Woods Hole Oceanographic Institution

SURVEY OF SHORELINE STRUCTURES POPPONESSET BEACH, MA

by

M. R. Goud
and
D. G. Aubrey

May 1983

Technical Report

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WOODS HOLE, MASSACHUSETTS 02543

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Approved for Distribution: Carl Bowin

Carl O. Bowin, Acting Department Chairman
Department of Geology and Geophysics

PREFACE

This report describes engineering structures along a stretch of shoreline in Mashpee, Massachusetts. It was prepared as part of a study of coastal sediment transport along the Nantucket/Vineyard Sound shoreline, with the aim of providing to the town a basis for sound management of the area. Funding for the project was provided through a Massachusetts Coastal Zone Management Program Community Assistance Grant, by the Town of Mashpee, and by the Woods Hole Oceanographic Institution Sea Grant Program, through grant number NA80AA-D-00077(RB-40).

ABSTRACT

The structures along a 12 km section of the shoreline of Cape Cod, Mass., were evaluated for condition and effectiveness at protecting the coast. Structures in the area include groins, jetties, revetments, and seawalls; each has been located, photographed and described. The region has been subject to erosion in recent years, including the loss of a 1 km section of barrier spit. The role of shoreline structures in controlling or enhancing the erosion was examined as part of a larger study of coastal processes in the area.

The shoreline structures serve two primary functions: beach enhancement and protection of the bluffs from erosion. The structures' effects on bluffs and beaches in their immediate vicinity (approximately 100m along the coastline to the north and south of the structure) are detailed in this report. Seawalls generally protect the cliffs into which they are built without enhancing erosion of surrounding bluffs, though the bluffs are protected at the expense of the beaches in the central area (Meadow Point). Large scale changes in beach configuration are not primarily caused by local, small-scale structures, but rather by a more regional paucity of sand input into the system. This scarcity is caused in part by large jetties controlling inlet flows to Waquoit Bay, which impedes free transport of sand into the area.

SURVEY OF SHORELINE STRUCTURES
POPPONESSET BEACH, MA.

The Cape Cod shoreline from Washburn Island to Cotuit Inlet displays numerous coastal engineering structures, including groins, jetties, sea walls and revetments. As part of a study of sediment transport patterns in the area, all structures were located, photographed and evaluated for effectiveness in protecting the coast. The results of this survey are presented in this report.

The Popponesset Beach coastline has undergone marked change in the past 25 years. The most obvious resulted from a breach in the spit in 1954, which caused the shift of the inlet to its present location and isolated the northeast limb of the spit, shortening it by 1.5 km. In response to local concerns over the best management program for the remainder of the spit and the beaches nearby, the Town of Mashpee and the Office of Sea Grant of the National Oceanic and Atmospheric Administration contracted with David Aubrey and Arthur Gaines at the Woods Hole Oceanographic Institution to conduct a historical survey of the changes in the area and to make management recommendations based on that survey (Aubrey and Gaines, 1982). The present study is an extension of that effort, with the aim of clarifying the paths and rates of sediment transport in the nearshore zone (Aubrey, Goud and Gegg, in prep.) References to other studies of the vicinity can be found in the Aubrey and Gaines report.

The engineering structures along the shoreline of the study area vary widely in state of repair and in effectiveness at controlling sand movement. Descriptions of the structures are presented in tabular form, with each structure discussed in sequence from southwest to northeast along the coast. The shoreline has been divided into a series of eight stations (Fig. 2). Each station contains a group of adjacent structures, generally serving similar purposes. Each structure within a station is described in detail; large scale location maps and sets of photographs accompany the descriptions.

Shoreline structure nomenclature conforms to the U.S Army Corps of Engineers' Shore Protection Manual (U.S Army Coastal Research Center, 1973). The following terms are used in this report to describe structures:

groin: a shore protection structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore.

jetty: on open seacoasts, a structure extending into a body of water, and designed to prevent shoaling of a channel by littoral materials, and to direct and confine the stream or tidal flow.

revetment: a facing of stone, concrete, etc., built to protect a scarp, embankment, or shore structure against erosion by wave action or currents. In this report it will be used to describe non-vertical reinforcements to seawalls

riprap: a layer, facing, or protective mound of stones randomly placed to prevent erosion, scour, or sloughing of a structure or embankment.

seawall: a structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action.

The survey was carried out in June, 1982 with some supplementary data collected in January and February, 1983. Dates of photographs are as follows:

24-25 June, 1982	photo #s 5-14,16-32,34-44,46-49
2 July 1982	photo # 1
23 January 1983	photo #s 15,45
20 February 1983	photo #s 2-4, 33

Height of seawalls is measured above sand level, and that of groins is above mean sea level.

Evaluation of the effectiveness of structures is based on appearance of the shore in the vicinity, on comparisons of aerial photographs of the area, and on conversations with local residents. Groins are judged on their effectiveness at trapping sand, as evidenced by local beach width. Seawalls and revetments are evaluated on the relative erosion of the cliff faces which they protect and on undercutting of the structures. Effects of the walls on surrounding coastline is noted.

The condition of seawalls and groins is a subjective judgement, based generally on the following criteria:

Excellent: smooth surfaces on structures; interstices of boulder structures filled with small cobbles; concrete uncracked.

Very Good: fairly smooth surfaces; some interstices filled.

Good: boulders in place; few cobbles in interstices.

Fair: boulders falling out of original structure; concrete displays holes; no cobbles.

Poor: boulders unpiled and in disarray; concrete falling apart.

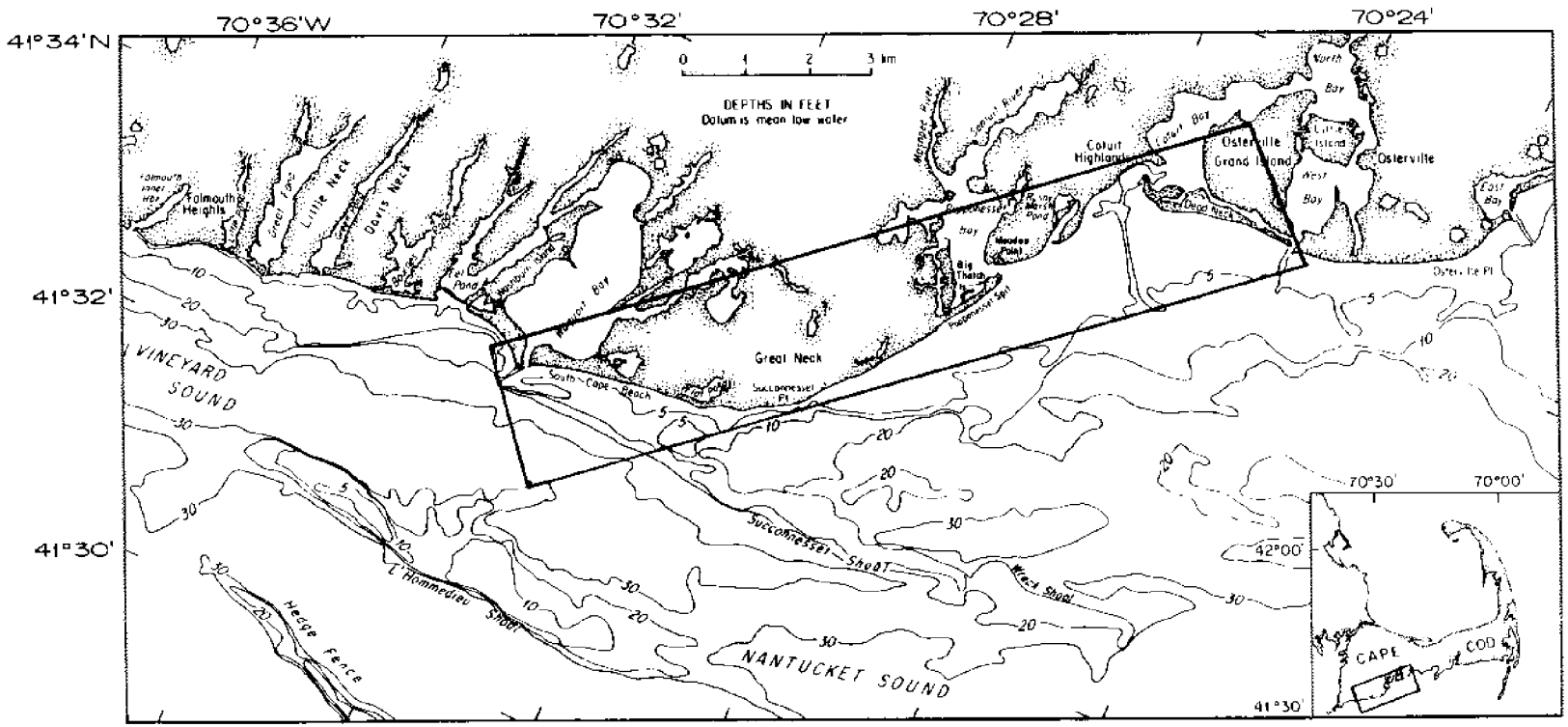


Figure I. Location of study area along coast of Cape Cod, Massachusetts. The area inside box is the area covered by Figure 2.

