A CRITICAL LOOK AT PREHISTORIC SETTLEMENT PATTERN DISTRIBUTION IN THE US VIRGIN ISLANDS: 1995

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Résumé
Cette communication revoit les quelques modèles de localisation existant pour expliquer la distribution des sites préhistoriques dans les Isles Vierges et dans les autres îles de l’archipel de la Caraïbe. Ces modèles ont été examinés à la lumière des informations obtenues dans les Isles Vierges. Constatant les limites des bases de données existantes, d’autres axes de recherche ont été explorés. Ils ont abouti à une localisation des sites préhistoriques durant certaines périodes de la préhistoire des Isles Vierges qui se base sur les résultats des dernières recherches, sur la géographie des Isles Vierges, en extrapolant les données ethnographiques.

Abstract
This paper reviews some of the locational models offered to explain observed prehistoric site distributions in the US Virgin Islands and some other islands of the Caribbean Island archipelago. These models are examined in light of the distributional information available for the US Virgin Islands. Recognising the limitations of the data base for the US Virgin Islands, another way of looking at site distribution is explored. Utilising archaeological information from recent investigations in the Virgin Islands and extrapolating from ethnographic accounts, a geographically-based land use model is presented to account for elements of the observed site distribution during certain periods of Virgin Islands prehistory.

In 1985, citing Bradstreet (1975:7-8), Bullen (1962:69-70) and Vescelius among others, Johnston and Lundberg (1985:47) stated: «the commonly held Virgin Islands model of prehistoric site distribution recognised a changing settlement pattern of preceramic shoreline sites, early ceramic (Saladoid series) coastal and inland agricultural villages, and late prehistoric (Elonoid series) dispersed shoreline villages». According to Johnston and Lundberg, the Virgin Islands model of 1985 was developed from «hit or miss» surveys which tended to focus on artifact rich settlement sites from which critical criteria of site selection were established by the archaeologist. These critical criteria were perceived to be access to fresh water, fertile soils, and coastal marine resources. Using a similar approach, Haviser (1991) examined physical geography, natural resources and archaeological remains to identify the development of a prehistoric interaction sphere among the northern Lesser Antillean Islands of St. Martin, Anguilla, Dog Island and St. Bartholomew’s Island. Haviser (1991:135) noted that, in his study area, major early Saladoid settlements, dated to between 300 B.C. and A.D.300, on a number of Caribbean islands were «all situated on elevated terraces, inland from the coast and adjacent to flowing water sources». He contrasted this «distinctive» settlement pattern to a Late Saladoid period pattern of sites located «in coastal settings on lower elevation plains and associated with both seasonal flowing and standing water sources.» Citing Goodwin (1979); Wilson (1989) and Watters (1980), Haviser (1991:138) identified a settlement pattern for Post-Saladoid sites that «consists most often of large villages, regularly spaced along the coastline near major reefs and often associated with standing water sources.»

The component parts of such environmental models of site distribution are: (1) locational information usually based upon the observed present day topographic, geographic and environmental setting of the site; (2) identification of sites and/or site components by cultural type and (3) chronology of occupation of such sites and site components. Sometimes cultural type and chronology of occupation or occupations are based on limited testing, surface collection and comparative ceramic chronology. From these types of information, predictive models for site survey are frequently developed; and statements about criteria for site selection are generated.

This paper will focus on locational data that underlie the distribution model for prehistoric sites in the US Virgin Islands (Figure 1) and on the limitations inherent in utilizing such data to identify critical environmental criteria of site selection. Time permitting, some criteria for site selection will be briefly examined.

Let us examine some of the limitations of locational models. During the 3500 years of known human occupation of the Virgin Islands; site locations have been altered by changing environmental and ecological conditions, and by natural and manmade changes to landforms. Locational information may reflect present day conditions, but bear no relationship to conditions that were extant or relevant in the past, and vice versa. Frequently, migration and erosion of landforms or changes in water courses, are so dramatic that archaeologists may be puzzled about the extent and nature of prehistoric settlement or uses of some areas. Over the years, relationships of sites to the sea has been affected by shoreline changes, sedimentation, formation of beachrock, transgression and regression of mangrove stands, migration of coastal features such as salt ponds, spits and barrier islands, and erosion related to sea level rise and storm surges. The latter may have, in fact, removed habitation areas entirely, skewing our perceptions of locations that were occupied by certain cultural groups at certain time periods. Finally, the effects of natural forces are exacerbated by the elimination from study of large sections of coast irreparably altered by post Colonial development of commercial and industrial facilities such as refineries, seaports, airports and their related roads and other amenities.

