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1984 SURVEY, TESTING, AND SHORE STUDIES

IN WESTERN MUSCONGUS BAY

June 1985

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ABSTRACT

Survey for prehistoric site locations in western Muscongus Bay, begun in 1983, was completed. Thirty sites were recorded. Test excavations were carried out at five sites. Very little evidence of Preceramic occupation has been discovered. One site tested was very rich in *Mercenaria*, that species is rather rare today. Another site contains a possible house pit feature.

Radiocarbon dating from 1983 test excavations of three sites are reported. The results illustrate the problems and complexities of dating shell midden deposits.

Pilot studies into the use of beach collections, and shell hash screening to recover information from eroded sites were conducted. Intensive beach collections recovered very little cultural material, except waste flakes. Most material was found high on the intertidal and supratidal shore. Statistical tests on the distribution of material on the shore fail to reveal any significant patterns.

Detailed shore profiles and box cores were obtained from several site shores. Sediments appear to erode from unvegetated scarps onto the supratidal shore. Higher energy marine events transfer sediments down shore. Quieter conditions, between erosional episodes, allow marsh grass to grow on the intertidal shore, sometimes peat accumulates.

Another pilot study into the identification of sub-

merged archaeological deposits by coring is reported. Two column samples of intact shell midden were characterized by weight percent through sieve analysis. The results are compared to sieve analysis of samples from shore contexts. Intact shell midden could probably be identified by a core through submerged deposits; however, eroded and redeposited cultural shell hash would be difficult to differentiate from naturally occuring shell hash.

ACKNOWLEDGMENTS

Financial support for this research was provided by grants from the Maine Historic Preservation Commission, the Nuclear Regulatory Commission (through a contract between the Maine Geological Survey and UMO), and Elizabeth Noyce of Medomak, Maine. Mrs. Noyce also provided housing and boat use. David Sanger supervised the research and edited the report.

Test excavations and shore collections were carried out with the assistance of Sharon Pekrul, Hein Bjerck, Christopher Borstel, Patrick Sanger, Anne Hilton, and Carolyn Daniel. Sharon Pekrul also cataloged and curated both the test excavation and beach collections. David Skinas assisted with the sieve analysis. The tedious sieve sorting was performed by Michele Burns, Ellen Cowie, Lynn Fitz-Patrick, and Lewis Richards.

Robert Stuckenrath, Jr. of the Smithsonian Institution Radiocarbon Lab provided the C^{14} dating. James Petersen of the University of Maine at Farmington identified and interpreted the ceramics recovered from test excavations. Steven Bicknell did the drafting and photography. Dan Belknap, Craig Shipp, and Bradley Bird provided the equipment and expertise to obtain the vibracore, MS-VC-5. The box corers were borrowed from Craig Shipp.

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INTRODUCTION

Activities in Muscongus Bay in the summer of 1984 had three main goals:

1) continued survey of the Medomak River and western Muscongus bay;
2) test excavations of selected sites; and
3) detailed shore studies of eroded sites.

These activities are aimed at continuing analysis of site ages and coastal erosion, and assessment for Historic Register nomination.

SURVEY

Survey activities were limited to the area west of Hatchet Cove in Friendship Township, and the eastern shore of Muscongus Sound south to Pemaquid Light. Survey was completed for this entire area up the Medomak River to the town of Waldoboro. Only some small islands south of Louds Island went unsurveyed (Bar, Ross, Haddock, and Western Egg Rock Islands). With the exceptions noted above, the marine shoreline of the Louds Island, Waldoboro East, and Waldoboro West 7.5' USGS quadrangles has been completely surveyed. The western half of the Friendship Island 7.5' quadrangle has also been totally surveyed.

Ninety-five kilometers of coastline were surveyed in 1984. Twenty-nine new sites were located, and one previously recorded site (27-9; Moorehead 1922, Snow 1969) was relocated. Survey maps and site forms are on file with the Maine Historic Preservation Commission, Augusta.

Thirteen sites (43%) fell along shore that had been classified as High Probability (Kellogg 1984:12). High Probility was determined from inspection of 7.5' USGS quadrangles and Maine Geological Survey Coastal Marine Geological Environment maps. In the field, it is obvious that maps do not provide enough detail to allow accurate classification. Thus, High Probability can be much more accurately determined in the field. For example, of the 30 sites surveyed in 1984, 22 (73.3%) were found at locations that fit the High Probability model as determined in the field. Nine sites (30%), then, fell outside High Probability as determined from maps. Therefore, the High Probability model may be more reliable than the survey results presented above imply. The failure is in the application. This is a serious shortcoming, however, because one of the purposes of such a predictive model is to expedite survey. If it cannot be applied, then a predictive model is of little practical value.

Another result of the survey is the location of seven sites solely on the basis of beach finds, or amateur reports. As far as could be determined, cultural deposits had been totally eroded at each location. All of these sites are along High Probility shore, which suggests that the High Probability model might be useful for locating some submerged, or eroded and redeposited cultural material.

RESULTS OF 1983 C^{14} DATING

Site 27-6

Site 27-6 is located at the mouth of the Medomak River estuary on Jones Neck. Artifacts recovered from two test pits excavated in 1983 (Kellogg 1984:40-48) indicate an age of 1100 BP. Both C^{14} dates were younger than expected. SI-6441 on charcoal from 30-35 cm depth in Test Pit A was 101.1% modern, while SI-6442 on charcoal from 30 cm depth in Test Pit A dated to 290±105 BP (A.D. 1660). Both samples were small, and required dilution.

There is evidence of Historic Period occupation in the test excavations in the form of kaolin pipe fragments; but not in association with the charcoal. The pipe fragments (two stems from Test Pit A, and two fragments of the same oval-heeled bowl from Test Pit B) have stem hole diameters of 5/64 inches. They date to no earlier than A.D. 1680, and probably fall into the range A.D. 1710-1750 (Noel Hume 1969:296-312; G. Faulkner, personal communication). There was little documented European contact in the area before A.D. 1605 (Stahl 1956:22-30); however, settlement of the Pemaquid area began soon after (ibid. 35-41). A trading post was established on the St. George River between A.D. 1630 and about A.D. 1675 (ibid. 39). Jones Neck, itself, was probably settled before A.D. 1650 (ibid.). It is possible that some of the shell midden deposits date to this early historic period; however, it is doubtful that Indians lived on Jones Neck after European settlement as hostilities were almost constant (ibid.). The modern C^{14} date indicates that the midden has been somewhat disturbed recently.

Site 17-137

This is a non-shell site location on the western shore of Friendship Island where only four flakes and a triangular felsite biface were found on the shore. Interestingly, none of these is made of the green felsite most commonly found in coastal sites in the area. SI-6443 (655±65 BP) dated charcoal from a hearth feature found in a tree throw. Apparently, this is a limited activity site of late Ceramic Period age. This type of site may be much more common, but is difficult to locate in comparison to shell middens. The shoreline type and aspect of the site are both unusual, also. The nearest beach is over 300 m away, and the shore faces due west.

Other non-shell lithic sites have been reported to me by amateurs. They are usually referred to as "chipping stations", and said to face the setting sun.

Site 17-11

A series of 21 dates was obtained from Site 17-11 (the Todd Site). Five dates (Table 1) were taken from the Test Pits (Kellogg 1984:34-40; 1985a:13) and a suite of 16 dates from a column sample of midden from Test Pit B (Table 2). The column sample was obtained by removing a 25x25 cm square in 5 cm levels from the south wall of Test Pit B following excavation (Figure 1). Charcoal was recovered from the column sample by dumping the shell midden sediments into water and skimming off the floating charcoal. All charcoal samples received a nitration pretreatment at the radiocarbon lab to remove uncharred organic matter (R. Stuckenrath, personal communication). Shells were selected by hand.

The dates in Table 1, and those from a similar depth (35-40 cm) in Table 2 (SI-6427,SI-6433, and SI-6434), indicate a range of 2390 C^{14} years (2035 years without SI-6421). The midden cannot have been laid down in a simple horizontal stratification.

The results of dating the column sample are very con-

TABLE 1: RADIOCARBON DATES FROM SITE 17-11

SAMPLE	CONTEXT	AGE	ASSOCIATION
SI-6420	TP A 40cm b.s.*	2390±70	Grit-tempered, dentate-stamped pottery at midden base
SI-6421	TP C 40cm b.s.	100.1% modern	Charcoal concentration with fish bone
SI-6422	TP B 35-40cm b.s.	355±70	Dark black, shell-free zone; 35-45cm depth
SI-6423	TP B 35-40cm b.s.	------	Same as above; Too small; No date
SI-6464	TP C 35-40cm b.s.	670±70	Flotation charcoal from bulk sample of same area as SI-6421

*b.s.: below surface

fusing. It appears that the midden is very disturbed at this location; however, no indication of such disturbance was seen in excavation. The charcoal dates present a reasonable sequence with a period of rapid deposition between 35 and 55 cm depth (Figure 2). The shell dates, however, suggest a more complicated history of deposition (Figures 2 and 3). One explanation is that a dark black, shell-free zone between 35 and 45 cm depth, encountered in the western

TABLE 2: RADIOCARBON DATES FROM SITE 17-11 COLUMN SAMPLE

SAMPLE	DEPTH	MATERIAL	DATE	COMMENTS
SI-6425	5-10cm	Charcoal*	355±70	Diluted
SI-6426	20-25cm	"	1125±60	
SI-6427	35-40cm	"	1520±75	Diluted
SI-6428	50-55cm	"	1525±70	Diluted
SI-6429	65-70cm	"	1740±90	Diluted
SI-6430	5-10cm	_Mya arenaria_	610±50	
SI-6431	20-25cm	"	1070±50	
SI-6433	35-40cm	"	640±75	
SI-6435	50-55cm	"	545±65	
SI-6438	65-70cm	"	2230±75	
SI-6432	20-25cm	_Mercenaria_	2680±105	
SI-6436	50-55cm	"	1445±55	
SI-6439	65-70cm	"	1900±50	
SI-6434	35-40cm	_Mytilus_	2215±55	
SI-6437	50-55cm	"	2015±70	
SI-6440	65-70cm	"	1615±55	

*from flotation of each level

3/4ths of Test Pit B (dated 355±70 B.P.; SI-6422, Table 1), is a late Ceramic Period house floor excavated into earlier midden accumulations. The column sample may have been taken through the back dirt pile from such a house. The jumbled sequence of dates could have resulted.

Given this kind of complex deposition, comparisons of dates on different materials, as originally intended, cannot be made. The results of the dating underscore the difficulties inherent in shell midden stratigraphy and interpreta-

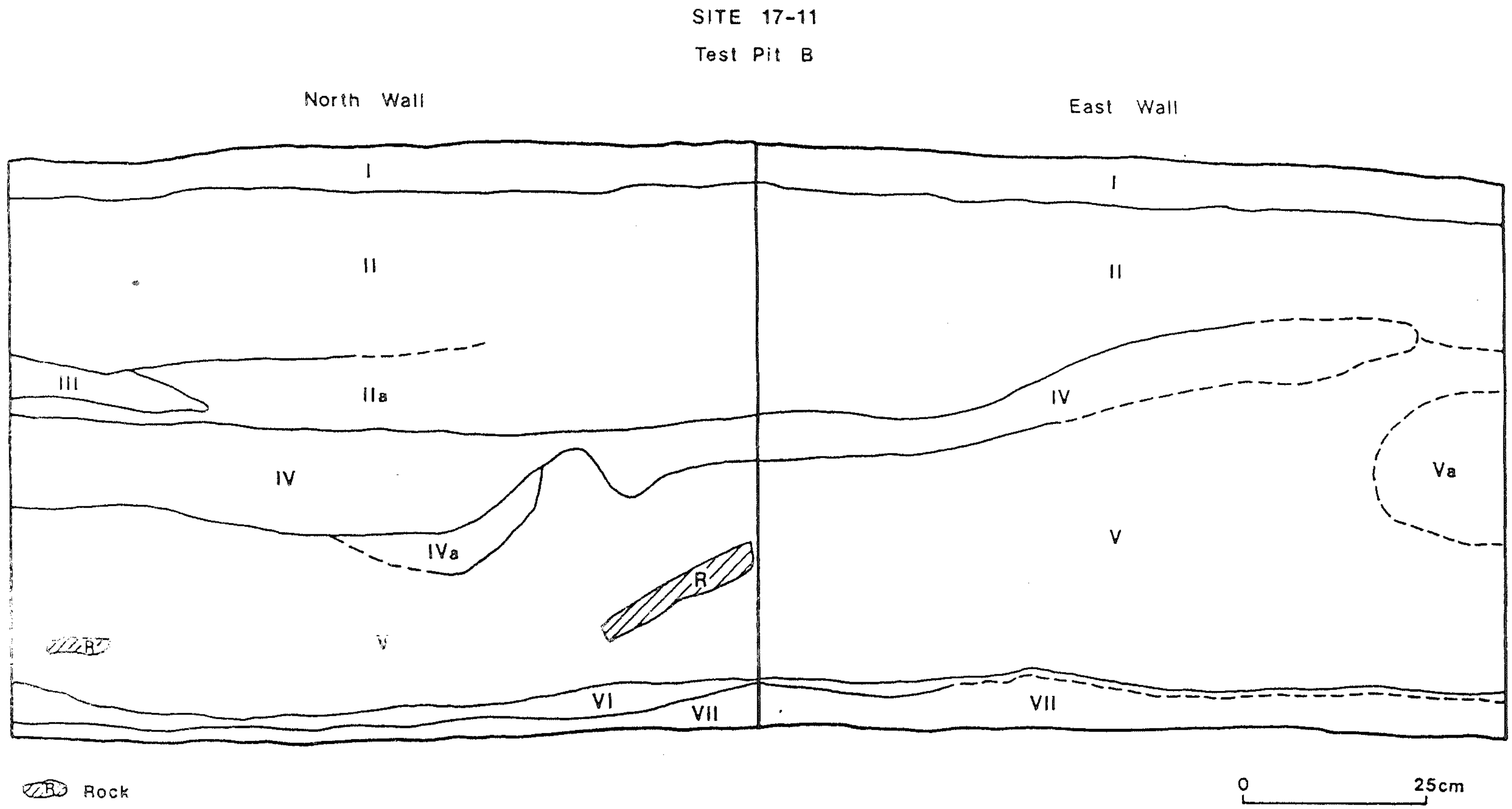

Figure 1 : Profile of Test Pit B, Site 17-11

FIGURE 1: SITE 17-11 TEST PIT B PROFILE

Key I: Forest duff
II: Broken-up shell with dark black soil
IIa: Finely crushed shell with dark black soil
III: Lens of yellow-grey silty clay with fragmented shell
IV: Very dark black soil with little shell; although there is some shell lensing within this zone
IVa: Dark, reddish-brown soil with no shell
V: Dense shell midden with many whole valves, most lying flat. Also, abundant mussel shell
VI: Whitish-grey grit with no shell (podzol layer)
VII: Yellow-orange brown, sterile submidden sediments

tion. Much more detailed analysis of the Todd Site is underway (Skinas, in prep.; and 1985) based on large scale excavations carried out in 1984 by David Sanger. A dozen additional charcoal and shell samples have been submitted to Beta Analytic and the Smithsonian Radiocarbon Laboratory for dating.

1984 TEST EXCAVATIONS

Three sites tested in 1984 are located on two small islands in outer Muscongus Bay. Sites 17-123 and 17-125 were initially explored in 1983 (Kellogg 1984:21-31). Two additional Test Pits were placed in each site.

Site 17-123

This site is relatively large (120 m by up to 25 m) (Figure 4), but shallow. All shell midden deposits are less than 40 cm thick. Most of the shell is *Mya* with smaller amounts of *Mytilus*, or *Modiolus*. Small amounts of sea urchin shell, fish bone, and mammal bone are also present. Very little prehistoric cultural material was recovered. No stone artifacts were excavated, although flakes, and broken, or unfinished, bifaces were found eroded onto the shore.