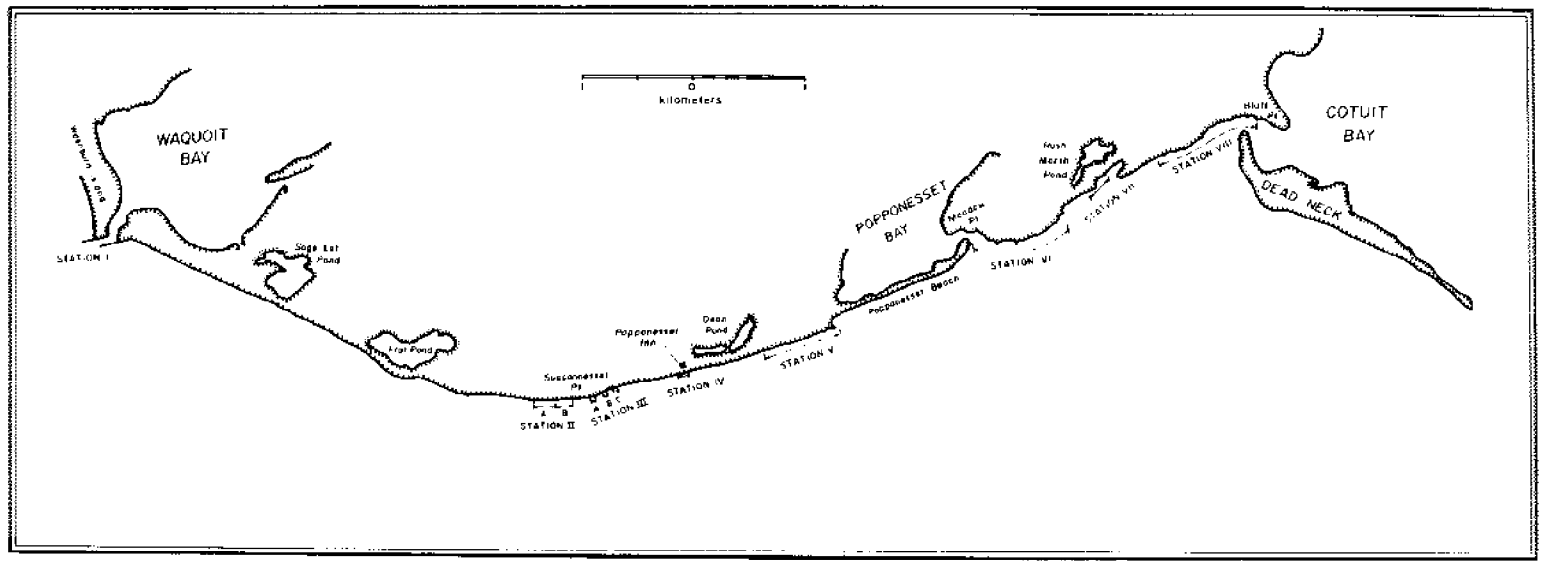


Figure 2. Location of stations within study area, as referred to in report.

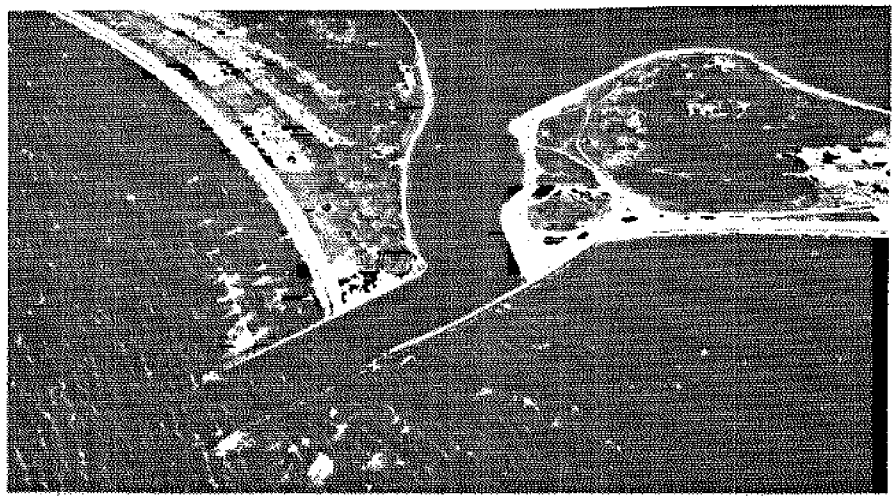


Photo #1. Sta. I. Waquoit Jetty aerial photograph; South Cape is on the right, Washburn's Island to left. Note gap in lower jetty approx. at midpoint.

RESULTS

STATION I

The only engineering structures on Washburn Island between the entrances to Eel Pond and Waquoit Bay are a series of groins near the entrance to Eel Pond, dating from the 40s. These groins, which at one time were shore-attached, are now in the subtidal region off the barrier beach. They indirectly affect beach stability, serving as non-coherent offshore breakwaters. They are a distinct hazard to navigation, which more than offsets their utility as beach stabilization structures.

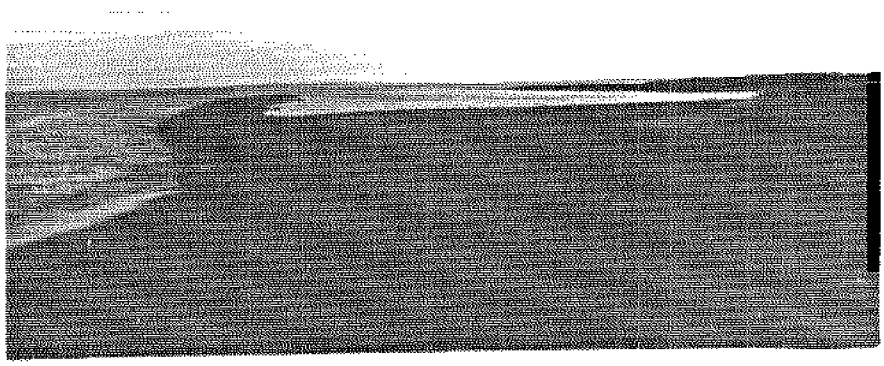


Photo #2. Sta. I. Waquoit jettys, western jetty in foreground.

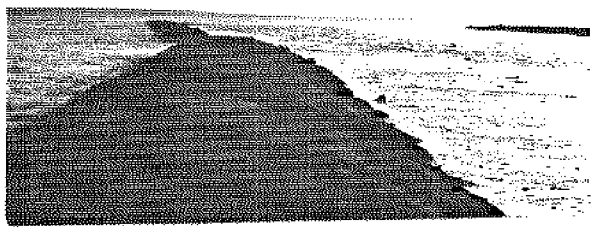


Photo #3. Sta. I. Waquoit jetty, end of eastern jetty in foreground, western to right.

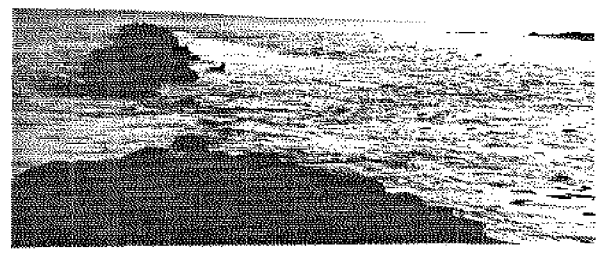


Photo #4. Sta. I. Waquoit eastern jetty gap at 280m.

Two jetties line the entrance to Waquoit Bay.
Photo #s: 1,2,3,4
Height: approximately 2m above sealevel
Width: 6m
Length: 285m (western jetty extending from Washburn's Island)
470m (eastern jetty extending from South Cape Beach)
Construction: loose boulders up 2m diameter
Condition: good , although the eastern jetty is discontinuous for 10m, from 270 to 280m; for 200m beyond this point the jetty is constructed of jagged boulders, in less ordered patterns (see photos 1 and 4).
Effectiveness: The jetties apparently help keep the inlet mouth open; dredging is not necessary in this channel. The jetties may have a profound effect on sediment transport in the rest of the study area, as discussed in the transport analysis section of the general report.

Photo #5. Sta. IIa. Concrete seawall with stone apron

Photo #6. Sta. IIa-b. North end of IIa. Compare smooth riprap surface with photo 5.

STATION II

There are no more shoreline structures east of station I until the vicinity of Succonnesset Point.

Station IIa: seawall with stone apron.

Photo #s: 5,6,7

Height: .8m (southwest end) to 1.5m (northeast end)

Length: 170m

Construction: concrete blocks,each 2m long, with apron of loose boulders up to 1.5m diameter.

Condition: fair to good; most of the small stones in the riprap apron have washed away, leaving only the boulders to act as reinforcement to the concrete blocks. The wall and apron made a smooth slope down to the beach when they were installed, and in the 4 years since then waves have left the blocks tilted and the rocks in disarray; this is shown in the first photograph, and can be contrasted with the second, where this seawall abuts structure IIb and the original smooth slope of the riprap is visible.

Effectiveness: very good; the shoreline has not retreated since the wall was built; there is no evidence of undercutting; and beach width is generally the same as that of the surrounding areas. Beach roses on slope above seawall provide additional stabilizing force (photo 7).

