South River Shoreline Management Plan Synopsis

April 2007

South River

Shoreline Management Plan Synopsis

Shoreline Studies Program
Virginia Institute of Marine Science
College of William & Mary
Gloucester Point, Virginia

April 2007
Table of Contents

List of Figures and Tables

Acknowledgements

Partner organizations include the Chesapeake Bay Foundation, the Virginia Institute of Marine Science, Burke Environmental Associates, South River Federation, and Riverkeeper. This project was funded by the National Fish & Wildlife Foundation, National Oceanic and Atmospheric Administration Restoration Center, and the Keith Campbell Foundation for the Environment.

1 INTRODUCTION

1.1 Background and Purpose

This Shoreline Management Plan (Plan) has been developed with funding from the Keith Campbell Foundation and the Chesapeake Bay Foundation in response to the Anne Arundel County's desire to create a comprehensive shoreline management plan for the South River coast (Figure 1). The study area includes shorelines along the South River from Chesapeake Bay west and north to just above the Route 2 Bridge. The total shoreline assessed for the study is about 82 miles.

This study makes recommendations that address shoreline erosion on an as-needed basis. The impacts of "doing nothing" to the shoreline are assessed as are various structural and non-structural alternatives. Recommendations include shoreline protection strategies that are relatively non-intrusive to natural surroundings yet effective within the context of long-term shoreline erosion control. The strategies may combine stone structures such as sills, revetments, and/or breakwaters along with sand nourishment to create a stable substrate for establishing wetland vegetation.

The South River has two basic shoreline settings: 1) those coasts along the main stem of the South River, and 2) the shorelines that occur up the sub-tributary creeks of the South River. A variety of shore types occur along the South River coast including high banks and low banks, marsh fringes and low sandy terraces. An abundance of shore protection structures, mostly bulkheads, presently exist along the reach. The purpose of this Plan is to provide alternatives to shore hardening that will provide shore protection as well as increased habitat value particularly wetlands.

1.2 Components of the Shoreline Management Plan

The South River Shoreline Management plan includes the following components:

1) Shoreline Management Plan Synopsis (this document)
2) South River Shoreline Management Map (Appendix A)
3) South River: Living Shoreline Treatments Summary (Appendix B)
4) South River: Living Shoreline Guidelines (Appendix C)

The South River Plan Synopsis summarizes the physical elements and resultant recommendations of the South River and will reference items 2, 3 and 4 as needed for the reader to get more data or information regarding the plan components. The Shoreline Management Plan Synopsis will include 3 basic components:

1) South River Shore Plan Elements
2) South River Setting: Physical and Hydrodynamic
3) South River Shore Treatment Recommendations

2 SHORELINE MANAGEMENT ELEMENTS

2.1 Objectives

The first step in developing a framework for shoreline management is establishing clear objectives toward which erosion control strategies can be directed. In developing the South River Shoreline Management Plan, the following objectives have been given consideration:

- Prevention of loss of land and protection of upland improvement.
- Protection, maintenance, enhancement and/or creation of wetlands habitat both vegetated and non-vegetated.
- Management of upland runoff and groundwater flow which may exacerbate bank erosion.
- For a proposed shoreline strategy, addressing potential secondary impacts within the reach which may include impacts to downdrift shores through a reduction in the sand supply or the encroachment of structures onto subaqueous land and wetlands.
- Providing access and/or creation of recreational opportunities such as beach areas.

These objectives must be assessed in the context of a shoreline reach. While all objectives should be considered, each one will not carry equal weight. In fact, satisfaction of all objectives for any given reach is not likely as some may be mutually exclusive. It is the intention of this study to develop shoreline management schemes for South River by creating a protective shore system using headland breakwaters and beach fill with vegetative plantings in higher energy areas. Sills and marsh plantings will be used where reduced energy allows for successful placement. Living Shorelines will be the emphasis in all recommendations where possible.

In the Chesapeake Bay watershed and elsewhere, increased attention is being paid to the importance of maintaining, creating, and restoring “living” or natural shorelines. The descriptive term “living shoreline” readily conveys the image of a shoreline characterized by wetlands, sand beaches, submerged aquatic vegetation, mud flats, and/or oyster reefs that provide living spaces for a broad array of aquatic and terrestrial organisms. Living shoreline information is designed to complement a voluntary, Bay-wide estuarine and shoreline restoration framework developed by the Chesapeake Bay Foundation and its partners, which waterfront landowners and others can reference to help restore the Bay’s tributaries. The fundamental objective of the living shoreline approach is to protect eroding shorelines while enhancing water quality and habitat for living resources in the Bay. However, the ultimate goal of shore protection must take priority.

2.2 Protection Strategies

Four general shore protection strategies have been considered in the discussion of each shore reach within the study area. These strategies are discussed below. The basic components of recommended strategies, other than do nothing, will be stone, sand, and plants.

1. Do nothing: This option is appropriate where no erosion is occurring or in areas where no infrastructure exists.
2. Defensive approach (stone revetments)

3. Offensive approach (stone sills with wetlands plantings; stone breakwaters and beach fill with plantings; trim trees, grade to the correct elevation and plant marsh grasses; *i.e*. living shorelines)
4. Headland control (stone breakwaters strategically placed)

No Action

Essentially, this strategy allows the natural processes of shoreline erosion and evolution to continue as they have for the past 1,000 years or so as part of the latest sea-level transgression. However, threatened infrastructure, such as roads and buildings, may force the implementation of shore protection strategies. Moving the buildings and roads will delay the problem, but it also might allow more room to initiate a lesser degree of bank work and a reduction in size and scope of shore structures.

