The Boston Back Bay Fish Weirs

Elena B. Décima and Dena F. Dincauze

The discovery of prehistoric aquatic features has been mostly an oddity in the archaeological record of New England. The discovery of fish weirs, understood as wooden or stone fences, enclosures, or barriers set in water for taking fish, is no exception.

The Boylston Street fish weirs of Boston, Massachusetts, have been well known among New England archaeologists since the publication of Frederick Johnson's excavation results in 1942 (Johnson 1942; see also Johnson 1949). The area where the weirs were once located is nowadays Back Bay (Figure 1), one of Boston's neighbourhoods; this area, filled during the nineteenth century, was once a large estuarine bay at the mouth of the Charles River.

The first exposure of the weirs' wooden stakes goes back to 1903, when excavators of a subway line under Boylston Street happened upon sharpened stakes. The stakes, clearly not the usual wooden pilings that support most of the old buildings of the area, were recognized as part of "what appears to be a prehistoric fish weir" (Boston Transit Commission 1913:44). Building construction on Boylston Street in 1939, 1957, and 1986, and in the immediate vicinity in 1946 (Figure 2), exposed additional segments of many weirs that once spread over more than 2 ha of the ancient bay.

The fish weirs have been described as a structure "composed of about 65,000 stakes ... distributed over more than two acres ... of mud flats and marsh land" (Johnson 1942:1), as large facilities for the exploitation of estuarine resources, and as large environment-modifying facilities (Dincauze 1985). The archaeological investigations of Johnson's team in the 1940s represent the first scientific examination of the structures, a remarkable study in interdisciplinary research (Johnson 1942). However, their interpretation relied on analogies with twentieth-century coastal weirs, which are built to trap large numbers of fish running in longshore currents of impressive speed and tidal amplitude.

The recent archaeological work of the 1980s supports a simpler picture. This interpretation proposes that the majority of the Back Bay weir

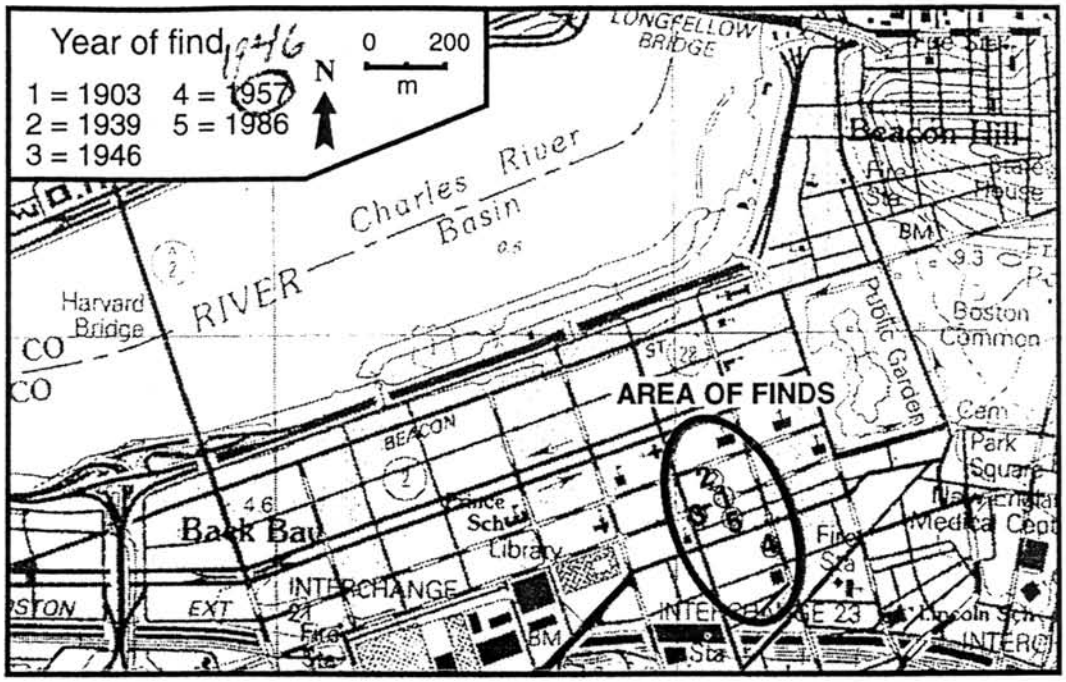

Figure 2. Location of fish weir finds in the Back Bay area of Boston. *USGS South Boston 1987.*

structures were built over a long period of time, as small, short-lived, uncomplicated tidal operations. The stakes and brushwork (horizontal wood) were designed to permit fish to swim over them during high tide; they then acted as barriers when the tide went out, preventing the fish from escaping the resulting enclosure. Baskets, bowls, scoops, and dip nets could have been used easily by women, men, and children to gather the fish almost effortlessly.