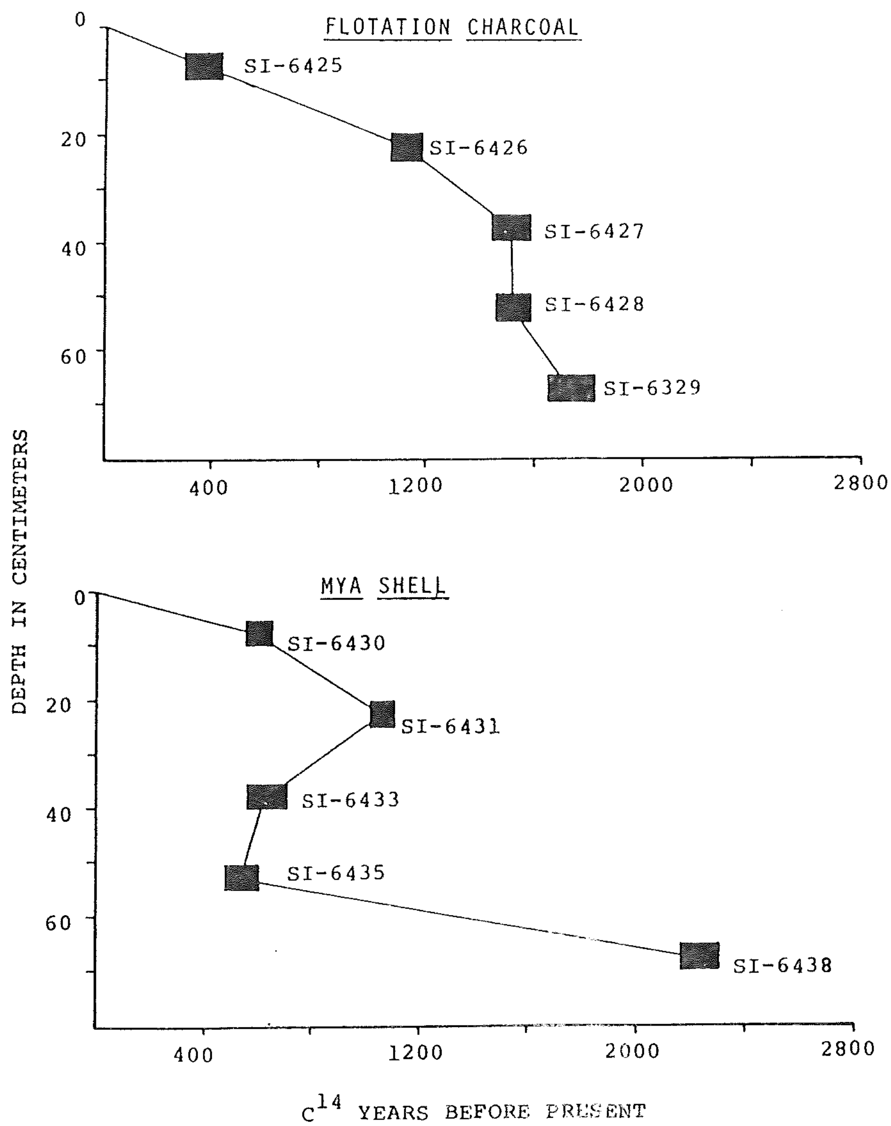

Figure 2: Plots of C^{14} Dates from Test Pit B Column sample

Three fragments of pottery were recoved. All are grit-tempered, and two are decorated with dentate stamping.

Site 17-125

1983 test excavations (Test Pit A; Kellogg 1984:25-30) uncovered a large anomaly in the slope of the submidden surface. Two additional excavation units were placed adjacent to T.P. A to investigate the idea that a semi-subterranean house pit had been encountered. Test Pit B was placed north of T.P. A, and Test Pit C to the west.

Test Pit B was excavated to a depth of 110 cm, or 35 cm deeper than Test Pit A. The profile (Figure 5) clearly shows that later shell deposits filled in a large depression. Near the base of the shell deposits, a zone of shell-free, charcoal-rich sediments thickened towards the SE corner of the square. An oval basin-shaped feature (Feature 2) was found there. Near the top of feature, linear charcoal stripes were discernable against the browner feature fill. Only bits of charcoal and very poorly preserved bone was recovered from the feature fill; a bulk sample of the fill was saved.

Test Pit C was much more complicated than expected. Instead of matching T.P. A, which sloped steeply to the north, the midden in Test Pit C sloped to the west and north

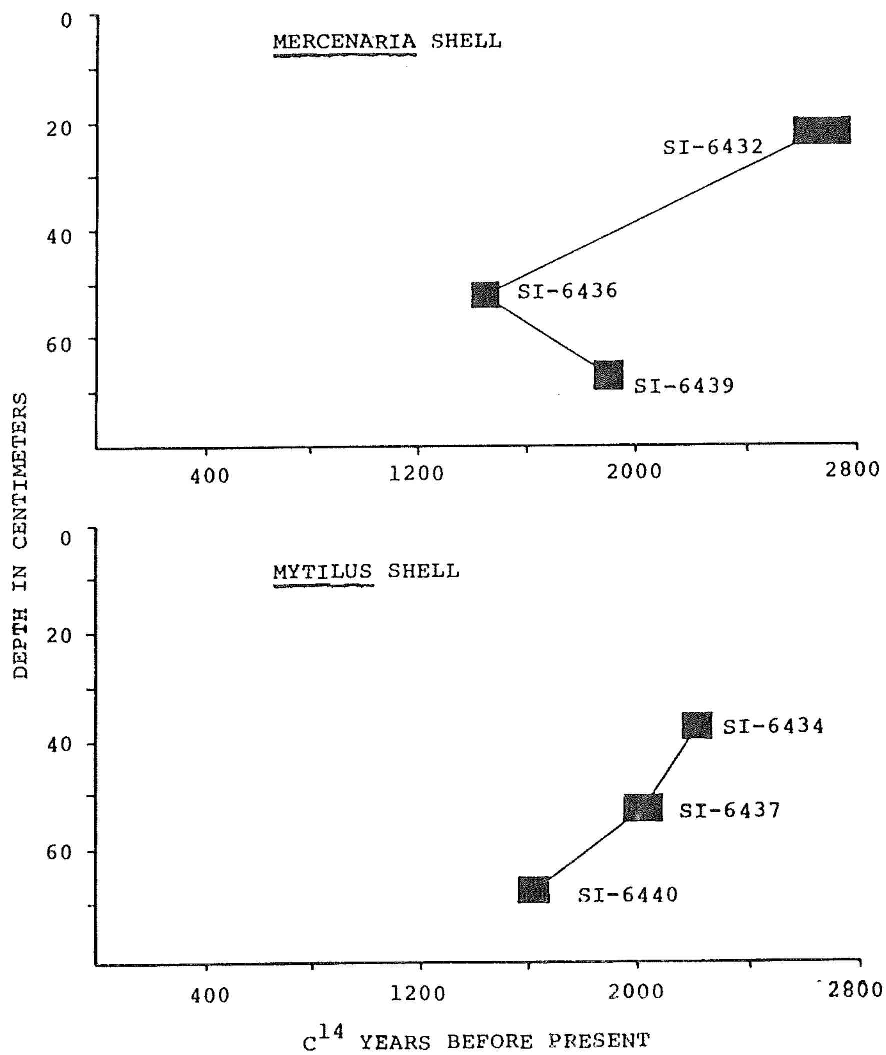

Figure 3: Plots of C^{14} Dates from Test Pit B Column Sample

to a depth of 70 cm. Some mixing of submidden B-horizon soil was encountered about 30 cm below surface in the SE quadrant. The west wall profile did, however, show the infilling of a depression to the north.

Pottery recovered from T.P. B was inspected by James B. Petersen. Pottery from the lower levels of the midden is earlier and distinct from pottery in the upper levels. Three vessels, represented by clusters of sherds, were identified. Vessel 1 is from Strata II and IIa (Figure 5), which are interpreted as depression fill. The pottery is shell tempered with cord wrapped stick decorations, and dates to between 850 and 450 BP.

Vessels 2 and 3 come from Strata III-IV (Figure 5) which appear to be associated with the large depression because shells are flat lying. Both vessels are grit tempered with rocker-dentate stamped designs which date to between about 1700-1200 BP. Thus, at least two distinct occupation periods are present. The earlier occupation may be associated with the large depression. 1984 test excavations, however, have not clearly resolved the nature of the large depression.

Site 17-124

One 1x1 m test pit was placed in this small shell midden

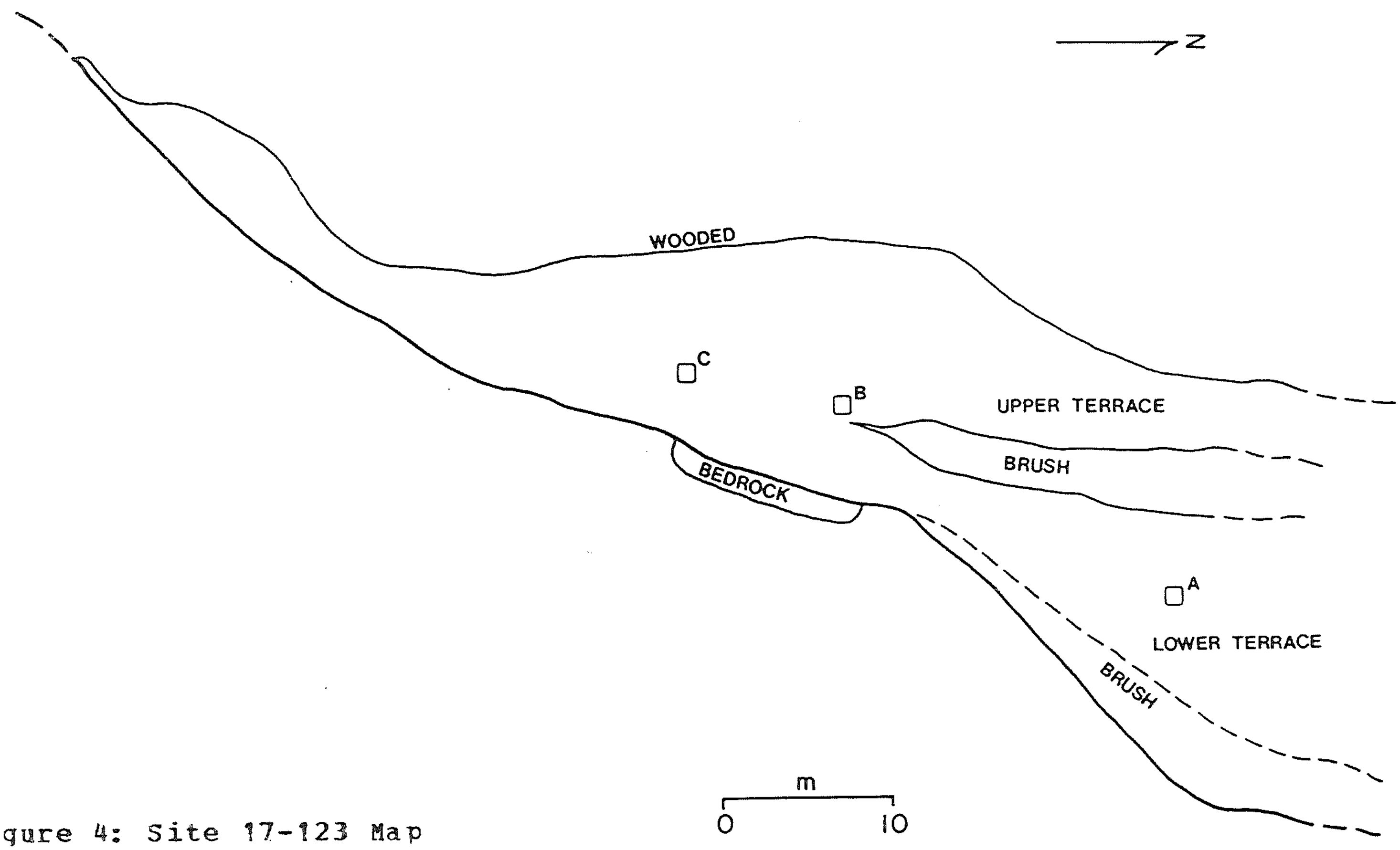

Figure 4: Site 17-123 Map

about 300 m south of Site 17-123. A gravel storm beach is over-riding the northern portion of the midden (Figure 6). Test Pit A was placed just behind the gravel berm.

Midden deposits consisted of a dark black, silty soil matrix with sparse broken Mya and some mussel shell. Many rocks were found in the upper level of the deposit. Only 15 cm of midden were present. Cultural material consisted of four flakes, and small amounts of bone.

Very little cultural information can be gleaned from this limited test; but it does appear that midden deposits are being buried beneath a storm berm. The exposure of bedrock lower on the shore (Figure 6) suggests that the midden deposits will not be protected from ultimate erosion, however.

Discussion

These three sites (17-123, 17-124, 17-125) are interesting. Although two of them are relatively barren of artifacts, their locations on two small islands in the outer bay where no mudflat is present today, emphasizes that environmental changes have occurred. The faunal material recovered in 1983 suggests different subsistence activities in comparison to other sites in the area (Spiess 1984).

Another interesting feature of this island group is

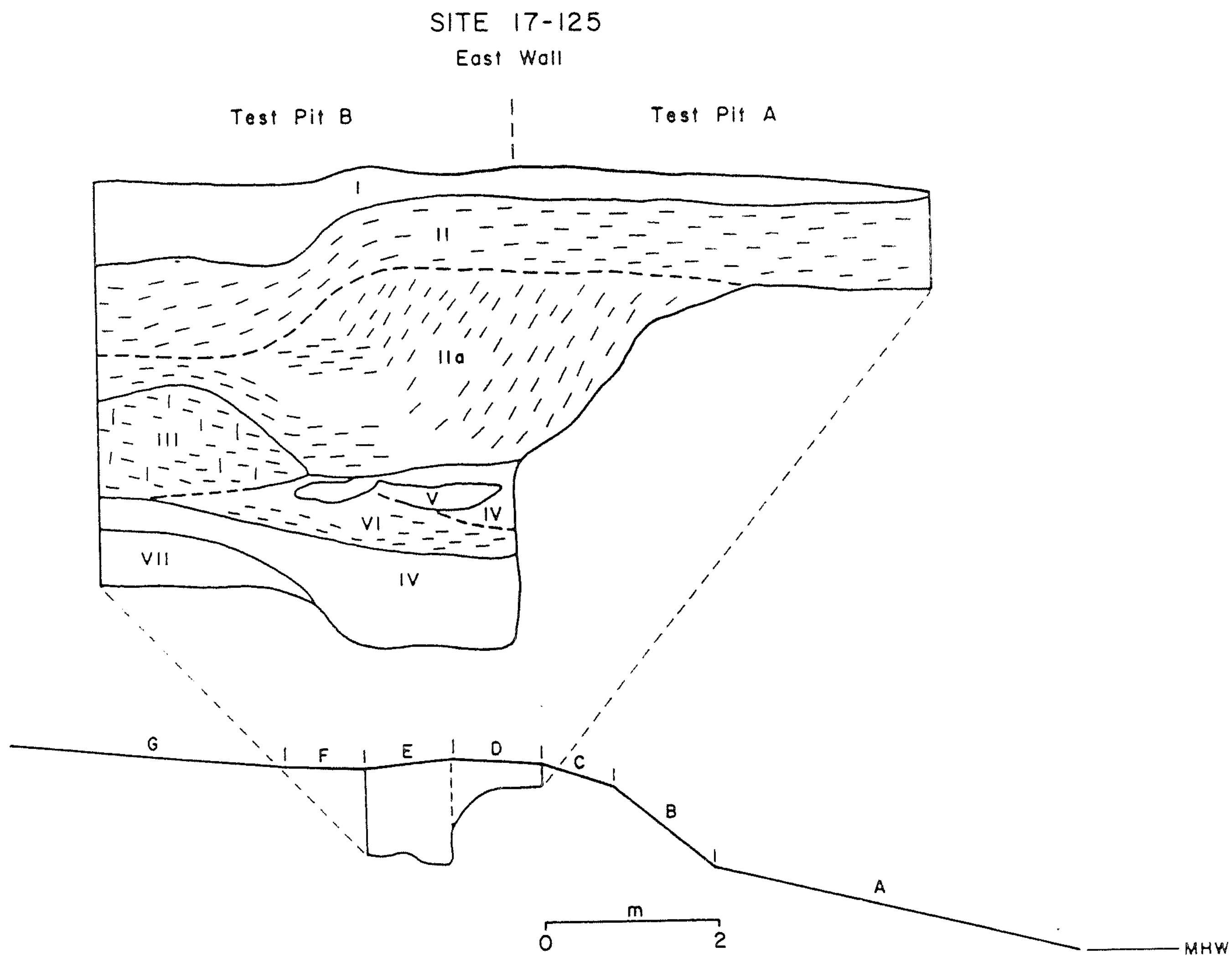

Figure 5: Site 17-125 Shore and Excavation Profile

FIGURE 5: SITE 17-125 EXCAVATION AND SHORE PROFILE

Stratigraphic Key

I: Very fragmented shell in sod

II: Dense *Mya* and mussel shell midden, whole valves horizontal

IIa: Dense mussel and whole *Mya* shell midden, whole shells dipping as indicated

