ON EXPLAINING CHANGES IN PREHISTORIC COASTAL ECONOMIES: THE VIEW FROM CASCO BAY

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The importance of coastal economies in prehistory has been recognized for a much longer period in the Old World than the New. Long-term research projects dealing with the origin and development of maritime economies are currently being undertaken in areas such as northwest Europe, South Africa, and the circum-Mediterranean region. In part, this interest may be due to the somewhat greater antiquity of maritime adapatations in the Old World, although our knowledge of this antiquity is relatively recent, and intensive use of marine resources apparently did not occur until late Pleistocene or early Holocene times. More likely, the difference in interest derives from the Old World perception of coastal life-ways as forming a distinct stage or period in prehistory. While this is not universally true -- e.g., in Australasia, Oceania, or the North Pacific Rim, where maritime adaptations were an important part of *late* Holocene prehistory -- in western Eurasia the use of marine resources has been considered a "definiens" of the Mesolithic period, a generalized epipalaeolithic hunting-and-gathering phase preceding the development of agriculture and animal husbandry. In North America, however -- perhaps because of the longer period between the end of big game hunting and the development of agriculture and ceramics -- coastal life-ways tend to be viewed less as a "stage" phenomenon than as local variants of regional hunting-and-gathering sequences. For this reason, it has become somewhat of a struggle to identify common elements in the increasing use of marine resources in North America during mid-Holocene times, e.g., on both the Northeast and Northwest Coasts.

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This is not to say that North American archaeologists have been totally uninterested in the problem of maritime adaptations; coastal sites have been a focus of interest since the late nineteenth century (Trigger *in press*). However, in its earliest phases, American coastal archaeology was primarily involved in refining local culture-historical sequences, because the preservation of certain classes of artifacts (bone tools and even ceramics) was greater in midden sites, and simply because such sites were more visible and often contained potentially larger archaeological samples (perhaps at least partially a result of greater population sizes and annual length of occupation at coastal sites). In certain areas, such as in California, an interest grew in the remains of the marine resources themselves, and what they could tell us about prehistoric coastal economies; however, this quickly degenerated into a largely methodological exercise, as researchers (e.g., the "Berkeley school") literally played in their backyards with various new approaches to midden excavation and analysis. Much of the theoretical concerns involved local questions of prehistoric time depth, population size, and so on; although a few investigators asked more basic questions concerning the nature of subsistence and settlement patterns in coastal environments, most of the concern with ecological and demographic variables involved either methodological experimentation or solving local questions of environmental adjustment. The degree to which these variables played a part in the *origins* of maritime economies was not even considered.

Similarly, in spite of ethnographic accounts suggesting considerable social complexity among some coastal hunter-gatherers -- particularly on the Northwest Coast -- archaeologists did not develop a vision that such social complexity was widespread among prehistoric coastal societies. This may be at least partly attributable to: (1) a perceived homogeneity of middens dating within the last few thousand years, which obscures understanding of population growth and evolutionary change; and (2) the low ratio of artifacts to food remains, resulting in an impression of low cultural complexity. Perhaps for this reason, reevaluation of cultural complexity among coastal hunter-gatherers in California and (more recently) the Northeast has predominantly come from mortuary rather than from habitation contexts. (Although the same site characteristics are also found on the Northwest Coast, it has always been assumed that those sites were part of a sequence leading to the development of the complex coastal societies of historic times.)

There is much reason to suspect that this picture is changing; there has recently been a significant increase in attention given to maritime adaptations in North America. From a theoretical viewpoint, this may be the result of increasing recognition that intensified use of marine resources in North America may be part of a broader-scale evolutionary picture and not simply the result of the playing out of local ecological adjustments. In addition, from the viewpoint of cultural resource management, coastal sites are receiving significant attention as a set of resources threatened with extinction by natural erosion and coastal zone development.