The 1986 Project

The construction of two 25-story buildings (covering 100 m x 78 m) in the Back Bay area, across from the old New England Life (NEL) building where Johnson's excavation had taken place (Johnson 1942), gave impetus to the 1986 archaeological project. The project was carried out by Timelines, Inc., with Dincauze as senior archaeologist and Décima as project archaeologist. The goals focused on obtaining a better understanding of the form, size, and function of the features, as well as obtaining possible evidence of human influence on the vegetation and estuarine fauna as an indirect result of the weirs' presence and function. It was expected that the results would augment and clarify the information gathered from the earlier exposures of the weirs.

The fieldwork, unfortunately, was far from ideal. It took place amid huge construction machines during the harsh New England winter. The team of archaeologists managed, nevertheless, to excavate two areas of the site, approximately 70 m apart (a total of approximately 7 m^2), and to register

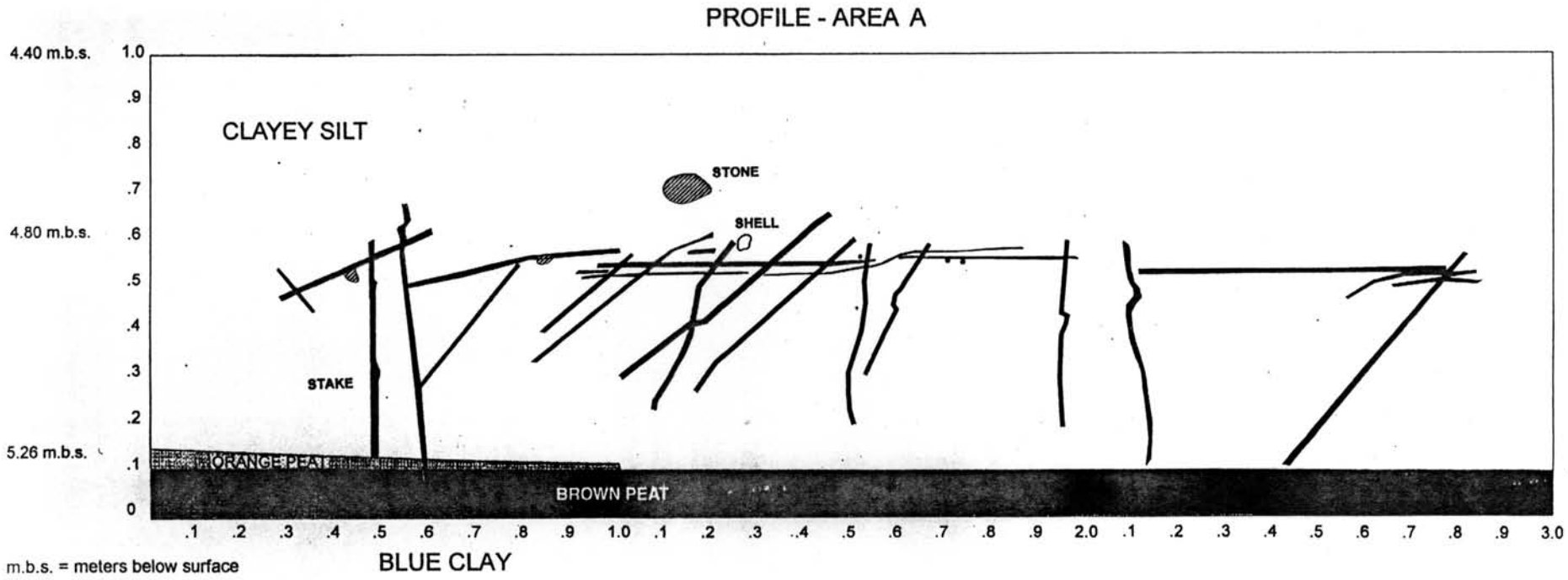

Figure 3. Profile view of Area A, showing stratigraphy and vertical distribution of stakes.

