Prevailing Winds and Site Aspects: Testable Hypotheses about the Seasonality of Prehistoric Shell Middens at Nantucket, Massachusetts.

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PREVAILING WINDS AND SITE ASPECTS: TESTABLE HYPOTHESES ABOUT THE SEASONALITY OF PREHISTORIC SHELL MIDDENS AT NANTUCKET, MASSACHUSETTS

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At Nantucket Island, 61% of the 60 inventoried prehistoric sites with shell remains have southeast or south aspects, with both protection from the prevailing northwest winter winds and solar warming in the winter. This southerly bias does not reflect the location of shellfish habitat, which lies north of 67% of the sites. I develop the hypotheses that all winter sites had southeast or south aspects and that summer sites had aspects roughly equally distributed in all directions. In addition, I discuss alternative hypotheses and suggest methods for testing these possibilities.

INTRODUCTION

Knowledge of the functions and seasonality of sites enables archaeologists to reconstruct and explore variations in the scheduling of resource procurement and settlement patterns of the prehistoric inhabitants of a region. In New England there are currently many lively questions concerning the seasonality of coastal sites (Barber 1982; Ceci 1982; Hancock 1982; Luedtke 1980a; McManamon 1982; Perlman 1980; Sanger 1982; Spiess et al. 1983; Yesner 1980).

Roger Williams reported in 1643 that the Indians of Narragansett Bay moved from "warm, thick woody bottoms where they winter" to "summer fields . . . where they plant corn" (Williams 1963:74). "Some times they remove to a hunting house in the end of the year" (Williams 1963:75). Ethnohistorical descriptions such as this, together with Champlain's 1605 drawing of cornfields next to wigwams at Cape Cod, have led to a model of historic occupations of the coast in the summer and early fall (Braun 1972; Bourque 1973; Ceci 1982; Luedtke 1980a). However, the seasonal settlement patterns of prehistoric peoples on the coast of New England may have changed substantially during the Contact period in response to European trade (Bourque 1973; Ceci 1982; Ludetke 1980a).

In order to determine prehistoric site seasonality, archaeologists have used as evidence the seasonal availability or growth patterns of certain contents of shell middens. Neither method is without pitfalls (Monks 1981). In Maine, using studies of the seasonal availability of shell midden contents, Bourque (1973), Sanger (1981), and Snow (1972) have found that sites with shell middens dating before A.D. 1150 were late fall, winter, or spring sites, and

that coastal summer shell middens date after A.D. 1550. A seasonal pond at the Quidnet site (1575±160 B.P., GX-4528), Nantucket, provided some evidence for occupations limited to winter (Little 1984). On the other hand, Ceci (1982) has reported only small summer camps with little or no maize horticulture for the pre-Contact coast of Long Island, New York. Although faunal identifications by Waters at six multicomponent Martha's Vineyard sites neither exclude any seasons, nor distinguish between repeated brief visits and long-term occupations, Ritchie (1969:234) proposed that the island may have had year-round, semisedentary occupants. Perlman (1980) and Yesner (1980) have also considered coastal sedentism. McManamon (1982, personal communication 1983), from a study of *Mercenaria* shell growth stages by Hancock, suggests that Cape Cod also had year-round occupants. Ongoing studies in Maine reveal a complex variety of seasonal settlement patterns (Sanger 1982; Spiess et al. 1983). To understand seasonality in coastal New England we need increased clarity and precision both in theory and in experiment.

In 1978 the Nantucket Historical Association, in cooperation with the Massachusetts Historical Commission, carried out a survey of prehistoric sites on Nantucket by collecting reports, cataloging collections, and visiting sites. The association inventoried 106 sites, 60 of which included shell remains (Little 1978). Two C-14 dates and artifact styles associated with the shell middens suggest that Nantucket's shell middens may all be younger than 3000 years (Little 1978, 1984; Moffett 1957; Ritchie 1969; Braun 1974:584; Dincauze 1974:49-53).