As a result of this increased attention, traditional assumptions about the population levels, stability, and complexity of maritime hunter-gatherers are being increasingly scrutinized with the use of archaeological data. In addition, environmental and demographic factors are being examined to increase our understanding of both the origins and development of coastal economies. As far as the former is concerned, recent debate among scholars has focused on the relative roles of environment change, population growth, and simply site loss resulting from coastal erosion in explaining the timing of initial use of marine resources in various parts of North America (cf. Yesner 1980a; Perlman *in press*).

Nowhere has the historical disparity between researchers been more apparent, however, than in attempts to explain *changes* in prehistoric coastal economies. The number of factors suggested for the development, as opposed to simply the origin, of maritime adaptions has been over-whelming, even *within* individual geographical regions. For example, in coastal California, changes in the use of shellfish species have been variously attributed to natural changes in species abundance (Nelson 1909; Greengo 1951), species "preferences" (Gould 1956; Warren and Pavesic 1963), or pressure on available resources resulting in over-exploitation (Gifford 1916; Botkin 1980), whether or not induced by human population growth. Rarely have there been systematic attempts to integrate these various types of explanations into a holistic, multivariate theory of maritime adaptation based on human responses to recognized geological and biotic features of maritime zones (Yesner 1980a). Such an approach would involve simultaneous analysis of changes in environment, technology, and settlement pattern within individual geographical regions.

In addition, when examining coastal adaptations, it is insufficient to analyze environmental change simply at the level of broad-scale changes in temperature as reflected in regional pollen diagrams, or broad-scale changes in sea-level reflected in regional sea-level curves. The abundance and distribution of the coastal biota on which humans depend for food -- sea-mammals, birds, fish, and invertebrates (particularly shellfish) -- respond to a wide variety of factors, including water temperature and salinity, location and extent of nutrient upwelling, and (in the case of invertebrates) availability of appropriate substrate for growth and reproduction. These are factors which are likely to vary substantially even within any given geographical region, since they are affected by local geomorphological configurations. For example, appropriate substrate for shellfish growth is dependent upon intertidal sedimentation which can only be understood in terms of local sediment sources and wave energy, the latter dependent on such factors as submarine topography and shore wave refraction. Similarly, salinity changes that occur under conditions of rising sea-level as a part of the process of estuarine formation and drowning, can only be understood in terms of local subsurface stratigraphy and geomorphology of river basins emptying on the coast. Before the response of humans -- as reflected in archaeological data -- to *broad-scale* changes in environment can be understood, the impact of such localized geomorphological factors must be assessed.

An illustration of this point is a debate that took place between scholars in the pages of *American Antiquity* in the early 1970s, relative to prehistoric cultural ecology of northern New England. Snow (1972), citing in particular data previously obtained by Loomis and Young (1912) from archaeological sites in Casco Bay, southwestern Maine, described changes in shellfish types in these sites over time, attributing them primarily to technological development and changes in species preferences on the part of the prehistoric inhabitants during late Holocene times. Braun (1974), on the basis of archaeological data from the Boston Harbor islands, concluded instead that shifts from species such as oysters (*Crassostrea virginica*), quahogs (*Mercenaria mercenaria*), and bay scallops (*Pecten irridians*) to soft-shell clams (*Mya arenaria*) ca. 3000-2000 yr. B.P. -- roughly corresponding to the transition between the "Archaic" and "Woodland" or "Ceramic" periods -- was the result of a downturn of ocean temperatures in the Gulf of Maine. Sanger (1975) has similarly attributed prehistoric shifts in fish exploitation from swordfish to various modern species to cooling ocean temperatures after the late Archaic period. Both Braun (1974) and Sanger (1975) have interpreted the cooling of ocean temperatures as the result of broad-scale climatic deterioration following the xerothermic maximum of ca. 5000 yr. B.P. as recorded in several regional pollen cores. Compounding this was the southward deflection of the cold labrador Current into the Gulf of Maine after ca. 2000 yr. B.P. (Fillon 1976; Andrews 1972; Yesner 1979, 1980b).