In the Virgin Islands, based on findings at the Krum Bay site in St. Thomas (Figure 2, Number 4) it is assumed that preceramic sites are located in coastal areas, but there is little evidence to verify either the exclusive selection of coastal areas for preceramic habitation or the limitation of preceramic resource procurement and utilisation to the immediate environs of an occupied area. Our present evidence, while inconclusive, suggests that a number of environmental zones, including submerged areas offshore, may contain evidence of prehistoric cultural activities. Studies such as that conducted by Nichols et al (1977) in the Mangrove lagoon of St. Thomas raise the possibility of submerged sites. Integrating information from probes, cores and radiocarbon dates for intertidal vegetation in the lagoon, investigators (Nichols et al 1977:59) were able to sketch the recent geologic evolution of the lagoon (Figure 3). In this reconstruction, the lagoon occupies a basin originally down-faulted and partly excavated by the ancestral streams of Turpentine Run. When sea level was lower prior to 5000 years B.P. (about 3000 B.C.) the streams flowed through valleys to a shoreline located farther seaward on the present-day submerged shelf. Thus, sites of this period, if they were present, would be underwater at the present time. The sedimentary infilling of the lagoon and growth of Bovoni Cay coincided with the rise of sea level during the last 5000 years. «By the time that the sea approached it present level, Bovoni Cay and the adjacent shoals were quickly stabilized by mangrove growth accreted landward and coalesced into a nearly continuous barrier island»
element in the Virgin Islands, sea level was about 2.7 meters or 8.32 feet lower than at present. By additional surveys, both terrestrial and offshore, and investigation of aceramic sites, the locational information for our preceramic site distribution model is incomplete until additional surveys, both terrestrial and offshore, and investigation of aceramic sites have been accomplished.

Studies on Acorepa palmata have revealed a method for reconstructing sea level rise in the Caribbean. Of the Virgin Islands, this information, shown in Figure 6, is only available for St.Croix. From these data, it is evident that at about 2100 B.C., sea level was about 8.50 meters or about 26.18 feet lower than at present. At about A.D. 100, the presently estimated period of initial Saladoid settlement in the Virgin Islands, sea level was about 2.7 meters or 8.32 feet lower than at present. By A.D. 500, sea level was only about 1 meter or 3.08 feet below present levels. These findings have been confirmed by recent studies conducted by Hubbard et al (personal communication, Dennis Hubbard July 18, 1995) in the Salt River estuary and in off-shore sites elsewhere in St. Croix. Erosion, related to sea level rise and storm surges on the south shore of St. Croix, is easily verified by the conditions of both the Aklis and the Estate Great Pond prehistoric sites (Figure 7, Numbers 1,12). Lawaetz (1994:76) indicated that remains of the Estate Great Pond sugar mill, depicted 600 feet from shore on the 1772 Oxholm map, are today under water offshore. Archaeological investigations at the Estate Great Pond site and the Aklis site, on the South Shore of St. Croix, have recovered evidence of occupation of both sites during the Late Saladoid period and continuing into the early Elenan-Ostionoid period (Baumgardt and Tyson 1987, Rouse 1992:52, and personal communication, Michele Hayward). However, it is possible that earlier components of these sites were originally situated further seaward, and that during the several hundred years of occupation of the sites, the inhabitants moved progressively inland in response to sea level rise, storm surges and increased erosion of the coastline. In such a scenario, evidence of earlier and smaller components of these sites would have been lost to erosion as is the case with the coastallly situated Saladoid site on Hassel Island, St. Thomas (Figure 2, Number 5), which has been subjected to modern intrusions and finally all but obliterated by the effects of the 1989 Hurricane Hugo. Unlike the Havisier’s model which notes, in his study area, a shift in distribution from Early Saladoid period inland riverine locations (dated generally between 300B.C. and A.D.300) to Late Saladoid period coastal sites; in the Virgin Islands, sites that are estimated to have been occupied as early as A.D. 100 occupy a variety of geographical and environmental locations. Present locations of such Early to Mid-Saladoid period sites include upland riverine valleys, as in the cases of the St. Georges (Figure 7, Number 10) and Glynn (Figure 7, Number 13) sites in St. Croix and the Tutu site (Figure 2, Number 2) in St. Thomas; low lying alluvial plains near the coast, as in the case of the Prosperity I site in St. Croix (Figure 7, Number 11); coastal berms and valleys as in the cases of the Limetree Bay (Figure 7, Number 12), Davis Bay (Figure 7, Number 2) and Prosperity II sites (Figure 7, Number 3) in St. Croix; and coastal locations immediately inland from sandy beaches, as in the case of the Salt River site (Figure 7, Number 5) in St.Croix; the Mainstreet Site in St. Thomas (Figure 2, Number 3) and the Early Saladoid component of the Lameshur Bay site (Figure 4, Number 6) in St. John.