Table 1

Radiocarbon dates from the Boston Back Bay fish weirs

Lab no.	Uncorrected ^{14}C date at 1σ	Sample locus[1]	Material	Depth below BCB[2] in cm	^{13}C corrected date at 1σ
Beta 24955	1790 ± 60	C8, s#54	sediment	-115, -123	1890 ± 60
Beta 24954	2090 ± 60	C8, s#46	sediment	-190	2170 ± 60
Beta 24953	3010 ± 80	C8, s#42	sediment	-225	3090 ± 80
Beta 24952	3470 ± 70	C8, s#36	sediment	-280	3540 ± 70
Beta 24951	3480 ± 110	C8, s#32	sediment	-305, -313	3570 ± 110
Beta 25163	3760 ± 70	SU11	wood, brush	-420	3700 ± 70
Beta 27611	3770 ± 80	SU10	wood, stake	vertical	3710 ± 80
Chicago 418	3851 ± 390	JH	wood	above stakes	—
Beta 27609	3950 ± 100	Area B, EU6	wood, stake	stake in blue clay	3910 ± 100
Wisconsin 1957	3990 ± 70	MU1	wood, stake	-482	3890 ± 70
Beta 27610	4200 ± 140	MU4	wood, stake	-550 (estimated)	4150 ± 140
Wisconsin 1958	4217 ± 70	MU1	wood, stake	-482	4120 ± 70
Geochron 14019W	4260 ± 60	MU1	wood, stake	-482	4175 ± 60
Beta 25161	4270 ± 70	MU9	wood, brush	-528	4260 ± 70
Geochron 14019B	4935 ± 130	MU1	wood, stake	-482	4315 ± 160
Beta 20107	4440 ± 90	MU1	wood, stake	-482	4340 ± 90
Humble Oil 1475	4450 ± 130	IBM	wood, brush	-510	—
Humble Oil 1474	4500 ± 130	IBM	wood, brush	-510	—
Beta 27606	4530 ± 80	Area A, EU5	wood, stake	vertical	4470 ± 80
Beta 25162	4550 ± 70	SU5	wood	-517	4540 ± 70
Beta 24950	4580 ± 80	C8, s#21	sediment	-405, -415	4630 ± 80
Beta 20106	4720 ± 70	MU1	wood, stake	-482	4690 ± 70

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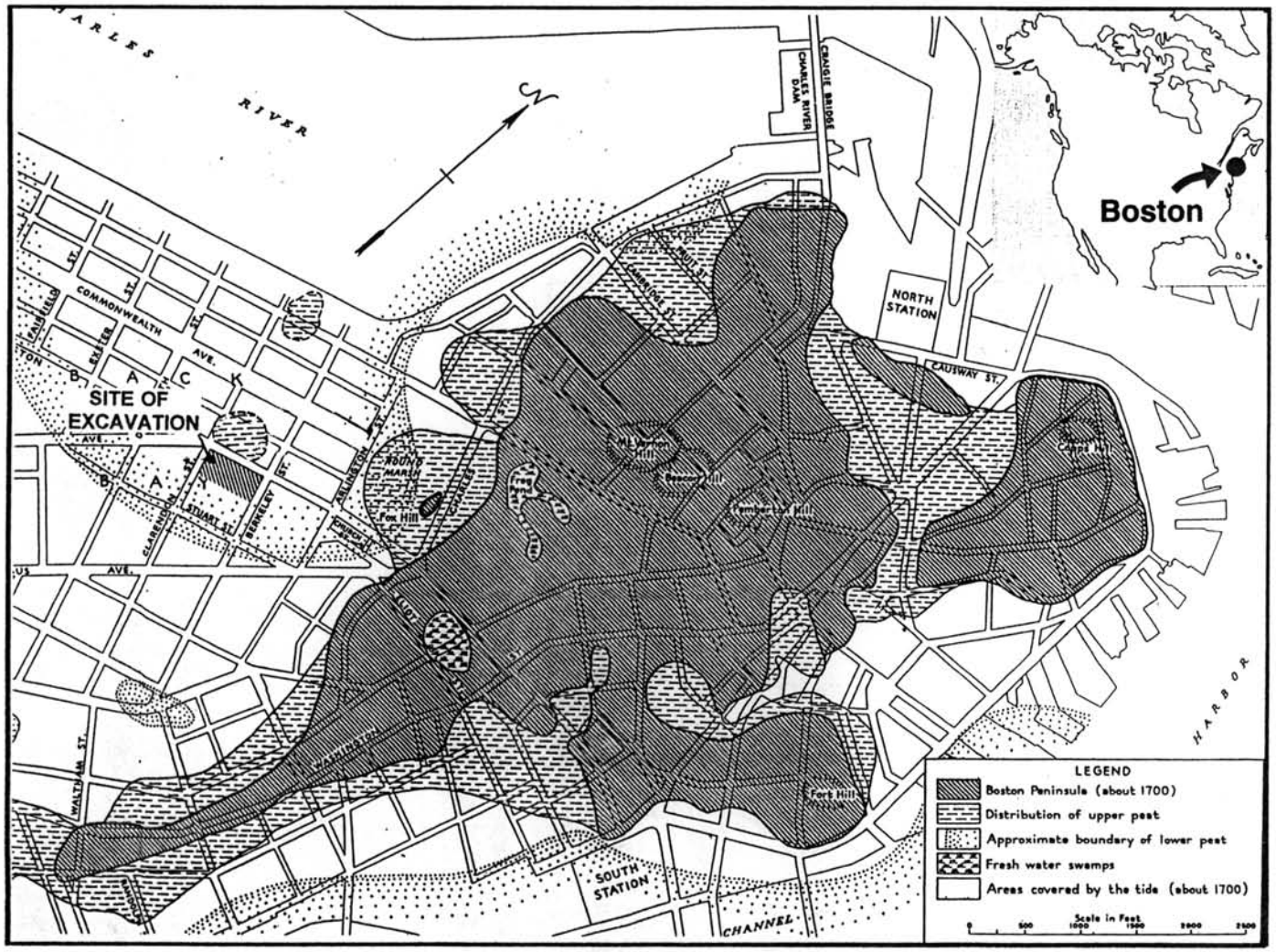


Figure 1. Detail from Johnson's (1942) map of the Boston peninsula in about AD 1700. Location of excavation is at left.