Again, more than simply broad-scale temperature change is involved in understanding changes in utilization of shellfish or other marine species in northern New England. Species such as oysters not only require relatively warm but also brackish-water conditions, and prefer clayey as opposed to sandy substrates. Therefore, understanding changes in the presence or absence of such species in coastal sites must also involve the analysis of changes in salinity and sedimentation which occur particularly under conditions of estuary formation associated with rising sea-level. This in turn requires reconstruction of changes in paleotopography and sedimentation in the coastal zone itself, as well as the geometry, gradient, and sediment load of streams emptying into particular sections of the coastal plain (cf. Matson 1976 for a similar analysis of the effects of local geomorphological change at the Northwest Coast Glenrose Cannery site).

Beginning in 1980, the University of Southern Maine has been undertaking a major effort to assess the magnitude of local geomorphological impacts on prehistoric subsistence and settlement change in coastal ecosystems, using the Casco Bay region of southwestern Maine as a model. The goal of this effort is to develop a model of *variability* in human adaptation to marine ecosystems, which can then be applied to understanding the effects of broader-scale processes of population growth and environmental change. In order to develop such a model, archaeological sites are examined for controlled comparison, primarily on the basis of whether or not they show changes in shellfish types in the manner described by Snow (1972). Appropriate analysis involves: (1) paleogeomorphological reconstruction of the site environs; and (2) archaeological analyses of changes in human adaptive patterns, focused primarily on faunal remains.

Casco Bay (Figure 1) is the first major invagination of the coastline of the Gulf of Maine, north of Boston Harbor (ca. 43°N. Lat., 70°W. Long.). It contains the so-called "Calendar Islands," supposedly 365 in number, but actually closer to 220 if one discounts unvegetated rocks and shoals. The bay is characterized by very high primary productivity, primarily as a result of strong upwelling patterns (Hurlburt 1970; Hurlburt and Corwin 1970). The upwelling is particularly pronounced in the passes between the islands, where water temperatures of ca. 13°C continue to occur during mid-summer, as cooler offshore waters are transported upward through the water column (Hurlburt 1968). Sediment influx from the Harraseeket, Royal/Cousins, Presumpscot, and Fore Rivers undoubtedly also contributes to the nutrient load (cf. Sutcliffe 1972). One consequence of this high primary production is a high secondary production of various species of fish and shellfish, which in turn support large numbers of seals in the bay (Little 1976; Hurlburt and Corwin 1970).