III: Lens of mostly whole *Mya* shell

IV: Shell-free dark soil

V: Lens of crushed shell

VI: Starts below Zone III as whole shell with dark black soil, and grades into lenses of crushed shell and Zone IV sediments

VII: Culturally sterile, reddish-brown, weathered till

Shore Profile Key

A: Boulder ramp; Slope=14°

B: Unvegetated erosional scarp of till; Slope=41°

C: Grass covered shore; Slope=14°

D: Sod covered shell midden; surface of Test Pit A; Slope=5°

E: Surface of Test Pit B; Slope=-5°

F: Sod covered shell midden; Slope=1°

G: Sod covered shell midden; Slope=6°

that the intertidal bedrock outcrops connecting the islands form a natural tidal pool which could very easily be exploited as a fish trap. Complete closure of the tidal pool is prevented only by two narrow channels with depths of 71 and 14 cm at Mean Low Water. At present rates of sea-level rise, based on the Portland tide gauge (Hicks and Crosby 1974), a natural fish trap existed prior to about 300 years ago (71 cm/23 cm X 100 yrs).

Site 17-22

Site 17-22 is a very large shell midden on the south end of Hog Island. The site was mapped in 1983, and few shovel tests were placed to determine the thickness of the midden. Three 1x1 m test pits were placed in 1984 (Figure 7). Collections from the site in the 1890's held by the Harvard Peabody Museum, contain Susquehanna Period cremation burial (4000-3200 BP) artifacts from the base of the midden.

Test Pit B was excavated to a depth of 85 cm. It contained predominantly *Mya* shell in the upper levels, and mussel shell in the lower levels. Ceramics from the upper levels are shell tempered, while ceramics from 45-60 cm depth are grit tempered. No ceramics were recovered from below 65 cm depth.

Test Pit C (Figure 8) contained shell midden to 65 cm

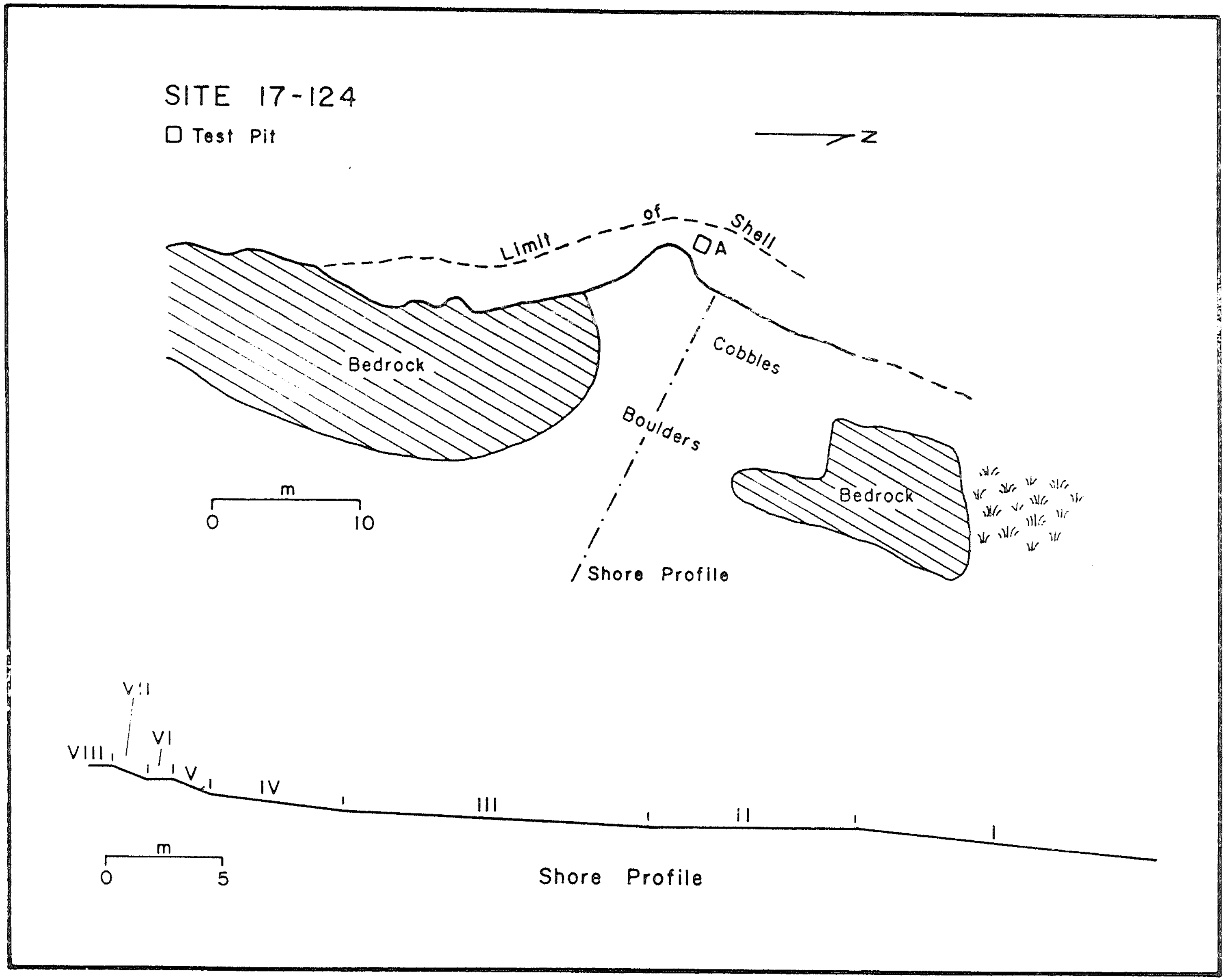

Figure 6: Site 17-124 Site Map and Shore Profile

FIGURE 6: SITE 17-124 SHORE PROFILE

Key

I: *Fucus* covered boulders and bedrock, Slope=6°

II: Dike of intrusive bedrock; Slope=0°

III: *Fucus* covered boulders, Slope=3°

IV: Cobbles and boulders; Slope=7°

V: Shore face of small storm berm; Slope=19°

VI: Small storm berm; Slope=1°

VII: Shore face of larger storm berm; Slope=19°

VIII: Crest of shingle storm berm; larger stones than on the small storm berm; Slope=0°

depth, except for the SE corner which extended to 85 cm depth. Mya-dominated deposits gave way to mussel shell with depth as in T.P. B. Shell and grit tempered ceramics were found throughout the square. A thin, corner-notched projectile point of grey chert was found at 35 cm depth. Some Mercenaria shell was found between 20-35 cm depth. A column sample (17.5 cmx17.5 cm in 5 cm levels) was removed from the east wall.

Test Pit D was much shallower than the others as it was near the limit of the shell midden. Deposits consisted of Mya with some mussel and other shell to a depth of 25 cm. One fragment of Mercenaria shell was recovered from the base of the midden. Both shell and grit tempered ceramics were found. The quantity of ceramic sherds recovered in this square was much greater than in the other two. Several flakes of exotic materials were found near the base of the midden.

Site 17-154

Site 17-154 (Figure 9) is an extensive, but damaged site along the western shore of Greenland Cove. Several houses have been constructed on, or near the site. The site is interesting because the midden contains a high percentage of Mercenaria shell. One 1x1 m test pit was placed near the

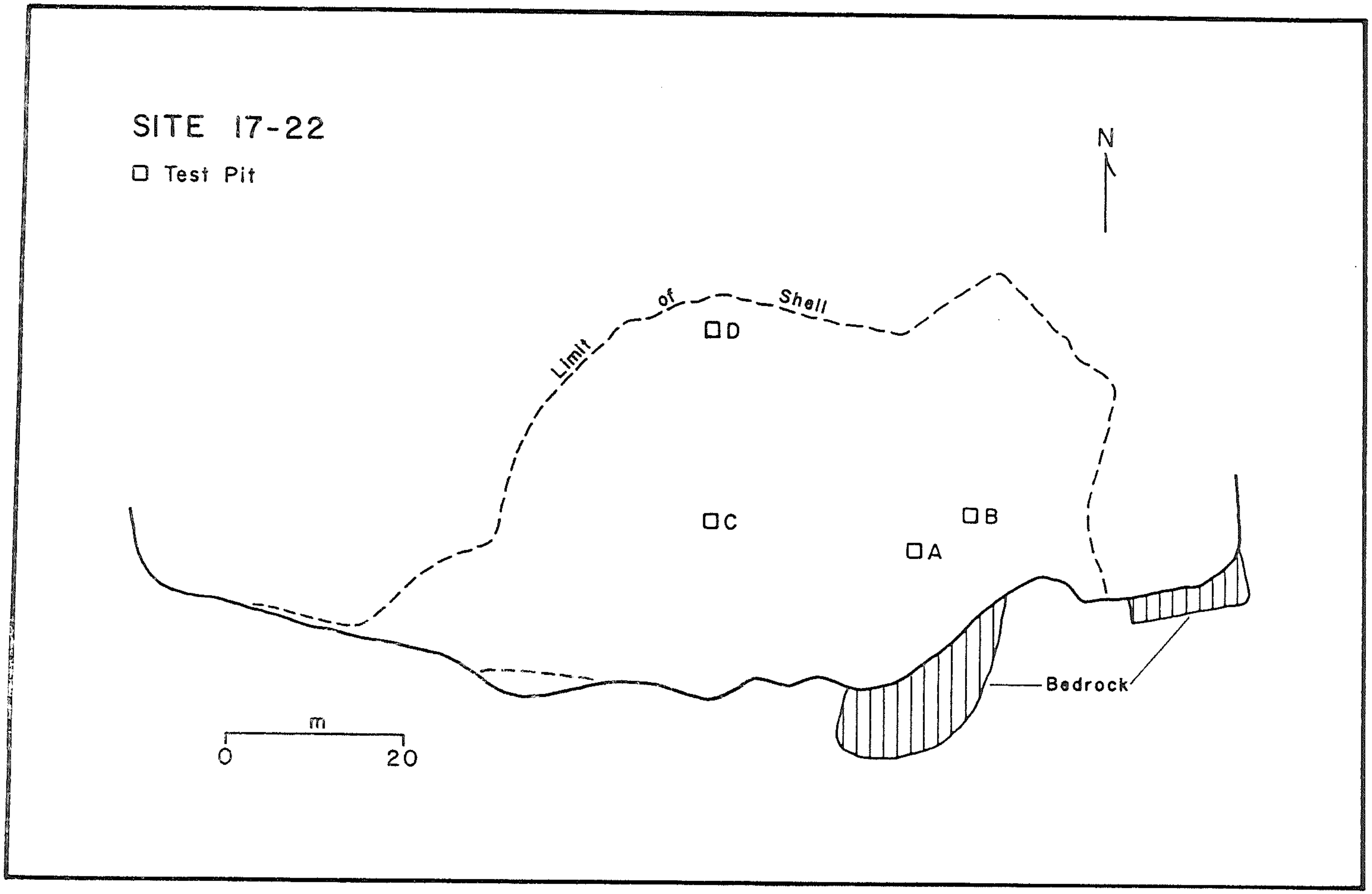

Figure 7: Site 17-22 Map

northern end of the site (Figure 10). The midden contained considerable amounts of Mya shell, as well as, Mercenaria. Some mussel shell was also present.

Unfortunately, the upper two-thirds of the midden in this test was disturbed. Culturally sterile, B-horizon soil was encountered diagonally across the whole square to a depth of 70 cm. The leather sole of a modern shoe was found at 55 cm depth. The midden below the disturbance appears to have been intact.

Mercenaria shell composed a large proportion of the midden to its base at 90 cm depth. Other faunal material, ie. mammal, fish, and bird bone, and minor shell fish species, was present throughout the midden. Small rodent burrows had disturbed the base of the midden, coming up into the midden from the subsoil.

No diagnostic cultural material was recovered. Only one small shell tempered sherd was found. Several modified beaver incisors, and bone point tips were discovered. Waste flakes of a variety of stones, including a striped chert, were found throughout the midden.

Comments

This site is the most striking example of trend noted in survey along the western shore of Greenland Cove.

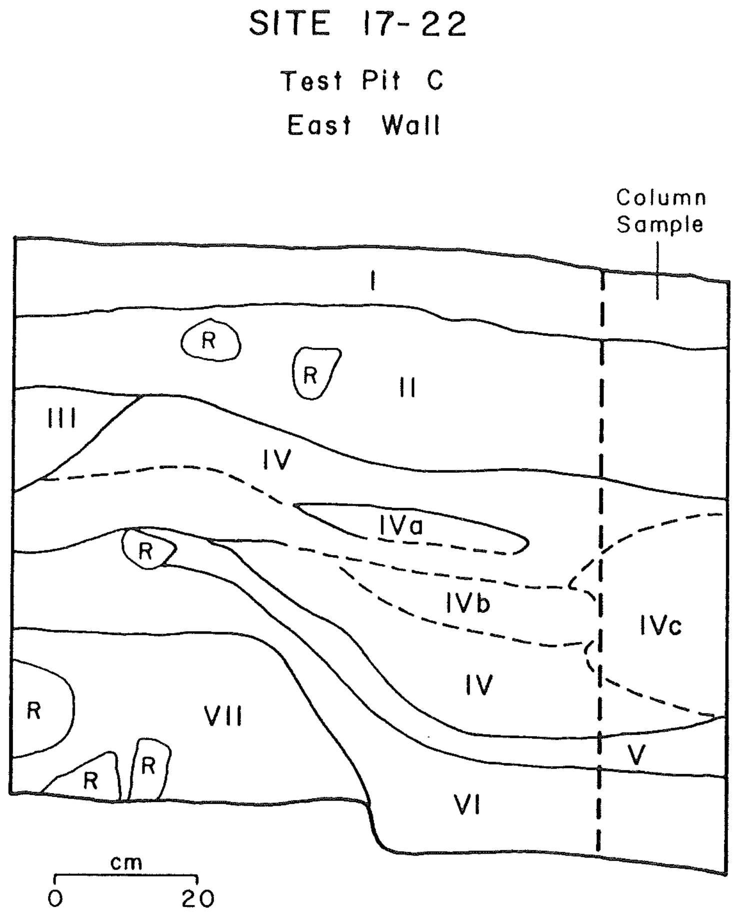

FIGURE 8: SITE 17-22 TEST PIT C PROFILE

<u>Key</u>

I: Sod

II: Chrushed *Mya* and mussel shell

III: Finely chrushed mussel shell

IV: Large fragments of *Mya* and mussel with dark black silty soil

IVa: Lens of shell-free, dark black, silty soil

IVb: Same as IVa

IVc: Very large *Mya* shell fragments and whole *Mya* shells

V: Shell-free, very dark black soil

VI: Finely crushed mussel shell with dark black soil

VII: Reddish/orange brown silt soil; weathered till

Mercenaria shell was observed eroding from four other sites in the vicinity, and found in test excavations at two others (17-11 and 17-22). Apparently Greenland Cove was once a good source of *Mercenaria*, and a small remnant population is still present in the extreme upper reaches. A *Mercenaria* shell was also recovered within inter/subtidal mud at a depth of 3.8 m in a vibracore (MS-VC-2) in upper Greenland Cove. With lower sea-level, upper Muscongus Sound would have been isolated from tidal mixing (Sanger and Belknap 1984; Kellogg 1985b), and thus, somewhat warmer. A changing shell fish fauna was utilized by prehistoric peoples as rising sea level brought changes in the local and regional environment (Braun 1974; Sanger 1975).