Defensive Approach

The Defensive Approach refers to the use of shore protection structures that commonly are placed along the base of an eroding bank as a "last line of defense" against the erosive forces of wave action, storm surge, and currents. For the purposes of this study, stone revetments are the strategy employed.

Offensive Approach

The Offensive Approach to shoreline protection refers to structures that are built in the region of sand transport to address impinging waves before they reach upland areas. These structures traditionally have been groins, but over the past decade, the use of breakwaters has become an important element for shoreline protection. For this study, stone breakwaters and sills will be the strategies employed. Spurs are installed on breakwaters and sills to move the wave diffraction point further offshore to assist in attaining local equilibrium of the shore planform. The use of offensive structures requires a thorough understanding of littoral processes acting within a given shore reach.

Headland Control

Headland control is an innovative approach to shoreline erosion protection because it addresses long stretches of shoreline and can be phased over time. The basic premise is that by controlling existing points of land (*i.e.* headlands) or strategically creating new points of land, the shape of the adjacent embayments can be predicted. A thorough understanding of the littoral processes operating within the reach is necessary to create a stable planform. Headland control can utilize elements of the three previous strategies. The approach was not offered at this level of assessment for the South River.

2.3 **Coastal Structures for the South River** (refer to Appendices B and C)

Shoreline stabilization methods can be broadly sorted into three categories:

- Non-structural: This involves nourishing existing beaches with additional sand or establishing marsh grass without installing permanent structures to support plants after they are established. These methods are typically, but not always, used where erosion potential is limited – often referred to as low wave energy environments. Other types of non-structural methods are creation or restoration of a fringe marsh on existing substrate or with coir log edging which gives minor bio-degradable structural support. Planting dune grass stabilizes moving sand and promotes growth of dunes on the backshore of beaches.
- Hybrid: This option may be employed where greater vulnerability to erosion is present. The approach is a combination of techniques which incorporate sand, wetland and other components along with permanent stone structures that help keep the restored features in place. Examples of hybrid management strategies include fringe marsh creation with stone containment groins, sill, or marsh toe revetment. Marsh restoration with breakwaters can also be considered a hybrid option.
- Structural: This utilizes shoreline armoring such as stone revetments and breakwater systems where considerable vulnerability to wave action exists. Breakwater systems allow the creation of beaches and dunes and usually include beach nourishment and dune plantings in their design.

What criteria do you use to determine appropriate shore management strategies? Management strategies are primarily based on severity of erosion, fetch, and proximity of infrastructure. Also, the level of protection will address return frequency of storms (*i.e.* 10, 25, 50, and 100 yr). Typically, the strategy will protect the adjacent shore from the 25 yr event. It must be remembered that implementing a shore protection strategy is not a one-time effort. Both living shorelines and hard structures require maintenance. Further, recommended strategies will include not only the shore protection strategy, but also how the upland bank should be treated, *i.e.* whether trees should be thinned or banks should be graded. The recommended strategies will have to interface with both the upland and the adjacent shoreline.

3 PHYSICAL AND HYDRODYNAMIC SETTING

The South River trends approximately northwest by southeast, and the mouth can be defined by a line connecting Sanders Point and Thomas Point (Figure 2). It is about five nautical miles (nm) from that line upriver to the Route 2 Bridge. The river width varies along its length from about 0.25 nm at the Route 2 Bridge and gets progressively wider toward the Bay to almost 2.0 nm at the mouth. The width and fetch exposure are variable along its length. The shoreline configuration is a result of antecedent geology and the Chesapeake Bay's fluvial/estuarine pattern. As sea level rose, it flooded the Bay's dendritic drainage.

In the upper reaches (with little fetch) of the Bay's creeks and small rivers, marsh fringes occupy much of the shoreline which in turn attenuate what little wave action occurs there such that shore erosion is minimal. Proceeding down river, the creeks get wider, fetch increases, and wind-driven waves become more significant. Marsh fringes begin to erode and shore erosion increases. Boat wakes can play an added role to the impinging wave climate especially when boat traffic occurs near the shoreline.

When natural marsh fringes become too narrow, storm waves are not attenuated, and they impact the base of the adjacent upland banks. With time, this causes bank undercutting and eventually bank slope failure. Exposed banks are an indication of active shore erosion, and the traditional response by waterfront lot owners is to install a bulkhead or stone revetment. About 82 miles were assessed as part of this study and approximately 36 miles of shoreline (including marinas) has been hardened along the South River (Table 1).

Marine resources, particularly submerged aquatic vegetation (SAV) and oysters, are the subject of extensive restoration efforts around Chesapeake Bay. Shoreline stabilization efforts should consider these and any potential impacts on them, whether positive or negative. The historic foot print of SAV and the location of designated oyster beds are included in the Appendix A.

