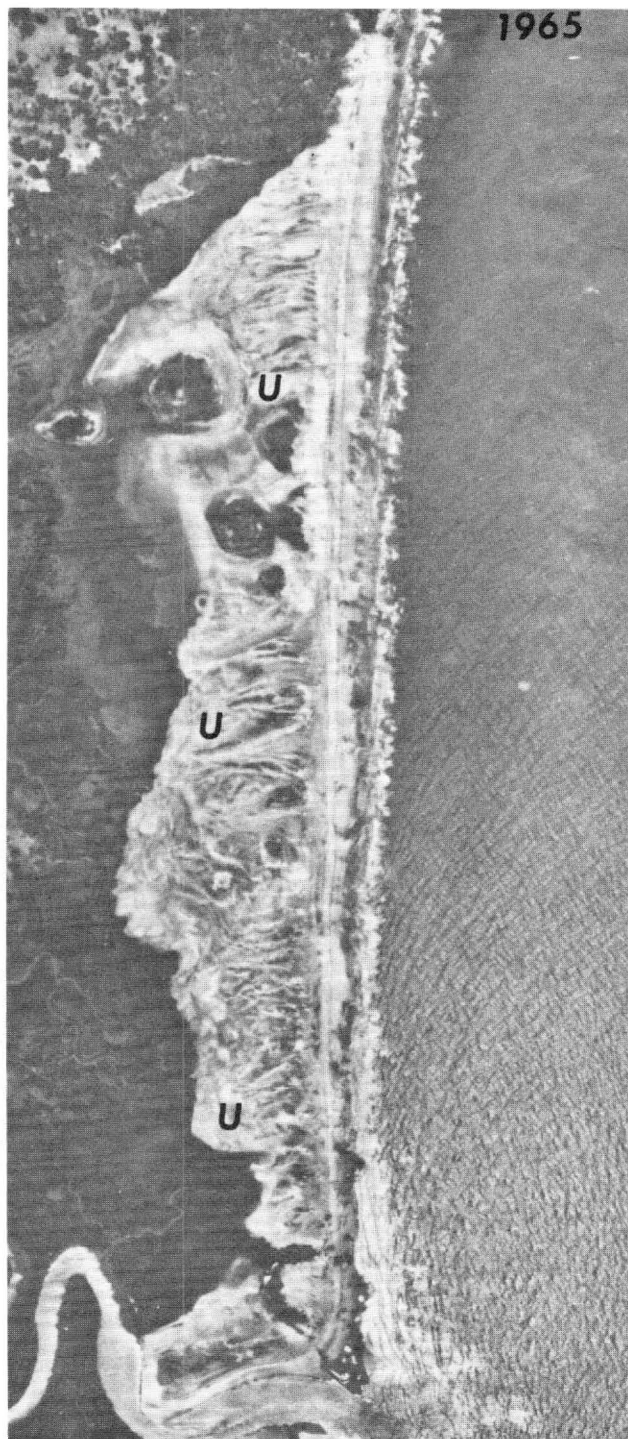
During the interval between 1933 and 1942 the beaches that faced the inlets and the mid-island beaches underwent small erosional retreats, while the beaches facing seaward adjacent to the inlets prograded seaward (fig. 4d). The next youngest period of photo coverage (1942-1952) illustrated similar patterns of erosion and accretion. The beach facing the inlet on the north end of the island eroded back approximately three times further than the previous time interval analyzed, and seaward accretion of the beach adjacent to the inlet was approximately double that determined for the analysis of 1933-1942 period. Shoreline progradation extended southward toward the mid-island shoreline that was previously eroding. Along the south end of the island, beaches prograded a much

Figure 5. Aerial photos (1942 and 1965) of a portion of the mid-island shoreline of St. Catherines Island showing shoreline erosion and the progressive expansion of washover fans. Undulating washover fans (U) on the 1965 photo has eliminated much of the foliage which was present on the older photo between washover plain (p) and the shoreline. The small inlet located in the southern portion of the photo has migrated northward between 1942 and 1965. Diamond line represents position of the 1965 washover fans. Solid line depicts the position of the 1965 shoreline.

a



b



shorter distance seaward than they had during the previous period of analysis (1933-1942). Between 1952 and 1965 the net change in shoreline positions illustrated that relatively high rates of sediment accretion took place adjacent to the ends of the islands (fig. 4e). During this interval, erosion or relatively low rates of accretion took place at mid-island beaches, and at beaches facing tidal inlets between islands. Shoreline retreat during this period (1952-1965) was approximately twice as great for the beach facing the major tidal inlet at the south end of the island as it was for the respective beach corresponding to the north end of the island (fig. 4f). During this same time interval (1952-1965), the headland beach at the north end of the island eroded over 200 yards landward. Much of the sand that was eroded from the headland appears to have accumulated along the arcuate beach and small cape south of the headland. This is illustrated in Figure 4 and shows up on the 1965 set of aerial photos as a new set of beach ridges. Areas of shoreline retreat adjacent to the ends of Sapelo Island were characterized by the lateral and offshore displacement of sediment, while erosional retreat at the mid-barrier shorelines was associated with washover fans.

Jekyll Island

The sediment budgets of the north end of Jekyll Island were partially affected by the periodic dredging of the seaward portion of the St. Simon Sound (the ramp to the sea). Extensive residential development of the island since 1942 has also affected the exchange of sediment between the dunes and beaches. However, sediment-budget analysis based on transect measurements was made in light of these alterations in order to make comparisons with the unaltered island shorelines. Aerial photo coverage

for Jekyll Island was available in 1942 sets, 1952 sets and 1965 sets, and oblique photos were taken from a small plane in 1972. Estimates of sediment budgets were again determined by measuring six transects that were established normal to the barrier shoreline.