BEACH COLLECTIONS AND BOX CORING

Test excavations in both 1983 and 1984 failed to recover evidence of pre-Ceramic occupations in the area. Indications from survey and amateur collections (Kellogg 1984) suggested earlier occupations, most of which has succumbed to erosion. Pre-Ceramic occupation has now been confirmed by excavations at the Todd Site (17-11) (Sanger personal communication, Skinas 1985). Because much of potential archaeological information is eroded, 1983 field work experimented with obtaining data from eroded sites.

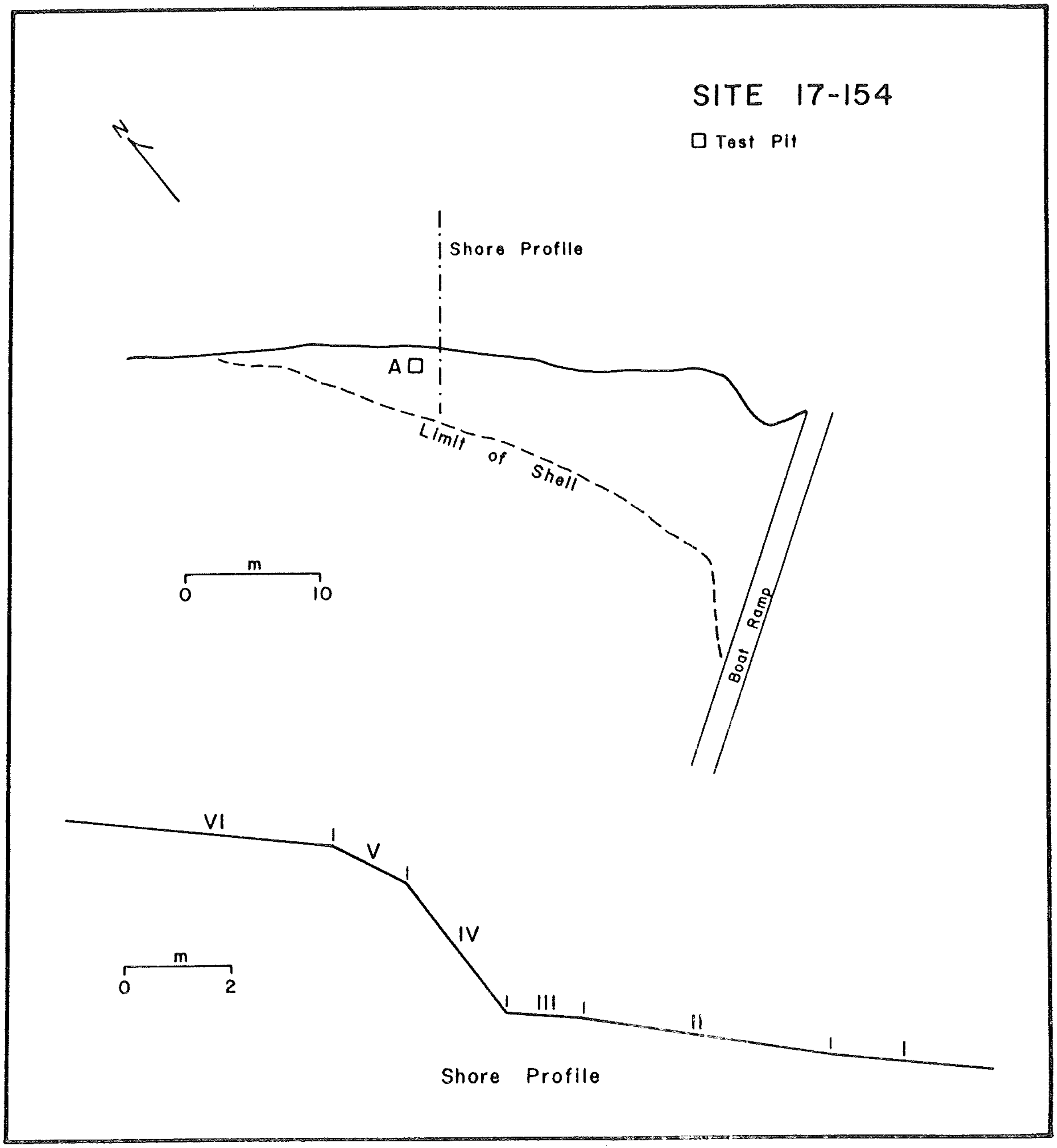

Figure 9: Map and Shore Profile of Site 17-154

FIGURE 9: SITE 17-154 SHORE PROFILE

Key
I: Boulder talus; Slope=5°
II: Intrusive bedrock ramp; Slope=9°
III: Intrusive bedrock shelf; Slope=4°
IV: Steep scarp of till; Slope=53°
V: Break in slope at crest of scarp; Slope=27°
VI: Grass covered land; Slope=6°

These efforts were aimed at characterizing eroded shell midden deposits, and determining the fate of cultural material in the intertidal zone.

Three sites were selected for intensive study. Beach collections mapped all cultural material on the intertidal shore of the sites. One site was collected twice.

Shore inspection was carried out in a systematic fashion, so that all areas were covered, often on hands and knees, over a period of several hours. Shore profiles (Kellogg 1985a:19,111) were taken, and either shovel holes, or box cores placed along the profile line. Shell hash samples were collected from site and non-site locations.

Site 17-85

A compass and tape map was produced (Figure 11) and four mapping reference points marked with flagging tape. About eight man hours were spent searching the shore for cultural material. Each find was bagged separately, and bearings to at least three reference points were recorded. Finds are listed in Table 3; numbers refer to points on Figure 11. Findings of the beach collection studies will be discussed later. Note, however, that most of the cultural material was found within 15 m of the erosional scarp.

Two profile lines (Figure 12) were run perpendicular to

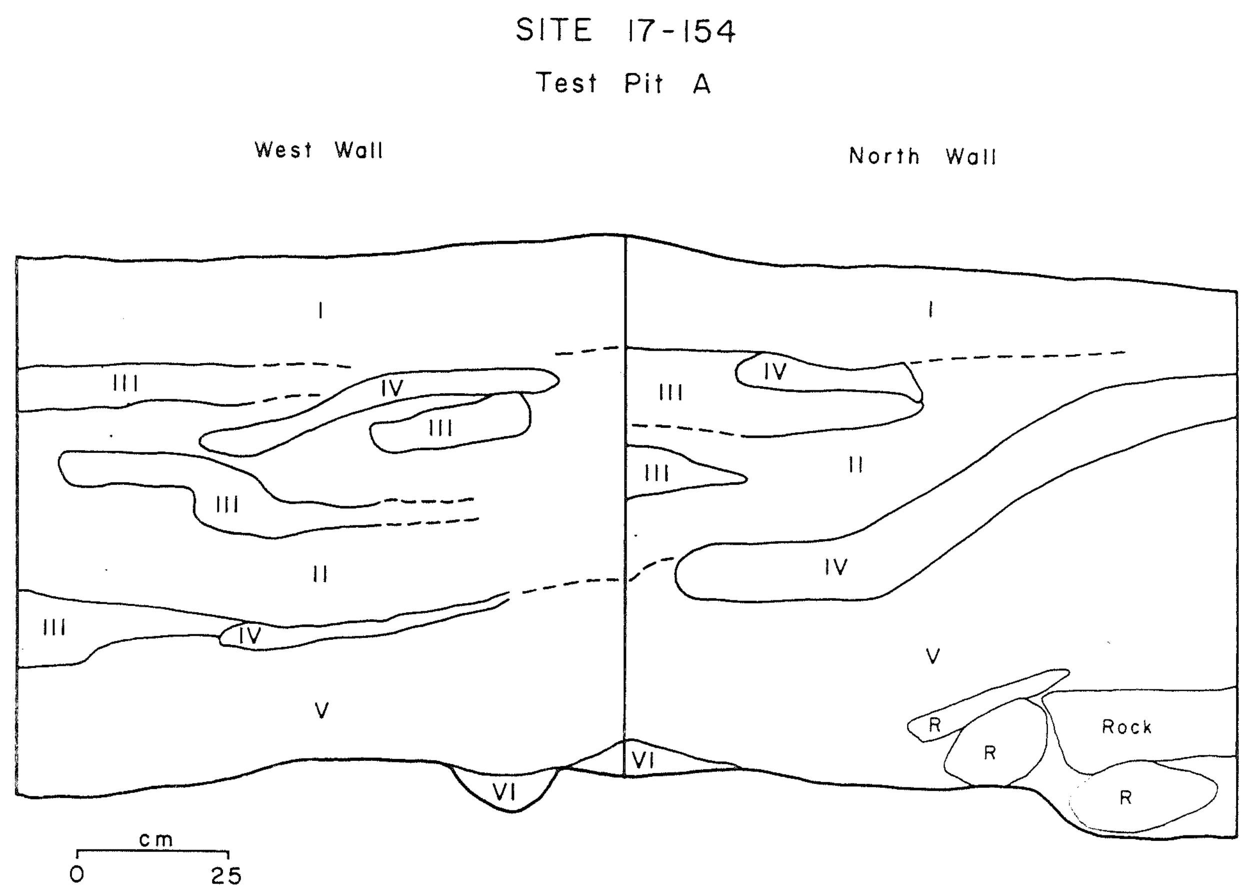

Figure 10: Site 17-154 Test Pit A Profile

FIGURE 10: SITE 17-154 TEST PIT A PROFILE

Key

I: Dense, flat-lying shell midden, with many whole valves

II: Dense shell midden, dipping along contact with Zone IV below

III: Shell-free, dark brown to black soil lens

IV: Yellow-brown, silty soil lens, with no shell or cultural material

V: Dense shell midden with many whole valves

VI: Undisturbed, culturally-sterile, yellow-brown, submidden soil

TABLE 3: SITE 17-85 BEACH FINDS

NO.	OBJECT	WFI	MPS	O-P	SHAPE	WEIGHT	DISTANCE	WEAR
6	BF	2.93	0.49	-12.1	DISK	1.4	3.7	1
7	BONE	7.33	0.29	22.2	BLADE	9.4	0.0	1
8	SHERD	2.93	0.49	-8.8	DISK	4.3	0.0	1
9	FLAKE	4.14	0.40	3.4	BLADE	3.8	10.2	1
10	COREF	2.29	0.58	-0.3	DISK	6.2	12.3	3
10A	BF	6.66	0.29	-9.4	BLADE	0.6	12.3	2
11	BF	2.58	0.53	-6.0	DISK	2.2	11.0	3
12	COREF	2.36	0.64	18.0	PROLATE	6.8	14.7	2
12A	BF	5.13	0.34	-17.5	DISK	0.6	14.7	3
13	FLAKE	4.48	0.38	-1.0	BLADE	16.8	5.7	2
14	BF	2.76	0.52	2.8	BLADE	2.3	15.2	2
15	FLAKE	5.44	0.34	6.3	BLADE	0.8	3.5	1
16	FLAKE	6.20	0.30	-1.1	BLADE	1.4	8.3	3
17	REF	5.76	0.31	-17.6	DISK	1.5	6.7	2
18	BF	4.54	0.37	0.6	BLADE	1.5	3.7	2
19	BF	3.56	0.43	-8.7	DISK	0.8	8.8	2
19A	BF	4.97	0.34	-23.8	DISK	1.5	8.8	2
20	SCR	1.53	0.76	-2.2	SPHERE	3.0	6.3	1
21	BF	2.85	0.50	-2.1	DISK	4.3	13.7	2
22	FLAKE	3.75	0.41	-12.5	DISK	6.9	8.0	2
22A	FLAKE	5.15	0.34	-24.8	DISK	1.4	8.0	1
23	FLAKE	2.51	0.54	-9.5	DISK	3.2	12.7	2
23A	FLAKE	6.44	0.29	-10.3	DISK	5.8	12.7	2
24	FLAKE	4.29	0.38	-15.9	DISK	1.2	4.7	2
25	BF	3.39	0.45	0.4	BLADE	5.8	11.7	2
26	FLAKE	4.62	0.37	-0.8	BLADE	2.2	2.3	2
27	BF	6.60	0.29	0.8	BLADE	1.8	9.5	2
28	BIFACE	4.81	0.35	-17.1	DISK	10.8	12.5	1
29	COREF	2.07	0.62	-9.6	DISK	12.8	12.5	2
30	BF	4.21	0.39	-7.1	DISK	0.9	8.5	2
31	BF	3.62	0.43	1.2	BLADE	16.2	30.3	2
32	BF	4.68	0.36	-4.0	BLADE	7.0	28.3	2
33	BF	4.07	0.39	-11.8	DISK	6.0	29.0	3
34	FLAKE	5.75	0.31	-16.0	DISK	2.3	7.2	1
35	BF	2.97	0.49	-1.4	DISK	7.1	13.2	2
36	COREF	2.87	0.50	-3.8	DISK	52.8	26.5	2
37	FLAKE	5.37	0.33	-0.6	BLADE	1.4	22.5	1

KEY
WEAR: 1=None, 2=Slight, 3=Obvious Beach Rounding
OBJECT: BF=Broken Flake, COREF=Core Fragment, SCR=SCraper
REF=Retouched Flake, PRE=Preform, FCR=Fire-cracked Rock

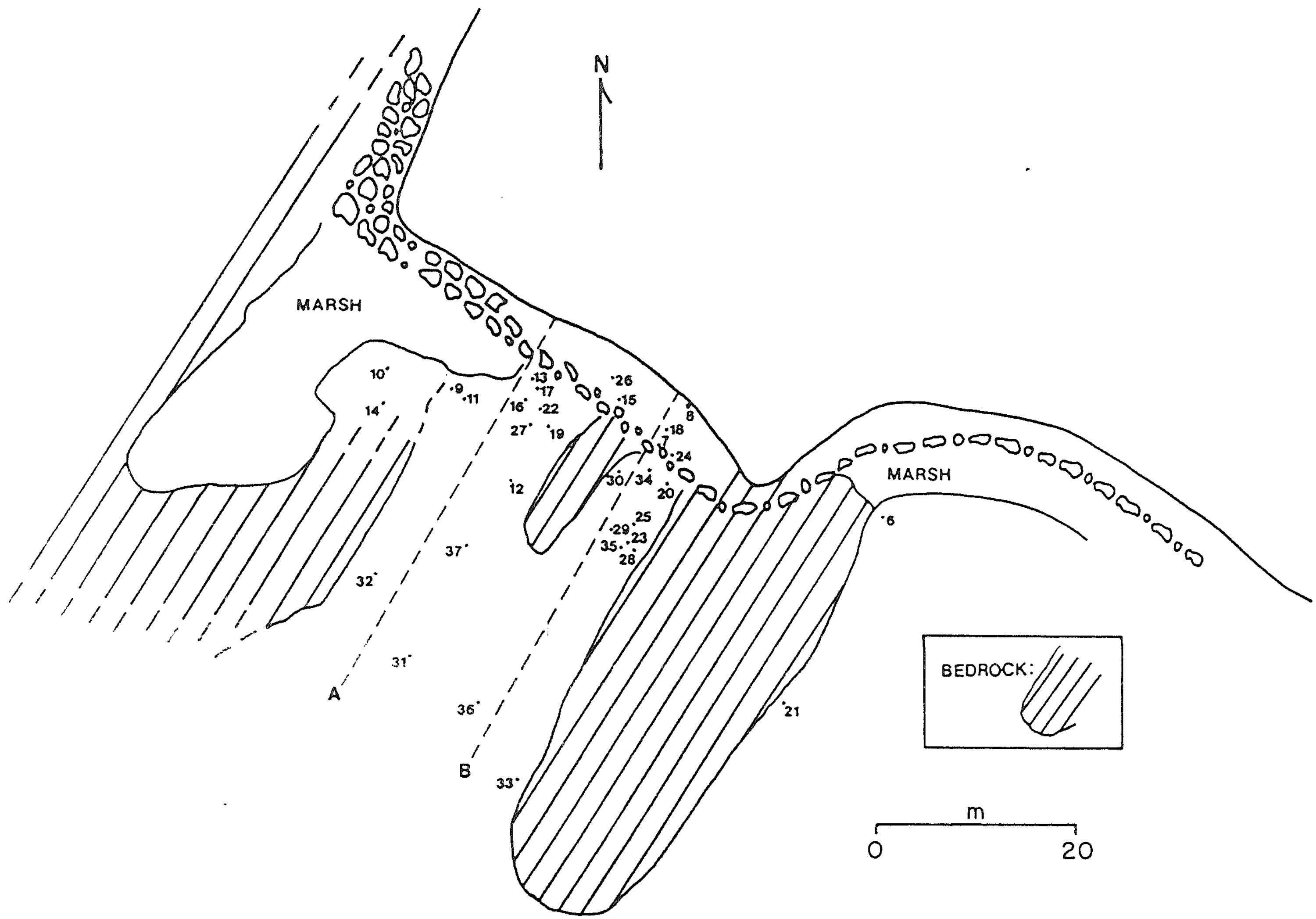

Figure 11: Beach Finds at Site 17-85

the shore, down the beach and mudflat between bedrock outcrops (Figure 11). Four box cores were placed along Profile B.