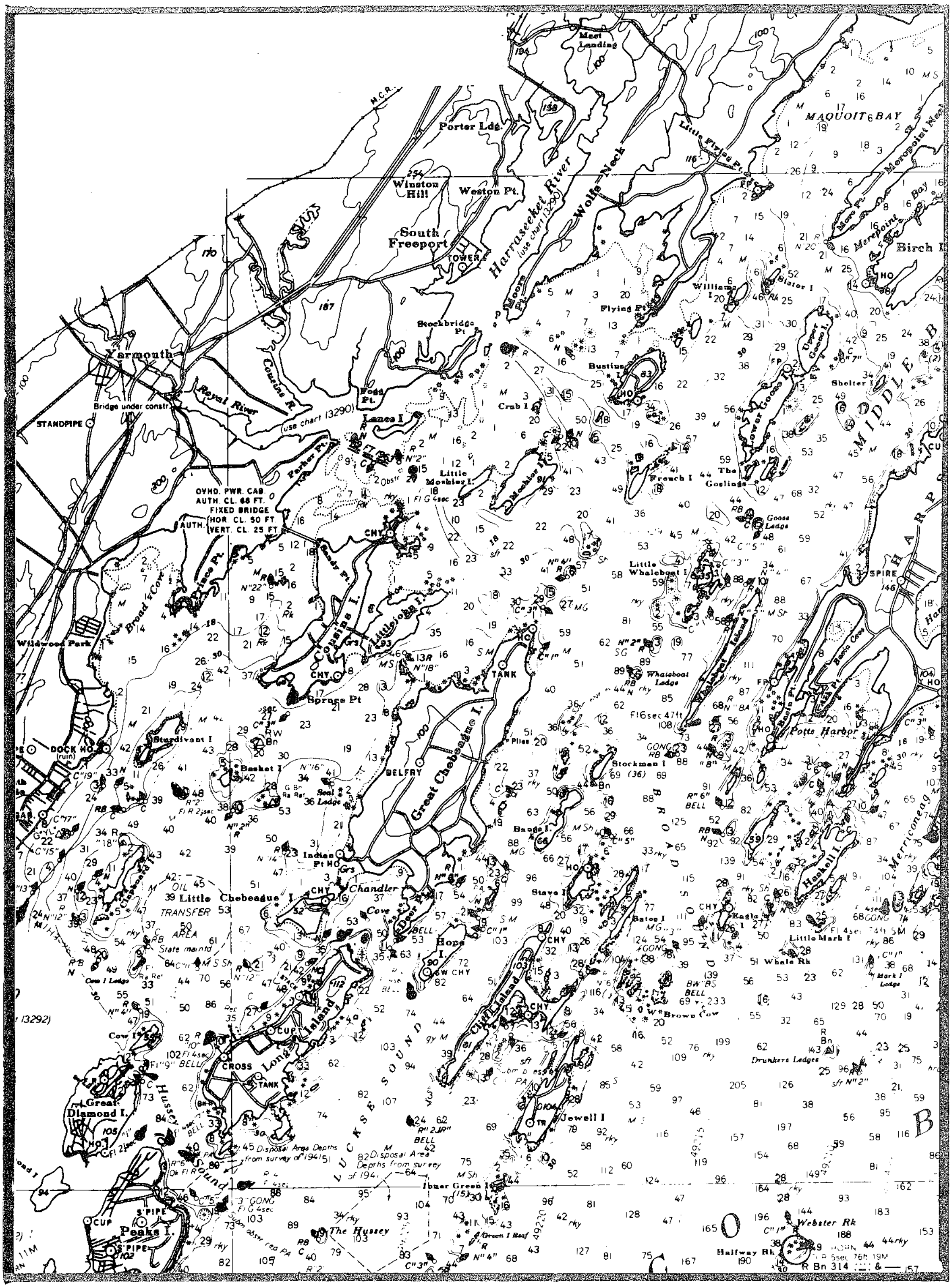

Figure 1. Casco Bay, Maine, and the submarine topography of the area adjacent to Moshier Island.

Sediment sources within Casco Bay, then, derive primarily from two sources: from riverborne sediment load, as described above; and from the reworking of glacial or glaciomarine drift in the coastal zone by (1) wave erosion of unconsolidated aeolian deposits in the marine fringe and (2) wave and tidal landward transport of submerged sediments. With Holocene sea-level rise, substrates available for shellfish growth would have changed as changes occurred in coastal topography (affecting wave refraction) and local river gradionts (affecting riverborne sediment load).

Although early Holocene sea-level rise was very rapid in northeastern North America, and has continued to be rapid in much of the Northeast, several data sources suggest that late Holocene sea-level rise has not exceeded the eustatic rate in the region of southwestern Maine and coastal New Hampshire: modern tidal data (Hicks 1972); comparisons of changing positions of benchmarks relative to sea-level (Tyler *et al.* 1979); basal peat dates from salt marshes (Keene 1971; Nelson and Fink 1978); buried shells in recent sediments (Fink 1977); and drowned intertidal tree stumps (Hussey 1959).

Taken together, these data suggest that a relative still-stand of sea-level may have occurred in Casco Bay after ca. 3000 B.P. One result of this may have been the cutting of rock platforms through wave-base planation of the dipping bedrock primarily on the eastern shores of the islands. With an increase in sedimentation (as the rate of sea-level rise slowed), and possibly an increase in productivity of the Gulf of Maine after ca. 5000 B.P. (Sanger 1975), both the substrate and food base became available for clam flats to form. This may help to explain why the Gulf was unexploited by human populations prior to ca. 5000 B.P., and why shellfish did not become a major item of interest for at least an additional thousand years. In a sense, this argument is analogous to Fladmark's (1975) model relating geological stabilization of the Northwest Coast to the florescence of late Holocene shellmound sites.[1]