In order to consider the relation of site aspects to the season, I define site aspect, as it is usually measured, as the direction with the furthest view toward the horizon, ignoring vegetation. A site with a certain aspect will have wind protection from the direction opposite to the aspect. I use eight aspect directions each consisting of 45°: N, NE, E, SE, S, SW, W, and NW. If I except 3 sites with 360° aspects, the 57 remaining sites, each with one aspect per site, form the data set on which this paper is based. For simplicity, I consider the year at Nantucket to consist of two seasons, summer and winter, as defined by the prevailing SW summer and NW winter winds at Nantucket.

Researchers in New England have often assumed that all sites will require southerly aspects in order to provide protection from northerly winds. Smith (1944), for example, assumed that there had been woods north of any site presently lacking protection to the north in the Concord River valley, and Braun (1972) found southerly site aspects on Boston Harbor islands, which he had predicted. His definition of a site excluded a number of small deposits of shell with northerly aspects. Recently Fairbanks (1980), Kellogg (1982), and Little (this paper) have shown that the majority of, but by no means all, sites in Massachusetts and Maine have southerly aspects.

I offer the hypothesis that site aspects at Nantucket can be correlated with season because of the unusually high local wind speed and its seasonal directions. Specifically, I propose that all winter (November through March) sites with shell remains had a SE or S aspect, which provided protection from the high prevailing NW winter wind and enhanced winter solar warming. If this holds, then all shell midden sites at Nantucket with aspects in directions other than S or SE were summer (May through September) sites. On the basis of site data, I propose that summer sites had aspects distributed roughly equally in all directions. In this paper I present data to support these hypotheses and tests which can refute them.

NORTHWEST WINDS AND SOLAR RADIATION AS INFLUENCES ON SITE LOCATION

Winter Site Locations

> In the winter . . . it is extremely cold; the northwest wind, the tyrant of this country, after having escaped from our mountains and forests, free from all

> impediment in its short passage, blows with redoubled force and renders this island bleak and uncomfortable [Crèvecoeur 1971:100, 101].

Modern weather records confirm that the average surface wind speed on the cape and islands is 60 to 90% higher than it is inland (Figure 1). At Nantucket, the prevailing wind blows from the northwest (Figure 2) during the months of November, December, January, February, and March, and has an average speed of 24.3 km per hour in February (Nantucket Weather Bureau Records 1887-1904).

For 57 reported Nantucket shell middens (Figure 3), the site aspects show a strong southeasterly bias (Figure 4). Sixty-one percent of the sites have S or SE aspects, which constitute only 25% of the eight possible aspect directions. The surplus of shell middens with S or SE aspects, on the S or SE sides of hills, suggests the vigorous influence of northwesterly winds at Nantucket, and I propose that all winter sites had NW wind protection (Hypothesis A).

In addition to obtaining wind shelter on the southeast of hills, winter occupants on south hillsides can maximize the warming effects of the sun. At 40°N, a south-facing hillside can receive two to three times as much solar radiation in December and January as an east-facing slope, and a south-facing 60° slope can receive twice as much solar radiation as a horizontal slope (Mazria 1979:103, 129). "Even a 10° slope will receive up to 28% more sun than a horizontal surface in mid-winter, which is enough to cause spring blooming to occur two weeks earlier" (Johnson 1982:59).

The topography of land to the north and west of a site can influence the prevailing winter wind direction, and hills on the south can diminish solar warming in winter. Potential cooling effects can arise from the pooling of cold air in the bottoms of hollows (Johnson 1982:59). Therefore, although highly visible shell remains tend to define a site, evidence for dwellings associated with shell middens might be discovered through measurements of winds and solar warming at a site.

A number of alternatives could account in part for the biased aspect data shown in Figure 4. One would expect shell middens close to shellfish habitat, if people do not carry shell any farther than necessary. Indeed, all but one of the inventoried shell midden sites lie within 1 km of modern shellfish habitat (Figure 3). Therefore, shellfish habitat lying predominantly S or SE of the sites could account for the bias in the aspect orientations. However, this cannot be so, because shellfish habitat lies N, NW, or NE of 67% of the sites.