The box corer is a rectangular sheet metal box 14 cm by 25 cm by 30 cm long with a handle on top. The corer is forced into the sediments with the stopper removed from a hole on top. The stopper is replaced and the core can then be removed with an intact section of sediments. The corer must be dug out with a shovel when the sediments are coarse and will not hold together, or if heavy wet clays are encountered. A metal plate can be slipped under the core to prevent slumping. Some cores were extruded into heavy plastic bags in the field. Others were transported intact for more careful removal later.

Box Core #4 was placed through shell hash on the supratidal shore below the erosional scarp (Plate 1). Sediments below the shell hash were finely bedded silts and clays dipping downshore on top of Presumpscot Formation clay. The bedded sediments are interpreted as slope wash from the steep unvegetated scarp (Figure 12, Profile B, Zone VI).

In general, the box cores and profile show an erosional "ravinement" unconformity (Belknap and Kraft 1981) overlain by 1) intertidal mud, low on the profile; by 2) gravel and sand lag over a thin remnant peat formed on redeposited Presumpscot Formation, intermediate on the profile; by 3) a sand and shell hash lag, on the high intertidal shore; and

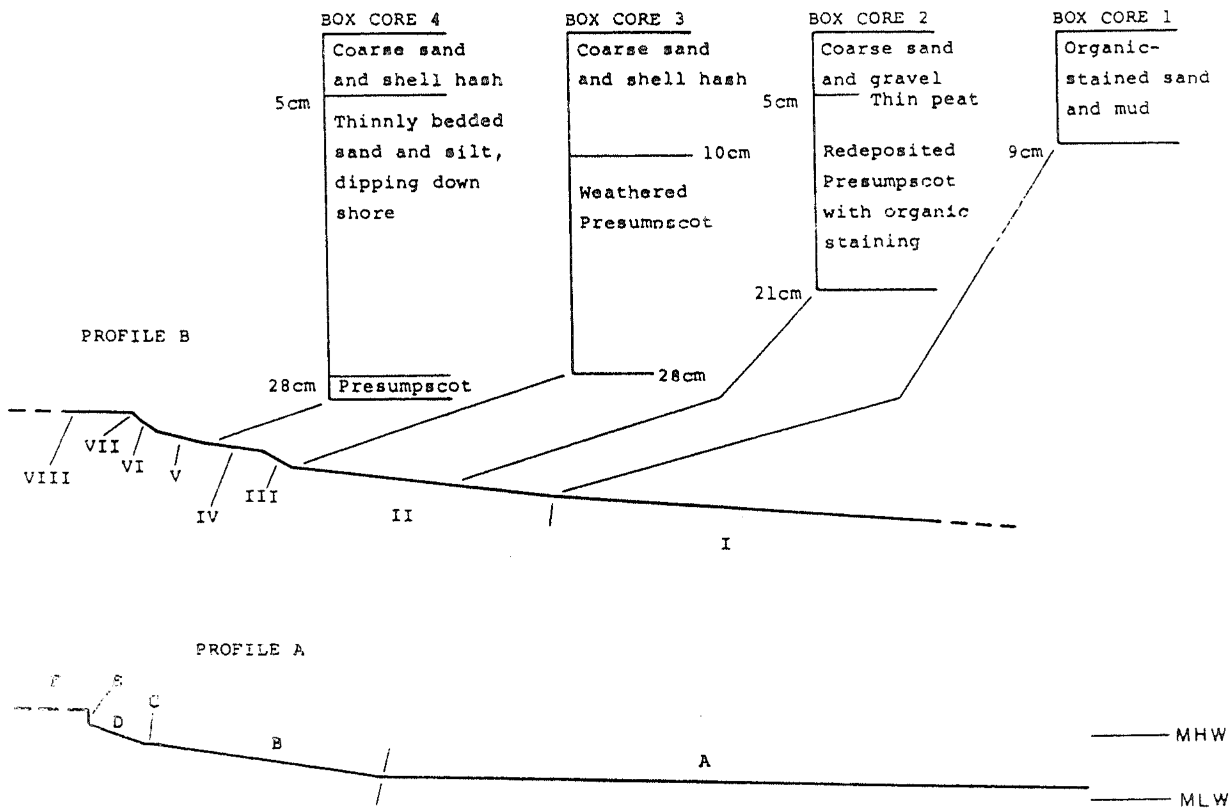

Figure 12: Shore Profiles of Site 17-85

FIGURE 12: SITE 17-85 SHORE PROFILES

Key to Profile B

I: Stoney, sand and mud shore; Slope=3°

II: Stoney, sand and mud shore with sparse shell hash; Slope=6°

III: Boulder line parallel to scarp

IV: Thick shell hash; Slope=8°

V: Shell hash covered scarp base; Slope=13°

VI: Steep, unvegetated scarp of weathered Presumpscot sediments; Slope=35°

VII: Scarp of eroding shell midden; Slope=60°

VIII: Sod covered shell midden; Slope=2°

Key to Profile A

A: Sandy, stoney mudflat with evidence of clamming; Slope<2°

B: Gravel and mud shore with sparse marsh grass; Slope=8°

C: Boulder line

D: Grass covered, supratidal shore with shell hash; Slope=19°

E: Vertical scarp of shell midden and underlying sediments; Slope=90°

F: Brush covered land; Slope=2°

by 4) slopewash on the supratidal shore.

Given that relative sea-level is rising, this erosional profile is migrating up into the shore. Sediments are eroded by subaerial processes from the steep scarp onto the supratidal shore where they remain in temporary storage until some high energy marine event transports them into the intertidal and subtidal environments. In between high energy erosional events, the scarp may stabilize, and marsh may develop on the high intertidal shore. This type of concave upward shore profile (Emery and Kuhn 1982) is common in the study area (Kellogg 1985a:33-35). The phenomena is exaggerated at Site 17-85 because a boulder sea wall several meters in front of the scarp holds back sediments, somewhat, in the supratidal zone.

Shell Hash Screening

A 1x1 m square was placed on the supratidal shore adjacent to Box Core #4, where shell hash completely covered the shore. The intent was to excavate in 5 cm levels, however, the shell hash was only about 5 cm thick. Shell hash was shoveled into a 1/4 in hardware cloth screen (Plate 2). Because the sediments were wet, buckets of water were poured over the screen to wash material through.

In approximately 0.05 cubic meters of shell hash, 10

Plate 1: Location of Box Core #4 at Site 17-85

flakes were recovered. Test excavations in 1983 (Kellogg 1984:32-34) recovered two flakes from 0.2 cubic meters of intact shell midden. If a rate of 10 flakes per cubic meter (2 flakes/0.2 m^3) is representative, then the ten flakes found in screening shell hash represent about one cubic meter of intact shell midden that has eroded (or 5 m^2 at 20 cm thick), and there are about 200 flakes per cubic meter of shell hash.

The volume of shell midden sediments has been reduced by a factor of 20 (1 m^3/0.05 m^3) during erosion. The total beach collection from the site contains 68 flakes representing perhaps 6.8 m^3 of intact shell midden, or 34 m^2 at 20 cm thick.

There is an area of shell hash, approximately 18 m x 2 m in extent by about 5 cm thick (1.8 m^3), in front of the erosional scarp. This shell hash could represent 36 m^3, or 180 m^2 at 20 cm thick, of intact shell midden. Extant midden deposits cover about 130 m^2, so by rough calculation, an original extent of 310 m^2 at 20 cm thick is represented, and 58% by volume has eroded (assuming that all of the original shell deposits are represented).

One other 1x1 m square from the sparse shell hash of the upper intertidal zone was screened. Only one flake was recovered.

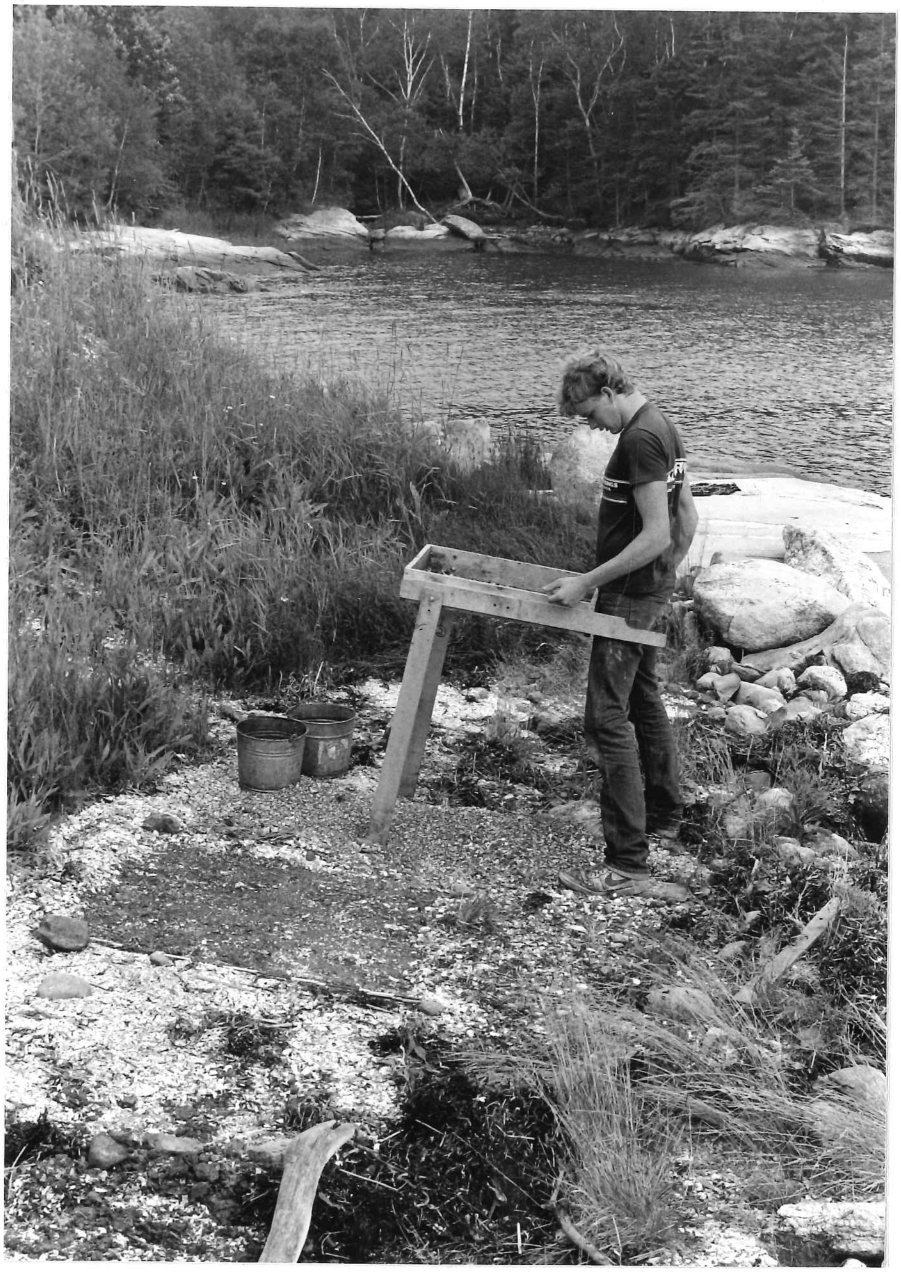

Plate 2: Screening shell hash at Site 17-85

Site 17-116

Only the barest remnant of shell midden deposits remain at this site on Oar Island in upper Muscongus Bay. The shore is mostly rocky with a narrow section of mudflat/beach in between bedrock outcrops (Figure 13). The rock wall low on the beach is most likely the foundation for an historic structure. The mudflat behind the wall may thus be a relatively modern accumulation. Only six objects were collected (Table 4).

Two box cores were taken. Box Core #1 was 12-15 cm of shell hash, sand, and gravel over 10-12 cm of dark, organic-stained sand. Box Core #2 penetrated to 25 cm depth. The top 5 cm consisted of mud and coarse sand, bioturbated and mottled black. The next 5 cm was compact mud penetrated by burrows from above and stained dark. Mya were found in growth position. The bottom 15 cm were weathered Presumpscot Formation clay with iron concretions.