A number of factors affect our perceptions of site locations relative to the sea coast. Prehistorically, because of lowered sea level, some sites presently located on the shore may have been further inland when occupied, while coastal components of some early sites may have been lost to erosion. Conversely, because of riverine geomorphological processes, some inland sites that are landlocked today may have been located along streams that, prehistorically, were navigable by canoe to the sea. A case in point is the Glynn site located in an inland valley about 1.5 miles from the head of the Salt River estuary (Figure 8, Number 2). Even though sea level was lower, during its occupation, the site was probably accessible to the sea by canoe. According to Lawaetz (1994:73) when he was a boy, a small waterway from the Salt River lagoon to the bridge by Concordia Estate (Figure 8) was kept open by the continuous flow of water running under and over the bridge where the children of the area swam. One could see snooks and mullets that swim up the channel from Salt River. Another resident kept his boat tied at Concordia. Johnston (DAHP 1982) also states that Mint Gut, was navigable by canoe to the St. Georges site which presently is located about 2.1 miles from the sea.

Today, most Virgin Island water courses, or guts, are characterized, by steeply cut channels that, except where springs extrude, are generally dry except for periods of intense flooding. Lawaetz (1994) believes that the present-day wide, dry and eroded channels of St. Croix’s guts today are the result of post Colonial land use and abuse; and he postulates, logically, that prior to clearing of the land for cattle grazing, tree and plant roots created a sponge effect that retained moisture in the ground so that major guts were continuously flowing narrow streams with shallow banks. To document this, Lawaetz (1992:456) notes the location of the Late Saladoid/Elenan Ostionoid middens of the River site in St. Croix (Figure 7, Number 8) which are eroding from the banks of the eastern end and offshore gut and were probably a relatively complete waterway prior to 1820. Another Roman Catholic priest and his father bought Little LaGrange in 1896, he could leap across the gut; but, by 1916 the gut was 40 feet wide and 15 feet deep. According to Lawaetz, the Harden Gut in Frederiksted ran all year long and women did their laundry there. For the past 40 years, the gut has been dry. Additional supporting evidence for the presence of continuously flowing streams during St. Croix’s prehistoric past is found in Blondel’s 1667 manuscript (Caron n.d.: 8): «The two opposite ends of this island [St.Croix] to the east and to the northwest are covered with very rough mountains, but the rest of the land of St. Croix is covered with hills and valleys watered by rivers, some filled with fresh water, others with brackish water, and the earth is so fertile that it refuses nothing which has been planted: this is evident from the quantities and the heights of the trees which exist where the land has not yet been cleared.»

If, in fact, Lawaetz is correct, we should expect to find many more sites along inland water courses. Dan Elliott’s findings on tributaries of Harden Gut (Figure 5) lend support both to Lawaetz’s description of Harden Gut as a source of continuously flowing surface water and to Johnston and Lundberg’s observations that, in the Virgin Islands, a past emphasis on large prehistoric settlement sites has led to under-representation of interior prehistoric sites in the inventory. It should be noted that many interior and coastal sites are not necessarily village sites, but appear to be special use or resource procurement and processing sites, the temporal positions of which are not yet clear.