Beta 27607	4840 ± 170	Area A, EU5	wood, brush	horizontal	4750 ± 170
Humble Oil 1902	4860 ± 130	IBM	wood, brush	-510	—
Beta 24987/ETH		C8	sedge achenes	-489	5125 ± 115
Wisconsin 1959	5330 ± 70	SU6	wood	-550	5300 ± 70
Humble Oil 1118	5600 ± 140	IBM	lower peat	-568, -570	—
Beta 24949	5620 ± 90	C8, s#8-11	sediment	-505, -510	5630 ± 90
Chicago 417	5717 ± 500	JH	lower peat	-624	—

[1] Key to loci: C8 = master core, EU = excavation unit, IBM = old IBM site located within the 1986 project area, JH = John Hancock building, MU = monitoring unit, SU = sample unit.

[2] Boston City Base = 3.04 m above United States Coast Guard Service (USCGS) Mean Sea Level.

in the process. Whichever the cutting method, the result was a thinned end, and driving it into the soft clayey silt was likely effortless.

Sassafras (*Sassafras albidum*), hickory (*Carya* sp.), and dogwood (*Cornus florida*) are the three leading species amounting to 62.5 percent of the identified wood. Looking at the order of vertical and oblique stakes, from east to west, we see a tentative pattern to the species distribution, reflecting, perhaps, the stockpiling arrangement: the first four are hickory, the fifth and sixth are white ash (*Fraxinus* sp.), the seventh is sassafras, the next four are dogwood, the twelfth is sassafras, the thirteenth is maple (*Acer* sp.), and the last is birch (*Betula* sp.). Only six stakes are greater than 2.5 cm in diameter, three of these also being the longest. It is possible that these bigger stakes, driven deeper into the mud, supported and anchored the shorter and thinner stakes. The preserved weir remains include two of the bigger vertical stakes anchored in blue clay, approximately 11 m apart, and 18 thinner stakes. However, these represent a small segment of fish weir (the longest continuous segment for which we have information being less than 3 m).

Only one layer of brushwork was detected, within 25 cm of the tops of the stakes (whereas Johnson [1942] reports two layers of brushwork). Most of the brushwork, or horizontal wood, was lying on a plane perpendicular to the stakes, alongside or between stake alignments; it was not woven among them, as the term "wattles" implies. Thirty percent of the brushwork is sassafras. The pieces vary in length from 2 cm to 70 cm, but this is not representative of their original dimensions since many were found broken or broke while being excavated. With diameters of less than 2 cm (with a single exception), the horizontal wood is slightly thinner than the stakes.

Thus, the original structure would have consisted of sparse walls of oblique and vertical stakes with brushwork placed horizontally between them, against the top section of the stakes. Noticeable characteristics, shared by all the weirs we observed, include the small size of constituent branches, an absence of artifacts, and an absence of basketry, netting, cordage, or wattles that could have been part of a trap used in conjunction with weir leads. Radiocarbon analysis for two pieces of wood from this area gives dates of 4470 ± 80 BP and 4750 ± 170 BP (Table 1).

Area B Structures

The second excavation area (Area B) revealed a different picture: more brushwork (330 vs. 90) and fewer stakes (10 vs. 14) than in Area A (Figure 4). The stake distribution suggests a northwest-southeast alignment, with possibly two lines of stakes. The brushwork resembles an intersecting perpendicular lattice oriented northwest-southeast and northeast-southwest. Most of the brushwork is located 15 cm to 27 cm above the blue clay substratum (vs. 60 cm to 70 cm in Area A). The majority of the stakes are very short, ranging in length from 18 cm to 40 cm (whereas the average length throughout the

site is around 50 cm), and all are driven through the underlying blue clay. All but two of the stake tops are broken. Three bottoms are snapped, four are torn and split, and one is slightly crushed. One of the unbroken top ends has been shaped to a point. Beech (*Fagus grandifolia*) and oak (*Quercus* sp.) seem to have been favoured in this area, accounting for 72 percent of the identified wood. One piece of wood from Area B was dated, yielding a date of 3910 ± 100 BP (^{13}C corrected).

This Area B structure has a large proportion of wood fragments that had been cut in the growing season, a characteristic present in "many" of the wood samples of Johnson's excavation (1942:84), about 100 m away, but quite rare in our total sample. These similarities and the proximity of the locations led us to entertain the hypothesis that the feature in Area B may be an end section of one of the weirs previously found in the NEL site.