Site 17-155

Site 17-155 was discovered in survey 30 June 1984, along the upper western shore of Greenland Cove (Figure 14). The former presence of a site was indicated by lithic

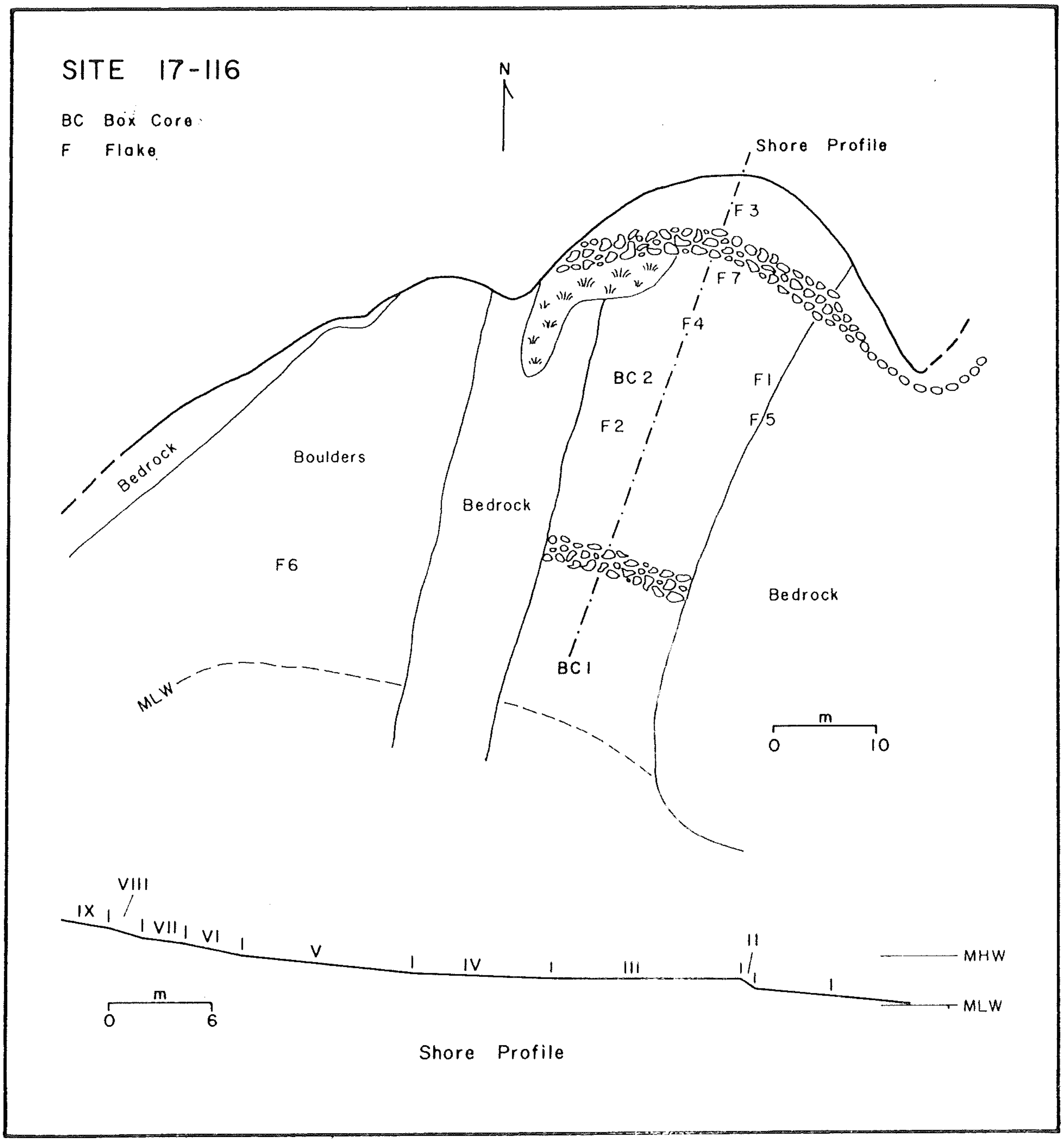

Figure 13: Beach Collection and Shore Profile of Site 17-116

FIGURE 13: SITE 17-116 SHORE PROFILE

Key
I: Littered mudflat; Slope=6°
II: Stone wall
III: Mudflat; Slope=0°
IV: Stoney mudflat; Slope=2°
V: Pebbly and shelly, mixed-sediment shore; Slope=6°
VI: Flotsam covered, pebble beach; Slope=11°
VII: Same as above; Slope=8°
VIII: Unvegetated, Presumpscot sediment scarp; Slope=17°
IX: Podzolic soil covered land; Slope=9°

TABLE 4: SITE 17-116 BEACH FINDS

NO.	OBJECT	WFI	MPS	O-P	SHAPE	WEIGHT	DISTANCE	WEAR
1	FLAKE	4.14	0.39	-5.1	DISK	0.9	12.8	2
2	FLAKE	3.75	0.43	7.3	BLADE	17.3	1.3	2
3	BF	4.48	0.37	-15.7	DISK	24.1	3.0	1
4	REF	7.20	0.27	-34.6	DISK	1.4	12.5	2
5	FLAKE	5.08	0.34	-14.7	DISK	16.9	15.7	3
7	CORE	2.35	0.58	4.3	BLADE	399.0	9.0	2

For Key to OBJECT and WEAR codes see Table 3.

material on the shore, including a Susquehanna type biface base. No indications of intact midden were found. Later conversations with the land owner revealed that a small portion of disturbed shell midden was present.

Two intensive collections were carried out on 18 July, and 1 August, 1984 (Table 5). Collection A recovered 14 items, while Collection B located seven items.

Collection B differs from Collection A only in its location on the shore, based on a Wilcoxon Test (Conover 1980:216-223) on Distance (Test Statistic=43.50, Significance Level=0.001). All of Collection B finds were 4 m, or less, from the scarp. Wilcoxon Tests on the shape measures (see below), size, and weight were not significant.

Four box cores were taken on July 18 (see Figure 15). The top nine centimeters of BC #1 were organic-stained,

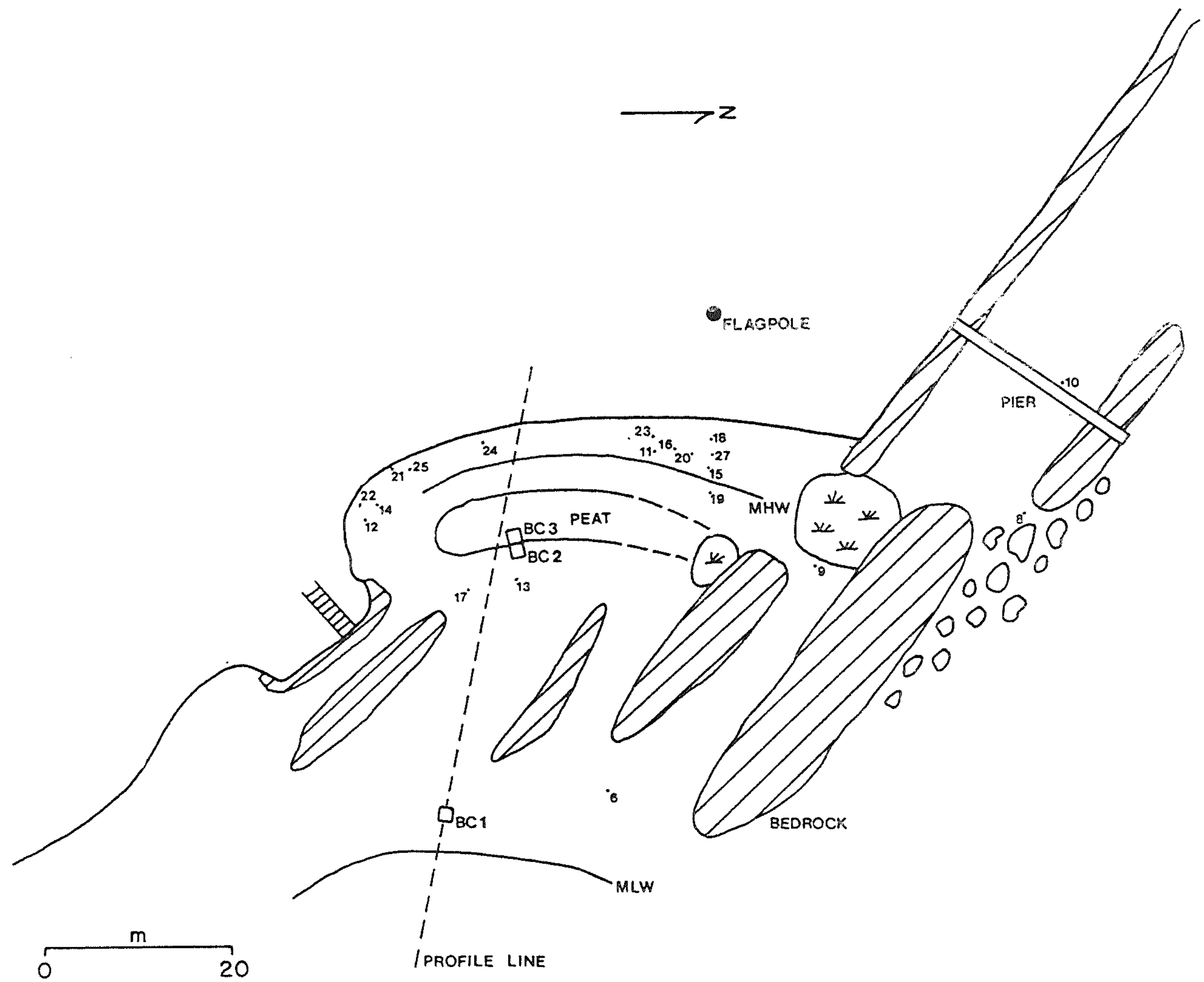

Figure 14: Beach Collection and Shore Map of Site 17-155

coarse sand and mud with Mya in growth position. Large fragments of broken shell, a spruce cone, and bits of bark and twigs were also present. This is interpreted as a disturbed mudflat buried by an erosional lag of sand.

Box Core #2 penetrated a thin lag of sand and gravel with an eroded remnant of peat overlying blue Presumpscot clay. The upper 15 cm of the clay were slightly bioturbated as indicated by pockets of sand. Below a color transition to greenish clay, iron concretions were present.

Box Core #3 was placed just above the erosional edge of a 10-15 cm thick peat deposit on the upper intertidal shore. The surface of the peat is pitted and eroded. Stratification within the peat consists of bands of marine mud to one cm thick in the upper 11 cm, and sand lenses grading to unstratified sand at 18 cm depth. The bottom 12 cm of the core, consisting of sand and gravel below the peat, was screened through 1/4 in mesh. A small brick fragment was found.

In general, this profile shows a recent erosional episode truncating a quieter period in which marsh had developed on top of an earlier erosional surface. Recent erosion had also moved sand downshore burying some mudflat deposits just below Mean Low Water. Stratification within the peat records the impacts of lesser erosional and depositional events on the intertidal shore.

Box Core #4 was a test of using a two gallon gas can as

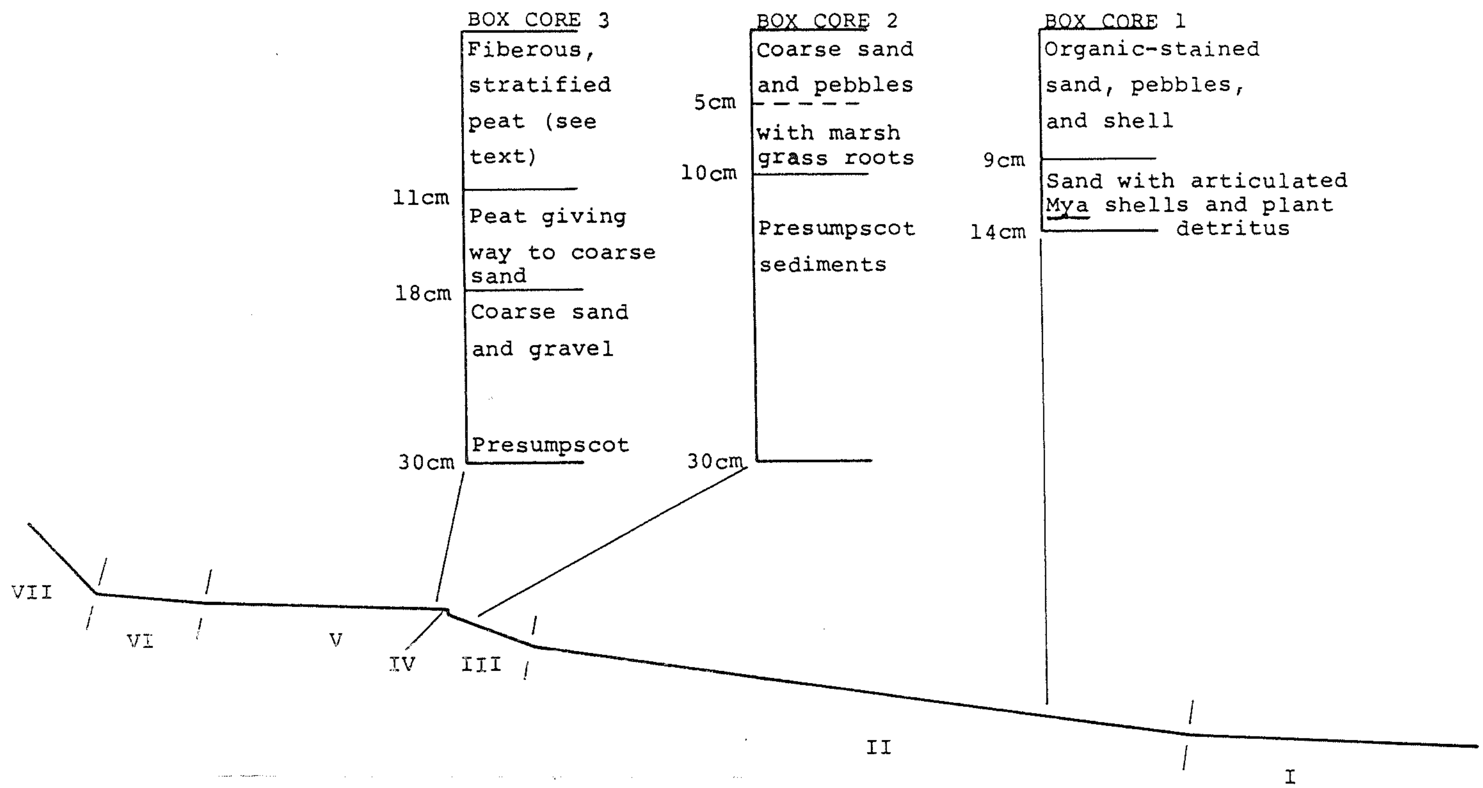

Figure 15: Site 17-155 Shore Profile

FIGURE 15: SITE 17-155 SHORE PROFILE

<u>Key</u>

I: Stoney mudflat shore; Slope=3°

II: Same as above; Slope=8°

III: Sand and pebble shore; Slope=21°

IV: Vertical scarp of eroding peat;

V: Pitted, erosional surface of peat; Slope=4°

VI: Flotsom covered cobble and mud shore; Slope=5°

VII: Unvegetated scarp of Presumpscot sediments; Slope=47°

TABLE 5: SITE 17-155 BEACH FINDS

NO.	OBJECT	WFI	MPS	O-P	SHAPE	WEIGHT	DISTANCE	WEAR
Collection A 18 July 1984								
6	BF	1.89	0.65	-5.7	DISK	37.6	30.7	1
8	BF	2.71	0.51	-9.5	DISK	0.6	18.7	2
9	FLAKE	1.94	0.64	-3.7	DISK	8.3	12.3	3
10	COREF	2.59	0.54	0.3	BLADE	72.0	12.0	2
11	PRE	2.20	0.60	2.8	BLADE	38.3	4.3	2
12	COREF	1.75	0.69	-7.1	DISK	102.2	2.7	1
13	BF	2.60	0.53	-12.8	DISK	1.6	13.0	2
14	FLAKE	4.87	0.35	-17.3	DISK	13.9	3.0	2
15	BF	4.58	0.36	-17.7	DISK	1.1	7.0	1
16	FLAKE	3.44	0.44	-8.4	DISK	2.2	4.7	2
17	COREF	2.87	0.51	4.2	BLADE	31.2	15.0	2
18	COREF	2.70	0.57	16.1	PROLATE	16.1	1.7	1
19	FCR	1.49	0.80	9.7	PROLATE	322.4	8.3	1
20	COREF	1.74	0.70	2.8	SPHERE	37.2	4.7	2
Collection B 1 August 1984								
21	BF	6.40	0.30	6.6	BLADE	8.4	1.0	2
22	COREF	2.44	0.57	6.4	BLADE	91.1	1.0	3
23	BF	4.35	0.38	-6.2	DISK	0.2	2.2	1
24	COREF	1.89	0.66	1.5	DISK	96.8	1.7	1
25	FLAKE	4.41	0.40	12.8	BLADE	2.3	0.5	1
26	BF	5.40	0.34	12.4	BLADE	3.6	0.5	1
27	BF	4.19	0.39	-12.3	DISK	1.0	4.0	2
27A	FLAKE	2.20	0.61	6.5	BLADE	1.7	4.0	1

For Key to OBJECT and WEAR codes see Table 3.

a box corer. The bottom of the can was removed with a can opener. The gas can worked well, however, the handle broke when extracting the can from the mud; it had to be dug out. Also, the thin sides of the can were dented and bent. Nonetheless, a useable core can be obtained cheaply in this fashion.