Natural amphitheaters or kettle holes with openings to the southeast are fairly common on Martha's Vineyard and Nantucket (Ritchie 1969; Little 1978). The melting of ice blocks embedded in glacial debris formed these hollows, which provide shelter from Nantucket's strong winds at all times of the year. Also, south-facing slopes with soil improved by old shell midden might have attracted early horticulturalists in the spring and summer (Ceci 1982). These phenomena could account for an increased number of sites with southerly aspects, and summer as well as winter occupants. On the other hand, kettle holes, even those with openings, can be oppressively warm and troubled with insects in summer, and little evidence has yet appeared for prehistoric horticulture at Nantucket.

Summer Site Locations

Although at present we recognize little evidence for summer sites on Nantucket, the scarce evidence for summer sites on the mainland (Barber 1979) does not support the hypothesis that the island was occupied only in winter. According to the weather data of Figure 2, the prevailing winds in May, June, July, August, and September (summer, in this paper) blow from the southwest. Where would one expect to find summer dwelling sites?

Hypothesis A, that all winter sites had S or SE aspects, implies logically that the 22 shell

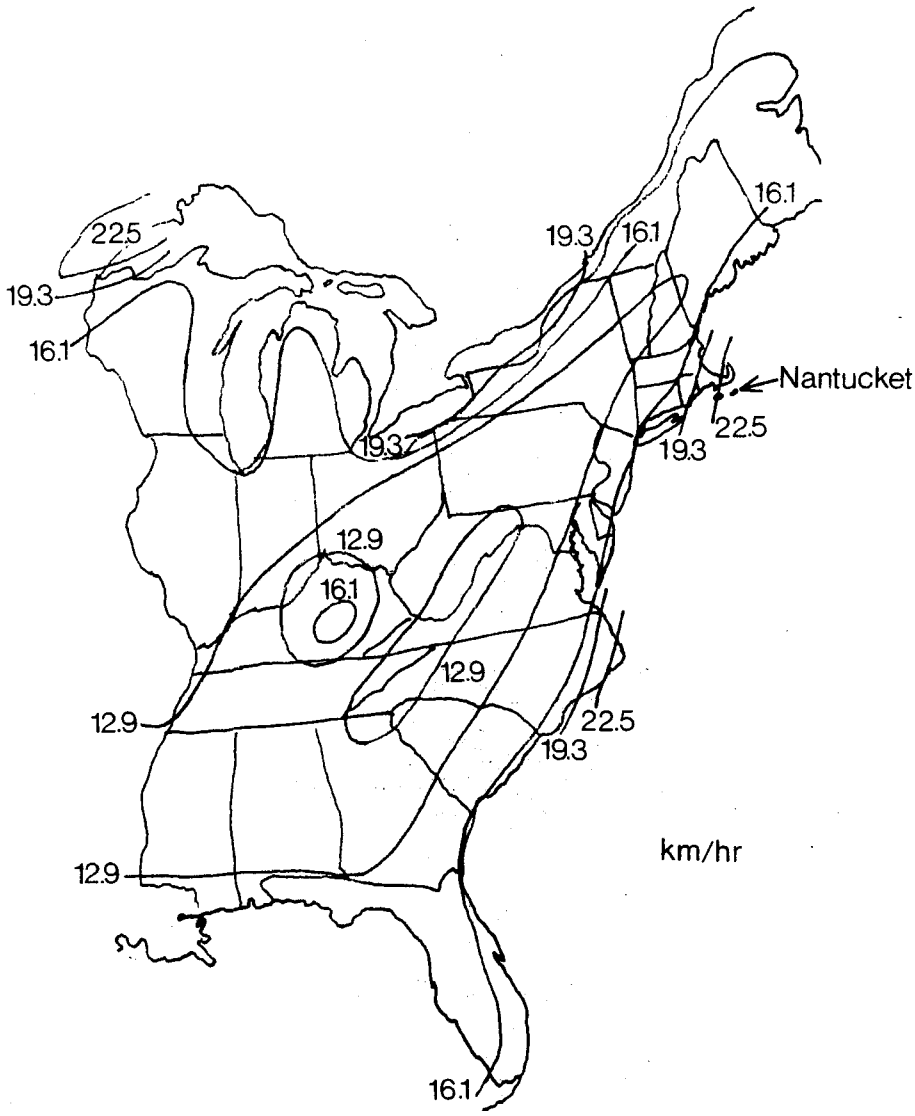

Figure 1. Average surface wind speeds in kilometers per hour in the eastern United States from Weather Bureau Records 1871-1945 (after Visher 1954:161), showing the high average wind speed at Nantucket. I have converted the isogram speeds from miles per hour to kilometers per hour.

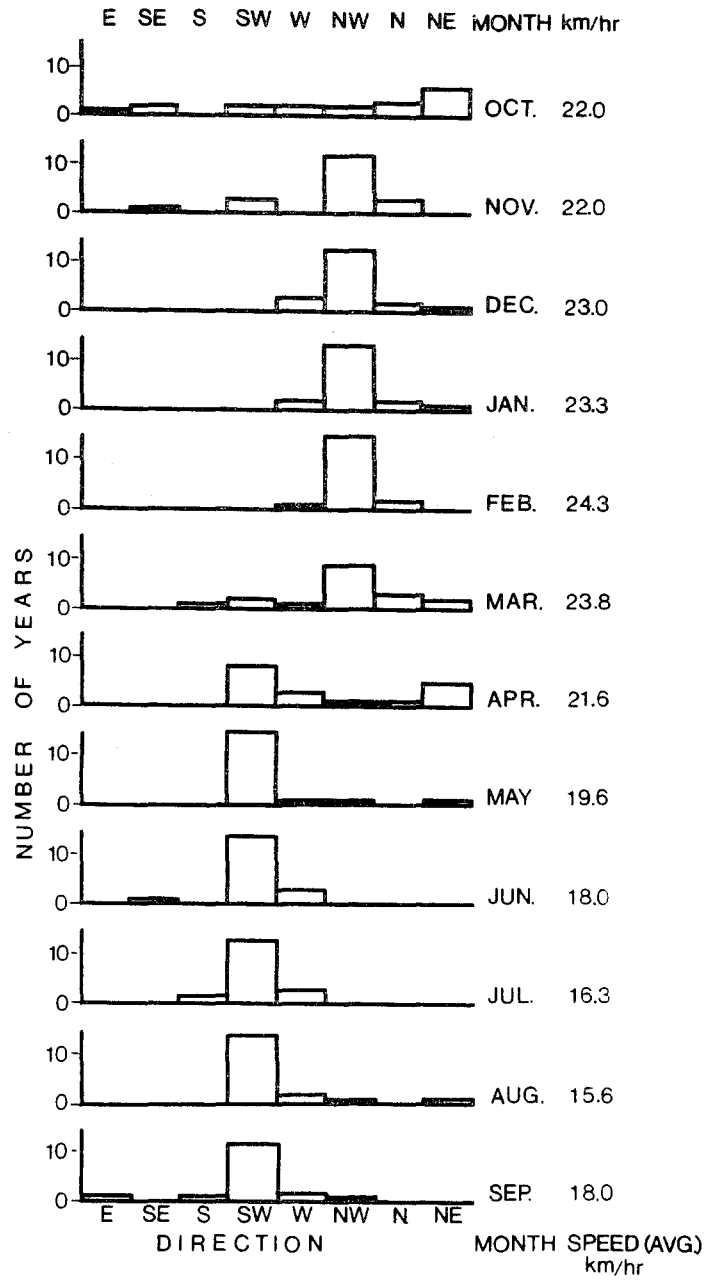

Figure 2. The frequency distribution of prevailing wind direction (from which the wind blows) by months and average monthly wind speeds in kilometers per hour at Nantucket 1886-1904 (Nantucket Weather Bureau Records 1886-1969). Notice the annual bimodal prevailing wind directions.