In Casco Bay, dating of basal oyster layers in two sites in Casco Bay (White and Moshier Islands) suggests that these layers were deposited between ca. 4000-3000 B.P. (Yesner 1980a). Most of the Casco Bay middens, which are composed nearly entirely of soft-shell clams (*Mya arenaria*), date later than 2000 B.P. Similarly, Braun (1974) found that basal oyster shell layers in Boston Harbor islands middens dated to ca. 3000 B.P. These data suggest the following scenario: with slowing sea-level rise, after 4000 B.P., rock platforms were cut, sediment was deposited, and shellfish became a potential element in the human diet. At this time, water temperatures were sufficiently warm to encourage the growth of oysters, quahogs (*Mercenaria mercenaria*) and bay scallops where salinity conditions and substrate permitted, i.e., in the estuaries at the margins of the bay. After 2000 B.P., when the Labrador Current was deflected into the Gulf of Maine, cooler ocean temperatures prevailed, and these species were replaced by the now ubiquitous soft-shell clams.

However, this process was by no means uniform within Casco Bay. In particular, sites showing large concentrations of oysters in basal levels overlain by soft-shell clams tend to be found on islands ringing the shoreline, particularly near areas where streams open on to the coast. During the summer of 1980, one such site -- on southwestern Moshier Island -- was selected for detailed examination.

Maps of submarine topography in the area of the bay adjacent to Moshier Island (Figure 1) show the presence of a submarine channel very close to, and terminating near, the site area. It appears that this channel may represent the previous seaward extension of the Royal/Cousins River system. Today, there is only a metre of water covering the area to the west of the island at low tide (Figure 1), whereas deep, open ocean is exposed to the east. If sea-level were ca. 1 m lower at 3000 B.P., consistent with the slow rate of sea-level rise in Casco Bay described above, there may well have been a river mouth close to the position of the site. This would have provided a source of brackish water to support the oyster populations exploited by the local inhabitants.

In order to substantiate this hypothesis, of course, it is necessary to determine the nature and depth of the local sedimentary environment during late Holocene time, i.e., to determine whether riverine sediments are overlain by marine sediments and at what time period. To this end, during the 1981 field season a series of sediment cores were taken in coves directly off Moshier Island, as well as in the large, shallow embayment that separates the island from the modern coast. Hopefully, analysis of these cores will allow us to delimit the courses and depths of ancestral river valley systems as well as to delineate the patterns of Holocene sediment erosion and accretion. In addition, core samples will eventually be examined for marine, brackish, and fresh water diatoms, as the most sensitive index for salinity changes accompanying local coastal evolution.

These shifts in shellfish exploitation accompanied changes in the technological inventory of the prehistoric occupants of Casco Bay. Data from survey and test excavation in Casco Bay suggest that the first intensive use of this coastal and insular zone was made by

Late Archaic peoples bearing a "small stemmed point" culture (cf. Tuck 1978), which Snow (1980) has recently termed the "Mast Forest Archaic." As on the island of Martha's Vineyard (Richie 1969) -- and elsewhere in southern New England (Dincauze 1975) -- this occupation includes a mixed assemblage which is characterized by small stemmed projectile points, eared points, plummets, whetstone fragments, and red ochre deposits. Although the Moorehead Phase (Maritime Archaic) culture is well represented immediately to the north and east of Casco Bay, the area evidently represents a boundary zone for this cultural tradition. While both Middle and late Archaic manifestations are highly visible in the Sebago Lake region to the north, the suddenness of the apparently widespread appearance of this culture -- dated at ca. 3850 B.P. at the Great Diamond Island site -- suggests the possibility of an immigration from the south, and lessens the likelihood that earlier coastal occupations existed but have simply been erased by rising sea-level. Evidence of a 3 x 3 m ovoid semi-subterranean house with a central hearth resting on bedrock was found in association with this occupation at Moshier Island during 1981. Also clearly in evidence is the Terminal Archaic "Susquehanna" tradition, reflected at Moshier Island by an apparent cremation burial associated with a basal fill of black soil and a cluster of broken broadpoints; this was located adjacent to a large pit with a floor containing beach gravel and red ochre, as well as several postmolds. This feature yielded a date of ca. 3400 B.P.; however, as at Martha's Vineyard (Ritchie 1969), this feature cannot be stratigraphically separated from the small stemmed point features, and is clearly associated with the same basal oyster-quahog shell stratum. Thus, whether or not the Susquehanna culture represents an additional intrusive migration from the south, little difference in coastal ecological adaptation is suggested.