RESULTS OF BEACH COLLECTIONS

A total of 65 objects from the three sites were classified as to artifact type, material type, shape, and beach wear. Perpendicular distance to the erosional scarp was taken from the mapped position on the shore, and each object was weighed to 0.1 grams.

In general, the amount of cultural information that could be obtained from an intensive beach collection is limited. Diagnostic artifacts are rarely recovered. Repeated visits over extended time periods might increase the chances of recovering a greater amount of material as shore conditions change.

Several hypotheses were posed to test some simple ideas about the transfer of objects from shell midden context to beach shore context. The ideas are: 1) flakes are broken by movement onto, and on the beach; 2) smaller objects are moved more frequently than larger objects; 3) smaller objects get moved further downshore; and 4) flattened objects remain higher on the shore than rounded objects.

Hypothesis I

Ho: There is no association between flake breakage and beach wear.

TABLE 6: FLAKE WEAR VS. FLAKE BREAKAGE

		WEAR			
		NONE	SLIGHT	OBVIOUS	TOTALS
FLAKES	BROKEN	6 7.22	16 14.44	3 3.33	25
	WHOLE	7 5.78	10 11.56	3 2.67	20
	TOTALS	13	26	6	45

KEY: Frequency / Expected

Test Statistic=0.91; $Chi^2(2,0.05)=5.991$; Cannot reject Ho.

Ha: Broken flakes are more beach worn.

Table 6 shows results of chi-square test on the 45 flakes from the three sites. The result is negative; Ho cannot be rejected. The forces acting to erode and move flakes about on the shore are not sufficient to break them.

Hypothesis II

If objects are being moved on the intertidal shore by wave action, or other processes, then smaller objects would

TABLE 7: OBJECT WEIGHT AND SIZE VS. WEAR

ALL OBJECTS

Ho: Object weight is distributed similarly in wear classes.

WEAR	SUM OF RANKS	EXPECTED
NONE	699	693
SLIGHT	1174	1188
OBVIOUS	272	264

Test Score=0.04

$Chi^2(2,0.05)=5.991$

Significance Level=0.979

Cannot reject Ho.

Ho: Object size is distributed similarly in wear classes.

WEAR	SUM OF RANKS	EXPECTED
NONE	708	693
SLIGHT	1167	1188
OBVIOUS	270	264

Test Score=0.08

$Chi^2(2,0.05)=5.991$

Significance Level=0.962

Cannot reject Ho.

be moved more; therefore, wear classes might be expected to show weight differences.

Ho: The weights of objects in different wear classes are similarly distributed.

Ha: Smaller objects are more worn.

On the basis of a Kruskal-Wallis test (Conover 1980:229-231) this hypothesis cannot be rejected (Table 7). A similar test on the maximum dimension of the objects vs. wear class is also negative (Table 7). The same two tests were performed on the flakes only. Again, no significant differences were found between the wear classes (Table 7).

Hypothesis III

This hypothesis assumes that smaller objects are more easily moved downshore, away from the erosional scarp, than larger objects. Weight and maximum dimension were tested against distance from the scarp.

Ho: Distance is independent of weight.

Ha: There is a tendency for larger objects to be associated with shorter distances.

A Spearman Rank Correlation Test is not significant (Rho=-0.0314; Significance Level=0.804). The distance of an object from the erosional scarp is independent of an objects weight. Testing this hypothesis for each site, however, a small <u>positive</u> correlation is obtained for site 17-85 (Rho=0.325; Significance Level=0.0499). Thus, <u>heavier</u> objects were found <u>further</u> from the scarp!

Ho: Distance is independent of size (measured as maximum dimension).

Ha: There is a tendency for larger objects to be associated with smaller distances.

TABLE 7: Continued

FLAKES ONLY

Ho: Object weight is distributed similarly in wear classes.

WEAR	SUM OF RANKS	EXPECTED
NONE	272	299
SLIGHT	612.5	598
OBVIOUS	150.5	138

Test Score=0.52

Chi² (2,0.05)=5.991

Significance Level=0.770

Cannot reject Ho.

Ho: Object size is distributed similarly in wear classes.

WEAR	SUM OF RANKS	EXPECTED
NONE	285	299
SLIGHT	599	598
OBVIOUS	151	138

Test Score=0.25

Chi² (2,0.05)=5.991

Significance Level=0.8821

Cannot reject Ho.

On the basis of a Spearman Rank Correlation Test, the null hypothesis cannot be rejected (Rho=-0.1048; Significance Level=0.406). Again, the same tests were applied to the 45 flakes alone with no significant results.

TABLE 8: SHAPE MEASUREMENT EXAMPLES

	WFI	MPS	O-P
Perfect Sphere	1.0	1.0	Not applicable
Perfect Rod	1.75	0.7368	Positive values
Perfect Blade	2.125	0.6114	0.0
Perfect Disk	2.5	0.5429	Negative values

(From Dobkins and Folk 1970, pp. 1180)

Hypothesis IV

There is a large literature concerned with pebble shapes on beaches vs. streams (see Reineck and Singh 1980:138-141; Dobkins and Folk 1970; and Brock 1974 for discussions) aimed primarily at discriminating between the two environments in rock strata. Studies of beach gravel (eg. Dobkins and Folk 1970) show that, depending on wave energies, different size pebbles are worn to different shapes and moved differently on a beach. Flat objects are tossed up, while spherical, or rod-shaped (prolate) objects roll down. This action eventually changes spherical objects into flattened ones.

All objects were classified according to several indicies based on measurements of the following three variables:

1) maximum dimension (MAX);

2) intermediate dimension (INT), and

3) minimum dimension (MIN).

For a spherical object, all three measurements are the same; for a rectangular object 'minimum dimension' corresponds to thickness, while 'intermediate dimension' is the width of the object.

Gross shape was divided into four categories following Zingg (1935, see Reineck and Singh 1980:138). The ratios of INT/MAX and MIN/INT were computed. Disk-shaped objects are > 2/3 for 1st ratio and < 2/3 for 2cd ratio; blade-like objects are < 2/3 for both ratios. Spherical objects are > 2/3 for both rations, and prolate objects fall in the remaining class. Other indicies, calculated as described in Dobkins and Folk (1970), are the Wentworth Flatness Index (WFI), Maximum Projection Sphericity (MPS), and Prolate-Oblate Ratio (P-R) (See Table 8).

Ho: Distance is independent of object shape.

Ha: Flatter objects are found closer to the scarp.

A negative correlation was expected between flatness and distance. Using a Kruskal-Wallis Test on the gross shape class, no significant differences in the distributions were found (Test Score=2.67; Significance Level=0.4457). Only five objects were classified as either prolate or spheroid, however.

Testing the WFI and MPS measures against distance, no

TABLE 9: SHAPE MEASURE VS. DISTANCE CORRELATIONS

All Objects

Shape Measure	Spearman Rank Correlation	Significance Level
WFI	-0.095	0.4496
MPS	0.069	0.5831
O-P	-0.240	0.054

Site 17-85 Only

Shape Measure	Spearman Rank Correlation	Significance Level
WFI	-0.247	0.1411
MPS	0.246	0.1428
O-P	0.047	0.7841

Site 17-155 Only

Shape Measure	Spearman Rank Correlation	Significance Level
WFI	-0.373	0.0871
MPS	0.310	0.1605
O-P	-0.476	0.0251

significant correlations were found (Table 9). The O-P Ratio, which measures disk vs. rod tendencies, was ,however, slightly correlated with distance (Rho=-0.24, Significance Level=0.054). Disk-like objects, having a negative value for O-P, therefore, were found somewhat further from the scarp. This is the opposite of expectations. The relationship is especially clear at Site 17-155, where 22 objects yielded a Spearman Rho=-0.476, with a Significance Level=0.0251. Thus, Hypothesis IV is clearly unsupported.

Summary

In summary, there appears to be little patterning to beach objects that might be attributed to wave processes. The only relationships found were the reverse of those expected. It is probably unwise to conclude, however, that objects found on the shore reflect a spatial relationship that is related to a spatial context within the site deposits before erosion. Ice and man, also, impact the shore and may affect shore assemblages to a much greater degree than do waves at fairly protected locations.

SHELL MIDDEN AND SHORE SEDIMENT ANALYSIS

The intent of this portion of the research is to compare samples of intact shell midden sediments to natural, and cultural shell hash deposits to assist in the development of criteria for the identification of submerged site locations.

A column sample from Site 17-11 Test Pit B (Figure 1) taken in 1983, and another from Site 17-22 Test Pit C (Figure 8) taken in 1984, were analyzed to characterize intact shell midden. Each level of the column was considered as a separate sample of shell midden. I do not assume that the results represent shell middens in general. Both columns, however, cut through several visually distinct strata, so that a variety of midden deposits were sampled.

Sediment samples from shore contexts were taken from the Box Cores discussed earlier, and from other locations of interest. Cultural shell hash (CSH) samples were taken from Box Cores 3 and 4 at Site 17-85, and from the supratidal shore at Site 27-6 (Figure 16). A sample of natural shell hash (NON) was collected from a small, pocket storm beach with an extensive overwash fan, on the north end of Crane Island. A sample from Box Core 1 at Site 17-85, and two samples from Box Core 2 at Site 17-155 were grouped together as sandy, intertidal mudflat (SIMF). Two levels from Box Core 1 at Site 17-116 were classified as low, intertidal mudflat (LIMF). Also, included in the analysis as unknowns were three samples of shell hash found in MS-VC-5, a 4 inch diameter vibracore taken from Hockomock Channel, across from the Todd Site, in 1984 (Kellogg 1985b).

Each sample was shaken through a set of three standard sized sieves (16 mm, 6.3 mm, and 2.38 mm). The two larger

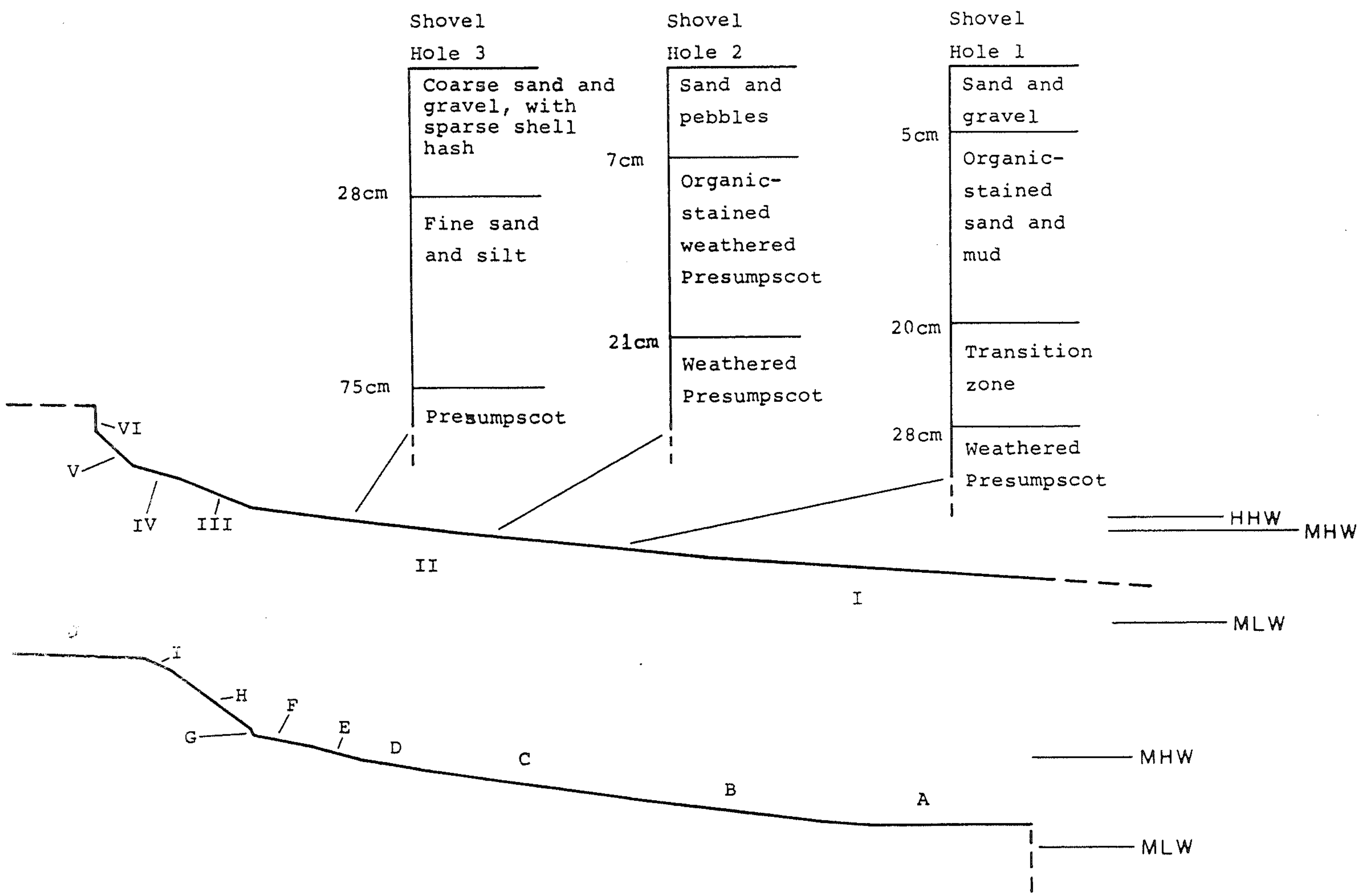

Figure 16: Site 27-6 Shore Profiles

FIGURE 16: SITE 27-6 SHORE PROFILES

Key to Profile A

I: Stoney mudflat shore; Slope=3°

II: Gravel and cobble covered shore with sparse shell hash; Slope=7°

III: Flotsom covered, stoney shore; Slope=22°

IV: Boulder line covered with flotsom

V: Brush covered scarp; Slope=44°

VI: Vertical, unvegetated scarp head

Key to Profile B

A: Intrusive bedrock

B: Metasedimentary bedrock trending 35°-215°; Slope=7°

C: Boulder strewn shore with sparse marsh grass; Slope=8°

D: Cobble and boulder strewn shore with shell hash; Slope=9°

E: Gravel and pebbles with shell hash; Slope=10°

F: Flotsom over shell hash and gravel; Slope=16°

G: Small vertical scarp at the base of H

H: Grass covered scarp slope with eroded shell midden; Slope=37°

I: Break in slope at scarp head; Slope=26°

J: Sod covered shell midden; Slope=3°

TABLE 10: RESULTS OF SIEVE ANALYSIS

	SM*	17-11	17-22	SIMF	CSH	LIMF	NON	CORE
Samples	27	13	14	3	4	2	1	3
CLAM16%	13.8	15.4	12.3	0.4	0.7	0.05	0.2	1.8
CLAM6%	29.5	30.6	28.4	1.4	4.5	0.3	10.5	2.6
CLAM%	43.3	46.0	40.7	1.7	5.2	0.4	10.7	4.4
MR%	0.7	1.5	0.0	0.0	0.0	0.0	0.0	0.7
MUS%	4.5	6.0	3.1	0.4	0.3	3.6	0.0	0.5
OTHER%	0.2	0.3	0.1	0.3	1.1	1.8	0.0	0.3
CHAR%	0.1	0.03	0.2	0.005	0.008	0.0	0.0	0.0
BONE%	0.2	0.02	0.3	0.0	0.008	0.0	0.0	0.0
CERAMIC%	0.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0
FLAKE%	0.001	0.0	0.001	0.0	0.0	0.0	0.0	0.0
ROCK%	3.7	2.5	4.8	37.7	13.7	16.6	2.7	9.0
FRAC3%	23.0	21.5	24.5	17.1	32.1	19.6	51.8	21.0
PAN%	24.3	22.1	26.3	42.7	47.5	57.9	34.7	64.1

Note: Charcoal was present in only one of the SIMF samples.
*Shell Midden

size fractions were sorted into shell types, bone, ceramics, rock, charcoal, and artifacts. Each category was weighed on a Mettler E200 balance. The smallest size fraction (FRAC3) and the Pan fraction were also weighed. The discussion that follows is based on averaged percentages of the total weight of each sample (Table 10).