3.1 Geology and Historical Shore Change

The geologic underpinnings of the South River are shown in Figure 3. From the most recent to the oldest, three types of deposits or strata occur within the lower South River watershed. These include Holocene Alluvium [Qal], Pleistocene Lowland Deposits [Qz] and Upper Paleocene Aquia Formation [TaTbr]. The Holocene Alluvium occurs as the more recent deposit (past 20,000 years) of sand and marsh on the points and spits like Melvin Point, Persimmon Point, Long Point, and Turkey Point. The Lowland deposits are generally composed of silts and clays exposed mostly along the southern shorelines of the lower South River. The Aquia strata, generally sandy in nature, often with various types of fossil shell including oysters and *Turritella*, the screw shell. These deposits are exposed mostly along the north coast of South River except for the headland feature of Brewer Point on the south shore. The nature of sediment input from bank erosion is dependent on what type of strata is eroding.

Table 1. Length of existing structures on the South River.

Structure Type	No. of Structures	Length (ft)
No Shore Structures	667	244,291
Breakwater	6	1,465
Bulkhead	365	93,408
Dilapidated Bulkhead	5	780
Groin	14	7,361
Jetty	2	232
Marina, <50 slips	24	6,824
Marina, >50 slips	14	10,948
Miscellaneous	17	2,014
Riprap	304	69,232
	Total Shore Length (ft)	436,552
	Total Shore Length (miles)	82.7
Total Length of Hardened shore (ft)		192,262
Total Length of Hardened shore (miles)		36.4

The historic shore positions along the South River are shown in Figure 4. A certain amount of error exists when determining the position of the shoreline from old charts and aerial imagery, particularly when interpreting change up the very narrow creeks. The net long-term erosion is between 1847 and 1994 shorelines. Between the Route 2 bridge and Mayo Point on the south and Hill Point on the north, some of the obvious areas of loss are on the west facing shorelines north of and adjacent to Ferry Point, Melvin Point, and Persimmon Point. Along the south shore, most erosion is on the north facing points like Cedar, Brewer and Mayo. The reach between Mayo Point and Long Point is also very erosive. Shorelines exposed to the open bay are historically erosive as well.

3.2 Hydrodynamics

The mean tide range in the South River is about 1.0 ft. The river shoreline is a series of headlands and embayments caused by secondary drainages (embayments) and interstream divides (headlands). Therefore, the fetch exposure varies along the north and south coasts.

Three basic elements in determining wave climate are: fetch, water depth, and wind speed. Hardaway and Byrne (1999) showed that shore orientation also is a factor. In fact, shorelines along the south shore of the northwest-southeast trending rivers in Virginia have historic erosion rates of 2 to 3 times more than the shoreline facing southward along the northern shorelines. For the purpose of developing a general wave climate along the river, the shore reaches were designated as per Figure 2.

Using Patuxent River Naval Air Station wind data and Solomon's Island tidal data, Basco and Shin (1993) determined a storm scenario of wind speeds of 35 mph and storm surge of +2.5 ft has a 50% probability of occurring in any given year from any given direction, except the southeast where the winds would be 25 mph. Recent storms including Hurricane Isabel and

Tropical Storm Ernesto had significant easterly wind components. Given these, the 35 mph condition was used to apply to a wave climate modeling effort for the South River.

Wind Wave Hindcast Model

Many models are available for wind-wave hindcast modeling. The U.S. Army Corps of Engineers (USACE) model ACES version 1.07 was selected because it provides a quick and simple estimate of wave growth over open-water and restricted fetches in deep and shallow water. Wind waves grow as a result of momentum flux as energy from the air goes across the water and into the wave field. Numerous parameters are accounted for including wind speed, direction, fetch and water depth. These must be input into the model, while other parameters such as temperature differences between air and water and wind reference level corrections, are taken at default values as specified by ACES.

The South River was divided into reaches (Figure 2) along the north and south shorelines. The more exposed reaches along the main trunk were delineated but not the smaller creeks where average fetch exposure is less than 0.5nm. The longest fetch exposure was calculated for each reach from a line that is shore normal from the middle of the reach. The average water depth in that direction also was computed from the most recent nautical chart. Then the selected storm surge was added bringing the average depth to +3.5 ft MLW which was rounded up. The model was run with the 35 mph input. Results are shown in Table 2 titled the South River general wave analysis for wave height (H) and period (T).

The resultant H and T from Table 2 were plotted against fetch exposure (Figure 5). Reach N-03 was taken out because it created an extreme outlier with a fetch of over 36nm. As expected the greater the fetch exposure the larger the impinging wave heights and periods. Site conditions will dictate the actual design of erosion control structures at a given location.

Boat wakes can be an issue especially where boats pass nearby to land. Displacement hulls also tend to create more destructive wakes than planning hulls (Bottin, McCormick and Chasten, 1993).

Table 2. South River general wave climate analysis for wave height and period.