Paradoxically, while later Woodland (Ceramic) cultures of coastal Maine are universally thought to be derivative from the Susquehanna tradition -- a notion which the data from Casco Bay would tend to support -- this transition appears to have been marked by substantial ecological change. Unlike elsewhere on the Maine coast, the Early Woodland period is well represented in Casco Bay by substantial amount of "Vinette I" (thick, grit-tempered, exterior/interior cordmarked) pottery, dated at Great Diamond Island to ca. 2300 B.P. At this time, an initial shift was made to the exploitation of soft-shelled clams -- at first very small in size -- as well as substantial numbers of mussels deposited in thin but extensive bands, and some sea-urchin remains. Following this, an intensive concentration on soft-shell clams is marked by extensive deposits of very large specimens, which gradually decrease in size through the Woodland period. The most parsimonious interpretation of the evidence would suggest the evolution of an estuary, with sea-level rise initially removing the warm, brackish-water conditions that formerly supported an oyster/quahog/bay scallop assemblage; this was followed by a more rocky intertidal zone, supporting mussel, sea-urchins, and small soft-shell clams; and finally a soft-shell clam economy became prevalent in Middle to Late Woodland times. These events occurred within a backdrop of cooling oceanic temperatures, that may be reflected in the shift from Terminal Archaic to Early Woodland coastal exploitation patterns.

In order to test this hypothesis archaeologically, it becomes necessary to analyze categories of faunal remains other than shellfish alone. In this regard, interesting corroborative information comes from analyses of fish remains at the Moshier Island site (Hedden n.d.). This information suggests that originally the populations concentrated on species such as sturgeon, which were trapped at river mouths; later there appears to have been a shift toward exploitation of cod and other deep water fish. In sum, both the fish and shellfish remains primarily suggest human adaptation to the evolution of a local estuary, followed by the drowning of that estuary by continued sea-levels rise, within the context of broader-scale paleotemperature change. Seal hunting continued to be important throughout this period, as indicated both by faunal remains and by bone tool inventories (i.e., multi-barbed harpoons).

What of the remains of the terrestrial species also found in these sites? Several researchers have recently argued that, in fact, most coastal hunter-gatherers are highly dependent upon terrestrial food resources. Even on offshore islands, those closer to the coast (which also tend to show the greatest changes in marine food utilization) would be likely to show greater use of terrestrial resources. It must be realized that the degree of sensitivity of these species to environmental change differs radically from the marine species, and reflects primarily broad-scale temperature patterns -- of the type likely to be reflected in regional pollen curves -- rather than local geomorphological change. In a sense, contrasting changes in the frequencies of marine and terrestrial species helps to calibrate the relative strength of the two different underlying processes of species change.

Casco Bay is particularly fortunately situated for such studies. It is "ecotonal" in character, lying at the western boundary for coastal spruce forest (Westveld *et al.* 1956; Davis 1966). Spruce dominates the vegetative assemblages on islands of the eastern part of the bay, while deciduous forest dominates islands of the western part of the bay. The region forms a "tension zone" for boreal and deciduous species, with implications for shifts in prehistoric faunal ranges. In this regard, the increased percentages of moose (relative to white-tailed deer) in late Woodland layers of Casco Bay sites seem to reflect a trend toward "borealization": the southward movement of spruce forest indicated by regional pollen diagrams (e.g., Bostwick 1978). However, terrestrial snail remains studied from the Great Diamond Island site (Barber n.d.) suggest that deciduous forest dominated the islands from the time of their earliest occupation until relatively recently.