In contradiction to the stated Virgin Islands coastal locational model for post-Saladoid sites, Late Saladoid and post-Saladoid period sites also are found in a variety of inland and coastal locations. Inland sites include, for St. Croix, the Late Saladoid/Elenan Ostionoid River and Fountain Valley sites (Figure 7, Numbers 8,9) located in upland valleys of Fountain Gut, Late Saladoid and early Elenan/Ostionoid components of the inland St. Georges Site (Figure 7, Number 10) and a Late prehistoric component at Work and Rest (Figure 7, Number 7). In St. Thomas, there is a Late prehistoric component of the inland Tutu site. Finally, in St. Croix, the single component «inland» Late Prehistoric (Chican Ostionoid/Taino) period Fairplain site (Figure 8, Number 4) occupied a prehistoric physical location similar to that of the Early Saladoid period Glynn site in the Upper Salt River area (Figure 8, Number 2). Locations of the Late Saladoid and post-Saladoid period sites are diverse in their
as offshore cays; shores of salt ponds; alluvial plains adjacent to salt ponds; areas immediately
inland of sandy beaches with access to salt ponds, fringing reefs and deep water reefs; and coastal
ridges and terraces on promontories and along coastal expanses.

For example, chronology, settlement sizes and patterns, and apparent subsistence patterns differ at
the Davis Bay, Prosperity II and Cane Bay sites situated on the north coast of St. Croix. (Figure 7,
Numbers 2,3,4, respectively). Similarly, although full reports of these investigations are not yet available,
initial investigations at three post-Saladoid ceramic period sites on the northwest coast of
St. John indicate that these sites exhibit distinct chronological and adaptive differences (Figure 4,
Numbers 1,2,3: Personal communication Ken Wild and Jeff Walker).

Inland and coastal sites and sites situated in diverse environmental and physical locations may be
linked: representing activities related to one or more groups. When developing locational models,
this factor should be taken into consideration. For example, some coastal sites, such as the Dertil
Point and Salt Pond Bay sites situated in the southern coastal area of St. John (Figure 4, Numbers
1,7), are located in close proximity to chert and rhyolite sources respectively and may be sites rel-
ted to procurement and reduction of lithic materials by occupants of settlement sites elsewhere on
the island or on other islands. Coastal conch shell middens and sites located adjacent to Lucina or
Codakia habitats, and coastal conch shell middens suggest transhumance or special harvesting and
processing at certain coastal locations. Finally, the recent discovery of post Saladoid ceramic sherds
and ground stone tools, such as axes and celts, atop Bordeaux Mountain, St. John, suggests that
Bordeaux Mountain may have been a tree procurement area for inhabitants of later prehistoric
culture periods throughout the Virgin Islands.

Thus, until our chronology and our understanding of cultural units represented at coastal sites are
refined, our distribution model for Late Saladoid and post-Saladoid sites remains too generalized to
be useful.

Although, there is an apparent increase in coastal sites during the Late Saladoid period, at face
value the distribution suggests, rather than a shift from inland to coastal locations, an increasing
expansion by a growing population into a variety of ecological and environmental zones. Cultural
deposits found in a number of different coastal ecological zones also suggest transhumance or spe-
cialized use of some coastal sites whose chronological positions are not yet clear. It is evident from the foregoing that environmental models of site distribution, require accurate locational data which in most cases must rely on full scale geomorphological and paleoenviron-
mental reconstitution. Such information is necessary before any interpretive statements may be
made and before critical criteria for site selection may be postulated.

PART II

Bearing in mind the limitations of locational information, let us look quickly at some environmen-
tal criteria that have been postulated for determining site selection, and explore some other possi-
bilities.

Availability of fresh water has been cited as an important factor in site selection, and in St. Thomas,
where information is available, there is a good correlation between extant and prior springs and
prehistoric site locations (Figure 9). At the Tutu site and at the Magens Bay site in St. Thomas,
springs extrude along guts today. Fresh surface water for bathing and potable spring water for
drinking must have been important criteria for site selection; and during the period of initial sett-
lement by Saladoid peoples, when population density must have been low, it would have been
necessary to settle close to these resources, whether coastal or inland.

Availability of fertile soils has been cited as a critical criterion for selection of prehistoric settlement
sites. This may be re-evaluated in light of rainfall data, results of phytolithic studies conducted at
the Saladoid / Late Post Saladoid Tutu site, and ethnohistorical data from which we may cautiously
extrapolate behavioral possibilities.