Chronology

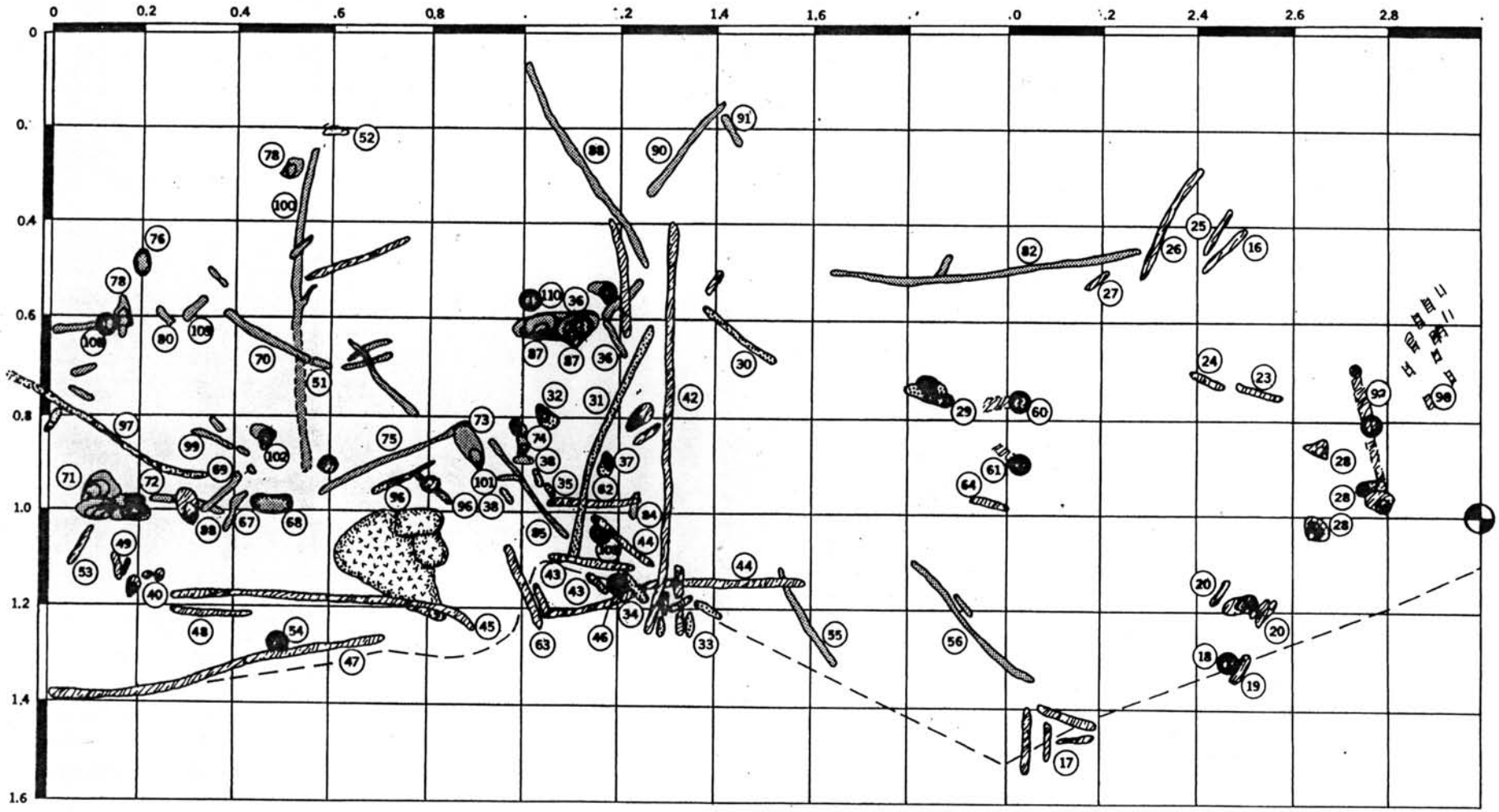
The research undertaken in the 1930s by Johnson's team suggested an age of between 3,700 and 3,400 years for the NEL weirs, based on desiccation of European bogs of the Subboreal period (Johnson 1942:122-123). The depth of the IBM stakes, recovered in 1946 during construction of the IBM building, suggested greater antiquity (Table 1); radiocarbon dating subsequently placed these weir fragments between 4,900 and 4,500 years of age.

Twenty-three ^{14}C dates obtained for the 1986 project definitely show that the archaeological features represent a series of constructions that range over approximately 1,500 years. The oldest dated weir element is about 5,300 years old, the youngest about 3,700 years old. This age range subsumes the IBM stakes, which are from the same area. The NEL features seem to belong to the late weir-building period. The few stakes to the southeast, undated, are estimated by the authors to be older than 5,000 years. The long time span demonstrates without doubt the existence of several fish weirs (rather than a single large one) that were constructed in Back Bay.