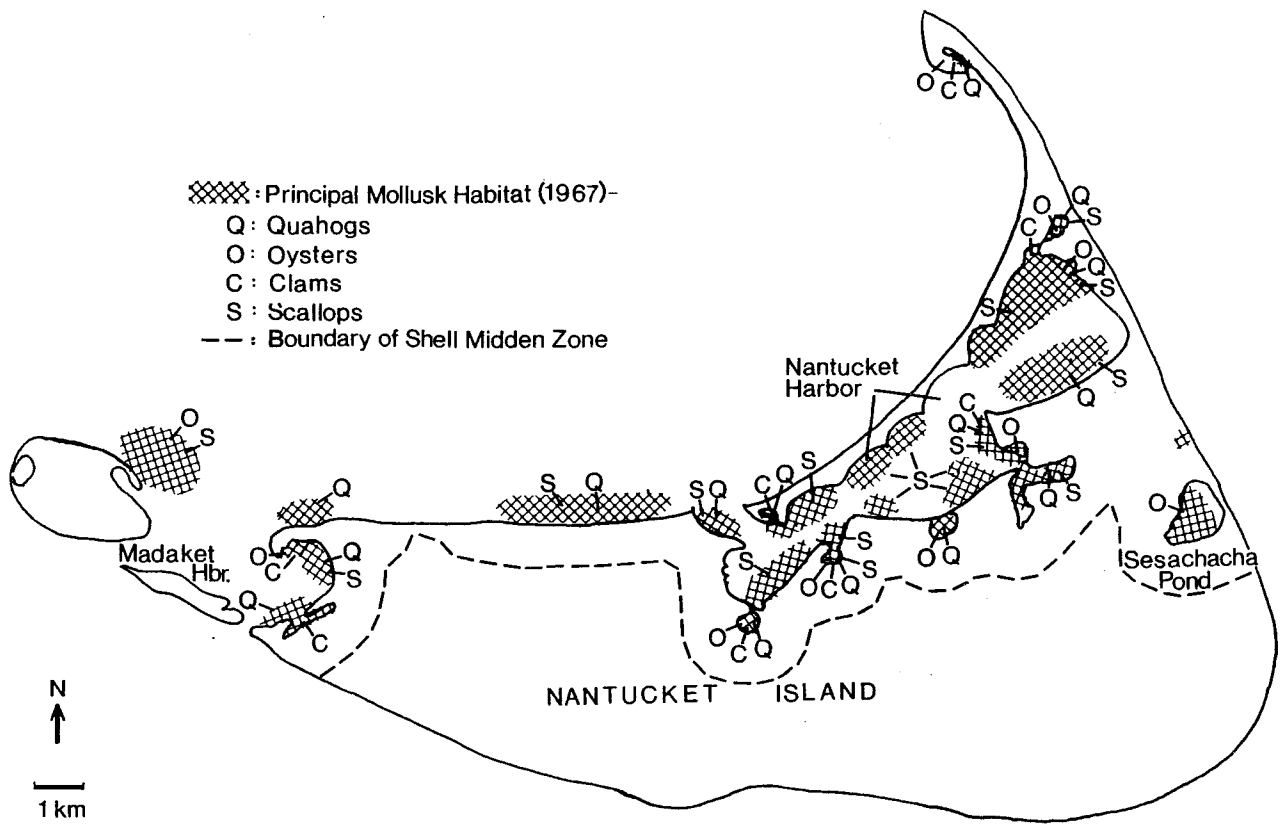

Figure 3. A map of Nantucket showing the principal mollusk habitat today (Zube and Carlozzi 1967: 45; J.C. Andrews, personal communication 1984), and the zone of prehistoric shell midden sites less than 1 km from mollusk habitat (Little 1978).