South River General Wave Analysis						
Location	Wave Height (ft)	Period (sec)	*Fetch (nautical miles)	Direction (degrees)	Depth (ft)	Reach Length (ft)
N - 01	1.46	2.23	1.55	254	16	1,350
N - 02	1.32	2.11	1.23	211	17	1,350
N - 03	6.04	4.98	36.63	157	33	3,750
N - 04	1.21	2.01	1.02	270	19	1,410
N - 05	1.54	2.3	1.72	180	18	2,100
N - 06	0.88	1.7	0.53	232	18	1,500
N - 07	1.57	2.32	1.82	157	16	1,200
N - 08	1.18	1.99	0.97	270	19	2,850
N - 09	0.9	1.72	0.55	245	19	1,950
N - 10	1.14	1.95	0.89	172	19	1,350
N - 11	1.34	2.13	1.24	270	23	2,550
N - 12	1.11	1.92	0.85	180	19	900
N - 13	0.95	1.76	0.63	170	14	1,800
N - 14	0.76	1.56	0.39	180	18	1,800
S -01	1.38	2.16	1.36	349	17	3,150
S -02	1.61	2.35	1.9	38	17	5,700
S -03	1.08	1.89	0.8	90	19	2,700
S -04	1.13	1.94	0.88	156	19	900
S -05	0.71	1.51	0.34	234	19	1,650
S -06	1.51	2.27	1.63	90	19	3,000
S -07	1.13	1.93	0.88	0	17	1,950
S -08	0.92	1.73	0.57	42	20	1,800
S -09	1.43	2.2	1.45	0	19	1,800
S -10	1.37	2.15	1.32	90	18	1,500
S -11	1.13	1.95	0.89	0	18	1,800
S -12	0.86	1.67	0.51	0	15	3,000
S -13	1.35	2.14	1.31	90	16	2,160
S -14	0.66	1.44	0.29	140	17	1,200
S -15	0.77	1.58	0.4	35	19	3,600
S -16	0.79	1.6	0.42	0	23	2,550

*Fetch = Effective fetch @ longest exposure with 90° window

Wind = 35 mph; Surge = +2.5 ft which is approximately +4.0 MLW

4 SOUTH RIVER SHORELINE RECOMMENDATIONS

The shoreline strategies for the South River coast are summarized in Appendix B and detailed in Appendix C. The determination of each strategy was done on sight during several boat trips along the South River coast. The recommendations are found in Appendix A as a GIS map of the South River. It was a combination of site conditions and best professional judgment as to which strategy was appropriate for each subject shoreline. The first condition was whether an erosion problem existed either on the base of bank or bank face. Bank face erosion almost always means an unstable or erosive base of bank. Bank face erosion was usually seen on the more open shores of South River while base of bank erosion with a relatively stable bank face was often found up the many low-energy, creek shorelines. Exceptions to these tendencies occurred. The "do nothing" option also was considered usually because the erosion was minimal and/or the land use was obviously not residential.

Addressing base of bank erosion, usually up the small creeks, can be done with the N series (N-2 and N-3) strategies as seen in Appendix B and C. Some hybrids, H series, were recommended up the creeks where a small sill (H-2 variation) was deemed necessary either because of one long fetch exposure, boat wakes or the bank had more critical erosion. Along the more open coasts of the South River, mostly H series options were recommended, particularly H-2, the sill system. Some S series were recommended when both base of bank and bank face erosion occurred. No N series options were recommended on those shorelines, and S series were only recommended on the open South River coasts.

Table 3 shows the type and length of shoreline treatments recommended for the plan. About 14.5 miles of shore options were recommended. Marsh fringe creation with sills, H-2, dominated the recommended strategies at 29,130 ft which includes both low and medium wave energy sites. This is a proven method of shore protection for those shoreline types and their moderate to low wave energy fetch exposures. The second most frequent recommended strategy was fringe marsh restoration with coir log edging, N3, at 18,260 feet. This provided for adding sand to the substrate, and it was felt the coir logs would help initial marsh establishment up the low energy creeks. The third ranked strategy was breakwater systems, S-2, at 8,520 feet of shoreline. The fourth and fifth ranked were N2 and H-2/S-2 combinations at 6,210 ft and 5,000 ft, respectively.

The average length per site for the three most recommended methods are: H-2= 300 ft/site, N3=275 ft/site and S-2 = 500 ft/site. Breakwater systems are usually more applicable to longer reaches of shoreline. However, the fourth (N2) and fifth (H-2/S-2) ranked strategies were 620 ft and 715 ft per site, respectively. This shows that long stretches of very low energy shoreline were deemed suitable for N2 and that once again breakwater systems and combinations therein are more applicable along longer segments of coast.

The level of protection for any given strategy needs to be understood by the waterfront property owner. A +2.5 ft storm surge (+3.5ft MLW) with a 35 mph wind from any given direction has a 50% probability of occurring during any given year as portrayed in the preceding section. This condition will impact the more open shorelines along the South River much more than the sub-tributary creeks. High water without significant wave action is generally not a problem. The recommended shoreline strategies exposed to moderate wave energy along the South River should offer protection against this condition at a minimum.

Table 3. Recommended shoreline strategies for the South River.

Series Option	Recommendation Type	Length (ft)	No. of Systems Recommended
	Primary Treatment is either Blank or it says "No Action"	3,156	18
H-1	Marsh fringe with groins	204	1
H-2	Marsh fringe with sills	29,126	97
H-2/S-2	Marsh fringe with sills and breakwater system	4,997	7
H-4	Beach replenishment with breakwaters	358	1
H-5	Marsh toe revetment	2,595	4
N-2	Fringe marsh creation or restoration	6,207	10
N-2/N-3	Fringe marsh creation or restoration / with coir logs edging	824	1
N-3	Fringe marsh creation or restoration with coir logs edging	18,262	66
N-?	Assumed N-1 = Beach Fill	361	1
S-1	Revetments	2,071	8
S-2	Breakwater systems	8,520	17
S-3	Spurs	87	1
	Total Length:	**76,770 or 14.5 miles**	

5 REFERENCES

Basco, D.R. & Shin, C.S., 1993. Design Wave Information for the Chesapeake Bay and Major Tributaries in Virginia. The Coastal Engineering Institute, Old Dominion University, Report No. 93-1. Norfolk, VA.