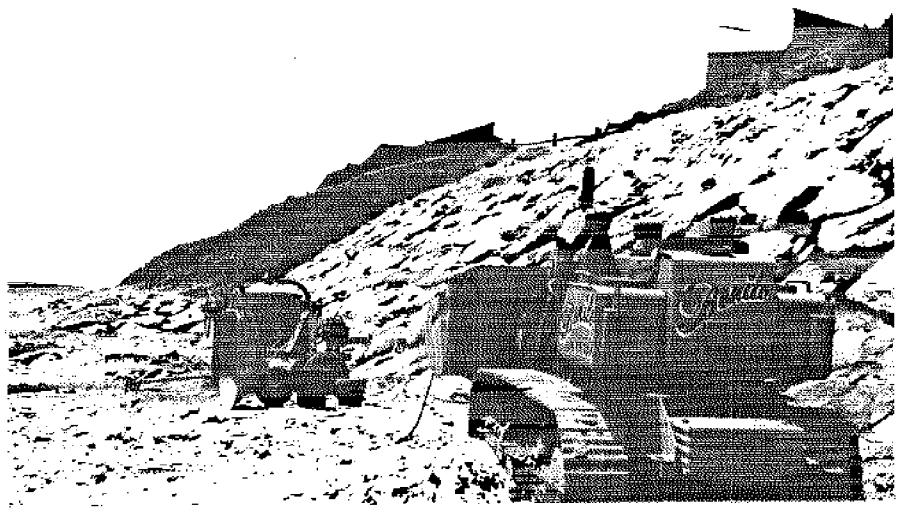


Photo #7. Sta. II, a-b. North end of IIa, South end of IIb, looking southwest. Note beach roses above wall in this photo and in photo 8.

Station IIb: seawall
Photo #s: 6,7,8
Height: 4.5m
Length: 144m
Construction: boulders set in concrete, except the southernmost 40m, which is loose boulders .
Condition: excellent; was being refurbished during this evaluation (June 1982)
Effectiveness: This height and steepness of this bluff insure that wave action on its exposed face would cause rapid erosion. The seawall effectively retards this process.

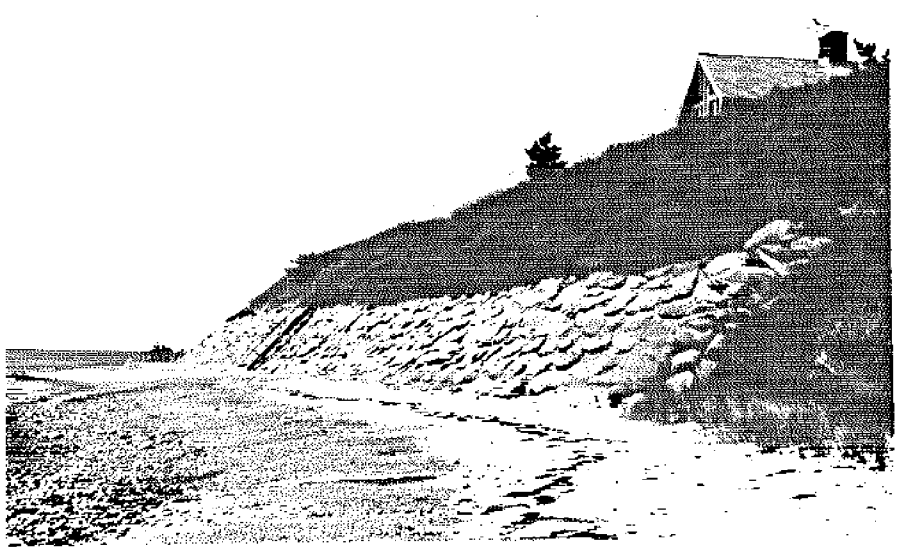


Photo #8. Sta. IIb. Northern end of seawall.

Photo #9. Sta. IIIa. Seawall with stone apron, looking northeast.

STATION III

This station consists of 3 separate seawalls on Succonnesset Point, each for the purpose of preventing erosion, slides, and landward migration of the cliff. The cliff is approximately 11m high.

Effectiveness of all 3 is good; reinforced cliffs are markedly less prone to erosion and slides than surrounding bluffs, and beach widths appear unaffected by the seawalls.

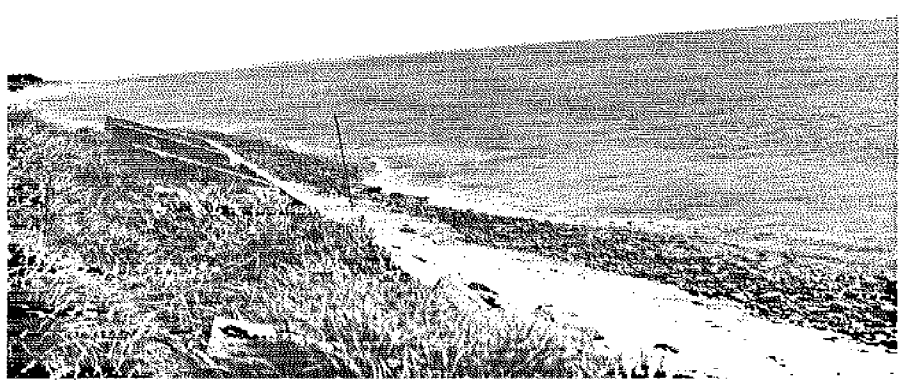
Station IIIa: Seawall with boulder apron.
Photo #s: 9,10
Height: 2m
Length: 37m

Construction: concrete wall, tilted with its base toward the shore with 5 concrete reinforcements extending shoreward (see photo 10) and an apron of small boulders (less than 1m diameter).

Condition: fair. Boulders in disarray; no matrix in riprap.

Effectiveness: fair. The grass on the slope appears to be essential for maintining slope stability, and there is some undercutting of the wall (photo 10).

Photo #10. Sta. IIIa. Seawall, landward side. Undercutting is occuring where grass thins between farthest reinforcements.



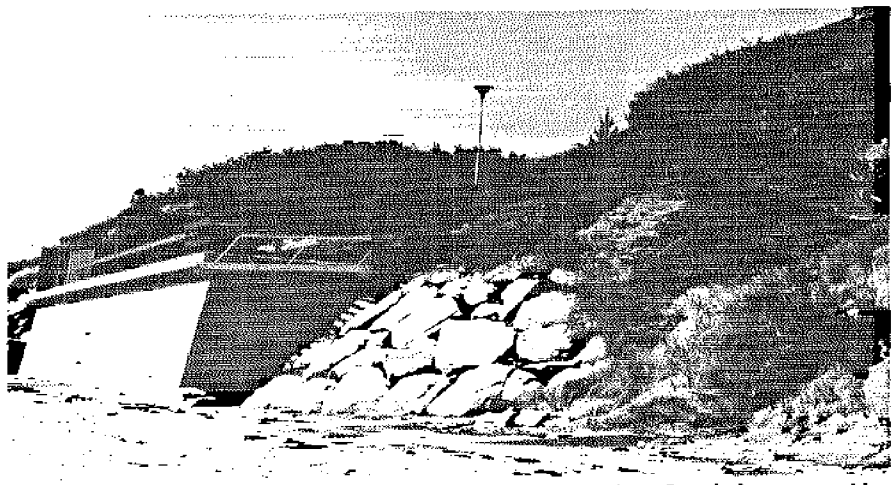


Photo #11. Sta. IIIb. Seawall and terraced deck, looking southwest.

Station IIIb. Seawall
Photo #: 11
Height: 3m
Length: 30m, plus 4m of boulder reinforcement to the south, 8m to the north.
Construction: vertical concrete wall, with terraced deck leading up to house; the reinforcement is constructed of flat boulders.
Condition: excellent
Effectiveness: very good; the beach is wide and the cliff is stable at this location.

Station IIIc: Seawall
Photo #s: 12
Height: 3 1/2m
Length: 35m
Construction: flat, slanted boulder apron at base of slope
Condition: very good
Effectiveness: good; slope retreat has been retarded and beach width is stable.

Photo #12. Sta. IIIc. Concrete seawall with boulder apron & cliff vegetation for increased stability; looking northward. Note increased landward migration of cliff immediately north of seawall.

Photo #13. Sta. IV. Set of backshore groins in front of Popponesset Inn; looking northeast.

STATION IV

Series of 6 small backshore groins which were placed in front of the Popponesset Inn in 1979 to trap sand in dunes and avoid shoreward migration of beach

Photo #: 13

Height: .2-.3m

Length: 4-6m

Width: .9m

Construction: concrete blocks, each 2.1m long, placed in rows 2-3 blocks long at intervals less than or equal to 60m.

Condition: fair

Effectiveness: Popponesset Inn officials reported some initial sand accumulation, but said the groins no longer appear to have any effect in stabilizing the dunes.

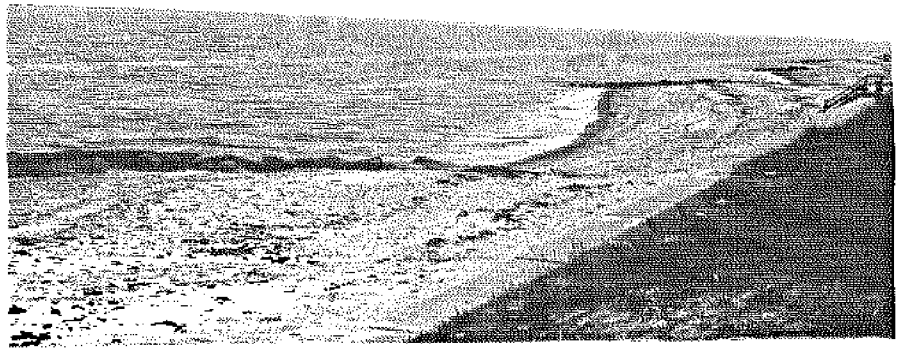


Photo #14. Sta. V. Southernmost 5 groins, looking south. Photo displays sand capture on northern side of groins in June 1982.

STATION V

Series of 9 loose boulder groins dating from the early to mid fifties for the purpose of sand entrapment. A seawall joins some of the groins.