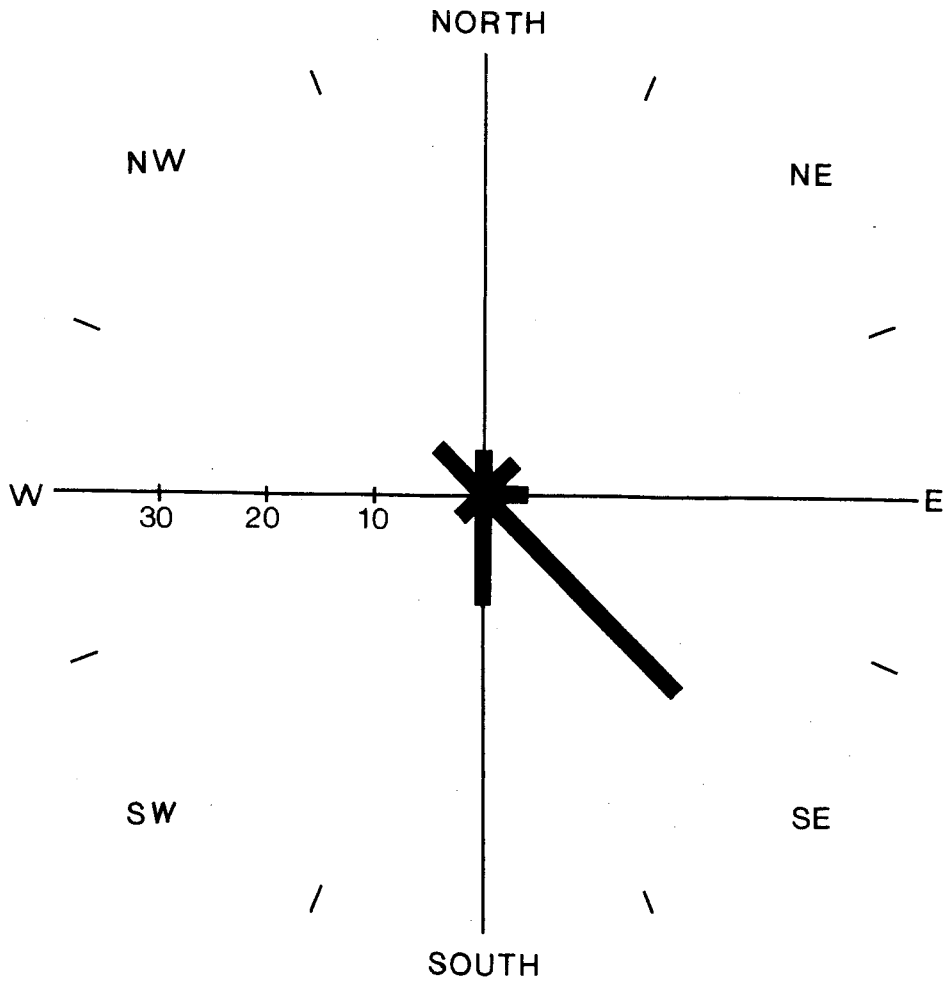

Figure 4. The frequency distribution of prehistoric site aspects for 57 Nantucket shell midden sites (Little 1978) in polar coordinates. The length of each radial bar is proportional to the number of sites for which the aspect falls in the corresponding 45° sector. While there are aspects in all directions, most sites face the south and southeast.

midden sites with SW, W, NW, N, NE, and E aspects were summer sites. From the roughly equal distribution of site aspects (Figure 4; Figure 6a) among these six directions (an average of 22/6 sites per 45°), I infer that a variety of influences such as access to boat launching places, shellfish habitat, and fresh water, as well as the prevailing southwest wind, helped determine the location of summer sites. Therefore, Hypothesis B is that summer sites had aspects distributed roughly equally in all directions. Although I doubt that summer residents would have avoided the oysters, quahogs, and clams that are available year-round, some summer sites at Nantucket may have no shell remains.

Implications

To summarize, Hypothesis A, that all shell midden sites used at Nantucket between November and March had SE or S aspects, implies that all SW, W, NW, N, NE, and E facing sites were only summer sites. Nantucket data show the number of sites to be roughly equally distributed over these six aspects. Therefore I infer, Hypothesis B, that summer sites at Nantucket had aspects approximately equally distributed in all eight directions. That would mean that there are 8 x 22/6 or roughly 29 summer sites in our data set. Therefore, Hypotheses A and B imply that the Nantucket data set contains roughly 22 summer (only) sites, 28 winter (only) sites (57-29=28), and 7 summer sites which may or may not also be winter shell midden sites.