Bottin, R.R., Jr, McCormick, J.W., & Chasten, M.A., (1993). Maryland guidebook for Marina owners and operators on alternatives available for the protection of small craft against vessel-generated waves. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Report prepared for Maryland Dept. of Natural Resources.

Glaser, J.D., 2002. Geologic Map of the South River Quadrangle, and Portions of the Annapolis Quadrangle,Anne Arundel County, Maryland. Maryland Geological Survey, Baltimore, Maryland.

Hardaway, C.S., Jr. and R.J. Byrne, 1999. Shoreline Management in Chesapeake Bay. Virginia Institute of Marine Science, College of William & Mary, Gloucester Point, Virginia.

Maryland Geologic Survey, 2001. Shoreline Changes, South River Quadrangle, Maryland. http://www.mgs.md.gov/coastal/maps/schangepdf.html

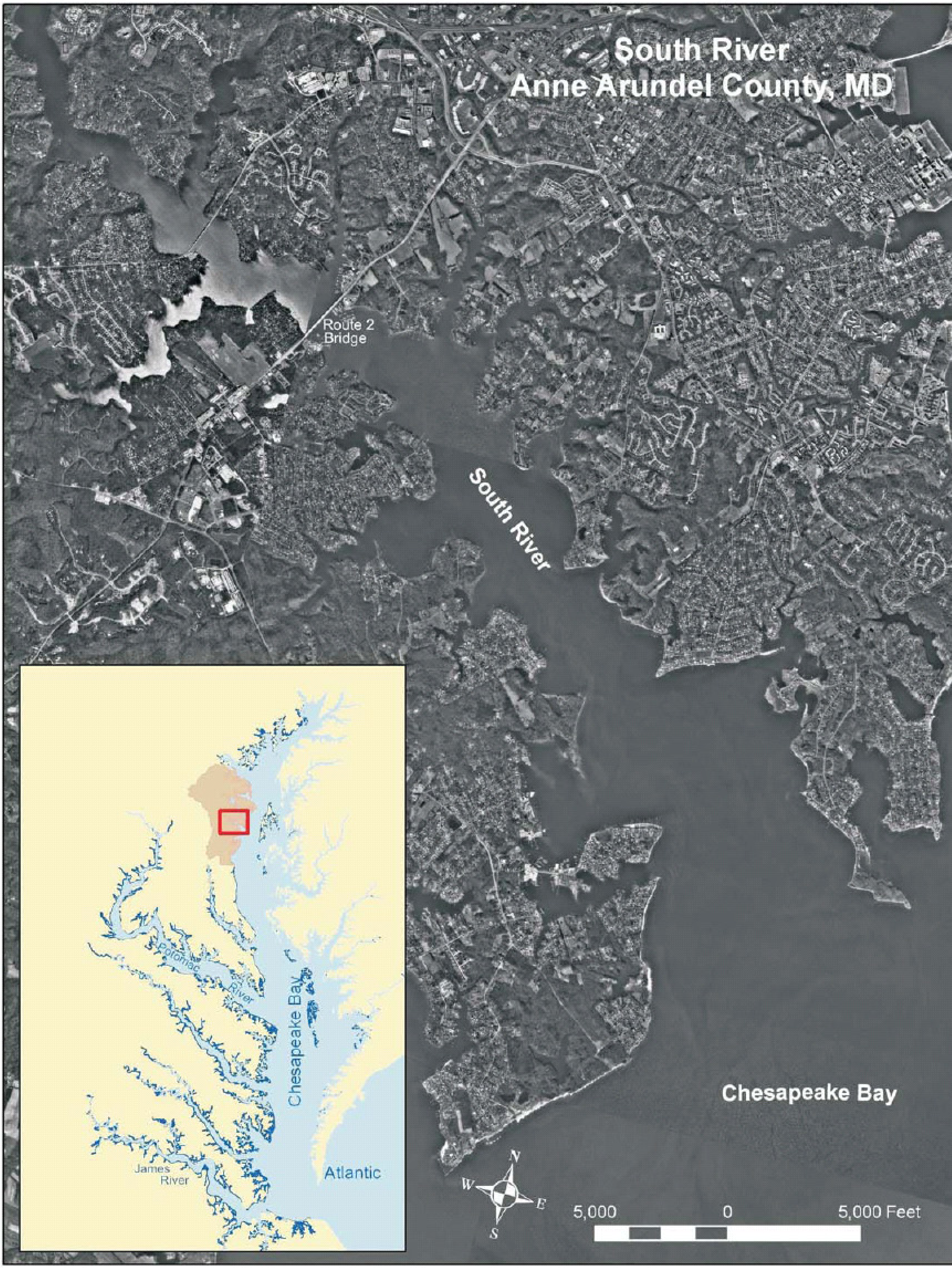
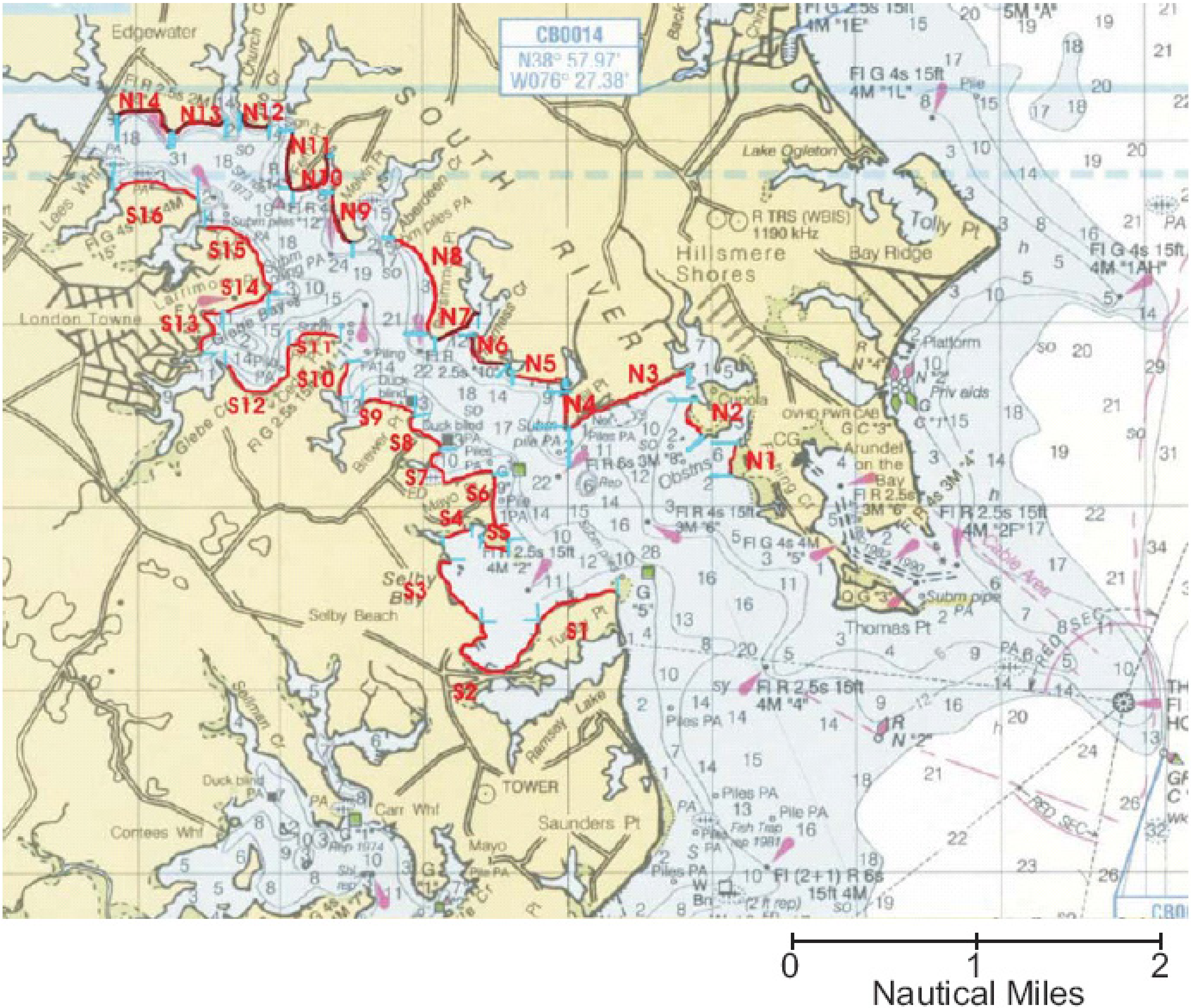