GROINS

Photo #s: 14,15,16,17
Height: average height of the groins is 1m
Length: 20-25m except the northernmost 2, which are 35 and 65m long
Width: 4m average
Construction: loose boulders up to 1.5m diameter
Condition: fair to good; very little cobble matrix
Effectiveness: The net effect of the groins appears to be minimal. Though the beach has remained stable since the construction of the groins, its width is not substantially different from beaches to the southwest where there are no groins. Sand trapping is seasonal, as can be seen by contrasting photo 14 with photo 15, where sand accumulation occurs on opposite sides of the groins in different seasons. This pattern has been irregularly repeated in past years (see Aubrey and Gaines, 1982), and suggests that the beach is in general equilibrium with the nearshore processes.

Photo #15. Sta. V. Groin displaying sand accumulation on southern side of structure in January, 1983.

Photo #16. Sta. Va. Northern end of seawall between second and fifth groins. Extent of erosion of unreinforced bluff can be seen to the right of the boulders.

SEAWALLS

Station Va: Seawall located between the second and fifth groins
Photo #s: 14,16
Height: 1.5m
Length: approx. 260m
Construction: concrete
Condition: excellent
Effectiveness: good. On the single lot without a seawall, the dune has been noticeably eroded (see photo 16)

Station Vb: seawall located between the seventh and ninth groins
Photo #: 17
Height: 1.5m at southern end, growing to 4m as cliff grows
Length: 170m
Construction: boulders in concrete matrix
Condition: excellent
Effectiveness: same as Va

Photo #17. Sta. Vb. Groins 7-9 and seawall between them, looking north. Increasing height of seawall to north is visible.

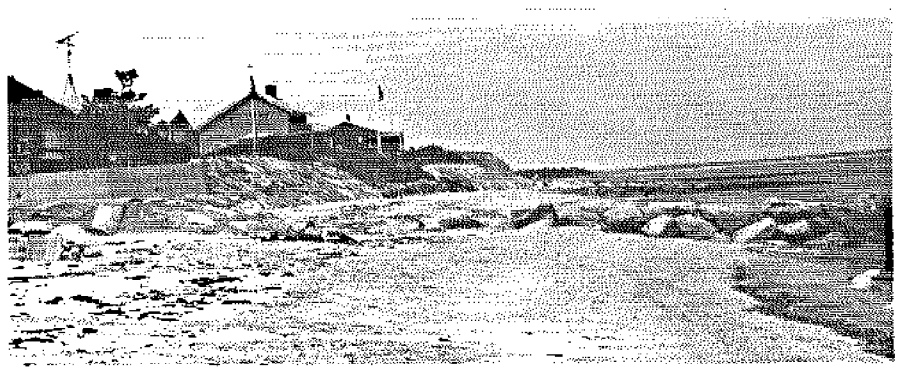


Photo #18. Sta. VI. Southwest end of sta.; note receding beach beyond seawall.

STATION VI

This station consists of a series of 13 groins constructed in the late fifties, most interconnected by seawalls, northeast of Meadow Point. The area is subject to active erosion, especially at the southwest end, where the bluff which was protected by the northeast limb of Popponesset Spit has been exposed to the open ocean since the transfer of the inlet to its present location. The seawalls and groins represent an attempt to protect the cliffs from further erosion and to trap sand.

GROINS (see Figure 3 for locations, construction parameters, conditions and photo references)

Height: 1.5m, average

Length: generally 30m; see diagram for variations

Width: 2.5-3m

Construction: loose boulders, up to 2.5m diameter

Condition: fair to excellent. The most southerly groins were rebuilt in spring of 1982, so they are flat and all interstices are filled with small stones (see photo 18). Groin 11, by contrast, is in only fair condition, and is falling apart at its seaward end.

Effectiveness: variable. The 2 farthest north have been effective at capturing sand on their southern sides, made evident by the fact that north of groin 13 the shoreline is pebbly, while to the south it is sandy (see photo 29). The 3 most southerly, however, have captured sand to their north. The groins in between, exposed to Nantucket Sound, have been less effective and only the large, jointed groin number 6 has preserved a beach, and that only in a thin fillet immediately south of the groin (see photo 22).

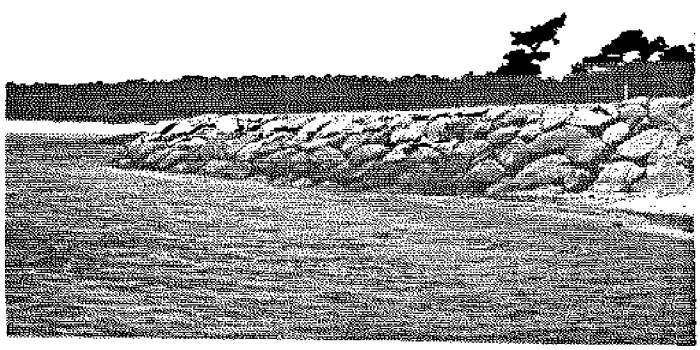
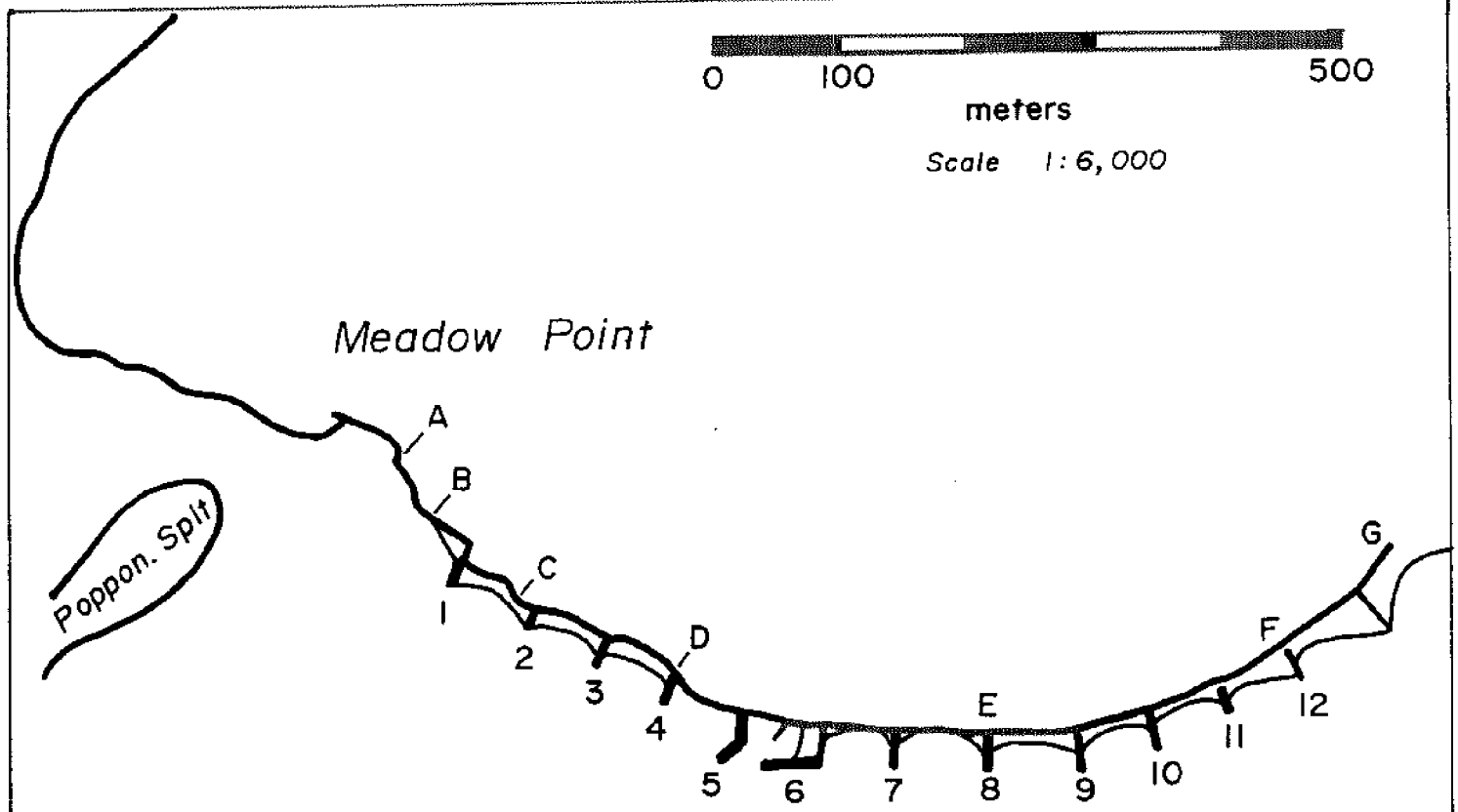


Photo #19. Sta. VI. Recently refurbished seawall just south of groin 1

Figure 3. Detail of Station VI, showing locations of groins as well as construction parameters, conditions, and photo references. Letters refer to seawall locations, as referred to in text.