Specialized Analyses

Sediment

Analysis of the master sediment core shows that the fish-weir elements (at least those in the vicinity of the core location) are in a zone dominated by clay deposits. The clay source is probably glacial, redeposited on brackish waters quiet enough to support deposition of fine sediments. Tidal amplitude at this time in the inundation of the Gulf of Maine is estimated around 1 m at maximum. The sediment qualities in the weir zone are characteristic of subtidal muds. Three stratigraphic units (lower, middle, and upper) were recognized; at the base of the lower unit, which contains the fish weir structures, the geologists see a change in sediments, which they interpret as a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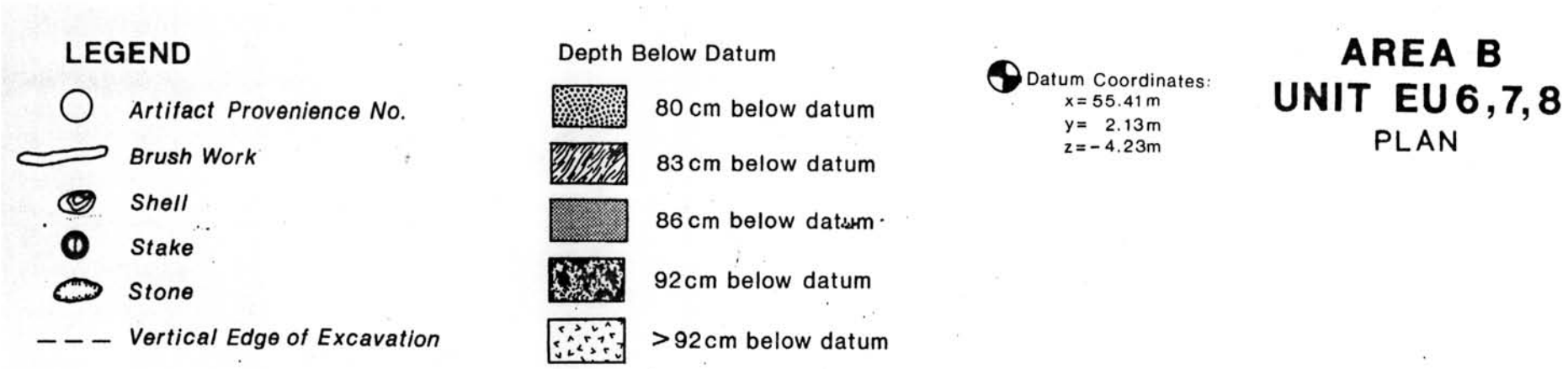

Figure 4. Plan view of Excavation Units 6, 7, and 8 in Area B showing distribution of finds.

transition from intertidal to subtidal environment (Rosen and Maybury 1988). Based on this analysis, they postulate that the fish weirs would have been set just below low-tide level in shallow and relatively quiet waters.

The grain-size chart registers an increase in particle size of sediments from layers dating just before 3500 BP, suggesting dramatic changes in local conditions. The changes, represented by increases in tidal amplitude and energy (reflecting rising sea level and a higher energy tidal system in the entire Gulf of Maine), affected the quiet, shallow water environment.

The younger weir structures of the 1986 excavations (SU10-12) and Johnson's trench across the street may reflect these changes. Both show an increase in the number and proportion of stout stakes and in the density of the wood (Johnson 1942:20-38, and personal observations) – an adaptation, perhaps, to stronger wave action and deeper water.

Pollen

The pollen diagram, which shows a predominance of hardwoods, agrees with other studies of the regional pollen rain at the time (Newby and Webb 1988). The ancient bay was rimmed with salt marshes, freshwater ponds, and swamps supporting alder (*Alnus* sp.) and red maples. Most of the species identified by pollen analysis are represented in the weir wood, white pine (*Pinus strobus*) being the conspicuous exception. The data do not indicate anthropogenic stress on the local vegetation, as might be expected if young wood were harvested in the quantities that have been calculated in earlier estimates (Johnson 1942:1). The pollen analysis (and the wood analysis) indicate a warm temperate climate during weir times, nearly like the present.

Wood

Two hundred and ten samples of wood were analyzed for species, number of growth rings, diameter, season of death (or time of harvest), and growth characteristics (compression and symmetry) at the University of Massachusetts, Boston (Kaplan et al. 1988). The species represented match those identified from pollen analysis, except for the noticeable absence of white pine in the weir structures (white pine was an important part of the forest of the time). In 92 percent of the cases, it was determined that the weir wood was harvested during the dormant season, before the middle of April and after the end of October. These results contrast with Johnson's (1942) findings at the NEL location, where most of the wood was harvested during the growing season.