Figure 1. Location of South River within the Chesapeake Bay Estuarine System.



Legend

N1, N2 = Reach segment number on ***north*** side of South River

S1, S2 = Reach segment number on ***south*** side of South River

I I, \ / = Reach segment indicator marks

Figure 2. Location of reaches for the general wave climate analysis.

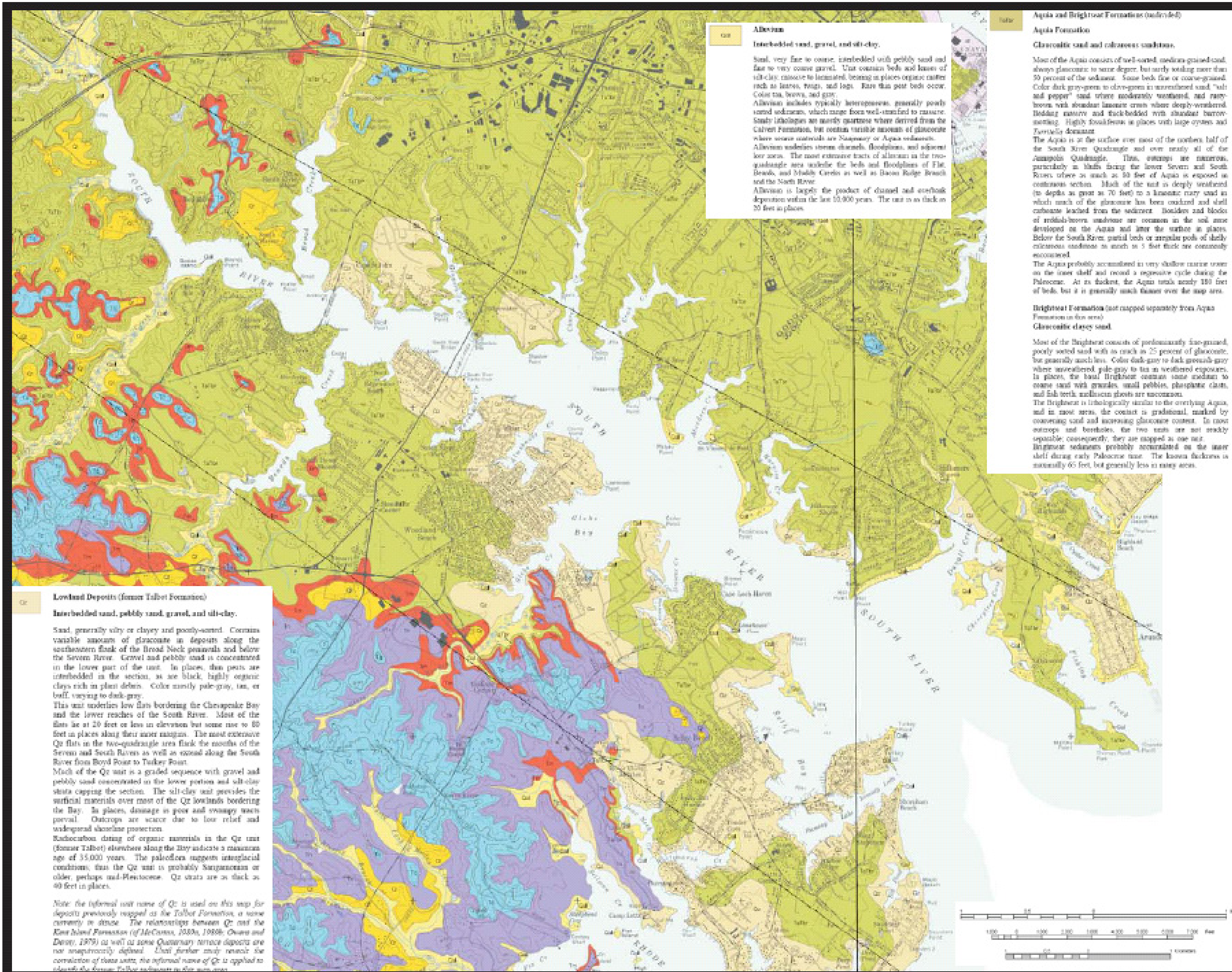


Figure 3. Geology of the South River. From the Geologic Map of the South River Quadrangle, andPortions of the Annapolis Quadrangle,Anne Arundel County, Maryland (Glaser, 2002).