Groin no.	*Length*	*Width*	*Condition*	*Photo #*
1	22m	3m	excellent	18
2	22m	3m	excellent	20, 21
3	22 m	3m	excellent	20, 21
4	30m	3m	excellent	20, 21
5	30m + 17m	3m	excellent	21, 22
6	30m + 40m	3m	very good	22
7	30m	3m	good	24
8	30m	3m	good	25
9	30m	3m	good	25
10	30m	3m	good	
11	30m	3m	fair	26, 28
12	29m	2.5m	good	
13	41m	3m	good	29

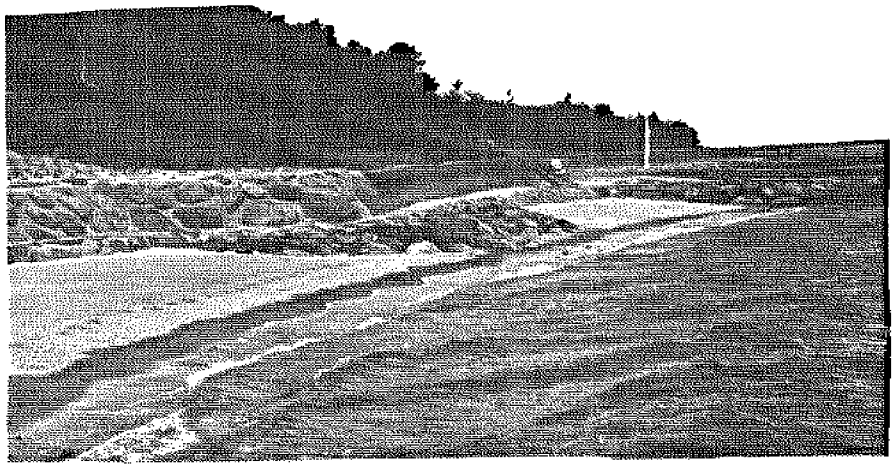


Photo #20. Sta. VI. Change in seawall construction at point C; groins 2-4.

SEAWALLS

Seawalls of various sorts extend northeast from 100m south of groin 1 to groin 13. They vary in effectiveness and condition, and are described individually, with reference to the letters on Figure 3.

A--B

Photo #s: 18, 19
Height: 1-2m
Length: 70m
Construction: loose boulders
Condition: excellent; recently refurbished
Effectiveness: unclear; though residents assert that there has been substantial erosion despite the structure, the beach recedes sharply just south of the seawall (see diagram and photo 18), indicating that the wall is preserving the beach, or at least decreasing the erosion rate.

Photo #21. Sta. VI. Groins 5-2, looking southwest. Note widening of beaches south of groin 4.

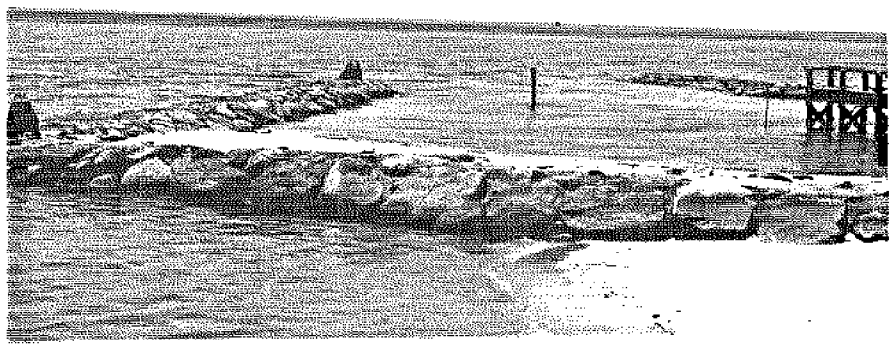


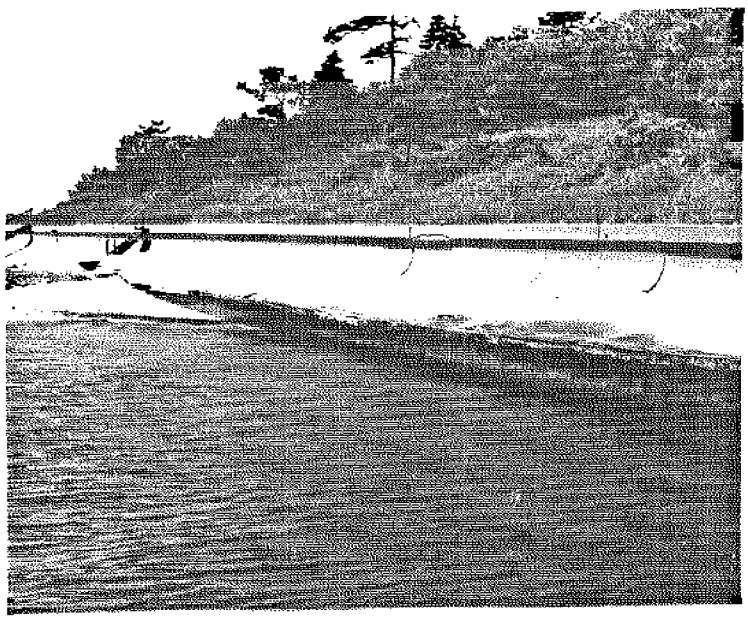
Photo #22. Sta. VI. Groin 6, with its 4m wide fillet of trapped sand. End of pier and groin 7 visible on right.

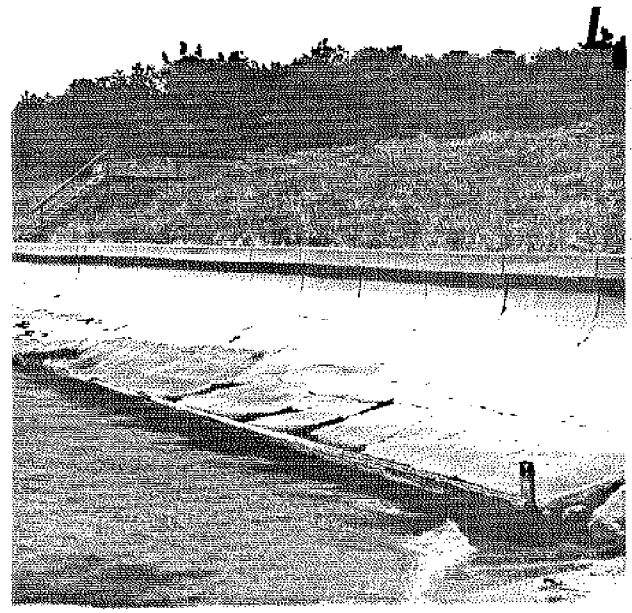
B--C

Photo #s:
Height: 1-2m
Construction: cemented boulders in a near-vertical wall.
Condition: excellent
Effectiveness: good, when combined with sand trapping of groin 1

C--D

Photo #: 19,21
Height: 1.5m (above riprap layer)
Length: 150m
Width: 1m
Condition: excellent
Construction: concrete seawall with a flat top and concave face; it is reinforced by a sloping layer of cemented riprap 1m high. At C, a pile of loose boulders provides further reinforcement
Effectiveness: apparently good when combined with groins; no undercutting is visible and the effectiveness of the beach at trapping sand is apparent in Figure 2 and photos.





Photos 23 and 24. Sta. VI. Seawalls between groins 6&7 and 7&8, each looking to southwest. Note poor condition of revetment.

D--E

Photo #s: 21,22,23

Height: 1.5m wall, plus 1-2m of slanting revetment and vertical, wooden wall

Length: 250m

Width: vertical wall is 1m wide; slanting revetment is 2-3m wide

Condition: fair to very good

Construction: concrete wall of the same type as above; the revetment is concrete, slanted seaward 15-20 degrees from the horizontal. Between groins 4 and 5 is a 2m wide reinforcement of loose boulders (photo 21). From groins 5 to 8, the revetment is terminated by a vertical wooden fencing, .3-.5m high (photo 23).

Effectiveness: The preservation of the bluffs in this area is dependent entirely on the seawalls; they are being undercut, in some places however, and will need regular attention.

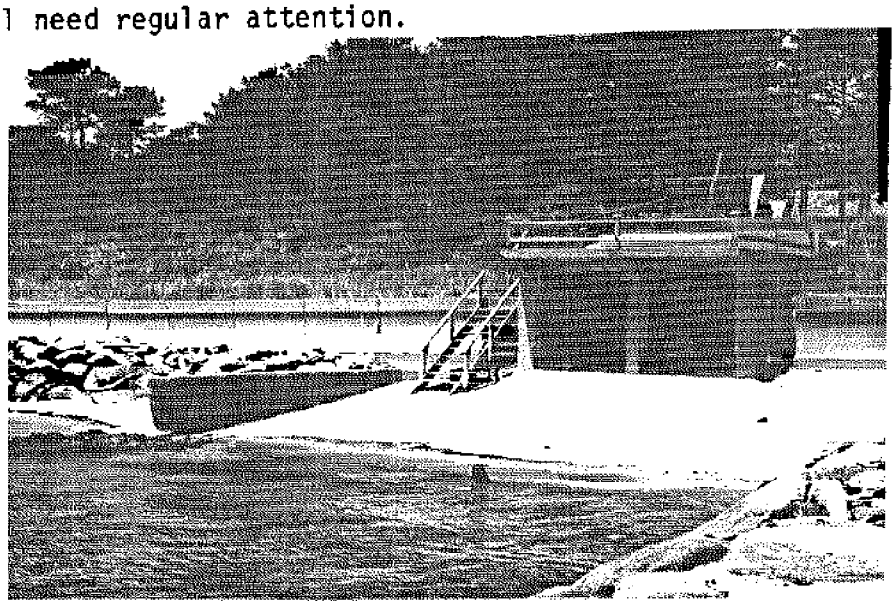


Photo #25. Sta.VI. Seawall and boathouse between groins 8&9.