These hypotheses suggest that the many small sites scattered about on the northern shores of Nantucket (Luedtke 1980b; Little 1978) were brief summer sites. Conversely, most of the large shell middens in protected hollows would fall into the winter site category.

The data and analysis unexpectedly suggest that the well-known New England storms, particularly northeasterlies, which have high winds in almost all directions (Figure 5), had less influence on a Nantucketer's choice of a habitation site than did the consistent northwest winter wind. This phenomenon still obtains (B. Andrews, personal communication 1983).

Comparison with Other New England Areas

Other areas in eastern Massachusetts with prevailing northwest winter winds (Williams 1963:107; Visher 1954:157) have produced site aspect distributions with a southeasterly bias. Fairbanks (1980) reported the aspects of a set of 54 eastern Massachusetts sites (Figure 6b), and Smith (1944) examined 79 sites along the Concord River (Figure 6c). The high average winter wind speed and small variations in topography at Nantucket can account for the greater focusing of the SE bias at Nantucket (Figure 6a) than at the inland sites. Results of a study in central Massachusetts which did not reveal asymmetry in site aspect distribution (D.F. Dincauze, personal communication 1983) may reflect wind conditions specific to that geographic region or inland settlement patterns. Braun's small shell deposits on the northern shores of some Boston Harbor islands (Braun 1972) could have been summer sites by my model.

The shellfish habitat of coastal Maine, which on the whole lies SE of the coast, provides an interesting contrast to Nantucket (and to the north shore of Long Island, New York). As at Nantucket, the aspects of the Maine sites are predominantly southerly (SW, S, SE, E) (Barber 1979:198; Kellogg 1982:62). Possible reasons given for southerly aspects include: protection from northwest winter winds and summer insects, the predominance of shellfish beds and landing places on the south of promontories, and solar radiation (Barber 1979; Kellogg 1982). Here, protection from the prevailing northwest winter winds (Visher 1954: 157) and access to salt water often coincide and suggest an ideal year-round site location (Kellogg 1982). At Nantucket, since shellfish habitat occurs predominantly on the north of

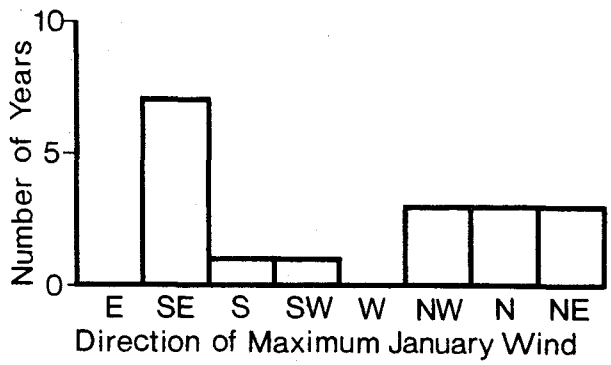

Figure 5. The frequency distribution of wind direction of the January winds with maximum speeds (53-114 km per hour) for the years 1887-1904 (Nantucket Weather Bureau Records 1886-1969).