The species analysis reveals some differences among the stake clusters. In Area A, the weir segment represented in units SU10, SU11, and SU12 has a predominance of beech, whereas the cluster in units SU6 and SU7 has mainly oak and no beech. In Area B, which is contemporary with the SU10-SU12

cluster, beech is the main species. Area A has the only stake cluster with a dominance of sassafras.

When the wood species data are compared to the radiocarbon sequence for the site, changes through time can be discerned. Specifically, sassafras, present in the older Area A structures, seems to have been replaced by beech and alder (*Alnus* sp.) in the younger SU10-SU12 cluster in our site. On the other hand, sassafras is the main species represented at the younger NEL site area.

Fauna

The number of fish bones recovered (113 fragments) constitutes a very small sample. Species include tomcod (*Microgadus tomcod*), flounder (Pleuronectidae), eel (*Anguilla rostrata*), herring (Clupeidae), and possibly sturgeon (*Acipenser* sp.). Most of the fragments (71) were unidentifiable. The predominant species is tomcod.

Today warm, brackish, shallow, estuarine waters in southern New England are home to several species of small fish, among them tomcod and mummichogs (*Fundulus heteroclitus*), or killifish. Tomcod are bottom feeders living in shallow brackish, or even fresh, water, ranging from Nova Scotia to New Jersey. They spawn during the winter in estuaries, where they may be numerous year-round. They can be taken in weirs or by hook and line. In habitat and size, tomcod are compatible with the function of small, inshore tidal weirs. Mummichogs, on the other hand, move inshore with the tide and may be easily caught in tidal pools until freed by the incoming tide. Weirs such as the Back Bay structure could have easily trapped mummichogs and other small inshore feeders. No mummichog bones were identified in our samples, but this could be because of their small size and fragility.

Discussion

Reinvestigation of the Boylston Street fish weir has demonstrated that there were many small weirs, rather than one large one, near the shore of the ancient Back Bay. The weirs spanned approximately one thousand years, during which time sea level was rising against the sloping shores. The ambiguity in functional interpretation following the initial investigations in the 1930s and 1940s appears to be the result of the application of an inappropriate analogue, specifically, large commercial weirs built to trap schools of fish by taking advantage of the energy of marine longshore currents.

The small weirs that we examined were built sequentially along the shores of the former bay, probably not very far from the coast of the time, in the intertidal zone. Our analysis shows changes through time in the characteristics of the saplings and the branches used to build the structures. The thin stakes were driven into the muddy deposits of the bay, sometimes extending into the top of the underlying blue clay. Lines of stakes and brushwork

fences paralleled the shoreline along natural contours on the sloping foreshore. As the sea level rose and the coastal environment changed, the builders used more robust stakes and apparently had to repair or reinforce weir structures, even in the summer. Increased higher tidal energy moved larger quantities of coarser sediments onto the foreshore, which likely buried the structures more frequently than did the fine sediments mobilized previously. Increased sedimentation rendered the weirs less efficient and required more frequent maintenance. The changing environmental conditions eventually rendered the facilities unusable. By 3500 BP, people had abandoned this stretch of coast.

The series of radiocarbon dates now available (Table 1) confirms that the Back Bay weirs existed during the Late Archaic period, when small groups of hunters-gatherers-fishers lived in New England. The absence of culturally diagnostic artifacts, in both the Johnson investigations and our own, precludes associating the builders, maintainers, and users of the many fish weirs with any particular tradition of the Late Archaic period. Chronologically, the weir features begin with the time of the Laurentian tradition and continue through the Small Point and the Susquehanna traditions (Dincauze 1975; Snow 1980). The time span indicated for the Back Bay weirs coincides with the time of construction and use of large freshwater river-current weirs in northeastern North America – at Atherley Narrows, Ontario, and at Sebasticook, Maine (Johnston and Cassavoy 1978; Petersen et al. 1994).

Late Archaic subsistence activities were oriented toward harvesting seasonally abundant resources. Exploitation of a wide range of terrestrial, riverine, estuarine, and maritime resources was characteristic of prehistoric economies in northeastern North America from initial settlement (about 12,000 BP to 10,000 BP). By the beginning of the Late Archaic period, ca. 6000 BP, land-use patterns include the partitioning of resource-collecting and residence areas. Foraging territories were approximately delimited by watersheds, and each group exploited its own particular area (Dincauze 1975). The technology and the workforce available in the Late Archaic period were entirely adequate to the task of constructing simple facilities to trap small fish swimming with the tide, like those indicated by the Back Bay finds.

Reconstruction of the spatial arrangement of the weir structures within Back Bay and understanding in detail how they would have been used await a more precise description of the environment of the area during the fourth and fifth millennia BP. We expect to learn such information from intensive spatial analysis of data within the investigated areas. Basically, we believe that the weirs were built as low fences following the curves of the paleoshores.