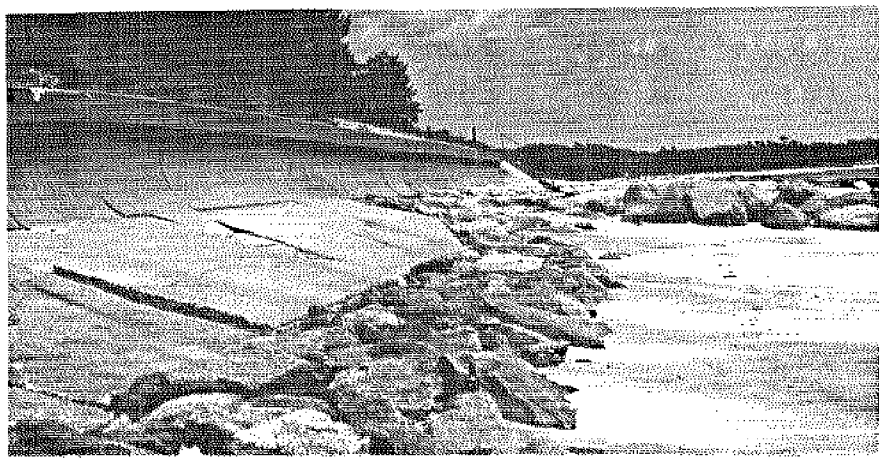


Photo #26. Sta. VI. Seawall and revetment with boulder apron, looking northeast, between groins 10&11.

E--F

Photo #s: 25,26,27

Height: 1.5m wall; between groins 10 and 11 a concrete revetment reinforces the seawall and is about 1m high

Length: 220m

Width: 1m wide wall; 2m wide revetment;

Condition: wall condition generally good; revetment fair: it is cracked and broken in places

Construction: concrete wall is the same as D--E, and a small boathouse is built in the wall between groins 8&9.

Effectiveness: wall effectively retards cliff retreat. The revetment seems ineffective in preventing scour beneath it, as can be seen in photo 27 where an airspace has been left under the concrete. The beach widens northward, shielding walls from wave stress.

Photo #27. Sta. VI. Cracked revetment between groins 10&11, showing space where sand has been eroded beneath the concrete.

Photo #28. Sta. VI. Groin #11, showing part of wide beach.

F--G

Height: .5m
Length: 100m
Condition: very good
Construction: cemented boulders
Effectiveness: very good due of onshore migration of sand from the abandoned spit, the wall comes under almost no wave attack, in sharp contrast to that farther south.

Photo #29. Sta. VI. Groin #13. Trapped sand on beach can be seen on southern side of groin (right), with pebble-covered shoreline on left where sand has been scoured away.

Photo #30. Sta. VII. Groin and seawall in area of onshore sand migration, looking northeast. Groin is visible in sand, extending from seawall at center left edge of photo. Embayment is visible at northern end of seawall, at center right edge of photo.

STATION VII

This station consists of a series of adjacent seawalls and 1 groin. They originally lined the channel between the mainland and the abandoned limb of Popponesset Spit, but onshore migration of sand from that spit has isolated the groin and some 140m of seawall from the water.

GROIN

Photo #: 30

This groin is about 30m long, constructed of loose boulders. It has been made obsolete by the onshore migration of sand from the abandoned limb of the spit, so that it is now 100m from the water's edge.

Photo #31. Sta. VII. Seawall beyond meter 130, showing embayment and exposed point. Note expanse of sand, all of which has migrated onshore from former NE limb of Popponesset Spit.

Photo #32. Sta. VII. Northern end of seawall, with sandbag reinforcement as it stood in June, 1982.

SEAWALL

Photo #s: 30,31,32,33

Length: 260m

Height: 1-2m

Construction: The series of seawalls have the following construction, from south to north:

100m long, 3m high, cemented boulders

30m long, .7m high, single line of loose boulders

20m long, 2m high, loose boulders

20m long, 2m high, cemented boulders

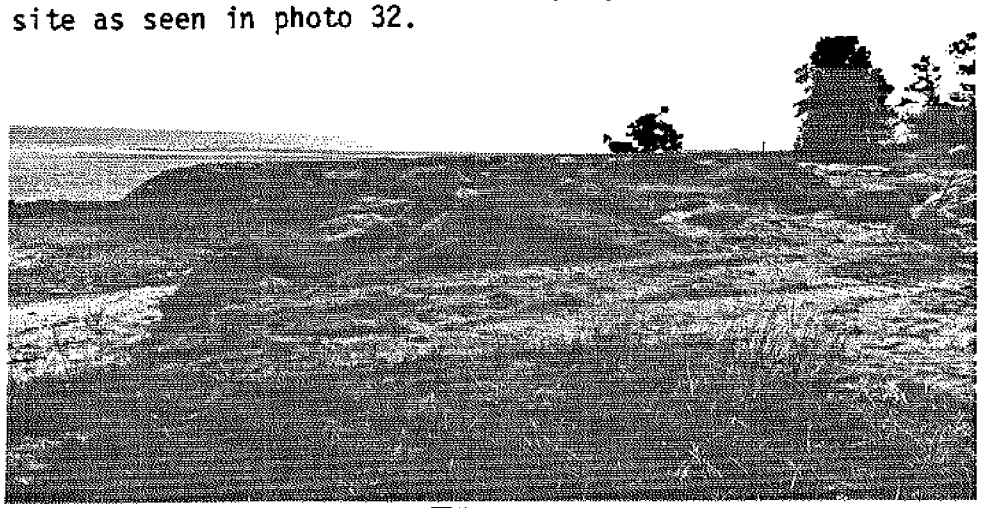
30m long, 1m high, loose boulders, extending around exposed point(photos 31,32)

The wall was augmented at its northern end by 10m of sandbags in 1m high piles from 1975-1983 (photo 32), and at the time of the final survey (February, 1983) the boulders were being extended around the bluff to protect it from further erosion (photo 33).

Condition: the first 150m are in fair to good condition; the last 110m are in good condition

Effectiveness: the first 150m of the seawall, like the groins, has been made obsolete by the wide beach. The last 110m is essential in protecting the small point from eroding.

Photo #33. Sta. VII. Seawall extension in progress, slightly landward of sandbag site as seen in photo 32.



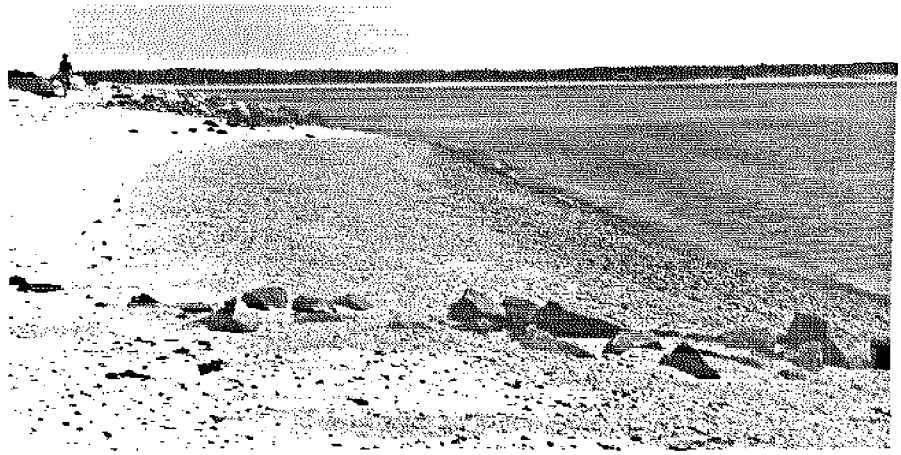


Photo #34 Sta. VIII Groin 1, neglected and nearly filled, in area of onshore sand migration.

STATION VIII

Station 8 extends from the sand spit near Rushy Marsh Pond to the last groin on the approach to Bluff Point (Figure 4). It consists of 26 groins of loose boulder construction, in poor to excellent condition, for the purpose of trapping sand. In a few locations there are seawalls between the groins.

Groin 1
Photo #: 34
Length: 10m
Width: .5m
Height: .3m
Condition: poor; probably immersed at high tide
Effectiveness: almost none; onshore migration of sand from the northeast limb of Popponesset Spit has made the stabilizing structures unnecessary. A wall which formerly prevented bluff erosion (photo 35) is likewise a vestige of the previous shoreline configuration.