Analysis

Spearman Rank Correlations were calculated for each of the two column samples independently, and as a group (see Appendix). For Site 17-11 inverse correlations between *Mya* (CLPCT's) and *Mercenaria* (MRPCT) confirm stratigraphic observations. Mussel (MUSPCT) is also negatively correlated with *Mya*, and positively correlated with *Mercenaria*. Higher in the column, *Mya* shell dominates, while deeper deposits are composed of mussel and *Mercenaria*. Other notable correlations are between mussel shell and charcoal, and between *Mya* shell size 6.3 mm (CL6PCT) and bone.

No *Mercenaria* shell was found in Site 17-22 samples. No significant correlations were found between shell types. Charcoal is again correlated with *Mya* shell, though. Ceramics (CERPCT) are negatively correlated with other shell types (OTHPCT) (such as, moon snail or whelks). Flakes (FLKPCT) are correlated with mussel shell. High negative correlations are found between *Mya* shell and the 2.38 mm size (FRAC3PCT), and Pan (PANPCT) fractions. Most of these are predictable relationships; for example, a sample with a high percentage of large shell fragments will have a low percentage of smaller material. Other correlations, like that between mussel shell and charcoal at Site 17-11, are intriguing because they may have implications for the cultural behavior, or post-depositional processes. When both sites are combined many significant correlations are found. Most of the correlations from each site survive, though. The thesis by D. Skinas (in prep.) will explore the character of shell midden deposits in much greater detail than can be achieved here. These results provide only for a tentative comparison to the shore samples.

The two sites were compared by Wilcoxon Tests on each variable (Table 11). Only the percentage of other shell types and ceramics differed. The column sample from Site 17-11 contained no ceramics, and the other column from Site 17-22 contains very little other shell types. Analysis of variance for each variable yields non-significant results for all variables (Table 11). Thus, on the basis of a sieve analysis, it would be difficult to assign shell midden sample to either of the two sites in a blind test.

Shore Sediment Samples

A variety of statistical procedures, ranging from median tests to canonical discriminant analysis, were attempted to explore the variation between, and among, the shell midden and shore samples. The small number of samples, however, renders such statistical treatment useless, and inappropriate. The discussion that follows is based only on the averaged percentages of Table 10. The results

TABLE 11: STATISTICAL TEST RESULTS FOR COMPARISONS OF SHELL MIDDEN SAMPLES

VARIABLE	WILCOXON SCORE	SIGNIF. LEVEL	F RATIO	SIGNIF. LEVEL
CLAM16%	204.0	0.297	0.827	0.372
CLAM6%	188.0	0.790	0.189	0.667
MUSSEL%	204.0	0.297	1.507	0.231
OTHER%	226.5	0.028	2.512	0.126
CHARCOAL%	170.5	0.589	1.689	0.206
BONE%	183.5	0.960	1.861	0.185
CERAMIC%	149.5	0.022	2.055	0.164
FLAKE%	175.5	0.374	0.926	0.345
ROCK%	161.5	0.332	1.732	0.200
FRAC3%	160.0	0.297	1.307	0.264
PAN%	172.0	0.645	0.983	0.331

may be considered as a pilot study.

Intact shell midden is clearly different from any of the shore samples. Percentages of large shell fractions (CL16, CL6, MUS, and MER) are much higher. Note, however, that the percentages of ceramics and flakes in the shell midden samples are very small. Thus, the chances of finding material for positive identification of cultural activity in shore, or core samples are very low. Recall (pp. 33) that midden at Site 17-85 contained flakes in a ratio of 10 flakes to 1 m^3, and that shell hash contained flakes in a ratio of 200 flakes to 1 m^3. The column samples levels were 0.003 m^3 and 0.0015 m^3 for Sites 17-11 and 17-22 respectively; so there is about 3% or 1.5% chance of flakes occurring in samples of this size even from intact midden.

The shore samples varied in size, but were no larger than about 2 liters (0.002 m^3); most were smaller. The possibility of finding a flake, even in the most dense shell hash, therefore, is about 40% (0.002x200=0.4). One flake was found on the surface of Box Core 3 at Site 17-85. The chances of obtaining a flake in a 4 in core through 20 cm of intact shell midden would be about 2%; through 5 cm of shell hash similar to Site 17-85, the chances would be about 8%. Based on these rough calculations, a sample size of 0.1 m^3 (50 times larger than any of the shore samples) would be needed to guarantee the recovery of at least one flake from deposits of either intact, or eroded shell midden.

Unfortunately, dense shell hashes, such as those found on the supratidal shores of Sites 17-85 and 27-6, do not appear to survive the process of submergence. Sandy and Low Intertidal Mudflat samples from eroded shell midden locations (17-116 and 17-155) contain very little shell by weight. Shell is either dispersed, or broken up, in the intertidal zone. Flakes also may be dispersed, as many fewer were recovered beyond four meters from the scarp at any of the sites. Cultural material could, in fact, be transported far from its original position by some processes; for example: ice rafting.

Ceramics are both rare and fragile; the only ceramic sherd in the shore collections came from the erosional scarp itself and not the actual shore.

Another problem is in the sampling itself. FRAC3 and PAN percentages for all the shore samples reflect the amounts of sand and mud obtained in sampling, but not found in shell midden samples. Thus, the negative correlations between larger shell fragments and FRAC3 and PAN fractions of the shell midden samples are potentially masked.

Percentages for all variables of the NON and CSH samples are very similar; thus, emphasizing the difficulties in identifying the source of a shell hash. How, indeed, do you tell if you have a shell hash of non-cultural origin in the first place? For a difinitive study of shell hash discrimination, many carefully selected samples would be required.

Despite the pessimism implied so far, it is fairly certain that intact shell midden could be identified in a core. First of all, midden deposits range up to well over one meter in thickness. Secondly, changes in stratigraphy, and the amounts of large shell fragments would be good indicators, even if no artifacts were encountered. The presence of charcoal and bone with large shell fragments would amount to virtually positive identification of cultural deposits

(Gagliano *et al.* 1982).

For eroded and redeposited shell midden sediments, I remain pessimistic. Only the recovery of artifacts would constitute good evidence of a cultural origin for a shell hash, either on an intertidal shore, or in a submerged context. Shell hash alone can derive from many natural processes (Bradley 1957, Reineck and Singh 1980:154-158). Intertidal mudflats are subject to seasonal fluctuations in erosion and deposition (Anderson *et al.* 1981), so shell hash might be a very common constituent of mudflat sediments. High percentages of large shell fragments, however, might suggest that further investigation is warranted, especially in a High Probability geomorphological setting as discussed previously (pp. 4).

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APPENDIX: CORRELATIONS FOR SHELL MIDDEN COLUMN SAMPLES

SPEARMAN CORRELATION COEFFICIENTS FOR BOTH SITES

CL16PCT

CL16PCT	PANPCT	FRAC3PCT	CLPCT	CHARPCT
1.00000	-0.75092	-0.69231	0.67460	0.58230
0.0000*	0.0001	0.0001	0.0001	0.0015

CL6PCT

CL6PCT	CLPCT	PANPCT	BONEPCT	FRAC3PCT
1.00000	0.80525	-0.48657	0.47480	-0.44017
0.0000	0.0001	0.0101	0.0123	0.0216

CLPCT

CLPCT	PANPCT	CL6PCT	FRAC3PCT	CL16PCT
1.00000	-0.81746	0.80525	-0.70391	0.67460
0.0000	0.0001	0.0001	0.0001	0.0001

MRPCT

MRPCT	MUSPCT	OTHPCT	CERPCT	CL6PCT
1.00000	0.49699	0.38172	-0.35081	-0.30646
0.0000	0.0084	0.0494	0.0728	0.1200

MUSPCT

MUSPCT	MRPCT	CL6PCT	CL16PCT	FLKPCT
1.00000	0.49699	-0.43677	0.29261	0.25194
0.0000	0.0084	0.0227	0.1386	0.2049

OTHPCT

OTHPCT	CERPCT	BONEPCT	FRAC3PCT	MRPCT
1.00000	-0.53032	0.41132	-0.38466	0.38172
0.0000	0.0044	0.0330	0.0476	0.0494

CHARPCT

CHARPCT	CL16PCT	PANPCT	CLPCT	CERPCT
1.00000	0.58230	-0.53560	0.35223	0.33101
0.0000	0.0015	0.0040	0.0716	0.0917

BONEPCT

BONEPCT	CL6PCT	OTHPCT	CLPCT	CERPCT
1.00000	0.47480	0.41132	0.39396	-0.38844
0.0000	0.0123	0.0330	0.0420	0.0453

*PROB > |R| UNDER H0:RHO=0

SPEARMAN CORRELATION COEFFICIENTS FOR BOTH SITES

CERPCT

CERPCT	OTHPCT	BONEPCT	FRAC3PCT	MRPCT
1.00000	-0.53032	-0.38844	0.38506	-0.35081
0.0000*	0.0044	0.0453	0.0473	0.0728

FLKPCT

FLKPCT	BONEPCT	MUSPCT	FRAC3PCT	MRPCT
1.00000	0.34262	0.25194	-0.25179	-0.14528
0.0000	0.0802	0.2049	0.2052	0.4697

ROCKPCT

ROCKPCT	CLPCT	CL6PCT	PANPCT	CERPCT
1.00000	-0.40513	-0.38528	0.38223	0.29188
0.0000	0.0360	0.0472	0.0491	0.1396

FRAC3PCT

FRAC3PCT	CLPCT	CL16PCT	PANPCT	CL6PCT
1.00000	-0.70391	-0.69231	0.48718	-0.44017
0.0000	0.0001	0.0001	0.0100	0.0216

PANPCT

PANPCT	CLPCT	CL16PCT	CHARPCT	FRAC3PCT
1.00000	-0.81746	-0.75092	-0.53560	0.48718
0.0000	0.0001	0.0001	0.0040	0.0100

*PROB > |R| UNDER H0:RHO=0

SPEARMAN CORRELATION COEFFICIENTS FOR INDIVIDUAL SITES
SITE 17-11

CL16PCT

CL16PCT	ROCKPCT	CL6PCT	OTHPCT	MUSPCT
1.00000	0.62637	-0.51648	0.47253	0.43956
0.0000*	0.0220	0.0707	0.1030	0.1329

CL6PCT

CL6PCT	MUSPCT	MRPCT	CLPCT	BONEPCT
1.00000	-0.88462	-0.75139	0.69231	0.54259
0.0000	0.0001	0.0031	0.0087	0.0554

CLPCT

CLPCT	MRPCT	CL6PCT	MUSPCT	PANPCT
1.00000	-0.84532	0.69231	-0.67582	-0.53846
0.0000	0.0003	0.0087	0.0112	0.0576

MRPCT

MRPCT	CLPCT	CL6PCT	MUSPCT	PANPCT
1.00000	-0.84532	-0.75139	0.72377	0.43095
0.0000	0.0003	0.0031	0.0052	0.1415

MUSPCT

MUSPCT	CL6PCT	MRPCT	CLPCT	CHARPCT
1.00000	-0.88462	0.72377	-0.67582	0.56354
0.0000	0.0001	0.0052	0.0112	0.0449

OTHPCT

OTHPCT	CL16PCT	FRAC3PCT	PANPCT	BONEPCT
1.00000	0.47253	-0.42308	-0.41209	0.37303
0.0000	0.1030	0.1497	0.1618	0.2093

CHARPCT

CHARPCT	MUSPCT	BONEPCT	CL6PCT	CL16PCT
1.00000	0.56354	-0.37510	-0.34255	0.33150
0.0000	0.0449	0.2066	0.2519	0.2685

*PROB > |R| UNDER H0:RHO=0

SPEARMAN CORRELATION COEFFICIENTS FOR INDIVIDUAL SITES
SITE 17-11

BONEPCT

BONEPCT	CL6PCT	MUSPCT	MRPCT	CHARPCT
1.00000	0.54259	-0.45216	-0.40351	-0.37510
0.0000*	0.0554	0.1208	0.1715	0.2066

ROCKPCT

ROCKPCT	FRAC3PCT	CL16PCT	CL6PCT	BONEPCT
1.00000	-0.66484	0.62637	-0.50000	-0.32781
0.0000	0.0132	0.0220	0.0819	0.2742

FRAC3PCT

FRAC3PCT	ROCKPCT	CL16PCT	OTHPCT	CLPCT
1.00000	-0.66484	-0.42857	-0.42308	-0.26374
0.0000	0.0132	0.1440	0.1497	0.3839

PANPCT

PANPCT	CLPCT	MRPCT	OTHPCT	CL16PCT
1.00000	-0.53846	0.43095	-0.41209	-0.41209
0.0000	0.0576	0.1415	0.1618	0.1618

*PROB > |R| UNDER H0:RHO=0

SPEARMAN CORRELATION COEFFICIENTS FOR INDIVIDUAL SITES
SITE 17-22

CL16PCT

CL16PCT	PANPCT	CLPCT	CHARPCT	CL6PCT
1.00000	-0.92967	0.90330	0.80245	0.71868
0.0000*	0.0001	0.0001	0.0006	0.0038

CL6PCT

CL6PCT	CLPCT	PANPCT	FRAC3PCT	CL16PCT
1.00000	0.91209	-0.82857	-0.80220	0.71868
0.0000	0.0001	0.0003	0.0006	0.0038

CLPCT

CLPCT	PANPCT	CL6PCT	CL16PCT	FRAC3PCT
1.00000	-0.96484	0.91209	0.90330	-0.81538
0.0000	0.0001	0.0001	0.0001	0.0004

MUSPCT

MUSPCT	FLKPCT	OTHPCT	FRAC3PCT	BONEPCT
1.00000	0.38009	0.31130	-0.28036	0.20038
0.0000	0.1801	0.2786	0.3316	0.4922

OTHPCT

OTHPCT	CERPCT	BONEPCT	CL6PCT	FRAC3PCT
1.00000	-0.52239	0.49507	0.46873	-0.42263
0.0000	0.0553	0.0719	0.0909	0.1322

CHARPCT

CHARPCT	CL16PCT	PANPCT	CLPCT	CERPCT
1.00000	0.80245	-0.74401	0.60015	0.38508
0.0000	0.0006	0.0023	0.0233	0.1739

*PROB > |R| UNDER H0:RHO=0

SPEARMAN CORRELATION COEFFICIENTS FOR INDIVIDUAL SITES
SITE 17-22

BONEPCT

BONEPCT	OTHPCT	CERPCT	FLKPCT	CL6PCT
1.00000	0.49507	-0.49507	0.47757	0.42480
0.0000*	0.0719	0.0719	0.0842	0.1300

CERPCT

CERPCT	OTHPCT	BONEPCT	FRAC3PCT	CL6PCT
1.00000	-0.52239	-0.49507	0.48922	-0.40213
0.0000	0.0553	0.0719	0.0758	0.1540

FLKPCT

FLKPCT	BONEPCT	MUSPCT	FRAC3PCT	OTHPCT
1.00000	0.47757	0.38009	-0.30961	0.20046
0.0000	0.0842	0.1801	0.2814	0.4920

ROCKPCT

ROCKPCT	FRAC3PCT	CL16PCT	CLPCT	PANPCT
1.00000	0.66154	-0.48571	-0.48571	0.45495
0.0000	0.0100	0.0783	0.0783	0.1022

FRAC3PCT

FRAC3PCT	CLPCT	CL6PCT	PANPCT	CL16PCT
1.00000	-0.81538	-0.80220	0.72747	-0.71429
0.0000	0.0004	0.0006	0.0032	0.0041

PANPCT

PANPCT	CLPCT	CL16PCT	CL6PCT	CHARPCT
1.00000	-0.96484	-0.92967	-0.82857	-0.74401
0.0000	0.0001	0.0001	0.0003	0.0023

*PROB > |R| UNDER H0:RHO=0