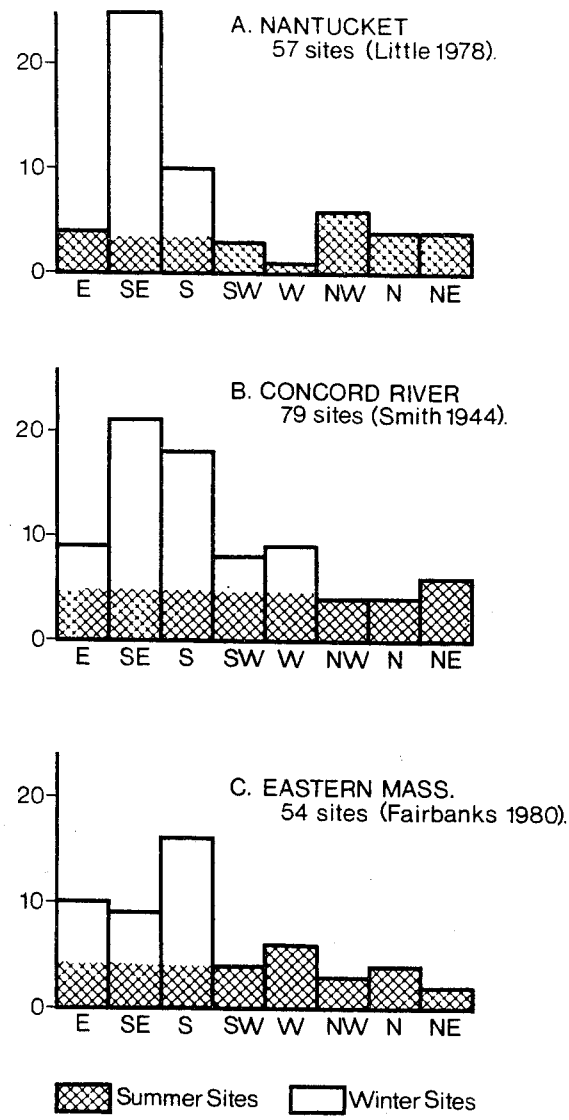

Figure 6. Histograms showing the frequency distribution of site aspects (number of aspects per 45°): A, for Nantucket (Figure 4); B, for Concord River valley (omitting 17 small sites on hilltops); and C, for some eastern Massachusetts sites; all of which show a southeasterly bias. Illustrated graphically are the hypotheses that the aspects of winter sites are confined to E, SE, S, and possibly SW or W directions, and that the aspects of summer sites are roughly equally distributed in all directions. The summer sites with southerly aspects may also be winter sites (see text).

the island, and shell middens predominantly on southeast-facing hillsides, we can separate the influences of winter wind and access to shellfish habitat on the location of shell middens. Not only were the northwest winds an important factor in site location (Kellogg 1982:93), but all winter sites at Nantucket may have required protection from northwest winds, even if this meant forgoing convenient access to the harbor.

The local geography differs and the direction of the prevailing winter wind varies throughout the Northeast (Visher 1954:157). These variations provide opportunities to test the relative effects of solar radiation, prevailing seasonal wind direction, and other influences on sites. Changes in the prevailing winter wind direction through time might also have left a record in site locations.

SEASONALITY TESTS

A determination by one or more independent methods of the season of collection or death for food remains from shell middens could readily test Hypotheses A and B and their implications.

Although botanical or faunal species in middens can give broad seasonal evidence, their presence or absence does not exclude any seasons. Therefore, Waters's data on faunal species for six Martha's Vineyard sites (five with SW, S, or SE aspects, and one with a NW aspect) do not test my model of the relation of site aspect to season (Ritchie 1969). Positive and increasingly precise evidence for the season of death of midden contents can be obtained from studies of the annual seasonal growth stage found in the shells of shellfish or snails, in the vertebrae, scales, and otoliths of fish, in the teeth of deer or seal, and in deer antlers (Barber 1982; Perlman 1973; Hancock 1982; Bourque et al. 1978; Bourque and Cox 1981; Monks 1981). Oxygen isotope analysis of growth rings in shells also shows promise as a seasonal indicator (Shackleton 1973; Killingley 1981, 1983; Bailey et al. 1983).

SUMMARY

On the basis of site and weather data at Nantucket, I have developed hypotheses that relate shell midden site aspects to summer or winter prevailing wind regimes, and identify seasonality tests that can disprove these hypotheses. I shall welcome any such tests of this model. Confirmation of the apparent connection between site aspect and season of occupancy of sites would provide a framework for further studies of prehistoric seasonal occupations, as well as provide a weather indicator at sites lacking faunal or floral remains. A firm connection between site aspect and season would provide a most interesting example of the influence of a weather pattern (prevailing winter winds) on prehistoric man.

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