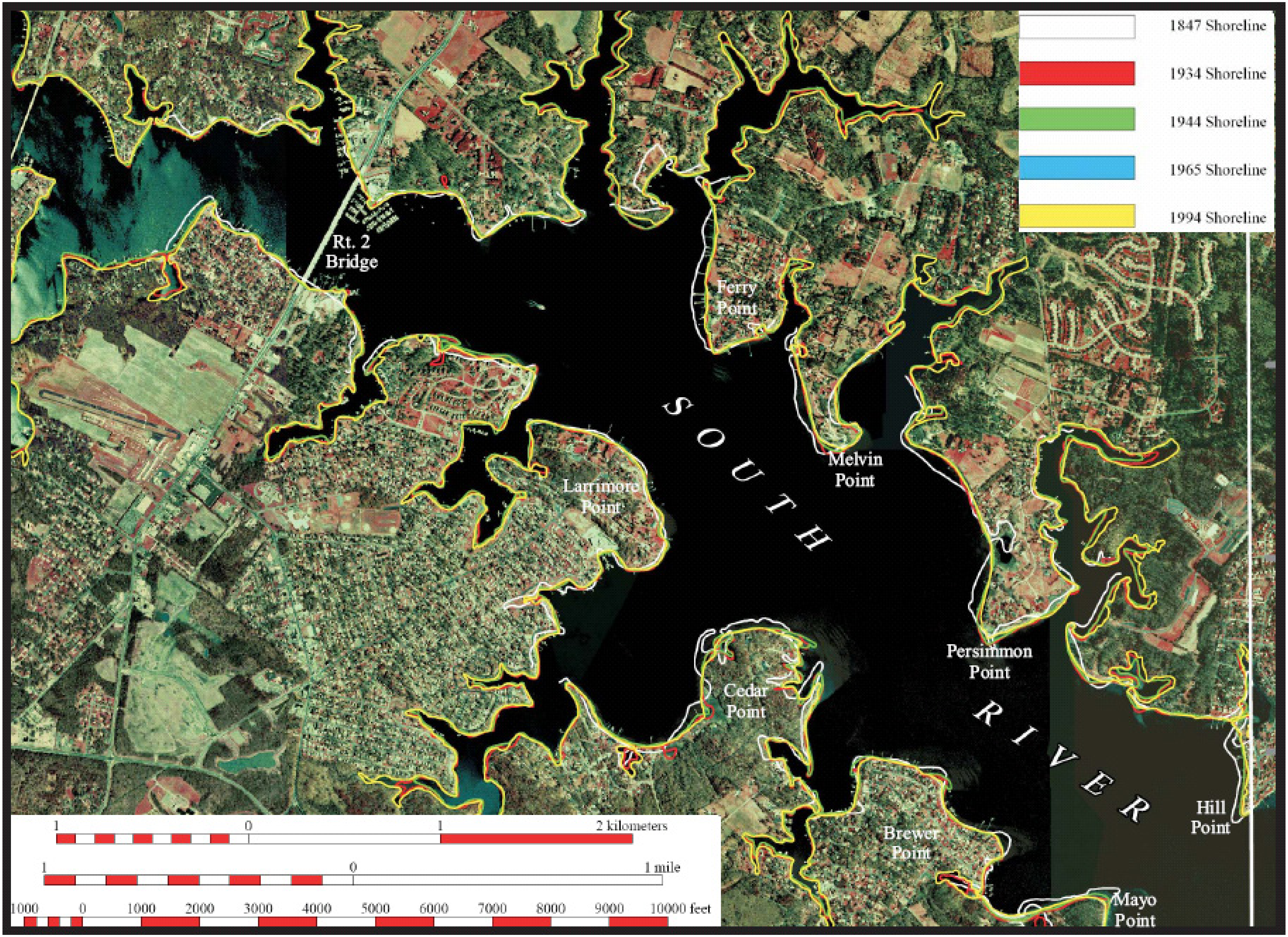


Figure 4. Historic shoreline positions along the South River. From Shoreline Changes, South River Quandrangle, Maryland, compiled by the Maryland Geologic Survey (2001).

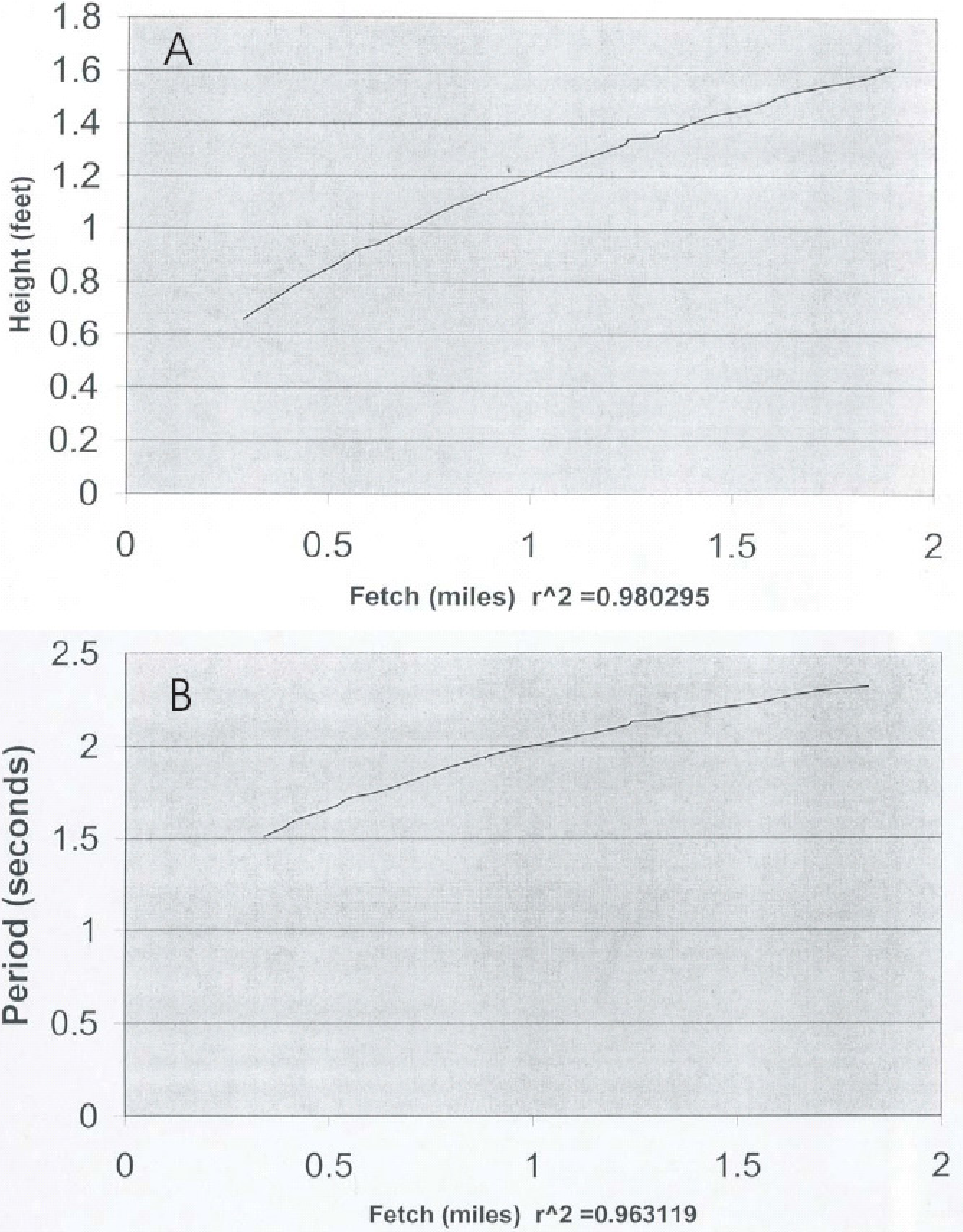


Figure 5. Fetch versus A) wave height and B) wave period.