As a result of their 1970 pilot 10-year study, Bowden et al (1970:20) found that rainfall in the Virgin
Islands is unreliable: for the three islands it was an average of 41 inches per year. Of more impor-
tance to cultivation of plants, were rainfall variability and the type and duration of rainfall. Bowden et
al (1970:20,43) found that less variable rainfall occurred on or near mountain ridges; and that,
in the Virgin Islands, only an average of 5 days a month produced rainfall that exceeded daily
potential evapotranspiration; a condition necessary to plant growth and build up of soil moisture
storage. Since many ceramic period prehistoric sites are located in areas of high rainfall variability, cultiva-
tion of crops at or near these sites, if it occurred, must have been limited to certain times of year
when adequate rainfall was available.

Piper's analysis of phytoliths recovered from excavated contexts at the Tutu site (Piper 1995:8)
yielded evidence of a wild or domesticated Cucurbita, Marantaceae, and Palmae. She concluded
that, «Many of the plants identified in the phytolith record can exist in a relatively undisturbed
forested setting. Grass and other weedy-type phytoliths, such as sedges (Cyperaceae) and
Compositae were rare, suggesting little environmental modification of the area near the site». Based on rainfall data, it is likely that fertile soils for cultivation were not important criteria for
selection of village sites. As suggested by an ethnohistorical account of Carib groups in Martinique
in 1619, it is more likely that gardens related to village settlements were located in the mountains
at some distance from the settlement (Moreau (1988:131). «When our Indians want to make a
garden, they pick a very high place and far from the river...the wife of a captain died and he had a gar-
den of about five hundred «pas» (1250 feet) from our habitat, which was unusual to be so close.»
Access to coastal resources has been cited as a third criterion for site selection. Evidence from the Tutu site and the River site in St. Croix indicates that, although the sites were not
situated in shoreline locations, their inhabitants had access to and made extensive of such coastal
resources as sea turtles, fish and shell fish. It is apparent that access to coastal resources could be
accomplished without location of settlements on the sea coast or even on streams navigable to the
coast. Other criteria must have influenced settlement of sites such as the Tutu site and the River
site.

These criteria may have been a combination of environmental conditions and socio-economic
considerations; such as, availability of springs and surface water; accessibility to large trees neces-
sary to house and canoe construction, and a low population density and consequently small labor
force. Such considerations may have influenced early Saladoid settlement not only of the Tutu site,
but also of the coastal Salt River and the upriver Glynn sites in St. Croix. Referring to an area inland
of the southwestern shore of the Salt River estuary, Blondel (Caron n.d.; 4) noted: «The island has
ideal trees for masts of medium sized ships, and since they may not be found in the other islands,
and since the most beautiful of these trees are in a section of St. Croix which was granted to the
Jacobin fathers...»

The labor force and cooperation needed in tree cutting and transportation is described by Moreau
(1988: 176): «...when he has decided he wants to make a canoe, he holds a caouyage and tells the
whole assemblage what his intention is...having found a tree...he goes all over the village and very
often to some other villages to ask all the men and boys which are going to pass their degree to
them. Having found a tree, he brings it to the whole assemblage and...comes help him to cut the tree...quantities of women and captives of both sexes go ahead to carry
wine and food because they are often five or six leagues from the tree...having it started and hol-
lowed...they come back to get more men to help to lug the canoe to a place where it is just at the
seashore.»

In terms of physical and social cost effectiveness, coastal resources could be transported by canoe
to within walking distance of a site, while trees were much more difficult to move long distances
overland.

Johnston and Lundberg (1985:53) suggested that other criteria, such as oceanographic features and
inter-group relations, affected site selection. Inter-island communication and patterns of exchange
may explain the presence of prehistoric sites of the ceramic period on almost every cay, both with
and without evident fresh water sources, between the western tip of St. Thomas and the eastern end of St. John. Exhibiting more than occasional use, these sites have been described as possible fishing or shellfishing stations, but they may also have served as stopovers along routes of exchange or other movement of peoples by sea between islands. In these cases drinking water could be transported in storage containers. Thus, it is apparent that criteria for prehistoric site occupation and/or utilization are numerous and complex and must be developed from adequate physical data. In summary, in the Virgin islands, there are many exceptions to the general environmentally-based locational model of prehistoric site distribution. Although our data base has improved, our ability to construct meaningful environmental models will require not only more comprehensive survey of a variety of environmental zones, including upland interior areas, but also sufficient sampling of sites to enable geomorphological and paleoenvironmental reconstructions. Also necessary will be closer dates for prehistoric sites and a refined ceramic classification system. Identification of critical criteria of site selection must include not only environmental variables but also the interplay of social, economic and cultural factors with environmental conditions. Although, prehistoric sites in many areas of the Virgin Islands have been lost to natural and manmade forces, refined site distribution information in other parts of the islands may compensate, enabling development of a sound data base for meaningful comparisons with those of other Caribbean islands.