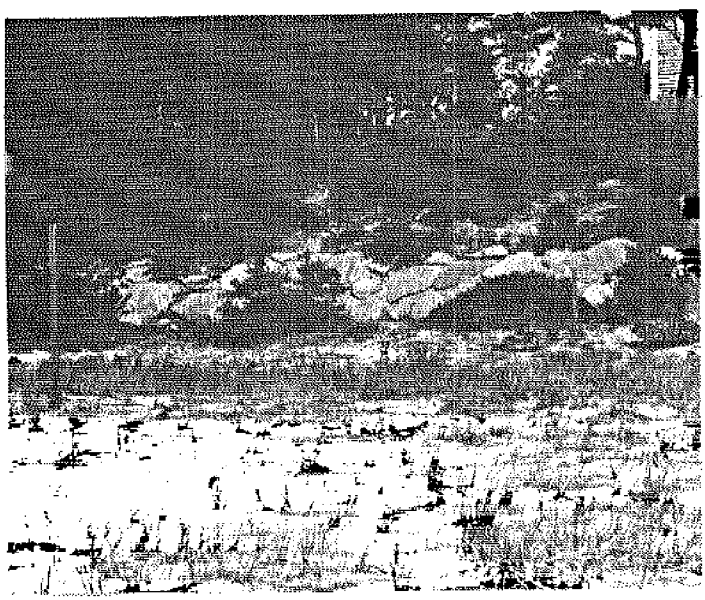
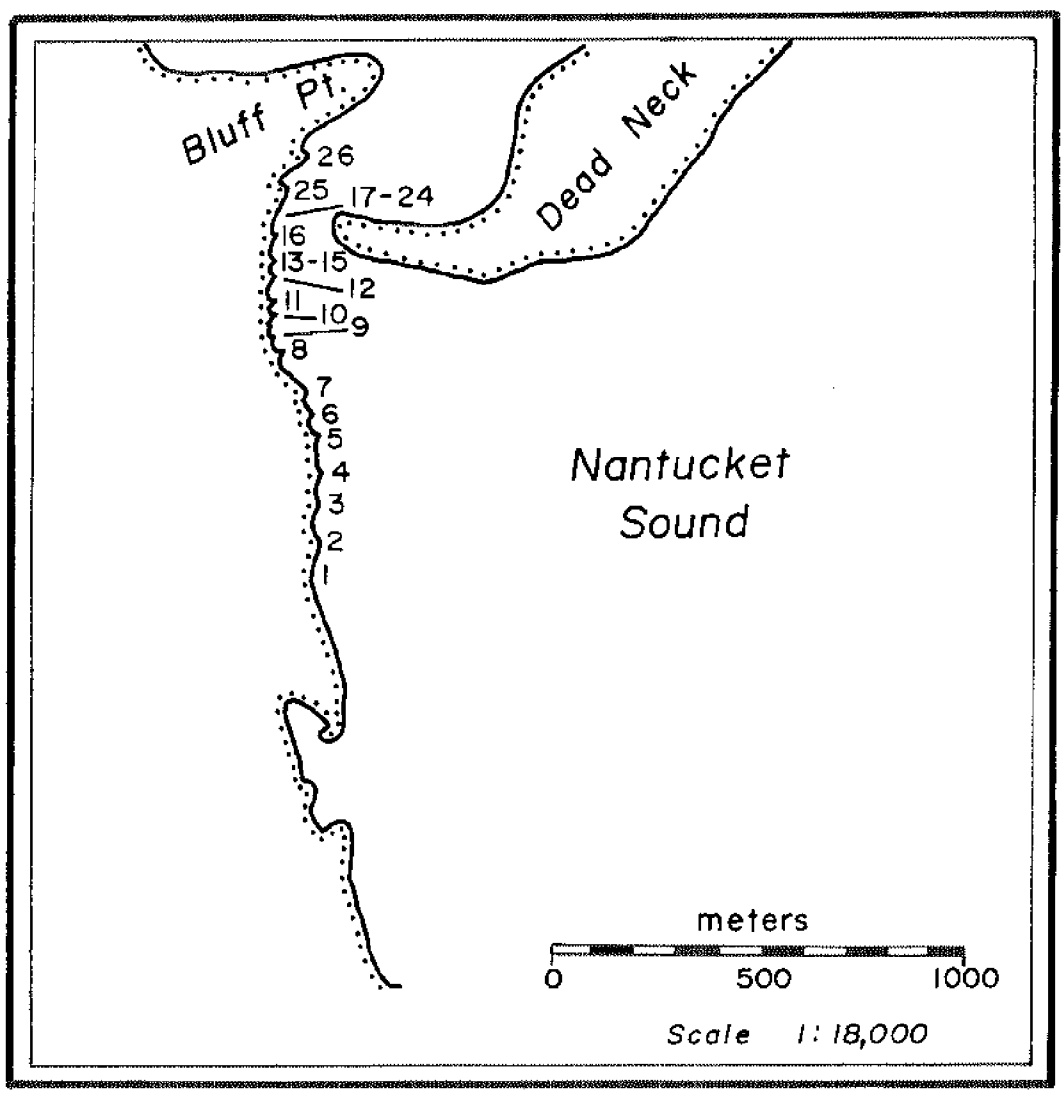


Photo #35. Sta. VIII. Seawall near Rushy Marsh Pond which has been isolated from water by onshore migration of sand.

Figure 4. Detail of Station VIII, showing locations of groins from Rushy Marsh Pond to Bluff Point.



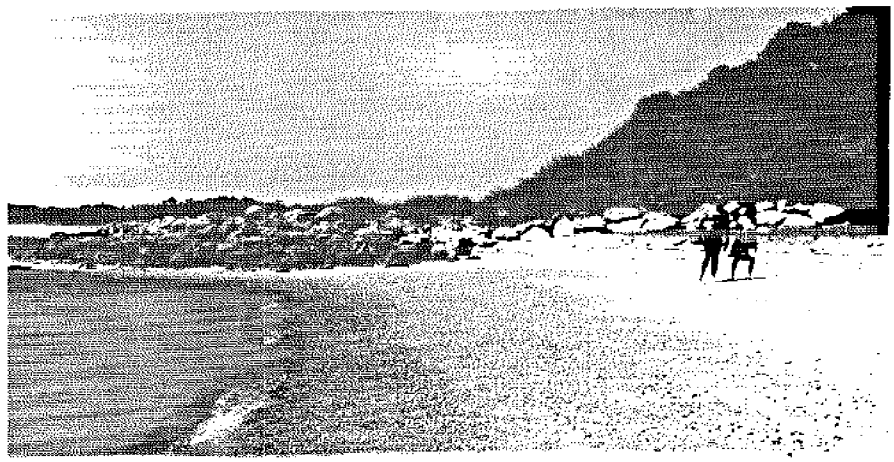


Photo #36. Sta. VIII. Groin 2, looking southwest, and the point of land it is protecting.

Groin 2
Photo #: 36
Length: 15m
Height: 2m
Construction: large pile of loose boulders, becoming a seawall about 1.5m high extending 15 m to the north along cliff (see photo)
Condition: fair
Effectiveness: good; the rock pile seems to have preserved the point of land

Groins 3-7
Photo #s: 37
Length: 10-15m, except groin 6 which is 30m
Height: .5-1m
Width: fair to poor
Effectiveness: minor sand accumulation on the south sides of the groins: the beach is stable here, again due to the abandoned limb of the spit, so these structures appear to have been neglected

Photo #37. Sta. VIII. Groins 4-6, looking northeast. Seawall visible behind grass on right.

Photo #38. Sta.VIII Groin 8, looking shoreward, displaying sand accumulation on southwest side of groin, nearly overtopping structure.

Seawall

Location: between groins 5 and 6
Photo #s: 37
Height: 1m
Length: 2m
Construction: loose boulders
Condition: good
Effectiveness: minor; the structure is under little wave stress

Groins 8-12

Photo #s: 38,39,40
Length: 23-30m
Height: usually 1.5-2m at seaward end
Width: 3m at seaward end
Construction: loose boulders, except Groin 9, which has concrete matrix. 9 and 11 are pier foundations, with concrete walkways which extend to the cliff, and wooden piers extending 20-30m beyond the foundations.
Condition: very good to excellent
Effectiveness: very good; the beaches are wide in these areas, noticably enhanced by sand trapping

Photo #39. Sta.VIII. Groin 9

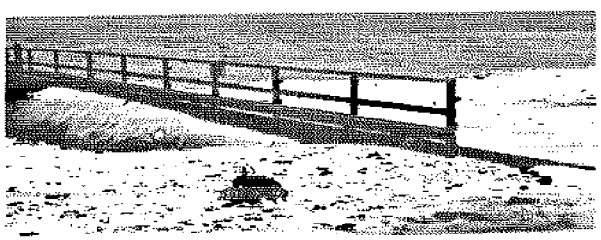


Photo #40. Sta. VIII. Groin 11

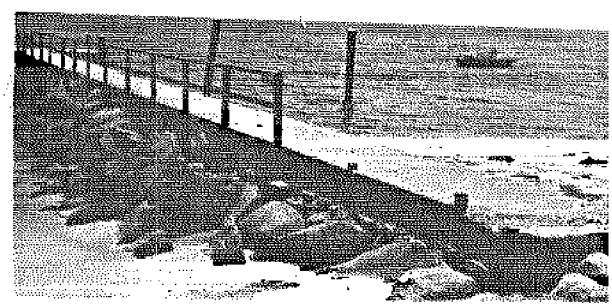


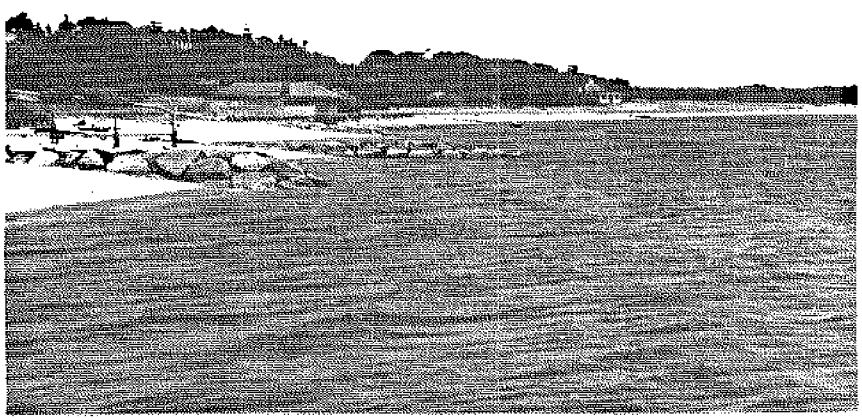
Photo #41. Sta. VIII. Groin 14, displaying sand accumulation on SW side of groin and erosion on NE.

Photo #42. Sta. VIII. Groins 14 & 15, and seawall, looking southwest.

Groins 13-15; these are 3 closely-spaced groins (20-30m apart), with a wooden seawall between groins 14 and 15 and a small wooden pier 2m north of groin 13.