The full length of any one structure has not yet been reconstructed. We do, however, know that the coastal tidal weirs from the Late Archaic period are not comparable in size, construction, or method of operation to weirs that use strong currents in rivers or along ocean shores. Their only

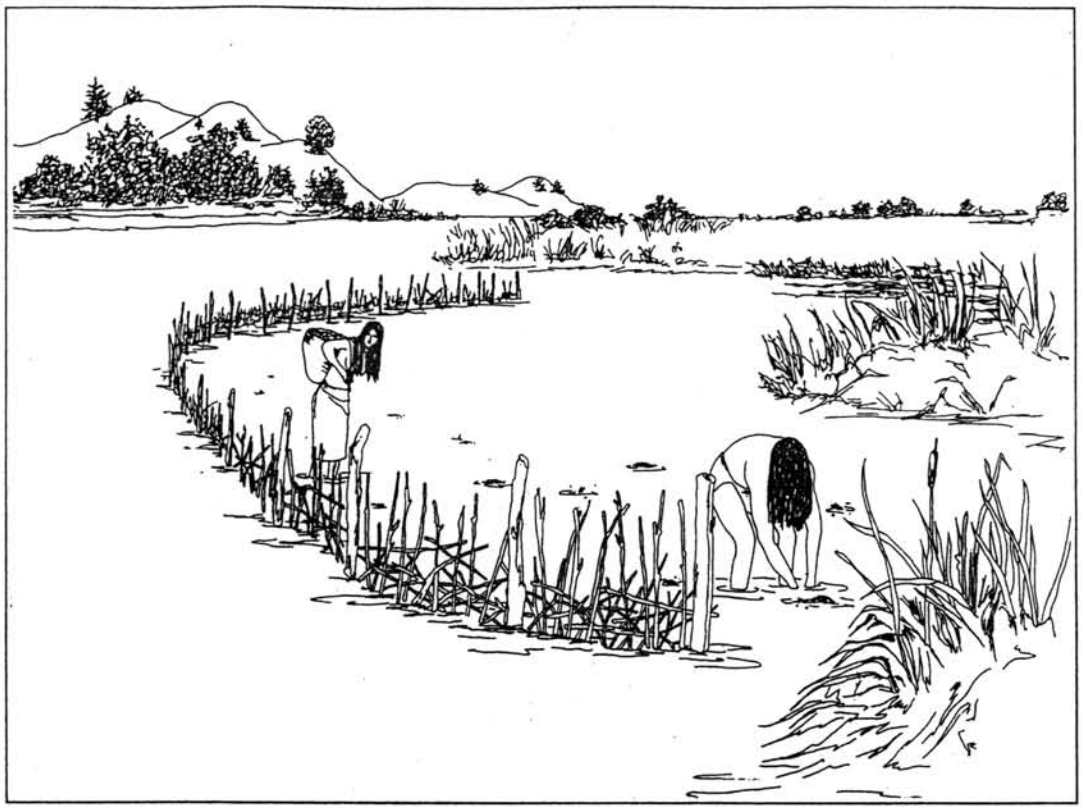

Figure 5. Artist's rendering of Boston fish weir. *Drawing by Elaine Chamberlain.*

similarity is that all types are facilities for catching fish. Understanding the differences is critical to understanding the Back Bay weirs.

At the time the Back Bay weirs were built and used, environmental conditions differed considerably from those of the region today. Sea level was 1 m to 2 m lower, tidal characteristics differed, and the climate was warmer. Low tidal amplitude, low tidal energy, a sloping shore, and warm, brackish water of weir times are probably essential requirements for the fish-catching technology displayed by the Back Bay weirs. The low brush fences constructed with small, widely spaced stakes would not have withstood coastal currents. They would not have been designed to sieve fish out of strongly flowing water. Rather, they would have held fish near the shoreline during ebb tides, retaining them in reach of wading fisherfolk. They may have been inspired by the behaviour of small fish, such as mummichogs, that are trapped naturally in tidal pools at low tide (Bigelow and Schroeder 1953:163).

Conclusion

The Back Bay structures appear to have been small, uncomplicated operations, protruding little if at all above mean sea level, apparently built as spring weather warmed the waters of the bay. Constructed on a sloping foreshore in ways that required a very small workforce, the small weirs had relatively short use lives. They represent a simple, low-cost, dependable system that produced a reliable but undramatic supply of marine proteins (Figure 5).

Shallow, brackish waters of the Back Bay area 4,000 to 5,000 years ago provided a perfect setting for small tidal weirs. As a result of a changing microtopography and increasing sedimentation, the environment disappeared and the weirs were abandoned. This reconstruction, though based on analysis of the structures, is nonetheless speculative. Using modern analogies would potentially lead us further astray. The initial interpretation of the Boylston Street "Fishweir" errs for this reason. It is time to devote attention and innovative critical analyses to prehistoric freshwater weirs, lest we overestimate them in the image of our own technology.

Acknowledgments

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