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USGS 1958, 1982. 7.5” Topographic Maps, St. Thomas, St. Croix and St. John.
Figure 2: Known Distribution of Prehistoric Sites in St Thomas, USVI 1995.

Figure 3: Probable Geologic Evolution of the Mangrove Lagoon, St Thomas After Nichols et al 1977.
Figure 4: Distribution of Known Prehistoric sites in St John, USVI.1995

Figure 5: Distribution of sites on Drainages of southwestern St Croix, USVI.
THE RIFLE WRECK OF GRENADA
Thomas J. BANKS

Résumé
Le 28 Août 1993 une épave de navire a été localisée pendant une campagne de prospection sub-aquatique à l’entrée du port St Georges à Grenade. Dix huit fusils furent localisés dans les coraux ou égarés dans le sable. Cinq des fusils furent ramenés à la surface, passés au rayon X et placés dans des bassins d’eau douce. Les épreuves furent envoyés au Musée de la Tour de Londres où les fusils furent identifiés comme des fusils Martini Henry MKII introduits par les militaires anglais en 1876. Des fragments de chaîne d’ancre, des bouteilles soufflées, des objets métalliques pris dans les coraux et des pierres de lest ont également été découverts avec les fusils. L’épave du bateau se situait à une profondeur de 7.7m (25 pieds) dans un récif corallien. La nature du naufrage et le nom du bateau son toujours inconnus.

Abstract
On August 28, 1993, a scattered ship wreck site was located during an underwater transect survey at the mouth of St George’s Harbour, Grenada. Eighteen rifles were located embedded in coral or lying loose in sand. Five of the rifles were brought to the surface, x-rayed, and placed in fresh water tanks. The x-rays were sent to the Tower of London Museum in England, where the rifles were identified as Martini-Henry MKII rifles introduced by the British military in 1876. One heavily coral encrusted cannon, segments of anchor chain, hand blown glass bottles, unidentified coral encrusted metal objects, and ballast stones were also found. The ship sank in a depth of 7.7 meters (25 feet) of water on a coral reef. The nature of the sinking and the ship are still unknown.

LOCATING THE WRECK
Under an act of the Grenada government cabinet and work visa. I was permitted to explore all of the near shore waters of Grenada for historic ship wrecks. Using Foundation For Field Research volunteers from the U.S.A, England, Canada, The Netherlands, Japan, and Grenada, from October 1992 to August 1994, certain hazardous reefs, mouths of harbors, known historic wreck locations, and reports of ship wrecks by local commercial divers were checked. Eight underwater sites were located and recorded with the Grenada National Museum. The rifle wreck was additionally reported to the Comptroller of Grenada Customs in compliance with the Ship Wreck Act. In searching potential areas of sea bottom, volunteer crews would spread out about 10 meters apart in a line and swim slowly on a compass course, pre-agreed upon, slowly checking for artifacts or unusual coral shapes, until we reached 500 psi in our SCUBA tanks.

On August, 1993 the Rifle Wreck was located on the south side of the mouth of St. George’s Harbour on a coral reef at a depth of 7.7 meters (25 feet). The wreck is 300 meters due south of the red entrance buoy of the harbour, that is used by ships for navigation. Coral encrusted rifles were found scattered across a sandy plane between two coral reef areas where more rifles were found embedded into the coral. A cannon, anchor chain, glass bottles, and ballast stones were located in later dives. The artifact scatter was over an area 67 meters long northeast to southwest and 30 meters wide northwest to southeast.

METHOD OF MAPPING
A two foot by two foot, 1 foot thick molded piece of concrete with a 6 inch diameter ABS pipe set upright into the block, was sunk next to the wreck/artifact scatter. This concrete block was then used as the datum point. A plane table and alidade was set up on the ABS pipe. The plane table was oriented to magnetic north and leveled by use of artificial bubble horizons. The table consisted of