To this point we have considered exogenous environmental change as the primary factor underlying observed changes in species frequencies in these sites. To what degree might changes in the utilization of both marine and terrestrial foods also be attributed to local growth of human populations and consequent pressures on resources? Decreasing size of soft-shell clams throught the Woodland period in Casco Bay sites -- a pattern similar to that in California middens described by Tartaglia (1976) and Botkin (1980) -- seems to indicate continued pressure on these resources. Whether this constitutes overexploitation of the resources, however, is difficult to judge, since shifts in a group's settlement pattern may well have allowed for periodic exploitation of alternate coastal and insular locales, temporarily abandoning sites for periods of time and thereby allowing the resources to regenerate. This phenomenon would be nearly impossible to detect archaeologically (Bailey 1981; Perlman 1982). For this reason, I would suggest that we turn to other sources of information to determine whether the observed economic changes may have been the result of local population growth and pressure on resources. Following Cohen (1975), one test for the latter might be based solely on whether increased utilization of more marginal environments was occurring over time. Island environments are particularly suited for such a study, since it is possible to determine through accurate dating of sites whether or not more intensive use is made over time of smaller islands, those further from the coast, those that contain fewer microhabitats for fishing or shellfish collecting, and those that are further from locations of bird colonies or sea-mammal rookeries. To date, our data suggest that, like the Boston Harbor islands to the south (Luedtke 1980), more intensive use was made over time of marginal habitats on the Casco Bay islands, possibly reflecting regional population growth, at least through Middle Woodland times.

CONCLUSION

In sum, in order properly to understand the meaning of species changes in coastal archaeological sites, one must be able to exercise control over the following:

1. The impact of local changes in coastal geomorphology on marine biota. In terms of shellfish, this involves changes in salinities and available substrate for implantation and growth. In terms of fish, this involves changes in local productivities as well as the position and geometry of river systems emptying on the coast.

2. The impact of broader-scale temperature changes as reflected in regional pollen diagrams. The degree of sensitivity of local human populations to this factor relative to smaller-scale changes in coastal evolution can be ascertained partly through studying remains of terrestrial species in coastal sites.

3. The impact of human population growth and pressure on available resources. This requires not only intensive study of faunal remains from coastal sites, but also independent sources of information from site locations and distributions.

This methodology would apply equally to the Northeast and Northwest Coasts of North America (although to the south of Casco Bay, the advent of horticulture in late prehistoric times becomes a complicating factor). Clearly, both Northeast and Northwest Coasts demonstrate a general phenomenon of coastal stabilization leading to increased importance of anadramous fish and shellfish resources, although in both cases the nature of the shift was complicated by local geomorphological factors and, in the case of northern New England, by oceanic temperature change as well. Nevertheless, the Northeast coast does appear to show the same basic long-term trend of population growth that characterizes the Northwest Coast (cf. Barber 1980). Unfortunately, we still know little about the nature of aboriginal socio-political systems of the Northeast Coast that were supported by what was apparently a rich coastal hunting and gathering lifestyle. However, once we begin to perceive the fact that many of the same broad-scale patterns apply to the prehistory of both the Northeast and Northwest Coasts, it should become easier to isolate the extent to which specific parallels -- either archaeological *or* ethnographic -- might be applied to either region.

FOOTNOTE

1. Fladmark's data also suggest that geological stabilization of the Northwest Coast led to establishment of the modern anadromous fish runs, contributing to population growth and the rise of the ranked societies of the ethnographic present. Similarly, on the Northeast Coast, stabilization of the coastline in mid-Holocene times may have resulted in the development of effective anadromous fish runs, exploited inland primarily during the late summer and fall, as well as coastal shellfish beds, exploited primarily during the winter, spring, and early summer months (Bourque 1973; Sanger 1979g; Yesner 1980b).