Between 1942 and 1952, a major portion of the island shoreline was also eroding; however, during this period the rate of erosion was highest at the beach front at the north end of the island (fig. 6a). The beaches facing the tidal inlets at the north and south ends of the island illustrate the second greatest rate of shoreline retreat. The mid-island and southern parts of the island shorelines were eroding at the lowest rates.

During the interval between 1952 and 1965 the rates of change of shoreline positions at Jekyll Island (fig. 6b) were very similar to the rates determined for the Wassaw shoreline (fig. 2a,b). Erosional retreat was common along most of the beach front. The mid-island beaches eroded back the greatest distances, the positions of the beaches facing the tidal inlets were relatively stable, and the only apparent progradation was at the beach front at the south end of the island.

Cumberland Island

At Cumberland Island, estimates of the sediment budget were also produced by measuring transects that were established on temporally spaced sets of aerial photos. Whereas, the trends of the sediment budgets of the individual islands described above were generally similar for the consecutive 10 and 20 year intervals described, the general sediment budget of Cumberland Island changed from a ubiquitously accreting barrier

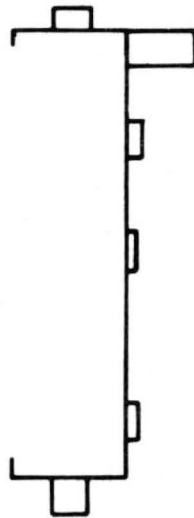
Figure 6. Graphic representation of patterns of erosion and accretion at Jekyll Island (a,b) and Cumberland Island (c,d) for the periods from 1942-1952 (a,c) and 1952-1965 (b,d). Seaward is toward the right.

Jekyll Island

Cumberland Island

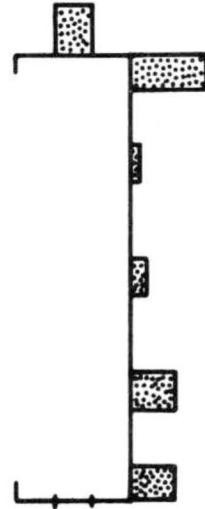
a

1942 - 1952



c

1942 - 1952

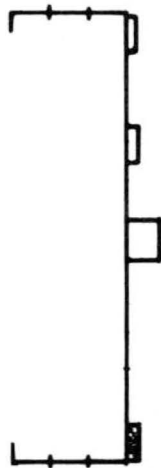


Yards

100 0 200

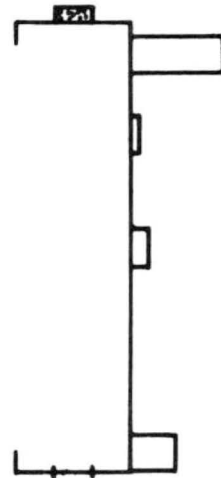
b

1952 - 1965



d

1952 - 1965



Erosion



Accretion

shoreline between 1942 and 1952 to a predominantly retreating barrier shoreline between 1952 and 1965. Between 1942 and 1952 (fig. 6c), the shoreline adjacent to the ends of the island prograded the greatest distance seaward, while the mid-island beaches prograded at a slower rate. The only portion of the island that prograded seaward during the 1952 and 1965 interval was the beach at the north end of the island facing the tidal inlet (fig. 6d). Although the beach facing the inlet at the south end of the island was also rapidly accreting, accretion rates probably were controlled by the presence of a 5000-yard jetty bordering the ramp to the sea. Erosional retreat of the beaches facing seaward and adjacent to the ends of Cumberland Island took place by the lateral and offshore displacement of sediment while erosional retreat of the mid-island shoreline took place by overwash in the form of washover fans.

Summary of Barrier Shoreline Stability

Although the interpretation of barrier-island sediment budgets by the observation of net shoreline positions on aerial photos is an elementary method of analysis, the overall picture of relatively long-term records (20-40 years) of shoreline advance and retreat can be determined for various sections of a barrier-island and then compared to the characteristics of the beach-ridge sequences landward of that shoreline and shoal configurations seaward of the shoreline.

The analysis of the positions of barrier-island shorelines illustrate several trends in coastline development. Of the fourteen periods analyzed at the six barriers only the two intervals at Wassaw Island illustrated erosion on the north end and accretion on the south end. Five of the fourteen periods analyzed were eroding on the south ends and depositing on the north ends. The remaining seven time intervals analyzed had eroding

mid-island shorelines and prograding shorelines adjacent to the ends of the barriers. At the mid-island shorelines, erosional rates decreased toward both island ends 64.5% of the time and increased toward both island ends 14.2% of the time. Erosional retreat at mid-island shorelines was characterized by the progressive expansion of washover fans. Erosion along other portions of the shoreline was characterized by the lateral and offshore displacement of sand. The greatest distance of shoreline accretion was predominantly located adjacent to the north end of the island along the seaward facing beaches.

ACKNOWLEDGEMENTS

Oblique air photos 1972 were taken by the author while flying the Georgia coast with Dr. J. D. Howard in an aircraft owned by Dr. Howard.

REFERENCES CITED

- Hoyt, John H. and Vernon J. Henry, 1967. Influence of Island Migration on Barrier-Island Sedimentation. Geo. Soc. of Amer. Bull. 78: 77-86.
- Johnson, D. W., 1919. Shore Processes and Shoreline Development, Hofner Publishing Company.
- Oertel, George F., 1971. Sediment-Hydrodynamic Interrelationships at the Entrance to the Doboy Sound Estuary, Sapelo Island, Georgia. Unpub. Ph.D. dissertation, University of Iowa, Iowa City, Iowa.