Photo #s: 41,42,43
Lengths: 16m; 30m; 10m
Widths: 5m; 5m; 2m
Heights: .5-1.5m
Construction: loose boulders, except groin 15, which is in part constructed of wood
Condition: very good
Effectiveness: Judging from substantial erosion to the north of 13 and 14 (photo 41), these seem very good at capturing sand. The seawall protects the cliff from undercutting.

Photo #43. Sta. VIII Groin 13 through end of station, looking northward.



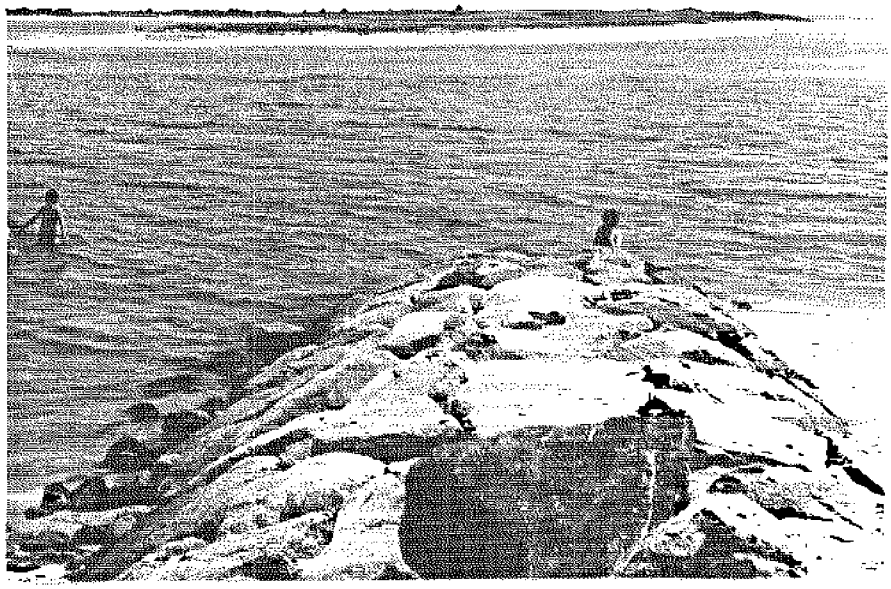


Photo #44. Station VIII. Groin 16. Note sand erosion from public beach on left.

Groin 16
Photo #: 44
Length: 25m
Width: 4-5m
Height: 1.5m
Condition: very good
Effectiveness: very good; this groin separates the public from the private beaches, and the public beach to the north is very low on sand, as can be clearly seen in photo

Seawall connects groins 16 and 17, slanting down from the parking lot to the beach
Photo #: 45
Length: 25m
Height: 3m
Width: 3m
Construction: loose boulders and cobbles, bordered on beach by concrete blocks .4m high and .1m wide
Condition: very good
Effectiveness: very good; the parking lot shows little sign of undercutting behind the wall.

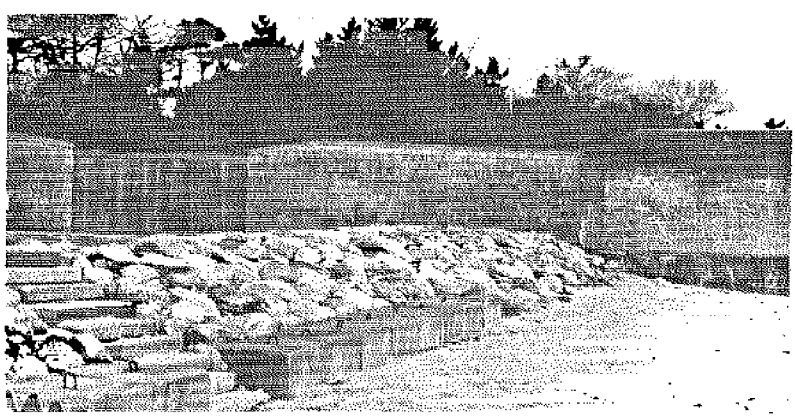
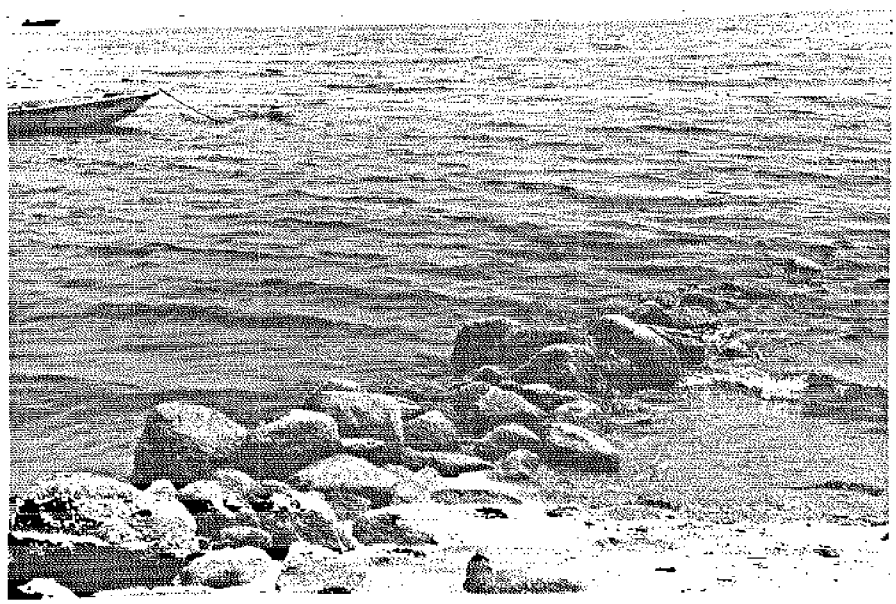


Photo #45 Sta. VIII Seawall between groins 16 &17, slanting down from public parking lot

Photo #46. Sta. VIII. Groins 17-26, bath house, and seawall. The view is north, toward Bluff Point.

Groins 17-24, and seawall
Photo #s: 46,47
Length: 10m (except groins 20 and 21, which are 3m long and more dock piling supports than groins)
Width: .1m
Height: less than .3m
Construction: loose cobbles in disheveled rows at intervals of approximately 8m, extending from seawall into ocean.
Condition: poor
Effectiveness: poor; the small rows of rocks trap almost no sand.

Photo #47. Sta. VIII. Typical groin of group 17-24, in poor condition.



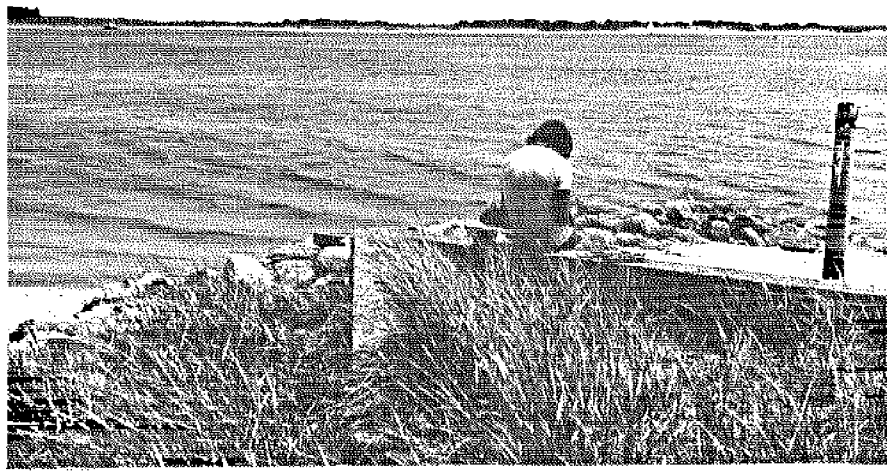


Photo #48. Sta. VIII. Groin 25 and end of wooden seawall. Note sand accumulation to southwest of groin.

Seawall
Photo #s: 46,48
Length: 90m
Height: 1.5m
Construction: concrete for 50m, then cemented boulders for 20m, then wooden fence; the first 70m serves as a foundation for a bath house for the public beach.
Condition: very good
Effectiveness: good; the bluff is not eroding behind the seawall.

Groins 25-26
Photo #s: 48,49
Length: 35-40m
Height: 1m
Width: 1.5-2m
Condition: fair
Effectiveness: good; the beach is substantially wider to the south of the groins, and downdrift erosion can be seen in photos 48 & 49.

Photo #49.
Sta. VIII Groin 26

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16. Abstract (Limit: 200 words)

The structures along a 12 km section of the shoreline of Cape Cod, MA., were evaluated for condition and effectiveness at protecting the coast. Structures in the area include groins, jetties, revetments, and seawalls; each has been located, photographed and described. The region has been subject to erosion in recent years, including the loss of a 1 km section of barrier spit. The role of shoreline structures in controlling or enhancing the erosion was examined as part of a larger study of coastal processes in the area.

The shoreline structures serve two primary functions: beach enhancement and protection of the bluffs from erosion. The sructures' effects on bluffs and beaches in their immediate vicinity (approximately 100m along the coastline to the north and south of the structure) are detailed in this report. Seawalls generally protect the cliffs into which they are built without enhancing erosion of surrounding bluffs, though the bluffs are protected at the expense of the beaches in the central area (Meadow Point). Large scale changes in beach configuration are not primarily caused by local, small-scale structures, but rather by a more regional paucity of sand input into the system. This scarcity is caused in part by large jettties controlling inlet flows to Waquoit Bay, which impedes free transport of sand into the area.

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